SPECIES PROFILES OF SOUTH AFRICAN
SHARKS, RAYS AND CHIMAERAS

VOLUME 1: THREATENED AND ENDEMIC SPECIES

WILDTRUST™

Shark Conservation Fund

Editors: Geremy Cliff and Jennifer M. Olbers

SPECIES PROFILES OF SOUTH AFRICAN SHARKS, RAYS AND CHIMAERAS.

Volume 1: Threatened and Endemic Species

Geremy Cliff and Jennifer M. Olbers (Editors)

CITATION: Cliff, G. and Olbers, J.M. (Eds). 2022. Species profiles of South African sharks, rays and chimaeras. Volume 1: Threatened and Endemic Species. *WILDTRUST Special Publication* 2, Durban, South Africa. 548pp.

DEDICATION

This volume is dedicated to the pioneers of South African chondrichthyan research. They provided the solid foundation on which the research listed in this document has been able to build and flourish

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ACKNOWLEDGEMENTS

The editors wish to thank Prof Aletta Bester-van der Merwe for providing information on the population genetics of some species and the project team at the WILDTRUST (Nikki Chapman, Lauren van Nijkerk, Azhar Hasham, Sandile Ntuli and Jean Harris) for their support and encouragement. The Shark Conservation Fund is thanked for funding via the WILDTRUST South Africa's Shark and Ray Protection Project.

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INTRODUCTION

Mainland South Africa has a coastline of over 3 600 km and more than a million square kilometres of marine area within its 200 nautical mile Exclusive Economic Zone. The continental shelf is narrow on the east coast, intermediate on the west coast and extends to over 260 km offshore to form the Agulhas Bank in the south, with the greatest depth recorded at 5 700 m. South Africa is well-known for its extraordinary biodiversity, with almost 13 000 known marine species, thus making it the third most biologically diverse country in the world. Approximately a third of South African marine species are endemic, with this high biodiversity and endemism being a by-product of marked changes in temperature and nutrient availability, which effectively form barriers around the coastline.

There are currently 194 species of chondrichthyans (sharks, batoids (rays and skates) and chimaeras) present in South African waters, comprising 50 families and 103 genera. There are 30 families, 64 genera, and 111 species of sharks; 17 families, 36 genera, and 72 species of batoids; and 3 families, 5 genera, and 8 species of chimaeras (Ebert *et al.* 2021). South Africa has one of the most diverse and richest chondrichthyan faunas in the world. The country ranks among the top five nations in terms of species diversity, behind Australia (329 species), Indonesia (221), Japan (212), and Brazil (210). All five countries have two or more ocean current ecosystems bounding them. South Africa has the cold Benguela Current on the west coast and the warm Agulhas Current on the east coast. These two major currents have a profound influence on species diversity, with the east coast being more diverse than the west coast (Ebert and van Hees, 2015). Cape Point (18°42'E) is regarded as the approximate demarcation point between these two large marine ecosystem currents.

Chondrichthyans around the world are being affected both directly and indirectly by various human activities. As a result, several chondrichthyan populations are depleted and assessed as threatened with extinction. Chondrichthyans have life histories characterised by low fecundity, slow growth rates and late maturity. These life-history strategies make them vulnerable and susceptible to over-exploitation. The rapid economic growth in the fisheries sector on a global scale has effectively been unregulated and driven by unrestricted international trade in shark products. Also, the high levels of mortality from bycatch and the degradation of essential nursery grounds and other critical coastal, estuarine, and freshwater habitats as a result of development and pollution are significant threats to chondrichthyans.

SOUTH AFRICAN LEGISLATION RELEVANT TO CHONDRICHTHYANS

In 1996, Section 24 of the South African Constitution preserved fundamental environmental rights with a strong emphasis on equitable access to resources. In 1998, NEMA, the National Environmental Management Act (No. 107 of 1998) was enacted, becoming the framework for all environmental legislation in South Africa. In the marine realm, and specifically related to sharks and rays, critical pieces of legislation (and related regulations) include the Marine Living Resources Act No. 18 of 1998 (MLRA), National Environmental Management: Biodiversity Act No. 10 of 2004 (NEMBA) and the National Environmental Management: Protected Areas Act No. 57 of 2003 (NEMPAA). Also, South Africa is a signatory to the international Convention of Migratory Species (CMS), including the Sharks MOU and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

IUCN RED LIST AND CLASSIFICATION OF THREATENED SPECIES

A total of 14 species, comprising 7 shark and 7 batoid species, are regarded as South African endemics, with a further 14 species (7 sharks, 5 batoids and 2 chimaeras) described as southern African endemics (Ebert *et al.* 2021).

Species are regarded as threatened according to their current IUCN Red List Assessment status. The IUCN Red List of Threatened Species is widely recognised as the most comprehensive source of information on the extinction risk of individual plant and animal species. The assessments are based on all available information on a species' taxonomy, distribution, population status, habitat and ecology, major threats, use and trade, and conservation measures. The IUCN Red List Categories and Criteria utilise a series of thresholds to evaluate extinction risk based on population size reduction, geographic range, population size, or the probability of extinction (IUCN, 2012; IUCN Standards and Petitions Subcommittee, 2019).

The IUCN Red List applies the following extinction risk categories (definitions from Mace *et al.* 2008; IUCN 2012):

Category	**Definition**
Extinct (EX)	There is no reasonable doubt that the last individual has died
Extinct in the Wild (EW)	Known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range
Critically Endangered (CR)	Facing an extremely high risk of extinction in the wild
Endangered (EN)	Facing a very high risk of extinction in the wild
Vulnerable (VU)	Facing a high risk of extinction in the wild
Near Threatened (NT)	Does not qualify for CR, EN or VU now, but is close to qualifying for or is likely to qualify for a threatened category in the near future
Least Concern (LC)	Does not qualify for CR, EN, VU, or NT
Data Deficient (DD)	Inadequate information to make a direct or indirect, assessment of its risk of extinction based on its distribution and/or population status
Not Evaluated (NE)	Species not yet assessed

Each species is assessed using five Red List criteria (Mace *et al.* 2008; IUCN, 2012; IUCN Standards and Petitions Subcommittee, 2019):

Criterion	**Consideration**
Criterion A	Population size reduction
Criterion B	Geographic range size
Criterion C	Small population size and decline
Criterion D	Very small or restricted population
Criterion E	Quantitative analysis (for example, population viability analysis)

To qualify for one of the three threatened categories (CR, EN, or VU), a species has to meet a quantitative threshold for that category in any of the five criteria (A–E) listed above (IUCN, 2012). Only one of the five criteria needs to be met for a species to qualify. If species meet multiple criteria, it is assigned the highest category for which it qualifies. The Red List Categories provided here are the global assessments of each species. For endemic species, the category can be considered to represent their status at the global scale. For other species, the South African range comprises only part of their broader global range. Their Red List Category is therefore based on the entire global population and reflects status, threats, population trends, and management at the global level. This category may be very different to a species' status within South African waters, but in many cases a regional or local (southern or South African) assessment has not been undertaken.

In general, the assessment assigned to a particular species includes the year of publication. This can be misleading as there are cases when the assessment is published several years after the assessment was undertaken. For this reason, the year presented here is the year in which the assessment was undertaken.

HOW TO USE THIS BOOK

The species reports included here focus on the situation, state of knowledge and fishery-related activities in South African waters. The information presented is sometimes supplemented from populations which occur outside South/southern Africa, particularly where the species is poorly known in South Africa.

The arrangement of species is in taxonomic order by family, first the Selachii (sharks) are presented, followed by the Batoidea (skates and rays).

To cite individual species profiles, references should include both the compiler and the reviewer, such as the example below:

CLIFF, G and DA SILVA, C. 2022. *Squalus acanthias*. In: Cliff, G. and Olbers (Eds). Species profiles of South African sharks, rays and chimaeras. Volume 1: Threatened and Endemic Species. WILDTRUST Special Publication 2, Durban, South Africa, pp 27-32.

DETAIL AND ARRANGEMENT OF HEADINGS USED IN EACH REPORT

The sizes of all sharks, torpediniform rays, skates and chimaeras are expressed as Total Length (TL), being the body length from the tip of the snout to the extremity of the tail. All other rays are measured in terms of maximum disc width (DW).

Information on each species is presented under the following headings:

SCIENTIFIC NAME	***Genus and species according to the most recent literature, together with the authority and year described***
COMMON NAME	Vernacular name/s most commonly used in South Africa.
FAMILY	Taxonomic family in which it is designated
ENDEMIC	Refers only to South African endemics; southern African endemics are noted as such
SIZE RANGE	The known size range (total length or disc width)
DISTRIBUTION	A summary of distribution based on the following areas: E Coast: East coast from Mozambique border to Cape Recife; S coast: South coast from west of Cape Recife to Cape Point; W coast: West coast from west and/or north of Cape Point to the Orange River mouth.
HABITAT	Summary of habitat type the species frequents
DEPTH RANGE	Range of known depth
MAJOR FISHERIES	Main fisheries in which the species is caught
IUCN STATUS	Category and year of Red List assessment, with a hyperlink to the report on Red List website
CITES REGS	Gives the Appendix in which the species is listed, where appropriate
MLRA REGS	Regulations within the Marine Living Resources Act applicable to that species
COMPILER	Author/s who compiled the species profile
REVIEWER	Author/s who reviewed and edited the species profile

SPECIES SUMMARY and RECOMMENDATIONS
A summary of the species profile, together with recommendations for management and research.

TAXONOMIC and IDENTIFICATION ISSUES
Summary of taxonomic or identification changes and issues encountered or unresolved. This section also notes other very similar looking species with which it may be confused.

SOUTH AFRICAN DISTRIBUTION
Describes the distribution of the species according to the following table:

COAST	REGION
E coast	East coast from Mozambique border to Cape Recife
S coast	South coast from west of Cape Recife to Cape Point
W coast	West coast from west and/or north of Cape Point to the Orange River mouth

REGIONAL DISTRIBUTION
Notes its presence in other countries in southern Africa.

SYNOPSIS OF RESEARCH
Summary of research on this species, primarily within South Africa, but includes regional work where none has been conducted locally.

ECOLOGY
Depth
Briefly describes the known depth range.

Habitat: Adults
Briefly describes the habitat of the adults.

Habitat: Juveniles/Nursery Grounds
Briefly describes the habitat of the juveniles and any information pertaining to known nursery areas.

Synopsis of tag deployments
Information on any tagging undertaken.

Movements
Brief summary of known movements and migrations.

Diet/feeding: adults
Brief summary of known prey or diet in adults.

Diet/feeding: juveniles
Brief summary of known prey or diet in juveniles.

South African toxicological studies
Known information on toxicology.

REPRODUCTION

REPRODUCTIVE MODE	The method of nourishment of the embryos

DURATION OF REPRO CYCLE	Time interval between pregnancies
MATING SEASON	Time of the year when mating takes place
GESTATION	Duration of pregnancy
LITTER SIZE	The number of offspring produced in a pregnancy
PUPPING/NURSERY GROUND	Region where the full-term pregnant females congregate to give birth/ where the new-borns occur
LENGTH/DISC WIDTH AT BIRTH	Size at birth expressed as length or disc width
LENGTH/DISC WIDTH AT MATURITY	Size at maturity expressed as total length or disc width. It may differ for males and females
MAXIMUM LENGTH/DISC WIDTH	The size of the largest individuals, expressed as total length or disc width. It may differ for males and females
GENERATION LENGTH	Defined as age of maturity + 0.5*(length of reproductive period in life cycle).

Mode
The method of nourishment of the embryos.

Duration of reproductive cycle
This is the time interval between pregnancies.

Mating season and location
Where known, the mating season and location is described.

Gestation
Duration of the pregnancy.

Litter size
The number of offspring produced in a pregnancy.

Length/disc width at birth
The size at birth expressed in terms of length or disc width.

Pupping season and nursery ground
Region where the full-term pregnant females congregate to give birth and where the new-borns occur.

Length/disc width at maturity
The size, expressed as length or disc width, at maturity for males and females.

Maximum length/disc width
The size of the largest individuals, expressed as expressed as total length or disc width. It may differ for males and females. In the absence of local information, details from elsewhere may be included.

Age and growth
Details of any age and growth studies.

Generation length
Generation length is defined as *age of maturity + 0.5*(length of reproductive period in life cycle*)

FISHERIES MANAGEMENT
SA catch sources
Summary of catches within South Africa.

SA catch quantities and characteristics
Types of fisheries and where known, catch information.

Population trends
Information pertaining to known populations in the region, supplemented with information from elsewhere.

ECOTOURISM
Information pertaining to the ecotourism value or potential of this species.

CONSERVATION MEASURES
Information pertaining to nature and status of protection within the national legislation, including the**:**

- **Marine Living Resources Act (MLRA) Regulations**
- **National Environmental Management: Biodiversity (NEMBA) Act and associated Regulations, such as Threatened or Protected Species (TOPS)**
- **Marine Protected Areas**

IUCN Red List Status:
Current category and assessment details/criteria

Previous IUCN assessments
Previous assessment information

Types and status of protection within the national legislation, including the:

- **Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)**
- **Convention on Migratory Species (CMS)**

MANAGEMENT CONSIDERATIONS
Comments specific to the current and future management of the species

RESEARCH REQUIREMENTS AND OPPORTUNITIES
Comments on current and future importance of research for this species

ACRONYMS AND ABBREVIATIONS

BRUV	Baited remote underwater video
CITES	Convention on International Trade in Endangered Species
CMS	Convention on Migratory Species
CR	Critically Endangered
DD	Data Deficient
DFFE	Department of Forestry, Fisheries and the Environment
DW	Disc Width
EN	Endangered
EW	Extinct in the Wild
EX	Extinct
FL	Fork Length
IUCN	International Union for Conservation of Nature
KZNSB	KwaZulu-Natal Sharks Board
LC	Least Concern
MLRA	Marine Living Resources Act
MMF	Marine Megafauna Foundation
MPA	Marine Protected Area
NE	Not Evaluated
NEMBA	National Environmental Management: Biodiversity Act
NT	Near Threatened
ORI	Oceanographic Research Institute
SAAMBR	South African Association for Biological Research
SAIAB	South African Institute for Aquatic Biodiversity
TL	Total Length
TOPS	Threatened or Protected Species
VU	Vulnerable

SOUTH AFRICAN THREATENED AND ENDEMIC CHONDRICHTHYAN SPECIES REPORTS:

SHARKS

FAMILY HEXANCHIDAE

Notorynchus cepedianus

SCIENTIFIC NAME	*Notorynchus cepedianus* (Péron 1807)
COMMON NAME	Broadnose sevengill shark, cow shark
FAMILY	Hexanchidae
ENDEMIC	No, widespread in coastal temperate waters
SIZE RANGE	35–300 cm TL
DISTRIBUTION	E, S, W coasts: Great Kei River mouth to Orange River mouth
HABITAT	Shallow coastal waters, including bays and kelp beds
DEPTH RANGE	0–360 m, but most abundant 0–50 m
MAJOR FISHERIES	Commercial linefishery; demersal shark longline fishery; recreational linefishery
IUCN STATUS	Vulnerable 2015
CITES	Not listed
MLRA	Daily bag limit of one per person in recreational fishery; no targeting in demersal shark longline fishery
COMPILER	G Cliff
REVIEWER	A Kock

SPECIES SUMMARY and RECOMMENDATIONS

Notorynchus cepedianus is a medium-sized shark with circumglobal distribution in the coastal waters of temperate seas. In South Africa is confined largely to the south and west coasts of South Africa, with seasonal incursions on to the east coast. It is associated with rocky reefs, including kelp beds and bays. Estimated total catch was 1–10 tons per annum (DFFE records: 2010–2012), which comprised largely the commercial linefishery and demersal shark longline fishery, although retention is now prohibited in the latter fishery. A small component is taken in the recreational linefishery. This species was globally assessed as Vulnerable on the IUCN Red List in 2015. It shows considerable site fidelity and will therefore gain protection from several coastal MPAs on the south and west coasts. It has one of the largest litter sizes of all sharks, but this is offset by slow growth and late maturity. Better quality catch data, particularly in the commercial linefishery, are required. Aspects of its biology have been well studied but nothing is known of the occurrence of pregnant females and nursery areas. A regional population study including specimens from Namibia would be beneficial.

TAXONOMIC and IDENTIFICATION ISSUES

Notorynchus cepedianus is one of four species in the family Hexanchidae, all of which occur in South African waters. It is one of two species which have seven pairs of gill slits; the other two have six pairs. *N. cepedianus* is the only species which permanently inhabits shallow coastal areas and it has a broad, blunt head which distinguishes it from the sharpnose sevengill shark *Heptranchias perlo* (Ebert *et al.* 2013).

SOUTH AFRICAN DISTRIBUTION

It occurs along the south and west coasts. It is most abundant on the west coast. Seasonally it may range into waters on the east coast (Ebert *et al.* 2020) as far north as the Great Kei River mouth (Engelbrecht *et al.* 2020).

REGIONAL DISTRIBUTION

In the region it only occurs in Namibia. Globally it is widely distributed in cool temperate waters of all oceans except the N Atlantic (Compagno 1984, Ebert *et al.* 2013).

SYNOPSIS OF RESEARCH

Bass *et al.* (1975) reported on the taxonomy of the family Hexanchidae and provided some anecdotal information on the biology of a small number of individuals. Local studies have focussed on aspects of the biology (Ebert 1996), in particular diet and predatory behaviour (Ebert 1991a, Ebert 1991b, Ebert 2002), trophic ecology (de Necker 2017), and, most recently movement patterns and growth rates, based on recaptures in a long-term tagging programme (Engelbrecht *et al.* 2020). Zweig and McCord (2013) provided a concise overview of its life history and fishery-related information. This species was regularly detected in baited remote underwater video (BRUV) deployments throughout False Bay (De Vos *et al.* 2015). The impact of predatory white sharks *Carcharodon carcharias* (Hammerschlag *et al.* 2019) and Orcas *Orcinus orca* (Engelbrecht *et al.* 2019) on *N. cepedianus* occurrence at well-known ecotourism locations in the bay has been documented. Comparative information on the biology and ecology of this species is available from studies largely conducted in southern Australia (Barnett *et al.* 2010, Stehfest *et al.* 2014) and California (Ebert 1989, Van Dykhuizen and Mollet 1992) and, more recently, those cited by Finucci *et al.* 2020a).

ECOLOGY

Depth

This coastal species is an active swimmer, usually moving slowly close to the bottom in water shallower than 50 m. It forages mostly at night and often rests inside kelp forests during the day (Barnett *et al*. 2010). It is mostly found in colder water, favouring deep water in more tropical regions. Larger individuals are known to venture into deeper water of at least 140 m (Compagno 1984), down to 360 m (Stehfest *et al*. 2014).

Habitat: Adults

Adults inhabit shallow coastal waters, frequenting shallow bays, often venturing close to the shoreline. They are commonly found in kelp beds.

Habitat: Juveniles/Nursery Grounds

Little is known of the juvenile habitat in South Africa. A small number of juveniles have been caught by shore anglers in Namibia (Engelbrecht *et al.* 2020). There is anecdotal evidence from recreational shore anglers that Betty's Bay on the south coast may be an important aggregation site (Zweig and McCord 2013).

Synopsis of tag deployments

A total of 3 513 *N. cepedianus* was tagged ORI Cooperative Fish Tagging Project 1984-2017 inclusive). They ranged in size from 61–286 cm (mean 184 cm), and therefore excluded neonates. No juvenile sharks (<100 cm) were caught in South African waters, while seven were tagged in central and northern Namibia. A total of 195 individuals (5.6%) were recaptured. Capture locations ranged from Cape Fria, northern Namibia, to the Great Kei River on the east coast, with most catches along the west coast. Recaptures showed connectivity between the west and south coasts, but not between South Africa and Namibia. Site fidelity was evident, with the majority of recaptures (67%) occurring <50 km from the tagging site, and many recaptures (33%) closer than 1 km. Some sharks (22.6%) were recaptured >100 km from the release site, while only three individuals (1.5%) were recaptured >500 km away. Size did not appear to play a role in these movements, with site fidelity and nomadic behaviour evident across all sizes (Engelbrecht *et al.* 2020).

Movements

It is a nomadic species, based on an apparently random pattern of movement, but the high percentage of individuals recaptured at or very close to their tagging location indicated a high degree of site fidelity. Studies conducted elsewhere in the world have revealed complex spatial dynamics, ranging from seasonal aggregations in shallow bays to broad-scale coastal movements (Engelbrecht *et al.* 2020, and references cited therein).

Diet/feeding: adults

This species occupies a high trophic position (Ebert *et al.* 1991a, 2002), higher than *C. carcharias* (Cortes 1999, de Necker 2017), employing several complex foraging strategies to obtain its prey (Ebert 1991b). The diet comprises primarily chondrichthyans, followed by marine mammals, with a lower incidence of teleosts (Ebert 2002, de Necker 2017). No apparent seasonal shift in diet was detected for sharks in False Bay (De Necker 2017). Catsharks of the genus *Poroderma* and houndsharks *Mustelus mustelus* and *Triakis megalopterus* as well as *Squalus acanthias* were the most common chondrichthyan prey. The marine mammal component increased with increasing predator size (Ebert 2002), constituting about one-third of the diet and comprising both dolphins and Cape fur seals *Arctocephalus pusillus.* Carrion is also taken (Ebert 1991a).

Diet/feeding: juveniles

There was an ontogenetic shift in diet; small *N. cepedianus* (<120 cm TL) fed primarily on small teleosts, comprising both demersal and pelagic species, with some chondrichthyans (Ebert 1991a, Ebert 2002).

South African toxicological studies

No studies have been undertaken, but as a large, coastal, slow-growing top predator it is susceptible to bioaccumulation of heavy metals and toxins.

REPRODUCTION

REPRODUCTIVE MODE	Lecithotrophic viviparity
DURATION OF REPRO CYCLE	24 months
MATING SEASON	Late spring and summer
GESTATION	1 year
LITTER SIZE	Unknown locally; 82 pups: California
PUPPING/NURSERY GROUND	Unknown in SA; spring-summer in California
LENGTH AT BIRTH	Unknown in SA: 35–45 cm California
LENGTH AT MATURITY	F: ±200 cm; M: 150-180 cm
MAXIMUM LENGTH	300 cm
GENERATION LENGTH	21.5 years, based on captive animals in California

Mode

This species exhibits lecithotrophic viviparity in which the embryos are entirely dependent on the nourishment supplied by the yolk-sac.

Duration of reproductive cycle

This is 24 months (Ebert 1996).

Mating season and location

Fresh mating bites were observed on both mature females and males during late spring and early summer, with a single observation of copulation in late spring in Nambia (Luderitz) (Ebert 1996).

Gestation

This is probably one year (Ebert *et al.* 2013).

Litter size

This species has one of the largest litter sizes of all elasmobranchs. No pregnant females have been examined in South Africa but fecundity estimates for 19 South African specimens with a maximum egg diameter of at least 40 mm indicated a range of 67–104 potential embryos per litter (Ebert 1996). A female from California contained 82 term embryos Ebert (1989).

Length at birth
This is unknown locally but is 35-45 cm in California (Ebert 1996).

Pupping season and nursery ground
This is unknown in South Africa, as no neonates have been caught in Namibia or South Africa, and juveniles were only caught in Namibia. Pupping takes place in shallow embayments in other locations and in spring–summer in California (Ebert 1989).

Length at maturity
Females mature at a size larger than 220 cm and males mature at 150–180 cm (Ebert 1996).

Maximum length
The largest individual was 300 cm (Compagno 1984).

Age and growth
Growth rates for *N. cepedianus* from tag-recapture data at reference precaudal lengths of 100 cm and 160 cm were estimated to be 4.7 cm yr^{-1} and 4.0 cm yr^{-1}, respectively (Engelbrecht *et al.* 2020).

Age at maturity was estimated at 11 years for captive females and 4–5 years for males (Van Dykhuizen and Mollet 1992). These authors concluded that growth rates in captivity and in the field are similar. Ebert (1996) noted the difficulty in determining age due to a lack of calcification of the vertebrae.

Generation length
In California female age-at-maturity is 11 years and maximum age is 32 years, resulting in a generation length of 21.5 years (Van Dykhuizen and Mollet 1992). This generation length should be used with caution as the growth parameters have not been validated and are based on captive individuals (Finucci *et al.* 2020a).

FISHERIES MANAGEMENT

SA catch sources, quantities and characteristics
Estimated total catch was 1–10 tons per annum (DFFE records: 2010–2012; da Silva *et al.* 2015), which comprised the commercial linefishery and demersal shark longline fishery, with a very small component taken in the recreational linefishery and possible catches in beach-seine and gillnet fisheries. Retention was recently prohibited in the demersal shark longline fishery

It was the third most common shark caught in the commercial linefishery in False Bay, with no evidence of a decline in catch, although there was a significant decline in catches in the recreational linefishery, where the total catch was 301 individuals (Best *et al*. 2013). It is one of the more common species of elasmobranch caught during shore angling competitions in the Western Cape and Namibia. Nearly 400 individuals may be caught on occasion in a single day's fishing competition (Ebert 1996).

This species was a rare catch in coastal gillnet fisheries on the west coast (Hutchings and Lamberth 2003) and in beach-seine nets in False Bay (Lamberth 2006).

Fishing outside South Africa
This species is infrequently reported as target and incidental catch from industrial and artisanal demersal trawl, longline, and gillnet fisheries across its range. It is also captured by recreational fishers. Discard rates are unknown, but fishing mortality is high; at-vessel-mortality estimates from gillnet fisheries range from 33–85% (Finucci *et al.* 2020a and references cited therein).

In 1990, a targeted fishery developed off southern Namibia but closed within a year of operation due to the collapse of the stock (David Ebert, South African Institute for Aquatic Biodiversity, pers. comm., cited by Finucci *et al.* 2020a).

Population trends
Population genetics indicate high genetic variability across oceanic basins, suggesting three genetically distinct populations (E Pacific, S Atlantic, and SW Pacific) with little to no mixing (Schmidt-Roach 2019).

There is high degree of overlap with regions which are subject to intensive fishing pressure. There were suspected marked declines in part of its range (S Atlantic, NW Pacific) but increasing trends in the SW Pacific, and a lack of species-specific management across its entire range. *N. cepedianus* is suspected to have undergone a population reduction of 30–49% over the past three generations (65 years) based on abundance data, actual levels of exploitation and a precautionary approach, and it was globally assessed as Vulnerable on the IUCN Red List in 2015 (Finucci *et al.* 2020a).

ECOTOURISM
Due to its large size, slow movements, tolerance of scuba divers and its site fidelity inside kelp beds, particularly those on the west coast of False Bay, this species has become popular with scuba divers and therefore should be recognised as an ecotourism species.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
Retention is prohibited in the demersal shark longline fishery. As with all other non-listed sharks and rays, there is currently a bag limit of 1 per person per day among recreational anglers, with no bag limits for commercial fisheries. There are no closed seasons.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
This species does show considerable site fidelity, during which it may benefit from MPAs on the south and west coasts. This species was commonly detected on BRUVs deployed in the Betty's Bay MPA and Table Mountain National Park MPA, but as solitary individuals (Roberson *et al.* 2015, De Vos *et al*. 2015, Osgood *et al.* 2019).

Additional local comment

IUCN Red List Status
<u>Vulnerable 2015: A2bd</u>

Previous IUCN assessments
Data Deficient 2009
Data Deficient 2000

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

MANAGEMENT CONSIDERATIONS
This species has a very high fecundity, but this is offset by its slow growth and late maturity. This species is now a prohibited species in the demersal shark longline fishery, but the lack of catch data and the absence of any catch limits in the commercial linefishery is of some concern and needs

attention. In view of increasing targeting by recreational anglers, post-release mortality should be investigated. Nursery grounds and areas regularly occupied by pregnant females should be protected.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

This species has been well studied in southern Africa, but its age and growth is poorly understood, primarily due to the difficulty of applying traditional age-and-growth techniques. Nothing is known of local nursery grounds or the location of pregnant females. Although there is no evidence of movements between South Africa and Namibia from tag-recapture studies, it seems that a single stock straddles the two countries. This should be confirmed using genetics and electronic transmitters.

FAMILY ECHINORHINIDAE

Echinorhinus brucus

SCIENTIFIC NAME	*Echinorhinus brucus* (Bonnaterre 1788)
COMMON NAME	Bramble shark
FAMILY	Echinorhinidae
ENDEMIC	No
SIZE RANGE	30–395 cm TL
SA DISTRIBUTION	E, S and W coasts: Mozambique border to Orange River mouth
HABITAT	Demersal on continental shelf and slope, sometimes inshore
DEPTH RANGE	Usually 200–900 m, occasionally shallower than 20 m
MAJOR FISHERIES	Nothing listed
IUCN STATUS	Endangered 2019
CITES	Not listed
MLRA	Production of squalene onboard vessels prohibited in offshore trawl fishery; daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	C da Silva

SPECIES SUMMARY and RECOMMENDATIONS

Echinorhinus brucus is a medium-sized demersal shark with a widespread but patchy distribution in deep coastal waters. It occurs along the entire South African coast, including Mozambique and Namibia. It was not listed as occurring in any local catches (DFFE records: 2010–2012), however it may be caught on rare occasions in deep-water fisheries, with a handful of reports from recreational anglers on the west coast. It was assessed globally as Endangered on the IUCN Red List in 2020. In South Africa it is known to science from a handful of individuals, which suggests that it is either very uncommon in local waters or it occurs outside the trawling grounds. As a result, it must be regarded as being of very low management priority. Information from other populations is also scant, although there are indications that it was fairly common in the Mediterranean. Further information is required on its distribution, ecology and life history, and interactions with fisheries in South Africa and any specimens should be used to collect basic life history information.

TAXONOMIC and IDENTIFICATION ISSUES

This species was first described from South Africa by Smith in 1838 as *Echinorhinus obesus*, but was subsequently found to be the same as the widely distributed *E. brucus* (Ebert *et al.* 2013). Historically the two recognised species in the genus, family Echinorhinidae, were considered part of the order Squaliformes (dogfish sharks) (Bass *et al.* 1976, Compagno 1984). These two species, of which only *E. brucus* occurs in the southern African region, are now considered part of their own order Echinorhiniformes. The unique features of these two species are the large, thorn-like denticles and the lack of any spines on the two closely-spaced dorsal fins, which are set well back on the body and the absence of an anal fin (Ebert *et al.* 2013).

SOUTH AFRICAN DISTRIBUTION

This species occurs along the entire South African coast, from the Mozambique border to Orange River mouth (Ebert *et al.* 2021).

REGIONAL DISTRIBUTION

This species is present in Mozambique, Namibia and Angola but not Madagascar (Finucci *et al.* 2020b).

SYNOPSIS OF RESEARCH
This is a very poorly studied species in South Africa. Bass *et al.* (1976) reviewed the taxonomy of the genus and provided detailed morphometric and biological information from less than a handful of individuals, including a single pregnant female from the east coast of South Africa. No further research on this species in South Africa has been documented. Very limited information on the biology, ecology and fisheries for this species is available from studies elsewhere in its range (see Finucci *et al*. 2020b and references cited therein).

ECOLOGY
Depth
This is a demersal deep-water species found in waters of 200–900 m depth, but is known to occur close inshore in cold, upwelled waters on the South African west coast, where it may be caught by shore anglers (Compagno *et al.* 1989, Ebert *et al.* 2013). A pregnant female was caught in a shark net set in water shallower than 20 m on the KZN south coast (Bass *et al.* 1976).

Habitat: Adults
Very little is known, but they commonly occur on or near the bottom (Ebert *et al.* 2013).

Habitat: Juveniles/Nursery Grounds
It is not known if the juveniles frequent a different habitat to the adults.

Synopsis of tag deployments
No tagging appears to have taken place in South African waters.

Movements
Insufficient published information exists to determine residency and movement patterns. The lower caudal fin is poorly developed in adults and absent in juveniles (Ebert *et al.* 2013), therefore this species is unlikely to be an active swimmer and therefore incapable of swimming long distances.

Diet/feeding: adults
This species feeds on teleosts, small sharks and crustaceans (Compagno 1984). It is not known whether there are any ontogenetic changes in the diet. The large mouth and pharynx may be used to suck in prey (Ebert *et al.* 2013).

Diet/feeding: juveniles
This species feeds on teleosts, small sharks and crustaceans (Compagno 1984). It is not known whether there are any ontogenetic changes in the diet.

South African toxicological studies
No such studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Lecithotrophic viviparity
DURATION OF REPRO CYCLE	Unknown
MATING	Unknown
GESTATION	Unknown
LITTER SIZE	14; 15–26 outside South Africa
PUPPING/NURSERY GROUND	Unknown
LENGTH AT BIRTH	40–50 cm (outside South Africa)
LENGTH AT MATURITY	F: 200–220 cm, M: <150 cm (outside South Africa)
MAXIMUM LENGTH	305–310 cm (outside South Africa)

GENERATION LENGTH	16 years (India)

Mode
This species exhibits lecithotrophic viviparity, with the embryos dependent entirely on the nourishment supplied by the yolk-sac.

Duration of reproductive cycle
This is unknown.

Mating season and location
This is unknown.

Gestation
This is unknown.

Litter size
Litter size is 15–26 (Ebert *et al.* 2013). The only documented pregnant female from South Africa was caught in a bather protection net on the KZN south coast in April 1973 and contained 24 embryos (10 male and 14 female) averaging 16 cm.

Length at birth
This is unknown locally, but is 40–50 cm elsewhere (Ebert *et al.* 2013).

Pupping season and nursery ground
This is unknown.

Length at maturity
This is unknown locally but elsewhere females mature at 200–220 cm and males less than 150 cm (Ebert *et al.* 2013). The single pregnant female from the KZN coast was 213 cm (Bass *et al.* 1976).

Maximum length
This is unknown locally but 395 cm elsewhere (Finucci *et al*. 2020)

Age and growth
No age and growth studies have been undertaken on the southern African population. In India female age-at-maturity was estimated at 7 years and maximum age at 25 years (Akhilesh *et al*. 2020, cited by Finucci *et al.* 2020b).

Generation length
Based on the age and growth data of Indian females as stated above, generation length is 16 years (Finucci *et al.* 2020b).

FISHERIES MANAGEMENT
SA catch sources
This species was not listed as a catch in the South African chondrichthyan fishery (da Silva *et al.* 2015). As it lives on or near the bottom, it is likely to be caught in trawl fisheries on rare occasions. There is a report of a single individual caught in the KZN bather protection programme in 1973 (Bass *et al.* 1976), with no subsequent catches reported (Geremy Cliff, formerly KZN Sharks Board, pers. comm.) This species may be hooked by shore anglers in shallow, cold upwelling areas of the west coast of South Africa and Namibia during the winter (Compagno *et al.* 1989, Ebert *et al.* 2013).

Fishing outside South Africa

E. brucus has been taken as both targeted and incidental catch across its range in demersal trawl, longline and setnet fisheries. The species is infrequently reported across most of its range. In European waters, the species is now very rarely reported after centuries of exploitation. Its liver oil is highly valued because of its high squalene content (Finucci *et al.* 2020b and references cited therein).

Population trends

Population size and trends for *E. brucus* across its entire range are decreasing (Finucci *et al.* 2020b). There is high distributional overlap with regions of intensive fishing pressure, particularly in the northern hemisphere. It is thought to be locally extinct in part of its range and lacks any species-specific management across its entire range. *E. brucus* was assessed as having undergone a global population reduction of 50–79% over the past three generations (48 years), based on abundance data and actual levels of exploitation and was globally assessed as Endangered on the IUCN Red List in 2019.

ECOTOURISM

E. brucus cannot be considered an ecotourism species as it primarily occurs in very deep waters and is rarely encountered in the shallows.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

Permit conditions in the offshore hake fishery prohibit the production of squalene on vessels. There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)

This species is not listed.

Marine Protected Areas

This demersal species does not appear to be common in South African waters and due to its deep-water habitat, it is unlikely to benefit from South Africa's Marine Protected Areas.

Additional local comment

Its absence in trawl fishery catches could either be because it is uncommon in South African waters or it occurs outside of the fishing grounds.

Current IUCN Status

<u>Endangered 2019: A2bd</u>

Previous IUCN assessments

Data Deficient 2003

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

This species is not listed.

Convention on Migratory Species (CMS)

This species is not listed.

International comments

No species-specific management or conservation measures are currently in place (Finucci *et al.* 2020b).

MANAGEMENT CONSIDERATIONS

This species appears to be very uncommon in South African waters and it was not even listed as a catch in the South African chondrichthyan fishery (da Silva *et al.* 2015). The southern African population is geographically discrete by some considerable distance from other populations in India, W Africa and Argentina therefore should be managed as such. This species must be regarded as being of very low management priority. It is questionable as to whether the assessment of Endangered is appropriate for the southern African population, given its apparent rarity in catches.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

This is an extremely poorly studied species in South African waters. Almost nothing is known of its biology, life history and ecology. This is unlikely to change as it appears to be extremely rare in any catches. In the unlikely event of any captures, the specimens should be used to collect such information.

FAMILY SQUALIDAE

Squalus acanthias

SCIENTIFIC NAME	*Squalus acanthias* (Linnaeus 1758)
COMMON NAME	Piked dogfish/Spiny dogfish/Spotty spiny dogfish
FAMILY	Squalidae
ENDEMIC	No, widely distributed elsewhere
SIZE RANGE	<31->91 cm TL; larger in other regions
DISTRIBUTION	W coast: Port Nolloth to Cape Point; possibly S and E coasts to Port Alfred
HABITAT	Rock and sand bottoms of outer shelf and upper slope
DEPTH RANGE	150–400 m in South Africa; down to 1950 m elsewhere
MAJOR FISHERIES	Demersal trawl fishery; small catch in commercial linefishery and demersal shark longline fishery
IUCN STATUS	Vulnerable 2016
CITES REGS	Not listed
MLRA REGS	Production of squalene onboard vessels prohibited in offshore trawl fishery; daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	C da Silva

SPECIES SUMMARY and RECOMMENDATIONS

Squalus acanthias is a small demersal shark which occurs along much of the west coast on the outer shelf and upper slope. It is one of four species of *Squalus* found in South Africa. There are still some taxonomic and identification problems. This species has patchy global distribution with several populations, many of which have been heavily fished. Local landed catch estimates were <1 ton per annum (DFFE records: 2010-2012). This catch was predominantly in the demersal trawl fishery, with most catches of this and other *Squalus* discarded. This species was assessed globally as Vulnerable in 2016 in the IUCN Red List, but appears to be Least Concern in South Africa. Improved identification within the genus *Squalus* and better observer coverage on South African demersal fishing vessels are needed. Locally, this species has been poorly studied, with little known of its reproductive biology and life history. By contrast, a considerable amount of information is known from populations elsewhere.

TAXONOMIC and IDENTIFICATION ISSUES

References to *Squalus* species in southern Africa have generally been rather confused, although *Squalus acanthias* has usually been assigned its correct name (Bass *et al.* 1976). There are currently four species in the genus recognised in South Africa (Ebert *et al.* 2021). *S. acanthias* typically has white spots on the flanks, which distinguishes it from the other species, although the spots may be indiscernible in adults. The position of the first dorsal spine relative to the pectoral fins is another diagnostic feature (Bass *et al.* 1976). Specimens caught on the east coast of South Africa should be examined carefully to confirm their identity (Ebert *et al.* 2021), which is indicative that there are still identification issues associated with this genus. Globally, there are a number of subpopulations of *S. acanthias*, with at least one, in the North Pacific, now recognised as a separate species, *S. suckleyi* (Fordham *et al.* 2016).

SOUTH AFRICAN DISTRIBUTION

This species occurs on the west coast from Port Nolloth to Cape Point. Records from the south coast and the east coast require confirmation as this species may be mistaken for other *Squalus* species (Ebert *et al.* 2021).

REGIONAL DISTRIBUTION

This species does not occur in Namibia (Compagno *et al.* 1989) but it is included in the shark fauna of that country (Bianchi *et al.* 1999) and is also listed as occurring there by Fordham *et al.* (2016) and Finucci *et al*. (2020c).

SYNOPSIS OF RESEARCH

This is a poorly studied species in South Africa. Bass *et al.* (1976) provided detailed taxonomic, morphometric and biological information from 102 individuals, including adults and three pregnant females, all from a single sample. Ebert *et al.* (1992) studied the diet of this and other squaloid species from the west coast. There have been no subsequent dedicated studies. Globally, this species has been well studied as a result of its importance in various fisheries (see Fordham *et al.* 2016 and Finucci *et al.* 2020c references cited therein).

ECOLOGY

Depth

On the South African west coast this species appears to occupy a relative narrow range of the outer shelf and upper slope at 150–400 m (Ebert *et al.* 2021). Globally it ranges from 30 to 900 m (Fordham *et al.* 2016) and more recently from the surface to 1980 m, but with most records shallower than 600 m (Finucci *et al.* 2020c).

Habitat: Adults

It is often found on soft substrates (Ebert *et al.* 2013). A primarily epibenthic species, it is not known to associate with any particular habitat (Fordham *et al.* 2016 and reference cited therein).

Habitat: Juveniles/Nursery Grounds

In some populations, pregnant females pup in shallow, inshore nursery grounds, while others pup in deep water on the outer shelf and upper slope (Ebert *et al.* 2013). Nothing is known of the South African population.

Synopsis of tag deployments

A total of 81 individuals have been tagged (ORI Cooperative Fish Tagging Project, 1984-2018) with a single recapture 36 km from the tagging location after 120 days at liberty (Jordaan *et al.* 2020).

Movements

Tagging studies conducted elsewhere have shown that some populations undertake long-distance seasonal migrations, either north-south or deep-shallow, in response to changes in water temperature. Others in the same region are resident year-round (Ebert *et al.* 2013). The migratory individuals travel in large, dense packs, segregated by size and sex (Fordham *et al.* 2016).

Diet/feeding: adults

In South Africa this species feeds predominantly on teleosts, and, to a lesser extent, cephalopods and crustaceans (Ebert *et al.* 1992). The study included both juveniles and adults but the results were not analysed by predator size.

Diet/feeding: juveniles

This species feeds predominantly on teleosts, and, to a lesser extent, cephalopods and crustaceans (Ebert *et al.* 1992). The study examined juveniles and adults but the results were not analysed by predator size.

South African toxicological studies
No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Lecithotrophic viviparity
DURATION OF REPRO CYCLE	Unknown in SA; about 2 years elsewhere
MATING SEASON	Unknown in SA; winter elsewhere
GESTATION	Unknown in SA; 18-25 months elsewhere
LITTER SIZE	At least 3-4 in SA; 1-32 elsewhere
PUPPING/NURSERY GROUND	Unknown, no seasonal pattern
LENGTH AT BIRTH	>22 and < 31 cm in SA
LENGTH AT MATURITY	F: 60 cm; M: 48-50 cm in SA
MAXIMUM LENGTH	At least 91 cm in SA; 160-200 cm, elsewhere but most are smaller than 100 cm
GENERATION LENGTH	17 years (NW Atlantic)

Mode
Lecithotrophic viviparity is the known reproductive mode of all squalid sharks.

Duration of reproductive cycle
The duration of the reproductive cycle in South Africa in unknown. It is about two years in the NE Atlantic (Ellis *et al.* 2015a and references cited therein).

Mating season and location
Nothing is known about the South African population. In the NE Atlantic, mating takes place offshore between October and February, soon after females have given birth (Ellis *et al.* 2015a and references cited therein).

Gestation
Nothing is known about the South African population. Elsewhere gestation is 12–24 months (Fordham *et al.* 2016 and references cited therein).

Litter size
Bass *et al.* (1976) reported three pregnant females with litters of only 3,3 and 4, which they attributed to the relatively small size of southern African sharks. Globally, litter size varies from 1-32; fecundity increases with maternal size (Fordham *et al.* 2016 and references cited therein).

Length at birth
The largest embryo found locally was 22 cm (Bass *et al.* 1976) and the smallest free-swimming individual was 31 cm (Ebert *et al.* 1992). Globally, size at birth ranges from 18-33 cm (Ebert *et al.* 2013) and 19-31 cm in NE Atlantic (Ellis *et al.* 2015a and references cited therein).

Pupping season and nursery ground
Nothing is known about the South African population. Pupping takes place between August and December in the NE Atlantic (Ellis *et al.* 2015a and references cited therein). Globally pupping may take place in winter, spring or summer (Ebert *et al.* 2013). Some populations utilise deep water nursery grounds and others shallow inshore waters (Fordham *et al.* 2016 and references cited therein).

Length at maturity
In South Africa males mature at 48-50 cm and females at about 60 cm (Bass *et al.* 1976). In the NE Atlantic females mature at 74-92 cm and males at 57-64 cm (Ellis *et al.* 2015a and references cited therein). Globally female length at maturity is 66-120 cm and male length at maturity is 52-100 cm (Ebert *et al.* 2013).

Maximum length
The maximum length recorded in South Africa is 91 cm (Ebert *et al.* 1992), which is considerably smaller than the maximum recorded for the species elsewhere of 160-200 cm, although most individuals are smaller than 100 cm (Ebert *et al.* 2013).

Age and growth
Using estimates from the NW Atlantic, female age-at-maturity is 9.1 years and maximum age is 24 years (Bubley *et al.* 2013).

Generation length
This is 17 years (Finucci *et al.* 2020c), based on the age and growth information presented above by Bubley *et al.* (2013).

FISHERIES MANAGEMENT
SA catch sources
Local catch estimates were <1 ton per annum (DFFE records: 2010-2012; da Silva *et al*. 2015). This species is primarily caught in the demersal trawl fishery, with a very small component of the catch taken in the commercial linefishery, demersal shark longline fishery and the gill and beach seine net fisheries. None of the catch is kept. Given that this species is most common at 150–400 m (Ebert *et al.* 2021), catches in the gill and beach seine net fisheries appear to be unlikely.

SA catch quantities and characteristics
Inshore trawl fishery
Walmsley *et al.* (2007) estimated that 14–24 tons of *S. acanthias* (4368-7530 individuals) were discarded from the demersal trawl fishery on the west coast in 1997. This fishery targets largely hake *Merluccius.* The catch is an order of magnitude larger than the total estimated South African catch of < 1 ton per annum (DFFE records: 2010-2012; da Silva *et al*. 2015). Between 2000 and 2018 an average annual catch of 1.2 t of *Squalus* spp. was reported (Charlene da Silva, DFFE unpublished data). Most individuals were caught at depths of 401–500 m, with very few individuals caught in shallower or deeper trawls on the west coast; no catches of this species were reported on the south coast (Walmsley *et al.* 2007).

Beach seine and gill net fisheries
This species was not reported in the beach seine fishery in False Bay (Lamberth *et al.* 1994), or gillnet and beach-seine fisheries in the Western Cape (Hutchings and Lamberth 2002).

Fishing outside South Africa
The principal threat to this species worldwide is over-exploitation, by target and bycatch fisheries. This is a valuable commercial species in many parts of the world, caught in bottom trawls, gillnets, line gear, and by rod and line (Fordham *et al.* 2016).

Population trends
There are several distinct regional populations, at least one of which is now recognised as a separate species *S. suckleyi* (Fordham *et al.* 2016). The species was assessed as declining in the NE Atlantic and Mediterranean, and increasing in the NW Atlantic and South Pacific. To estimate a global population trend, the estimated three generation population trends for each region were weighted according to

the relative size of each region. The overall estimated median reduction was 51.9%, with the highest probability of no major reduction over three generation lengths (51 years). However, due to uncertainty in some regional estimated trends, inferred declines in the SW Atlantic, and high levels of exploitation, expert judgement elicitation was used to estimate a global population reduction of 30–49% over three generation lengths (51 years). Therefore, *S. acanthias* was assessed as Vulnerable globally in 2019 (Finucci *et al.* 2020c).

In South Africa population trend data of annual density estimates (kg per nm^2 area swept) were available from demersal research trawl surveys conducted over 26 years (1991–2016) in commercially fished areas of South Africa during autumn and spring along the south coast (DFFE unpubl. data 2018). The risk assessment result was Least Concern, with no significant decline in catch trend over the assessment period for this species (Finucci *et al.* 2020c).

ECOTOURISM
It cannot be considered an ecotourism species as it only occurs in very deep waters.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
Permit conditions in the offshore hake trawl fishery prohibits the production of squalene on vessels. There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
This species is not likely to receive much benefit from MPAs.

Additional local comment
This species may benefit from the long-standing ban on trawling in False Bay.

IUCN Red List Status
<u>Vulnerable 2019: A2bd+3bd</u>

Previous IUCN assessments
Vulnerable 2016.
This species was assessed as Endangered (A2bd) in Europe and the Mediterranean in 2014 (Ellis *et al.* 2015a).

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
The northern hemisphere population of this species is listed on Appendix II of the Convention on the Conservation of Migratory Species of Wild Animals (CMS) and Annex I of its Migratory Sharks Memorandum of Understanding (CMS Secretariat 2019). Through these listings, CMS Party Range States have committed to collaborate toward regional conservation, but no specific actions have been agreed under CMS since the listing in 2008 (Finucci *et al.* 2020c).

International comments
S. acanthias is subject to species-specific management action across much of its range. The North Atlantic populations, once heavily overfished of the United States, are now protected by strict science-based catch limits. The European Union introduced a maximum landing length of 100 cm to deter the

targeting of mature females, accompanied by huge reductions in Total Allowable Catch (TAC) (Finucci *et al.* 2020c). New Zealand manages the species, which is taken in target and bycatch fisheries, through its Quota Management System (Fordham *et al.* 2016). Elsewhere, management measures are lacking (Finucci *et al.* 2020c).

MANAGEMENT CONSIDERATIONS
Identification of all *Squalus* catches to species level would improve management. Increased observer coverage in the demersal trawl and demersal longline fisheries is imperative. Much of the catch of all *Squalus* spp appears to be discarded. Post release mortality is unknown and may be high; this should be investigated.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
This species has been poorly studied in South Africa, with little known of its reproductive biology and life history. Samples should be retained for this purpose. Tissue samples should be kept to study population genetics. The identity of individuals caught on the south and east coasts should be carefully checked.

FAMILY CENTROPHORIDAE

Centrophorus granulosus

SCIENTIFIC NAME	*Centrophorus granulosus* (Bloch and Schneider 1801)
COMMON NAME	Lowfin gulper shark
FAMILY	Centrophoridae
ENDEMIC	No, present in Mozambique and Madagascar
SIZE RANGE	35–176 cm TL
SA DISTRIBUTION	E, S, W coasts: entire South African coast
HABITAT	Demersal on continental slopes
DEPTH RANGE	100–1500 m
MAJOR FISHERIES	Offshore hake trawl fishery; all catches lumped as unidentified dogfish *Squalus* spp
IUCN STATUS	Endangered 2019
CITES REGS	Not listed
MLRA REGS	Production of squalene onboard vessels prohibited in offshore trawl fishery; daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	C da Silva

SPECIES SUMMARY and RECOMMENDATIONS
Centrophorus granulosus is a medium sized, demersal shark that is generally found on the continental shelf at depths of 100-1500 m. This widely distributed species occurs along the entire South African coast and Namibia. Local catches are lumped as *Centrophorus* spp. and are estimated to be <1 ton per year (DFFE records 2010–2012). Due to its occurrence in deep water, catch is likely to be restricted to the offshore hake trawl fishery. It was assessed globally as Vulnerable on the IUCN Red List in 2019, due to decreasing population trends in other regions. A local/regional Red List assessment should be undertaken, although this may be hampered by its apparent scarcity and lack of species-specific catch data. Very little is known about the distribution, habitat, life-history and movement of this species in South Africa.

TAXONOMIC and IDENTIFICATION ISSUES
The genus *Centrophorus* is one of the most taxonomically complex and confusing elasmobranch groups (White *et al.* 2013). There are at least four, possibly five, species of *Centrophorus* currently recognised as occurring in South Africa. Historically most large South African *Centrophorus* species were referred to as *C. lusitanicus* which was found only on the east coast (Bass *et al*. 1976, Compagno *et al*. 1989), until White *et al*. (2017) determined that *C. lusitanicus* is a junior synonym of *C. granulosus* (Ebert *et al.* 2021). *C. granulosus* is the largest member of this genus attaining 1.7 m. The only other species that attains a similar size is *C. squamosus*, at 1.6 m, which is also the most morphologically similar species to *C. granulosus.* These two species can be easily distinguished by their denticle morphology at all sizes in that the lateral trunk denticles of adult *C. granulosus* have flat, tear-drop shaped crowns with one long posterior cusp, and are not raised on pedicels or are overlapping (White *et al.* 2013).

SOUTH AFRICAN DISTRIBUTION
This species occurs along the entire South African coast (Ebert *et al.* 2021).

REGIONAL DISTRIBUTION

The distribution of this species appears to be contentious. Ebert (2013) stated that it occurs along much of the southern African coast from Angola to Mozambique, as well as Madagascar. In the 2019 IUCN Global Red List assessment (Finucci *et al.* 2020d), the distribution map shows that *C. granulosus* is confined to the east coast of South Africa and part of the Mozambique coast and is absent from Namibia and Madagascar.

SYNOPSIS OF RESEARCH

This is a very poorly studied species in South Africa, as a result of taxonomic confusion and identification issues. Bass *et al.* (1976) reviewed the taxonomy of the genus and provided detailed morphometric and biological information from twelve individuals, identified as *C. lusitanicus*¸ taken on the east coast of South Africa. Only five individuals were recorded in extensive research trawls on the west coast (Compagno *et al.* 1991). No further research on this species in South Africa has been documented.

ECOLOGY

Depth

This species occurs at depths of 400–1000 m on the east coast (Bass *et al.* 1976) and was caught in a very narrow depth range of 400–480 m on the west coast and Namibia (Compagno *et al.* 1991). Elsewhere in its range it has been recorded from the continental shelves and upper slopes at depths of 98–1,500 m (possibly down to 2,300 m), and mostly 300–1,100 m (Finucci *et al.* 2020d and references cited therein).

Habitat: Adults

Little is known about the habitat of this demersal species.

Habitat: Juveniles/Nursery Grounds

Little is known about the habitat of juveniles of this demersal species.

Synopsis of tag deployments

None have been tagged in South African waters.

Movements

Little is known about movement of this species in South Africa.

Diet/feeding: adults

The stomach contents of nine mature individuals (112–160 cm) caught on the east coast and Mozambique, comprised mainly teleosts, followed by squid, small squalid sharks and a crustacean (Bass *et al.* 1976). A single individual on the west coast had ingested a crustacean (Ebert *et al.* 1992).

Diet/feeding: juveniles

It is not known if there is an ontogenetic change in diet.

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Lecithotrophic viviparity
DURATION OF REPRO CYCLE	Unknown
MATING	Unknown
GESTATION	Unknown
LITTER SIZE	1–8

PUPPING/NURSERY GROUND	Unknown
LENGTH AT BIRTH	35–47 cm (outside South Africa)
LENGTH AT MATURITY	F: 140–150 cm; M: 105–118 cm (outside South African waters)
MAXIMUM LENGTH	F: 176 cm; M: 124 cm (outside South African waters)
GENERATION LENGTH	27.75 (NE Atlantic)

Mode
This species exhibits lecithotrophic viviparity, with the embryos dependent entirely on the nourishment supplied by the yolk-sac.

Duration of reproductive cycle
This is not known.

Mating season and location
This is not known, other than pregnant females tend to segregate from the rest of the population (Cotton 2010, cited by Finucci *et al.* 2020d).

Gestation
This is unknown as mating appears to be asynchronous (Cotton, 2010, cited by Finucci *et al.* 2020d).

Litter size
This is 1–6 locally (Bass *et al.* 1976) and elsewhere 1–8, mostly 4–6 (White *et al.* 2013 and Finucci *et al.* 2020d and references cited therein).

Length at birth
This is unknown locally but is 35–47 cm elsewhere (White *et al.* 2013).

Pupping season and nursery ground
This is unknown; pregnant females tend to segregate from the rest of the population (Cotton, 2010, cited by Finucci *et al.* 2020d). Bass *et al.* (1976) reported that all nine females sampled in KZN and southern Mozambique were pregnant.

Length at maturity
All locally caught females over 144 cm and all males over 112 cm were mature (Bass *et al.* 1976). Elsewhere length at 50% maturity for females was 143–147 cm and 110 cm for males (White *et al.* 2013 and Finucci *et al.* 2020d and references cited therein).

Maximum length
The largest southern African female sampled was 160 cm. Elsewhere females reach a maximum of 176 cm and males 124 cm (White *et al.* 2013).

Age and growth
Female age-at-maturity is 16.5 years for this species in the NE Atlantic (Guallart 1998, cited by Finucci *et al.* 2020d).

Generation length
Given the age-at-maturity of 16.5 years and a maximum age of 39 years (Guallart 1998, cited by Finucci *et al.* 2020d), the generation length is 27.75 years.

FISHERIES MANAGEMENT

SA catch sources, quantities and characteristics

Catches of all species of *Centrophorus* combined have been estimated at less than <1 ton per year for the period 2010–2012 with all catches listed as unidentified dogfish (DFFE records). The trawl fishery is responsible for the bulk of the catch and the hake longline fishery being a suspected source of catches (da Silva *et al.* 2015). As *C. granulosus* occurs on the KZN coast it may be caught in deep-water east coast crustacean trawl fishery, which occurs in water 100–600 m, with most fishing effort concentrated in 300–600 m on the shelf (Fennessy and Groeneveld 1997).

Fishing outside South Africa

This species is taken as both targeted and incidental catch across its range in midwater and demersal trawl, surface and demersal longline, and setnet fisheries. As *Centrophrus* spp. are a rich source of squalene, targeted fishing in certain areas, notably the NE Atlantic and Indonesia is intensive (Finucci *et al.* 2020d).

Population trends

Population size and trends for this species across its range are declining (Finucci *et al.* 2020d). Taxonomic uncertainty and identification issues have led to some confusion over the occurrence of gulper sharks, often leading to this group being reported as *Centrophorus* spp. (Finucci *et al.* 2020d), as in the case in South African fisheries. The species is suspected to have undergone large population reduction, with ongoing declines across the Indo-Pacific and West Africa. Globally, *C. granulosus* is estimated to have reduced by 50–79% over the last three generations (~83 years), and the species was globally assessed as Endangered on the IUCN Red List in 2019.

ECOTOURISM

It occurs in deep water and therefore it cannot be regarded as an ecotourism species.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

Permit conditions in the offshore hake fishery prohibit the production of squalene on vessels. There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act

Threatened or Protected Species (TOPS)

This species is not listed.

Marine Protected Areas

In the absence of more detailed distributional data, it seems that the existing network of South African MPAs is unlikely to protect this species.

Additional local comment

IUCN Red List Status

Endangered 2019 A2bd

Previous IUCN assessments

None

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

This species is not listed.

Convention on Migratory Species (CMS)

This species is not listed.

International comments

Targeted deep-water shark fishing is not permitted in the SE Atlantic Fisheries Organization (SEAFO) Convention Area or under the Southern Indian Ocean Fisheries Agreement (SIOFA) (SIOFA 2019, SEAFO 2016). Since 2010, the European Union Fisheries Council prohibited direct fishing for deep-water sharks, including *Centrophorus* spp., in European Community and international waters, and in 2012, no allowances for bycatch were implemented (ICES-WGEF 2018) (Finucci *et al.* 2020d).

MANAGEMENT CONSIDERATIONS

Centrophorus spp. are slow growing and not suitable for exploitation by fisheries. In South Africa there is little concern regarding the overexploitation of these species as long as the prohibition against squalene production in the demersal fishery remains in effect and catches of squaliform sharks released from this fishery have a high rate of survival. An assessment of survival rates is recommended but will be very difficult to complete. The global status of Endangered for *C. granulosus* is due to decreasing population trends in other regions. A local/regional Red List assessment should be undertaken, but in view of its apparent scarcity in local catches, this species should be regarded as being of very low management priority. Improved identification is needed in the trawl industry to obviate the need to lump all Squaliformes as unidentified dogfish.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

Local knowledge of this species is extremely limited and is based on a very small number of specimens. Taxonomic clarity is required on the identity of *Centrophorus* spp. in South African waters. More information is needed on the biology and ecology of this and other members of the genus.

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Centrophorus moluccensis

SCIENTIFIC NAME	*Centrophorus moluccensis* (Bleeker 1860)
COMMON NAME	Smallfin gulper shark
FAMILY	Centrophoridae
ENDEMIC	No, present in Mozambique
SIZE RANGE	35–100 cm TL
SA DISTRIBUTION	E coast: Mozambique border to Durban
HABITAT	Demersal on continental slopes
DEPTH RANGE	125–820 m
MAJOR FISHERIES	Deep water trawl fishery; all catches lumped as *Squalus* spp
IUCN STATUS	Vulnerable 2019
CITES REGS	Not listed
MLRA REGS	Production of squalene onboard vessels prohibited in offshore trawl fishery; daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	C da Silva

SPECIES SUMMARY and RECOMMENDATIONS

Centrophorus moluccensis is a small demersal shark that is generally found on the continental shelf and slope at depths of 125–820 m and in South African waters only occurs on part of the east coast. Local catches are lumped as *Squalus* spp. and are estimated to be <1 ton per year (DFFE records 2010–2012). Due to its occurrence in deep water, catch is likely to be restricted to the deep-water trawl fishery. This species was assessed globally as Vulnerable on the IUCN Red List in 2019 due to decreasing population trends in other regions. A local/regional Red List assessment should be undertaken, although this will be hampered by its apparent scarcity and lack of species-specific records. Very little is known about the distribution, habitat, life-history and movement of this species in South Africa.

TAXONOMIC and IDENTIFICATION ISSUES

The genus *Centrophorus* is one of the most taxonomically complex and confusing elasmobranch groups (White *et al.* 2013). There are at least four, possibly five, species of *Centrophorus* currently recognised as occurring in South Africa. *C. moluccensis* was first described in South Africa as a new species *Atractophorus armatus* by Gilchrist in 1922. This species was known as *C. sculpratus* (Bass *et al.* 1976). This species is known as the endeavour dogfish in Australia (Last and Stevens 1994).

SOUTH AFRICAN DISTRIBUTION

This species is very common off northern KZN (Bass *et al*. 1976) and has been recorded as far south as Durban (Ebert *et al.* 2021).

REGIONAL DISTRIBUTION

This species is also very common in southern Mozambique (Bass *et al*. 1976) but does not occur in any other countries in the region.

SYNOPSIS OF RESEARCH

This is not a well-studied species in South Africa, possibly as a result of taxonomic confusion and identification issues. Bass *et al.* (1976) reviewed the taxonomy of the genus and provided detailed morphometric and biological information from over 200 individuals identified as *C. sculpratus* taken from KZN and southern Mozambique. No further research on this species from the region has been documented. This species does occur elsewhere in the Indo-Pacific, but there appears to be very little species-specific research published (Finucci *et al.* 2020e).

ECOLOGY

Depth

This species is found on the outer shelf, and possibly the continental slope of KZN and southern Mozambique, with the shallowest records being in about 250 m of water (Bass *et al.* 1976). Elsewhere *C. moluccensis* has been recorded on continental and insular shelves and slopes at depths of 125–820 m (Ebert *et al.* 2013).

Habitat: Adults

Little is known about the habitat of this demersal species.

Habitat: Juveniles/Nursery Grounds

Little is known about the habitat of juveniles of this demersal species.

Synopsis of tag deployments

None have been tagged in South African waters.

Movements

Nothing is known about the movements of this species in southern Africa.

Diet/feeding: adults

The stomach contents of 101 individuals comprised mainly teleosts, followed by squid, octopus and crustaceans (Bass *et al.* 1976).

Diet/feeding: juveniles

Juveniles have a higher proportion of squid than the adults (Bass *et al.* 1976).

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Lecithotrophic viviparity
DURATION OF REPRO CYCLE	2 years
MATING	Unknown
GESTATION	Unknown
LITTER SIZE	2 (locally and elsewhere)
PUPPING/NURSERY GROUND	Unknown
LENGTH AT BIRTH	33–37 cm
LENGTH AT MATURITY	F: 85–90 cm; M: 70–90 cm (outside South African waters)
MAXIMUM LENGTH	100 cm (outside South African waters)
GENERATION LENGTH	29.5 years inferred from *C. harrissoni*

Mode

This species exhibits lecithotrophic viviparity, with the embryos dependent entirely on the nourishment supplied by the yolk-sac.

Duration of reproductive cycle

The duration of the reproductive cycle is two years (Ebert *et al.* 2013).

Mating season and location

This is not known; Bass *et al.* (1976) found females with newly-laid ova *in utero* between May and December.

Gestation
This is unknown.

Litter size
Litter size is two, both locally (Bass *et al.* 1976) and in Australia (Last and Stevens 1994).

Length at birth
This is 31–37 cm (Bass *et al.* 1976) locally and about 35 cm in Australia (Last and Stevens 1994).

Pupping season and nursery ground
This is unknown, although Bass *et al.* (1976) reported that all three full-term litters were found in November and December.

Length at maturity
The smallest mature female was 89 cm males were usually mature at 73 cm (Bass *et al.* 1976). Females mature at 85–90 cm and males 70–90 cm (Ebert *et al.* 2013).

Maximum length
The largest individual, a female, was 98 cm (Bass *et al.* 1976). Elsewhere the maximum size is reported at 100 cm (Finucci *et al*. 2020e).

Age and growth
Female age-at-maturity and maximum age are not listed (Finucci *et al.* 2020e).

Generation length
Age parameters are unknown but can be inferred from a closely related species *C. harrissoni* that has a female age-at-maturity of 23 years and a maximum age of 36 years, resulting in a generation length of 29.5 years (Finucci *et al.* 2020e).

FISHERIES MANAGEMENT

SA catch sources, quantities and characteristics
Catches of all species of *Centrophorus* combined have been estimated at less than <1 ton per year for the period 2010–2012, with all catches listed as unidentified dogfish (DFFE records). The trawl fishery is responsible for the bulk of the catch and the hake longline fishery is a suspected source of catches (da Silva *et al.* 2015). As *C. moluccensis* only occurs on the KZN it will not be caught in any hake fishery but may be caught in deep-water east coast crustacean trawl fishery, which occurs in water 100–600 m, with most fishing effort concentrated in 300–600 m on the shelf (Fennessy and Groeneveld 1997).

Fishing outside South Africa
Centrophorus spp. have been taken as both targeted and incidental catch across its range in midwater and demersal trawl, surface and demersal longline, and setnet fisheries (Finucci *et al*. 2020e).

Population trends
Population size and trends for this species across its entire range are declining (Finucci *et al.* 2020e). Taxonomic uncertainty and identification issues have led to some confusion over the occurrence of gulper sharks, often leading to this group being reported as *Centrophorus* spp. There is high distributional overlap with areas of intensive fishing pressure, reported declines in part of its range but stable population in others, and a lack of species-specific management across its entire range. *C. moluccensis* was suspected to have undergone a population reduction of 30–49% over the

past three generations (89 years) and was globally assessed as Vulnerable on the IUCN Red List in 2019 (Finucci *et al.* 2020e).

ECOTOURISM
As it occurs in deep water, it cannot be regarded as an ecotourism species.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
Permit conditions in the offshore hake fishery prohibit the production of squalene on vessels and should therefore also apply to the east coast deep water crustacean fishery. There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
The deepest waters of the iSimangaliso Wetland Park will protect this species. It is likely to occur in water deeper than that protected in the uThukela Banks MPA.

Additional local comment

IUCN Red List Status
Vulnerable 2019 A2bd

Previous IUCN assessments
Data Deficient 2013
Data Deficient 2013

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

International comments
This species does derive some protection in Australian waters (Finucci *et al.* 2020e).

MANAGEMENT CONSIDERATIONS
Centrophorus spp. are slow growing and not suitable for exploitation by fisheries. In South Africa there is little concern regarding the overexploitation of these species as long as the prohibition against squalene production in the demersal fishery remains in effect and catches of squaliform sharks released from this fishery have a high rate of survival. The same restriction should be applied to the east coast deep water crustacean trawl fishery. The global status of Vulnerable for *C. moluccensis* is due to decreasing population trends in other regions. A local/regional Red List assessment should be undertaken, but in view of its scarcity in local catches, this species should be regarded as being of very low management priority. Improved identification is needed in the trawl industry to obviate the need to lump all Squaliformes as unidentified dogfish.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
Local knowledge of this species is limited, with some information on life-history parameters and diet available.

Centrophorus squamosus

SCIENTIFIC NAME	*Centrophorus squamosus* (Bonnaterre 1788)
COMMON NAME	Leafscale gulper shark
FAMILY	Centrophoridae
ENDEMIC	No
SIZE RANGE	35–160 cm TL
SA DISTRIBUTION	E, S, W coasts: entire South African coast
HABITAT	Demersal on continental slopes
DEPTH RANGE	400–750 m
MAJOR FISHERIES	Offshore hake trawl
IUCN STATUS	Endangered 2019
CITES REGS	Not listed
MLRA REGS	Production of squalene onboard vessels prohibited in offshore trawl fishery; daily bag limit of one individual in recreational fishery
COMPILER	C da Silva
REVIEWER	G Cliff

SPECIES SUMMARY and RECOMMENDATIONS

Centrophorus squamosus is a medium sized, demersal shark that is generally found on the continental shelf at depths between 450–750 m. This globally distributed species occurs along the entire South African coast and Namibia. Local catch is likely to be <1 ton per annum (DFFE records 2010–2012), however it is not identified to species level. Due to its occurrence in deep water, catch is likely to be restricted to the offshore hake trawl fishery but it may also occur in other fisheries on occasion. It was assessed globally as Vulnerable in 2019. Very little is known about the distribution, habitat, life-history and movement of this species in South Africa.

TAXONOMIC and IDENTIFICATION ISSUES

There are at least four, possibly five species of *Centrophorus* currently recognised to occur in South Africa. Historically in South Africa, this species was identified as *Centroscymnus fuscus* (Gilchrist and von Bonde 1924), *Encheiridiodon hendersoni* (Smith 1967) and *Lepidorhinus squamosus* (Smith 1967) (Ebert *et al.* 2021). *Centrophorus* spp appear superficially very similar and are often misidentified or not identified to species level. Leafscale gulper sharks are large dark grey or chocolate-brown, with a broad snout, a long and low first dorsal fin and short pectoral rear tips. The most useful diagnostic tool is the large rough leaf-shaped denticles that are on raised pedicels extending above the denticle base (Ebert and Mostardo 2015).

SOUTH AFRICAN DISTRIBUTION

This species occurs along the entire South African coast (Ebert *et al.* 2021).

REGIONAL DISTRIBUTION

This species has also been recorded from Namibia, but due to its widespread global distribution in most temperate and tropical seas, it is likely to occur in Mozambique.

SYNOPSIS OF RESEARCH

This is a very poorly studied species in South Africa, as it is uncommon. Knowledge of its life history is as a result of several studies undertaken in other parts of its global distribution, particularly the northern hemisphere (see Finnucci *et al.* 2020f and references cited therein). Tissue samples from South African individuals have been used in an international population genetics study (Veríssimo *et al.* 2012).

ECOLOGY

Depth

This species is demersal on the continental shelf slope at depths of 450–750 m (Compagno *et al*. 1989), although deeper records from up to 4000 m have been reported (White 2003). Clarke *et al*. (2001) found more males at shallower depths and more females in deeper waters. A study by Bañón *et al.* (2006) also indicated segregation by size and sex.

Habitat: Adults

Little is known about the habitat requirements of adults.

Habitat: Juveniles/Nursery Grounds

Little is known about the habitat requirements of juveniles, although a study by Bañón *et al.* (2006) suggests segregation by size. Juveniles are closely associated with steep bottom floor (Ebert *et al*. 1992).

Synopsis of tag deployments

None have been tagged in South African waters.

Movements

Little is known about movement of this species in South Africa. In the NW Atlantic, Severino *et al.* (2009) has suggested the occurrence of reproduction migration based on sexual and size segregation and the presence of gravid females in some regions and absent from others. Genetic studies which included samples from South Africa indicate long-term female philopatry with an increase in dispersal by males (Veríssimo *et al*. 2012). Preliminary tagging data indicate that this species is highly migratory, travelling speeds of 20 nautical miles per day between different deep-water areas. Some individuals undergoing dramatic diurnal vertical migrations between shallower depths at around midnight and maximum depths at midday. Temperature preferences of 6–11°C were also reported (Rodríguez-Cabello *et al*. 2014; Rodríguez-Cabello *et al.* 2016).

Diet/feeding: adults

The stomach contents of 18 individuals (43-131 cm) were dominated by cephalopods and teleosts, including deepwater hake *Merluccius paradoxus* (Ebert *et al.* 1992). The size range comprised both juvenile and adult sharks.

Diet/feeding: juveniles

See comments above on diet of adults.

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Viviparity with a yolk-sac placenta
DURATION OF REPRO CYCLE	Unknown
MATING	Unknown
GESTATION	Unknown
LITTER SIZE	5–11 (outside South African waters)
PUPPING/NURSERY GROUND	Unknown
LENGTH AT BIRTH	35 to 43 cm (Australasia)
LENGTH AT MATURITY	F: 125 cm; M: 100 cm (outside South African waters)
MAXIMUM LENGTH	160 cm (Indonesia)

GENERATION LENGTH	52.5 years (NE Atlantic); 31.4 years (SW Pacific)

Mode
This species exhibits viviparity, with a yolk-sac attachment (Breder and Rosen 1966).

Duration of reproductive cycle
Little is known; there is no apparent reproductive cycle in males (Girard *et al.* 2000).

Mating season and location
Clarke *et al*. (2001) and Bañón *et al.* (2006) found that gravid females occurred only in waters shallower than 1200 m.

Gestation
This is unknown.

Litter size
In Australia and N Atlantic litters of 5–11 pups are known from few females (Cox and Francis, 1997; Last and Stevens, 2009; (Girard and Du Buit 1999).

Length at birth
In Australasia pups are born at 35–43 cm (Cox and Francis, 1997; Last and Stevens, 2009).

Pupping season and nursery ground
This is unknown.

Length at maturity
Preliminary data estimates female length at maturity at 120-122 cm, with male length at maturity at 98-101 cm (Bañón *et al.* 2006, White *et al.* 2006, Girard and Du Buit 1999, Clarke *et al*.2001, Clarke *et al*. 2002).

Maximum length
Maximum length of unsexed sharks has been recorded as 160 cm (White *et al*. 2006), females 140-145 cm and males 122 cm from global studies (White *et al.* 2006, Girard and Du Buit 1999, Clarke *et al*. 2001, Clarke *et al*. 2002).

Age and growth
Nothing known in South Africa. The species appears to attain maturity at a late age (White *et al*. 2006). There are regional differences in age parameters. In the NE Atlantic, female age-at-maturity is 35 years and maximum age is 70. In the SW Pacific, female age-at-maturity is 20.8 years and maximum age is 42 (Finucci *et al.* 2020f and references cited therein).

Generation length
Given the regional differences in female age-at-maturity and maximum age, generation length is 52.5 years in the NE Atlantic and 31.4 years in the SW Pacific (Finucci *et al.* 2020f and references cited therein).

FISHERIES MANAGEMENT
SA catch sources
Due to its distribution and preferred deep water, offshore habitat it is unlikely to be caught by many fisheries. Preliminary diet studies indicate that deep water hake (Ebert *et al.* 1992) is a significant source of food, hence it is likely that this species is captured by the offshore hake fishery, but members of the genus *Centrophorus* are not identified to species level. This is due to their scarcity and perceived difficulty in separating the species.

SA catch quantities and characteristics
Catches of all species of *Centrophorus* combined have been estimated at less than <1 ton per annum for the period 2010–2012 (DFFE records, da Silva *et al.* 2015).

Fishing outside South Africa
This species is an important component of deep-water fisheries (longline and trawl) off Ireland, Spain, Portugal and France. The flesh and liver are marketed in many areas throughout its range (White 2003). Its meat is utilized dried and salted for human consumption and was historically caught for the production of squalene. It is still used in some areas due to high concentrations of squalene and other bioactive lipids in livers and other tissues (Remme *et al.* 2005).

Population trends
No population trends are available in South Africa. In an international study Veríssimo *et al.* (2012) found a single genetic stock of *C. squamosus* and the existence of sex-biased dispersal across the Indian Ocean.

ECOTOURISM
It cannot be considered an ecotourism species as it only occurs in very deep waters.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
Permit conditions in the offshore hake fishery prohibit the production of squalene on vessels. There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
The existing network of South African MPAs is unlikely to protect this species.

Additional local comment

IUCN Red List Status
Endangered 2019 A2bd

Previous IUCN assessments
Vulnerable 2003

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

International comments

MANAGEMENT CONSIDERATIONS
This species is slow growing and not suitable for exploitation by fisheries. In South Africa there is little concern regarding the overexploitation of these species as long as the prohibition against squalene production in the offshore fishery remains in effect. Chondrichthyan biodiversity associated with continental slope remains largely unknown. Effects of habitat destruction through activities such as offshore mining and bottom trawling need to be investigated.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

Very little is known about this species, with life-history parameters and diet known from a few samples taken from a few regions. The chondrichthyans occurring on the slope edge of the continental shelves need to be researched in more detail (life-history, distribution, occurrence, species composition). This is a largely unstudied region where what is known is mostly due to capture by fisheries.

Centrophorus uyato

SCIENTIFIC NAME	*Centrophorus uyato* (Rafinesque 1815)
COMMON NAME	Little gulper shark
FAMILY	Centrophoridae
ENDEMIC	No, present in Mozambique and Namibia
SIZE RANGE	35–128 cm TL
SA DISTRIBUTION	W coast and possibly S and E coasts
HABITAT	Demersal on continental slopes
DEPTH RANGE	50–1400 m, usually 400–800 m
MAJOR FISHERIES	Deep water trawl fishery; all catches lumped as unidentified dogfish
IUCN STATUS	Endangered 2019
CITES REGS	Not listed
MLRA REGS	Production of squalene onboard vessels prohibited in offshore trawl fishery; daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	DA Ebert

SPECIES SUMMARY and RECOMMENDATIONS

Centrophorus uyato is a small demersal shark that is usually found on the continental shelf at depths of 400–800 m. This widely distributed species occurs along the entire South African coast and Namibia. Local catches are lumped as *Squalus* spp. and are estimated to be <1 ton per year (DFFE records 2010–2012). Due to its occurrence in deep water, catch is likely to be restricted to the deep-water trawl fishery. This species was assessed globally as Endangered on the IUCN Red List in 2019 due to decreasing population trends in other regions. A local/regional Red List assessment should be undertaken, although this will be hampered by its apparent scarcity and lack of species-specific records. Very little is known about the distribution, habitat, life-history and movement of this species in South Africa.

TAXONOMIC and IDENTIFICATION ISSUES

The genus *Centrophorus* is one of the most taxonomically complex and confusing elasmobranch groups (White *et al.* 2013). There are at least four, possibly five, species of *Centrophorus* currently recognised as occurring in South Africa. Both *C. granulosus* and *C. uyato* occur In South African waters, but historically have been misidentified. Compagno *et al*. (1991) listed *C. uyato* in synonymy with *C. granulosus*, but there were in fact two species involved: a large species now known to be *C. granulosus* and a small species now referred to as *C. uyato*. This is discussed in some detail by White *et al.* (2017). *C. uyato* has shorter and more triangular first dorsal fin and the lateral trunk denticles are flat and block-like with only a short cusp which gives the skin a smooth feel (White *et al.* 2013). A review of the genus is presently underway to clarify the status of this small species of *Centrophorus* (Ebert *et al.* 2021). The most recent IUCN Red List assessment is presented under the name *C. uyato*, pending this review (Finucci *et al.* 2020g).

SOUTH AFRICAN DISTRIBUTION

Its presence off the west coast around the Orange River, based on a single record from off Hondeklip Bay (Compagno *et al.* 1991), and most likely on the east and south coasts KZN (Ebert *et al.* 2021).

REGIONAL DISTRIBUTION

C. uyato also occurs in southern Mozambique (Bass *et al.* 1976), where it is described as common (Compagno *et al.* 1989). It appears to be more common in Namibia and Angola than on the west coast of South Africa (Compagno *et al.* 1991). It also occurs in Madagascar (Finucci *et al.* 2020g).

SYNOPSIS OF RESEARCH

This is not a well-studied species in South Africa, as a result of taxonomic confusion and identification issues. Bass *et al.* (1976) reviewed the taxonomy of the genus and provided detailed morphometric and biological information from 16 individuals identified as *C. uyato* taken from southern Mozambique. Only a single individual was sampled in research trawls on the west coast (Compagno *et al.* 1991). No further research on this species from the region has been documented.

ECOLOGY

Depth

Locally this species is found in southern Mozambique at depths of 270–450 m (Bass *et al.* 1976). Elsewhere *C. uyato* has been recorded on continental and insular shelves and slopes at depths of 50–1,400 m, and mostly between 400–800 m (Finucci *et al.* 2020g).

Habitat: Adults

Little is known about the habitat of this demersal species.

Habitat: Juveniles/Nursery Grounds

Little is known about the habitat of juveniles of this demersal species.

Synopsis of tag deployments

None have been tagged in South African waters.

Movements

Nothing is known about the movements of this species in southern Africa.

Diet/feeding: adults

The stomach contents of nine individuals comprised teleosts and squid (Bass *et al.* 1976).

Diet/feeding: juveniles

It is not known if there is an ontogenetic change in diet.

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Lecithotrophic viviparity
DURATION OF REPRO CYCLE	Unknown
MATING	Unknown
GESTATION	Unknown
LITTER SIZE	1 (Australia)
PUPPING/NURSERY GROUND	Unknown
LENGTH AT BIRTH	About 35 cm (outside South Africa)
LENGTH AT MATURITY	F: 85–90 cm; M: 70–90 cm (outside South African waters)
MAXIMUM LENGTH	128 cm (outside South African waters)
GENERATION LENGTH	60 years

Mode

This species exhibits lecithotrophic viviparity, with the embryos dependent entirely on the nourishment supplied by the yolk-sac.

Duration of reproductive cycle
The duration of the reproductive cycle is unknown.

Mating season and location
This is not known locally as Bass *et al.* (1976) only sampled immature females.

Gestation
This is unknown.

Litter size
No pregnant females have been sampled in South Africa, but in Australia litter size is one (Last and Stevens 1994).

Length at birth
In Australia length at birth is about 35 cm (Last and Stevens 1994).

Pupping season and nursery ground
This is unknown.

Length at maturity
The largest immature female was 70 cm and the smallest mature male was 86 cm (Bass *et al.* 1976). Elsewhere females mature at about 96 cm and males at about 80 cm (Finucci *et al*. 2020g)

Maximum length
Elsewhere the maximum is reported at 128 cm (Finucci *et al*. 2020g).

Age and growth
Female age-at-maturity and maximum age are not listed (Finucci *et al.* 2020g).

Generation length
This is estimated at 60 years but should be used with caution as further validation is required (Finucci *et al.* 2020g).

FISHERIES MANAGEMENT
SA catch sources, quantities and characteristics
Catches of all species of *Centrophorus* combined have been estimated at less than <1 ton per year for the period 2010–2012 (DFFE records), with all catches listed as unidentified dogfish. The trawl fishery is responsible for the bulk of the catch and the hake longline fishery is a suspected source of catches (da Silva *et al.* 2015).

Fishing outside South Africa
Centrophorus spp. have been taken as both targeted and incidental catch across its range in midwater and demersal trawl, surface and demersal longline, and setnet fisheries (Finucci *et al.* 2020g).

Population trends
Population size and trends for this species across its range are unknown. Taxonomic uncertainty and identification issues have led to some confusion over the occurrence of gulper sharks, often leading to this group being reported under a generic category of *Centrophorus* spp. (Finucci *et al.* 2020g), as is the case in South African fisheries. There is high distributional overlap with areas of intensive fishing pressure, as well as reported declines in part of its range but stable populations in others, and a lack of species-specific management across its entire range. *C. uyato* is suspected to be declining across

much of its range with a population reduction of 50–79% over the last three generations, resulting in a global assessment of Endangered on the IUCN Red List in 2019 (Finucci *et al.* 2020g).

ECOTOURISM
As it occurs in deep water, it cannot be regarded as an ecotourism species.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
Permit conditions in the offshore hake fishery prohibit the production of squalene on vessels. There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
The deepest waters of the iSimangaliso Wetland Park will protect this species on the assumption that if it occurs in southern Mozambique it may well occur south of the Mozambique border.

Additional local comment

IUCN Red List Status
Endangered 2019 A2bd

Previous IUCN assessments
Data Deficient 2003

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

International comments
Targeted deep-water shark fishing is not permitted in the SE Atlantic Fisheries Organization (SEAFO) Convention Area or under the Southern Indian Ocean Fisheries Agreement (SIOFA) (SIOFA 2019, SEAFO 2016). Conservation measures are generally lacking elsewhere in the patchy range of this species, although there are bans on the use of deep-water trawls in the Mediterranean and NE Atlantic (Finucci *et al.* 2020g).

MANAGEMENT CONSIDERATIONS
Centrophorus spp. are slow growing and not suitable for exploitation by fisheries. In South Africa there is little concern regarding the overexploitation of these species as long as the prohibition against squalene production in the demersal fishery remains in effect and catches of squaliform sharks released from this fishery have a high rate of survival. The prohibition of squalene production should also apply to the deep-water east coast crustacean trawl fishery. An assessment of survival rates of *Centrophorus* spp. would be beneficial but very difficult to achieve. Chondrichthyan biodiversity associated with continental slope remains largely unknown. The global status of Endangered for *C. uyato* is due to decreasing population trends in other regions. A local/regional Red List assessment should be undertaken, but in view of its apparent extreme scarcity in local catches, this species should be regarded as being of very low management priority. Improved identification is needed in the trawl industry to obviate the need to lump all Squaliformes as unidentified dogfish.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

Local knowledge of this species is extremely limited and is based on a very small number of specimens taken in southern Mozambique. Taxonomic clarity is required on the identity of *Centrophorus* spp. in South African waters. More information is needed on the biology and ecology of this and other members of the genus.

Deania quadrispinosa

SCIENTIFIC NAME	*Deania quadrispinosa* (McCulloch 1915)
COMMON NAME	Longsnout dogfish
FAMILY	Centrophoridae
ENDEMIC	No, present in Mozambique and Namibia
SIZE RANGE	25–118 cm TL
SA DISTRIBUTION	W coast and possibly S and E coasts
HABITAT	Demersal on continental slopes
DEPTH RANGE	150–1360 m, usually >400 m
MAJOR FISHERIES	Deep water trawl fishery; all catches lumped as unidentified dogfish
IUCN STATUS	Vulnerable 2019
CITES REGS	Not listed
MLRA REGS	Production of squalene onboard vessels prohibited in offshore trawl fishery; daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	C da Silva

SPECIES SUMMARY and RECOMMENDATIONS

Deania quadrispinosa is a small demersal shark that is found on the continental shelf and slope at depths of 150–1360 m. It has a very patchy distribution along the South African coast and Nambia and southern Mozambique. Local annual catch is estimated at <1 ton (DFFE records 2010–2012), but is not identified to genus or even family. Due to its occurrence in deep water, the catch is likely to be restricted to the deep-water trawl fisheries. It was assessed globally as Vulnerable on the IUCN Red List in 2019 due to decreasing population trends in other regions. A local/regional Red List assessment should be undertaken. Very little is known about the distribution, habitat, life-history and movement of this species in South Africa.

TAXONOMIC and IDENTIFICATION ISSUES

There are at least three species in the genus *Deania*, all of which occur in South African waters. The validity of a fourth species and the nomenclature for the genus is currently under investigation (Ebert *et al*. 2021). They all have long snouts, large yellow eyes, strong dorsal fin spines and large pitchfork-shaped denticles which give them a bristly appearance (Compagno *et al.* 1989). *D. quadrispinosa* is the least common of the three species in South African waters (Rob Leslie, formerly DAFF) and can be distinguished from its conspecifics by its short, high first dorsal fin, together with its lack of a subcaudal keel (Compagno *et al.* 1989). It was previously known as *D. quadrispinosum* (Bass *et al.* 1976)

SOUTH AFRICAN DISTRIBUTION

D. quadrispinosa is only known from a few scattered records off Cape Town (WC), Algoa Bay (EC), and northern KZN (Compagno *et al.* 1992, Ebert *et al.* 2021).

REGIONAL DISTRIBUTION

D. quadrispinosa also occurs in southern Mozambique (Bass *et al.* 1976) and Namibia (Compagno *et al.* 1991), but it does not appear to occur in Madagascar (Finucci *et al.* 2020h).

SYNOPSIS OF RESEARCH

This is not a well-studied species in southern Africa, as a result of taxonomic confusion and its apparent rarity. Bass *et al.* (1976) reviewed the taxonomy of the genus and provided detailed morphometric information from two males taken from southern Mozambique. No further research on this species from the region has been documented.

ECOLOGY

Depth

The small number of southern African specimens were taken at depths of 275–640 m (Bass *et al.* 1976, Compagno *et al.* 1991). Elsewhere *D. quadrispinosa* has been recorded on continental and insular shelves and slopes at depths of 150–1,360 m, and mostly deeper than 400 m (Ebert *et al.* 2013).

Habitat: Adults

Little is known about the habitat of this demersal species.

Habitat: Juveniles/Nursery Grounds

Little is known about the habitat of juveniles of this demersal species.

Synopsis of tag deployments

None have been tagged in South African waters.

Movements

Nothing is known about the movements of this species in southern Africa.

Diet/feeding: adults

The stomach of a single individual contained teleosts (Bass *et al.* 1976).

Diet/feeding: juveniles

It is not known if there is an ontogenetic change in diet.

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Lecithotrophic viviparity
DURATION OF REPRO CYCLE	Unknown but aseasonal (Australia)
MATING	Unknown
GESTATION	Unknown
LITTER SIZE	8–18 (Australia)
PUPPING/NURSERY GROUND	Unknown
LENGTH AT BIRTH	25 cm (Australia)
LENGTH AT MATURITY	F: 94 cm; M: 80 cm (Australia)
MAXIMUM LENGTH	118 cm (outside South African waters)
GENERATION LENGTH	37 years (inferred from *Deania calcea*)

Mode

This species exhibits lecithotrophic viviparity, with the embryos dependent entirely on the nourishment supplied by the yolk-sac.

Duration of reproductive cycle

The duration of the reproductive cycle is unknown but is aseasonal in Australian waters (Irvine *et al.* 2012).

Mating season and location

This is not known as Bass *et al.* (1976) only sampled immature females.

Gestation

This is unknown.

Litter size
This is unknown locally but is 8–18 in Australia (Irvine *et al.* 2012).

Length at birth
This is about 25 cm in Australian waters (Irvine *et al.* 2012).

Pupping season and nursery ground
This is unknown.

Length at maturity
Female and male length at 50% maturity was about 94 cm and 80 cm, respectively in Australia (Irvine *et al.* 2012).

Maximum length
Elsewhere the maximum is reported at 118 cm (Finucci *et al*. 2020h).

Age and growth
Female age-at-maturity and maximum age are not known (Finucci *et al.* 2020h).

Generation length
This is inferred at 30 years from a closely related species *D. calcea* that has a female age-at-maturity of 21.5 years and a maximum age of 37 years (Irvine *et al*. 2012).

FISHERIES MANAGEMENT

SA catch sources, quantities and characteristics
Due to its very patchy but limited distribution and preference for deep water it is unlikely to be caught in large numbers. Bass *et al.* (1976) reported two individuals from southern Mozambique and none from the east coast. Only a single individual was taken in a deep-water research trawl survey of the west coast of South Africa (Compagno *et al.* 1991).

Catches of all species of *Deania* combined have been estimated at less than <1 ton per year for the period 2010–2012 (DFFE records, da Silva *et al.* 2015), but none are retained and all catches listed as unidentified dogfish. In the South African inshore trawl fishery, *Deania* spp. comprised <0.2% of the total catch with a reported 126 t landed between 2010–2018 (MSC 2020), by comparison *Deania* spp. comprised 0.02% (3.6 tons) of the total unsorted annual catch for inshore trawl fishery the period 2003–2006 (Attwood *et al.* 2011).

Fishing outside South Africa
D. quadrispinosa has been taken as both targeted and incidental catch across its range in midwater and demersal trawl, demersal longline, and gillnet fisheries. It is likely to be misreported with similar looking *Deania* spp. (Finucci *et al.* 2020h).

In Namibia, deep-water sharks have been reported as bycatch from hake *Merluccius capensis* fisheries but species-specific catches are difficult to determine and likely underestimated with on-board processing resulting in deep-water sharks being rarely landed whole (Finucci *et al.* 2020h and references cited therein).

Population trends
Further information is required on population size and trends, as well as interactions with fisheries across its range, particularly around Africa (Finucci *et al*. 2020h). Elsewhere in its Indo-Pacific range,

largely Australasia, Taiwan and W Pacific islands, this species is inferred to have undergone a population reduction of 30–49% over the past three generations (90 years) based on abundance data and actual levels of exploitation, and it was globally assessed as Vulnerable on the IUCN Red List in 2019.

ECOTOURISM
D. quadrispinosa cannot be considered an ecotourism species as it primarily occurs in very deep waters and is rarely encountered in the shallows.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
Permit conditions in the offshore hake fishery prohibit the production of squalene on vessels. There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
Its distribution is too poorly known to ascertain if any South African MPAs will provide it with any protection.

Additional local comment

IUCN Red List Status
<u>Vulnerable 2019 A2bd</u>

Previous IUCN assessments
Near Threatened 2008

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

International comments
There have been a number of management measures implemented in recent years, both species-specific and more general, for deep-water sharks. Targeted deep-water shark fishing is not permitted in the South East Atlantic Fisheries Organization (SEAFO) Convention Area or under the Southern Indian Ocean Fisheries Agreement (SIOFA) (SIOFA 2019, SEAFO 2016). Conservation measures are generally lacking elsewhere in its patchy range (Finucci *et al*. 2020h).

MANAGEMENT CONSIDERATIONS
Deania spp. are slow growing and not suitable for exploitation by fisheries. In South Africa there is little concern regarding the overexploitation of these species as long as the prohibition against squalene production in the demersal fishery remains in effect and catches of squaliform sharks released from this fishery have a high rate of survival. An assessment of survival rates is recommended. Chondrichthyan biodiversity associated with continental slope remains largely unknown. Its global status as Vulnerable is due to decreasing population trends in other regions and may not be appropriate for the southern African population. A local/regional Red List assessment

should be undertaken. Improved identification is needed in the trawl industry to obviate the need to lump all Squaliformes as unidentified dogfish.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

This is an extremely poorly studied species in South African waters. Almost nothing is known of its biology, life history and ecology. This is unlikely to change as it appears to be extremely rare in any catches. In the unlikely event of any captures, the specimens should be used to collect such information.

FAMILY SOMNIOSIDAE

Centroscymnus owstonii

SCIENTIFIC NAME	*Centroscymnus owstonii* (Garman 1906)
COMMON NAME	Roughskin dogfish
FAMILY	Somniosidae
ENDEMIC	No, found in Namibia
SIZE RANGE	27–120 cm TL
DISTRIBUTION	S coast: only Mossel Bay but likely to be more wide-ranging
HABITAT	Demersal on soft bottoms of outer shelf and upper slope
DEPTH RANGE	150–1500 m
MAJOR FISHERIES	Demersal trawl fishery
IUCN STATUS	Vulnerable 2017
CITES REGS	Not listed
MLRA REGS	Production of squalene onboard vessels prohibited in offshore trawl fishery; daily bag limit of one individual in recreational fishery
COMPILER	C da Silva
REVIEWER	G Cliff

SPECIES SUMMARY and RECOMMENDATIONS

Centroscymnus owstonii is a small demersal species generally found on continental slopes, oceanic ridges and seamounts; it is most common at depths >600 m. This species is suspected to be widespread and is often misidentified with other members of the family Somniosidae. There are only a few records off Mossel Bay. Local catch is likely to be < 1 ton per annum (DFFE records 2010–2012), however catch is not identified to species level. Due to its depth distribution, catch is likely to be restricted to the offshore hake trawl fishery but may also occur in other fisheries on occasion. *Centrosymnus owstonii* was assessed globally as Vulnerable in 2017, due to decreasing population trends in other regions. Very little is known about the distribution, habitat, life-history and movement of this species.

TAXONOMIC and IDENTIFICATION ISSUES

There are five genera and six species in the family Somniosidae in South Africa (Ebert *et al.* 2021). This species can be identified from similar sleeper sharks by the size of the second dorsal fin, which is considerably taller than the first (Ebert 2015). Most of the previous records of this species from South Africa were misidentifications of either *C. coelolepis* or *C. crepidater*, but a few specimens of *C. owstonii* were caught in very deep water off Mossel Bay (Ebert *et al.* 2021).

South African Distribution

The distribution includes Mossel Bay on the south coast but it is likely to be more wide-ranging (Ebert *et al.* 2021).

Regional Distribution

This species also occurs in Namibia (Finucci and Kyne 2018). It has been recorded east of South Africa on the Walters Shoal and Madagascar Ridge, indicating a widespread distribution (Ebert *et al.* 2021).

SYNOPSIS OF RESEARCH

This is a very poorly studied species in South Africa, which the only confirmed records caught off Mossel Bay. Elsewhere in its range it is taken in deepwater fisheries, which have been a source of very limited study material, especially in countries like Australia and New Zealand (Finucci and Kyne 2018 and references cited therein).

ECOLOGY

Depth

This species is recorded on continental slopes, oceanic ridges, and seamounts at depths of 150–1400 m, but is most common deeper than 600 m (Blackwell 2010).

Habitat: Adults

Little is known about the habitat of adults, except that it is found on upper continental shelves, on or near the bottom (Compagno 1984a).

Habitat: Juveniles/Nursery Grounds

It is not known if juveniles utilise other habitats.

Synopsis of tag deployments

No tagging has taken place.

Movements

Nothing is known.

Diet/feeding: adults

This species feeds on fish and cephalopods (Last and Stevens, 1994).

Diet/feeding: juveniles

It is not known if the diet is different from the adults.

South African toxicological studies

No local studies have been undertaken but the flesh is high in mercury and is not used for human consumption in Australia (Last and Stevens, 1994).

REPRODUCTION

REPRODUCTIVE MODE	Viviparity with a yolk-sac placenta
DURATION OF REPRO CYCLE	Unknown
MATING SEASON	Unknown
GESTATION	Unknown
LITTER SIZE	5-34 pups (New Zealand)
PUPPING/NURSERY GROUND	Unknown
LENGTH AT BIRTH	27–30 cm
LENGTH AT MATURITY	F 104; M 84 cm
MAXIMUM LENGTH	120 cm
GENERATION LENGTH	30 years

Mode

This species exhibits viviparity with a yolk-sac placenta.

Duration of reproductive cycle

This is unknown.

Mating season and location

This is unknown.

Gestation
This is unknown.

Litter size
This is 5–34 pups in New Zealand waters (Blackwell 2010).

Length at birth
This is 27–30 cm (Finucci and Kyne 2018).

Pupping season and nursery ground
This is unknown.

Length at maturity
Males mature at 67–84 cm; females mature at 95–104 cm.

Maximum length
Largely unknown but is around 120 cm.

Age and growth
This is unknown

Generation length
Generation length is estimated to be 30 years (Irvine 2004).

FISHERIES MANAGEMENT
SA catch sources, quantities and characteristics
Estimated annual catches for *Centroscymnus* spp for the period 2010-2012 in the demersal trawl fishery was <1 ton (DFFE records; da Silva *et al.* 2015).

Fishing outside South Africa
It is taken incidentally in benthic trawl and longline (surface and benthic) fisheries across its range (Finucci and Kyne, 2018 and references therein; Compagno 2016). This species is strongly associated with seamounts (Tracey *et al*. 2004), potentially increasing its susceptibility to capture. It is utilised for its flesh and squalene oil, and is also used for fishmeal (Compagno 2016). In Australia and New Zealand, >90% of catches have historically been retained (Finucci and Kyne, 2018 and references therein).

Population trends
Population size and trends for this species are unknown across most of its range. Some of its known range is confirmed only from a few reported specimens, and thus, any assessment of population trends from these areas is extremely difficult. There is some information from Australia and New Zealand in the SW Pacific and from the NE Atlantic (Finucci and Kyne, 2018).

ECOTOURISM
It cannot be considered an ecotourism species as it only occurs in very deep waters.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
Permit conditions in the offshore hake trawl fishery prohibits the production of squalene on vessels. There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)

This species is not listed.

Marine Protected Areas
This species is not expected to receive any benefit from inshore and offshore MPAs.

Additional local comment
None

IUCN Red List Status
Vulnerable A2d: 2018

Previous IUCN assessments
Least Concern: 2003

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

MANAGEMENT CONSIDERATIONS
This species is slow growing and not suitable for exploitation by fisheries. In South Africa there is little concern regarding the overexploitation of these species as long as the prohibition against squalene production in the offshore fishery remains in effect. Chondrichthyan biodiversity associated with continental slope remains largely unknown. Effects of habitat destruction need to be investigated (offshore mining and bottom trawling).

RESEARCH REQUIREMENTS AND OPPORTUNITIES
Very little is known about this species; knowledge on life-history and diet is known from a few samples taken from a few regions. The chondrichthyans occurring on the slope edge of the continental shelves and seamounts need to be researched in more detail (life-history, distribution, occurrence, species composition). This is a largely unstudied region where what is known is mostly due to capture by fisheries.

FAMILY OXYNOTIDAE

Oxynotus centrina

SCIENTIFIC NAME	*Oxynotus centrina* (Linnaeus 1758)
COMMON NAME	Angular roughshark
FAMILY	Oxynotidae
ENDEMIC	No, much of African west coast including Mediterranean
SIZE RANGE	20–150 cm TL
SA DISTRIBUTION	W coast: single record off Cape Point
HABITAT	Demersal on shelf and slope
DEPTH RANGE	35–800 m
MAJOR FISHERIES	None, but possibly demersal trawl
IUCN STATUS	Endangered 2020
CITES	Not listed
MLRA	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	C da Silva

SPECIES SUMMARY and RECOMMENDATIONS

Oxynotus centrina is a medium-sized demersal shark found along most of the west coast of Africa. Its presence in South Africa is based on a single individual caught over 70 years ago. It was not recorded in local catches (DFFE records: 2010–2012), but its occurrence in deep water indicates that it may be caught in demersal trawls. It is a rare catch off Namibia. There have been occasional anecdotal reports of this species being caught on the West Coast by recreational anglers. It was assessed globally as Endangered in 2020, but it must be regarded as Data Deficient in South Africa. In 2016 it was assessed as Critically Endangered in the Mediterranean Sea, where most of the current knowledge on its life history was obtained. Given its rarity in South African waters, it must be regarded as a very low priority species, with no management recommendations formulated. Research opportunities will be minimal.

TAXONOMIC and IDENTIFICATION ISSUES

Oxynotus centrina is one of five species of roughshark, all in a single genus. This species is the only representative in southern Africa, although its extensive range in the East Atlantic Ocean does overlap with *O. paradoxus* in the Northern Hemisphere (Ebert *et al.* 2013). Previously Bass *et al*. (1976) had expressed concern over the identity of an individual caught off Namibia which had a much shorter interdorsal space than *O. centrina*. He stated that it could be the result of intraspecific variability. Finucci *et al.* (2020b) reiterated this concern for the same reason, stating that individuals recorded as *O. centrina* from Angola, Namibia, and South Africa may be an undescribed species. If this is correct, the records of *O. centrina* from tropical West Africa need to be re-examined, but until the problem is resolved, the southern and southwestern African *Oxynotus* is retained in *O. centrina* Finucci *et al.* (2020b).

SOUTH AFRICAN DISTRIBUTION

This species has only been recorded on the west coast, with a single specimen taken off Cape Point (Ebert *et al.* 2021). There are occasional anecdotal reports and photographs of catches by recreational anglers on the West Coast (Charlene da Silva DFFE pers. comm).

REGIONAL DISTRIBUTION

This species occurs along almost the entire W African coast, Mediterranean Sea up to Norway; records from Mozambique require verification (Ebert *et al.* 2013).

SYNOPSIS OF RESEARCH

In a review of sharks of the east coast of southern Africa, Bass *et al.* (1976) refers to only two specimens. One was trawled in Namibia and the other was the preserved jaw from an individual trawled off west cost of the Cape Peninsula and documented by Barnard (1949). Nothing has been published on this species in southern Africa waters since then.

ECOLOGY

Depth

This is a slow-swimming demersal species inhabiting continental shelves and upper slopes, 35–800 m, mostly below 100 m (Ebert *et al.* 2013, Finucci *et al.* 2020b).

Habitat: Adults

The adults inhabit coralline algal and mud bottoms (Ebert *et al.* 2013).

Habitat: Juveniles/Nursery Grounds

It is not known if the juveniles inhabit a different location.

Synopsis of tag deployments

No tagging has been undertaken.

Movements

Members of this family may be weak swimmers (Ebert *et al*. 2013) and therefore are unlikely to move large distances.

Diet/feeding: adults

This species feeds on worms, crustaceans and molluscs (Ebert *et al*. 2013).

Diet/feeding: juveniles

It is not known if the diet differs from that of the adults.

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Viviparity with yolk-sac placenta
DURATION OF REPRO CYCLE	Annual (Mediterranean)
MATING	Unknown
GESTATION	Unknown
LITTER SIZE	10–12 (Mediterranean)
PUPPING/NURSERY GROUND	April–September (Mediterranean)
LENGTH AT BIRTH	21–24 cm (Mediterranean)
LENGTH AT MATURITY	F: 65 cm; M: 60 cm (Mediterranean)
MAXIMUM LENGTH	150 cm, rarely over 100 cm
GENERATION LENGTH	20 years

Mode

This species exhibits viviparity with a yolk-sac placenta (Capape *et al.* 1999).

Duration of reproductive cycle

In the Mediterranean and North Africa this is possibly annual (Capape *et al.* 1999).

Mating season and location
This is not known.

Gestation
This is unknown.

Litter size
In the Mediterranean and North Africa litter size ranged from 10–12 (Capape *et al.* 1999).

Length at birth
In the Mediterranean and North Africa length at birth was 21–24 cm (Capape *et al.* 1999).

Pupping season and nursery grounds
In the Mediterranean and North Africa neonates were found in small numbers between April and September (Capape *et al.* 1999).

Length at maturity
In the Mediterranean and North Africa length at maturity of females was in the region of 65 cm and males 60 cm (Capape *et al.* 1999).

Maximum length
This species reaches a maximum length of 150 cm but individuals over 100 cm are uncommon (Serena 2009 and references cited therein).

Age and growth
No age and growth studies have been undertaken.

Generation length
Age parameters are unknown and are inferred from another species in the family Squalidae, the shortnose spurdog *Squalus megalops* which has a female age-at-maturity of 19 years and a maximum age of 25 years, resulting in a generation length of 19.5 years (Rigby *et al*. 2016). This is similar to the generation length of 20 years that has been used for other *Oxynotus* spp. (Soldo and Guallart 2015, cited by Finucci *et al.* 2020b).

FISHERIES MANAGEMENT

SA catch sources, quantities and characteristics
This species is not listed in local catch estimates (DFFE records: 2010-2012) (da Silva *et al.* 2015). As it a deep-water species it is likely to be taken as bycatch in the demersal trawl fishery, but there are no published records.

Fishing outside South Africa
This species is infrequently reported as bycatch across its range in demersal trawl and bottom longline fisheries in the Mediterranean Sea and the NE Atlantic. It may be susceptible to capture because of its unique shape; it is often discarded and post-release survival may be high (Finucci *et al.* 2020b and references cited therein). It is rarely caught by large offshore trawling fleets in Namibia (Bradai *et al.* 2007).

Population trends
Species-specific population trend data are not available for this species, which is generally reported as uncommon or rare. A number of reports suggest the species has undergone local extinction in the Mediterranean, with large declines (>90%) or complete disappearance. Similarly, there are few data on the occurrence of this species in the NE Atlantic. West Africa has some of the highest levels of Illegal, Unreported, and Unregulated (IUU) fishing in the world, and IUU fishing by large industrial

trawlers has contributed to depleted fish stocks across the region. Overall, it is suspected that *O. centrina* has undergone a population reduction of 50–79% over the past three generation lengths (60 years), based on actual levels of exploitation and was globally assessed as Endangered in 2020 (Finucci *et al.* 2020b).

Off southern Africa, this species is only known from a few specimens. It may occasionally be caught as bycatch in trawl fisheries there, but in 2007 it was not possible to assess this species beyond Data Deficient in this region (Bradai *et al.* 2007).

ECOTOURISM
It cannot be considered an ecotourism species as it only occurs in very deep waters.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
Insufficient is known of the distribution of this species, which will potentially only benefit from offshore MPAs on the west coast.

Additional local comment

IUCN Red List Status
Endangered 2020: A2d

Previous IUCN assessments
Vulnerable 2007

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

International comments
Some general management arrangements have been implemented by the European Union Fisheries Council. They include a prohibition on direct fishing for deep-water sharks in European Community and international waters and a restrictive bycatch allowance. Other regional initiatives include localised bans on the use of deep-water gillnets and trawls, based on water depth (Finucci *et al.* 2020b and references cited therein).

MANAGEMENT CONSIDERATIONS
Only a single specimen has been documented in South African waters, over 70 years ago. As this species has a highly distinctive and unusual shape, it is unlikely that other specimens would have escaped notice by the trawl fishery. No management considerations therefore have been formulated for this species which is of very low priority.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

Nothing is known of the life history and ecology of this species locally. For reasons articulated above, it is unlikely that any research opportunities will arise. Life history information and tissue samples for genetic studies are needed. Any individuals caught should be used to ascertain if *O. centrina* occurs in the region or it is another unnamed species.

FAMILY DALATIIDAE

Dalatias licha

SCIENTIFIC NAME	*Dalatias licha* (Bonnaterre 1788)
COMMON NAME	Kitefin shark
FAMILY	Dalatiidae
ENDEMIC	No, Mozambique and patchy global distribution
SIZE RANGE	30–182 cm TL
SA DISTRIBUTION	E coast: Mozambique border to Algoa Bay
HABITAT	Demersal to mesopelagic
DEPTH RANGE	40–1800 m; commonly > 200 m
MAJOR FISHERIES	Deep-water trawl
IUCN STATUS	Vulnerable 2017
CITES	Not listed
MLRA	Production of squalene onboard vessels prohibited in offshore trawl fishery; daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	S Fennessy and C da Silva

SPECIES SUMMARY and RECOMMENDATIONS
Dalatias licha is a medium-sized, demersal to mesopelagic shark, which occurs along the entire east coast and Mozambique, mostly at depths of below 200 m. It was regularly recorded in deepwater crustacean trawls on the South African east coast. This species is both bycatch and a target species in other parts of its range. This resulted in it being assessed globally as Endangered in 2019. It is difficult to formulate any management considerations, other than to monitor its incidence in trawl catches. Life history information is lacking; tissue samples should be collected for population genetic studies.

TAXONOMIC and IDENTIFICATION ISSUES
The family Dalatiidae comprises seven genera, five of which are monotypic, and ten species worldwide. *Dalatias* is one of these monotypic genera; it attains more than twice the length of any of the other species in the family and, apart from its size, can be distinguished from other species in this family largely by the position of the first dorsal fin relative to the pelvic fins, the relative lengths of the dorsal fin bases and the presence or absence of a spine in the first dorsal fin (Bass *et al.* 1976, Ebert 2013).

SOUTH AFRICAN DISTRIBUTION
This species occurs on the entire east coast of South Africa from the Mozambique border to Algoa Bay (Ebert *et al*. 2021).

REGIONAL DISTRIBUTION
Regionally this species also occurs in Mozambique, and it has a patchy distribution in all three oceans (Ebert 2013).

SYNOPSIS OF RESEARCH
In South Africa Bass *et al.* (1976) provided taxonomic, morphometric and biological information from many specimens, but no pregnant females. No subsequent research has been undertaken locally on this species.

ECOLOGY

Depth

This species occurs at depths of 40–1800 m but is more common deeper than 200 m (Ebert *et al*. 2013).

Habitat: Adults

This is a demersal and mesopelagic species which may spend time hovering well off the bottom, buoyed up by its large oil-filled liver (Ebert *et al*. 2013).

Habitat: Juveniles/Nursery Grounds

No details are available.

Synopsis of tag deployments

No tagging has been undertaken.

Movements

Nothing is known of the movements of this species.

Diet/feeding: adults

This species feeds on deepwater teleosts and sharks and eggcases, and it has the dentition to remove large chunks of tissue from very large prey (Capapé *et al.* 2008, Ebert *et al*. 2013).

Diet/feeding: juveniles

This is unknown.

South African toxicological studies

No local studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Viviparity with a yolk-sac placenta
DURATION OF REPRO CYCLE	Unknown
MATING	Unknown
GESTATION	Unknown
LITTER SIZE	3–16, average 6–8
PUPPING/NURSERY GROUND	Autumn-summer (Mediterranean)
LENGTH AT BIRTH	30–40 cm
LENGTH AT MATURITY	F: 120 cm; M: 100 cm
MAXIMUM LENGTH	182 cm
GENERATION LENGTH	29 years, inferred from *Deania*

Mode

This species exhibits viviparity, with a yolk-sac placenta (Bass *et al.* 1976).

Duration of reproductive cycle

Little is known about the reproduction of the species in South Africa, however, in the Mediterranean they appear to reproduce in alternate years (Capapé *et al.* 2008).

Mating season and location

Parturition in the species has been recorded in summer and autumn in the Mediterranean and autumn in the Aegean Sea (Capapé *et al.* 2008).

Gestation
This is unknown.

Litter size
This is 3–16, but more commonly 6–8 (Finucci *et al.* 2018 and references cited therein). Larger females have larger litters (Capapé *et al.* 2008).

Length at birth
This is 30–40 cm (Ebert *et al*. 2013). The smallest local specimen was 36 cm, with an open umbilical scar (Bass *et al.* 1976). Larger females do not produce larger pups (Capapé *et al.* 2008).

Pupping season and nursery ground
This is unknown.

Length at maturity
This is 120 cm for females and 100 cm for males (Ebert *et al*. 2013). All southern African males larger than 105 cm and females larger than 134 cm were mature (Bass *et al.* 1976).

Maximum length
The largest individual was 182 cm (Ebert *et al*. 2013). The largest local individual was 159 cm (Bass *et al.* 1976).

Age and growth
This is unknown.

Generation length
Generation length is estimated to be 29 years, based on age data from *Deania* (Finucci *et al.* 2018 and references cited therein).

FISHERIES MANAGEMENT
SA catch sources, quantities and characteristics
This species was not listed in catches on the South African south and west coasts (DEFF records: 2010–2012; da Silva *et al*. 2015). Given its distribution and habitat it is likely to only be taken by fisheries operating in deep water, such as the demersal trawl and potentially the hake longlines. On the South African east coast in 70 research trawls at depths of 300–500 m between July and September, conducted intermittently between 1920 and 1932, *D. licha* contributed 0.01% to total catch numbers and occurred in 2.9% of trawls. By comparison, in 83 commercial trawls at the same depths (300–500 m) and over the same 3-month period (July-September) between 2003 and 2011, *D. licha* contributed 0.35% to total catch numbers and occurred in 49% of trawls. If these results are valid, as it is unclear how consistently elasmobranchs were recorded in the 1920s-1930s, given that the focus was on potentially valuable species, they represent a huge increase in abundance. This species appears to proliferated at the expense of members of the family Squalidae, which declined markedly between these two widely spaced sampling periods (Oceanographic Research Institute, unpubl. data). Misidentification of *D. licha* by observers in 2003-2011 is unlikely to have biased these observations, as this species is very different to the co-occurring *Squalus* spp. (S. Fennessy, ORI. pers. comm).

There were several *D. licha* recorded in numerous trawl surveys undertaken intermittently between 1977 and 2014 by the Norwegian research vessel Dr Fridtjof Nansen in Mozambique, Tanzania and Madagascar (Fennessy *et al*. 2017). However, it cannot be confirmed whether these specimens were indeed *D. licha*, as experienced taxonomists were seldom onboard.

Fishing outside South Africa

This species is taken as both targeted and incidental catch across its range in midwater and benthic trawl, surface and benthic longline, and setnet fisheries (Finucci *et al.* 2018 and references cited therein).

Population trends

This species is believed to be relatively common yet low in abundance. Population size and trends are unknown for this species across its range; it is considered to form distinct regional subpopulations, with little to no exchange between areas separated by the deep ocean or occurring in different ocean basins (Compagno and Cook 2005).

The species was once targeted in European fisheries, but these fisheries have since closed due to evidence of collapse. Over three generations, populations have declined by >99% in SE Australia and by 52% in the NE Atlantic and Mediterranean. Overall, the global population is inferred to have declined by at least 30%. With much of its distribution still susceptible to fishing, it is inferred that population declines will continue and therefore this species was assessed globally as Vulnerable in 2017 (Finucci *et al.* 2018 and references cited therein).

ECOTOURISM

It cannot be considered an ecotourism species as it occurs mainly in very deep waters.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

Permit conditions in the offshore hake trawl fishery prohibits the production of squalene on vessels. There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)

This species is not listed.

Marine Protected Areas

This species will derive little protection in the deep waters of all the MPAs on the South African east coast.

Additional local comment

IUCN Red List Status

<u>Vulnerable 2017: A2bd+3d</u>

Previous IUCN assessments

Near Threatened 2009
Data Deficient 2000

International comments

There are some species-specific and general management arrangements in place in parts of its range, but conservation measures are generally lacking. In Australia there is legislation to prevent targeted fishing for this species; area closures and depth restrictions in sectors of the trawling industry may indirectly offer this species some refuge. In 2010, the European Union Fisheries Council prohibited directed fishing for this species in European Community and international waters, and in 2012, further restrictions were imposed with no allowances for bycatch. In this region there are other restrictions in deepwater trawling and gillnetting which may offer limited indirect refuge from fishing (Finucci *et al.* 2018 and references cited therein).

MANAGEMENT CONSIDERATIONS

This species is not uncommon in deepwater crustacean trawls on the east coast but effort in this fishery has declined in the last two decades. Although *D. licha* is regarded as slow growing and not suitable for exploitation by fisheries, there is little concern over possible overexploitation as long as the prohibition against squalene production in the offshore fishery remains in effect and catches do not increase in the east coast crustacean fisheries. Effects of habitat destruction through offshore mining and bottom trawling need to be investigated. It is likely to occur in the deeper waters of several MPAs in its local range. In terms of local management, this species would appear to be a low priority.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

Very little is known of the life history of this species. Any opportunistic sampling should be used to collect information on the general biology and to collect tissue samples for genetic studies.

FAMILY GINGLYMOSTOMATIDAE

Nebrius ferrugineus

SCIENTIFIC NAME	*Nebrius ferrugineus* (Lesson 1831)
COMMON NAME	Tawny nurse shark
FAMILY	Ginglymostomatidae
ENDEMIC	No, Indo-Pacific
SIZE RANGE	60–320 cm TL
SA DISTRIBUTION	E coast: northern KZN
HABITAT	Shallow inshore waters
DEPTH RANGE	0–30 m
MAJOR FISHERIES	None in South Africa
IUCN STATUS	Vulnerable 2020
CITES	Not listed
MLRA	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	A Flam

SPECIES SUMMARY and RECOMMENDATIONS
Nebrius ferrugineus is a large, bottom-dwelling, shallow-water shark with a wide distribution in tropical, continental and insular waters of the Indo-Pacific. It is primarily associated with coral and rocky reefs. There were no records of local fishery catches (DFFE records: 2010–2012). Elsewhere in its range it has experienced heavy fishing pressure, particularly in SE Asia. The declining catches together with the destruction of coral reefs have resulted in this species being assessed globally as Vulnerable on the IUCN Red List in 2020. It will derive some protection from the iSimangaliso MPA but it appears to be rare there. Given its apparent absence in local catches it must be regarded as an extremely low priority species. As its life history is poorly known, any opportunistic sampling should be used to collect biological information and tissue samples for genetic studies.

TAXONOMIC and IDENTIFICATION ISSUES
There are three species, all from different genera, in the family Ginglymostomatidae. Historically the genus *Nebrius* was considered a subgenus of *Ginglymostoma* but was accorded full generic status. Two species, *N. ferrugineus* and *N. concolor*, were recognised but the latter is now regarded as a synonym of *N. ferrugineus. Pseudoginglymostoma brevicaudatum* also occurs in the SW Indian Ocean, but has far shorter nasal barbels and tail than *N. ferrugineus* (Compagno 2001).

SOUTH AFRICAN DISTRIBUTION
This species only occurs in the extreme northern part of the east coast (Ebert *et al*. 2021), with a single record from about 8 km south of the Mozambique border (Bass *et al.* 1975).

REGIONAL DISTRIBUTION
It is present in Mozambique, Madagascar and other islands in the western Indian Ocean (Compagno 2001).

SYNOPSIS OF RESEARCH
Bass *et at.* (1975) reported on the taxonomy of this species under the family Orectolobidae and provided some information on the biology of two individuals. Movement patterns were monitored in Seychelles using acoustic tracking (Lea *et al.* 2016). Reproduction has been studied in captivity and in

Japan (Teshima *et al.* 1995). For recent studies on the biology and ecology of this species conducted elsewhere in its range, see Simpfendorfer *et al.* (2021a) and references cited therein.

ECOLOGY

Depth

This bottom-dwelling shark occurs on continental and insular shelves, from the intertidal zone and the surf line down to a depth of 70 m, but more commonly between 5 and 30 m (Compagno 2001).

Habitat: Adults

The adults occur on or near the bottom in channels and lagoons, on or near rocky and coral reefs, where they shelter in caves and crevices during the day (Compagno 2001).

Habitat: Juveniles/Nursery Grounds

The juveniles prefer crevices in shallow lagoons (Compagno 2001).

Synopsis of tag deployments

No individuals have been tagged in the ORI Cooperative Fish Tagging Project 1984-2018 inclusive (Jordaan *et al.* 2020). Six individuals, comprising adults and juveniles, were fitted with acoustic tags in the Amirantes, Seychelles (Lea *et al.* 2016).

Movements

This species has a limited home range and individuals often return to the same resting area every day after foraging (Compagno 2001). In the Seychelles the majority of detections (70%) occurred within the atoll with regular movement throughout. Almost all (98%) of detections within the lagoon were from the three individuals smaller than 200 cm, whereas 84% of detections outside the lagoon were from the three individuals larger than 200 cm. These larger sharks frequently travelled more widely across the plateau (Lea *et al.* 2016).

Diet/feeding: adults

This species feeds on cephalopods (mainly octopus), crustaceans and reef associated fish, sea urchins and coral (Compagno 2001).

Diet/feeding: juveniles

There is no evidence that the diet of juveniles is different from the adults.

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Oophagous viviparity
DURATION OF REPRO CYCLE	Unknown
MATING	Unknown
GESTATION	6 months (captive animals in Saudi Arabia)
LITTER SIZE	1-4 (Japan); up to 32 (Australia)
PUPPING/NURSERY GROUND	Unknown
LENGTH AT BIRTH	60 cm (Japan)
LENGTH AT MATURITY	F: 230 cm; M: 225 cm
MAXIMUM LENGTH	320 cm
GENERATION LENGTH	Unknown

Mode

In captivity in Japan this species exhibits oophagous viviparity, in which the embryos are nourished by the production of large numbers of unfertilised eggs (Teshima *et al*. 1995), resulting in very small litters. By contrast in Australia viviparity with a yolk sac placenta results in a far larger litter size **(**Last and Stevens 2009).

Duration of reproductive cycle
This is unknown

Mating season and location
A single captive female shark in Saudi Arabia sustained a wound on her pectoral fin consistent with a mating bite in May (Cocks *et al.* 2019).

Gestation
Gestation is possibly about six months based on behaviour and pupping in a captive population in Saudi Arabia (Cocks *et al.* 2019).

Litter size
In captivity this is 1-4 in Japan (Teshima *et al*. 1995) and 1–2 in Saudi Arabia (Cocks *et al*. 2019) but in Australia the litter size is about 26, with a maximum of 32 (Last and Stevens 2009).

Length at birth
This is possibly 60 cm in Japan (Teshima *et al*. 1995). Ten captive-born sharks in Saudi Arabia measured 52–67 cm at birth (mean 60 cm), with one weighing 1.9 kg (Cocks *et al.* 2019).

Pupping season and nursery grounds
Captive sharks from the Red Sea pupped 12 times between 2008 and 2015, with all births occurring in late October to early December (Cocks *et al.* 2019).

Length at maturity
Females mature at about 230 cm and males 225 cm (Pillans 2003a).

Maximum length
This species attains a maximum length of 320 cm (Compagno 2001).

Age and growth
No age and growth studies appear to have been undertaken.

Generation length
No generation length has been determined.

FISHERIES MANAGEMENT

SA catch sources, quantities and characteristics
This species was not reported in local catch estimates (DFFE records: 2010–2012; da Silva *et al.* 2015).

Fishing outside South Africa
No details of any possible catches in Mozambican artisanal fisheries are available (Pierce *et al*. 2008). This species is taken in inshore fisheries (demersal trawls, floating and fixed bottom gill nets and baited hooks) in Indonesia, Thailand, Philippines, Pakistan and India (Pillans 2003a).

Population trends
There is no species-specific information on the population trend for *N. ferrugineus.* The species rarely reaches high levels of abundance, being relatively uncommon in many parts of its range. Results from baited remote underwater video (BRUV) system surveys of coral reefs across its range (242 reefs in 37

nations) suggest that the species has declined to very low levels through much of its range in Asia and Africa, but remains common in Australia, southern Red Sea and many of the island nations of the Pacific and Indian Oceans. It is estimated that it has undergone a population reduction of 30–49% over the last three generation lengths (90 years) due to levels of exploitation and declines in habitat quality, and it was assessed as Vulnerable on the IUCN Red List in 2020 (Simpfendorfer *et al.* 2021a).

ECOTOURISM
This species is a popular ecotourism species elsewhere in its range. Solitary individuals are rarely seen in shallow waters of the iSimangaliso MPA (Grant Smith, Sharklife and Rob Kyle, SAAMBR pers. comm.), and therefore, pending additional information, there appears to be insufficient for it to be considered as an ecotourism species in South Africa.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
This species will derive some benefit from the iSimangaliso MPA, although it is rarely seen in these waters (Grant Smith, Sharklife and Rob Kyle, SAAMBR pers. comm.).

Additional local comment

IUCN Red List Status
<u>Vulnerable 2020 A2bcd</u>

Previous IUCN assessments
Vulnerable 2003

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

International comments
This species is occasionally seen in Mozambique, but very rarely (Marine Megafauna Foundation, unpublished data).

MANAGEMENT CONSIDERATIONS
This species is confined to the extreme northern section of the east coast, where it is apparently rare. It has not been recorded in South African catches. As such, it must be regarded as a very low priority species.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
As this species is only found in the far northern region of the east coast, research opportunities will be extremely limited. Any opportunistic catches should be used to obtain life history information as well as genetic material to assess any regional population structure. Individuals released alive should be tagged.

Pseudoginglymostoma brevicaudatum

SCIENTIFIC NAME	*Pseudoginglymostoma brevicaudatum* (Günther 1866)
COMMON NAME	Shorttail nurse shark
FAMILY	Ginglymostomatidae
ENDEMIC	No, W Indian Ocean
SIZE RANGE	?–75 cm TL
SA DISTRIBUTION	E coast: extreme northern KZN
HABITAT	Shallow inshore waters
DEPTH RANGE	0–70 m
MAJOR FISHERIES	None in South Africa
IUCN STATUS	Critically Endangered 2018
CITES	Not listed
MLRA	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	R Bennett

SPECIES SUMMARY and RECOMMENDATIONS

Pseudoginglymostoma brevicaudatum is a very small, bottom-dwelling, shallow-water shark with a relatively limited distribution in the tropical W Indian Ocean. It is primarily associated with coral reefs and its presence in South Africa is based on photographic records from two very recent (2020 and 2021) sightings at Sodwana Bay. There were no records of local fishery catches (DFFE records: 2010–2012). Elsewhere in its range it has experienced heavy fishing pressure, which, together with the destruction of coral reefs, have resulted in this species being assessed globally as Critically Endangered on the IUCN Red List in 2018. It will derive some protection from the iSimangaliso MPA but it appears to be extremely rare there. There are no obvious management interventions which will benefit this species and improve its status from Critically Endangered. Given its apparent absence in local catches, and that its known South African distribution is entirely encompassed within the iSimangaliso MPA, is must be regarded as an extremely low priority species. As its life history is poorly known, any opportunistic sampling should be used to collect biological information and tissue samples for genetic studies.

TAXONOMIC and IDENTIFICATION ISSUES

There are three species, all from different genera, in the family Ginglymostomatidae. Of these, only two occur in the W Indian Ocean. *Pseudoginglymostoma brevicaudatum* can be distinguished from *Nebrius ferrugineus* by its smaller maximum size, slightly shorter tail (relative to total length) and more rounded dorsal and pectoral fin tips. *P. brevicaudatum* was originally described under the genus *Ginglymostoma* but was assigned to its own genus (Dingerkus 1986, cited by Compagno 2001).

SOUTH AFRICAN DISTRIBUTION

This species was only recently sighted in the extreme northern part of the east coast of South Africa, with two records from Sodwana (Rhett Bennett, Wildlife Conservation Society, unpublished data).

REGIONAL DISTRIBUTION

The presence of this species was long recognised from Tanzania, Kenya and Madagascar and possibly Seychelles (Bass *et at.* 1975, Compagno 2001), but the record from the Seychelles proved to be incorrect (Bennett *et al.* 2021). Its presence was recorded at several locations in Mozambique, including the Ponta do Ouro Partial Marine Reserve, which abuts the South African coastline, in 2017 (Bennett *et al.* 2021).

SYNOPSIS OF RESEARCH

Bass *et at.* (1975) reported on the taxonomy of this species under the family Orectolobidae and provided morphometric information and very limited biological information from four individuals from Zanzibar and Madagascar. Bennett *et al.* (2021) provided morphometrics from a specimen caught in Mozambique in 1967, and the first description of the dentition based on specimens from Madagascar.

ECOLOGY

Depth

This bottom-dwelling shark inhabits coral reefs in shallow coastal waters (Compagno 2001), but its full depth range is not known (Ebert *et al.* 2013).

Habitat: Adults

In captivity the adults are slow-moving and nocturnally active. They sit on the bottom in the open or hide in holes and crevices during the day (Compagno 2001).

Habitat: Juveniles/Nursery Grounds

It is not known if the juveniles occupy a different habitat (Compagno 2001).

Synopsis of tag deployments

No individuals have been tagged in the ORI Cooperative Fish Tagging Project 1984-2018 inclusive (Jordaan *et al.* 2020). There do not appear to be any records of tagging elsewhere in the W Indian Ocean.

Movements

It does not appear to be an active swimmer. Based on research conducted on *N. ferrugineus*, *P. brevicaudatum* is likely to have a very limited home range.

Diet/feeding: adults

In captivity this species feeds on annelid worms, mussels, fish and shrimps. In the wild the species presumably eats small teleosts, molluscs and crustaceans (Compagno 2001).

Diet/feeding: juveniles

There is no evidence that the diet of juveniles is different from the adults.

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Oviparity
DURATION OF REPRO CYCLE	Unknown
MATING	Unknown
GESTATION	Unknown
LITTER SIZE	Unknown
PUPPING/NURSERY GROUND	Unknown
LENGTH AT BIRTH	Unconfirmed, possibly <14 cm
LENGTH AT MATURITY	F: 55 cm; M: 59 cm
MAXIMUM LENGTH	75 cm
GENERATION LENGTH	Possibly 10 years (inferred from *Ginglymostoma cirratum*)

Mode

This species exhibits oviparity, based on observations made in captivity (Janse *et al.* 2017).

Duration of reproductive cycle
This is unknown.

Mating season and location
This is not known.

Gestation
This is not known.

Litter size
This is unknown.

Length at birth
Based on an illustration of a juvenile approximately 14 cm in length, size at birth is smaller than 14 cm (https://shark-references.com/index.php/species/view/Pseudoginglymostoma-brevicaudatum).

Pupping season and nursery grounds
This is unknown.

Length at maturity
Females mature at 55 cm, and males at 59 cm (Ebert *et al.* 2013).

Maximum length
This species reaches a maximum size of 75 cm (Compagno 2001).

Age and growth
No age and growth studies appear to have been undertaken, but this species can survive for over 30 years in captivity (Compagno 2001).

Generation length
This species is estimated to have a generation length of ~10 years based on information available for the closely-related but much larger (to 300 cm) nurse shark *Ginglymostoma cirratum*, which has a generation length of 30 years (Carrier and Luer 1990, cited by Pollom *et al.* 2019a).

FISHERIES MANAGEMENT

SA catch sources, quantities and characteristics
This species was not reported in local catch estimates (DFFE records: 2010–2012; da Silva *et al.* 2015).

Fishing outside South Africa
P. brevicaudatum is captured as targeted and non-targeted catch in a variety of fisheries, especially artisanal fisheries, and is also affected by habitat degradation and loss. Dynamite fishing is prevalent along the entire Tanzanian coastline and has been recorded in Madagascar (Pollom *et al.* 2019a and references cited therein). It is not listed among species taken in artisanal fisheries in Mozambique (Pierce *et al.* 2008), however, this species is caught in artisanal fisheries in Kenya and Tanzania (WCS unpublished data). It is common in aquaria, with 26 individuals in 10 different facilities in Europe (Janse *et al*. 2017). Several of these sharks are thought to have been sourced by illegal means from Kenya.

Population trends
There is no species-specific information on population trends for *P. brevicaudatum.* Overall, this species is subjected to heavy subsistence and artisanal fishing pressure across its geographic and depth range. Available data suggest catch declines and local depletion of sharks due to fisheries. This

species has very little refuge from fishing effort, and is also subject to habitat loss and degradation. It is therefore suspected that *P. brevicaudatum* has undergone a population reduction of >80% over the past three generations (30 years) based on a decline in habitat quality and actual and potential levels of exploitation and it was globally assessed as Critically Endangered on the IUCN Red List in 2018 (Pollom *et al.* 2019a).

ECOTOURISM

This species is a popular ecotourism species elsewhere in its range, but as there are only two records from the iSimangaliso Wetland Park, it cannot be recognised as such in South Africa.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)

This species is not listed.

Marine Protected Areas

This species is strongly associated with coral reefs and all reefs of this type on the east coast of South Africa occur in the iSimangaliso MPA, where this species has been sighted on two occasions.

Additional local comment

IUCN Red List Status

Critically Endangered 2018 A2cd

Previous IUCN assessments

Vulnerable 2004

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

This species is not listed.

Convention on Migratory Species (CMS)

This species is not listed.

International comments

MANAGEMENT CONSIDERATIONS

This species is confined to the extreme northern section of the east coast, where it is apparently rare. It has not been recorded in South African catches. There are no obvious management interventions which will benefit this species and improve its status from Critically Endangered and therefore it must be regarded as a very low priority species.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

As this species is only found in the far northern region of the east coast, research opportunities will be extremely limited. Any opportunistic catches should be used to obtain life history information as well as genetic material to assess any regional population structure.

FAMILY STEGASTOMATIDAE

Stegostoma tigrinum

SCIENTIFIC NAME	*Stegostoma tigrinum* (Forster 1781)
COMMON NAME	Zebra shark/leopard shark
FAMILY	Stegastomatidae
ENDEMIC	No, Indo-Pacific
SIZE RANGE	20–250 cm TL
SA DISTRIBUTION	E, S coasts: Mozambique border to Cape St Francis
HABITAT	Shallow inshore waters
DEPTH RANGE	0–60 m
MAJOR FISHERIES	None in South Africa
IUCN STATUS	Endangered 2015
CITES	Not listed
MLRA	Daily bag limit of one individual in recreational fishery
AUTHOR	G Cliff
REVIEWER	A Flam

SPECIES SUMMARY and RECOMMENDATIONS

Stegostoma tigrinum is a medium-sized, bottom-dwelling, shallow water shark with a wide distribution in tropical, continental and insular waters of the Indo-Pacific. It is primarily associated with coral and rocky reefs. There were no records of local fishery catches (DFFE records: 2010–2012), but it was caught in very small numbers in the now closed KZN prawn trawl fishery. Elsewhere in its range it has experienced heavy fishing pressure, particularly in SE Asia. The declining catches together with destruction of coral reef resulted in this species being assessed globally as Endangered in 2015. It will derive some protection from the iSimangaliso MPA but it appears to be rare there. Given its absence in local catches, it must be regarded as an extremely low priority species. Any opportunistic sampling should be used to collect biological information and tissue samples for genetic studies.

TAXONOMIC and IDENTIFICATION ISSUES

Stegostoma tigrinum was until fairly recently known as *Stegostoma fasciatum.* It is it the only species in the family Stegastomatidae. With its unique colour pattern (zebra-like stripes as a juveniles and spots as adults) and very long tail, this species is very distinctive (Bass *et al.* 1975).

SOUTH AFRICAN DISTRIBUTION

This species occurs along the entire east coast and a small part of the south coast (Cape St Francis) but it is rare south of KZN (Bass *et al.* 1975, Ebert *et al*. 2021). It is uncommon but not rare in shallow water around Durban in the warmer months of December to March (Bass *et al.* 1975).

REGIONAL DISTRIBUTION

It is present in Mozambique and Tanzania, as well as Madagascar (Compagno 2001). The Inhambane Province in Mozambique is home to one of the largest identified populations in the world (C. Dudgeon, University of Queensland, unpubl. data). Since 2010 over 73 individual sharks have been identified (Pottie 2018).

SYNOPSIS OF RESEARCH

Bass *et al.* (1975) provided detailed taxonomic, morphometric and biological information from 14 individuals, including adult females. No subsequent dedicated scientific study has been conducted in

South Africa. Research into movement patterns and site fidelity has been undertaken in Southern Mozambique (Pottie 2018).

ECOLOGY

Depth

This bottom dwelling shark occurs on continental and insular shelves, from the intertidal zone down to a depth of about 60 m (Compagno 2001).

Habitat: Adults

The adults and subadults occur on sand bottoms near rocky and coral reefs (Compagno 2001). Sightings of this species in Mozambique occur most often close to reefs with a high percentage of soft coral (Clavey 2020).

Habitat: Juveniles/Nursery Grounds

Juveniles are found in shallow, inshore waters including mudflat, mangrove and seagrass beds Dudgeon *et al.* 2019).

Synopsis of tag deployments

No individuals have been tagged in the ORI Cooperative Fish Tagging Project 1984-2018 inclusive.

Movements

Acoustic tagging has shown that this species demonstrates strong seasonal (summer) site fidelity to particular reefs on the east coast of Australia but it also makes regular long-distance movements of 1000-2000 km to return to these particular reefs (Dudgeon *et al.* 2019). The Mozambique population also demonstrates strong summer site fidelity (Pottie, 2018).

Diet/feeding: adults

This species feeds on gastropods and bivalves, crustaceans (crabs and shrimp) and small teleosts (Compagno 2001).

Diet/feeding: juveniles

There is no evidence that the diet of juveniles is different from the adults.

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Oviparity
DURATION OF REPRO CYCLE	Unknown
MATING	Unknown
GESTATION	Unknown
LITTER SIZE	Unknown
PUPPING/NURSERY GROUND	Unknown
LENGTH AT BIRTH	20–36 cm
LENGTH AT MATURITY	F: 170 cm; M: 147-183 cm
MAXIMUM LENGTH	250 cm, reports of 354 cm may be exaggerated
GENERATION LENGTH	17 years

Mode

This species exhibits oviparity (Bass *et al.* 1975)

Duration of reproductive cycle
This is unknown

Mating season and location
This is unknown.

Gestation
This is unknown.

Litter size
This is unknown; a female was found with four fully formed egg cases in one uterus (Compagno 2001).

Length at birth
This is 20–36 cm (Compagno 2001).

Pupping season and nursery grounds
In captivity females have undertaken egg laying for periods of up to 3 months (Dudgeon *at al.* 2019).

Length at maturity
Females mature at about 170 cm and males between 147 and 183 cm (Compagno 2001).

Maximum length
Most adults are apparently below 250 cm (Compagno 2001). A maximum length of 354 cm attributed to this species may be exaggerated (Bass *et al.* 1975).

Age and growth
Based on individuals kept in captivity, females mature at 6-8 years and males at 7 years and both sexes live to over 28 years (Dudgeon *et al.* 2019 and references cited therein).

Generation length
Generation length was estimated at 17 years, based on age at maturity of 6 years and maximum female longevity of 28 years (Dudgeon *et al.* 2019).

FISHERIES MANAGEMENT
SA catch sources
This species was not reported in local catch estimates (DFFE records: 2010–2012) (da Silva *et al.* 2015).

SA catch quantities and characteristics
KZN prawn trawl fishery
This species was a rare bycatch in the KZN prawn trawl industry on the uThukela Banks (Fennessy 1994), with a single individual recorded. Based on the observer-recorded catches, the extrapolated average annual catch between 1989 and 1992 was 12 (range 9-17). This fishery was dormant for nearly two decades due to the extended closure of the mouth of Lake St Lucia, resulting in poor prawn recruitment and diminishing prawn catches on the uThukela Banks. The fishing grounds were closed to trawling following the declaration of the uThukela MPA in August 2019.

KZN bather protection nets
A single individual was caught in the KZN bather protection nets in the period 1978-2017.

Fishing outside South Africa
No details of any possible catches in Mozambican artisanal fisheries are available (Pierce *et al*. 2008). This species is usually found within a narrow band of shallow coral reef habitat and soft bottom that is heavily fished throughout all of its range, except Australia. It is taken in inshore fisheries (demersal

trawls, floating and fixed bottom gillnets and baited hooks) and regularly seen in fish markets in Indonesia, Thailand, Philippines, Pakistan, India, Taiwan, and elsewhere (Dudgeon *et al.* 2019). Interviews with artisanal fishermen in Mozambique indicate the species is not targeted, and is rarely caught (Pottie 2018).

Population trends

Based on population genetic analysis, this species comprises two distinct subpopulations: an Indian Ocean-SE Asian subpopulation and E Indonesian-Oceania subpopulation (Dudgeon *et al*. 2019). The greatest levels of exploitation and ongoing threats occur in Southeast Asia, particularly Thailand through to Indonesia. It is suspected that this subpopulation has declined by at least 50% over the last three generations (51 years) and these threats are expected to continue at these levels. Therefore, the Indian Ocean-Southeast Asian subpopulation was classified as Endangered in 2015. The species also faces threats as a result of human-inflicted degradation of its seagrass, mangrove and coral reef habitats, as well as extensive coral bleaching during periods of elevated water temperatures in 2010 (Dudgeon *et al.* 2019).

The E Indonesian-Oceania subpopulation is exposed to minimal exploitation in regions such as Australia, where the species is considered Least Concern. In the Arafura Sea in E Indonesian waters extensive and increasing levels of trawling have taken place over the last 30 years. Based on these ongoing fishing and habitat threats posed by these trawl fisheries in the Arafura Sea, reductions of at least 20% of its population size within three generations (51 years) were suspected and the E Indonesian-Oceania subpopulation was assessed in 2015 as Near Threatened (Dudgeon *et al.* 2019).

In addition to its susceptibility to capture in a wide range of fisheries, this species has a narrow habitat range, it shows strong site fidelity and forms aggregations which facilitate the rapid removal of individuals (Dudgeon *et al.* 2019).

By combining the subpopulation assessments according to relative area (the Indian Ocean-SE Asian subpopulation has approximately 70% of the available habitat; the E Indonesian-Oceania subpopulation has approximately 30% of the available coastal habitat), and given the ongoing threats from fishing and habitat loss across much of its range and suspected reductions of over 50% of its population size within three generations, this species was assessed globally in 2015 as Endangered (Dudgeon *et al.* 2019).

ECOTOURISM

It is a very popular aquarium species and elsewhere in its tropical range it is frequently seen by scuba divers lying on the sand, where it is easily approached. It is not often seen in South African waters but should be regarded as an ecotourism species.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

There is a daily bag limit of one individual in the recreational fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)

This species is not listed.

Marine Protected Areas

This species will derive some benefit from all the inshore MPAs on the east coast, but even in the iSimangaliso MPA, which is in the far north and has extensive coral reef habitat, this species is not regarded as common, with solitary individuals occasionally seen throughout the year (Grant Smith, Sharklife and Rob Kyle, SAAMBR pers. comm.). In Mozambique, the species derives some protection from the Bazaruto Archipelago National Park, but they are more commonly seen further south in the province, and are not well protected in key areas such as Morrungulo and Praia do Tofo (Pottie 2018, Marine Megafauna Foundation unpublished data).

Additional local comment

IUCN Red List Status
Endangered 2015: A2bd+3bd

Previous IUCN assessments
Vulnerable 2003

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

International comments
Individuals are landed whole and used for their fins, skin (dried), meat and cartilage. Individuals are kept in aquaria around the world. Although they breed well in captivity, both eggs and adults are taken from the wild. They are valuable as ecotourism species in the recreational diving industry (Dudgeon *et al.* 2019).

MANAGEMENT CONSIDERATIONS
This species occurs along the entire east coast and a small part of south coast. Based on research into patterns of residency In Australia, it is likely to be a summer visitor to most of its South African habitat. Catches in South African fisheries are extremely low and, according to interviews with artisanal fishers in Mozambique, it is rarely caught there (Pottie 2018). As a result, it must be regarded as a very low priority species.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
Despite being present on the entire east coast, possibly only during summer, this species does not appear to be common and research opportunities will be extremely limited. Any opportunistic catches should be used to obtain life history information as well as genetic material to assess any regional population structure. This species is common in southern Mozambique in the summer months and the area could be used for reproductive purposes (Pottie 2018; Marine Megafauna Foundation unpublished data). Telemetry studies should be undertaken in southern Mozambique to determine critical habitat for protection.

FAMILY RHINCODONTIDAE

Rhincodon typus

SCIENTIFIC NAME	*Rhincodon typus* (Smith 1828)
COMMON NAME	Whale shark
FAMILY	Rhincodontidae
ENDEMIC	No
SIZE RANGE	60–2000 cm
SA DISTRIBUTION	E, S, W coasts: Mozambique border to Lamberts Bay
HABITAT	Pelagic in coastal and oceanic waters
DEPTH RANGE	0–2000 m, but generally coastal in South Africa
MAJOR FISHERIES	None
IUCN STATUS	Endangered 2016
CITES	Appendix II
MLRA	No targeted catch in any fishery
COMPILER	G Cliff
REVIEWER	CEM Prebble

SPECIES SUMMARY and RECOMMENDATIONS

Rhincodon typus is the world's largest fish, and one of only three filter feeding sharks. This wide ranging and highly mobile species has a global distribution in coastal and oceanic waters in tropical and warm-temperate regions. Individuals show regional philopatry to specific seasonal coastal feeding sites where large aggregations can occur. No such aggregation sites have been identified within South African waters. Due to their long-distance movements and connectivity, the whale sharks in South Africa are considered to be part of the same management unit as those in Mozambique, which is dominated by immature males. Individuals are most often seen swimming at the surface within 2 km of the shore on the east coast. Despite being a comparatively well studied elasmobranch, very little is known of its life history, especially its reproductive biology. It has never been a target species in any South African fisheries, and was not recorded in DFFE catches (2010-2012). The main threats in this region are still anthropogenic, including entanglement in fishing gear, especially gill nets, and ship strikes. Strandings have been recorded along much of the South African coastline, including cooler waters of the Western Cape. As a result of historically high levels of exploitation elsewhere in its range and despite habitat protection in many parts of the world, this species was assessed globally by the IUCN Red List as Endangered in 2016. This assessment was in large part due to a significant (>50%) decrease in the numbers of sightings in the Western Indian Ocean. Due to their highly mobile and largely unpredictable behaviour in this region, there will be limited benefits to this species from the many established coastal MPAs on the east and south coasts. Most sightings take place in the clearer waters of the iSimangaliso MPA. Research opportunities are largely limited to opportunistic in-water encounters. Strandings, although infrequent, do provide extremely valuable opportunities for histological and biochemical-based research.

TAXONOMIC and IDENTIFICATION ISSUES

R. typus is not easily confused with any other shark, due to its large size, wide, almost terminal mouth and large number of white spots over the entire dorsal surface. It belongs to the monotypic family Rhincodontidae.

SOUTH AFRICAN DISTRIBUTION

It occurs along the entire east and south coasts and much of the west coast up to Lamberts Bay (Beckley *et al.* 1997). As it is a tropical species it is most common on the east coast, particularly in northern KZN, in the summer months (Cliff *et al*. 2007).

REGIONAL DISTRIBUTION

It occurs along the entire Mozambique coast as well as countries to the north in the western Indian Ocean, including Madagascar.

SYNOPSIS OF RESEARCH

This species has been widely studied globally, with reviews by Stevens (2007) and Rowat and Brooks (2012), but less so in South Africa. The docile nature, charismatic status and predictable occurrence of aggregations of whale sharks has been the catalyst for the development of popular and lucrative ecotourism industries in several countries. In the southwest Indian Ocean these locations include Mozambique, Kenya and Tanzania, where these industries have facilitated research (Cagua *et al*. 2014, Haskell *et al*. 2014, Pierce and Norman 2016). The presence of this species in and around Sodwana Bay in the iSimangaliso MPA proved too erratic to develop a dedicated whale shark viewing industry there (Cliff *et al.* 2007).

Research into movement patterns has focussed on residency at the aggregating sites, using electronic tagging and photo-identification of individuals. Photo-identification (photo-ID) is often also used as a method for long term population monitoring (Norman *et al*. 2017), utilising unique and stable skin colouration patterns on the dorsal surface (Arzoumanian *et al*. 2005, Marshall and Pierce 2012), which allows accurate identification and recognition of individuals across time and space. This method of mark-recapture has been used to assess population structure and inter-annual abundance at several feeding areas, including Mozambique and Tanzania (Rohner *et al.* 2013, Cagua *et al.* 2015, Rohner *et al.* 2020). Biochemical and electronic tagging studies have shown very little connectivity between these two sites (Prebble *et al*. 2018, Norman *et al*. 2017).

South Africa appears to have one of the highest incidents of stranding (Beckley *et al.* 1997). These animals, which generally move parallel to the shore behind the surfline, possibly venture too close inshore and are caught by the waves which causes them to become disorientated. Water temperature and changes in inshore currents are also likely to play a role here. On one occasion six individuals stranded over a 10 km stretch of coast in the iSimangaliso MPA (KZN Sharks Board, unpublished records). Coastal aggregations are invariably dominated by immature individuals, usually males, very little is known of the reproductive biology of this species.

ECOLOGY

Depth

It is a pelagic species which occurs in both coastal and oceanic waters. On the east coast of South Africa, Mozambique, and Tanzania individuals are most commonly found at the surface within 2 km of the shore (Cliff *et al.* 2007; Cagua *et al*. 2015; Rohner *et al.* 2017), spending most of their time in the epipelagic zone (0-200 m), and much of the daytime in the top 10 m of water (Rowat and Brooks 2012), but they have also been recorded diving close to 2000 m (Tyminski *et al.* 2015), where they may be exposed to temperatures as low as 2°C. (Wilson *et al*. 2006), though little time is spent at these depths. The purpose of these deep dives is unclear, but is suspected to be related to feeding or foraging behaviours, especially when crossing the open ocean with its low productivity, oligotrophic waters (Tyminski *et al.* 2015).

Habitat: Adults

Larger sharks are generally absent from coastal areas and it is therefore not surprising that adults of both sexes are uncommon on the South African coast (Beckley *et al.* 2007, Cliff *et al.* 2007). They appear to be predominantly oceanic and can be reliably observed at only a handful of sites worldwide, the closest being St Helena Island in the mid-Atlantic. As yet, no mating sites have been formally identified for this species, save two isolated but reliable reported observations of mating behaviour at St Helena (Clingham, Brown, *et al.* 2016).

Habitat: Juveniles/Nursery Grounds

On the South African coast most of the individuals are immature males (Beckley *et al.* 1997, Cliff *et al.* 2007). Other Western Indian Ocean sites, including those in Seychelles and Maldives, are also typically dominated by juvenile male sharks (Pierce and Norman 2016). This is consistent with the pronounced size- and sex-based segregation seen in most coastal feeding aggregation sites. Only a handful of whale sharks smaller than 1.5m have been reported in the wild (Rowat & Brooks 2012) so it remains unclear whether whale sharks have specific pupping areas.

Synopsis of tag deployments

No tagging of this species has been undertaken in South African waters. In Mozambique satellite tracking has shown that individuals spend much time in cooler, productive coastal waters (Rohner *et al.* 2018). They make forays a considerable distance offshore as well as regular international movements into South African waters.

Movements

A variety of techniques, primarily acoustic and satellite tracking, as well as photo ID, has shown that this species is highly mobile, with some individuals showing seasonal site fidelity over multiple years (up to 20 years in Australia), returning to the same coastal aggregation sites (Cagua *et al*. 2015; Prebble *et al.* 2018; Rohner *et al*. 2020). In Mozambique, most sharks show high residency to a 200 km stretch of coastline (Rohner *et al*. 2017), and very high residency can be found in Tanzania (Cagua *et al*. 2015, Rohner *et al.* 2020). Sharks leaving these sites travel vast distances, swimming at median horizontal rates of 28 km per day; they have been shown to cross international boundaries from national Exclusive Economic Zones (EEZ) into the high seas (Rohner *et al.* 2017).

Diet/feeding: juveniles

The whale shark is one of only three filter-feeding shark species, all of which are among the largest extant marine vertebrates. Whale sharks have a pad-like filtering apparatus and are able to passively ram feed or actively feed by suction (Motta *et al*. 2010). They have been observed targeting a wide variety of prey items including sergestid shrimp (Rohner *et al*. 2015a), tuna spawn (Robinson *et al*. 2016), copepods, chaetognaths, euphausiids, fish larvae (Motta *et al*. 2010) and various other surface zooplankton species, as well as small schooling fishes (Rowat and Brooks 2012). A component of whale shark diet may also derive from deep-water sources and emergent zooplankton (Couturier *et al*. 2013). Stomach contents of four stranded sharks from Mozambique and South Africa were dominated by mysids and sergestids (Couturier *et al.* 2013; Rohner *et al.* 2015).

Diet/feeding: adults

Isotope analysis of whale shark tissues indicates some ontogenetic and sexual differences in feeding behaviour, with larger sharks feeding at a higher tropic level overall, and/or in different locations (Borrell *et al*. 2011, Marcus 2016).

South African toxicological studies

No local studies have been undertaken. Studies in the Gulf of California documented trace levels of phthalates and POPs in whale shark skin tissues (Fossie *et al.* 2017), likely from contamination through the ingestion of plastics.

REPRODUCTION

REPRODUCTIVE MODE	Aplacental viviparity

DURATION OF REPRO CYCLE	Unknown
MATING	Unknown
GESTATION	Unknown
LITTER SIZE	304 from a single litter (Taiwan)
PUPPING/NURSERY GROUND	Unknown
LENGTH AT BIRTH	60–65 cm
LENGTH AT MATURITY	F: ±900; M: 920cm
GENERATION LENGTH	Unknown but assumed to be 25 years

Mode
This species exhibits aplacental viviparity, but because each embryo initially develops inside brown, horny egg cases and hatches *in utero* where it undergoes further development, this mode of reproduction has been described as retained oviparity (Stevens 2007).

Duration of reproductive cycle
Reproductive periodicity is unknown: resightings rarely occur in the areas where adult female whale sharks are observed (Acuña-Marrero *et al.* 2014). There is evidence that female sharks can store sperm making the assessment of reproductive periodicity and gestation difficult (Schmidt *et al*. 2010).

Mating season and location
This is unknown, although there are two reliable reports of mating at St Helena Island in the mid-Atlantic (Clingham *et al*. 2016).

Gestation
This is unknown.

Litter size
The single pregnant female examined from Taiwan had 304 embryos in varying stages of development (Joung *et al*. 1996).

Length at birth
Size at birth appears to be about 60–65 cm, based on the observation that the largest size class of embryos, 58–64 cm, appeared close to full development (Joung *et al*. 1996).

Pupping season and nursery grounds
Seasonal aggregations of large, apparently pregnant, females have been reported from the Eastern Pacific, particularly off Darwin Island in the Galapagos Archipelago and the Gulf of California, as well as St Helena Island (Pierce and Norman 2016 and references cited therein).

Length at maturity
This appears to vary regionally. Historically underwater assessment of clasper condition was used to assess maturity in males. Using laser photogrammetry to improve length estimates, 50% maturity was attained at 9.2 m in Mozambique (Rohner *et al*. 2015). In South Africa Beckley *et al.* (1997) found that three males of 9.0, 9.4 and 10.3 m were mature but the others of 9.0, 9.1 and 9.2 m were immature. Based on clasper morphology, 50% of males were mature at a visually estimated length of 8.1 m in Western Australia and 7 m in the Gulf of Mexico (Pierce and Norman 2016 and references cited therein).

Ascertaining maturity in female sharks is extremely difficult. All seven stranded female specimens reported from South Africa were immature and ranged from 4.8 to 8.7 m (Beckley *et al*. 1997). There are no confirmed reports of mature females the western Indian Ocean. Based on visual estimates and laser photogrammetric measurements, female length at maturity elsewhere is in the region of 9 m

(Hearn *et al.* 2016, Acuña-Marrero *et al*. 2014 and Ramírez-Macías *et al*. 2012). The single known pregnant female from Taiwan was 10.6 m (Joung *et al*. 1996).

Maximum length

The largest recorded shark was approximately 20 m and 42 t in mass from Taiwan (Chen *et al.* 1997). Individuals larger than 15 m are rare (Pierce and Norman 2016 and references cited therein).

Age and growth

Basic demographic parameters for whale sharks, such as longevity and mortality are poorly known. Previous studies have utilised vertebrae, either collected from stranded sharks in South Africa (Wintner 2000) or from fisheries in Taiwan (Hsu *et al.* 2014), but these individuals were mainly immature and the results were confounded by the absence of strong evidence indicating whether the vertebral growth bands are annual or biannual. In other shark species of the same order, Orectolobiformes, this banding is aperiodic (Huveneers *et al.* 2013), making it extremely difficult to accurately age individuals. More recent bomb radiocarbon assays have provided the first validation of the annual growth band formation, with ages of up to 50 years (Ong *et al*. 2020).

Generation length

This is estimated at 25 years (Norman and Pierce 2016), but may be revisited as a result of the recent study by Ong *et al*. (2020).

FISHERIES MANAGEMENT

SA catch sources

There have never been any targeted fisheries for this species in South Africa and as such it was not listed in estimated catches/landings recorded by DFFE for the period 2010-2012 (da Silva *et al.* 2015). In South African waters it is most commonly found at the surface close to shore and is therefore unlikely to be caught in any trawl fishery. As a filter feeder it is unlikely to be caught in the linefishery. It is taken as an occasional bycatch in the KZN bather protection programme. One of the major sources of mortality in South Africa appears to be strandings, where individuals venture too close inshore, possibly while feeding, and become disorientated in the surf zone (Beckley *et al.* 1997).

SA catch quantities and characteristics

KZN bather protection nets

A total of 33 sharks were caught in the KZN bather protection nets between 1978 and 2017; 22 were released alive. This equates to <1 per annum. There were 36 strandings (3 per annum) reported along the entire South African coast between 1984 and 1995 (Beckley *et al.* 1997).

Fishing outside South Africa

As a result of national protective legislation, a number of commercial fisheries for the species closed during the 1990–2000s. The largest of these were in India, the Philippines and Taiwan, with hundreds of sharks caught annually in each country. There is still demand for whale shark products¸ and the species is still opportunistically caught in some areas, particularly in the South China Sea. Serious injury and possible mortality through vessel strikes is a threat, particularly in regions such as Mexico, where this species is known to aggregate to feed at the surface. Bycatch in net fisheries remains a problem, as well as tail roping (the practice of looping large gauge ropes around the caudal peduncle to remove them from nets) in some countries (Pierce and Norman 2016 and references cited therein).

In the southwest Indian Ocean, the dominant threat has been identified as entanglement in coastal fishing nets. Data collected from Mozambique has shown that around 5% of the total population is either entangled in a section of gill-net or shows some evidence of escape from previous entanglement (Pierce *et al.* 2008*).* Regional bycatch assessments in the Mozambique Channel indicate that small scale fisheries catch a variety of vulnerable megafauna including many shark and ray species (Temple *et al*. 2019). Whale sharks are rarely caught in these fisheries. Ship collisions appear to be a major cause of injury in Indian Ocean whale sharks, including Mozambique (Speed *et al.* 2008), though an assessment of mortality remains unquantified.

Population trends

Current knowledge on long term, global scale connectivity of whale shark populations is based largely on genetic studies (Castro *et al*. 2007, Schmidt *et al*. 2009, Vignaud *et al*. 2014) which has found a lack of spatial population structure between the Indian and Pacific ocean basins, but with some separation of the Atlantic subpopulation. As a result the Indo-Pacific population is treated as a single entity, necessitating an ocean basin-wide conservation strategy (Castro *et al*. 2007, Schmidt *et al*. 2009).

On the other hand, juvenile sharks commonly seen at coastal areas, as in South Africa, are generally considered philopatric to a particular coastal aggregation and feeding site over many years, where they often face particular regional threats (Norman *et al.* 2017, Prebble *et al.* 2018). As such, regional management plans and conservation activities would perhaps be more effective.

Based on count data, modelled population estimates and habitat availability, 75% of the global population is inferred to occur in the Indo-Pacific, and 25% in the Atlantic (Pierce and Norman 2016 and references cited therein). A variety of datasets presented declines of 40-92%, inferring an overall decline of 63% in the Indo-Pacific over the last 75 years (three generations), resulting in a subpopulation assessment of Endangered. In the Atlantic, the overall population decline is considered to be lower at ≥30%, resulting in a subpopulation assessment of Vulnerable. Given the bulk of the global population occurs in the Indo-Pacific, the overall global decline is inferred to be ≥50%. Globally, the Whale Shark was therefore assessed as Endangered in 2016 (Pierce and Norman 2016).

ECOTOURISM

It is a very important ecotourism species in many parts of the world, with dedicated whale shark viewing in areas which include Mozambique, Tanzania, Seychelles, Red Sea, Western Australia and the Gulf of Mexico. The presence of this species in and around Sodwana Bay in the iSimangaliso MPA proved too erratic to develop a dedicated whale shark viewing industry there. Nevertheless, it should be regarded as an ecotourism species in South Africa.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

By legislation this species may not be targeted in any South African fisheries**.**

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)

This species is listed as Vulnerable.

Marine Protected Areas

This species would benefit from physical protection from boat strikes and possible harassment by tourists in those parts of the various MPAs throughout its range which exclude human presence. The most important of these is the iSimangaliso MPA in the extreme north of KZN, where Sodwana Bay is the regional centre for recreational scuba diving. The Ponta do Ouro Partial Marine Reserve in southern Mozambique which is adjacent to the iSimangaliso MPA is also a very important protected area in the region. These benefits are likely to be limited due to low levels of residency in these MPAs.

Additional local comment

IUCN Red List Status

<u>Endangered 2016: A2bd+4bd</u>

Previous IUCN assessments
Vulnerable 2005
Vulnerable 2000
Data Deficient 1996

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species was listed on Appendix II in 2002. None of the commercial fisheries for this species, which are all confined to the northern hemisphere, have been certified as sustainable under these regulations (Peirce and Norman 2016).

Convention on Migratory Species (CMS)
It was listed on Appendix II in 1999.

International comments
This species is protected in many countries where it was historically heavily fished, such as Indonesia, India, Philippines and Taiwan. Countries where it is still caught, either as a target or bycatch, include China, Mozambique, Oman, Pakistan and Tanzania. The active fishery in Chinese waters is almost certainly unsustainable (Li *et al.* 2012) and is likely to be the largest single direct threat to whale shark recovery in the Indo-Pacific (Pierce and Norman 2016).

Key habitats, such as coastal feeding locations or movement corridors, are protected in Australia (Ningaloo Reef), Belize (Gladden Spit), Costa Rica (Cocos Island), Ecuador (Galapagos Islands), Mexico (Yum-Balam Biosphere Reserve), Panama (Coiba Island) and the UK (St Helena Island). Most of these locations have large whale shark viewing operations, many of which are managed through legislation; these countries include Australia, Belize, Ecuador, Mexico and St Helena Island (UK); in others voluntary codes of conduct exist (Pierce and Norman 2016 and references cited therein).

Whale shark tourism can benefit developing countries, and the resulting high economic value has also encouraged varying levels of protection (Cagua *et al*. 2014, Graham 2003). However, if left unregulated, disturbance of the sharks by snorkelers and boats can lead to short-term stress, as evidenced by the sharks exhibiting avoidance behaviours (Pierce *et al.* 2010b, Haskell *et al*. 2014).

MANAGEMENT CONSIDERATIONS
This species in not targeted in any South African fishery and is protected in the linefishery. In locations where divers and other tourists opportunistically interact with whale sharks, a code of conduct is essential to avoid disturbing or potentially harming the animals. This is achievable by creating the legislation, similar to that required for whale and white shark watching, or by developing a Code-of-Conduct (Pierce *et al*. 2010). These interactions are most likely to take place at Sodwana Bay in the Isimangaliso Wetland Park, where Ezemvelo KZN Wildlife, as custodians of the marine resources in this MPA, historically prepared a code of conduct for divers. Several years may pass between periods of high densities of whale sharks and issues such as a code of conduct are then overlooked.

Given the absence of any genetic structure in the entire Indo-Pacific region it is essential that management decisions which could impact this population are made at the highest regional level, so at the least, countrywide or ideally ocean region protections. Assessment of whale shark bycatch in purse seine fisheries remains a regional management priority and should be pursued in South Africa.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
Despite being caught in several coastal fisheries around the world, very little is known of its reproductive biology; only a single pregnant female has been examined. Mid-oceanic islands such as the Galapagos and St Helena appear to be important sites for mature females. The whereabouts of nursery areas are still unknown. Much of the research conducted globally has taken place at coastal

aggregation sites. In South Africa the presence of this species is too sporadic to plan any targeted scientific research. The occasional stranding provides an excellent and unique opportunity to collect tissue samples for histological, genetic, toxicological or trophic ecology studies. Such occasions should be used to promote collaborative research.

FAMILY ODONTASPIDIDAE

Carcharias taurus

SCIENTIFIC NAME	*Carcharias taurus* (Rafinesque 1810)
COMMON NAME	Spotted raggedtooth shark
FAMILY	Odontaspididae
ENDEMIC	No, widely distributed in the Atlantic and Indo-West Pacific
SIZE RANGE	100–325 cm TL
SA DISTRIBUTION	E, S, W coasts, but most common on E and S coasts
HABITAT	On or near the bottom of rocky reefs
DEPTH RANGE	0–230 m, commonly 10–40 m
MAJOR FISHERIES	KZN bather protection programme, commercial and recreational linefisheries
IUCN STATUS	Critically Endangered 2020
CITES	Nil
MLRA	No retention in commercial and traditional linefisheries, demersal shark longline or beach seine net fisheries; daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	ML Dicken

SPECIES SUMMARY and RECOMMENDATIONS

Carcharias taurus is a large, demersal shark with a circumglobal but patchy distribution in coastal waters. Local catch was estimated at 1–10 tons per annum (DFFE records: 2010–2012), with the KZN bather protection programme as the major contributor, followed by the recreational and commercial linefisheries. This species has a particularly low fecundity of two pups every two years. It was assessed globally as Critically Endangered on the IUCN Red Listin 2020, but in South Africa there is strong evidence that the species is stable. Capture by recreational shore anglers in northern KZN should be prohibited as the sharks are largely pregnant females. These females spend much of their 10-month gestation in the waters of the iSimangaliso Wetland Park, while neonates remain in the shallow water nursery grounds of the Eastern Cape, which include the Addo Elephant National Park MPA, for 4-5 years. Declining catch rates in the KZN bather protection programme should be monitored. Despite extensive research, little is known of the life history of mature males. More information is needed on movement patterns and philopatry. A detailed genetic assessment of the various populations around the world should be undertaken.

TAXONOMIC and IDENTIFICATION ISSUES

The taxonomy of this species in terms of the name of the genus has undergone several changes. It was first described in 1810 under the genus *Carcharias*, but it has subsequently been referred to as *Odontaspis*, *Triglosis* and most recently *Eugomphodus*¸ before reverting back to *Carcharias*. There are three species in the family Odontaspidae, the best known being *Carcharias taurus*, and two species of *Odontaspis, O. ferox* and *O. noronhai. C. taurus* is restricted to shallow coastal waters and is the most common. It can be distinguished from *Odontaspis* by small differences in dentition, snout shape, eye size and the relative size and position of the two dorsal fins (Compagno 2001). It is possible that inexperienced viewers might confuse *C. taurus* and *O. ferox*, claiming that they had a seen giant *C. taurus*, unaware of the existence of *O. ferox.* This was the case with an individual of about 4 m sighted along the Wild Coast (region south of KZN), (Matt Dicken, KZN Sharks Board pers. comm., Graham *et al.* 2016).

SOUTH AFRICAN DISTRIBUTION

This species occurs along the entire South African coast but is most common on the east and south coasts (Ebert *et al.* 2021).

REGIONAL DISTRIBUTION

This species occurs in southern Mozambique and Namibia (Compagno 1984a).

SYNOPSIS OF RESEARCH

In South Africa this is a well-studied species. In a scientific assessment of the sharks of the east coast of Southern Africa, Bass *et al.* (1975) provided taxonomic, morphometric and biological information from a large number of specimens. Dedicated investigations have subsequently focussed on diet (Smale 2002), nursery areas (Smale 2005, Smale *et al.* 2015), spatial and seasonal distribution (Dicken *et al.* 2006, 2007), tag shedding and biofouling (Dicken *et al.* 2006), photo-identification of individuals (Van Tienhoven *et al.* 2007), abundance estimates (Dicken *et al.* 2008) and liver lipid composition (Davidson and Cliff 2011). Dudley and Dicken (2013a) provided an overview of the life history and fisheries details of this species. More recent studies have investigated aspects of embryo development (Naidoo *et al.* 2017a, 2017b), the genome (Klein *et al.* 2019a), the genetics associated with reproductive philopatry (Klein *et al.* 2019b) and the historical biogeography (Klein *et al*. 2020).

ECOLOGY

Depth

This species occurs from the surf zone down to 190 m, but is most common in depths of 10–40 m (Compagno 1984a). It usually swims 1–2 m off the seabed.

Habitat: Adults

They are strong, active swimmers found close to the bottom in association with rocky reefs in gullies and caves (Compagno 2001).

Habitat: Juveniles/Nursery Grounds

The nursery grounds comprise shallow, inshore reefs at the southern end of the east coast and on the south coast, with neonates remaining there for the first 4–5 years (Dicken *et al.* 2007).

Synopsis of tag deployments

A total of 6391 individuals have been tagged (ORI Cooperative Fish Tagging Project, 1984-2018) with 14% recaptured. Mean distance travelled was 139 km; mean time at liberty 2,0 years, with a maximum of 2966 km and 22,6 years (Jordaan *et al.* 2020). A large percentage of those tagged were adults released from the KZN bather protection programme.

Movements

The results of the tagging studies referred to above indicate that it is a migratory/nomadic species. Mature females undertake a biennial reproductive migration along the east coast (Bass *et al*. 1975, (Dicken *et al.* 2007). Some larger juveniles move northwards, entering southern KZN waters during the winter months when water temperatures are coldest, as part of a seasonal range extension.

Diet/feeding: adults

They feed on a wide variety of teleosts, small elasmobranchs and cephalopods (Bass *et al*. 1975, Smale 2005).

Diet/feeding: juveniles

Their diet is similar to the adults.

South African toxicological studies

Total mercury levels were quantified in adults caught in the KZN bather protection programme and found to be high, although no comparable values were available from other populations (McKinney *et al*. 2016). Naidoo *et al.* (2017a) investigated possible maternal offloading of heavy metals to the embryos.

REPRODUCTION

REPRODUCTIVE MODE	Viviparity with oophagy and adelophagy
DURATION OF REPRO CYCLE	Two years in South Africa, but both annual and biennial elsewhere
MATING	October-November
GESTATION	10 months
LITTER SIZE	Only 2 per litter, due to intra-uterine cannibalism
PUPPING/NURSERY GROUND	Inshore reefs in the southern part of the east coast and on the south coast
LENGTH AT BIRTH	100 cm
LENGTH AT MATURITY	F: 224 cm; M: 209 cm
MAXIMUM LENGTH	F: 326 cm; M: 266 cm
GENERATION LENGTH	20 years

Mode
This species exhibits viviparity with oophagy and adelophagy (intra-uterine cannibalism) as a means of nourishment for the embryos (Bass *et al.* 1975).

Duration of reproductive cycle
This is two years in South Africa (Dicken *et al.* 2006, 2007) and the SW Atlantic, but one year has been proposed for Australia and the NW Atlantic (Dudley and Dicken 2013a and references cited therein).

Mating season and location
This is August to October on the southern and central KZN coasts and the Wild Coast (immediately south of KZN) (Dicken *et al.* 2006). Pregnant females spend much of their gestation in northern KZN and southern Mozambique before returning south to the Eastern Cape to pup (Bass *et al.* 1975).

Gestation
This is approximately 10 months (Bass *et al.* 1975).

Litter size
As a result of intra-uterine cannibalism, maximum fecundity is two pups per litter (Bass *et al.* 1975).

Length at birth
The birth length is about 100 cm (Bass *et al.* 1975), but there is some regional variation from 95-120 cm (Dudley and Dicken 2013a and references cited therein).

Pupping season and nursery ground
Pupping takes place at approximately 100–120 cm in the south of the east coast and on the south coast in September to February (Smale 2002). The neonates and juveniles remain in the geographically distinct nursery areas for their first 4–5 years, with the primary zone being East London to Jeffreys Bay (Dicken *et al*. 2006, 2007).

Length at maturity
Length at 50% maturity is 224 cm for females and 209 cm for males (Dudley and Simpfendorfer 2006).

Maximum length

The maximum recorded length for females is 326 cm and males 266 cm (Dudley and Dicken 2013a and references cited therein).

Age and growth
Local age and growth studies have not been undertaken. The longest time at liberty of a tagged adult female was 26.2 years. The shark was in all likelihood pregnant when it was tagged in the iSimangaliso Wetland Park (KZNSB unpublished data), suggesting that it was at least 30 years old. In the NW Atlantic, female age of maturity is 9–10 years, with a maximum age of 40 years (Rigby *et al.* 2021e and references cited therein).

Generation length
Based on the ageing data from the NW Atlantic presented above, generation length is calculated as 24.8 years (Rigby *et al.* 2021e and references cited therein).

FISHERIES MANAGEMENT
SA catch sources and characteristics
Local catch was estimated at 1-10 tons per annum (DFFE records: 2010-2012; da Silva *et al*. 2015), with the KZN bather protection programme as the major contributor, followed by the recreational and commercial linefisheries.

KZN bather protection nets
The mean annual catch in the KZN bather protection nets was 242 (1978-1989), 180 (1990-1999) and 81 (2000-2009) (Cliff and Dudley 2011). Between 2010 and 2019 the mean annual catch in the KZNSB nets was 48 (M Dicken, KZN Sharks Board pers. comm.). The catch comprised largely adults with a sex ratio of 2:1 (F:M); 39% of the catch was released alive (Dudley and Simpfendorfer 2006).

Recreational shore angling
In KZN competitive shore anglers caught 30 *C. taurus* over a 24-year period, with a mean individual mass of 119 kg (Pradervand *et al.* 2007). On the Wild Coast (northern part of the Eastern Cape), over a similar period, competitive shore anglers caught 73 *C. taurus*, at a rate of 3 per annum, with a mean mass of 59 kg (Pradervand 2004). Competitive shore anglers from the Border region (Kei River to Fish River; 146 km of coastline immediately south of Wild Coast) caught 572 individuals over a 17-year period at a rate of 34 per annum, each with a mean weight 22 kg (Pradervand and Govender 2003). In the region to the south of the Border (Port Alfred to Plettenberg Bay) 683 *C. taurus* were caught in Angling Week competitions between 1999 and 2010, with a mean mass of 42 kg (range: 5-195 kg) (Dicken *et al.* 2012). These catches are generally released alive, however, some post-release mortality is possible.

This species is also occasionally caught by commercial and recreational skiboat anglers but it is not a target species.

Fishing outside South Africa
This species has been fished throughout its range in the past. It is caught primarily with line fishing gear, but is also taken in bottom-set gillnets and trawls. It is taken in the New South Wales Shark Meshing and the Queensland Shark Control Programmes. It is a popular aquarium species (Pollard and Smith 2009).

Population trends
Genetic studies support at least five subpopulations of this species where it has been sampled, with deep oceanic water a likely barrier. These regions are NW Atlantic, Japan, W Australia, E Australia and South Africa which is possibly also the same subpopulation as Brazil and the Mediterranean Sea (Rigby

et al. 2021d and references cited therein). Its low fecundity of two offspring every second year makes *C. taurus* highly vulnerable to population declines, even at low capture rates.

The standardised CPUE from the KZN bather protection data for 1981–2019 initially rose, then steadily declined followed by an increase in recent years. This increase may be a reflection of the management changes in the bather protection program which has seen a reduction in effort in order to reduce captures. The trend analysis of this 39-year long dataset revealed an annual rate of reduction of 1.6%, consistent with an estimated median reduction of 61% over three generation lengths (74 years), with the highest probability of 50–79% reduction over three generation lengths (Matt Dicken, KZN Sharks Board and Henning Winker, unpubl. data, cited by Rigby *et al.* 2021d). The trend analysis should be interpreted with caution due to the population structure and seasonal movement patterns of this species. It is possible that catch trends reflect the removal of individuals philopatric to the netted beaches rather than the level of decline along the entire South African coast. Recreational shore angling catch rates for this species in the Eastern Cape increased between 1989–2004 (Pradervand and Govender 2003, Dicken *et al*. 2012), indicating a stable population over at least 16 years. This recent assessment of stable population is supported by both mark-recapture (Dicken *et al*. 2008) and recent multilocus genotype population assessments (Klein *et al*. 2020). Based on localised declines in the KZNSB bather protection program and a stable population elsewhere in South Africa for at least 16 years, expert judgement elicitation inferred a population reduction of 30–49% over the past three generation lengths (74 years), which would give it a status of Vulnerable (Rigby *et al.* 2021e).

Species-specific population trend data reveal or infer subpopulation reductions of >80% in E Australia, W Africa and SE Asia over the past three generation lengths (74 years). The species is suspected to be Critically Endangered in the Southwest Atlantic, Mediterranean, and the Arabian Seas region where it is either no longer or rarely encountered. Globally, it is suspected that *C. taurus* has undergone a population reduction of >80% over the past three generations lengths (74 years) due to levels of exploitation, and it was assessed as Critically Endangered in 2020 (Rigby *et al.* 2021e and references cited therein).

ECOTOURISM

It is a very popular ecotourism species, as it favours high profile reefs where individuals are commonly found 1–2 m off the bottom. They are easily approached by slow moving scuba divers. The Aliwal Shoal and Protea Banks MPAs are popular viewing locations for large juveniles and adolescents, while pregnant females are encountered on the shallow reefs in the iSimangaliso MPA.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

Retention of this species is prohibited in the commercial and traditional linefisheries and demersal shark longline and beach seine net fisheries. This is to prevent sale of the fins, and, to a lesser extent, jaws and teeth. There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)

This species is listed as Vulnerable.

Marine Protected Areas

This species will derive considerable benefit from several inshore MPAs on the east and south coasts. The pregnant females spend a large portion of their gestation in the iSimangaliso Wetland Park. Aggregations of these females have been observed close to Inhaca Island in southern Mozambique. As a result, they will benefit from the Maputo Protected Area which extends southwards from Maputo to Ponta D'Óuro, and which is contiguous with the Isimangaliso Wetland Park. Aggregations of larger juveniles occur in the Aliwal Shoal and Protea Banks MPAs in the second half of the year, where the sharks are a popular attraction for scuba divers. Their presence appears to be a northward range extension, facilitated by seasonally colder water on the KZN coast south of Durban. Further south along the east coast, in the Eastern Cape, the Addo Elephant National Park MPA is one of three new MPAs proclaimed in May 2019. This MPA provided protection as it encompasses a large part of the nursery area of this species.

Additional local comment

IUCN Status
[Critically Endangered 2020 A2bd]

Previous IUCN assessments
2009 – Vulnerable
2000 – Vulnerable
1996 – Endangered

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed on any of the appendices of CITES.

Convention on Migratory Species (CMS)
This species is not listed.

MANAGEMENT CONSIDERATIONS
This species is regularly caught by competitive shore anglers targeting sharks, but there is a strong catch-and-release ethic which needs to be encouraged. Captures by shore anglers during the summer months in northern KZN, especially the iSimangaliso Wetland Park, must be prohibited as the sharks are all likely to be pregnant females. An education campaign should be mounted among shore anglers who pose for photographs with their shark catch prior to release. They are inclined to lift the tail well off the ground, often to the point that the tail tip is above their shoulders as they crouch next to the shark. This imposes huge strain on the vertebral column which depends heavily on the surrounding water for support and could result in spinal deformities such as scoliosis, which are not uncommon.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
Despite extensive research, there are still gaps in our knowledge of the life history of this species, especially for mature males. Further work is required on movement patterns and philopatry in relation to mating and pupping. Genetic connectivity of the various populations around the world has yet to be fully explored.

Odontaspis ferox

SCIENTIFIC NAME	*Odontaspis ferox* (Risso 1810)
COMMON NAME	Smalltooth sandtiger shark
FAMILY	Odontaspididae
ENDEMIC	No, circumglobal but very patchy distribution
SIZE RANGE	100–450 cm TL
SA DISTRIBUTION	E coast: Mozambique border to Port Shepstone, possibly further south to include Wild Coast
HABITAT	On or near the bottom of rocky reefs, drop-offs and sand bottoms, also epipelagic
DEPTH RANGE	10–880 m
MAJOR FISHERIES	None listed in South Africa
IUCN STATUS	Vulnerable 2015
CITES	Not listed
MLRA	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	ML Dicken

SPECIES SUMMARY and RECOMMENDATIONS

Odontaspis ferox is a large demersal shark which has a circumglobal but patchy distribution. There were no reported local catches (DFFE records: 2010–2012). The only confirmed local records are from a deep water (400-420 m) trawl in KZN several decades ago. Outside its South African range it is regularly encountered by scuba divers in water of 15–60 m. It is a bycatch in deepwater fisheries and was assessed as Vulnerable globally in 2015, largely as a result of perceived declines in the eastern North Atlantic and Mediterranean. This species appears to be rare in South Africa making it difficult to formulate management considerations and to identify research opportunities. It could easily be mistaken for the far more common and smaller spotted raggedtooth shark *Carcharias taurus* by inexperienced observers. Life history information is lacking; tissue samples should be collected for population genetic studies.

TAXONOMIC and IDENTIFICATION ISSUES

There are no taxonomic issues. *Odontaspis ferox* was previously described as *O. herbsti* by Bass *et al.* (1975), who conceded that when further data on Mediterranean specimens are obtained *O. herbsti* may prove to be a synonym of *O. ferox.* This was confirmed by Compagno (1984). There are three species in the family Odontaspidae, the best known being *Carcharias taurus*, and two species of *Odontaspis, O. ferox* and *O. noronhai. O. ferox* is the only one of the three which occurs in both shallow and extremely deep water. It can be distinguished from *C. taurus*, which is restricted to shallow coastal waters and is far more common by small differences in dentition, snout shape, eye size and the relative size and position of the two dorsal fins. It can be distinguished from *O. noronhai* by marked differences in colour and eye size (Ebert and Mostardo 2013). It is possible that inexperienced viewers might confuse smaller individuals of *O. ferox* with *C. taurus.*

SOUTH AFRICAN DISTRIBUTION

This species is restricted to most of the KZN coast, from the Mozambique border to Port Shepstone, but its distribution may extend into the Eastern Cape (Ebert *et al.* 2021) as there are unconfirmed but reliable reports of diver sightings on the Wild Coast (Graham *et al.* 2016).

REGIONAL DISTRIBUTION

This species occurs offshore in southern Madagascar and Tanzania but not Mozambique (Ebert and Mostardo 2013, Graham *et al.* 2016).

SYNOPSIS OF RESEARCH

In a study of the sharks of the east coast of Southern Africa, Bass *et al.* (1975) provided taxonomic, morphometric and biological information from four juveniles, all trawled off the KZN coast. Nothing has been published subsequently on the life history and ecology in South Africa. Fergusson *et al.* (2008) provided a global overview of the distribution, abundance and biology of this species.

ECOLOGY

Depth

This essentially demersal species occurs inshore on steeply sloping continental and island shelves and on slopes down to 880 m, but most individuals are shallower than 300 m. In a small number of locations, including Tanzania, this species is regularly observed by scuba divers at shallow water (15-60 m) locations (Fergusson *et al.* 2008).

Habitat: Adults

They are associated with mud, sand, or rocky reef bottom habitats, but may show pelagic habits, frequenting the upper part of the water column (70–500 m) in water depths of 2000–4000 m (Fergusson *et al.* 2008).

Habitat: Juveniles/Nursery Grounds

There appears to be some segregation by size and depth, as juveniles smaller than about 150 cm mostly occur in deeper water at 300–600 m (Fergusson *et al.* 2008).

Synopsis of tag deployments

There are no documented reports of tagging anywhere in its South African range.

Movements

Captures in mid-ocean waters on or adjacent to deep–sea ridges and seamounts suggests that individuals might move over large distances by following submarine ridges or through island or seamount ‘‘hopping” (Fergusson *et al.* 2008).

Diet/feeding: adults

They feed on small teleosts, cephalopods, crustaceans and small sharks (Fergusson *et al.* 2008).

Diet/feeding: juveniles

They feed on small teleosts, squid and crustaceans (Bass *et al.* 1975).

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Viviparity with oophagy
DURATION OF REPRO CYCLE	Unknown
MATING	Unknown
GESTATION	Unknown
LITTER SIZE	Unknown
PUPPING/NURSERY GROUND	Deeper water on the continental slope of 330-600 m
LENGTH AT BIRTH	100 cm (based on neonates caught off Durban)
LENGTH AT MATURITY	F: 300–350 cm; M: 200–250 cm
MAXIMUM LENGTH	F: 450 cm; M: 345 cm
GENERATION LENGTH	Assumed to be 20 years, based on *Carcharias taurus*

Mode
This species exhibits viviparity, with oophagy as a means of nourishment of the embryos. This is based on a mature female with a large ovary comprising hundreds of ova of 3 mm modal diameter (Fergusson *et al.* 2008). It is not known if the embryos practise intra-uterine cannibalism, like *C. taurus,* another member of the family Odontaspidae.

Duration of reproductive cycle
This is unknown.

Mating season and location
This is unknown.

Gestation
This is unknown.

Litter size
This is unknown (Fergusson *et al.* 2008) but could possibly be only two if this species practises intra-uterine cannibalism like *C. taurus.*

Length at birth
The birth length is between 100 and 110 cm (Fergusson *et al.* 2008), based on the four juveniles of 105-110 cm reported by Bass *et al.* (1975).

Pupping season and nursery grounds
Neonatal *O. ferox* are either born, or move soon after birth into deeper, offshore nursery depths on the upper slope and perhaps also around oceanic seamounts (Fergusson *et al.* 2008). Bass *et al.* (1975) sampled four juveniles of 105-110 cm trawled at 400-420 m depth off the KZN coast.

Length at maturity
Males mature between 200 and 250 cm, and females between 300 and 350 cm (Fergusson *et al.* 2008).

Maximum length
The maximum recorded length for females is 450 cm and males 344 cm (Fergusson *et al.* 2008).

Age and growth
Nothing is known.

Generation length
Age and growth data are not available for this species, but generation length can be estimated from *C. taurus* from the NW Atlantic which has a female age of maturity of 6 years and a maximum age of 35 years, resulting in a generation length of 20.5 years (Graham *et al.* 2016).

FISHERIES MANAGEMENT
SA catch sources, quantities and characteristics
No local catch estimates were reported (DFFE records: 2010-2012; da Silva *et al*. 2015). This species was not reported in the elasmobranch bycatch of the shallow water (10–45 m) prawn trawl fishery on the uThukela Bank (Fennessy 1994). There are also deep-water crustacean trawling grounds in 100–600 m, with most effort concentrated off Durban at 300–600 m. No details of the elasmobranch bycatch are available, only the more common species are listed, which did not include *O. ferox* (Fennessy and Groeneveld 1997). This fishery was the source of the four specimens reported by Bass *et al.* (1975).

Fishing outside South Africa

This species is taken incidentally in longline and trawl fisheries, but its distribution is too patchy to be of interest to directed fisheries. However, with increasing deepwater fishing efforts, these sharks may become more susceptible to fishing pressure than is currently assumed (Ebert and Mostardo 2013).

There are commercial landings of this species from bottom trawls, set-nets and line gear in many parts of the world, including the Mediterranean Sea, Japan, Indonesia and occasionally Australia (Graham *et al.* 2016).

Population trends

The connectivity of this species between widely separated localities is unknown and its fragmentary occurrences may represent a series of isolated subpopulations. There are no estimates of the numbers of these sharks that may be taken as bycatch. Although larger and bulkier, this species is morphologically very similar to *C. taurus* and could possibly have a similarly very low reproductive capacity, whereby only two pups are produced every two years. This likely very low fecundity makes it potentially susceptible to population declines, even at seemingly small capture rates.

Off the SE coast of Australia, fishery-independent surveys indicated a decline of over 50% in catches after 20 years of trawling on the upper slope (200–650 m). Similar declines are likely to have occurred in other parts of its range impacted by fisheries, especially the Mediterranean Sea where the decline is even greater than in Australia. The species was assessed as Critically Endangered in the Mediterranean in 2016. Although it is more often found deeper than 200 m, small aggregations in shallow water at a number of locations (eastern tropical Atlantic, eastern and SW Pacific Ocean) suggest that the species may be more vulnerable to fishing pressure than previously assumed. It may also be susceptible to coastal habitat impacts, similar to those that impact *C. taurus.* A precautionary assessment of Vulnerable was considered appropriate in 2016 (Graham *et al.* 2016).

ECOTOURISM

This species is rarely seen by divers and therefore cannot be regarded as an ecotourism species.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)

This species is not listed.

Marine Protected Areas

Insufficient information is known of the distribution and movement patterns to determine if this species gains any protection from the existing network of MPAs on the KZN coast. Unconfirmed but reliable sightings of this species by divers on the Wild Coast suggest that the Pondoland MPA could provide benefit to this species, but only when it ventures into shallow water.

Additional local comment

The ban on any demersal shark longlining east of the Kei mouth, which generally occurs at depths of 50–100 m (da Silva *et al*. 2015) will benefit this species.

IUCN Red List Status

Vulnerable 2015: A2bd

Previous IUCN assessments

Vulnerable 2009
Data Deficient 2003

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

International comments

MANAGEMENT CONSIDERATIONS

This species appears to be a rare in South African fisheries, but it is possible that it is mistaken for the more common *Carcharias taurus.* Observers on trawl and demersal longliners need to be made aware of this species and how it differs from *C. taurus.* If this species is caught in trawls it is unlikely to survive being hauled up from depths of 200 m and more. The reports of sightings by divers on the Wild Coast should be followed up, especially if they are close to or inside the Pondoland MPA.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

This species is apparently rare which makes it difficult to plan any research projects. Any opportunistic sampling should be utilised to obtain biological information and tissue samples for genetic studies to establish if there are any links with adjacent populations off Madagascar and Tanzania or further afield.

FAMILY ALOPIIDAE

Alopias pelagicus

SCIENTIFIC NAME	*Alopias pelagicus* (Nakamura 1935)
COMMON NAME	Pelagic thresher shark
FAMILY	Alopiidae
ENDEMIC	No, tropical waters of the entire Indo-Pacific Oceans
SIZE RANGE	130–428 cm TL
SA DISTRIBUTION	Part of E coast: KZN only
HABITAT	Pelagic in oceanic waters, occasionally coastal
DEPTH RANGE	0–150 m
MAJOR FISHERIES	Largely pelagic longline and small pelagic fisheries
IUCN STATUS	Endangered 2018
CITES	Appendix II (2017)
MLRA	No retention in any longline fisheries; daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	C da Silva

SPECIES SUMMARY and RECOMMENDATIONS

Alopias pelagicus is a large, epipelagic species, generally found offshore but occasionally close to the coast. It occurs in tropical waters throughout the Indo-Pacific Ocean; in South Africa it is restricted to KZN waters. Local catch was estimated at <1 ton per annum (DFFE records: 2010-2012), from a number of fisheries, with the pelagic longline fishery listed as the biggest contributor. Based on declines in catches in the North Atlantic, this species was globally assessed as Endangered in 2018. As a largely mobile oceanic species, it will derive no benefit from any of the South African MPAs, including those offshore. It is listed in CITES Appendix II and as a result no retention in any South African longline fisheries is permitted. Post-capture mortality rates may be high and should be monitored. Little is known of its life history. The location of regional or local pupping and nursery grounds should be investigated.

TAXONOMIC and IDENTIFICATION ISSUES

The existence of a single genus *Alopias* with three species has long been recognised. The three species are strongly differentiated by external and skeletal anatomy (Compagno 2001). Superficially they appear similar, but *A. pelagicus* has relatively small eyes, a dorsal fin just behind the pectoral fin axil and broad-tipped pectoral fins.

SOUTH AFRICAN DISTRIBUTION

This species is the most tropical of the thresher sharks. It only occurs in KZN, along the northern half of the east coast of South Africa (Ebert *et al.* 2021).

REGIONAL DISTRIBUTION

It is found in Mozambique and Madagascar but not Namibia, as it is absent from the Atlantic Ocean (Rigby *et al.* 2019a).

SYNPOSIS OF RESEARCH

This is a very poorly studied species. In South Africa Bass *et al.* (1975) provided morphometric and biological information from only a single individual. Only two individuals have been reported from the KZN bather protection programme (1978-2018).

ECOLOGY

Depth

This epipelagic species occurs in the open ocean, and occasionally in coastal waters with a narrow continental shelf. It occurs from the surface to at least 150 m and is likely to undertake diurnal vertical migrations (Compagno 2001).

Habitat: Adults

They are epipelagic in the open ocean and occasionally in coastal waters (Compagno 2001).

Habitat: Juveniles/Nursery Grounds

The juveniles are also apparently pelagic (Compagno 2001).

Synopsis of tag deployments

No tagging appears to have been undertaken in South African waters.

Movements

This species is probably migratory but its movements are little known (Compagno 2001).

Diet/feeding: adults

The diet is little known but presumably comprises pelagic shoaling teleosts and squid, like the other two species of *Alopias.* The tail is used to herd and stun the prey, which explains why tail hooking is common on longlines (Compagno 2001).

Diet/feeding: juveniles

No information is available.

South African toxicological studies

No local studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Viviparity with oophagy
DURATION OF REPRO CYCLE	Possibly 12 months
MATING	Aseasonal (Taiwan)
GESTATION	< 12 months (Taiwan)
LITTER SIZE	2 (167 litters: Taiwan)
PUPPING/NURSERY GROUND	Unknown but aseasonal (Taiwan)
LENGTH AT BIRTH	130–190 cm
LENGTH AT MATURITY	F: 282–292 cm; M: 267–276 cm
MAXIMUM LENGTH	F: 383 cm; M: 428 cm
GENERATION LENGTH	18.5 years

Mode

This species exhibits viviparity, with oophagy (Compagno 2001).

Duration of reproductive cycle

This is thought to be 12 months in Taiwan, with no resting period between pregnancies (Liu *et al.* 2006).

Mating season and location

This is unknown but is aseasonal in Taiwan (Snelson *et al.* 2008).

Gestation
This is unknown but is possibly just less than 12 months in Taiwan (Snelson *et al.* 2008).

Litter size
Litter size is 2, based on 167 litters in Taiwan (Compagno 2001, Liu *et al*. 2006).

Length at birth
Length at birth is 130–190 cm (Compagno 2001, Liu *et al*. 2006).

Pupping season and nursery ground
This is unknown.

Length at maturity
Length at maturity for females is 282–292 cm and 267–276 cm for males (Compagno 2001).

Maximum length
Maximum length is 428 cm (unsexed) (Weigmann *et al.* 2016)

Age and growth
Female age-at-maturity varies from 9 (Taiwan) to 13 years (Indonesia) and maximum age from 24 (Taiwan) to 28 years (Indonesia) (Rigby *et. al* 2019a and references cited therein).

Generation length
Generation length is 16.5 years in Taiwan, and 20.6 years in Indonesia. The mean of these two values is 18.5 years, which was used in the 2018 Red List assessment (Rigby *et al*. 2019a).

FISHERIES MANAGEMENT

SA catch sources, quantities and characteristics
Local catch was estimated at <1 ton per annum (DFFE records: 2010–2012; da Silva *et al*. 2015), from a number of fisheries, with the small pelagic fishery and the KZN bather protection programme listed as the largest contributors. It may be caught in the pelagic longline fishery, the demersal trawl fishery and the commercial linefishery. No further details are available from any of these fisheries, apart from the KZN bather protection programme where reported catches of this species are less than one per decade. This species was not recorded among the large pelagic sharks caught in the Southern African tuna and swordfish longline fisheries (1998–2005), unlike the other two *Alopias* species (Petersen *et al.* 2009). As it has been a CITES-listed species (Appendix II) since 2017, catches in this fishery can no longer be retained. A recent analysis of observer data suggests that 70% of *Alopias* spp. are dead or in poor condition on release (Jordaan *et al.* 2020).

Fishing outside South Africa
This species is caught globally as target and bycatch in commercial and small-scale pelagic longline, purse seine, and gillnet fisheries. Most of the catch is taken as bycatch of industrial pelagic fleets in offshore and high-seas waters (Rigby *et al.*2019a).

The species is generally retained for the fins and meat which are both highly prized (Compagno 2001). The fins from all three species of *Alopias* accounted for 2-3% of fins traded in Hong Kong. Thresher sharks are highly valued by big-game recreational fishers, and although many practise catch and release, this form of recreational fishing could be a threat, due to post-release mortality that has been estimated at 78% for tail-hooked and 0% for mouth-hooked *A. vulpinus*. At-vessel mortalities of 49-68% were estimated for *A. superciliosus* and 67% for *A. vulpinus* on Portuguese longlines in the Atlantic (Rigby *et al.* 2019a and references cited therein).

Population trends

A. pelagicus has a low fecundity (average two pups per litter) and a very low annual rate of population increase of 0.033 (Rigby *et al*. 2019a). Genetic results indicate some genetic structuring between Eastern and Western Pacific, but it is not known if there is any genetic structure between the Indian and Pacific Oceans. This species experienced declines in catches in both these two oceans. Across its Indo-Pacific distribution, it is estimated to have been reduced by 50–79% over the last three generations (55.5 years), based on abundance data and levels of exploitation, and therefore the species was assessed as Endangered in 2018 (Rigby *et al.* 2019a and references cited therein).

ECOTOURISM
This pelagic species is rarely seen by divers and therefore cannot be regarded as an ecotourism species.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
As this species is listed on CITES Appendix II, no retention is permitted in either the pelagic or demersal longline fisheries. There is a daily bag limit of one in the recreational linefishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
Given its wide-ranging movements, it is unlikely that this species will derive any benefit from South African MPAs.

Additional local comment

IUCN Red List Status
<u>Endangered 2018: A2bd</u>

Previous IUCN assessments
Vulnerable 2009

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
All three thresher species were placed on Appendix II in 2017.

Convention on Migratory Species (CMS)
All three thresher shark species were placed on Appendix II in 2014.

International comments
In 2009, the Indian Ocean Tuna Commission (IOTC) banned the retention, transhipment, landing, storage, and sale of all three species of thresher sharks (Rigby *et al.* 2019a).

MANAGEMENT CONSIDERATIONS
As a CITES Appendix II species it may not be retained in the longline fisheries. Longliners must be encouraged to avoid fishing in locations which have historically rendered high catches of prohibited shark species such as *A. pelagicus*. The survival rate of individuals released from this fishery is of concern, given that the post-release mortality in pelagic sharks can be high, especially for tail-hooked individuals. Fishery inspectors need to be able to confidently distinguish the three species of *Alopias.* Thresher Sharks are highly prized for their fins, consequently improved management of the fin trade is vital to their conservation.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

This is a very poorly studied species with very little known locally or regionally of its life history and reproductive biology. This is possibly because it is not common in South African waters. Opportunistic sampling should be used to collect life history information and genetic samples to investigate regional population structure.

Alopias superciliosus

SCIENTIFIC NAME	*Alopias superciliosus* (Lowe 1841)
COMMON NAME	Bigeye thresher shark
FAMILY	Alopiidae
ENDEMIC	No, circumglobal in tropical and warm-temperate waters
SIZE RANGE	100–460 cm TL
SA DISTRIBUTION	E, S coasts: entire KZN to Cape Peninsula
HABITAT	Pelagic in oceanic and coastal waters
DEPTH RANGE	0–500 m, but mostly below 100 m
MAJOR FISHERIES	Largely pelagic longline and small pelagic fisheries
IUCN STATUS	Vulnerable 2018
CITES	Appendix II (2017)
MLRA	No retention in any longline fisheries; daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	C da Silva

SPECIES SUMMARY and RECOMMENDATIONS

Alopias superciliosus is a large, epipelagic species, found in coastal and offshore waters. It has a circumglobal distribution in tropical and warm-temperate waters. Local catch was estimated at <1 ton per annum (DFFE records: 2010-2012), from a number of fisheries, with the pelagic longline fishery listed as by far the biggest contributor (>95%). Based on declines in catches in the North Atlantic, this species was globally assessed as Vulnerable in 2018. As a largely mobile oceanic species, it will derive no benefit from any of the South African MPAs, including those offshore. It is listed in CITES Appendix II and as a result no retention in South African longline fisheries is permitted. Post capture mortality rates may be high and should be monitored. The location of regional or local pupping and nursery grounds should be investigated.

TAXONOMIC and IDENTIFICATION ISSUES

The existence of a single genus *Alopias*, with three species has long been recognised. The three species are strongly differentiated by external and skeletal anatomy (Compagno 2001). Superficially they appear similar, but *A. superciliosus* is distinctive because of its extremely large eyes extending on to the dorsal surface of the head and the notched or helmeted contour of the head.

SOUTH AFRICAN DISTRIBUTION

This species occurs along the entire east and south coasts of South Africa (Ebert *et al.* 2021).

REGIONAL DISTRIBUTION

It is found in Mozambique and Madagascar but not Namibia (Rigby *et al.*2019b).

SYNOPSIS OF RESEARCH

This is a poorly studied species. In South Africa Bass *et al.* (1975) provided morphometric and biological information from only 2 individuals. Only 14 individuals have been caught in the KZN bather protection programme (1978-2018). Young *et al.* (2016) provided a global status report for this species.

ECOLOGY

Depth

This epipelagic species occurs in the open ocean, and occasionally in coastal waters with a narrow continental shelf. It undertakes vertical daily migrations, frequenting the surface at night and diving to depths of at least 500 m (Compagno 2001).

Habitat: Adults
They are epipelagic and epibenthic in the open ocean and in coastal waters (Compagno 2001).

Habitat: Juveniles/Nursery Grounds
The juveniles are also apparently pelagic (Compagno 2001).

Synopsis of tag deployments
A tagging project is currently underway, funded through the IOTC to investigate post-release mortality associated with the SA pelagic longline fleet.

Movements
This species is highly migratory but little is known (Compagno 2001).

Diet/feeding: adults
The diet comprises pelagic fishes and bottom fishes and squid. The tail is used to herd and stun the prey, which explains why tail hooking is common on longlines (Compagno 2001).

Diet/feeding: juveniles
Diet is unknown in juveniles.

South African toxicological studies
No local studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Viviparity with oophagy
DURATION OF REPRO CYCLE	Possibly 12 months
MATING	Unknown
GESTATION	12 months
LITTER SIZE	Usually 2, occasionally 3–4
PUPPING/NURSERY GROUND	Weakly seasonal
LENGTH AT BIRTH	100–140 cm
LENGTH AT MATURITY	F: 300–360 cm; M: 270–300 cm
MAXIMUM LENGTH	F: 460 cm; M: 420 cm
GENERATION LENGTH	18.5 years

Mode
This species exhibits viviparity, with oophagy (Compagno 2001).

Duration of reproductive cycle
The reproductive cycle is possibly 12 months, but the duration of any resting period between pregnancies is unknown (Snelson *et al.* 2008).

Mating season and location
This is unknown but is aseasonal (Snelson *et al.* 2008).

Gestation
Gestation is 12 months (Snelson *et al.* 2008).

Litter size

Litter size is usually 2, occasionally 3–4 (Compagno 2001). A pregnant female from KZN waters had a single pup, with a large number of capsules containing small ova in the other uterus, indicative of a failed pregnancy (KZN Sharks Board, unpubl. data).

Length at birth
This is 100–140 cm (Compagno 2001).

Pupping season and nursery ground
Pupping is weakly seasonal: autumn and winter in the eastern Atlantic (Compagno 2001) and summer, autumn and winter in the western Atlantic (Snelson *et al.* 2008).

Length at maturity
Length at maturity for females is 300–360 cm for females and 270–300 cm for males (Snelson *et al.* 2008).

Maximum length
Maximum length is 460 cm for females and 420 cm for males (Compagno 2001).

Age and growth
Observed female age-at-maturity is 12–13 years and maximum age 20 years in Taiwan, NW Pacific. These Taiwanese age data were used to generate growth curves that encompass a wider age and size range than the observed data, and thus were used to estimate female age-at-maturity at 9 years and maximum age at 28 years (Rigby *et. al* 2019b and references cited therein).

Generation length
Generation length is 18.5 years (Rigby *et al*. 2019b).

FISHERIES MANAGEMENT
SA catch sources
Local catch was estimated at <1 ton per annum (DFFE records: 2010-2012; da Silva *et al*. 2015), from a number of fisheries, with the small pelagic fishery and the KZN bather protection programme being the largest contributors. It may be caught in the pelagic longline fishery, the demersal trawl fishery and the commercial linefishery but is not reported. In the KZN bather protection programme catches of this species are far less than one per annum. A summary of catches in the pelagic longline fishery is given below. No information is available from any of the other fisheries.

SA catch quantities and characteristics
Pelagic longline fishery
This species comprised 0.3% of the large pelagic sharks caught in the Southern African tuna and swordfish longline fisheries (1998–2005), and was equally discarded/released and retained. In a fishery where the estimated annual catch is 40,000-70,000 sharks per annum, this equates to about 120 *A. vulpinus* each year (Petersen *et al.* 2009). As it has been a CITES-listed species (Appendix II) since 2013, catches in this fishery can no longer be retained. A recent analysis of observer data suggests that 70% of *Alopias* spp. are dead or in poor condition on release (Jordaan *et al.* 2020).

Fishing outside South Africa
This species is caught globally as target and bycatch in commercial and small-scale pelagic longline, purse seine, and gillnet fisheries. Most of the catch is taken as bycatch of industrial pelagic fleets in offshore and high-seas waters (Rigby *et al.*2019b). All three thresher species are retained for the fins and meat which are highly prized (Compagno 2001). Collectively their fins accounted for 2-3% of fins traded in Hong Kong. Thresher sharks are highly valued by big-game recreational fishers, and although many practise catch-and-release, this form of recreational fishing could be a threat due to post-release

mortality that has been estimated as 78% for tail-hooked and 0% for mouth-hooked *A. vulpinus*. At vessel mortality of 49-68% in a longline fishery was estimated for *A. superciliosus* (Rigby *et al.* 2019b and references cited therein).

Population trends
A. superciliosis has a low fecundity (average two pups per litter) and the lowest intrinsic rebound potential of the thresher shark species (Rigby *et al.* 2019b). Genetic results indicate one global population, however there is some genetic structuring between the NW Atlantic and the Pacific Oceans (Rigby *et al.* 2019b and references cited therein). The species showed a decline in the Atlantic and Indian Oceans, and an increase in a large area around Hawaii, with the trends uncertain in the wider Pacific. Globally, the population was estimated to have reduced by 30–49% over the last three generations (55.5 years), based on abundance data and current levels of exploitation. *A. superciliosus* was therefore assessed as Vulnerable in 2018 (Rigby *et al.* 2019b).

ECOTOURISM
This pelagic species is rarely seen by divers and therefore cannot be regarded as an ecotourism species.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
As this species is listed on CITES Appendix II, no retention is permitted in either the pelagic or demersal longline fisheries. There is a daily bag limit of one in the recreational linefishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
Given its wide-ranging movements, it is unlikely that this species will derive any benefit from South African MPAs.

Additional local comment

IUCN Red List Status
<u>Vulnerable 2018: A2bd</u>

Previous IUCN assessments
Vulnerable 2009

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
All three thresher shark species were placed on Appendix II in 2017.

Convention on Migratory Species (CMS)
All three thresher shark species were placed on Appendix II in 2014.

International comments
In 2008 an Ecological Risk Assessment ranked this species as the most vulnerable of 16 Atlantic elasmobranchs in terms of overfishing from longlines. As a result, the International Commission for the Conservation of Atlantic Tunas (ICCAT) adopted a requirement for prompt release and minimal harm to all individuals retrieved alive. In 2009, ICCAT banned retention, transhipment, landing, storage, and sale of this species, with a small exception for Mexico. In 2009, the Indian Ocean Tuna Commission (IOTC) adopted a similar ban for all three species of thresher sharks (Rigby *et al.* 2019b).

MANAGEMENT CONSIDERATIONS

As a CITES Appendix II species it may not be retained in the longline fisheries. Fishery inspectors need to be able to confidently distinguish the three species of *Alopias.* Longliners need to be encouraged to avoid fishing in locations which have historically rendered high catches of prohibited shark species, such as the thresher sharks. The survival rate of individuals released from this fishery is of concern, given that the post-release mortality in pelagic sharks, including all thresher sharks, can be high. Threshers are highly prized for their fins; improved management of fin trade is vital to their conservation. As with other oceanic sharks caught by tuna fleets, the movement of *A. superciliosus* between regions managed by the IOTC and ICCAT needs to be investigated.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

This is a very poorly studied species, with very little known locally or regionally of its life history and reproductive biology. Opportunistic sampling should be used to collect life history and other biological information, as well as genetic samples to investigate regional population structure.

Alopias vulpinus

SCIENTIFIC NAME	*Alopias vulpinus* (Bonnaterre 1788)
COMMON NAME	Common thresher shark
FAMILY	Alopiidae
ENDEMIC	No, circumglobal in tropical and temperate waters
SIZE RANGE	115–610 cm TL
SA DISTRIBUTION	E, S, W coasts: entire South African coast
HABITAT	Pelagic in coastal and oceanic waters
DEPTH RANGE	0–370 m
MAJOR FISHERIES	Largely pelagic longlines and commercial linefishery, with some catch in gill and beach seine net, small pelagic and demersal trawl fisheries
IUCN STATUS	Vulnerable 2018
CITES	Appendix II (2017)
MLRA	No retention in any longline fisheries; daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	C da Silva

SPECIES SUMMARY and RECOMMENDATIONS

Alopias vulpinus is a large, epipelagic species and is generally found in coastal and offshore waters. It has a circumglobal distribution in tropical and warm-temperate waters and occurs offshore along the entire South African coast. Local catch was estimated at 1–10 tons per annum (DFFE records: 2010-2012) from a number of fisheries, with the pelagic longline fishery listed as the biggest contributor. Based largely on declines in catches in the North Atlantic, this species was globally assessed as Vulnerable in 2018. As a largely mobile oceanic species, it will derive no benefit from any of the South African MPAs, including those offshore. It is listed in CITES Appendix II and as a result no retention in any South African longline fisheries is permitted. Post capture mortality rates may be high and should be monitored. The location of regional or local pupping and nursery grounds should be investigated.

TAXONOMIC and IDENTIFICATION ISSUES

The existence of a single genus *Alopias* with three species has long been recognised. The three species are strongly differentiated by external and skeletal anatomy (Compagno 2001). Superficially they appear similar, but *A. vulpinus* has relatively small eyes, a tall dorsal fin positioned almost over the pectoral fin axil, narrow-tipped pectoral fins and a white patch on the lower flanks extending forward from the abdominal area.

SOUTH AFRICAN DISTRIBUTION

This species is the most common of the thresher sharks in South Africa. It occurs along the entire South African coast but is most abundant in temperate waters on the south and west coasts (Ebert *et al.* 2021).

REGIONAL DISTRIBUTION

It is found in Namibia and Angola but not Mozambique (Compagno 2001).

SYNOPSIS OF RESEARCH

This is a very poorly studied species. In South Africa Bass *et al.* (1975) provided morphometric and biological information from only 2 individuals. A total of 33 individuals were caught in the KZN bather protection programme (1978-2018). Young *et al.* (2016) provided a global status report on this species.

ECOLOGY

Depth
This epipelagic species occurs in the open ocean and in coastal waters, but is most abundant near land as the pups utilise inshore nursery areas (Ebert *et al.* 2013). It occurs from the surface down to 650 m (Rigby *et al.* 2019c). In summer it ventures inshore and has been seen inside bays such as Saldanha Bay and caught in gillnet fisheries on occasion in False Bay (Lamberth 2006). Individuals may undertake daily vertical migrations and display spatial and depth segregation by sex (Compagno 2001).

Habitat: Adults
Larger thresher sharks typically inhabit waters offshore of the continental shelf and exhibit diel patterns of vertical distribution generally remaining in the upper 20 m by night and moving deeper by day to depths exceeding 300 m (Cartamil *et al.* 2011).

Habitat: Juveniles/Nursery Grounds
The juveniles are also pelagic, but are often close inshore and in shallow bays. They may be less cold-tolerant than adults (Compagno 2001). Juveniles also undertake diel vertical migrations, inhabiting the upper 20 m at night, and making frequent daytime dives to depths exceeding 50 m, with a maximum recorded dive depth of 192 m (Cartamil *et al.* 2016).

Synopsis of tag deployments
No tagging has been undertaken in South African waters.

Movements
This species is a seasonal migrant with extensive long-distance seasonal migrations, with spatial and depth segregation elsewhere in its range (Compagno 2001).

Diet/feeding: adults
The adult diet is predominantly small shoaling teleosts and some bottom species, as well as cephalopods. The tail is used to herd and stun the prey, which explains why tail hooking is common on longlines (Compagno 2001).

Diet/feeding: juveniles
The diet of juveniles is unknown but may include similar prey species to adults.

South African toxicological studies
No local studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Viviparity with oophagy
DURATION OF REPRO CYCLE	Unknown locally; annual or biannual elsewhere
MATING	Summer (California)
GESTATION	9 months (California)
LITTER SIZE	2–4, maximum 6
PUPPING/NURSERY GROUND	Spring (California)
LENGTH AT BIRTH	115–160 cm
LENGTH AT MATURITY	F: 260–465 cm; M: 260–420 cm
MAXIMUM LENGTH	At least 573 cm, possibly 610 cm
GENERATION LENGTH	25.5 years

Mode
This species exhibits viviparity, with oophagy (Compagno 2001).

Duration of reproductive cycle
This is unknown locally, but elsewhere it is both annual or biannual (Gubanov 1978, Cailliet and Bedford 1983, Gervelis and Natanson 2013).

Mating season and location
This is unknown in the SW Indian Ocean, but in California (eastern North Pacific) mating takes place in summer (Compagno 2001).

Gestation
This is unknown in the SW Indian Ocean, but in California (eastern North Pacific) it is 9 months (Compagno 2001).

Litter size
Two pregnant females from KZN waters both had 4 pups (KZN Sharks Board unpubl. data). In California (eastern North Pacific), litter size is usually 2–4, with a maximum of 6 (Compagno 2001).

Length at birth
Length at birth from multiple sources outside the SW Indian Ocean falls within the range 115-160 cm (Rigby *et al*. 2019c).

Pupping season and nursery ground
This is unknown in the SW Indian Ocean, but in California (eastern North Pacific) pupping takes place in spring (Compagno 2001).

Length at maturity
Length at maturity for females is 260–465 cm and males mature at 260–420 cm (Young *et al.* 2016).

Maximum length
Maximum length is at least 573 cm, possibly over 610 cm, with no details by sex (Compagno 2001).

Age and growth
Female age at maturity was estimated at 13 years and maximum age 38 years, based on bomb-radiocarbon validated ages from the NW Atlantic. In the Eastern Central Pacific, age-at-maturity estimates were much younger, though not validated, with female age-at-maturity at 5.3 years and a maximum age at 22 years in California (Rigby *et. al* 2019c and references cited therein).

Generation length
Adopting a precautionary approach, the validated bomb radiocarbon ages from the Atlantic were used for both regions to give a generation length of 25.5 years (Rigby *et al*. 2019c).

FISHERIES MANAGEMENT
SA catch sources, quantities and characteristics
Local catch was estimated at 1–10 tons per annum (DFFE records: 2010–2012; da Silva *et al*. 2015), from a number of fisheries, with the pelagic longline fishery listed as the biggest contributor, followed by the commercial and recreational linefishery, small pelagic fishery and bather protection programme (da Silva *et al*. 2015).

Pelagic longline fishery
This species comprised 2.2% of the large pelagic sharks caught in the Southern African tuna and swordfish longline fisheries (1998–2005), and was equally discarded/released and retained. In a fishery where the estimated annual catch is 40,000-70,000 sharks per annum, this equates to about 1,000 *A. vulpinus* each year (Petersen *et al.* 2009). As it has been a CITES-listed species (Appendix II) since 2017, catches in this fishery can no longer be retained. A recent analysis of observer data

suggests that, as a group, 72% of thresher sharks are dead or in poor condition on release (Jordaan *et al*. 2020).

Fishing outside South Africa
This species is caught globally as target and bycatch in commercial and small-scale pelagic longline, purse seine, and gillnet fisheries. Most of the catch is taken as bycatch of industrial pelagic fleets in offshore and high-seas waters (Rigby *et al.* 2019c). The species is generally retained for the fins and meat which is highly prized (Compagno 2001). The fins from all three species of *Alopias* accounted for 2-3% of fins traded in Hong Kong. This species is highly valued by big-game recreational fishers, and although many practise catch-and-release, recreational fishing could be a threat due to post-release mortality that has been estimated as 78% for tail-hooked and 0% for mouth-hooked animals. At vessel mortality of 67% was estimated on Portuguese longlines in the Atlantic (Rigby *et al.* 2019c and references cited therein).

Population trends
A. vulpinus is long-lived (38 years), with larger litters (2–6 pups) and possibly an annual reproductive cycle. Consequently, it has a higher rate of population increase than the other two species of *Alopias* (Rigby *et al.* 2019c). Genetic results indicate one global population, however there is some genetic structuring between the NW Atlantic and the Pacific Oceans. The species has declined in the North Atlantic. It has increased in the NE Pacific, which is a managed fishery and may not be representative of trends in the wider Pacific. To determine a global population trend, the estimated three generation population trends for each region were weighted according to the relative size of each region. The overall estimated median population reduction was 47%, with the highest probability of a <20% reduction over three generation lengths (76.5 years). However, as the trends were uncertain and there was a lack of data from other regions of the world, expert judgement elicitation was used to estimate a global population reduction of 30–49% over the last three generations, based on abundance data and levels of exploitation. Therefore, the species was assessed as Vulnerable in 2018 (Rigby *et al.* 2019c and references cited therein).

ECOTOURISM
This pelagic species is rarely seen by divers and therefore cannot be regarded as an ecotourism species.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
As this species is listed on CITES Appendix II, no retention is permitted in either the pelagic or demersal longline fisheries. There is a daily bag limit of one in the recreational linefishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
Given its wide-ranging movements, this species is unlikely to derive any benefit from South African MPAs.

Additional local comment

IUCN Red List Status
<u>Vulnerable 2018: A2bd</u>

Previous IUCN assessments

Vulnerable 2009
Data Deficient 2002
Near Threatened 2000

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
All three thresher species were placed on Appendix II in 2017.

Convention on Migratory Species (CMS)
All three thresher species were placed on Appendix II in 2014.

International comments
In 2009, the International Commission for the Conservation of Atlantic Tunas (ICCAT) adopted a measure banning retention of *A. superciliosus* that also discourages targeted fishing of *A. vulpinus*. In 2009, the Indian Ocean Tuna Commission (IOTC) banned the retention, transhipment, landing, storage, and sale of all three species of thresher sharks (Rigby *et al.* 2019c).

MANAGEMENT CONSIDERATIONS
As a CITES Appendix II species it may not be retained in the pelagic longline fishery. Longliners need to be encouraged to avoid fishing in locations which have historically rendered high catches of this and other prohibited shark species. The survival rate of individuals released from this fishery is of concern, given that the post-release mortality in pelagic sharks, especially *Alopias* can be high. Fishery inspectors need to be able to confidently distinguish the three species of *Alopias.* As thresher sharks are highly prized for their fins, improved management of fin trade is vital to their conservation.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
This is a poorly studied species with very little known locally of its life history and reproductive biology. The possibility of an inshore nursery ground needs to be investigated. Opportunistic sampling should be used to collect life history information and genetic samples to investigate regional population structure.

FAMILY CETORHINIDAE

Cetorhinus maximus

SCIENTIFIC NAME	*Cetorhinus maximus* (Gunnerus 1765)
COMMON NAME	Basking shark
FAMILY	Cetorhinidae
ENDEMIC	No, circumglobal in temperate waters
SIZE RANGE	150 –1000+ cm TL
SA DISTRIBUTION	E, S and W coasts: Salt Rock to Orange River
HABITAT	Pelagic in coastal and oceanic waters
DEPTH RANGE	0–1200 m
MAJOR FISHERIES	None documented in South Africa
IUCN STATUS	Endangered 2018
CITES	Appendix II (2019)
MLRA	No targeted catch in any fishery
COMPILER	G Cliff
REVIEWER	AV Towner

SPECIES SUMMARY and RECOMMENDATIONS

Cetorhinus maximus is a very large, epipelagic species found in coastal and offshore waters. It is circumglobal in temperate waters, but does enter the tropics by remaining below the thermocline. There were no local catches (DFFE records: 2010–2012). Historically this species was heavily fished in many regions outside South Africa. Based on declines in catches in the North Atlantic, this species was globally assessed as Endangered in 2018. It was listed in CITES Appendix II in 2019. Legislation prevents any deliberate targeting in South African waters. As it appears to be such a poorly known species locally, it is difficult to ascertain which South African MPAs would provide any benefit. Collation of all sightings and historic catch records should be undertaken.

TAXONOMIC and IDENTIFICATION ISSUES

There are no taxonomic or identification issues. It is the only species in the genus and the family. It is highly distinctive with a bulbous pointed snout and enormous gill slits which almost encircle the head. It is one of only three planktivorous sharks and is the second-largest shark after the whale shark.

SOUTH AFRICAN DISTRIBUTION

This species occurs on part of the east coast, the entire south coast and the extreme southern part of the west coast (Cape Point to Table Bay). It is usually encountered between Cape Agulhas and Table Bay (Ebert *et al.* 2021). The capture of a 2.6 m individual in the KZN bather protection programme is possibly one of the few records for the east coast of South Africa, although this species is generally found in deeper water and far offshore in subtropical regions. Another record exists off Plettenberg Bay where a whale watching vessel photographed a pod of six *Orcinus orca* killing and consuming the liver from a large individual in 2010 (Alison Towner, Rhodes University, pers. comm.)

REGIONAL DISTRIBUTION

It is found in Namibia and is absent from the Indian Ocean except in South Africa and Australia (Compagno 2001).

SYNOPSIS OF RESEARCH

This is not a well-studied species. In South Africa Bass *et al.* (1975) were unable to obtain any specimens locally and were only able to present a literature review. No dedicated research on this species has been conducted in South Africa.

ECOLOGY

Depth

This slow-moving pelagic species inhabits coastal waters but is also found in the open ocean. It occurs near the surface in warm-temperate water and in deeper water below the thermocline down to over 1200 m (Ebert *et al*. 2013). It is thought to overwinter in deep offshore waters (Compagno 2001).

Habitat: Adults

They are epipelagic from the coast out to continental shelf edge and slope, often associated with coastal and oceanic fronts (Ebert *et al*. 2013).

Habitat: Juveniles/Nursery Grounds

Very little is known of the juveniles (Compagno 2001).

Synopsis of tag deployments

No tagging has been undertaken in South African waters.

Movements

In other regions this species migrates thousands of kilometres across ocean basins, often crossing the tropics by remaining in cooler water below the thermocline (Ebert *et al*. 2013).

Diet/feeding: adults

This species is planktivorous, feeding on copepods and crustacean and teleost larvae (Compagno 2001). The species sheds its gill rakers during winter and ceases feeding or feeds demersal growing a new set before spring in waters around the United Kingdom (Simms 2008).

Diet/feeding: juveniles

No information is available.

South African toxicological studies

There are no known local studies.

REPRODUCTION

REPRODUCTIVE MODE	Viviparity with oophagy
DURATION OF REPRO CYCLE	Possibly 2–3 years
MATING	Unknown
GESTATION	Unknown, but possibly 3.5 years
LITTER SIZE	A single litter of 6
PUPPING/NURSERY GROUND	Spring (United Kingdom)
LENGTH AT BIRTH	150–170 cm
LENGTH AT MATURITY	F: 800–980 cm; M: 400–700 cm
MAXIMUM LENGTH	F: 980 cm; M: 850 cm
GENERATION LENGTH	34 years

Mode

This species exhibits viviparity with oophagy (Compagno 2001).

Duration of reproductive cycle

This is possibly 2–3 years (Compagno 2001).

Mating season and location
This is unknown.

Gestation
Based on vertebral growth rings it has been suggested that there is a 3.5-year gestation (Compagno 2001).

Litter size
Litter size in one pregnant female was six (Compagno 2001).

Length at birth
This is 150–170 cm (Compagno 2001).

Pupping season and nursery ground
Juveniles larger than 200 cm appear in waters around the United Kingdom in spring, suggesting spring pupping (Compagno 2001). Southern Hemisphere pupping grounds have not been identified.

Length at maturity
Length at maturity for females is 800-980 cm and for males 400-750 cm, but based on a small number of individuals (Compagno 2001).

Maximum length
Maximum length is 980 cm for females 850 cm for males, although there have been reports of 12-15 m individuals (Compagno 2001).

Age and growth
Female age-at-maturity was estimated at 16–20 years (18 years average) and maximum age was estimated at 50 years, although earlier studies gave much lower ages (Compagno 2001).

Generation length
Generation length was estimated at 34 years (Rigby *et al*. 2019d).

FISHERIES MANAGEMENT

SA catch sources, quantities and characteristics
This species was not recorded in local catches (DFFE records: 2010–2012; da Silva *et al*. 2015). A single specimen was caught in the KZN bather protection programme.

Fishing outside South Africa
Currently there are no target fisheries for this species which was heavily fished for several centuries by harpoon and net fisheries for meat, fins, skin, cartilage, and liver oil. The species is still caught as bycatch in trawl and set nets and in pot lines. The large fins are extremely valuable (Rigby *et al*. 2019d).

Population trends
Genetic results indicate one global population. Historically there have been some severe declines, however there are indications of some stability and possible slow recovery since cessation of targeted fishing and the introduction of high levels of protection. The NE Atlantic population showed signs of stabilising. Despite this, estimated abundances were still well below historic levels and demand for the high-value fins persisted. A global population reduction of 50–79% is suspected over the past three generations (102 years) and as a result this species was assessed as Endangered in 2018 (Rigby *et al*. 2019d).

ECOTOURISM
This species is rarely seen by divers and therefore cannot be regarded as an ecotourism species.

Marine Living Resources Act (MLRA) Regulations
By legislation this species may not be targeted in any South African fisheries**.**

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species listed as Vulnerable.

Marine Protected Areas
In South Africa the core of its distribution appears to be Cape Agulhas to Table Bay. As so little is known about this species locally it is difficult to ascertain which MPAs will provide significant protection. The Agulhas Bank Complex and the De Hoop MPA appear to be potentially the most beneficial.

Additional local comment

IUCN Status
Endangered 2018: A2bd

Previous IUCN assessments
Vulnerable 2009
Vulnerable 2000
Vulnerable 1996
Insufficiently Known 1994
Insufficiently Known 1990

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species was listed on Appendix II in 2002.

Convention on Migratory Species (CMS)
This species was listed on Appendix I and Appendix II in 2005.

International comments
This species was among the first shark species listed under several wildlife treaties. Many fishing nations worldwide and the European Union protect basking sharks through wildlife conservation legislation or apply zero quotas under fisheries management regulations (Rigby *et al.* 2019d).

Since 2005, the North-East Atlantic Fisheries Commission (NEAFC) has banned directed fisheries in the Convention Area. There are a range of conservation measures in the UK, along with a recommended Basking Shark code of conduct (OSPAR 2009). This species is listed on Appendix II of the Bern Convention for the Conservation of European Wildlife and Habitats. In 2012, the General Fisheries Commission for the Mediterranean (GFCM) banned retention and mandated careful release for the this and 23 other elasmobranch species listed on the Barcelona Convention Annex II. Implementation by GFCM Parties, however, has been very slow (Rigby *et al.* 2019d).

MANAGEMENT CONSIDERATIONS
This species is protected and may not be targeted. The absence of information as to where it occurs and the fact that it was not documented in catches in the period 2010-2012 make it very difficult to formulate any considerations for management. A first step would be to collate all sighting data and historic catch records to try and formulate a better understanding of this species in South African waters.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

This is a very poorly studied species with very little known locally or regionally of its life history and reproductive biology. Opportunistic sampling should be used to collect life history information as well as genetic samples to investigate regional population structure. .

FAMILY LAMNIDAE

Carcharodon carcharias

SCIENTIFIC NAME	*Carcharodon carcharias* (Linnaeus 1758)
COMMON NAME	White shark
FAMILY	Lamnidae
ENDEMIC	No, circumglobal in temperate, subtropical and tropical waters
SIZE RANGE	120–600 cm TL
SA DISTRIBUTION	E, S, W coasts: entire South African coast
HABITAT	Pelagic in coastal and oceanic waters
DEPTH RANGE	0–1300 m
MAJOR FISHERIES	KZN bather protection programme, recreational linefishery and possible bycatch in various commercial fisheries
IUCN STATUS	Vulnerable 2018
CITES REGS	Appendix II (2004)
MLRA REGS	Full protection, no catch allowed
COMPILER	G Cliff
REVIEWER	A Kock

SPECIES SUMMARY and RECOMMENDATIONS

Carcharodon carcharias is a very large, epipelagic species and is generally found inshore, but larger sharks move into the open ocean. It has a circumglobal distribution in tropical, subtropical and temperate waters. It is an important top order predator along the South African coast. The local catch was estimated at <1 ton per annum (DFFE records: 2010-2012), with the KZN bather protection programme listed as the sole contributor. Juveniles, including neonates, are caught by recreational shore anglers on the south coast and in Algoa Bay. This species grows far more slowly than was originally calculated, with females maturing at 30-33 years. Based on steep declines in catches elsewhere in its range, this species was globally classified as Vulnerable in 2018. It has been fully protected in South Africa since 1991 and is listed in CITES Appendix II. As a highly nomadic and migratory species, it will derive little benefit from South African MPAs on the south and east coasts, although some MPAs may protect favourable feeding locations, such as seal colonies. Individuals regularly move between South Africa and Mozambique where they are not afforded protection. South Africa needs to initiate a regional conservation plan for this species which includes sharing data and catch statistics and the promotion of protection in Mozambique. The KZN bather protection programme is the largest source of mortalities in South Africa, and there is a need to find alternative, non-lethal methods to keep bathers safe from sharks and to reduce these and other mortalities. White sharks are undoubtedly occasionally caught in various commercial fisheries, especially longlines and by recreational anglers. A national database of catches would increase our understanding of fisheries-induced mortality for this species, but non-reporting remains a problem. Improved fisheries observer coverage and reporting is recommended, particularly in fisheries using gill nets and longlines. The location of regional or local pupping and nursery grounds and the identification of adult aggregation sites and behaviour needs to be investigated.

TAXONOMIC and IDENTIFICATION ISSUES

Historically there have been attempts to name a regional species of white shark and to distinguish separate regional populations, but only a single extant species in the genus is recognised globally (Compagno 2001). Very small individuals have a slender body and narrow, pointed teeth which may result in them being mistaken for the shortfin mako shark *Isurus oxyrinchus. C. carcharias* is the only species in the family with serrated teeth.

South African Distribution
This species occurs along the entire South African coast with its regional distribution concentrated on the south coast (Ebert *et al.* 2021). The average size of white sharks increases along the South African coast from KwaZulu-Natal to False Bay (Hewitt *et al*. 2017).

Regional Distribution
It is also found in Namibia, Mozambique and Madagascar and countries to the north (Compagno 2001).

SYNOPSIS OF RESEARCH
C. carcharias is a well-studied species, with shark attack providing the initial impetus for local research. In South Africa Bass *et al.* (1975) provided detailed taxonomic, morphometric and biological information from about 65 individuals. This was followed by an analysis of catch statistics and general biology of 591 individuals caught in the KZN bather protection programme over the period 1978-1988 (Cliff *et al.* 1989). Tissue samples from animals caught in this programme have been used for several studies, which are listed by Dudley (2012) in his review of white shark research in southern Africa. The rapid development of the white shark viewing industry, centred around island seal colonies in False Bay, Gansbaai and Mossel Bay, provided a huge catalyst for various ecological and behavioural studies, as well as local population estimates (Dicken *et al*. 2013, Hewitt *et al.* 2018, Kock *et al.* 2013, 2018, Ryklief *et al*. 2014, Towner *et al*. 2013). Several studies have investigated non-lethal solutions to reduce shark encounters and the human dimensions of shark-human conflict (Kock *et al*. 2012, Huveneers *et al.* 2013, Engelbrecht *et al*. 2017, O'Connell *et al*. 2014). Cliff and Wintner (2013) provided an overview of the life history and fisheries details of this species in South Africa.

ECOLOGY
Depth
This epipelagic species is found in coastal waters from the shoreline out to the shelf edge. It is also encountered in the open ocean, especially large females, including around islands (A Kock, SAN Parks unpublished data). It occurs from the surface down to 1300 m (Compagno 2001).

Habitat: Adults
Adults are rarely encountered in South African coastal waters (Hewitt *et al*. 2018). They occur further offshore, occasionally venturing inshore to feed at seal colonies. They sometimes visit oceanic islands and appear more frequently in the tropics (Cliff *et al.* 2000; Compagno 2001).

Habitat: Juveniles/Nursery Grounds
The juveniles are more common close inshore, with some evidence of a nursery ground in Algoa Bay (Cliff *et al.* 1996, Dicken and Booth 2013). They appear to be less tolerant of warm water and therefore are less likely to be found in tropical waters (Compagno 2001). Most aggregations associated with pinniped colonies range from 2–5 m which encompasses large juveniles, sub-adults and adults of both sexes. Juveniles and sub-adults are the most abundant age class, with mature males more common than mature females (Towner *et al*. 2013, Ryklief *et al*. 2014 and Hewitt *et al*. 2017).

Synopsis of tag deployments
A total of 508 individuals, mostly juveniles, have been tagged, mainly on the east and south coasts (ORI Cooperative Fish Tagging Project, 1984-2018) with 3% recaptured. Mean distance travelled was 290 km; mean time at liberty 0.9 years (max: 1543 km and 2.6 years) (Jordaan *et al.* 2020).

Movements
This species is regarded as nomadic, visiting seal colonies for short periods, as transients or temporary residents, but often returning several days or even years later (Compagno 2001). Individuals move up and down the east and south coasts. It is also migratory, undertaking extensive long-distance seasonal

migrations. An immature female crossed the Indian Ocean to West Australia and then returned to South Africa, while two others remained coastal, moving into southern Mozambique before returning to the south coast (Bonfil *et al.* 2005). Large individuals caught in the tropical western Indian Ocean may have originated from South Africa (Cliff *et al.* 2000).

Seasonal aggregations associated with pinniped colonies tend to occur mostly during autumn and winter (Dicken *et al*. 2013, Kock *et al*. 2013, Towner *et al*. 2013, and Ryklief *et al.* 2014), except at Bird Island where sightings peaked in winter and spring (Dicken *et al*. 2013). The sex ratios of these sharks were close to unity. Aggregations at select coastal sites not associated with pinnipeds occur mostly in spring and summer, with females dominant (Kock *et al*. 2013, Towner *et al.* 2013). These aggregations may show seasonal variations in the sex ratio (Hewitt *et al*. 2017), and/or age class (Dicken and Booth 2013).

Diet/feeding: adults

White sharks are top predators that exert strong predation pressure on the species they feed on. At colonies in the Western Cape, Cape fur seals *Arctocephalus pusillus pusillus* alter their behaviour in time and space to avoid predation risk by white sharks (De Vos *et al*. 2015a, 2015b, Wcisel *et al*. 2015). There is an ontogenetic shift in diet, with larger white sharks feeding on teleosts and sharks and also tackling much larger prey which included dolphins and seals (Cliff *et al.* 1989). They opportunistically scavenge on whale carcasses (Compagno 2001).

Diet/feeding: juveniles

Juveniles feed mainly on teleosts and small sharks, followed by cephalopods (Cliff *et al*. 1989) but are capable of predating on seal pups (Compagno 2001).

South African toxicological studies

There are four local studies, using mostly immature sharks caught in the KZN bather protection programme. The first investigated concentrations of 10 metals, which included mercury, lead and cadmium, measured in the liver and muscle tissues of 14 individuals (Watling *et al.* 1982). Two investigated the levels of organochlorine pesticides (Schlenk *et al.* 2005, Beaudry *et al.* 2015) and the other mercury concentrations (McKinney *et al.* 2014).

REPRODUCTION

REPRODUCTIVE MODE	Viviparity with oophagy
DURATION OF REPRO CYCLE	Possibly 3 years
MATING	Unknown
GESTATION	18 months
LITTER SIZE	2–17
PUPPING/NURSERY GROUND	Unknown locally, possibly Algoa Bay
LENGTH AT BIRTH	120–150 cm
LENGTH AT MATURITY	F: 450–500 cm; M: 360–380 cm
MAXIMUM LENGTH (F:M)	F: 600 cm; M: 520 cm
GENERATION LENGTH	53 years

Mode

This species exhibits viviparity with oophagy (Francis 1996).

Duration of the reproductive cycle

This is possibly 3 years (Mollet *et al.* 2000, Bruce 2008), based on information obtained elsewhere, as no pregnant females have been documented from South African waters. The closest individuals were a shark from Kenya and another from Madagascar (Cliff *et al.* 2000), which, based on evidence from subsequent tracking studies (Bonfil *et al.* 2005), could have come from South Africa.

Mating season and location
This is unknown.

Gestation
This is possibly 18 months (Bruce 2008).

Litter size
Litter size is 2–17 (Bruce 2008).

Length at birth
Length at birth is 120–150 cm (Francis 1996).

Pupping season and nursery ground
In other locations pupping appears to occur in temperate locations in spring to summer (Francis 1996, Bruce 2008). In South Africa the Algoa Bay region appears to be a nursery ground (Cliff *et al.* 1996, Dicken 2008, Dicken and Booth 2013)

Length at maturity
Length at maturity for females is 450–500 cm and for males 360–380 cm (Bruce 2008).

Maximum length
There is considerable debate about the validity of some of the claims of individuals between 640 and 1100 cm. Maximum length is possibly 600 cm for females and 520 cm for males (Compagno 2001).

Age and growth
Age of the local population was assessed, sexes combined, from band counts of sectioned vertebrae, but with only immature individuals of 150–436 cm sampled (Wintner and Cliff 1999). It was one of three regional studies, which, when combined, indicated that males matured at 7–9 years and females at 12–17 years (Bruce 2008).

More recent studies have utilised bomb radiocarbon (carbon 14) dating to validate annual growth band formation. This technique capitalises on the rapid increase in radiocarbon in the world's oceans as a result of atmospheric testing of thermonuclear devices in the 1950s and 1960s. The results have shown that this species, including South African individuals (Christiansen *et al.* 2016), grows far more slowly than originally estimated. In the NW Atlantic, NE Pacific, and SW Indian Oceans, female age-at-maturity is 30–33 years and maximum age of 30–73 years (Rigby *et al.* 2019m and references cited therein).

Generation length
Using the precautionary approach and the validated, most conservative bomb radiocarbon ages of age-at-maturity of 33 years and maximum age of 73 years, generation length is 53 years (Rigby *et al*. 2019m).

FISHERIES MANAGEMENT

SA catch sources
The local catch was estimated at <1 ton per annum (DFFE records: 2010-2012; da Silva *et al*. 2015), with the KZN bather protection programme listed as the only contributor. As this species is piscivorous, it may be accidentally caught in any of the line or longline fisheries, but there are no published records and non-reporting may be an issue. There is evidence on social media of small

individuals landed by recreational anglers. It is a very rare bycatch in beach seine nets in False Bay (Lamberth 2006).

SA catch quantities and characteristics

KZN bather protection nets

The mean annual catch in the KZN bather protection nets was 39 (range 22-61) individuals (1974-1988). The catches were all immature individuals (Cliff *et al.* 1989). Subsequently, a few adult males were caught. There was a 4–6-year cyclical trend in catches, with low catches following El Nino years (Cliff *et al.* 1996). More recently, the mean annual catch was 33 (2000-2018) (KZN Sharks Board, unpublished data). Approximately 10% of the catch is released, with most individuals tagged as part of the ORI Cooperative Fish Tagging Project (Cliff and Dudley 2011).

Recreational linefishery

Juveniles and sub-adults, including neonates, are caught by shore anglers in the recreational line fishery, particularly on the south coast and the southern end of the east coast (Algoa Bay), but catches have not been quantified. This species may be deliberately targeted for sport, despite a ban on such practices (Cliff and Wintner 2013).

Fishing outside South Africa

Globally, this species is caught as bycatch, mostly in inshore fisheries in a range of gears, such as longlines, set lines, gillnets, trawls, hand-held rod and reel, and fish-traps; it is rarely caught in offshore pelagic fisheries. This includes neighbouring Mozambique and Madagascar, where the species obtains little protection. Globally, it has a relatively high post-release survival in net fisheries Rigby *et al.* (2019m). Fins and jaws have a high market value. Small white shark fins are present, illegally, in the international fin trade (Rigby *et al.* 2019m). Jaws may be retained domestically as curios (CITES 2004).

Population size and trends

There have been two white shark population estimates for South Africa. Locally numbers range from 438 (Andreotti *et al*. 2016), although there are concerns over the validity of this estimate (Irion *et al.* 2017) to 1279 (Cliff *et al.* 1996). There are population estimates for local aggregation sites: 389 individual sharks at Mossel Bay (Ryklief 2012); 908 individuals at Gansbaai (Towner *et al.* 2013) and 723 individuals at Seal Island, False Bay (Hewitt 2014). These local estimates likely reflect an index of abundance rather than absolute abundance for the South African coastline.

There are no data available on the global population size of the white shark. Genetic studies suggest one global population; however, there is some genetic structuring between ocean basins, potentially within ocean basins, and likely global male-biased dispersal and female philopatry (Rigby *et al.* 2019m and references cited therein).

Population trend data are available from four sources, one in the Atlantic, two in the Pacific and one in the SW Indian Ocean, with the last one utilising catch statistics from the KZN bather protection programme (Dudley and Simpfendorfer 2006) (see Rigby *et al*. 2019m for details). In KZN catch rates fluctuated considerably but were stable over time and over the period 1978–2012 (35 years) revealed annual rates of increase of 0.1%, consistent with an estimated median increase of 13.1% over three generation lengths (159 years), with the highest probability of increases over three generation lengths. This is possibly attributable to the fact that this species was protected in South Africa in 1991. This was in contrast to the assessments from the other three regions, which revealed marked declines.

Across the regions, this species was estimated to be declining from historic levels in the NW Atlantic and South Pacific, and increasing in the NE Pacific and the Indian Ocean. The trends among ocean regions were highly variable. While they were mostly based on long datasets, they were extrapolated over a very long three-generation length of 159 years which increases the uncertainty in the estimated regional trends. Except for the NW Atlantic, they were also based on datasets from limited areas within each region. They may not accurately represent the trend in white sharks across the entire region. Despite these caveats, the trend data were the best available and were used for the estimation of a global population trend, weighted according to the relative size of each region. Due to various uncertainties, expert judgment elicitation resulted in an estimated global population reduction of 30–49% over the last three generations (159 years), based on long-term abundance data and protections instigated in the 1990s that have since reduced catches. Therefore, in 2018 the white shark was assessed as Vulnerable A2bd (Rigby *et al.* 2019m and references cited therein).

ECOTOURISM

South Africa is world-renown as a premier white shark viewing destination. Individuals are regularly seen patrolling the waters around colonies of Cape fur seals *Arctocephalus pusillus pusillus* on Seal Island (False Bay) Dyer Island (Gans Bay), Sea Island (Mossel Bay) and Bird Island (Algoa Bay) on a seasonal basis (see section on Movements for more information and citations). Sightings elsewhere along the South African are generally opportunistic, including during the winter sardine run on the east coast.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

South Africa was the first country to fully protect this species in 1991 (Compagno 1991). It is a no-catch species in all South African fisheries.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)

This species is listed as Vulnerable.

Marine Protected Areas

This highly mobile species will derive limited direct benefit from MPAs on the east and south coasts. Individuals are likely to spend disproportionately longer time around seal colonies, seamounts and other specific inshore sites (Bonfil *et al*. 2015, Kock *et al*. 2018,) which provide favourable feeding opportunities. MPAs which include seal colonies therefore provide considerable benefit, but the largest of these aggregation sites, namely Seal Island, False Bay and Dyer Island, Gansbaai are not yet protected in MPAs, and should be considered for future protection (Kock *et al*. 2018). The nursery grounds of this species appear to include Algoa Bay, and the Addo Elephant National Park MPA may provide protection for the neonates there.

Additional local comment

IUCN RED List Status

Vulnerable 2018: A2bd

Previous IUCN assessments

Vulnerable 2009
Vulnerable 2000
Vulnerable 1996

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

This species was placed on Appendix II in 2004.

Convention on Migratory Species (CMS)

This species was placed on Appendix II in 2002.

International comments

The white shark was among the first shark species listed under several wildlife treaties. Many fishing nations worldwide and the European Union have domestic regulations specifically aimed at protecting it. In 2012, the General Fisheries Commission for the Mediterranean (GFCM) banned retention and mandated careful release of this and 23 other elasmobranch species listed on the Barcelona Convention Annex II. Implementation by GFCM Parties, however, has been very slow (Rigby *et al.* 2019m).

MANAGEMENT CONSIDERATIONS

As a fully protected species, *C. carcharias* may not be retained in any South African fishery. The KZN bather protection programme is the largest known source of white shark mortalities in South Africa. Alternative non-lethal methods are needed to keep bathers safe from sharks and to reduce the mortalities of white sharks and other species caught in the nets and drumlines. Concerns of deliberate targeting of juveniles and sub-adults by shore anglers on the south coast and in Algoa Bay need to be investigated. There is evidence of an illegal international white shark fin trade. It is essential to ensure that South Africa, as one of the global hotspots for this species, is not a source of these fins. This species regularly moves between South Africa and Mozambique but is not protected in Mozambique and countries to the north. South Africa needs to initiate a regional white shark conservation plan which includes sharing data and catch statistics and the promotion of protection in Mozambique and countries to the north. Legislation is needed to protect the two major aggregating sites of Seal Island in False Bay and Dyer Island off Gansbaai.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

Recently a global assessment of research needs was undertaken (Huveneers 2018), and many of them apply locally. In South Africa, this is a well-studied species, probably the most heavily researched shark. Despite this, nothing is known about regional mating and pupping, as no pregnant females have been recorded in South African waters. Movement patterns of the adult females will also help determine their critical habitats and elucidate aspects of the reproductive biology of this species. More information is needed on the location of the nursery ground and the movement patterns of neonates. Given the controversy surrounding the most recent local population size estimate as being unrealistically small, this should be revisited using a combination of genetic, tracking and photo-identification methods to enhance the accuracy and precision of an estimate. The recent prolonged absence of white sharks from Dyer Island and Seal Island in the southwestern Cape has caused huge concern, especially as it has adversely impacted white shark tourism at these two locations. Research is urgently needed to identify the primary cause and implications of the disappearance.

Isurus oxyrinchus

SCIENTIFIC NAME	*Isurus oxyrinchus* (Rafinesque 1810)
COMMON NAME	Shortfin mako shark
FAMILY	Lamnidae
ENDEMIC	No, circumglobal in tropical and warm-temperate waters
SIZE RANGE	60–396 cm TL
SA DISTRIBUTION	E, S, W coasts: entire South African coast
HABITAT	Pelagic in oceanic waters, occasionally coastal
DEPTH RANGE	0–500 m
MAJOR FISHERIES	Largely pelagic longlines, with some catch in small pelagic fishery, KZN bather protection programme and linefisheries
IUCN STATUS	Endangered 2018
CITES	Appendix II (2019) but South Africa has an active reservation
MLRA	Targeting in the pelagic longline fishery is discouraged by means of punitive observer requirements but the landing of bycatch is still permitted; daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	GL Jordaan and D Parker

SPECIES SUMMARY and RECOMMENDATIONS

Isurus oxyrinchus is a large, epipelagic species and is generally found offshore in the open ocean. It has a circumglobal distribution in tropical and warm-temperate waters. Local catch was estimated at 301-700 tons per annum (DFFE records: 2010-2012), from a number of fisheries, with the pelagic longline fishery listed as the biggest contributor. It is also caught in the KZN bather protection programme and the recreational and commercial linefisheries. Based on heavy declines in catches elsewhere in its range, this species was globally assessed as Endangered in 2018. it may still be landed in the pelagic longline fishery, with certain provisos. As a largely oceanic species it will only very derive benefit from offshore MPAs, such as Agulhas Bank Complex and Southwest Indian Seamounts, where an investigation of a possible nursery ground on the Agulhas Bank shelf edge is nearing completion. Although it is listed on CITES Appendix II, it may still be landed in the pelagic longline fishery, provided catches are not so high as to indicate deliberate targeting. Very high levels of mercury were detected in muscle tissues. Continued research on reducing post-release mortality is still needed.

TAXONOMIC and IDENTIFICATION ISSUES

The systematics of the genus *Isurus* was historically chaotic (Compagno 2001) with a few regional species recognised, based on growth changes of *I. oxyrinchus.* Two species are now recognised, with *I. paucus* described in 1966 as a second, highly distinctive mako species. This poorly known and uncommon species, which is frequently misidentified as *I. oxyrinchus*, has a slightly blunter snout and longer pectoral fins. The teeth of the two species also differ.

SOUTH AFRICAN DISTRIBUTION

I. oxyrinchus occurs along the entire South African coast where it is regarded as a common pelagic offshore species (Ebert *et al.* 2021).

REGIONAL DISTRIBUTION

This species is found in offshore waters of Namibia and Mozambique and countries to the north (Compagno 2001).

SYNOPSIS OF RESEARCH

This is a well-studied species. In South Africa Bass *et al.* (1975) provided detailed taxonomic, morphometric and biological information from about 15 individuals. This was followed by an analysis of catch statistics and general biology of 255 individuals caught in the KZN bather protection programme over the period 1978-1989 (Cliff *et al.* 1990). A global overview of the reproductive biology of this species utilised the small number of individuals caught in the KZN bather protection programme which were either in mating condition or pregnant (Mollett *et al.* 2000). Foulis and Groeneveld (2013) provided a concise overview of life history and fishery-related information on this species in southern Africa. Groeneveld *et al.* (2014) investigated the population structure and biology of this species in the SW Indian Ocean, incorporating data from the KZN bather protection programme and the pelagic longline fishery. Corrigan *et al*. (2018) included animals sampled in KZN bather protection programme in a global perspective of the genetic structure of this species. Jordaan *et al.* (2020b) investigated at fishing mortality (landings + discards) of this species in the South African pelagic longline fishery. Stevens (2008) provided a global review of the biology and ecology of this species and Snelson *et al.* (2008) its reproductive biology.

ECOLOGY

Depth

This epipelagic species occurs in the open ocean and may be found close to the coast in areas with narrow continental shelves. It occurs from the surface down to at least 600 m (Compagno 2001, Stevens 2008).

Habitat: Adults

They are epipelagic in the open ocean (Compagno 2001), but may occasionally be found close inshore (<1 km) on the east coast of South Africa (Cliff *et al.* 1990, Groeneveld *et al.* 2014).

Habitat: Juveniles/Nursery Grounds

The juveniles are also pelagic, with higher catches recorded along the 200 m isobath on the Agulhas Bank (Petersen *et al.* 2009), which appears to be a feeding ground for these individuals during winter and spring (Groeneveld *et al.* 2014).

Synopsis of tag deployments

A total of 45 individuals were tagged, mainly by deepsea recreational and charter vessels, in the ORI Cooperative Fish Tagging Project 1984-2018, inclusive. There have been 5 recaptures (11%), with a mean distance travelled of 24 km (maximum 69 km) and mean time at liberty of 8 months (maximum 2.1 years) (Jordaan *et al.* 2020a). A suspected nursery ground off the Agulhas Bank shelf edge is being investigated, utilising satellite tracking, with 19 individuals tagged (Charlene da Silva, DFFE, unpublished data).

Movements

Despite the short distances moved by individuals tagged in South African waters (Jordaan *et al.* 2020a, see above), this species is regarded as migratory with extensive long-distance seasonal migrations elsewhere in its range (Stevens 2008).

Diet/feeding: adults

The diet of predominantly mature individuals caught inshore is dominated by elasmobranchs, mainly small (<1.2 m) sharks, followed by teleosts and pelagic cephalopods (Cliff *et al.* 1990, Groeneveld *et al.* 2014). Elsewhere the diet is dominated by teleosts and pelagic cephalopods (Stevens 2008).

Diet/feeding: juveniles

Juveniles taken in the longline fishery feed almost exclusively on small shoaling teleosts (Groeneveld *et al.* 2014).

South African toxicological studies
Three local studies have been conducted, using samples from individuals caught in the KZN bather protection programme. Watling *et al*. (1981) found that there was a positive relationship between muscle mercury concentrations and body size. Watling *et al.* (1982) determined the concentrations of mercury and nine other metals in various tissues. McKinney *et al.* (2016) found that *I. oxyrinchus* had the highest mercury muscle tissue concentrations among 17 species of sharks found inshore along the east coast. The levels were far higher than in individuals from coastal waters of the North Atlantic and parts of the Pacific and consequently above the regulatory guidelines for fish health effects and safe human consumption.

REPRODUCTION

REPRODUCTIVE MODE	Viviparity with oophagy
DURATION OF REPRO CYCLE	3 years
MATING	Autumn and early winter
GESTATION	15–18 months
LITTER SIZE	Usually 4–16, mean 12, maximum 25
PUPPING/NURSERY GROUND	Late winter to early spring
LENGTH AT BIRTH	60–70 cm
LENGTH AT MATURITY	F: 265–280 cm; M: 195–205 cm
MAXIMUM LENGTH	F: 396 cm; M: 296 cm
GENERATION LENGTH	24–25 years

Mode
This species exhibits viviparity, with oophagy (Mollett *et al.* 2000).

Duration of reproductive cycle
This is 3 years (Mollett *et al.* 2000).

Mating season and location
This includes March and June (autumn and early winter) (Cliff *et al.* 1990, Mollett *et al.* 2000).

Gestation
This is 15–18 months (Mollett *et al.* 2000).

Litter size
Litter size is usually 4–16, with a mean of 12 and a maximum of 25. Litter size increases with maternal size (Mollett *et al.* 2000, Stevens 2008).

Length at birth
Length at birth is 60–70 cm (Mollett *et al.* 2000).

Pupping season and nursery ground
Pupping occurs in late winter to early spring (Mollett *et al.* 2000). A suspected nursery ground off the Agulhas Bank shelf edge is being investigated, utilising satellite tracking, with 19 individuals tagged (C da Silva, DFFE, unpublished data).

Length at maturity
Based on catches in the KZN bather protection programme, length at maturity for females is 265–280 cm and for males 195–205 cm (Cliff *et al.* 1990, Mollett *et al.* 2000). This varies regionally (Snelson *et al.* 2008, Stevens 2008), with a global size range at maturity of 265–312 cm for females and 166–204 cm for males (Rigby *et al.* 2019e).

Maximum length
Maximum length is 396 cm for females and 296 cm for males (Compagno 2001), with regional variation. Rigby *et al.* (2019e) listed a maximum of 445 cm.

Age and growth
Age in the local population was assessed from band counts of sectioned vertebrae. Males matured at age 7 years and females at age 15 years (Groeneveld *et al.* 2014); these authors conceded that age-at-maturity appeared to be lower than in the NW Atlantic and Pacific, possibly due to the small number of large individuals available for ageing. Range in female age at maturity from other regions was 18–21 years, with a maximum age of 28–32 years (Rigby *et al*. 2019e and references cited therein).

Generation length
This is 24–25 years (Rigby *et al*. 2019e).

FISHERIES MANAGEMENT
SA catch sources
Local catch was estimated at 301–700 tons per annum (DFFE records: 2010-2012), from a number of fisheries, with the pelagic longline fishery listed as the biggest contributor, followed by the commercial and recreational linefishery and bather protection programme. It is a suspected catch in the hake longline fishery and the beach-seine and gillnet fisheries (da Silva *et al*. 2015).

SA catch quantities and characteristics
Pelagic longline fishery
I. oxyrinchus is the second most common large pelagic shark caught in the Southern African tuna and swordfish longline fishery, comprising 17% of shark landings (by number), after the blue shark *Prionace glauca* at 69% (Petersen *et al.* 2009). On average, this equates to an annual catch of approximately 17,250 individuals (DFFE landings data: 2000-2015; Jordaan *et al.* 2018). More recent catches from the large pelagic longline fishery ranged from 314 – 870 tons for the period 2010 – 2018 (DFFE 2021), however these catches have decreased substantially to 200 and 143 tons in 2019 and 2020, respectively. These catches are largely by vessels which had historically targeted sharks prior to 2005 when the tuna/swordfish and shark longline fisheries were a single fishery (da Silva *et al.* 2015). *I. oxyrinchus* are mainly retained (96%) with only 4% discarded (1% alive and 3% dead) (Jordaan *et al.* 2020a), because of their high-quality meat and fins. Onboard observer data showed that there was an increase in the number of *I. oxyrinchus* caught from 2013–2018, but a subsequent decline as a result of stricter permit conditions thereafter. Petersen *et al.* (2009) showed that there was a decline in the mean size caught between 2002 and 2007. Foreign vessels that target tunas use a different gear configuration and set hooks deeper and during daytime, thus avoiding high shark bycatches. Local vessels fished mostly in the highly productive SE Atlantic and in the transition zone over the Agulhas Bank, where sharks were more numerous (Petersen *et al*. 2009; Groeneveld *et al*. 2014; Jordaan *et al*. 2020a). Landings of *I. oxyrinchus* increased sharply in 2004 and 2005, and after a decline, peaked again in 2016 (approx. 38,000 fish or 870 tons). Thereafter, there has been a significant decline to current (2020) catches of approx. 6,000 fish or 143 tons, which equates to a 84% decrease in 4 years. (Denham Parker DFFE, unpublished data).

KZN bather protection nets
The mean annual catch in the KZN bather protection nets was 11 (range 3-27; 1966-1989). The catches were largely adults and included a very small number of recently mated and pregnant females (Cliff *et al.* 1990).

Recreational linefishery

This species is rarely, if ever, caught by shore anglers. It is occasionally caught by deepsea anglers, as evident in the ORI-CFTP tagging data. Catches were year-round, with greater numbers in the Western Cape around Cape Point and Hout Bay, with a size range of 80–250 cm.

Fishing outside South Africa

Smale (2008) provided a synopsis of pelagic shark fisheries in the Indian Ocean. This species is caught globally as target and bycatch in pelagic commercial and small-scale longline, purse seine, and gillnet fisheries. The majority of the catch is taken as bycatch in industrial pelagic longline fleets. It is one of the most valuable shark species due to its high-quality meat. The fins are commonly traded, comprising 1.2% of the fin imported in Hong Kong in 2014. (Rigby *et al.* 2019e). Commercial post-release mortality has been reported as 30–33% for this species (Campana *et al.* 2016).

Population trends

Genetic results indicate one global population, with genetic structure between ocean basins (Corrigan *et al*. 2018). Population trend data are available from four sources, one in the Atlantic, two in the Pacific and one in the Indian Ocean (see Rigby *et al*. 2019e for details). Across the regions, this species was estimated to be declining in all oceans, except the south Pacific, where it is increasing. To determine a global population trend, the estimated three generation population trends for each region were weighted according to the relative size of each region. The overall estimated median reduction was 47%, with the highest probability of 50–79% reduction over three generation lengths (72–75 years), and therefore the species was assessed as Endangered A2 in 2018 (Rigby *et al.* 2019e).

ECOTOURISM

This species is not well known as an ecotourism species, although dive companies are offering blue *Prionace glauca* and mako shark viewing 50–70 km out of Gansbaai on the south coast, and similar distances off Cape Point.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

Although this species was listed on CITES Appendix II in 2019, it may still be landed by pelagic longline vessels, but only as bycatch, according to the 20/21 permit conditions. The vessels in this fishery are not allowed to target any pelagic shark species. Targeting is defined as >50% shark catch, by weight, per year. Furthermore, should the combined catch of this species and the blue shark *Prionace glauca* exceed 60% of the catch in a particular quarter, that vessel is required to have 100% observer coverage for the remainder of the fishing season. In addition to these catch restrictions, the use of stainless-steel hooks and wire traces is prohibited in the large pelagic longline fishery; these regulations aim to decrease catches of large sharks and improve post-release survival. Permit conditions also stipulate that sharks must be landed with fins attached so as to halt destructive finning practices. There is a daily bag limit of one individual in recreational fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)

This species is not listed.

Marine Protected Areas

This species will largely only benefit from offshore MPAs, with two in particular, the Agulhas Bank Complex and Southwest Indian Seamounts MPAs. These recently proclaimed MPAs will protect the nursery grounds of *I. oxyrinchus.* The impact of a decrease in pelagic longlining effort as a result of their exclusion from these MPAs is close to completion (Jodie Reed, Nelson Mandela University).

Additional local comment

IUCN Red List Status
<u>Endangered 2018: A2bd</u>

Previous IUCN assessments
Vulnerable 2009
Near Threatened 2000

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species was listed on Appendix II in 2019.

Convention on Migratory Species (CMS)
This species was listed on Appendix II in 2008.

International comments
Globally, there are very few limits on catches of this species. In 2012, the General Fisheries Commission for the Mediterranean (GFCM) banned retention and mandated careful release for this and 23 other elasmobranch species listed on the Barcelona Convention Annex II. Implementation by GFCM Parties, however, has been very slow. A 2017 measure agreed by the International Commission for the Conservation of Atlantic Tunas (ICCAT), in response to scientific advice to ban retention of overfished north Atlantic stocks, instead aims to maximize live release by narrowing the conditions under which individuals from this population can be landed (Rigby *et al*. 2019e). Importantly, Spain and Portugal, the countries in ICCAT with the highest and second highest catches of this species, respectively, have implemented their own ban on landing *I. oxyrinchus.*

MANAGEMENT CONSIDERATIONS
Although it is a CITES Appendix II species, it may be landed in the South African pelagic longline fishery. Recent permit conditions in the Large Pelagic longline fishery that prohibit the targeting of sharks have been effective and resulted in an 80% decrease in *I. oxyrinchus* landings since 2019. A similar response was seen in landings of blue shark *Prionace glauca*, which have decreased by 94% since 2019 (Denham Parker unpubl. data). The survival rate of live individuals released remains a concern, given that the post-release mortality in pelagic sharks can be high.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
This is a well-studied species, with extensive knowledge of its life history, reproductive biology and ecology. Despite this, knowledge of the location of local pupping and nursery areas is lacking. Given the high catches of small juveniles on the Agulhas Bank, an investigation of the presence of a nursery ground on the shelf edge has been undertaken. A total of 19 neonates were fitted with satellite tags; the results are currently being analysed. Continued research on reducing post-release mortality is also needed.

Isurus paucus

SCIENTIFIC NAME	*Isurus paucus* (Guitart 1966)
COMMON NAME	Longfin mako shark
FAMILY	Lamnidae
ENDEMIC	No, circumglobal in tropical and warm-temperate waters
SIZE RANGE	100–430 cm TL
SA DISTRIBUTION	S coast: only Cape Agulhas
HABITAT	Pelagic in oceanic waters, occasionally coastal
DEPTH RANGE	Midwater to 700 m, occasionally down to 1700 m
MAJOR SA FISHERIES	Possibly pelagic longlines and small pelagic fisheries
IUCN STATUS	Endangered 2018
CITES	Appendix II (2019) but South Africa has an active reservation
MLRA	Targeting in the pelagic longline fishery is discouraged by means of punitive observer requirements but the landing of bycatch is still permitted
COMPILER	G Cliff
REVIEWER	G Jordaan

SPECIES SUMMARY and RECOMMENDATIONS

Isurus paucus is a large, epipelagic species and is generally found offshore in deep water of the open ocean. It has a circumglobal distribution in tropical and warm-temperate waters. It was not recorded in South African catches (DFFE records: 2010-2012). Its presence in South African waters is based on the jaws of a single specimen. It is easily mistaken for the more common shortfin mako *I. oxyrinchus*, which is a significant bycatch species in the pelagic longline fishery. Based on heavy declines in the North Atlantic, this species was globally assessed as Critically Endangered in 2018, although catches in SW Pacific, which represent a totally different stock, showed very modest declines. As an oceanic species it will derive no benefit from any of the South African MPAs. Although this species was listed on CITES Appendix II in 2019 it may still be landed by pelagic longline vessels, but only as bycatch, according to the 20/21 permit conditions. Post capture mortality rates may be high and should be monitored. Fisheries observers need to be trained to distinguish between the two species of *Isurus*. If any specimens of *I. paucus* are landed they should be sampled for basic life history parameters; tissue samples should be kept to assess population genetic structure.

TAXONOMIC and IDENTIFICATION ISSUES

The systematics of the genus *Isurus* was historically chaotic (Compagno 2001), with a few regional species recognised, based on ontogenetic growth changes of the shortfin mako *I. oxyrinchus.* Two species are now recognised, with *I. paucus* described in 1966 as a second mako species. Because it is poorly known and uncommon, it is frequently misidentified as *I. oxyrinchus. I. paucus* has a slightly blunter snout and longer pectoral fins and the teeth of the two species also differ, albeit slightly (Compagno 2001).

SOUTH AFRICAN DISTRIBUTION

No specimens were reported by Bass *et al.* (1975). Its presence in South African waters is based solely on a set of jaws from a large individual caught off Cape Agulhas (south coast) by a commercial fisher (Ebert *et al.* 2021).

REGIONAL DISTRIBUTION

This species is found in offshore waters of Namibia and Mozambique (Rigby *et al.* 2019f), but its distribution is poorly documented (Ebert *et al.* 2013).

SYNOPSIS OF RESEARCH

This is a very poorly studied species. Its presence in South Africa is only known from a single set of jaws. Snelson *et al.* (2008) provided a global overview of the state of knowledge of this species.

ECOLOGY

Depth

This epipelagic species commonly occurs in deep water in the open ocean and may be found close to the coast in areas with narrow continental shelves. It commonly occurs down to 700 m but has been recorded at 1700 m (Rigby *et al*. 2019f).

Habitat: Adults

They are epipelagic in deep water in the open ocean from the surface to the bottom (Compagno 2001).

Habitat: Juveniles/Nursery Grounds

No information on juveniles and nursery grounds is available.

Synopsis of tag deployments

No tagging has been undertaken in South African waters (Jordaan *et al.* 2020).

Movements

This species is regarded as migratory, with extensive long-distance seasonal movements elsewhere in its range (Compagno 2001).

Diet/feeding: adults

Food of this species is possibly schooling teleosts and pelagic cephalopods (Compagno 2001).

Diet/feeding: juveniles

There is no evidence that the diet of juveniles is different from that of adults.

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Viviparity with oophagy
DURATION OF REPRO CYCLE	Unknown
MATING	Unknown
GESTATION	Unknown
LITTER SIZE	Usually 2, maximum 4
PUPPING/NURSERY GROUND	Unknown
LENGTH AT BIRTH	100–120 cm
LENGTH AT MATURITY	F: 245 cm; M: 190–228 cm
MAXIMUM LENGTH	430 cm
GENERATION LENGTH	25 years, based on *I. oxyrinchus*

Mode

This species exhibits aplacental viviparity with oophagy (Snelson *et al.* 2008).

Duration of reproductive cycle

This is unknown (Snelson *et al.* 2008).

Mating season and location

This is unknown (Snelson *et al.* 2008).

Gestation
This is unknown (Snelson *et al.* 2008).

Litter size
Litter size is usually two (one per uterus) but may be three or four, with an unconfirmed report of eight (Snelson *et al.* 2008).

Length at birth
Length at birth is 100–120 cm, based on the largest embryo of 97 cm and the smallest free swimmer of 123 cm (Snelson *et al.* 2008).

Pupping season and nursery ground
This is unknown (Snelson *et al.* 2008).

Length at maturity
Length at maturity for females is 245 cm and for males 190–228 cm (Ebert *et al.* 2013).

Maximum length
Maximum length is 430 cm (Ebert *et al.* 2013).

Age and growth
No ageing studies have been conducted on this species. Comparative data is available from *I. oxyrinchus.*

Generation length
This is unknown, but that of *I. oxyrinchus*, which is 25 years, has been used (Rigby *et al*. 2019f).

FISHERIES MANAGEMENT
SA catch sources, quantities and characteristics
This species was not recorded in the estimated local catches (DFFE records: 2010–2012; da Silva *et al*. 2015). It is possibly caught in the pelagic longline fishery but it was not reported (Petersen *et al.* 2009).

Fishing elsewhere in southern Africa and globally
This species is caught globally as target and bycatch in pelagic commercial and small-scale longline, purse seine, and gillnet fisheries. The majority of the catch is taken as bycatch in industrial pelagic fleets in offshore and high-seas waters, but it is also caught in coastal areas with narrow continental shelves. It prefers water deeper than its congener and is therefore likely less vulnerable to shallow set pelagic longline gear (Rigby *et al*. 2019f). This species is seldom retained for its meat, which is regarded as poor quality compared to *I. oxyrinchus,* and it is often finned and discarded at sea (Compagno 2001). Capture and post-release mortalities are unknown (Rigby *et al.* 2019f).

Population trends
There are no data available on the population size or structure of this species. The only available population trend data are from standardized catch-per-unit-effort (CPUE) in the Atlantic Ocean United States pelagic longline fishery. The trend analysis of these data revealed annual rates of decline of 4%, consistent with an estimated median decline of 93% over three generation lengths (75 years), with the highest probability of ≥80% reduction over three generation lengths (Rigby *et al.* 2019f).

The species is considered to occur in all oceans but population trend data are missing from the south Atlantic, Indian and Pacific Oceans, which accounts for approximately 80% of the species' range. Considering the large areas of the species distribution with no data, expert judgement suspected that global scale declines would be similar to those of the *I. oxyrinchus*, and in the range of 50–79% over three generation lengths. As a result, *I. paucus* was classified as Endangered in 2018. This assessment includes only one time series and is based on suspected declines, so the assessment should be revisited when catch data are available from more regions (Rigby *et al.* 2019f).

ECOTOURISM

This pelagic species occurs in deep water far offshore and cannot be regarded as an ecotourism species.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

Although this species was listed on CITES Appendix II in 2019 it may still be landed by pelagic longline vessels, but only as bycatch, according to the 2020/21 permit conditions. Targeting is defined as >50% shark catch, by weight, per year. Furthermore, should the combined catch of this species and the blue shark *Prionace glauca* exceed 60% of the catch in a particular quarter, that vessel is required to have 100% observer coverage for the remainder of the fishing season. In addition to these catch restrictions, the use of stainless-steel hooks and wire traces is prohibited in the large pelagic longline fishery; these regulations aim to decrease catches of large sharks and improve post-release survival. Permit conditions also stipulate that sharks must be landed with fins attached so as to halt destructive finning practices. There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act

Threatened or Protected Species (TOPS)

This species is not listed.

Marine Protected Areas

Insufficient is known about the distribution of this species to ascertain if it will benefit from any of the existing offshore MPAs, but it appears unlikely.

Additional local comment

IUCN Red List Status

Endangered 2018 A2d

Previous IUCN assessments

Vulnerable 2006

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

This species was listed on Appendix II in 2019.

Convention on Migratory Species (CMS)

This species was listed on Appendix II in 2008.

International comments

This species is far rarer than *I. oxyrinchus,* but the two species are often caught together and are confused or combined in landings reports. The United States adopted a precautionary ban on retention of *I. paucus* in 1999, but there are no other known species-specific catch limits (Rigby *et al.* 2019f). Post-release mortality of pelagic sharks varies by species and has been reported as 30–33% for the closely-related *I. oxyrinchus* on longlines (Campana *et al.* 2016).

MANAGEMENT CONSIDERATIONS

It is possible that this species has been caught in South African waters and mistaken for the more common *I. oxyrinchus.* Fisheries observers need to be made aware of the subtle differences between the two species. Although this species was listed on CITES Appendix II in 2019 it may still be landed by pelagic longline vessels, but only as bycatch, according to the 20/21 permit conditions. The survival rate of individuals released is of concern, given that the post-release mortality in pelagic sharks can be high.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

This is an extremely poorly studied species, with very little known of its life history, reproductive biology and ecology. In the absence of any known catches in South Africa, research opportunities are extremely rare. Any opportunistic sampling should be used to collect biological information and tissue samples for genetic analysis.

Lamna nasus

SCIENTIFIC NAME	*Lamna nasus* (Bonnaterre 1788)
COMMON NAME	Porbeagle
FAMILY	Lamnidae
ENDEMIC	No, circumglobal in temperate waters
SIZE RANGE	67–237 cm TL (SW Pacific)
SA DISTRIBUTION	S, W coasts: Knysna to southwest off Cape Town
HABITAT	Pelagic in oceanic waters; occasionally coastal
DEPTH RANGE	0-200 m, but occasionally 350-700 m in open ocean
MAJOR FISHERIES	Pelagic longlines and small pelagic fisheries
IUCN STATUS	Vulnerable 2018
CITES REGS	Appendix II (2013)
MLRA REGS	No retention in any longline fisheries
COMPILER	G Cliff
REVIEWER	RH Bennett

SPECIES SUMMARY and RECOMMENDATIONS

Lamna nasus is a large, pelagic species and is generally found offshore on continental shelf edges and the open ocean. It has a circumglobal distribution in temperate wasters of both the southern and northern hemispheres. It is uncommon off the South African mainland, specifically part of the south and west coasts, but is common to the south and around Prince Edward Islands where the water temperatures are below 18°C. Local catch was estimated at <1 ton per annum (DFFE records: 2010–2012) from the small pelagic fishery. It is also a bycatch in the pelagic longline fishery. Based on heavy declines in the NE Atlantic, this species was assessed as Critically Endangered in 2018, although catches in SW Pacific, which represent a totally different stock, showed very modest declines. As an oceanic species it will derive no apparent benefit from any of the South African MPAs. It is listed in CITES Appendix II and as a result no retention in the demersal and pelagic longline fisheries is permitted. Although catches in the South African pelagic longline fishery are released or discarded, post capture mortality rates determined elsewhere in its range may be as high as 75%. Protecting this species in the South African EEZ around Prince Edward and Marion Islands may be logistically problematic. No research on this species has been conducted in South Africa. Opportunistic sampling in the fishery should be used to improve knowledge of the life history of this species and to collect tissue samples from specimens to confirm the lack of genetic structure in southern hemisphere individuals.

TAXONOMIC and IDENTIFICATION ISSUES

There are currently no taxonomic issues. In the past there was some confusion as to the number of valid species. It is now regarded as one of two species in the genus *Lamna* but *L. nasus* is the only species which occurs in the southern hemisphere (Compagno 2001).

South African Distribution

This pelagic species is uncommon on the south coast, from Knysna to southwest of Cape Town, on the west coast. It is common to the south/offshore and around Prince Edward and neighbouring Marion Islands where the water temperatures are below 18°C (Ebert *et al.* 2021).

Regional Distribution

It is not found in neighbouring southern African countries. It occurs in a longitudinal band of 30–50°S across the southern hemisphere (Francis *et al.* 2008).

SYNOPSIS OF RESEARCH

This is a well-studied species internationally. In South Africa, Bass *et al.* (1975) only had access to the cast of a single specimen and no dedicated local studies of this species have been undertaken. Compagno (2001) and Francis *et al.* (2008) provided a global overview of the state of knowledge of this species.

ECOLOGY

Depth

It is most common in water colder than 18°C on continental shelves and edges and offshore banks and in the open ocean and occasionally close inshore. It occurs from the surface down to at least 700 m (Compagno 2001).

Habitat: Adults

The adults occur in open water from the surface to the bottom (Compagno 2001).

Habitat: Juveniles/Nursery Grounds

Fishery data indicate that this species does segregate by size (age) (Compagno 2001) but no additional information on juveniles and nursery grounds is available.

Synopsis of tag deployments

No tagging has been undertaken in South African waters.

Movements

This species is regarded as migratory, with extensive long-distance seasonal migrations elsewhere in its range (Compagno 2001, Fowler 2014).

Diet/feeding: adults

This species feeds largely on a variety of small to medium-sized pelagic shoaling teleosts. It also feeds on demersal teleosts, small sharks and cephalopods (Compagno 2001).

Diet/feeding: juveniles

There is no evidence that the diet of juveniles is different from that of adults.

South African toxicological studies

There have been no local studies. The presence of organohalogens and trace metals has been quantified in specimens from the northeast Atlantic (Bendall *et al.* 2014).

REPRODUCTION

REPRODUCTIVE MODE	Viviparity with oophagy
DURATION OF REPRO CYCLE	Possibly 1 year
MATING	Possibly spring
GESTATION	8–9 months (SW Pacific)
LITTER SIZE	4 (range 1–5) (SW Pacific)
PUPPING/NURSERY GROUND	Winter
LENGTH AT BIRTH	67-77 cm (SW Pacific)
LENGTH AT MATURITY	F: 193-205 cm; M: 160-170 cm (SW Pacific)
MAXIMUM LENGTH	F: 237 cm; M: 232 cm (SW Pacific)
GENERATION LENGTH	38.3 yr (SW Pacific)

Mode

This species exhibits viviparity, with oophagy (Francis *et al.* 2008).

Duration of reproductive cycle
The reproductive cycle in the SW Pacific is less than 1 year. It is 1 year in the NW Atlantic as all the mature females caught in winter were pregnant (Francis *et al.* 2008). No pregnant females have been documented from South African waters.

Mating season and location
An extended mating period seems to exist for southern hemisphere populations (Compagno 2001).

Gestation
This is 8–9 months in the SW Pacific (Francis *et al.* 2008).

Litter size
Litter size is usually four, with a range of 1–5 in the SW Pacific (Francis *et al.* 2008).

Length at birth
This is 67–77 cm in the SW Pacific (Francis *et al.* 2008).

Pupping season and nursery ground
Young are probably born from March to September (June–July peak) in the southern hemisphere (Compagno 2001).

Length at maturity
Length at maturity for females and males is 193–205 cm and 160–170 cm respectively, in the SW Pacific. Individuals from the N Atlantic mature at larger lengths (Francis *et al.* 2008).

Maximum length
Maximum lengths in the SW Pacific are 237 cm for females and 232 cm for males, although this species is much larger in the N Atlantic, attaining 335 cm and 285 cm respectively (Francis *et al.* 2008).

Age and growth
In the SW Pacific the estimated ages at maturity were about 13–16 years for females and 6–8 years for males (Francis *et al.* 2015). In the N Atlantic median age at maturity was 13 years for females and 8 years for males with a maximum longevity of more than 26 years (Francis *et al.* 2008).

Generation length
Despite similar ages at maturity in the two populations, generation length is 38.3 years in the SW Pacific and 19.5 years in the N Atlantic (Rigby *et al*. 2019g). This can be attributed to very different maximum ages: 60 years in SW Pacific and 26 years in the N Atlantic (Rigby *et al*. 2019g and references cited therein).

FISHERIES MANAGEMENT

SA catch sources and quantities
Local catch was estimated at <1 ton per annum (DFFE records: 2010-2012; da Silva *et al*. 2015), but from only the small pelagic fishery. It was also caught in the pelagic longline fishery (Petersen *et al.* 2009).

SA catch quantities and characteristics
Small pelagic fishery
This fishery targets anchovy *Engraulis encrasicolus*, sardine *Sardinops sagax* and redeye *Etrumeus whiteheadi*, using purse-seine gear in four areas off the south and west coasts of South Africa. Fishing grounds generally range in depth from 100 to 400 m. The chondrichthyan bycatch is discarded once the catch has been sorted, with 100% mortality of all chondrichthyans (da Silva *et al.* 2015). No details of the bycatch in this fishery have been published.

Longline fisheries
This species is one of the large pelagic sharks caught in the Southern African tuna and swordfish longline fisheries. This species represented 0.3% of the total shark bycatch by number in the period 1998-2005, which equates to about 100-200 individuals per year. Catches are either discarded or released (Petersen *et al.* 2009).

Fishing outside South Africa
This species is caught globally as target and bycatch in commercial and small-scale pelagic longline, purse seine, and gillnet fisheries. Most of the catch is taken as bycatch of large-scale pelagic fleets in offshore and high-seas waters. It may also be captured in coastal longlines, gillnets, trammel nets and sometimes trawls, as well as on rod and reel, particularly in areas with narrow continental shelves (Rigby *et al.* 2019g).

This species was assessed as the third most vulnerable shark species in the tuna longline fishery in the IOTC area of competence (Murua *et al.* 2018). The NE Atlantic stock under the jurisdiction of ICCAT has the longest history of commercial exploitation, with the highest catches during the 1930s and 1950s (Rigby *et al.* 2019g).

This species is often retained for its meat and fins, although fishing and/or retention is prohibited in some areas. Under-reporting of catches in the pelagic and domestic fisheries is likely. The species is highly valued by recreational fishers, and although many practise catch-and-release, this fishing could be a threat, due to post-release mortality (Rigby *et al.* 2019g and references cited therein). The post-release mortality in commercial longline fisheries has been reported as 10–75% (Campana *et al.* 2016).

This species is used for its fins, liver oil, and high-quality meat (Francis *et al.* 2008). Together with the salmon shark *Lamna ditropis*, the two species accounted for 0.2% of the fins imported into Hong Kong in 2014. In counties such as Spain, porbeagle meat accounts for a significant proportion (±15%) of all shark meat imported annually (Rigby *et al.* 2019g and references cited therein).

Population trends
There are no data available on the absolute global population size. Genetic data support two separate subpopulations, the N Atlantic and the southern hemisphere. No genetic structure was found within these two subpopulations (Rigby *et al.* 2019g).

Three of the four risk assessments were undertaken on regional catches in the northern hemisphere. Overall, the N Atlantic subpopulation reduction was 50–79% over three generations (58.5 years) (Rigby *et al*. 2019g and references cited therein). The fourth, the southern hemisphere subpopulation, indicated that fishing mortality is low, decreasing eastward from South Africa to New Zealand, and that there was a very low risk of overfishing. Catch rate indicators showed stable or increasing catches across most of the southern hemisphere (Hoyle *et al.* 2017). The trend analysis of the modelled relative abundance for 1962–2015 (54 years) revealed modest annual rates of reduction of 0.2%, consistent with a median reduction of 19.9% over three generation lengths (114.9 years), with the highest probability of <20% reduction over three generation lengths (Rigby *et al.* 2019g).

To estimate a global population trend, the estimated three-generation population trends for each region were weighted according to the relative size of each region; the two sources of NW Atlantic data were used to generate two global trends. The overall estimated median reduction was 26.5%, with the highest probability of <20% reduction over three generations. However, this global trend was strongly influenced by the southern hemisphere which accounts for a larger proportion of the global distribution. Expert judgement elicitation was used to estimate that globally, the reduction is 30–49% over three generations (58.5 and 114.9 years) and, therefore, the porbeagle was assessed globally as Vulnerable in 2018 (Rigby *et al*. 2019g).

ECOTOURISM
This pelagic species occurs in deep water far offshore and cannot be regarded as an ecotourism species.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
As this species is on CITES Appendix II, no retention is permitted in either the pelagic or demersal longline fisheries.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
This highly migratory and in South Africa it is a little-known, offshore species, which is unlikely to benefit from any of the offshore MPAs in South Africa.

Additional local comment

IUCN Red List Status
Vulnerable 2018: A2bd
Critically Endangered 2015: A2bd in the NE Atlantic.

Previous IUCN assessments
Vulnerable 2006
Near Threatened 2000
Vulnerable 1996

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species was placed on Appendix II in 2013.

Convention on Migratory Species (CMS)
This species was listed on Appendix II in 2008. The species is also covered by the CMS Memorandum of Understanding for Migratory Sharks.

International comments
In 2010, the NE Atlantic Fisheries Commission (NEAFC) adopted a ban on directed fishing for this species that has since been renewed several times. The Western and Central Pacific Fisheries Commission (WCPFC) designated the porbeagle as a “Key Shark Species” in 2010, but has yet to set fishing limits. In 2012, the General Fisheries Commission for the Mediterranean (GFCM) banned retention and mandated careful release of this and 23 other elasmobranch species listed on the Barcelona Convention Annex II. Implementation by GFCM Parties, however, has been very slow. In 2015, to address depletion in the N Atlantic, the International Commission for the Conservation of Atlantic Tunas (ICCAT) adopted a requirement for prompt, careful release of porbeagle retrieved alive in ICCAT-managed fisheries. ICCAT also pledged to consider additional measures if future catches exceed 2014 levels (Rigby *et al.* 2019g). Catch quotas were introduced in New Zealand in 2004 (Francis *et al.* 2008).

MANAGEMENT CONSIDERATIONS
This species is regarded as common around Prince Edward and Marion Islands, approximately 1600 km south of Qeberha. These islands belong to South Africa and therefore fall into its EEZ. The ability of fisheries authorities to control any foreign and other illegal fishing in these waters is of concern. As a CITES Appendix II species, it may not be retained in the pelagic longline fishery. The survival rate of

individuals released is also of concern, given that the post-release mortality in similar fisheries in the northern hemisphere may be as high as 75%.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

This is a well-studied species, particularly in the N Atlantic. The vast differences in maximum ages (60 years in the southern hemisphere and 26 years in the north), despite similar ages at maturity, require attention. These differences may be real but may also be an artefact of differences in age estimation methods, and such discrepancies would have significant effects on generation length, and thus on the rate of population decline, in turn affecting the most likely IUCN threat category. Catches of this species in South African fisheries appear to be low and very little, if any, biological information has been collected from these individuals to establish important life history parameters, such as the duration of the reproductive cycle. In the northern hemisphere this is a 1-year cycle, but this has not been confirmed in the southern hemisphere. Very little is known about mating and pupping. Although there is no documented structure in the entire southern hemisphere population, it would still be advisable to collect tissue samples to be able to readdress this issue in the future.

FAMILY PENTANCHIDAE

Galeus polli

SCIENTIFIC NAME	*Galeus polli* (Cadenat 1959)
COMMON NAME	African sawtail catshark
FAMILY	Pentanchidae
ENDEMIC	No
SIZE RANGE	10–43 cm TL
SA DISTRIBUTION	W coast: immediately south of Orange River mouth
HABITAT	Demersal
DEPTH RANGE	200-720 m
MAJOR FISHERIES	None listed but suspected in trawl fishery
IUCN STATUS	Vulnerable 2020
CITES	Not listed
MLRA	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	DA Ebert

SPECIES SUMMARY and RECOMMENDATIONS

Galeus polli is a very small demersal catshark with very restricted distribution in the far north of the west coast, extending northwards into Namibia, where this species appears to be common, and beyond. It occurs on the outer shelf and upper slope. It is not reported in South African chondrichthyan catches (DFFE records: 2010–2012. It is a regular catch elsewhere in its W African range in the trawl fishery. Given its very small size, most catches are unlikely to be retained, but nothing is known of its survival. It was assessed globally as Vulnerable on the IUCN Red List in 2020, but this is presumed to be the result of heavy fishing pressure to the north outside South African waters. It currently has no legislated protection, but it may gain refuge inside the Orange Shelf Edge MPA. Given is extremely limited distribution in South African waters, this species must be regarded as being of very low management priority. Very little is known of its life history and ecology.

TAXONOMIC and IDENTIFICATION ISSUES

The family Scyliorhinidae was recently split, with a large number of genera, including *Galeus,* placed in the family of deepwater catsharks Pentanchidae. G. polli is one of 17 species in the genus, and the only one which occurs in the region. It is characterised by an upper caudal fin margin with a prominent crest of enlarged sawtooth-like denticles.

SOUTH AFRICAN DISTRIBUTION

G. polli is known from a few specimens collected during research survey cruises south of the Orange River (Ebert *et al.* 2021).

REGIONAL DISTRIBUTION

The species is most common from about central Namibia northwards, but is less common south of Lüderitz, Namibia, where it is replaced *by Holohalaelurus regani* and *Scyliorhinus capensis* (Compagno *et al.* 1991). It was the most common catshark species caught in Namibian waters in research trawls (Ebert *et al.* 1996).

SYNOPSIS OF RESEARCH

No dedicated research has been conducted on this species in South African waters. It was not included in the taxonomic and morphometric study undertaken by Bass *et al.* 1975. It was only recorded in

Namibia and not in South African waters as part of study of deep-water demersal chondrichthyans on the west coast of South Africa (Compagno *et al.* 1991). Its presence in South Africa was first reported by Ebert (2015). For information from elsewhere in its range, see Finucci *et al.* (2021) and references cited therein.

ECOLOGY

Depth

This demersal species is tolerant of low oxygen levels and occurs on the outer shelf and upper slope. It was the most common catshark species caught at depths of 258–490 m in Namibian waters in research trawls (Ebert *et al.* 1996). Elsewhere it occurs at depths of 160–720 m (Weigmann 2016, cited by Finucci *et al.* 2021).

Habitat: Adults

Nothing is known of the habitat.

Habitat: Juveniles/Nursery Grounds

Nothing is known of the habitat.

Synopsis of tag deployments

This species has not been tagged in South African waters.

Movements

Nothing is known of the movement patterns of this species.

Diet/feeding: adults

In specimens which included both adults and young juveniles, the most common prey group was teleosts, while crustaceans and cephalopods constituted a minor portion of the diet. The dominant teleost species consumed were lanternfish Myctophidae; euphausiids and mysids were the only crustaceans (Ebert *et al.* 1996). The diet also includes lightfish Photichthyidae (Compagno *et al.* 1989).

Diet/feeding: juveniles

It is not known if there is an ontogenetic shift in diet.

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Aplacental viviparity
DURATION OF REPRO CYCLE	Unknown
MATING	Unknown
GESTATION	Unknown
LITTER SIZE	6-13 (outside South Africa)
PUPPING/NURSERY GROUND	Unknown
LENGTH AT BIRTH	10–12 cm (outside South Africa)
LENGTH AT MATURITY	F: 30 cm; M: 30 cm (outside South Africa)
MAXIMUM LENGTH	F: 43 cm; M: 36 cm (outside South Africa)
GENERATION LENGTH	15 years (*Galeus sauteri*)

Mode

This species exhibits aplacental viviparity (Ebert *et al.* 2006).

Duration of reproductive cycle
This is unknown.

Mating season and location
This is unknown.

Gestation
This is unknown.

Litter size
This is 5–13, with litter size increasing with maternal length (Ebert *et al.* 2006).

Length at birth
This is 10–15 cm (Ebert *et al.* 2006).

Pupping season and nursery ground
This is unknown.

Length at maturity
Females and males attain 50% maturity at 30 cm (Ebert *et al.* 2006).

Maximum length
This is 43 cm for females and 36 cm for males (Ebert *et al.* 2006)

Age and growth
No age and growth studies have been undertaken. The vertebrae do not show any banding (David Ebert, South African Institute of Aquatic Biodiversity, pers. observation)

Generation length
Age parameters are unknown but can be inferred from a related species, *Galeus sauteri* that has a female age-at-maturity of 9.1 years and a maximum age of 20.9 years, resulting in a generation length of 15 years (Liu *et al.* 2011, cited by Finucci *et al.* 2021).

FISHERIES MANAGEMENT

SA catch sources
G. polli was not listed in the catches of chondrichthyans in South African fisheries (da Silva *et al.* 2015). This is possibly due to its very small size (Ebert, SAIAB, pers. observation), in that specimens were only caught in any numbers when RV *Africana* replaced the conventional end of the research trawl nets with one of a smaller mesh size.

Fishing outside South Africa
This species has been reported as bycatch in demersal trawl fisheries across its range but may inhabit depths beyond the reach of some regional fishing activities.

Population trends
There are no population estimates for this species. Overall, there is high spatial distribution overlap with intensive fishing pressure and reported declines of sharks its range but with no species-specific management. Despite this, this species may have some refuge at depth. It is suspected to have undergone a population reduction of 30–49% over the past three generation lengths (45 years) based on actual levels of exploitation, and it was assessed as Vulnerable on the IUCN Red List in 2020 (Finucci *et al.* 2021).

ECOTOURISM

It inhabits very deep water and is therefore is not an ecotourism species.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act

Threatened or Protected Species (TOPS)

This species is not listed.

Marine Protected Areas

This species, with its very narrow distributional range on the west coast, will potentially derive protection from the Orange Shelf Edge MPA, which spans a depth range of 250–1500 m.

Additional local comment

IUCN Red List Status

Vulnerable 2020: A2d

Previous IUCN assessments

Least Concern 2004

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

This species is not listed.

Convention on Migratory Species (CMS)

This species is not listed.

International comments

There are no species-specific measures in place for the protection of *G. polli.*

MANAGEMENT CONSIDERATIONS

This species is most likely to be a bycatch in the trawl fishery, especially in central Namibia where it appears to be common. Little known of its survival in this fishery. This should be investigated. When discarded without undue harm, post-release mortality is likely low, based on generally very low at-vessel and post-release mortality for catsharks (Ellis *et al.* 2017). Given its extremely limited distribution on the South African west coast and the scarcity of catches from these waters, it must be regarded as being of extremely low management priority.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

Very little is known of the life history, reproductive biology and ecology of this wide-ranging species. As it appears to be extremely rare on the west coast of South Africa, it will be very difficult to obtain specimens from commercial trawling operations to improve our understanding of this species.

Halaelurus natalensis

SCIENTIFIC NAME	*Halaelurus natalensis* (Regan 1904)
COMMON NAME	Tiger catshark
FAMILY	Pentanchidae
ENDEMIC	Yes
SIZE RANGE	>4–50 cm TL
SA DISTRIBUTION	E, S coasts: East London to Cape Point
HABITAT	Demersal on sand bottoms in coastal and shelf waters
DEPTH RANGE	0–170 m, but most common in 20–90 m
MAJOR FISHERIES	None listed but suspected in commercial and recreational linefishery
IUCN STATUS	Vulnerable 2019
CITES	Not listed
MLRA	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	J Escobar-Porras

SPECIES SUMMARY and RECOMMENDATIONS
Halaelurus natalensis is a very small demersal endemic, which is restricted to part of the east coast and the entire south coast of South Africa. It is most abundant in coastal waters of 20–90 m. Total South African catch was estimated at <1 ton per annum (DFFE records: 2010–2012), with no details of the associated fisheries. This species is taken as bycatch in the demersal trawl fishery and the commercial and recreational linefisheries. Given its very small size, most catches are unlikely to be retained. It was assessed as Vulnerable in 2019. It currently has no legislated protection. Limited tagging studies have shown this species to be highly resident, hence it will receive considerable protection from coastal MPAs within its range. Very little is known of its life history and ecology.

TAXONOMIC and IDENTIFICATION ISSUES
H. natalensis was long recognised as the only member of the genus on the South African coast; *H. lineatus* was only described in 1975. These two species are the only members of this genus, with no overlap in their distribution, on the South African coast. *H. natalensis* has larger fins and a different colouration with dusky saddles outlined by broad, dark brown stripes on a yellow-brown background (Bass *et al.* 1975; Compagno *et al.* 1989). *H. lineatus* only occurs on the east coast from East London to the Mozambique border and beyond (Ebert *et al.* 2021).

SOUTH AFRICAN DISTRIBUTION
H. natalensis is endemic to South Africa and occurs from East London on the east coast to Cape Point at the southern limit of the south coast. Records from KZN on the east coast and Saldanha Bay on the west coast require confirmation (Ebert *et al.* 2021).

REGIONAL DISTRIBUTION
This species is not found outside South Africa.

SYNOPSIS OF RESEARCH
A taxonomic and morphometric study, which included limited life history information (Bass *et al.* 1975), was the first dedicated studies of this species. The only subsequent studies have been genetic, with the sequencing of various genes (Human *et al*. 2006), and other markers for species delineation (van Staden 2018, van Staden *et al.* 2020). No population genetic studies have been undertaken.

ECOLOGY

Depth

This demersal species is associated with sandy areas from the shoreline out to at least 170 m in shelf waters, but most records are from 20-90 m. In False Bay this species was most commonly detected in BRUVs deployed at depths of 20-25 m during summer (De Vos *et al*. 2015).

Habitat: Adults

In False Bay the adults are more common on sand bottoms than rocky reefs (De Vos *et al*. 2015).

Habitat: Juveniles/Nursery Grounds

This is unknown, but possibly similar habitat in shallower water. This species segregates by size and depth with mostly adults found in offshore trawls (Ebert *et al.* 2013)

Synopsis of tag deployments

A total of 34 individuals tagged (ORI Cooperative Fish Tagging Project 1984-2018 inclusive) with 35% recaptured. Mean distance travelled was 1 km; mean time at liberty 1.2 years (max: 9 km and 3.3 years) (Jordaan *et al.* 2020).

Movements

The tagging results listed above are indicative of a highly resident species, with an extremely high recapture rate.

Diet/feeding: adults

Adults feed primarily on small bony fishes and crustaceans, as well as cephalopods and small elasmobranchs (Bass *et al.* 1975).

Diet/feeding: juveniles

Unknown, but it is assumed that the diet of the juveniles is similar to that of the adults, without the larger prey items.

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Oviparity
DURATION OF REPRO CYCLE	Unknown
MATING	Unknown
GESTATION	Unknown
LITTER SIZE	6-11, usually 6-9
PUPPING/NURSERY GROUND	Unknown
LENGTH AT BIRTH	Unknown, but larger than 4 cm
LENGTH AT MATURITY	F: 37 cm; M: 35 cm
MAXIMUM LENGTH	50 cm
GENERATION LENGTH	Unknown

Mode

This species exhibits oviparity, with the female retaining the egg cases until the embryos are larger than 4 cm (Bass *et al.* 1975).

Duration of reproductive cycle

This is unknown.

Mating season and location
This is unknown.

Gestation
This is unknown.

Litter size
This is usually 6-9 but with a maximum of 11 (Bass *et al.* 1975).

Length at birth
This is unknown, but larger than 4 cm (Bass *et al.* 1975).

Pupping season and nursery ground
This is unknown.

Length at maturity
Females mature at 37 cm and males at 39 cm (Bass *et al.* 1975).

Maximum length
This is 50 cm (Ebert *et al.* 2013)

Age and growth
No age and growth studies have been undertaken. The longest time at liberty of a tagged individual was 3.3 years.

Generation length
This is 15 years (Pollom *et al*. 2020a).

FISHERIES MANAGEMENT

SA catch sources
Total South African catch was estimated at <1 ton per annum (DFFE records: 2010–2012), with no details of the associated fisheries, other than a suspected catch in the commercial and recreational linefisheries (da Silva *et al.* 2015). This species is a bycatch in the inshore and hake trawl industry and is caught by recreational and commercial linefishers. This species was rarely caught in the beach seine (trek net) fishery in False Bay (Lamberth 2006), and is not listed in a survey of beach seine catches in the SW Cape (Hutchings and Lamberth 2002).

SA catch quantities and characteristics

Inshore trawl fishery
Annual average catch estimates for the inshore trawl fleet, based on unsorted samples by observers, was 12.7 tons for the period 2003-2006 (Attwood 2011), but this was for the two *Halaelurus* species combined. With an assumed mean weight of 1 kg, this catch would equate to 1270 individuals per annum, all of which were discarded. They are likely to be mainly *H. natalensis* as *H. lineatus* is confined to the east coast and the industry is restricted to waters west of the Kei River mouth.

Fishing outside South Africa
Not applicable as this is an endemic species.

Population trends
There are no population estimates for this species. Population trend data were obtained from demersal research trawl surveys conducted over 26 years (1991–2016) in fished areas of South Africa during autumn and spring along the south coast (DFFE, unpubl. data, 2018). The analysis revealed an annual rate of reduction of 2.0%, consistent with a median reduction of 88% over three past

generation lengths (45 years), with the highest probability (65%) of >80% reduction over three generation lengths. The estimated reduction is driven partly by a steep decline in catch rates during the early 1990s when fishing pressure in South Africa was substantially higher; over the last two decades the population reduction has been less dramatic. Some of the reduction is possibly a result of a geographic shift in abundance away from the trawl grounds due to climate change (Currie *et al.* 2019). It is suspected that this species has undergone a population reduction of 30–49% over the past three generation lengths (45 years) and as a result was assessed as Vulnerable in 2019 (Pollom *et al.* 2020a).

ECOTOURISM
This species is most common on sandy bottoms and is seldom seen by scuba divers; therefore it should not be regarded as an ecotourism species.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
This highly resident species will derive protection from all the inshore MPAs within its range on the east and south coasts.

Additional local comment

IUCN Red List Status
<u>Vulnerable 2020: A2bcd</u>

Previous IUCN assessments
Data Deficient 2004

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

International comments

MANAGEMENT CONSIDERATIONS
This species is predominantly taken as a bycatch in the trawl and linefisheries. Little is known of its survival. This should be investigated. When discarded without undue harm, post-release mortality is likely low, based on generally very low at-vessel and post-release mortality for catsharks (Ellis *et al.* 2017). Another management intervention would be an education campaign among linefishers who regard this species as a nuisance and therefore do not release their catches. Careful handling and prompt return to the water must be promoted.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
Very little is known of the life history, reproductive biology and ecology of this endemic species. It is likely to be easy to sample as a bycatch in the inshore trawl fishery.

Haploblepharus edwardsii

SCIENTIFIC NAME	*Haploblepharus edwardsii* (Schinz 1822)
COMMON NAME	Puffadder shyshark
FAMILY	Pentanchidae
ENDEMIC	Yes
SIZE RANGE	9–60 cm TL
SA DISTRIBUTION	E, S, W coasts: Algoa Bay to Langebaan
HABITAT	Demersal on sand bottoms and rocky reefs in coastal and shelf waters
DEPTH RANGE	0–130 m, but most common down to 90 m
MAJOR FISHERIES	Demersal trawl fishery; commercial and recreational linefishery
IUCN STATUS	Endangered 2019
CITES	Not listed
MLRA	No take in demersal shark longline fishery; daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	J Escobar-Porras

SPECIES SUMMARY and RECOMMENDATIONS

Haploblepharus edwardsii is a very small, demersal endemic catshark. It is most abundant in coastal waters mainly on the south coast. Local catch was estimated at 1–10 tons per annum (DFFE records: 2010–2012), mainly as bycatch in the inshore demersal trawl fishery and the commercial and recreational linefisheries. It was assessed as Endangered in 2019, based on low fecundity, limited distribution, heavy fishing pressure and possible habitat degradation. It currently has limited legislated protection. Given its small size (maximum of 60 cm), most catches are unlikely to be retained. It is important to ensure that these animals are promptly returned to the water and not mishandled or discarded, irrespective of the fishery. Limited tagging studies have shown this species to be highly resident, hence it will receive protection from inshore MPAs on the west and south coasts. There are still large gaps in our knowledge of the life history of this species.

TAXONOMIC and IDENTIFICATION ISSUES

Identification of species in the genus *Haploblepharus* has been problematic due to the reliance on colour patterns, that have proven to be variable, and the poor choice of morphological characters, such as the position of the first dorsal fin relative to the pelvic fin (Human 2007). Initially it was thought that there were two forms of this species, a Cape form and a Natal form, although it was acknowledged that they mature at different sizes (Bass *et al.* 1975). A taxonomic revision of this genus found that the Natal form was a new species, *H. kistnasamyi.* The two species are morphologically almost identical, differing only in the pattern of the markings. Additional problems have resulted from the difficulty in identifying juveniles and possible hybridisation between species (Human 2007). The sequence for gene Cytochrome Oxidase subunit I (COI), which is widely used for species identification was unable to differentiate among three *Haploblepharus* species, including *H. edwardsii* (van Staden *et al.* 2020). These low levels of differentiation allude to recent divergence and possible contemporary hybridisation within the genus (van Staden *et al*. 2020).

SOUTH AFRICAN DISTRIBUTION

This species occurs in the southern end of the east coast (Algoa Bay), along the entire south coast and the southern part of the west coast as far north as Langebaan lagoon, but is most common from False Bay to Cape Agulhas (Human 2007).

This species was the most common *Haploblepharus* between False Bay and Hermanus on the south coast during the 1980s and early 1990s, but in recent years appears to have been replaced in this region by *H. pictus* due to cooling oceanographic conditions. *H. pictus* is a near endemic, occurring on the south coast up into Namibia and overlapping with *H. edwardsii* between Hermanus and False Bay (Ebert *et al.* 2021).

REGIONAL DISTRIBUTION
This species is not found outside South Africa.

SYNOPSIS OF RESEARCH
This is a fairly well-studied species. In South Africa Bass *et al.* (1975) provided detailed taxonomic, morphometric and biological information from numerous specimens, including adults and pregnant females and those of the Natal form, which are now recognised as a separate species *H. kistnasamyi*. There have been studies on the diet, age and growth and reproduction of this species (Bertolini 1993, Dainty 2002). The taxonomy of the genus *Haploblepharus* was revisited (Human 2007). Genetic studies comprised the sequencing of various genes (Human *et al.* 2006), and other markers for species delineation and genetic differentiation (van Staden 2018, van Staden *et al*. 2020). No wide-scale population genetic studies have been undertaken.

ECOLOGY
Depth
This demersal species is associated with sand areas and rocky reefs, including kelp forests from the shoreline out to at least 130 m, but most records are shallower than 90 m. The preferred depth range and habitat of this species varies across its distribution. In the west, it occurs from the intertidal to 30 m in kelp forests and rocky reefs (K Gledhill, Stellenbosch University, unpubl. data, 2018). In False Bay this species was most commonly detected in BRUVs deployed on sand bottoms at depths of 20-25 m (De Vos *et al.* 2015). On the east it is found predominantly deeper on sandy habitat (Bass *et al.* 1975, Human 2007).

Habitat: Adults
Adults are found on shallow reef and kelp forest and in deeper water on sand bottoms. In parts of False Bay there is evidence that males occur in shallower water (< 5 m) than females (>5 m) (Dainty 2002).

Habitat: Juveniles/Nursery Grounds
Juveniles possibly occupy a similar habitat in shallower water.

Synopsis of tag deployments
A total of 369 individuals were tagged (ORI Cooperative Fish Tagging Project 1984-2018 inclusive) with 9% recaptured. Mean distance travelled was 1 km; mean time at liberty 0.5 years (max: 10 km and 3.7 years) (Jordaan *et al.* 2020).

Movements
The tagging results listed above are indicative of a highly resident species. This is supplemented with anecdotal observations that individuals of this species are highly site specific.

Diet/feeding: adults
Adults feed on small bony fishes, crustaceans, annelid worms and cephalopods (Dainty 2002).

Diet/feeding: juveniles
The diet of the juveniles is similar to that of the adults, but there was an increase in the teleost component with decreasing size (Dainty 2002).

South African toxicological studies
No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Oviparity
DURATION OF REPRO CYCLE	Unknown, possibly annual
MATING	Unknown, but aseasonal
GESTATION	Possibly 6–10 months; aseasonal
LITTER SIZE	2
PUPPING/NURSERY GROUND	Where the animals occur
LENGTH AT BIRTH	9 cm
LENGTH AT MATURITY	35 cm (False Bay); 45 cm (Eastern Cape)
MAXIMUM LENGTH	48 cm (west of Cape Agulhas); 60 cm (east)
GENERATION LENGTH	9.33 years (DAFF); 15.5 (Dainty 2002); 20 (Pollom *et al.* 2020b)

Mode
This species exhibits oviparity, with the female producing only 2 egg cases (Bass *et al.* 1975).

Duration of reproductive cycle
This is unknown

Mating season and location
There is a year-round breeding season, as egg cases were found in summer and winter (Dainty 2002), with individuals apparently mating where they occur.

Gestation
This is unknown, as females may retain the egg cases for some time after fertilisation before depositing them on kelp, reef or sea fans. In many instances the cases were found lying on the seabed (Pretorius 2012). Hatching times of egg cases in an aquarium varied over 6-10 months and was temperature dependent (Dainty 2002). Bertolini (1993) reported a case of a 3-month hatching.

Litter size
This species deposits 2 egg cases (in pairs) on the substrate (Bertolini 1993).

Length at birth
This is 9 cm (Bertolini 1993).

Pupping season and nursery ground
There is no obvious breeding season, with females depositing the eggs where they occur (Dainty 2002). Egg cases are more commonly found at depths of 21–25 m (Pretorius 2012).

Length at maturity
This is 35 cm (sexes combined) for False Bay individuals (Dainty 2002).

Maximum length
This is 60 cm, but for individuals east of Cape Agulhas. To the west the maximum is only 48 cm. This size difference may be due to the deeper habit of *H. edwardsii* east of Cape Agulhas (Human 2007).

Age and growth
This species is seven years old at 50% maturity for both sexes combined, and lives to at least 22 years of age, assuming an annual vertebral band deposition rate (Dainty 2002).

Generation length

This is 9.33 (DFFE unpublished data: Table 2), but based on the age and growth information of Dainty (2002) presented above, generation length is 14.5.

Pollom *et al.* (2020b) inferred a value of 20 years from the most reliable age estimates to date for a catshark, the blacktip sawtail catshark *Galeus sauteri.* This species has an age-at-maturity of 9 years and maximum age of 21 years, resulting in a generation length of 15 years. This species is smaller than *H. edwardsii* (48 cm vs 64 cm) and thus based on scaled-size, the generation length is inferred as 20 years for *H. edwardsii*.

FISHERIES MANAGEMENT

SA catch sources

Local catch was estimated at 1–10 tons per annum (DFFE records: 2010–2012), with the highest catch in the demersal trawl fisheries and possible catch sources being the recreational and commercial linefisheries, the demersal shark and hake longline fisheries and the rocklobster (pot) fishery (da Silva *et al.* 2015).

SA catch quantities and characteristics

Inshore trawl fishery

Annual average catch estimates for the inshore trawl fleet, based on unsorted samples by observers, was 10.2 tons for the period 2003–2006 (Attwood 2011), but this was for all shysharks *Haploblepharus* spp. combined. With an assumed mean weight of 1 kg, this catch would equate to 1000 individuals per annum, all of which were discarded. No species breakdown of this bycatch is available.

Beach seine fishery

This species was rarely caught in the beach seine (trek net) fishery and beach seine catches in the SW Cape (Hutchings and Lamberth 2002), including False Bay (Lamberth 2006).

Linefishery

This species was the most common elasmobranch caught by shore anglers in the Tsitsikamma National Park (Hanekom 1997). It is likely to be one of the unspecified catsharks caught by shore anglers in the Goukamma Marine Protected Area (Pradervand and Hiseman 2006).

Fishing outside South Africa

Not applicable as this is an endemic species.

Population trends

The high degree of site fidelity suggested fragmented populations (Human 2009), however no genetic structure among *H. edwardsii* from different sampling locations was evident (van Staden 2018). Nevertheless, low levels of significant differentiation were found between some of these locations and it is likely that at least two populations exist, given that this species attains a larger size in the east of its range, and therefore population sub-structuring needs quantifying (Human 2007).

There are no population estimates for this species. Population trend data are available from annual density estimates in demersal trawl research surveys conducted on the south coast over the period 1991-2016 (DFFE, unpubl. data, 2018) and catch rates by research shore anglers in the De Hoop Marine Protected Area over the period 1996–2017 (DFFE, unpubl. data, 2018).

The trend analysis of the trawl catches revealed an annual rate of reduction of 3.4%, consistent with a median reduction of 88% over three past generation lengths (60 years), with the highest probability (64.9%) of >80% reduction over three generation lengths. There was a steep decline in catch rates during the early 1990s when fishing pressure was substantially higher; over the last two decades the population reduction has been less dramatic. Some of the reduction is possibly a result of a geographic shift in abundance away from the trawl grounds due to climate change (Currie *et al.* 2019). The southward range shift also likely represents a loss of habitat for this species (Pollom *et al.* 2020b).

The abundance of the species fluctuated considerably in the shore anglers' catches. The trend analysis revealed an annual rate of reduction of 6.6%, consistent with a median reduction of 96.5% over three past generation lengths (60 years), with the highest probability (93.2%) of >80% reduction over three generation lengths. The De Hoop MPA was established in 1985 and is a no-take reserve, and this may not be representative of the population trends in fished areas of South Africa (Pollom *et al.* 2020b).

Overall, due to an estimated population reduction over most of its range, combined with a substantial reduction in fishing effort in South Africa and a suspected range shift due to climate change that could account for some of the estimated reduction, but also likely represents a decline in area of occupancy, it is suspected that this species has undergone a population reduction of 50–79% over the past three generation lengths (60 years) and it was therefore assessed as Endangered in 2019 (Pollom *et al.* 2020b).

ECOTOURISM
This species occurs on rocky reefs where it is frequently seen by scuba divers and therefore must be regarded as having ecotourism value.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
Catches of all members of the genus *Haploblepharus* are prohibited in the demersal shark longline fishery. There is a daily bag limit of one individual in the recreational line fishery. This species will benefit from the long-standing ban on trawling in False Bay.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
As this species is highly resident, it will benefit from all the inshore MPAs, namely the West Coast National Park on the west coast, the Table Mountain National Park which encompasses the western shores of False Bay and those on the south coast, especially the De Hoop, Goukamma and Tsitsikamma MPAs.

IUCN Red List Status
<u>Endangered: 2019: A2bcd</u>

Previous IUCN assessments
Near Threatened 2008
Near Threatened 2000

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

International comments
None, as this is a South African endemic.

MANAGEMENT CONSIDERATIONS

The bycatch of *Haploblepharus* spp. in the inshore trawl is large and is all discarded or released. Little is known of its survival. This should be investigated. When discarded without undue harm, post-release mortality is likely low, based on generally very low at-vessel and post-release mortality for catsharks (Ellis *et al.* 2017). In sectors of the linefishery this species may be regarded as a nuisance and discarded rather than released by fishermen targeting more desirable species. Careful handling and prompt return to the water must be promoted in all fishing sectors. This would require an educational campaign. As with endemics which have a restricted range in heavily utilised inshore waters, it is vulnerable to habitat degradation and loss.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

There are still gaps in the knowledge of the life history of this endemic species. Samples should be collected from the bycatch in the inshore trawl fishery, rather than collecting live animals in locations such as False Bay where they are common. The possibility of two separate populations, one in the east (Algoa Bay) and the other in the southwest (False Bay and up the west coast) and the lack of genetic structure from various sampling locations should be pursued.

Haploblepharus fuscus

SCIENTIFIC NAME	*Haploblepharus fuscus* (Smith 1950)
COMMON NAME	Brown shyshark
FAMILY	Pentanchidae
ENDEMIC	Yes
SIZE RANGE	At least 70 cm TL
SA DISTRIBUTION	E, S coasts: southern KZN to Cape Agulhas
HABITAT	Demersal on rocky reef areas and sand bottoms
DEPTH RANGE	0–35 m
MAJOR FISHERIES	Trawl and recreational line fisheries
IUCN STATUS	Vulnerable 2019
CITES	Not listed
MLRA	No take in demersal shark longline fishery; daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	J Escobar-Porras

SPECIES SUMMARY and RECOMMENDATIONS

Haploblepharus fuscus is a very small, demersal, endemic species which occurs along the east and south coasts of South Africa. It inhabits rocky reefs and sand substrates from the shore to depths of 35 m. Total South African catch was estimated at <1 ton per annum (DFFE records: 2010–2012), which was largely as bycatch in the inshore trawl industry. This species is also caught in the recreational and commercial linefisheries and the demersal longline and rock lobster fishery. Based on angler surveys in the De Hoop Marine Protected Area, this species is suspected to have undergone a population reduction of approximately 57 % over the past three generation lengths (60 years), and it was assessed as Endangered in 2019. This highly resident species will derive benefit from the inshore MPAs in its range. Survival of discarded bycatch is of concern. Almost nothing is known of its life history and ecology.

TAXONOMIC and IDENTIFICATION ISSUES

Identification of species in the genus *Haploblepharus* has been problematic due to the reliance on colour patterns, that have proven to be variable, and the poor choice of morphological characters, such as the position of the first dorsal fin relative to the pelvic fin. This problem has been compounded by the difficulty in identifying juveniles and possible hybridisation between species (Human 2007). *H. fuscus* is the least patterned of the four species in this genus, which are all South African endemics. It always has chocolate brown or dull brown background colouration, occasionally with indistinct saddles, and occasionally with white or dark spots, but never both (Bass *et al.* 1975, Human 2007).

A genetic study found very little genetic differentiation between this species and *H. pictus* which is more consistent with that found at a population level rather than at a species level (van Staden *et al*. 2020). Despite this, all *H. fuscus* samples included in this study showed high membership assignment to a single genetic cluster indicating no admixture and accurate taxonomic assignment of the species.

SOUTH AFRICAN DISTRIBUTION

This species is endemic to South Africa and occurs on the east coast from Hibberdene (KZN south coast) to the south coast (west of Cape Agulhas), but it is most common from East London to Storms River (Bass *et al.* 1975; Human 2007; Ebert *et al.* 2021). The last authors consider the record from Langebaan on the west coast to be an anomaly, stating that improved species identification within the genus will assist in refining the distributional limits.

REGIONAL DISTRIBUTION
This species does not occur outside South Africa.

SYNOPSIS OF RESEARCH
In South Africa Bass *et al.* (1975) provided detailed taxonomic, morphometric and biological information from seven individuals, including adults but no pregnant females. Human (2007) undertook a taxonomic reassessment of the genus. Movement patterns have been investigated and localised population size estimated (Escobar-Porras 2009). Genetic studies comprised the sequencing of various genes (Human *et al.* 2006), and other markers for species delineation (van Staden 2018, van Staden *et al*. 2020). No population genetic studies have been undertaken.

ECOLOGY
Depth
The species inhabits shallow coastal waters from the shoreline to a depth of 35 m (Human 2007).

Habitat: Adults
They are commonly found on rocky habitats (Compagno *et al.* 1989).

Habitat: Juveniles/Nursery Grounds
The juveniles and their whereabouts and those of the egg cases are unknown (Bass *et al*. 1975, Human 2007).

Synopsis of tag deployments
A total of 413 individuals were tagged (ORI Cooperative Fish Tagging Project 1984-2018 inclusive) with 28 recaptured (7%). Mean time at liberty and distance travelled were 0.8 years and 10 km, respectively; maximum time at liberty and distance travelled were 2.7 years and 102 km, respectively (Jordaan *et al.* 2020).

Movements
The tag-recapture study is indicative of a strongly resident species, which undertakes short distance movements of up to 100 km. A far smaller-scale tagging study on the south coast (Tsitsikamma MPA and Rebelsrus Nature Reserve just west of Cape St Francis) revealed far higher degrees of residency, with all the recaptured sharks recording zero distance travelled at both locations (Escobar-Porras 2009).

Diet/feeding: adults
This species feeds on crustaceans and small teleosts (Compagno *et al.* 1989).

Diet/feeding: juveniles
Unknown, due to the scarcity of juveniles.

South African toxicological studies
No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Oviparity
DURATION OF REPRO CYCLE	Unknown
MATING	Unknown
GESTATION	Unknown
LITTER SIZE	Only 2 egg cases
PUPPING/NURSERY GROUND	Unknown

LENGTH AT BIRTH	Unknown
LENGTH AT MATURITY	35 -55 cm for both sexes
MAXIMUM LENGTH	73 cm
GENERATION LENGTH	Unknown

Mode
This species exhibits oviparity, as is the case with all scyliorhinids (Bass *et al.* 1975).

Duration of reproductive cycle
This is unknown.

Mating season and location
This is unknown.

Gestation
This is unknown.

Litter size
Egg cases are laid in pairs (Ebert *et al.* 2013)

Length at birth
This is unknown.

Pupping season and nursery ground
This is unknown.

Length at maturity
All males examined were mature at 55 cm and all females were mature at 61 cm (Human 2007).

Maximum length
This species attains 73 cm (Compagno *et al.* 1989).

Age and growth
No age and growth studies have been undertaken.

Generation length
Generation length was based on the most reliable age estimates to date for a catshark, the blacktip sawtail catshark *Galeus sauteri,* that has an age-at-maturity of 9 years and maximum age of 21 years, resulting in a generation length of 15 years. This species is smaller than *H. fuscus* (48 cm vs 73 cm) and thus based on scaled-size, the generation length is inferred as 20 years for *H. fuscus* (Pollom *et al.* 2020c).

FISHERIES MANAGEMENT
SA catch sources
Estimated total catch was <1 ton (DFFE records: 2010–2012), mainly as bycatch in the demersal trawl industry. It is a suspected catch in the recreational and commercial linefisheries and the demersal shark longline and rock lobster fisheries (da Silva *et al.*2015).

SA catch quantities and characteristics
Inshore trawl fishery
Annual average catch estimates for the inshore trawl fleet, based on unsorted samples by observers, was 10.2 tons for the period 2003–2006 (Attwood 2011), but this was for all shysharks *Haploblepharus*

spp. combined. With an assumed mean weight of 1 kg, this catch would equate to 1000 individuals per annum, all of which were discarded. No species breakdown of this bycatch is available.

Linefishery

This species was not recorded in the catches of shore anglers in the Goukamma MPA on the south coast (Gotz *et al.* 2013) but were present at a catch rate of 0.3 individuals per 100 angling hours in the Tsitsikamma MPA (Hanekom *et al.* 1997). This species is relatively common in the De Hoop MPA (DAFF unpublished records). It is generally returned to water by anglers but it is sometimes regarded as a pest and killed (Human 2007).

Fishing outside South Africa

This species does not occur outside South African waters.

Population trends

A localised population study was undertaken in the Rebelsrus Nature Reserve (~1 km^2 study area) and 181 individual sharks were identified, giving a density of 175 sharks km^{-2} (Escobar-Porras 2009).

There are no estimates of population size for this species. Population trend data of standardized catch per unit effort (CPUE) (number of fish per angler per day) for 1996–2017 (22 years) were available from the De Hoop Marine Protected Area (MPA) shore-based research angling surveys (DFFE, unpubl. data, 2018). The analysis revealed an annual rate of reduction of 1.2%, consistent with an estimated median reduction of 57.0% over the past three generation lengths (60 years), with the highest probability (41.3%) of <20% reduction over three generation lengths but also with a high probability (36.3%) of >80% reduction over three generation lengths. The 22 years of CPUE data fluctuated greatly and led to a high degree of uncertainty in the modelled abundance index, and also required extrapolation to a long period of three generations (60 years). This combined to produce a probability distribution with contrasting high probabilities of extinction risk. The De Hoop MPA was established in 1985 and is a no-take reserve, and the population trend is indicative only and may not be representative of the trends in fished areas of South Africa. However, currently there are no other data available to assess population trends. Overall, due to estimated declines over part of its range, its limited inshore distribution range that is exposed to habitat degradation, and levels of exploitation across its range, it is suspected that this species has undergone a population reduction of 30–49% over the past three generations (60 years) and it was therefore assessed as Vulnerable in 2019 (Pollom *et al*. 2020c).

ECOTOURISM

This species occurs on shallow rocky reefs where it may be seen by scuba divers and therefore must be regarded as having ecotourism value.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

Catches of all members of the genus *Haploblepharus* are prohibited in the demersal shark longline fishery. There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)

This species is not listed.

Marine Protected Areas

This highly resident species will derive protection from all the inshore MPAs within its range on the east and south coasts, especially the De Hoop MPA.

Additional local comment

The sequence for gene Cytochrome Oxidase subunit I (COI), which is widely used for species identification, was unable to differentiate the three *Haploblepharus* species, including *H. fuscus* (van Staden *et al.* 2020).

IUCN Red List Status

Vulnerable A2bcd: 2019

Previous IUCN assessments

Near Threatened 2008
Near Threatened 2000

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

This species is not listed.

Convention on Migratory Species (CMS)

This species is not listed.

MANAGEMENT CONSIDERATIONS

The inshore trawl bycatch of *Haploblepharus* spp. is large and is all discarded. Little is known of its survival and so this should be investigated. When discarded without undue harm, post-release mortality is likely low, based on generally very low at-vessel and post-release mortality for catsharks (Ellis *et al.* 2017). Another management intervention would be an education campaign among linefishers who regard this species and other catsharks as a nuisance and therefore do not release their catches. Careful handling and prompt return to the water must be promoted. An improvement in the ability of linefishers to identify all *Haploblepharus* species is needed. Due to the frequent misidentification of species among *Haploblepharus* taxa, it is recommended that conservation strategies be targeted at generic level, until species identification is determined with more precision (van Staden *et al.* 2020).

RESEARCH REQUIREMENTS AND OPPORTUNITIES

This species is relatively easy to keep alive in laboratory research aquaria. Almost nothing is known of its life history, reproductive biology and trophic ecology. Population connectivity using genetic studies needs attention. The juveniles of most of the *Haploblepharus* species are elusive, with poor representation in research collections and as a result there is still considerable confusion as to the identity of some juvenile *Haploblepharus* specimens. Tissue samples from juveniles are needed. Identification problems and possible hybridisation among *Haploblepharus* species call for future research to combine morphometrics and molecular tools to define species (van Staden *et al*. 2020), and to create a taxonomic key for juvenile specimens.

Haploblepharus kistnasamyi

SCIENTIFIC NAME	*Haploblepharus kistnasamyi* (Human and Compagno 2006)
COMMON NAME	Natal shyshark, Eastern shyshark
FAMILY	Pentanchidae
ENDEMIC	Yes
SIZE RANGE	10–50 cm TL
SA DISTRIBUTION	E, S coasts: central KZN to Mossel Bay
HABITAT	Demersal on rocky reef areas and sand bottoms
DEPTH RANGE	0–30 m
MAJOR FISHERIES	Trawl and linefisheries
IUCN STATUS	Vulnerable 2018
CITES	Not listed
MLRA	No take in demersal shark longline fishery; daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	J Escobar-Porras

SPECIES SUMMARY and RECOMMENDATIONS

Haploblepharus kistnasamyi is a very small, endemic, demersal species which occurs along part of the east and south coasts. It inhabits inshore rocky reefs and sand areas from the intertidal to a depth of 30 m. It was not listed in South African catches (DFFE records: 2010–2012), possibly because it was only formally recognised as a separate species, distinct from *H. edwardsii*, in 2006. It is likely to be caught in very shallow inshore trawls and in commercial and recreational linefisheries. This together with and a lack of recent records despite surveys, resulted in it being assessed as Vulnerable in 2018. Almost nothing is known of its biology.

TAXONOMIC and IDENTIFICATION ISSUES

Identification of species in the genus *Haploblepharus* has been problematic due to the reliance on colour patterns, that have proven to be variable, and the poor choice of morphological characters, such as the position of the first dorsal fin relative to the pelvic fin, in species identification keys. Juveniles that are difficult to identify and possible hybridisation between species further compound the problem (Human 2007).

Originally *H. edwardsii* was thought to have a Cape and a Natal colour variant (Bass *et al*. 1975) but the latter is now regarded as a separate species *H. kistnasamyi.* These two species are very similar in overall morphology and colouration, but *H. kistnasamyi* has a less depressed body, a compressed caudal peduncle and far darker brown saddles with irregular white spots on a creamy background (Human and Compagno 2006). The validity of the two species was confirmed based on comparative CO1 sequences; in fact, the sequences of *H. kistnasamyi* were the only ones that were distinguishable from the other members of the *Haploblepharus* (Aletta Bester-van der Merwe, Stellenbosch University, unpubl. data).

SOUTH AFRICAN DISTRIBUTION

This species is endemic to South Africa and occurs on the east coast (central KZN; south of the Thukela River) southwards to Mossel Bay on the south coast. There is some evidence of size-based segregation. Adults have been found in northern KZN, while juveniles, tentatively allocated to this species, occur further south, from the Eastern Cape to Mossel Bay, also usually close to the coastline (Human 2007).

REGIONAL DISTRIBUTION

This species does not occur outside South Africa.

SYNOPSIS OF RESEARCH

In South Africa Bass *et al.* (1975) provided detailed taxonomic, morphometric and biological information from numerous specimens of *H. edwardsii.* At that stage the Natal form was not recognised as a separate species, although these authors acknowledged the supporting evidence pointing to this. Its status as a valid species *H. kistnasamyi* was confirmed by Human and Compagno (2006), as part of a taxonomic reassessment of the genus (Human 2007) No subsequent research has been undertaken on this species.

ECOLOGY

Depth

This species inhabits inshore rocky reefs and sandy areas from the intertidal to 30 m depth (Human 2007).

Habitat: Adults

The adults are commonly found on rocky reef and sand bottoms (Human 2006a).

Habitat: Juveniles/Nursery Grounds

It is assumed that the juveniles inhabit similar areas to the adults.

Synopsis of tag deployments

A total of 369 individuals were tagged as *H. edwardsii* (ORI Cooperative Fish Tagging Project 1984-2018 inclusive) with 34 recaptured (9%) (Jordaan *et al.* 2020). It is highly likely that some of these individuals were H. *kistnasamyi.* Mean time at liberty and distance travelled for *H edwardsii* were 0.6 years and 1 km, respectively; maximum time at liberty and distance travelled were 3.7 years and 20 km, respectively (Jordaan *et al.* 2020).

Movements

It is unconfirmed but highly likely that *H. kistnasamyi* is strongly resident, with marked site fidelity, like its congener *H. edwardsii*.

Diet/feeding: adults

Unknown, but congeners feed on crustaceans, teleosts, annelid worms and cephalopods (Compagno *et al.* 1989).

Diet/feeding: juveniles

This is unknown.

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Oviparity
DURATION OF REPRO CYCLE	Unknown
MATING	Unknown
GESTATION	Unknown
LITTER SIZE	Possibly only 2 egg cases
PUPPING/NURSERY GROUND	Unknown
LENGTH AT BIRTH	10 cm
LENGTH AT MATURITY	F: 48 cm; M: 50 cm
MAXIMUM LENGTH	50 cm
GENERATION LENGTH	Unknown

Mode
Oviparity is assumed, as it is the case with all scyliorhinids (Bass *et al.* 1975).

Duration of reproductive cycle
This is unknown.

Mating season and location
This is unknown.

Gestation
This is unknown.

Litter size
It is assumed that two egg cases are produced, based on all the other members of the genus (Bass *et al.* 1975).

Length at birth
This species is free-swimming at about 10 cm (Human and Compagno 2006).

Pupping season and nursery ground
This is unknown.

Length at maturity
Males mature at 50 cm and females at 48 cm (Human and Compagno 2006) but too few individuals were examined to ascertain length at first or 50% maturity.

Maximum length
This species attains 50 cm (Human and Compagno 2006).

Age and growth
This is unknown.

Generation length
This is unknown.

FISHERIES MANAGEMENT

SA catch sources
This species was not listed in catches (DFFE records: 2010–2012). It is likely to be caught in very shallow inshore demersal trawls and in commercial and recreational linefisheries.

SA catch quantities and characteristics

Inshore trawl fishery
Annual average catch estimates for the inshore trawl fleet, based on unsorted samples by observers, was 10.2 tons for the period 2003–2006 (Attwood 2011), but this was for all shysharks *Haploblepharus* spp. combined. With an assumed mean weight of 1 kg, this catch would equate to 1,000 individuals per annum, all of which were discarded. No species breakdown of this bycatch is available.

Linefishery
This species was not reported in the catches of south coast shore anglers made in the Goukamma MPA (Gotz *et al.* 2013) It is highly likely that most anglers cannot distinguish it from its congener *H. edwardsii.* It is generally returned to water by anglers but it is sometimes regarded as a pest and killed (Human 2009b).

Fishing outside South Africa
This species does not occur outside South African waters.

Population trends
There are no estimates of population size for this species. It was caught in historical research trawl surveys but has not been caught recently (C da Silva, DFFE, unpubl. data, 2018). This species was not reported during annual research surveys in the Pondoland Marine Protected Area in the period 2006–2011 (Maggs *et al.* 2013).

Its range overlaps with trawl and line fisheries, and a lack of recent records despite surveys leads to inference of a continuing decline in the number of mature individuals. Its presence in historical research surveys and its absence in recent surveys leads to an inferred continuing decline this species, hence it was assessed as Vulnerable in 2018.

ECOTOURISM
This species occurs on shallow rocky reefs. Although it is not often seen by scuba divers, it has ecotourism value.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
Catches of all members of the genus *Haploblepharus* are prohibited in the demersal shark longline fishery. There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is listed as Protected.

Marine Protected Areas
This apparently highly resident species will derive protection from all the inshore MPAs within its range on the east and south coasts.

Additional local comment

IUCN Red List Status
<u>Vulnerable 2018: B2ab(v)</u>

Previous IUCN assessments
Critically Endangered 2008 B1ab(iii), but this assessment miscalculated its extent of occurrence (Pollom *et al.* 2019b)

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

MANAGEMENT CONSIDERATIONS
The inshore trawl bycatch of *Haploblepharus* spp. is large and is all discarded. Little is known of its survival. This should be investigated. When discarded without undue harm, post-release mortality is likely low, based on generally very low at-vessel and post-release mortality for catsharks (Ellis *et al.* 2017). Another management intervention would be an education campaign among linefishers who regard this species as a nuisance and therefore do not release their catches. An improvement in the ability of linefishers to identify all *Haploblepharus* species is needed.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

Almost nothing is known of its life history, reproductive biology or ecology. A further detailed morphological and genetic study is required to fully delineate and define this species from the other members of the genus (Ebert *et al.* 2021). Genetic studies to investigate population connectivity are needed. The juveniles of most of the *Haploblepharus* species are elusive, with poor representation in collections. If juveniles are collected, a genetic sample should be taken before preserving the specimen, as there is still considerable confusion as to the identity of some juvenile *Haploblepharus* specimens (Human 2007).

Holohalaelurus favus

SCIENTIFIC NAME	*Holohalaelurus favus* (Human 2006)
COMMON NAME	Honeycomb Izak catshark/Natal Izak catshark
FAMILY	Pentanchidae
ENDEMIC	No; southern Mozambique
SIZE RANGE	?–52 cm TL
SA DISTRIBUTION	E coast: Mozambique border to Durban
HABITAT	Demersal
DEPTH RANGE	200–1000 m
MAJOR FISHERIES	Trawl
IUCN STATUS	Endangered 2019
CITES	Not listed
MLRA	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	J Escobar-Porras and S Fennessy

SPECIES SUMMARY and RECOMMENDATIONS

Holohalaelurus favus is a very small, demersal species with a narrow distributional range from Durban to southern Mozambique, occurring at depths of 200–1000 m. Historically it was regarded as a Natal form of *H. regani.* It was not listed in South African landings (DFFE records: 2010–2012), but is likely to be caught in any deep-water crustacean trawling on the east coast. It may have been previously regarded as common in trawls, but this was assumed to no longer be the case, resulting in it being assessed as Endangered in 2019. It is difficult to formulate any management considerations other to monitor its incidence in regional trawl catches. Almost nothing is known of its biology.

TAXONOMIC and IDENTIFICATION ISSUES

The KZN and southern Mozambique region has several species of *Holohalaelurus* with overlapping ranges and until recently a lack of accurate descriptions precluded species-specific identification (Human 2006a). Bass *et al.* (1975) recognised two southern African species of *Holohalaelurus*, one of which was *H. regani*, with a Cape/typical form and a Natal/northeastern form. Human (2006a) completely revised the taxonomy of the genus, which is endemic to southern and east Africa. This resulted in the description of two new species, one of which was *H. favus*, being the Natal/northeastern form of *H. regani*. The Cape/typical form represents the true *H. regani* as originally described by Gilchrist in 1922, although this species does occur, albeit rarely, as far north as Durban. Both species (*H. regani* and *H. favus*), unlike the other species in the genus, have a series of relatively large denticles on the back and top of the head. Separating adult forms of these two species is based largely on the size of the spots relative to eye diameter and whether or not the spots form "horseshoe"-shaped markings. The patterning of the juveniles of both species is very different from that of the adults (Human 2006a) and the taxonomic keys for these species were created only on adult features (Escobar-Porras 2018).

SOUTH AFRICAN DISTRIBUTION

This species occurs on the northern part of the east coast from the Mozambique border to Durban (Human 2006a).

REGIONAL DISTRIBUTION

This species also occurs in southern Mozambique, with a single individual recorded just north of Maputo (Human 2006a).

SYNOPSIS OF RESEARCH

In South Africa Bass *et al.* (1975) provided taxonomic, morphometric and biological information from numerous specimens of *H. regani* caught in KZN*,* some of which were *H. favus.* At that stage the Natal form was not recognised as a separate species, although these authors acknowledged the supporting evidence pointing to this. The latter's status as a valid species, *H. favus*, was confirmed by Human (2006a), as part of a taxonomic reassessment of the genus. No subsequent research has been undertaken on this species, probably due to the difficulty in obtaining specimens. This species is of serious conservation concern since a single record from 2007 represents the only contemporary record despite its range being subject to surveys, since the mid-1970s (S. Fennessy and B. Everett, Oceanographic Research Institute, pers. comm., cited by Pollom *et al.* 2020d).

ECOLOGY

Depth

This species occurs at depths of 200–1000 m (Human 2006a).

Habitat: Adults

No details are available.

Habitat: Juveniles/Nursery Grounds

Juveniles prefer deeper waters than the adults (Bass *et al.* 1975, Human 2006a).

Synopsis of tag deployments

No tagging has been undertaken.

Movements

Nothing is known of the movements of this species.

Diet/feeding: adults

Unknown, but congeners feed on crustaceans, teleosts and cephalopods (Bass *et al.* 1975).

Diet/feeding: juveniles

This is unknown.

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Oviparity
DURATION OF REPRO CYCLE	Unknown
MATING	Unknown
GESTATION	Unknown
LITTER SIZE	Possibly only 2 egg cases
PUPPING/NURSERY GROUND	Egg laying is possibly year-round
LENGTH AT BIRTH	Unknown
LENGTH AT MATURITY	F: 29-42 cm; M: 19-51 cm
MAXIMUM LENGTH	F: at least 42 cm; M: at least 51 cm
GENERATION LENGTH	15 years, inferred from *Galeus sauteri*

Mode

Oviparity is assumed, as it occurs in *H. punctatus* and *H. regani* (Bass *et al.* 1975).

Duration of reproductive cycle

This is unknown.

Mating season and location
This is possibly year-round, as is the case with its congener *H. regani* (Richardson *et al.* 2000).

Gestation
This is unknown.

Litter size
It is assumed that two egg cases are produced, based on all the other members of the genus (Bass *et al.* 1975).

Length at birth
This is unknown. Bass *et al.* (1975) reported a 13 cm *H. regani* caught off Durban, but it is not known if this was *H. favus.*

Pupping season and nursery ground
This is unknown.

Length at maturity
This is unknown. Based on four individuals examined, the 29 cm female was immature and the 42 cm female was mature; the 19 cm male was immature and the 52 cm male was mature (Human 2006a).

Maximum length
This species attains at least 52 cm (Human 2006a).

Age and growth
This is unknown.

Generation length
Catsharks are difficult to age and the most reliable age estimates to date are from the similar-sized blacktip sawtail catshark *Galeus sauteri* that has an age-at-maturity of 9 years and maximum age of 21 years. This resulted in an inferred generation length of 15 years (Pollom *et al.* 2020d).

FISHERIES MANAGEMENT

SA catch sources, quantities and characteristics
This species was not listed in catches (DFFE records: 2010–2012; da Silva *et al*. 2015). There is a deep-water crustacean trawl fishery off the KZN central coast (Fennessy and Groeneveld 1997) and, based on its distribution, *H. favus* is a likely bycatch in this fishery, although effort has declined substantially over the last two decades (Pollom *et al.* 2020d).

Fishing outside South Africa
The species is a possible bycatch of deep-water demersal crustacean trawl fisheries in southern Mozambique (Pollom *et al.* 2020d). There are also anecdotal reports of a recent substantial increase in general demersal trawling along much of the Mozambique coast (Sean Fennessy, Oceanographic Research Institute, pers. comm.).

Population trends
There are no estimates of population size for this species, which, since it has such a restricted range, is likely to be a single population. Historically, *H. regani*, as it was known at the time, was possibly a common species in the east coast deep-water trawl fishery and research surveys in the 1960s and 1970s, but few records have been confirmed since. On the other hand, *Holohalaelurus* spp were

recorded regularly by onboard observers in this fishery from 2003-2012, but their identity is uncertain due to taxonomic confusion (S. Fennessy, ORI, pers. comm.).

This species was commonly caught in fisheries and research surveys in the 1960s and 1970s, but catch levels dropped suddenly and very few records have been confirmed since. Due to historically heavy levels of fishing pressure, ongoing fishing at lower levels of effort, a lack of recent records despite research, and some possible refuge at depth, *H. favus* was suspected to have experienced a population reduction of 50–79% over the past three generations (45 years), and it was assessed as Endangered in 2019 (Pollom *et al.* 2020d).

ECOTOURISM
This species only occurs in deep water and therefore is not an ecotourism species.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
This very small species with its very narrow distribution is likely to be highly resident. It will only derive protection in the deepest waters of the iSimangaliso MPA.

Additional local comment
This species will benefit from the marked decline in fishing effort in the deep-water crustacean trawl fishery operating from Durban northwards in the last three decades (S. Fennessy, Oceanographic Research Institute, pers. comm., cited by Pollom *et al.* 2020d).

IUCN Red List Status
Endangered 2019: A2d

Previous IUCN assessments
Endangered 2009

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

International comments

MANAGEMENT CONSIDERATIONS
This species is now regarded as rare in deep-water trawls from Durban northwards into southern Mozambique, the only known source of fishing mortality. This makes it difficult to formulate management considerations. The species has an extremely limited range, occurs in a heavily trawled area and it is unprotected in South Africa and Mozambique. A possible management intervention would be an awareness campaign within the trawling industry to promote the preservation of specimens or at least the recording and reporting of the species.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

Virtually nothing is known of the life history of this species, unlike its congener *H. regani*, which is subject to heavy fishing pressure in the South African demersal trawl fishery on the south coast (Richardson *et al.* 2000). Despite its rarity in deepwater trawls, any opportunistic sampling should be used to gather information on the general biology and to collect tissue samples for genetic studies.

Holohalaelurus punctatus

SCIENTIFIC NAME	*Holohalaelurus punctatus* (Gilchrist 1914)
COMMON NAME	African spotted catshark/Whitespotted Izak catshark
FAMILY	Pentanchidae
ENDEMIC	No; southern Mozambique and Madagascar
SIZE RANGE	?–34 cm TL
SA DISTRIBUTION	E coast: Mozambique border to Durban
HABITAT	Demersal
DEPTH RANGE	220–420 m
MAJOR FISHERIES	Deepwater trawl
IUCN STATUS	Endangered 2019
CITES	Not listed
MLRA	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	ST Fennessy

SPECIES SUMMARY and RECOMMENDATIONS

Holohalaelurus punctatus is a very small, demersal species which occurs along the northern part of the east coast and southern Mozambique from 220–420 m depth. It was not listed in South African fisheries' landings (DFFE records: 2010–2012), but is likely to be caught in any deepwater trawling in its very limited range. It was previously regarded as common in the South African east coast crustacean trawl fishery, but this may no longer be the case, resulting in it being assessed as Endangered in 2019. It is difficult to formulate any management considerations, other than to monitor its incidence in trawl catches. Very little is known of its biology due to the scarcity of specimens.

TAXONOMIC and IDENTIFICATION ISSUES

The KZN and southern Mozambique region has several species of *Holohalaelurus* with overlapping ranges and until recently a lack of accurate descriptions precluded species-specific identification (Ebert *et al.* 2021). Human (2006a) completely revised the taxonomy of the genus, which is endemic to southern and east Africa. There are now five species recognised, with three in South African waters. Of the five, only *H. punctatus* lacks a series of relatively large denticles on the back and top of the head. *H. polystigma* is a junior synonym of *H. punctatus* (Human 2006a). Human (2010) described a specimen of *H. grennian* from southern Mozambique, with anatomical features that are typically associated with *H. punctatus.* He concluded that these differences could be speculatively attributed to hybridisation between the two species.

SOUTH AFRICAN DISTRIBUTION

This species occurs on the northern part of the east coast, from the Mozambique border to Durban (Human 2006a).

REGIONAL DISTRIBUTION

This species also occurs in southern Mozambique as far north as Bazaruto, and Madagascar (Human 2006a).

SYNOPSIS OF RESEARCH

In South Africa Bass *et al.* (1975) provided taxonomic, morphometric and biological information from about 46 specimens. The taxonomy of the genus was revised by Human (2006a), as part of a taxonomic reassessment of the genus. No subsequent research has been undertaken on this species.

ECOLOGY

Depth
This species occurs at depths of 220–420 m. There is some evidence of sexual segregation, with more males caught in KZN, while in Mozambique the sex ratio was close to unity (Bass *et al.* 1975).

Habitat: Adults
No details are available.

Habitat: Juveniles/Nursery Grounds
No details are available.

Synopsis of tag deployments
No tagging has been undertaken.

Movements
Nothing is known of the movements of this species.

Diet/feeding: adults
This species feeds on crustaceans, teleosts and cephalopods (Bass *et al.* 1975).

Diet/feeding: juveniles
This is unknown.

South African toxicological studies
No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Oviparity
DURATION OF REPRO CYCLE	Unknown
MATING	Unknown
GESTATION	Unknown
LITTER SIZE	Only 2 egg cases
PUPPING/NURSERY GROUND	Egg laying is possibly year-round
LENGTH AT BIRTH	Unknown
LENGTH AT MATURITY	F: at least 24 cm; M: at least 29 cm
MAXIMUM LENGTH	F: at least 26 cm; M: at least 34 cm
GENERATION LENGTH	10 years, inferred from *Galeus sauteri*

Mode
This species exhibits oviparity (Bass *et al.* 1975).

Duration of reproductive cycle
This is unknown.

Mating season and location
This is possibly year-round, as it the case with its congener *H. regani* (Richardson *et al.* 2000).

Gestation
This is unknown.

Litter size
Only two egg cases are produced (Bass *et al.* 1975).

Length at birth
This is unknown. The smallest recorded juvenile was 15 cm (Bass *et al.* 1975).

Pupping season and nursery ground
This is unknown.

Length at maturity
The smallest mature female was 24 cm and male 29 cm (Bass *et al.* 1975).

Maximum length
The largest individual was a male of 34 cm, with males apparently attaining a larger size than females (Bass *et al.* 1975).

Age and growth
This is unknown.

Generation length
Catsharks are difficult to age and the most reliable age estimates to date are from the similar-sized blacktip sawtail catshark *Galeus sauteri* that has an age-at-maturity of 9 years and maximum age of 21 years, resulting in an inferred generation length of 15 years. As this species is larger than *H. punctatus* (48 cm vs 34 cm), the generation length is inferred as 10 years for *H. punctatus* (Pollom *et al.* 2020e).

FISHERIES MANAGEMENT

SA catch sources
This species was not listed in landed catches (DFFE records: 2010-2012; da Silva *et al*. 2015).

SA catch quantities and characteristics

KZN deepwater crustacean trawl fishery
This fishery is active off the KZN central coast (Fennessy and Groeneveld 1997). Based on its distribution, *H. punctatus* is a bycatch in this fishery, and *Holohalaelurus* spp were regularly recorded by bycatch observers from 2003-2012, although abundance of *H. punctatus* cannot be established from these records, owing to confusion between congeners. Effort in this fishery has declined substantially over the last two decades (S. Fennessy, Oceanographic Research Institute, pers. comm.).

Fishing outside South Africa
The species is a bycatch of deep-water demersal crustacean trawl fisheries in southern Mozambique (Pollom *et al.* 2020e). There are recent anecdotal reports of high levels of general demersal trawling along the southern and central Mozambican coast (S. Fennessy, ORI, pers. comm.), which is also likely to catch this species.

Population trends
There are no estimates of population size for this species. The species was commonly caught in KZN and southern Mozambique fisheries and research surveys in the 1960s and 1970s, but catch levels were reported to have dropped. Only a single individual was caught in biodiversity trawl surveys in that region as part of the coelacanth (*Latimeria chalumnae*) project. This species was not recorded from more recent FRS Algoa surveys conducted off Mozambique. A single specimen was collected during a Fridtjof Nansen survey cruise off Mozambique during 2007, but other deep demersal sharks were more common (P. Heemstra, SA Institute of Aquatic Biodiversity, pers. comm. 2008, cited by Human 2009d).

It has been suggested that this species has been replaced by *H. grennian* (B. Human, formerly Iziko South African Museum pers. comm.). Due to historically heavy levels of fishing pressure, ongoing fishing at lower levels of effort, a lack of recent records, and some possible refuge at depth, *H. punctatus* was suspected to have experienced a population reduction of 50–79% over the past three generations (30 years), and it was assessed as Endangered in 2019 (Pollom *et al.* 2020e).

ECOTOURISM
This species only occurs in deep water and therefore is not an ecotourism species.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
This very small, possibly highly resident, species will only derive protection in deeper waters of the iSimangaliso and uThukela MPAs.

Additional local comment

IUCN Red List Status
<u>Endangered 2019: A2d</u>

Previous IUCN assessments
Endangered 2009

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

International comments
This species also occurs off Madagascar where its population status is unknown. Its depth range possibly places it beyond the capabilities of local fisheries, thus providing a potential refuge. It is likely that the Madagascar population is separate from the one off southern Mozambique and KZN, with the deep waters of the Mozambique channel present a migration barrier (Human 2009d).

MANAGEMENT CONSIDERATIONS
This species is now thought to be much less common in deepwater trawls from Durban northwards into southern and central Mozambique, the only known source of fishing mortality. This makes it difficult to formulate management considerations.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
Very little is known of the life history of this species, unlike its congener *H. regani*, which is subject to heavy fishing pressure in the South African demersal trawl fishery on the Agulhas Bank (Richardson *et al.* 2000). Despite the suspected rarity of *H. punctatus* in deep-water trawls, any opportunistic sampling should be used to gather information on the general biology and to collect tissue samples for genetic studies.

FAMILY SCYLIORHINIDAE

Poroderma africanum

SCIENTIFIC NAME	*Poroderma africanum* (Gmelin 1789)
COMMON NAME	Pyjama catshark, pyjama shark, striped catshark
FAMILY	Scyliorhinidae
ENDEMIC	Yes
SIZE RANGE	15–100 cm TL
SA DISTRIBUTION	Some of E and W and entire S coast: East London to Saldanha Bay
HABITAT	Demersal, primarily on rocky reef areas, including kelp beds
DEPTH RANGE	0–100 m
MAJOR FISHERIES	Trawl fishery, commercial and recreational line fisheries, rock lobster, beach seine and gill net
IUCN STATUS	Least Concern 2019
CITES	Not listed
MLRA	No retention in demersal longline fishery or commercial and traditional linefisheries; daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	RGA Watson

SPECIES SUMMARY and RECOMMENDATIONS

Poroderma africanum is a very small, demersal, endemic species which occurs along much of the South African coast. It inhabits rocky reefs, including kelp beds from the shore to depths of 100 m. Estimated total catch was 1-10 tons per annum (DFFE records: 2010–2012), which was largely as bycatch in the inshore trawl industry. This species is also caught in the recreational and commercial linefisheries, rock lobster fishery and beach seine and gill net fisheries. Results of angler surveys in the De Hoop Marine Protected Area estimated a population increase of 133% over the past three generation lengths (75 years). It is regarded as common within its range and was assessed as Least Concern in 2019. This highly resident species will derive considerable benefit from the inshore MPAs in its range. Retention in any commercial linefisheries is prohibited. An education campaign would be beneficial among linefishers who regard this species as a nuisance and therefore do not release their catches. There are still some gaps in current knowledge of its reproductive biology. Population connectivity using genetic studies needs attention.

TAXONOMIC and IDENTIFICATION ISSUES

There are no taxonomic issues. It is easily identified and is unlikely to be confused with any other species. It is distinguished from its congener, *Poroderma pantherinum*, and other catsharks by its broad, longitudinal black stripes. *P. africanum* may have occasional spotting, but never rosettes and the spotting is never as marked as *P. pantherinum* (Human 2006b). *Poroderma* has distinct nose barbels, with those of *P. africanum* not reaching the upper lip, while those of *P. pantherinum* extend past the upper lip (Human, 2006).

SOUTH AFRICAN DISTRIBUTION

This species is endemic to South Africa and occurs on the east coast from East London, along the entire south coast and on the west coast as far as Saldanha Bay (Human 2006b).

REGIONAL DISTRIBUTION

This species does not occur outside South Africa.

SYNOPSIS OF RESEARCH

The reproductive system and embryo development was described by von Bonde (1945). Bass *et al.* (1975) provided taxonomic, morphometric and biological information from 26 individuals, including adults. Several student projects have examined aspects of reproduction, diet and age and growth (Bertolini 1993, Dainty 2002, Roux 2002) and movement patterns (Escobar-Porres 2009, Ralph Watson, Dyer Island Conservation Trust and Rhodes University, unpublished data). Human (2006b) undertook a taxonomic reassessment of the genus. Escobar-Porras and Mann (2013a) provided an overview of the life history and fisheries details of this species. Grusd *et al.* (2019) used mark-recapture to determine the size of a localised population.

ECOLOGY

Depth

This demersal species inhabits coastal shelf waters, where it is found in water less than 5 m deep. The deepest verified record was 108 m in St Francis Bay (immediately west of Algoa Bay; Human 2006b). In False Bay it is most common in waters of 20–30 m (De Vos *et al.* 2015) and it was trawled at depths of 27–73 m on the south coast (Buxton *et al.* 1984).

Habitat: Adults

Adults are commonly found on rocky substrates, including kelp beds, but also occur on sand bottoms in False Bay (De Vos *et al.* 2015).

Habitat: Juveniles/Nursery Grounds

The juveniles appear to inhabit similar areas to the adults, with no distinct nursery grounds.

Synopsis of tag deployments

A total of 1753 individuals were tagged (ORI Cooperative Fish Tagging Project 1984-2018 inclusive) with 133 recaptured (8%). Mean time at liberty and distance travelled were 0.9 years and 6 km, respectively; maximum time at liberty and distance travelled were 7.1 years and 381 km, respectively (Jordaan *et al*. 2020).

Movements

The tag-recapture study is indicative of a strongly resident species, with marked site fidelity, but with some limited evidence of long-distance movements. Acoustic telemetry data shows that some individuals move over 15 km (Ralph Watson, unpublished data).

Diet/feeding: adults

This species is a generalist feeder, with the diet dominated by small teleosts, cephalopods and crustaceans (Dainty 2002). Larger individuals showed a large amount of bait in their diet, suggesting a high degree of anthropogenic influence or adaptation (Ralph Watson, unpublished data).

Diet/feeding: juveniles

The diet was similar to that of the adults but with fewer cephalopods and crustaceans and more teleosts (Dainty 2002). Juveniles showed less of an anthropogenic influence on their diet than adults (Ralph Watson, unpublished data).

South African toxicological studies

No local studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Oviparity
DURATION OF REPRO CYCLE	Unknown

MATING	No seasonal pattern
GESTATION	Approx 1 year
LITTER SIZE	Only 2 egg cases
PUPPING/NURSERY GROUND	No seasonal pattern, assumed to occur throughout its range
LENGTH AT BIRTH	14–19 cm
LENGTH AT MATURITY	F: 85 cm; M: 86 cm
MAXIMUM LENGTH	100 cm
GENERATION LENGTH	21 years

Mode
This species exhibits oviparity, as is the case with all scyliorhinids (Bass *et al.* 1975).

Duration of reproductive cycle
This is unknown, largely because this species appears to reproduce throughout the year (Dainty 2002).

Mating season and location
Gonad characteristics, egg size and embryo development suggest a year-round breeding season (Dainty 2002), presumably wherever individuals occur (Escobar-Porras and Mann 2013a). Based on egg diameter, there is a peak in reproductive activity in autumn (March-May) in the Eastern Cape (Roux 2002; cited by Escobar-Porras 2009).

Gestation
This ranges from 5 months (von Bonde 1945) to approximately a year (Dainty 2002). Both studies were based on a single captive individual.

Litter size
Two egg cases are always laid (Dainty 2002).

Length at birth
Two individuals born in captivity were 14-19 cm (Dainty 2002).

Pupping season and nursery grounds
This appears to occur throughout the year and the species range, based on the observations of Dainty (2002).

Length at maturity
Total length at 50% maturity was 86 cm for males and 85 cm for females (Dainty 2002).

Maximum length
This species attains 100 cm (Escobar-Porras and Mann, 2013a), with males noticeably larger than the females (Dainty 2002). Larger specimens were consistently recorded from the Eastern Cape, compared to the Western Cape (Human 2006b).

Age and growth
Age at 50% maturity for both sexes combined was 24 years and the oldest individual of 89 cm was estimated to be 26 years old (Dainty 2002).

Generation length
Catsharks are difficult to age and the most reliable age estimates to date are from the blacktip sawtail catshark *Galeus sauteri* that has an age-at-maturity of 9 years and maximum age of 21 years, resulting in a generation length of 15 years (Liu *et al.*2011, cited by Pollom *et al.* 2020f). This species is smaller

than *P. africanum* (48 cm vs 109 cm) and thus based on scaled-size, the generation length is inferred as 25 years for the latter (Pollom *et al.* 2020f).

FISHERIES MANAGEMENT

SA catch sources

Estimated total catch was <1 ton (DFFE records: 2010–2012), mainly as bycatch in the demersal trawl industry. It is also caught in the recreational linefishery and is a suspected catch in the commercial linefishery, demersal shark longline and rock lobster fisheries (da Silva *et al.* 2015). This species is utilised occasionally for lobster bait and in the aquarium trade (Compagno 2005).

SA catch quantities and characteristics

Inshore trawl fishery

Annual average catch estimates for the inshore trawl fleet, based on unsorted samples by observers, was 14.3 tons for the period 2003-2006 (Attwood 2011). With an assumed mean weight of 4 kg, this catch would equate to 3575 individuals per annum, all of which were discarded. No information on survival was presented.

Linefishery

This species is occasionally caught by shore anglers in the Border region on the east coast (Pradervand and Govender 2003); on the south coast (Goukamma MPA; Pradervand and Hiseman 2006; Gotz *et al.* 2013); (Tsitsikamma MPA; Hanekom *et al.* 1997), and is relatively common in the De Hoop MPA (DEFF unpublished records). It is generally returned to water by anglers but it is sometimes regarded as a pest and killed (Human 2009e). It is also taken in the commercial linefishery,

Beach seine and gill net fishery

This species is very occasionally caught in beach seine nets in False Bay (Lamberth 2006).

Fishing outside South Africa

This species does not occur outside South African waters.

Population trends

There are no estimates of population size for this species. Population trend data are available from catch rates by research shore anglers in the De Hoop Marine Protected Area over the period 1996–2017 (MPA), (DFFE unpubl. data, 2018). The trend analysis revealed an annual rate of increase of 2%, consistent with an estimated median increase of 132% over the past three generation lengths (75 years), with the highest probability (76%) of an increase over the past three generation lengths (75 years). The De Hoop MPA was established in 1985 and is a no-take reserve, and the population trend is indicative only and may not be representative of fished areas outside such an MPA. As this species is common within its range, its population size appears to be increasing and its retention in commercial line fisheries is prohibited it was assessed as Least Concern in 2019 (Pollom *et al.* 2020f).

It was the second most common chondrichthyan observed in Baited Remote Underwater Video (BRUV) surveys in False Bay in 2011 (De Vos 2012) and Mossel Bay between 2015 and 2018 (Ralph Watson, unpublished data).

ECOTOURISM

This species occurs on shallow rocky reefs where it is often encountered by scuba divers and therefore must be regarded as an ecotourism species.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

Retention of this species and its congener is prohibited in the demersal shark longline fishery and commercial and traditional linefisheries. There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is listed as Protected.

Marine Protected Areas
This highly resident species will derive considerable protection from all the inshore MPAs within its range on the south and west coasts. It is present in MPAs at Betty's Bay, De Hoop and Tsitsikamma National Park on the south coast and Robben Island on the west coast.

Additional local comment

IUCN Red List Status
Least Concern 2019

Previous IUCN assessments
Near Threatened 2009
Lower Risk/Near Threatened 2000

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

MANAGEMENT CONSIDERATIONS
Despite being a highly resident endemic, this species is still regarded as common throughout its range. While its population trend is increasing in the De Hoop MPA, it appears to be declining elsewhere. It derives considerable protection from the various inshore MPAs in its range. One management intervention would be an education campaign among linefishers who regard this species as a nuisance and therefore do not release their catches. As this species was one of the common chondrichthyans observed on BRUVs in False Bay, it does benefit from a ban on trawling in the bay.

The IUCN assessment was based on multi-year catch data from De Hoop MPA. While this showcases the benefits of MPAs in the protection of the species, downward population trends elsewhere along the coast (Grusd *et al*. 2019; Ralph Watson, unpublished data), and with 18% of the species distribution range overlapping with MPAs with various levels of enforcement (including newly established ones), it is likely that the IUCN assessment is not representative across the entire species' range. Until more information is available, and erring on the side of caution, the species would benefit from an assessment of Vulnerable.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
This species is relatively easy to study and to keep alive in laboratory research aquaria. There are still some gaps in current knowledge of its reproductive biology. Population connectivity in this highly residential species using genetic studies needs attention. Population trends would need to be confirmed using multiple methods elsewhere within its range – both in and outside of MPAs.

Poroderma pantherinum

SCIENTIFIC NAME	*Poroderma pantherinum* (Müller and Henle 1838)
COMMON NAME	Leopard catshark
FAMILY	Scyliorhinidae
ENDEMIC	Yes
SIZE RANGE	11–84 cm TL
SA DISTRIBUTION	E, S, W coasts: central KZN to Saldanha
HABITAT	Demersal on rocky reef areas and sand bottoms in coastal waters
DEPTH RANGE	0–274 m, but most common shallower than 50 m
MAJOR FISHERIES	Trawl and recreational line fisheries
IUCN STATUS	Least Concern 2019
CITES	Nil
MLRA	No retention in demersal longline fishery or commercial and traditional linefisheries; daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	RGA Watson

SPECIES SUMMARY and RECOMMENDATIONS

Poroderma pantherinum is a very small, demersal, endemic species which occurs along most of the South African coast. It inhabits the continental shelf and upper slope on rocky substrates, including kelp beds, and sandy areas, but is most common shallower than 50 m. Total South African catch was estimated as <1 ton per annum (DFFE records: 2010–2012), which was largely as bycatch in the inshore trawl industry. This species is also caught in the recreational linefishery. Angler surveys in the De Hoop Marine Protected Area resulted in an estimated population increase of 267% over the past three generation lengths (66 years). As it is regarded as common within its range it is classified as Least Concern. This highly residential species will derive considerable benefit from the inshore MPAs in its range. Retention in any commercial linefisheries is prohibited. An education campaign would be beneficial among linefishers who regard this species as a nuisance and therefore do not release their catches. There are still some gaps in current knowledge of its reproductive biology. Population connectivity using genetic studies needs attention.

TAXONOMIC and IDENTIFICATION ISSUES

There are no current taxonomic issues. *Poroderma marleyi* was previously considered separate from *P. pantherinum*, however the former is one of a number of colour variants of *P. pantherinum*. Typically the latter is pale grey dorsally and laterally, with whole or broken rosettes of black spots. The *marleyi* form has large black spots and the “salt and pepper” form has small, densely packed, black spots. There is also a melanistic form, which is entirely black laterally and dorsally or charcoal grey with a variable number of broad longitudinal stripes or spots (not rosettes). The stripes and spots are sometimes absent (Human 2006b).

Colour patterns tend to vary with location. The melanistic form appears to be exclusive to False Bay. The salt and pepper form and the *marleyi* form appear to be exclusive to the Eastern Cape and KwaZulu-Natal, while the typical form and intermediates are encountered throughout its range (Bass *et al*. 1975). The *marleyi* form also occurs in the extreme northern end of the range on the west coast (Ebert *et al.* 2021). There is also an ontogenetic component involved (Bass *et al*. 1975), in that smaller individuals tend to have complete rosettes and/or large solid spots, but with growth the large spots diffuse into rosettes, broken rosettes or scattered spots or the spots fuse into longitudinal stripes with varying degrees of spotting and rosettes. The *marleyi* colour form at birth may be retained throughout the life of that individual (Human 2006b). In Algoa Bay this species invariably hatches with a *marleyi* pattern which diffuses as the animals grow (M Smale, Port Elizabeth Museum, pers, comm., cited by Human 2006b).

SOUTH AFRICAN DISTRIBUTION

This species is endemic to South Africa and occurs on the east coast from central KZN, along the entire south coast to Cape Town (Bass *et al.* 1975, Human 2006b). Its range has been extended up on the west coast as far as Saldanha Bay (Ebert *et al*. 2021). It is considered rare in KZN (Bass *et al.* 1975).

REGIONAL DISTRIBUTION

This species does not occur outside South Africa.

SYNOPSIS OF RESEARCH

Bass *et al.* (1975) provided taxonomic, morphometric and biological information from approximately 20 individuals, including adults of both sexes. Several student projects have examined aspects of reproduction, embryo development, diet and age and growth (Bertolini 1993, Dainty 2002, Roux 2002, Pretorius and Griffiths 2013) and movement patterns (Escobar-Porres 2009). Human (2006b) undertook a taxonomic reassessment of the genus. Escobar-Porras and Mann (2013b) provided an overview of the life history and fisheries details of this species. van Staden *et al.* (2018) presented the complete mitochondrial DNA and determined the phylogenetic position.

ECOLOGY

Depth

This demersal species inhabits the continental shelf and upper slope from the shallows to depths of over 250 m, as evident in trawl catches (Human 2006b). In locations such as False Bay it is most common in depths of 15–25 m (De Vos *et al.* 2015) and it was trawled at depths of 16–48 m on the south coast (Buxton *et al.* 1984).

Habitat: Adults

They are often found on rocky substrates, including kelp beds, in False Bay, but they also inhabit sand bottoms (De Vos *et al.* 2015).

Habitat: Juveniles/Nursery Grounds

Little is known. The juveniles may inhabit similar areas to the adults, with no distinct nursery grounds.

Synopsis of tag deployments

A total of 869 individuals were tagged (ORI Cooperative Fish Tagging Project 1984–2018 inclusive) with 111 recaptured (13%). Mean time at liberty and distance travelled were 0.9 years and 11 km, respectively; maximum time at liberty and distance travelled were 12.1 years and 722 km, respectively (Jordaan *et al.* 2020).

Movements

The tag-recapture study is indicative of a resident species, with strong site fidelity, but there is very limited evidence of some long-distance movements. The possibility of separate sub-populations along the coast has been proposed (Human 2009e). Acoustic telemetry data shows that some individuals move over 15 km, limited to water depths of less than 30 m (Ralph Watson, Dyer Island Conservation Trust and Rhodes University, unpublished data).

Diet/feeding: adults

The diet was dominated by small teleosts, cephalopods and crustaceans (Dainty 2002). The species showed an ontogenetic shift from teleosts towards cephalopods (Ralph Watson, unpublished data).

Diet/feeding: juveniles

The diet was similar to that of the adults but with fewer cephalopods and more teleosts and crustaceans (Dainty 2002).

South African toxicological studies
No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Oviparity
DURATION OF REPRO CYCLE	Unknown
MATING	No seasonal pattern
GESTATION	About 9 months
LITTER SIZE	Only 2 egg cases
PUPPING/NURSERY GROUND	No seasonal pattern, assumed to occur throughout the range
LENGTH AT BIRTH	9–11 cm
LENGTH AT MATURITY	F: 59 cm; M: 59 cm
MAXIMUM LENGTH	84 cm
GENERATION LENGTH	Unknown

Mode
This species exhibits oviparity, as is the case with all scyliorhinids (Bass *et al*. 1975).

Duration of reproductive cycle
This is unknown, largely because this species appears to reproduce throughout the year (Dainty 2002).

Mating season and location
Gonad characteristics, egg size and embryo development suggest a year-round breeding season (Dainty 2002), presumably taking place where ever individuals occur (Escobar-Porras and Mann 2013b). Based on egg diameter alone there is a peak in reproductive activity in autumn (March-May) in the Eastern Cape (Roux 2002; cited by Escobar-Porras 2009).

Gestation
This is approximately 9 months, based on a single individual (Dainty 2002). Embryo development is strongly influenced by water temperature (Pretorius and Griffiths 2013).

Litter size
Two egg cases are always laid. Mean deposition depth in False Bay was 16 m (Pretorius and Griffiths 2013).

Length at birth
Human (2006b) referred to juveniles of 9–10 cm. A single individual of 11 cm was born in captivity (Dainty 2002).

Pupping season and nursery grounds
This appears to occur throughout the year and the species range, based on the observations of Dainty (2002) which are listed above. More egg cases were observed in the summer (Pretorius and Griffiths 2013).

Length at maturity
Total length at 50% maturity was 59 cm for both males and females (Dainty 2002).

Maximum length
This species attains 84 cm (van der Elst 1993), with males noticeably larger than the females (Dainty 2002). Larger specimens were consistently recorded from the Eastern Cape, compared to the Western Cape (Human 2006b).

Age and growth
Age at 50% maturity for both sexes combined was 17 years and the oldest individual of 70 cm was 19 years (Dainty 2002).

Generation length
This is listed as 22 years (Pollom *et al.* 2020g).

FISHERIES MANAGEMENT
SA catch sources
Estimated total catch was <1 ton (DFFE records: 2010–2012), mainly as bycatch in the demersal trawl industry. It is also caught in the recreational linefishery and is a suspected catch in the commercial linefishery, demersal shark longline and rock lobster fisheries (da Silva *et al.*2015). This species is utilised occasionally for lobster bait and in the aquarium trade (Compagno 2005).

SA catch quantities and characteristics
Inshore trawl fishery
Annual average catch estimates for the inshore trawl fleet, based on unsorted samples by observers, was 0.2 tons for the period 2003-2006 (Attwood 2011). With an assumed mean weight of 2 kg, this catch would equate to 100 individuals per annum, all of which were discarded, with no information on survival.

Linefishery
This species is occasionally caught by shore anglers on the south coast (Goukamma MPA; Pradervand and Hiseman 2006; Gotz *et al.* 2013); (Tsitsikamma MPA; Hanekom *et al.* 1997), but it is relatively common in the De Hoop MPA (DEFF unpublished records). It has not been recorded on the east coast in shore anglers catches (Pradervand and Govender 2003, Pradervand 2004, Pradervand *et al.* 2007). It is generally returned to water by anglers but it is sometimes regarded as a pest and killed (Human 2009e).

Fishing outside South Africa
This species does not occur outside South African waters.

Population trends
There are no estimates of population size for this species. Population trend data are available from catch rates by research shore anglers in the De Hoop Marine Protected Area over the period 1996–2017 (MPA), (Department of Environmental Affairs (DEA), unpubl. data, 2018). The trend analysis revealed an annual rate of increase of 3%, consistent with an estimated median increase of 267% over the past three generation lengths (66 years), with the highest probability (81%) of an increase over the past three generation lengths (66 years). The De Hoop MPA was established in 1985 and is a no-take reserve, and the population trend is indicative only and may not be representative of fished areas outside such an MPA. As this species is common within its range, its population size appears to be increasing and its retention in commercial line fisheries is prohibited it was assessed as Least Concern in 2019 (Pollom *et al.* 2020g).

ECOTOURISM
This species occurs on shallow rocky reefs where it is often encountered by scuba divers and therefore must be regarded as an ecotourism species.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

Retention of this species and its congener is prohibited in the demersal shark longline fishery and commercial and traditional linefisheries. There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)

This species is listed as Protected.

Marine Protected Areas

This highly resident species will derive considerable protection from all the inshore MPAs within its range on the south and west coasts. It is present in MPAs at Betty's Bay, De Hoop and Tsitsikamma National Park and Robben Island.

Additional local comment

As it was one of the common chondrichthyans observed on BRUVs in False Bay, it does benefit from a ban on trawling in the bay.

IUCN Red List Status

Least Concern 2019

Previous IUCN assessments

Data Deficient 2005

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

This species is not listed.

Convention on Migratory Species (CMS)

This species is not listed.

MANAGEMENT CONSIDERATIONS

Despite being a highly resident endemic, this species is still regarded as common throughout its range and is increasing in the De Hoop MPA. It derives considerable protection from the various inshore MPAs in its range. One management intervention would be an education campaign among linefishers who regard this species as a nuisance and therefore do not release their catches.

The IUCN assessment was based on multi-year catch data from the De Hoop MPA. While this showcases the benefits of MPAs in protecting the species, and with 16% of the species distribution range overlapping with MPAs with various levels of enforcement (including newly established ones), it is likely that the IUCN assessment is not representative across the entire species' range. Until more information is available, and erring on the side of caution, the species would benefit from an assessment of Vulnerable.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

This species is relatively easy to study and to keep alive in laboratory research aquaria. There are still some gaps in our knowledge of its reproductive biology. Population genetic studies are needed to investigate philopatry and stock connectivity and to determine if the variation is colour patterns is genetically driven. Population trends need to be confirmed using multiple methods outside of the De Hoop MPA, both in and outside the other MPAs.

FAMILY TRIAKIDAE

Galeorhinus galeus

SCIENTIFIC NAME	*Galeorhinus galeus* (Linnaeus 1758)
COMMON NAME	Soupfin shark, tope
FAMILY	*Triakidae*
ENDEMIC	No, occurs in Atlantic, Indian and Pacific Oceans
SIZE RANGE	40–165 cm TL
SA DISTRIBUTION	Part of E coast; entire S and W coasts: East London to Namibian border
HABITAT	Bentho-pelagic in shelf and upper slope waters
DEPTH RANGE	0–830 m, but mostly shallower than 200 m
MAJOR FISHERIES	Demersal shark longline, demersal trawl, commercial linefishery
IUCN STATUS	Critically Endangered 2020
CITES	Not Listed
MLRA	Slot limits in the demersal longline fishery; daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	ME McCord

SPECIES SUMMARY and RECOMMENDATIONS

Galeorhinus galeus is a medium-sized, demersal shark found in temperate coastal and upper slope waters on the South African coast. It is an active, strong swimmer. Local catch was estimated at 101-400 tons per annum (DFFE records: 2010–2012), from a number of fisheries, dominated by the demersal shark longline fishery, the inshore demersal trawl fishery and the commercial linefishery. It was assessed globally in 2020 as Critically Endangered, largely due to its long generation time and low fecundity. The white meat is prized and South African catches are largely exported as fillets to Australia. There is currently limited protective legislation in the form of slot limits which only allow the retention of individuals between 70 and 130 cm. Due to its migratory behaviour, MPA protection is likely to be minimal, although juveniles may benefit from some of the large MPAs on the south and west coasts. A dedicated management plan should be implemented for this common but poorly studied species. Identification and protection of nursery areas, which appear to be inshore, should be a priority.

TAXONOMIC and IDENTIFICATION ISSUES

G. galeus is the only species in the genus, despite the historical recognition of several species from different geographical regions; Compagno (1984) acknowledged that they possibly represent subspecies. Within the family Triakidae it is one of only two genera, both monospecific, in southern Africa that has a prominent lower caudal fin. The other is *Hypogaleus hyugaensis*, which is tropical in its distribution, and as a result the ranges of the two species do not overlap.

SOUTH AFRICAN DISTRIBUTION

G. galeus occurs along the entire south and west coasts and part of the east coast to East London (Ebert *et al.* 2021).

REGIONAL DISTRIBUTION

This species also occurs in Namibia and Angola, with only a few records from these locations (Ebert *et al.* 2021).

SYNOPSIS OF RESEARCH

In South Africa this is not a well-studied species, despite being heavily fished. Bass *et al.* (1975) provided detailed taxonomic, morphometric and biological information from about 35 individuals. Freer (1992) documented aspects of the fishery. McCord (2005) studied the ecology, including age and growth, and fisheries management of this species. da Silva and McCord (2013a) provided an overview of the life history and fisheries details of this species. Bitalo *et al.* (2015) and Maduna *et a*l. (2017) documented the genetic connectivity of the South African population, while Bester-van der Merwe *et al.* (2017) investigated population genetic structure within the southern hemisphere (South America, South Africa and Australia-New Zealand). This species has been extensively studied in other parts of the world, largely driven by its importance in commercial fisheries (Walker *et al.* 2020 and references cited therein).

ECOLOGY

Depth

This bentho-pelagic species occurs in temperate waters of continental and insular shelves and upper to mid slopes from the shallows inshore to well offshore down to depths of 830 m, although it most frequently occurs to depths of 200 m (Walker *et al.* 2020 and references cited therein).

Habitat: Adults

This species usually occurs in schools, partially segregated by size and sex (Walker *et al.* 2020 and references cited therein).

Habitat: Juveniles/Nursery Grounds

This species has pupping and nursery areas in shallow, protected bays and estuaries where the young can remain for up to two years (Walker *et al.* 2020 and references cited therein). No confirmed nursery areas have been found in South Africa but could include Gans Bay, Walker Bay, False Bay and Tsitsikamma (McCord 2005).

Synopsis of tag deployments

In South Africa no tagging has been conducted (McCord 2005).

Movements

The seasonal variation in the sex ratio of commercial catches is suggestive of a seasonal migration in the South African population (Freer 1992). This species appears to aggregate in South African waters during autumn (March – May) and spring (September – November) (McCord 2005). Some adults travel long distances offshore well away from the continental shelves and slopes, but they do not cross ocean basins. This species may move from shallow water at night to deep water by day (Walker *et al.* 2020 and references cited therein).

Diet/feeding: adults

The diet is primarily pelagic and benthic teleosts, including hake, snoek, mackerel, sardines, gurnard, herring and remoras. Invertebrates such as octopus, squid, crabs, and shrimp are also eaten (McCord 2005).

Diet/feeding: juveniles

This is unknown (da Silva and McCord 2013a).

REPRODUCTION

REPRODUCTIVE MODE	Viviparity with yolk-sac placenta
DURATION OF REPRO CYCLE	1–3 years, varies regionally
MATING	Spring and early summer (October-January)

GESTATION	12 months
LITTER SIZE	6–52, generally 20–35
PUPPING/NURSERY GROUND	Spring (October-November) inshore waters
LENGTH AT BIRTH	26–40 cm, varies regionally
LENGTH AT MATURITY	F: 118-185 cm; M: 107-170 cm, varies regionally
MAXIMUM LENGTH	200 cm, varies regionally
GENERATION LENGTH	26.3 years

Mode
This species exhibits viviparity with a yolk-sac attachment (Walker *et al.* 2020 and references cited therein).

Duration of reproductive cycle
The reproductive cycle appears to vary regionally from annual to triennial, although studies with more intensive sampling indicate a triennial cycle (Walker *et al.* 2020 and references cited therein).

Mating season and location
This is unknown.

Pupping season and nursery grounds
In South Africa pregnant females comprise a high proportion of catches in some areas during spring, suggesting that females have moved inshore to pup. Gans Bay, Walker Bay, False Bay and Tsitsikamma may be nursery areas (Freer 1992, McCord 2005).

Gestation
The gestation period is about 12 months (Walker *et al.* 2020 and references cited therein).

Litter size
The range in litter size is 6–52, with an average of 20–35 (Walker *et al.* 2020 and references cited therein).

Length at birth
The size at birth varies regionally from 26–40 cm (Walker *et al.* 2020 and references cited therein).

Length at maturity
There is regional variation in size-at-maturity; females mature at 118–185 cm and males at 107–170 cm (Walker *et al.* 2020 and references cited therein). In South Africa females of up to 133 cm were immature and another of 143 cm was mature; the smallest of six mature males was 123 cm (Bass *et al.* 1975). Length at 50% maturity for South African males was 101 cm (McCord 2005).

Maximum length
The maximum varies regionally from 155 cm in the Southwest Atlantic to 200 cm in the Mediterranean Sea (Walker *et al.* 2020 and references cited therein). In South Africa the largest individual sampled in commercial catches was a 173 cm female (Freer 1992).

Age and growth
Female age-at-maturity varies from 10–15 years (average 12.5 years) and maximum age is estimated as 40 years. Tag returns suggest a possible maximum age of 60 years (Walker *et al.* 2020 and references cited therein). In the South African age and growth study, McCord (2005) assumed annual periodicity of growth rings, based on validated studies in Australia and New Zealand and ascertained that age at 50% maturity was 6 years for both sexes combined.

Generation length
This is estimated at 26.3 years (Walker *et al.* 2020 and references cited therein).

FISHERIES MANAGEMENT
SA catch sources
G. galeus is one of the main target species of the demersal longline and handline fisheries in South Africa, constituting approximately 21% of the total catch. The fishery for this species has existed since the 1930s, originally using handlines, but more recently supplemented by short longlines and gillnets. In 1948, due to concerns about high catches and the high proportion of pregnant females in the catch, a minimum mesh-size restriction of 9 inches (23 cm) was implemented in the gillnet fishery. There is currently no legal gillnet fishery for the soupfin shark (McCord 2005).

The commercial longline fishery for this species extends from the Orange River to St. Francis Bay, but most of the catches are made between Gans Bay and St. Francis. The handline fishery occurs primarily between the Orange River and St. Francis Bay, although catches are occasionally taken as far north as the Kei River. The principal landing sites for both fisheries are Cape Town, Hout Bay and Gans Bay, although they are also occasionally landed between Mossel Bay and East London (McCord 2005). As the soupfin shark fishery is multi-species in nature, *G. galeus* is generally only targeted when catches of more valuable teleost species are low (Kroese and Sauer, 1998). Some commercial vessels may target *G. galeus* during autumn and spring when catches are highest. Small catches are recorded year-round (McCord 2005).

With the continuing decline of teleost stocks and the increasing domestic and international economic value of sharks, there is likely to be an associated increase in targeting of *G. galeus*. It is exported as frozen fillets to several countries, including Australia and Japan and parts of the European Union. Dried meat is sold and consumed in South Africa, while some of this biltong is also exported to West Africa. Shark fins are exported to the Far East and Australia. Soupfin sharks larger than 7 kg are generally not exported due to stringent mercury tests applied to larger animals in the international market, specifically Australia (McCord 2005).

Catch trend analysis showed that catches and CPUE of *G. galeus* are increasing in the demersal longline fishery, and decreasing in the handline fishery. Decreasing catches and CPUE were observed in fishery-independent research survey data. The status of the stock was modelled using per-recruit analysis. The SB/R (spawner biomass per recruit) model indicated the soupfin shark is being optimally exploited and spawner biomass is at 43% of pre-exploitation levels. Current fishing levels ($F = 0.14\ yr^{-1}$) approximate the F_{SB40} level ($F=0.17\ yr^{-1}$); thus, an increase in fishing pressure may lead to stock collapse. Another recommendation was that the current age-at-capture (7,9 years) should be increased to 10 years, or 142 cm, to maximise yield and minimise the possibility of recruitment failure (McCord 2005).

SA catch quantities and characteristics
Demersal shark longline fishery
Catches of *G. galeus* in the demersal shark longline fishery fluctuated from 5-48 tons dressed weight (1992-1994) (Kroese and Sauer (1998). In 2001 it declined from 17 tons to 2 tons dressed weight in 2005; this decline in catch was attributed to decrease in effort rather than stock depletion (da Silva and Bürgener 2007).

Inshore trawl fishery
The average annual catch based on observer records of *G. galeus* in the inshore trawl fishery for the period 2003-2006 was 38 tons (Attwood *et al.* 2011). Assuming a mean body weight of 7 kg, this would equate to a catch of over 5,000 individuals per annum. This fishery targets shallow-water Cape hake

Merluccius capensis and Agulhas sole *Austroglossus perctoralis*. By contrast, da Silva and Bürgener (2007) listed catches of *G. galeus* in this fishery in 2002 and 2004 at 243 and 180 tons respectively.

Commercial linefishery

There is no published information on *G. galeus* catches in this fishery, apart from the brief mention in the synopsis of da Silva *et al.* (2015).

Fishing outside South Africa

G. galeus is caught globally as target and bycatch in industrial and small-scale demersal and pelagic gillnet and longline fisheries, and to a lesser extent in trawl and hook-and-line fisheries. It is often retained for the meat, fins and liver oil, but is discarded or released in some areas, in line with regional management measures. Large catch regions are New Zealand, Australia, Argentina, Uruguay and California. At-vessel-mortality varies from 2–73% in gillnets and may be as low as 0% on longlines (Walker *et al.* 2020 and references cited therein).

Population trends

Genetic and tagging data support up to six separate subpopulations of *G. galeus* globally. While the species makes extensive movements within each of the subpopulations, there is no evidence of admixture between them (Bester-van der Merwe *et al.* 2017, Walker *et al.* 2020 and references cited therein). This species has a particularly low biological productivity with a late age-at-maturity and triennial reproductive cycle. In a regional genetic study, there was little evidence of population structure (Bitalo 2015). Another study highlighted the Atlantic/Indian Ocean boundary as a possible barrier to dispersal (Maduna *et al*. 2017), with indications of asymmetric regional southward movement from the SW Indian Ocean to the SE Atlantic Ocean.

Steep stock reductions have occurred all the subpopulations, with the only exceptions being in those regions where management interventions have been introduced, resulting in some population recovery (Walker *et al.* 2020 and references cited therein). The global population is estimated to have undergone a reduction of 88% with the highest probability of >80% reduction over the last three generations (79 years) due to levels of exploitation, and as a result this species was assessed as Critically Endangered in 2020.

ECOTOURISM

This species is seldom encountered by divers and therefore cannot be regarded as an ecotourism species.

Marine Living Resources Act (MLRA) Regulations

This is one of a small number of shark species that may be targeted in the demersal shark longline fishery. A slot limit of 70–130 cm was recently introduced for this species, as well as all members of the genus *Carcharhinus* (excluding *C. longimanus*) in this fishery and the commercial linefishery. This is aimed at protecting the juveniles (*G. galeus* is born at 40 cm) and the larger, more fecund adult females. There is a daily bag limit of one individual in the recreational line fishery.

The practice of “finning” was officially banned in South African waters in 1998 under the Marine Living Resources Act.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)

This species is not listed.

Marine Protected Areas

The inshore network of MPAs will not protect adults because of their high mobility and occurrence offshore. Anedotal evidence suggests that protected bays within existing MPAs such as Tsitsikamma, Stilbaai and De Hoop may provide some protection for neonates and pregnant females (da Silva and McCord 2013a).

Additional local comment
The demersal shark longline fishery, which is responsible for much of the national catch of this species, is managed under a TAE of only 6 vessels. This species will benefit from the long-standing ban on trawling in False Bay.

IUCN RED List Status
<u>Critically Endangered 2020: A2bd</u>

Previous IUCN assessments
Vulnerable 2006
Vulnerable 2000

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species was placed on Appendix II in 2020.

International comments
Countries that have significant soupfin fisheries have implemented various measures (Walker *et al.* 2020 and references cited therein). In Argentina, legislation dictates the release of all large individuals (>160 cm) and no recreational landings. In Australia, all live-caught individuals must be released; there is limited entry for the use of gillnets and longlines; total allowable catch is capped and there are gear restrictions and permanent and seasonal closures for nursery and breeding areas. In New Newland, there are bag limits. In Canada a management plan for this species mandates careful release of all catches.

In the Northeast Atlantic, longline landings by European Union vessels are prohibited over a large part of its northern European range. In the United Kingdom, fishing is prohibited other than using rod and line and bycatch in other commercial gears is limited to 45 kg per day (ICES 2019). In the Mediterranean Sea any retention is banned; careful release of this and 23 other listed elasmobranch species (Barcelona Convention Annex II) is mandatory.

MANAGEMENT CONSIDERATIONS
McCord (2005) proposed the introduction of an immediate South African fishery management plan for *G. galeus* with several recommendations. They included a second stock assessment; stabilising the current level of fishing mortality, (0.14-0.17 yr^{-1}), by capping effort at six vessels in the demersal longline fishery to ensure the sustainability; the implementation of licence and size restrictions and seasonal/area closures. The potential for an experimental gillnet fishery should be investigated. An increase in the percentage of fishing trips that collected accurate biological and fisheries data should be promoted. These proposals were motivated on the basis of the slow growth, late maturity and relatively low fecundity of this species. da Silva and McCord (2013a) recommended a maximum size restriction to limiting the removal of larger, more fecund sharks. This has been enacted in the form of the recently introduced slot limit of 70-130 cm.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

The life history and ecology of *G. galeus* has not been well studied in South Africa. Information is needed on the size and age at maturity, the incidence and fecundity of pregnant females, habitat use by adults and juveniles, the location of nursery grounds and the collection of tissue for genetic studies. Much of this can be implemented on board the demersal longliners. A research program to ascertain levels of hooking mortality should be conducted in the recreational fishery.

Mustelus mustelus

SCIENTIFIC NAME	*Mustelus mustelus* (Linnaeus, 1758)
COMMON NAME	Common smoothhound, Blackspotted smoothhound
FAMILY	*Triakidae*
ENDEMIC	No, Western Atlantic and Mediterranean Sea
SIZE RANGE	40–173 cm
SA DISTRIBUTION	E, S and W coasts: Durban to Namibian border
HABITAT	Demersal on sand bottoms and rocky reef areas in coastal waters
DEPTH RANGE	0-50 m, but as deep as 350 m
MAJOR FISHERIES	Demersal shark longline, demersal trawl, commercial linefishery
IUCN STATUS	Endangered 2020
CITES	Not listed
MLRA	Slot limit of 70–130 cm in demersal longline and commercial line fisheries; daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	C da Silva

SPECIES SUMMARY and RECOMMENDATIONS

Mustelus mustelus is a medium-sized, demersal shark found in shallow waters along almost the entire South African coast. Local catch was estimated at 101-300 tons per annum (DFFE records: 2010-2012; updated to 195 tons in 2018), from a number of fisheries, dominated by the demersal shark longline fishery, followed by the offshore and inshore demersal trawl fishery and the commercial linefishery. It was assessed globally as Endangered in 2020, with fishing being the greatest threat. The meat is prized and South African catches are largely exported as fillets to Australia. As a resident species it derives protection from all the inshore Marine Protected Areas on the west and south coasts and those on the east coast south of Durban. Slot limits of 70–130 cm have been introduced for management in the demersal shark longline and commercial linefisheries. These aim to protect the juveniles and the larger, more fecund females from fishing activity, while allowing fishers to retain the most valuable portion of the catch. Identification and protection of nursery areas, which appear to be very close inshore in large embayments, should be a priority. Recent genetic studies on the species indicate two genetically different populations meeting at Cape Agulhas, with a limited gene flow from east to west. The implications of this finding need to be investigated.

TAXONOMIC and IDENTIFICATION ISSUES

Taxonomy and identification of members of the genus *Mustelus* in South African waters, like many other regions, is very convoluted and confused. This is due to poorly chosen characteristics separating species, misidentification of local species, and new or previously unknown species. This problem was recognised by Bass *et al*. (1975) and still persists (Ebert *et al.* 2021). The latter authors recommend that local synonymy for each of the species occurring in South African should be treated with caution until a more thorough study has been undertaken. Three species of *Mustelus* occur in South Africa; *M. mustelus*, *M. palumbes* and *M. mosis*. They are morphologically very similar and catches are aggregated as *Mustelus* spp. in some fisheries. Some specimens of *M. mustelus* have black spots (especially those from Saldanha Bay), hence its alternative common name, blackspotted smoothhound. This feature is size-related, with little pigmentation present on sharks smaller than 100 cm. Black spots on the larger individuals conflate identification issues with the spotted gully shark *Triakis megalopterus*. On the South African coast, the distribution of *M. mustelus* overlaps extensively with that of *M. palumbes*, which has conspicuous white spots. Similar identification problems are experienced with this species and its congeners in the NE Atlantic and the Mediterranean (Ebert *et al.* 2021).

SOUTH AFRICAN DISTRIBUTION

M. mustelus occurs along the entire South African coast from Durban southwards (Ebert *et al.* 2021)**.** The existence of two phenotypically distinct populations in South Africa on either side of Cape Agulhas has been confirmed (Maduna *et al.* 2016). The Angolan population is genetically distinct from the South African population which is also distinct from the West African and Mediterranean populations (Hull *et al*. 2019).

REGIONAL DISTRIBUTION

This species also occurs in Namibia and southern Angola. A northern population occurs off West Africa and extends into the Mediterranean Sea (Serena *et al.* 2009).

SYNOPSIS OF RESEARCH

This species is well-studied in South Africa and elsewhere because of its commercial value in several global fisheries. In South Africa Goosen and Smale (1997), Smale and Compagno (1997) and da Silva (2018) examined its life history, including age and growth and diet. The fishery on the south coast and east coast has been investigated (da Silva 2007, da Silva *et al.* 2015). da Silva *et al.* (2013) examined movement patterns and residency in a protected embayment. da Silva and McCord (2013b) provided an overview of the life history and fisheries details of this species. Makwela *et al*. (2016) detected this species in deep reef surveys on the Agulhas Bank. Population genetics was investigated by Maduna *et al.* (2016) and Maduna (2017). Maduna *et al.* (2018) documented sperm storage in females after mating and detected multiple paternity, as did Rossouw *et al.* (2016). Klein *et al.* (2022) combined tag-recapture data with a population genetic study. Biological information is also available from Tunisia, Mauritania and other areas of the Mediterranean Sea (Serena *et al.* 2009 and references cited therein).

ECOLOGY

Depth

This demersal coastal species is usually found in water shallower than 50 m, although it occurs at depths of at least 350 m (Serena *et al.* 2009).

Habitat: Adults

Adults are generally found on sand and other soft substrates, but may occur in association with rocky reefs. There is evidence of sexual segregation, with females more often found in shallow water, possibly to fulfil reproductive needs. Adults have also been observed on deep slopes of temperate reef habitats of the central Agulhas Bank (Gotz *et al*. 2014: Makwela *et al*. 2016).

Habitat: Juveniles/Nursery Grounds

Nursery grounds are found in the shallow waters of large sheltered embayments, which include Algoa and Saldanha Bay. Langebaan Lagoon has been confirmed as a nursery ground, pupping and mating ground for the species (da Silva 2018).

Synopsis of tag deployments

A total of 7270 individuals were tagged (ORI Cooperative Fish Tagging Project 1984-2018 inclusive) with 215 (3%) recaptures. Mean distance travelled was 45 km; mean time at liberty 1.5 years (max:

582 km and 12.1 years) (Jordaan *et al.* 2020). Acoustic telemetry tags have been deployed in 24 individuals in the Langebaan Lagoon (da Silva *et al.* 2013).

Movements
This species is regarded as resident, based on the low mean distance travelled of 45 km by 215 tag recaptures. Extended residency has been demonstrated within the Langebaan Lagoon MPA (da Silva *et al.* 2013). Adults are regarded as philopatric but some individuals do show large-scale movements (maximum of 582 km) (da Silva and McCord 2013b, Jordaan *et al.* 2020, Klein *et al.* 2022).

Diet/feeding: adults
The diet is dominated by crustaceans and other invertebrates, with the larger sharks taking larger prey such as octopus and spiny lobster (Smale and Compagno 1997). Individuals from Langebaan Lagoon feed on a small number of crustacean species, predominantly sand and mudprawn (da Silva 2018).

Diet/feeding: juveniles
The diet is similar to the adults, with small crustaceans and other benthic invertebrates and a low incidence of teleost fishes (Smale and Compagno 1997). A study confined to Langebaan Lagoon suggested no ontogenetic change in diet (da Silva 2018).

South African toxicological studies
A study by Bosch *et al.* (2016) found high levels of methylmercury, with 11 of 30 sharks sampled exceeding the maximum allowable limit. These samples were only collected from Langebaan where there is no ontogenetic switch in diet (da Silva 2018) and no relationship between mercury levels and size was found. It is suspected that methylmercury accumulation increases with size in individuals occurring elsewhere in of South Africa as found in products during export. Average values for arsenic exceeded regulatory maximum limits, however all other metals were well below these limits.

REPRODUCTION

REPRODUCTIVE MODE	Placental viviparity
DURATION OF REPRO CYCLE	Possibly 2 years
MATING	Spring and early summer (October-January)
GESTATION	9-11 months
LITTER SIZE	2-23, mean 11.5
PUPPING/NURSERY GROUND	Spring (October-November) inshore waters
LENGTH AT BIRTH	40 cm
LENGTH AT MATURITY	F: 125 cm; M: 105 cm
MAXIMUM LENGTH	173 cm
GENERATION LENGTH	10.5 years

Mode
This species exhibits viviparity with a yolk-sac placenta. There is evidence of sperm storage, possibly for several months, by females in their oviducal glands (Maduna *et al.* 2017). Polyandry, with one female reproducing with multiple males, has been documented in this species from KZN (67% of litters examined) (Rossouw *et al.* 2016) and Langebaan Lagoon (Maduna *et al.* 2018).

Duration of reproductive cycle
Reproduction is highly seasonal, with the smallest embryos in January and the largest in October and November, indicative of a 9–11-month gestation (Smale and Compagno 1997). As many as 40% of mature females were not pregnant between July and September, which Smale and Compagno (1997) took as evidence for a resting period between pregnancies, thereby indicating that the reproductive

cycle could be 2 years in some females, but only 1 in others. The recent finding of sperm storage by Maduna *et al.* (2018) would lend support to a 2-year reproductive cycle.

Mating season and location
Mating is in spring and early summer (October-January) in inshore regions, based on the presence of fertilised eggs *in utero* (Smale and Compagno 1997). Langebaan Lagoon is a known mating location (da Silva 2018).

Gestation
The gestation period is 9–11 months (Smale and Compagno 1997, da Silva 2018).

Litter size
There are 2–23 pups per litter with a mean of 11. Larger females have larger litters (Smale and Compagno 1997). In Langebaan, larger females had significantly larger pups but not larger litters (da Silva 2018).

Length at birth
Length at birth is 39–42 cm (Smale and Compagno 1997).

Pupping season and nursery grounds
Pupping is in spring (October-November), with females moving inshore into sheltered embayments such as Algoa Bay and Saldanha Bay to pup. Pupping on the east coast is rare (da Silva and McCord (2013b) and reference cited therein).

Length at maturity
Females mature at 125 cm and males at 105 cm (Smale and Compagno 1997).

Maximum length
This is 165 cm for females and 145 cm for males (Smale and Compagno 1997). In Langebaan Lagoon maximum length was 173 cm for females and 151 cm for males (da Silva, 2018).

Age and growth
Age at 50% maturity for specimens collected between Algoa Bay and Mossel Bay is 10-12 years for females and 7–9 years for males, with a maximum observed age of 24 years (Goosen and Smale 1997). The most recent growth assessment in individuals from Langebaan Lagoon found false check marks in the vertebrae that overinflated previous age estimates studies. Maximum age is 13, which is similar (9–16+ years) to other members of the genus. The updated age at 50% maturity is 6 years for females and 3 years for males. Based on the existence of these false check marks, this difference in growth and maturity is not due sampling location (i.e., differences between the eastern and western populations) (da Silva 2018).

Generation length
In their IUCN Red List assessment, Jabado *et al.* (2021d), citing Goosen and Smale (1997) and da Silva (2007). used female age-at-maturity of 10.75 years and a maximum age of 25 years to obtain a generation length of 17.8 years.

FISHERIES MANAGEMENT
SA catch sources
This species is taken in a wide range of fisheries, due to its demersal habit and piscivorous diet. Estimated total catch was 101-300 tons per annum for the period 2010–2012, but this was refined to 195 tons in 2018 (DFFE records). It is caught as by-catch and target in the following fisheries: demersal shark longline fishery, commercial boat-based line fishery, demersal inshore trawl fishery, recreational linefishery, beach seine and gillnet fishery (da Silva *et al*. 2015). Catch data are available for the first

three of these fisheries that contribute an estimated 98% of the catch (da Silva *et al*. 2015). Catches in some of fisheries were historically often reported in generic categories, such as “houndshark” for the genus *Mustelus*. Conversion ratios from dressed to total weight and others such as fin to trunk weights are provided by de la Cruz (2016).

SA catch quantities and characteristics

Demersal shark longline fishery

The demersal shark longline fishery is the only target fishery for this species. The total upscaled (dressed to total weight) catch estimate was 136 tons in 2018, representing 70% of the total catch of the species in South Africa. Fishing for the species is concentrated between St. Francis and Port Elizabeth.

Commercial linefishery

The commercial linefishery is the oldest sector to have targeted sharks in South Africa. These catches have typically fluctuated in response to the availability of higher priced linefish species and market forces. *M. Mustelus* is targeted by linefishers when higher value teleosts are scarce and is largely exported as fillets to Australia, with the individuals between 70 and 130 cm fetching the highest prices (da Silva and Bürgener 2007). Although fins are exported to Asia, they are not of high value. In 2018 total catch estimates for this species was 51 t which represents 26% of its total catch.

Inshore demersal trawl fishery

The inshore trawl fishery targets shallow-water Cape hake *Merluccius capensis* and Agulhas sole *Austroglossus pectoralis* between Cape Agulhas and the Great Kei River, but has by-catch of smoothhound sharks (*Mustelus* spp), in addition to other species. The total estimated catch of *Mustelus* spp. in this fishery in 2018 was 7.4 t.

Beach seine and gillnet fisheries

The beach seine fishery which is distributed primarily on the west coast from Port Nolloth to False Bay, catches *Mustelus* spp., but is prohibited from retaining them in most regions. Beach seine fishers in False Bay are subject to the same catch limitations that are imposed on the commercial linefishery. The gillnet fishery, especially the nets set for St. Joseph, also operating on the west coast, catch smoothhounds but permit conditions dictate that they must be released alive. In the late 1990s, an illegal gillnet fishery for *M. mustelus* developed in Saldahna Bay-Langebaan Lagoon area, spreading north to St. Helena Bay. Fishers reported catches of up to 20 tons per month over the summer (Hutchings and Lamberth 2002). Recent reports suggests that this illegal gillnet fishery has expanded to the rest of South Africa due to confiscation of shark-specific gillnets across the coast. Although catch has not been estimated for this illegal fishery, it may be as high as 200–300 t per annum. Due to a scarcity of Compliance and Enforcement as a result of lockdown measures during the Covid pandemic, the illegal gillnet fishery has increased in recent months.

Fishing outside South Africa

This species is caught in trawl, gillnet, trammel net and line gear, but limited species-specific fisheries catch data are available. It is commonly marketed in the Mediterranean Sea and Western Africa, where it is valued for its white meat (Serena *et al.* 2009).

Population trends

Previous genetic studies on *M. mustelus* in South Africa indicated two genetically different populations on either side of Cape Agulhas (Maduna *et al*. 2016; 2017). A more recent study confirms shallow interoceanic structure and historical southward gene flow following the Agulhas Current (Klein *et al*. 2022). In a global study, the Angolan population was found to be genetically distinct from the South African population although there were no samples from Namibia, which lies in between South Africa and Angola (Hull *et al*. 2019).

A stock assessment for the species in 2019 (da Silva *et al*. 2019) showed that the current catch levels of 124 t are too high. Model projections predict that the stock will continue to decline, unless fishing mortality is reduced to below 75 t. This should be achieved by the recent implementation of slot limits, which should drop catches to 18 and 61t in the commercial linefishery and demersal shark longline fishery, respectively (79 t in total) which is close to the optimal catch of 75 t, inferred from by JABBA base-case model projections.

The trend analysis of stock assessment biomass from demersal trawl surveys conducted along the south coast of South Africa (1990–2016) revealed annual rates of reduction of 1.7%, consistent with an estimated median reduction of 59% over three generation lengths (53 years), with the highest probability of >50% reduction over the past three generation lengths (53 years) (Jabado *et al.* 2021d).

Globally, it is suspected that this species has undergone a population reduction of 50–79% over the past three generation lengths (53 years) based on abundance data and actual levels of exploitation, and it was assessed as Endangered in 2020 (Jabado *et al.* 2021d).

ECOTOURISM
This species commonly occurs in shallow coastal waters but it is rarely encountered by scuba divers and therefore cannot be regarded as an ecotourism species.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
This is one of a small number of shark species that may be targeted in the demersal shark longline fishery. A slot limit of 70–130 cm was recently introduced for this species, as well as all members of the genus *Carcharhinus* (excluding *C. longimanus*) and *Galeorhinus galeus* in this fishery and the commercial linefishery. This is aimed at protecting the juveniles (*M. mustelus* is born at 40 cm) and the larger, more fecund adult females. There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
This species, being residential, will derive considerable benefit from all the inshore Marine Protected Areas on the west and south coasts and those on the east coast south of Durban. Research has shown that the Langebaan MPA, being a large embayment is an important habitat, including that of a nursery ground (da Silva *et al.* 2013).

Additional local comment
As a commercially valuable demersal shark this species is covered in detail in the National Plan of Action (NPOA) for Sharks. Specific progress with respect to this species has been made in terms of limiting the catch by means of slot limits, as it was highlighted as a priority species within the plan in 2013.

IUCN Red List Status
Endangered A2bd

Previous IUCN assessments
Vulnerable 2004
Least Concern 2000

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

International comments
There are no specific management measures in place for *M. mustelus* throughout the majority of its range (Serena *et al.* 2009).

MANAGEMENT CONSIDERATIONS
Relatively fast growth and early age at maturity indicate that this species has a low susceptibility to overfishing. However, according to the most recent stock assessment, current fishing levels are far too high and have to be decreased across the major fisheries. This problem is exacerbated by the decline in the more valuable teleost stocks, forcing commercial linefishers to target this and other shark species. Market values related to fillet quality (in terms of safety for human consumption) were used to design slot limits to decrease catches in the demersal shark longline and commercial linefishery, which account for more 75% of landings. The slot limit of 70–130 cm was chosen to protect the newborns, and, more importantly, the adult females. The high levels of residency in the Langebaan MPA indicate that area closures and inshore MPAs will also benefit this species, especially the females, which move inshore in certain areas in spring (October–November) to drop their young.

Cognisance needs to be taken of the presence of significant interoceanic genetic structure between the South-East Atlantic and South-West Indian Oceans. There is, however, gene flow, predominantly from east to west. This needs to be considered in future stock assessments and the two stocks should be managed separately. In addition, gillnet catches from the illegal fishery needs to be quantified for incorporation in the next stock assessment. In addition, given the large compliance issues that exist within South African fisheries, the only feasible way to monitor the gillnet fishery is to licence the manufacturers of the gillnets themselves. An improvement in the ability of the fishing industry to identify all *Mustelus* spp to species is needed.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
The biology and life history of this species has been well studied in South Africa. However, as one of the ten most commercially valuable species, it is important to continue research for input into future stock assessments. Of priority is the validation of age estimates (critical for accurate stock assessments), identification of other important pupping and nursery areas and how these currently overlap with existing MPAs. The movement and occurrence of common smoothhound sharks offshore on Agulhas Bank shelf edge needs to be investigated in detail.

Scylliogaleus quecketti

SCIENTIFIC NAME	*Scylliogaleus quecketti* (Boulenger 1902)
COMMON NAME	Flapnose houndshark
FAMILY	Triakidae
ENDEMIC	Yes
SIZE RANGE	35–137 cm TL
SA DISTRIBUTION	E coast: Richards Bay to East London
HABITAT	Demersal on shallow coastal reefs
DEPTH RANGE	0–50 m
MAJOR FISHERIES	Recreational shore angling; boat angling
IUCN STATUS	Vulnerable 2018
CITES	Not listed
MLRA	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	BQ Mann

SPECIES SUMMARY and RECOMMENDATIONS
Scylliogaleus quecketti is a small, little known, demersal endemic shark which is confined to portion of the east coast of South Africa. It occurs from the surf-zone down to about 50 m depth. It is mainly caught by shore anglers and ski-boat anglers (bottom fishing) in southern KZN and along the Wild Coast. This species was not listed in estimated catches/landings recorded by DFFE for the period 2010–2012. It currently has no legislated protection other that a recreational daily bag limit of one per person per day. It was assessed as Vulnerable in 2018, based on low fecundity, limited distribution, heavy fishing pressure and possible habitat degradation. A minimum measure would be to decommercialise this species, as previously it has been sold in the small shark export market to Australia. Tagging studies have shown this species to be highly resident, hence it will receive protection from four east coast MPAs, namely the Pondoland MPA where it is relatively common, and to a lesser extent, Protea Banks, Aliwal Shoal and uThukela MPAs, which are all inside the distribution and depth range of this species. This species is difficult to study as it does not appear to be common in any localities. Specimens caught by shore anglers that cannot be released should be retained for biological studies.

TAXONOMIC and IDENTIFICATION ISSUES
There are none as it is a monotypic genus. This species could be confused by anglers with the more common blackspotted/common smoothhound *Mustelus mustelus* and its two congeners. All have a similar body shape, size and colour, but the three *Mustelus* spp. lack the prominent nasal flaps on the underside of the snout of *S. quecketti*.

SOUTH AFRICAN DISTRIBUTION
This small demersal species is confined to shallow rocky reefs on the east coast of South Africa, from central KZN (Richards Bay) to East London. The epicentre of its distribution appears to be southern KZN and the Wild Coast (northern section of the Eastern Cape) (Ebert *et al.* 2021).

REGIONAL DISTRIBUTION
This species does not occur outside South Africa.

SYNOPSIS OF RESEARCH
Bass *et al.* (1975c) provided detailed taxonomic, morphometric and biological information from 16 individuals, including adults and pregnant females. No subsequent dedicated scientific study has been conducted in South Africa. In a scientific assessment of the Pondoland MPA, 93 individuals were

caught over a 6-year period (2006-2011), with almost equal numbers in the protected and exploited zones of the MPA. All angling was boat-based in water depths of 10–30 m. It was the most common elasmobranch caught during the project (Maggs *et al.* 2013).

ECOLOGY

Depth

It occurs inshore from the shoreline to about 50 m depth (Compagno *et al.* 1989; Fennessy 1994), possibly to 70 m (Pollom *et al.* 2019c); smaller individuals are caught by shore anglers, while larger individuals are caught further offshore by ski-boat anglers.

Habitat: Adults

Rocky reefs and adjacent sand patches.

Habitat: Juveniles/Nursery Grounds

Similar to adults but mainly inshore within the surf-zone.

Synopsis of tag deployments

A total of 332 individuals have been tagged by the ORI Cooperative Fish Tagging Project (1984-2018), with 13% recaptured. Mean distance travelled was 1 km in 1.8 years at liberty (max: 43 km and 8.2 years) (Jordaan *et al*. 2020). The individual at liberty for 8.2 years was recaptured in the same location, within the Pondoland MPA. Another individual was also recaptured in the same location it was tagged in southern KZN, about 40 km north of the KZN/Eastern Cape border. It had grown 40 cm (680-1080 cm) in 6.5 years at liberty (ORI-CFTP unpublished data).

Movements

This species appears to be highly resident, as the tag-recapture data, some of it long-term (6-8 years), shows a mean distance moved of only 1 km. High levels of residency would also account for the high recapture rate of 13% reported above.

Diet/feeding: adults

Mainly crustaceans, especially East Coast rock lobster *Panulirus homarus* (Bass *et al.* 1975c).

Diet/feeding: juveniles

No details available

South African toxicological studies

No studies have been conducted to date.

REPRODUCTION

REPRODUCTIVE MODE	Viviparity with yolk-sac placenta
DURATION OF REPRO CYCLE	Possibly 2 years
MATING	Possibly early summer
GESTATION	Appears to be 9–10 months
LITTER SIZE	2–4; mean 2.6 from 8 litters
PUPPING/NURSERY GROUND	Possibly spring; location unknown
LENGTH AT BIRTH	35 cm
LENGTH AT MATURITY	F: 80 cm; M: 70 cm
MAXIMUM LENGTH (F:M)	F: 137 cm; M: 113 cm
GENERATION LENGTH	Unknown

Mode

This species exhibits viviparity with a yolk-sac placenta (Bass *et al.* 1975c).

Duration of reproductive cycle
This is possibly 2 years (Bass *et al.* 1975c).

Mating season
This possibly occurs in early summer (Bass *et al.* 1975c).

Gestation
Gestation appears to be 9–10 months (Bass *et al.* 1975c).

Litter size
Litter size is 2.6 (range 2–4) from 8 litters (Bass *et al.* 1975c).

Length at birth
Embryos of up to 34 cm were reported to be full-term, hence size at birth is believed to be 35 cm (Bass *et al.* 1975c).

Pupping season and region
This is possibly in spring (Bass *et al.* 1975c) and appears to be inshore within the surfzone (B Mann, Oceanographic Research Institute, unpublished data).

Length at maturity
Based on a very small sample, females are mature at 80 cm and males at 70 cm (Bass *et al.* 1975c).

Maximum length
Based on observations made in the Pondoland MPA, the largest female measured was 137 cm and male 113 cm (B. Mann, ORI, unpublished data).

Generation length
This is unknown.

Age and growth
Maximum age is at least 8.2 years, based on the time at liberty of a single tagged but unsexed individual; no formal aging study has been undertaken.

FISHERIES MANAGEMENT

SA catch sources
This species was not listed in estimated catches/landings recorded by DFFE for the period 2010-2012 (da Silva *et al.* 2015). The primary catch source in South Africa is recreational shore angling on the south coasts of KZN and adjacent Wild Coast (Pradervand 2004; Pradervand and Govender 2003; Pradervand *et al.* 2007). It is likely that most specimens are released alive. It is also periodically caught by recreational and commercial ski-boats bottom fishing on shallow reefs (< 50 m). It is too small to be caught in KZN bather protection nets (only 2 individuals: 1981-2018) and only one specimen was recorded in the bycatch of the KZN prawn trawl fishery (Fennessy 1994). Other than for competition purposes among recreational shore anglers, this species is not a target of any fishery. In the early 2000's it was sold by commercial boat fishermen to a fishmonger on the KZN south coast along with other small sharks, particularly dusky shark *Carcharhinus obscurus,* for export to the Australian fish and chip market. Once the fishmonger was informed that it was an endemic species with a very limited range, he agreed to stop its purchase (Kevin Cox, KZN Sharks Board, pers. comm.).

SA catch quantities and characteristics

Recreational shore angling

In KZN, competitive shore anglers caught 1074 individuals over a 24-year period at a rate of 45 per annum and 1 per 1000 angling hours. This species comprised 0.5% of the total number of fish caught, with a mean individual mass of 2.0 kg (Pradervand *et al*. 2007). Over a similar period on the Wild Coast (northern half of the Eastern Cape), 777 individuals were caught at a rate of 32 per annum and 13 per 1000 angling hours. This species comprised 4.3% of the total number of fish caught, with a mean size 1.9 kg (Pradervand 2004). With the current rules for competitive shore angling, all fish caught during competitions must be returned unharmed to the water (Pradervand *et al*. 2007). It was not recorded in similar records from the Border region (Kei River to Fish River; 146 km of coast immediately south of the Wild Coast) over a 17-year period (Pradervand and Govender 2003).

It is regularly caught in small numbers on the KZN lower south coast (Port Shepstone-Port Edward) by shore anglers for much of the year, but with a peak in winter (Louis Allison, KZN Coast Anglers Union, pers. comm.).

Population trends

No population estimate is available. This species was assessed as Vulnerable in 2018, based on low fecundity, limited distribution, heavy fishing pressure and possible habitat degradation (Pollom *et al.* 2019c).

ECOTOURISM

This species only occurs in shallow coastal waters but it is rarely encountered by scuba divers and therefore cannot be regarded as an ecotourism species.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)

This species is listed as Vulnerable.

Marine Protected Areas

As a highly resident species, it will benefit from protection in the Pondoland, Protea Banks, Aliwal Shoal and uThukela MPAs. It was the most common elasmobranch caught in the Pondoland MPA during research angling trips conducted over a period of 10 years (Maggs and Mann 2016).

Additional local comment

This species will benefit from the current ban on any demersal shark longlining east of the Kei River mouth (this excludes the entire KZN and Wild Coast), which usually occurs at depths of 10–100 m.

IUCN Red List Status

<u>Vulnerable 2018: B1ab(iii,v)</u>

Previous IUCN assessments

Vulnerable 2009
Vulnerable 2000

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

This species is not listed.

Convention on Migratory Species (CMS)

This species is not listed.

International comments
This species only occurs in South African waters.

MANAGEMENT CONSIDERATIONS

It does not appear to be an important component of any small-scale commercial fishery. While important to competitive shore anglers, in most cases it is either returned to the water or discarded as a nuisance by non-competitive anglers. Its low fecundity and limited distribution means that it is unlikely to be able to sustain any commercial fishing pressure, such as the export fishery for small sharks to support the Australian "fish and chip" or "flake" market. Because of its endemism, restricted distribution, high levels of residency and low fecundity, this species should be given additional protection, such as decommercialisation and anglers should be encouraged to release catches unharmed.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

This is a very poorly researched species. Knowledge of its basic biology and life history is largely limited to research conducted five decades ago. The whereabouts of nursery areas is still largely unknown. Ecological studies are difficult, other than through opportunistic tagging. Such tagging is unlikely to substantially change the current perception of a highly resident species, but it could provide an insight into its longevity, which is at least 8 years, based on a single tag recapture, and will provide valuable data on growth rate. It may be opportunistically detected using BRUVs, but it does not appear to be present anywhere in large numbers. Furthermore, definitive identification (distinguishing this species from other similar triakid houndsharks) on BRUVs is often compromised by low light/poor visibility (Bruce Mann, pers. obs.). Any specimens caught that cannot be released should ideally be retained for biological examination, and samples collected for studies of trophic ecology, population genetics and pollutant accumulation.

FAMILY HEMIGALEIDAE

Hemipristis elongata

SCIENTIFIC NAME	*Hemipristis elongata* (Klunzinger 1871)
COMMON NAME	Snaggletooth shark
FAMILY	Hemigaleidae
ENDEMIC	No, Indo-west Pacific Ocean
SIZE RANGE	45–240 cm TL
SA DISTRIBUTION	E coast: entire KZN
HABITAT	Demersal on sand bottoms and rocky reef areas in coastal waters
DEPTH RANGE	0–130 m
MAJOR FISHERIES	None in South Africa
IUCN STATUS	Vulnerable 2015
CITES	Not listed
MLRA	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	RH Bennett

SPECIES SUMMARY and RECOMMENDATIONS

Hemipristis elongata is a medium-sized shark found in coastal waters of KZN on the east coast of South Africa, where it appears to be uncommon. It was not recorded in catches (DFFE records: 2010–2012). It was assessed globally as Vulnerable in 2015 because it is heavily fished throughout its East African and Indo-West Pacific range. In South Africa it will potentially derive some benefit from the MPAs in KZN, but this is highly unlikely to improve the current status of the species, as KZN represents the southern extremity of its distribution. As a result, is must be regarded as a low priority species. Little is known locally of its behaviour or reproductive biology, with no evidence of mating or pupping taking place in KZN. Local research opportunities are extremely limited.

TAXONOMIC and IDENTIFICATION ISSUES

Hemipristis elongata is the only species in the genus. The Weasel shark family, Hemigaleidae, is a small one, comprising eight species from four genera. All are small to medium-sized sharks with oval eyes, precaudal pits and large second dorsal fins. In South Africa there is another weasel shark *Paragaleus leucolomatus*, the whitetip weasel shark, which is similar in shape to *H. elongata* and their ranges overlap in northern KZN. *H. elongata* is much larger and lacks prominent white tips to its fins (Ebert *et al.* 2013).

SOUTH AFRICAN DISTRIBUTION

This species is confined to KZN waters in the northern half of the east coast (Ebert *et al.* 2021), with Margate on the KZN south coast being the most southerly record (Bass *et al*. 1975c).

REGIONAL DISTRIBUTION

It also occurs in Mozambique and possibly the entire east coast of Africa (White and Simpfendorfer 2016).

SYNOPSIS OF RESEARCH

This is a poorly studied species. Bass *et al.* (1975c) only had access to a single specimen caught in South Africa. No dedicated research has been undertaken on this species in South Africa. There is limited biological information from the Red Sea, India and Australia (White and Simpfendorfer 2016).

ECOLOGY

Depth

This coastal species occurs from the shallows down to depths of 130 m in Australia (Stevens and McCloughlin 1991).

Habitat: Adults

They inhabit sand bottoms and rocky reef areas in coastal waters.

Habitat: Juveniles/Nursery Grounds

Their habitat is not known and may be similar to that of the adults. The presence of neonates and larger juveniles has not been documented in KZN.

Synopsis of tag deployments

No individuals were reported as tagged (ORI Cooperative Fish Tagging Project 1984-2018 inclusive) (Jordaan *et al.* 2020).

Movements

In the absence of any tagging data, movement patterns remain unknown. Globally, the species is considered possibly migratory (Fowler 2014).

Diet/feeding: adults

In Australia the diet is dominated by cephalopods, mainly squid and cuttlefish, and a variety of demersal fish, with a low incidence of sharks and rays (Stevens and McLoughlin 1991).

Diet/feeding: juveniles

The diet is assumed to be similar to that of the adults, but without the larger prey such as sharks and rays.

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Placental viviparity
DURATION OF REPRO CYCLE	2 years
MATING	June (Australia)
GESTATION	7–8 months (Australia)
LITTER SIZE	2–11, mean 6 (Australia)
PUPPING/NURSERY GROUND	April (Australia)
LENGTH AT BIRTH	45–50 cm (Australia)
LENGTH AT MATURITY	F: 120 cm; M: 110 cm (Australia)
MAXIMUM LENGTH	F: 240 cm; M: 180 cm (Australia)
GENERATION LENGTH	9 years (Australia)

Mode

This species exhibits placental viviparity (Stevens and McLoughlin 1991).

Duration of reproductive cycle

The reproductive cycle is two years, with a 7–8-month gestation in Australia (Stevens and McLoughlin 1991).

Mating season

In Australia this is in June (Stevens and McLoughlin 1991).

Gestation
In Australia the gestation period is 7-8 months (Stevens and McLoughlin 1991).

Litter size
In Australia mean litter size is 6 (range 2–11) from 6 litters (Stevens and McLoughlin 1991).

Length at birth
In Australia length at birth is 45–50 cm (Stevens and McLoughlin 1991).

Pupping season and nursery grounds
In Australia this is in April (Stevens and McLoughlin 1991).

Length at maturity
In Australia males mature at 110 cm and females at 120 cm (Stevens and McLoughlin 1991).

Maximum length
This is at least 180 cm in males and 240 cm in females (Stevens and McLoughlin 1991).

Age and growth
There have not been any local or regional studies. In Australia this species grows rapidly and matures at 2–3 years, with a maximum observed age of 15 years (Smart *et al*. 2013).

Generation length
In Australia this is 9 years (Smart *et al*. 2013).

FISHERIES MANAGEMENT

SA catch sources, quantities and characteristics
This species was not listed in the estimated catches (DFFE records: 2010–2012; da Silva *et al*. 2015). It was not reported in the bycatch of the KZN prawn trawl industry (Fennessy 1994) or the catch records of recreational shore anglers taking part in competitions on the KZN coast (Pradervand *et al.* 2007). It is rarely caught in the KZN beach protection nets (<1 per annum; KZN Sharks Board unpublished data).

Fishing outside South Africa
This species is commonly landed in intensive and largely unmanaged coastal trawl and gillnet fisheries throughout its shallow (down to 130 m) tropical Indo-West Pacific range, with the possible exception of Australia. It is caught in several east African artisanal fisheries (Shehe and Jiddawi 1997; Robinson and Sauer 2013; Rhett Bennett, World Conservation Society, unpublished data). It is a popular catch in certain regions as the flesh is considered of very high quality, as are the fins and liver. Life history data demonstrate that it grows rapidly and matures early, suggesting a relatively high ability to sustain fishing (White and Simpfendorfer 2016).

Population trends
No data are available to estimate population size in southern Africa. The Indo-Pacific region has some of the most poorly managed and intensely fished waters. A population reduction of greater than 30% over the past three generations (27 years) was inferred for this species and a decline at a similar rate is expected over the next three generations; hence the species was assessed as Vulnerable in 2015 (White and Simpfendorfer 2016).

ECOTOURISM

This species does occur in shallow coastal waters but it is rarely encountered by scuba divers and therefore cannot be regarded as an ecotourism species.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act

Threatened or Protected Species (TOPS)

This species is not listed.

Marine Protected Areas

It is unclear if it is a nomadic or residential species, nevertheless it may derive some benefit from all the inshore Marine Protected Areas in KZN, but there is no evidence of a mating or nursery ground in KZN.

Additional local comment

IUCN Red List Status

Vulnerable 2015: A2bd+3bd

Previous IUCN assessments

Vulnerable 2003

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

This species is not listed.

Convention on Migratory Species (CMS)

This species is not listed.

International comments

The Indo-Pacific is one of the most poorly managed and heavily fished regions. Fishing effort is likely to continue and probably increase in these waters, resulting in ongoing declines in stocks. In Australian waters, this species is suspected to be Least Concern as a result of well-managed fisheries and low catches (White and Simpfendorfer 2016).

MANAGEMENT CONSIDERATIONS

This species only occurs in the northern half of the east coast of South Africa, where it is not common. It is rarely caught in the KZN bather protection programme. No management intervention at the extreme southern end of its range will improve the status of this species from its current evaluation as Vulnerable. It would only benefit from enhanced protection in countries to the north of South Africa, such as Mozambique and Tanzania. In South Africa it must be regarded as a low priority species.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

The biology and life history of this species has not been studied in South Africa and this situation is unlikely to change as this species is uncommon. Data is available from a very small number of individuals caught in the KZN bather protection programme. Any opportunistic sampling should be used to gather biological and life history information and to collect tissues samples for genetic studies.

Paragaleus leucolomatus

SCIENTIFIC NAME	*Paragaleus leucolomatus* (Compagno and Smale 1985)
COMMON NAME	Whitetip/whitefin weasel shark
FAMILY	Hemigaleidae
ENDEMIC	No, Mozambique and W Indian Ocean
SIZE RANGE	45–240 cm TL
SA DISTRIBUTION	E coast: Mozambique border to Sodwana Bay
HABITAT	Demersal on sand bottoms and rocky reef areas in coastal waters
DEPTH RANGE	0–20 m
MAJOR FISHERIES	None in South Africa
IUCN STATUS	Vulnerable 2019
CITES	Not listed
MLRA	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	RH Bennett

SPECIES SUMMARY and RECOMMENDATIONS

Paragaleus leucolomatus is a very small shark found in northern KZN, where it appears to be rare. It was not recorded in catches (DFFE records: 2010–2012). Based largely on its scarcity and an extremely small distributional range in the W Indian Ocean, it was assessed globally as Vulnerable on the IUCN Red List in 2019. It will derive benefit from the iSimangaliso MPA which encompasses its entire known distribution in South Africa. There are no obvious management interventions which will benefit this species and improve its status from Vulnerable. Nothing is known of life history and ecology. Any opportunistic sampling should be used to collect biological information and tissue samples for genetic studies.

TAXONOMIC and IDENTIFICATION ISSUES

Paragaleus leucolomatus is the only species of this genus found in South Africa. It is a member of the Weasel shark family, Hemigaleidae, which comprises eight species from four genera. All are small to medium-sized sharks with oval eyes, precaudal pits and large second dorsal fins. In South Africa there is another weasel shark *Hemipristis elongata*, the snaggletooth shark, which is similar in appearance to *P. leucolomatus,* but is much larger (240 cm). Major differences lie in the dentition and the colouration of the fins which are white-tipped, with the exception of the second dorsal fin which is black-tipped, in *P. leucolomatus*, while the fins of *H. elongata* lack prominent markings. Their ranges overlap in northern KZN (Compagno and Smale 1985).

SOUTH AFRICAN DISTRIBUTION

This species is confined to waters in the extreme north of KZN from the Mozambique border south to Sodwana Bay (Robert Kyle, Oceanographic Research Institute, pers. comm. cited by Ebert *et al.* 2021), although Kyle (pers. comm.) has not seen one south of Banga Nek.

REGIONAL DISTRIBUTION

It also occurs in Mozambique and Madagascar based on a very small number of individuals and in Yemen, based on a single record; its occurrence between Mozambique and Yemen is uncertain (Pollom *et al*. 2020h).

SYNOPSIS OF RESEARCH

This is an extremely poorly studied species, which was only recently described (Compagno and Smale 1985) and is only known locally from a few specimens. No dedicated research appears to have been undertaken on this species anywhere in its range.

ECOLOGY

Depth

This coastal species occurs in the extreme shallows to depths of 20 m (Compagno *et al.* 1989).

Habitat: Adults

They inhabit sand bottoms and rocky reef areas in coastal waters. Their body and fin shape indicate that they are active swimmers.

Habitat: Juveniles/Nursery Grounds

Their habitat is not known and may be similar to that of the adults.

Synopsis of tag deployments

A single individual was tagged by an angler on the KZN north coast (Gareth Jordaan, Tagging Officer, Oceanographic Research Institute, unpublished data).

Movements

In the absence of any tagging data, movement patterns remain unknown. Body and fin shape are indicative of an active swimmer.

Diet/feeding: adults

Nothing is known of the diet of this species. Its triangular, serrated teeth in the upper jaw suggest that softer prey, such as teleosts and cephalopods, are an important component of the diet.

Diet/feeding: juveniles

The diet is possibly similar to that of the adults, but with smaller prey.

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Placental viviparity
DURATION OF REPRO CYCLE	Unknown
MATING	Unknown
GESTATION	Unknown
LITTER SIZE	2 (n=1)
PUPPING/NURSERY GROUND	Unknown
LENGTH AT BIRTH	Unknown: >22 cm
LENGTH AT MATURITY	F: at least 96 cm (n=1)
MAXIMUM LENGTH	Unknown
GENERATION LENGTH	<9 years, based on Australian *Hemipristis elongata*

Mode

All members of the family Hemigaleidae exhibit placental viviparity.

Duration of reproductive cycle

The duration of the reproductive cycle is unknown.

Mating season

This is not known.

Gestation

This is not known.

Litter size
This is two, based on a single litter (Compagno and Smale 1985).

Length at birth
The two sub-term embryos of the pregnant female examined by Compagno and Smale (1985) were 22 cm.

Pupping season and nursery grounds
This is unknown.

Length at maturity
A single pregnant female was 96 cm Compagno and Smale (1985).

Maximum length
This is at 96 cm based on a single female; no information is available for males.

Age and growth
There have not been any local or regional studies, so age-at-maturity and maximum age are unknown.

Generation length
As age-at-maturity and maximum age are unknown, generation length is based on that of *H. elongata*, which has an age-at-maturity of 2.5 years and maximum age of 14.7 years and a resultant generation length of 8.6 years, based on Australian findings. This species reaches a considerably larger size than *P. leucolomatus* (240 cm vs 96 cm) and therefore the generation length of the latter is likely to be much shorter (Pollom *et al*. 2020h).

FISHERIES MANAGEMENT
SA catch sources, quantities and characteristics
This species was not listed in the estimated catches (DFFE records: 2010–2012; da Silva *et al*. 2015). As it is a coastal species restricted to a depth of 20 m and less, it is unlikely to have been caught in the now closed KZN prawn trawl industry (Fennessy 1994). It has not been reported in the catch records of recreational shore anglers taking part in competitions on the KZN coast (Pradervand *et al.* 2007). Beach anglers around Kosi Bay in the far north of KZN are familiar with this species and release them if caught (Robert Kyle, Oceanographic Research Institute, pers. comm., cited by Ebert *et al.* 2021).

Fishing outside South Africa
There is no species-specific information on catches in Mozambique, Madagascar or Yemen, the only other countries in which it is known to occur. It is possibly targeted and taken as bycatch in artisanal and small commercial inshore fisheries within its range, and retained for human consumption, especially in small artisanal fisheries. While the full extent of this species' distribution is currently unknown, extensive artisanal fisheries operate in coastal waters of the SW Indian Ocean (Pollom *et al.* 2020h and references cited therein). This species was not reported in a first description of the artisanal fishery of N or SW Madagascar (Robinson and Sauer 2013, Humber *et al*. 2017).

Population trends
Nothing is known of population size or structure. It is likely that a single population occurs in South Africa and Mozambique. Despite considerable fisheries research surveys in the region and the distinctive white fin markings of the species, it has rarely been recorded. Its limited South African range is within the iSimangaliso MPA, and although extremely rare, the South African portion of the range does offer some refuge. In contrast, the extensive inshore artisanal fisheries in Mozambique and Madagascar are suspected to have driven a population reduction, given the species' restricted

depth range and low biological productivity. Balancing these contrasting situations, it is suspected that *P. leucolomatus* has undergone a population reduction of 30–49% over the past three generation lengths (26 years) due to actual levels of exploitation, and it was assessed globally as Vulnerable on the IUCN Red List in 2019 (Pollom *et al*. 2020h).

ECOTOURISM
This little-known species inhabits shallow coastal waters but it is rarely encountered by scuba divers and therefore cannot be regarded as an ecotourism species.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
This species will benefit from the iSimangaliso MPA, which encompasses the entire known range of its South African distribution.

Additional local comment

IUCN Red List Status
<u>Vulnerable 2019: A2d</u>

Previous IUCN assessments
Data Deficient 2009

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

International comments

MANAGEMENT CONSIDERATIONS
This species only occurs in the far north of the east coast of South Africa which encompasses the iSimangaliso MPA. It appears to be rare wherever it occurs which, together with its apparently low productivity, makes it vulnerable to overexploitation. It is very difficult to propose meaningful management interventions in South Africa which will benefit this species. In South Africa it must be regarded as a low priority species.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
The biology and life history of this species have not been studied in South Africa and this situation is unlikely to change as this species is regarded as rare. Any opportunistic sampling should be used to gather biological and life history information and to collect tissue samples for genetic studies. Sightings should also be recorded to provide more information on its distribution in the SW Indian Ocean and to ascertain whether its presence in the iSimangaliso MPA shows any seasonal pattern.

FAMILY CARCHARHINIDAE

Carcharhinus albimarginatus

SCIENTIFIC NAME	*Carcharhinus albimarginatus* (Rüppell 1837)
COMMON NAME	Silvertip shark
FAMILY	Carcharhinidae
ENDEMIC	No, Indo-Pacific
SIZE RANGE	70–300 cm TL
SA DISTRIBUTION	E coast: Mozambique border to St. Lucia
HABITAT	Pelagic, shelf and coastal, not oceanic
DEPTH RANGE	0–800 m
MAJOR FISHERIES	Not listed in South African fisheries
IUCN STATUS	Vulnerable 2015
CITES	Not listed
MLRA	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	RH Bennett

SPECIES SUMMARY and RECOMMENDATIONS

Carcharhinus albimarginatus is a medium-sized, pelagic shark which is widely distributed in tropical coastal and semi-oceanic waters of the Indo-Pacific Ocean. It is associated with coral reefs and occurs in the extreme north on the east coast of South Africa. It was not listed in estimated catches/landings recorded by DFFE for the period 2010–2012. Elsewhere it is widely taken as a bycatch in pelagic longline fisheries and is targeted by artisanal fisheries through most of its range. It is largely utilised for its fins but the meat is also consumed. It is a slow growing species with relatively low fecundity and was assessed globally as Vulnerable in 2015, with fishing being the greatest threat. Given its very limited South African distribution, with no evidence of mating aggregations or nursery grounds in South African waters, it must be regarded as a low priority species. Any opportunity should be used to collect life history information and tissue samples for genetic studies.

TAXONOMIC and IDENTIFICATION ISSUES

There are no taxonomic issues, although there are 16 other species in the genus *Carcharhinus* on the east coast of South Africa. The distinctive white tips on many of the fins distinguish this species from all other members of this genus except *C. longimanus,* which has broadly rounded rather than pointed fins (Bass *et al.* 1973).

SOUTH AFRICAN DISTRIBUTION

It occurs only on the east coast of South Africa, from the Mozambique border to north of St Lucia (Ebert *et al.* 2021).

REGIONAL DISTRIBUTION

It is present in Mozambique up to Kenya and around Madagascar and other islands in W Indian Ocean.

SYNOPSIS OF RESEARCH

In southern Africa published information on the life history, taxonomy and morphometrics of this species is limited to a study of approximately 40 individuals (Bass *et al.* 1973). Despite its wide distribution, this species has been poorly studied and little is known of its life history. Research conducted elsewhere has examined habitat use and movements to ascertain how protected areas could contribute to its conservation (Espinoza *et al*. 2016 and references cited therein).

ECOLOGY

Depth

This pelagic species is usually found near the edges of offshore banks and islands from the surface to depths of 800 m (Compagno *et al.* 1989). It is commonly associated with coral reefs and is not oceanic (Ebert *et al.* 2015).

Habitat: Adults

Adults are generally found in deeper water but may move into shallower coral reef areas at night to feed (Espinoza *et al*. 2016 and references cited therein).

Habitat: Juveniles/Nursery Grounds

Juveniles are generally found in shallower water closer to the shore and may venture into lagoons (Espinoza *et al*. 2016 and references cited therein).

Synopsis of tag deployments

No individuals have been tagged in the ORI Cooperative Fish Tagging Project 1984-2018 inclusive.

Movements

Research elsewhere in its range has shown that this species may be relatively site-specific for long periods with limited dispersion, particularly in remote and isolated coral reef atolls (Stevens 1984a, Barnett *et al*. 2012, Espinoza *et al*. 2015). On the continental shelf, larger individuals of the species tend to be more mobile and use large areas (Espinoza *et al*. 2016 and references cited therein). Globally, the species is considered possibly migratory (Fowler 2014).

Diet/feeding: adults

Adults feed mainly on small shoaling teleost species, smaller sharks and rays, cephalopods and crustaceans (Bass *et al.* 1973, Compagno 1984a).

Diet/feeding: juveniles

This is possibly the same as the adults.

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Placental viviparity
DURATION OF REPRO CYCLE	2 years
MATING	Summer: December and January
GESTATION	12 months
LITTER SIZE	1–11, mean 6 from 25 litters
PUPPING/NURSERY GROUND	Summer: December and January
LENGTH AT BIRTH	70–80 cm
LENGTH AT MATURITY	F: 190–210 cm; M: 170–180 cm
MAXIMUM LENGTH	300 cm
GENERATION LENGTH	Assumed to be about 22 years

Mode

This species exhibits placental viviparity (Bass *et al.* 1973).

Duration of reproductive cycle

This is 2 years (Bass *et al.* 1973).

Mating season and location
In the SW Indian Ocean mating appears to be seasonal in December and January (Bass *et al.* 1973). There is no evidence of any mating aggregation in South African waters.

Gestation
This is 12 months (Bass *et al.* 1975).

Litter size
Litter size ranges from 1–11 with a mean of 6 from 25 litters (Bass *et al.* 1973).

Length at birth
Length at birth is 70–80 cm (Bass *et al.* 1973).

Pupping season and nursery grounds
In the SW Indian Ocean pupping is seasonal in December and January (Bass *et al.* 1973). There is no evidence of a nursery ground in South African waters.

Length at maturity
Males mature at 170–180 cm and females at 190–210 cm. There are regional variations in these sizes (Bass *et al.* 1973, Espinoza *et al*. 2016).

Maximum length
This species reaches a maximum length of 300 cm (Compagno *et al.* 1989).

Age and growth
No age and growth studies have been undertaken in the SW Indian Ocean, although very limited results were obtained by Stevens (1984a). In the Western Pacific males matured at 10 years and females at 15 years (Smart *et al*. 2017).

Generation length
No estimate of generation length was available for the species (Espinoza *et al.* 2016. As a result, it was inferred from its congener, the pigeye or Java shark *C. amboinensis*, which has a similar maximum size and an estimated generation length of 21.5 years (Tillett *et al*. 2011). Based on a more recent age and growth study (Smart *et al.* 2017), generation length is likely to be closer to 23 years.

FISHERIES MANAGEMENT
SA catch sources, quantities and characteristics
This species was not listed in estimated catches/landings recorded by DFFE for the period 2010–2012 (da Silva *et al.* 2015). Elsewhere in its range it is caught in pelagic longline fisheries, but it is not listed as bycatch in the tuna- and swordfish-directed longline fishery off southern Africa (Petersen e*t al.* 2009).

Fishing outside South Africa
This species is one of the nine important pelagic shark species landed by high seas longline and net tuna fleets. Numbers of sharks landed are generally not available and may be underreported. This species is also caught in artisanal longline, gillnet, and trawl fisheries throughout its range (Shehe and Jiddawi 1997; Robinson and Sauer 2013; Cripps *et al*. 2015; Wildlife Conservation Society (WCS) unpubl. data). It is utilised for its fins, meat, cartilage, liver, teeth, jaws, and skin (Espinoza *et al*. 2016).

Population trends
The global population appears to be fragmented with apparently low potential for interchange between localised stocks. Its site-specificity, patchy population, and life history characteristics indicate

that remote populations that are not currently managed are highly susceptible to depletion (Espinoza *et al.* 2016).

No information is available on the SW Indian Ocean population. Elsewhere in its range there have been large declines in the abundance of all reef shark species around inhabited islands (MacNeil *et al.* 2020). It is suspected that this species has experienced population reductions of more than 30% across the Indo-Pacific Ocean over three generations, hence it was assessed as Vulnerable in 2015. This assessment should be revisited when more reliable catch data become available (Espinoza *et al*. 2016). There is no evidence of gene flow between populations in the WIO (Seychelles) and those in the Eastern Indian and Western Pacific oceans (Green *et al*. 2019).

ECOTOURISM
This species occurs in shallow coastal waters where it is occasionally encountered by scuba divers and therefore must be regarded as an ecotourism species.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
This species will only benefit from the iSimangaliso MPA, given its restricted distribution in the extreme north of the east coast. As there is evidence of some degree of residence elsewhere in the western Indian Ocean, the potential benefits of this particular MPA may be high. This species is present within the Ponta do Ouro Partial Marine Reserve in southern Mozambique (WCS unpubl. data), which is likely to also provide some protection.

Additional local comment
This species will benefit from the restrictions imposed on pelagic longlining, which is only permitted more than 12 nm off the KZN coast.

IUCN Red List Status
<u>Vulnerable 2015: A2bd</u>

Previous IUCN assessments
Near Threatened 2009

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed on any of the appendices of CITES.

Convention on Migratory Species (CMS)
This species is not listed.

International comments

MANAGEMENT CONSIDERATIONS
The species is vulnerable to overexploitation in remote island/atoll locations due to its limited dispersal and localised movement patterns, relatively slow growth and low fecundity. Only a very small part of its regional distribution is in South African waters, all of which is an MPA but with no evidence of any mating aggregations or nursery ground. For this reason, the silvertip shark must be regarded as

a low priority species. The potential for illegal exploitation in deeper coastal waters within the South African EEZ does remain a concern.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

Very little is known of the life history of this widely distributed pelagic species, particularly the SW Indian Ocean population. As it only occurs in the extreme northern waters of the east coast, research opportunities in South Africa are extremely limited. Furthermore, it is a very low priority species, given its apparent absence from catches in any South African fisheries. Any opportunistic sampling opportunities should be used to collect more life history information and tissue samples for genetic studies.

Carcharhinus amblyrhynchos

SCIENTIFIC NAME	*Carcharhinus amblyrhynchos* (Bleeker 1856)
COMMON NAME	Grey reef shark
FAMILY	Carcharhinidae
ENDEMIC	No, Indo-Pacific
SIZE RANGE	65–180 cm TL, possibly 255 cm
SA DISTRIBUTION	E coast: Mozambique border to Sodwana Bay
HABITAT	Drop-offs around coral reefs
DEPTH RANGE	0–280 m, usually < 100 m
MAJOR FISHERIES	None in South Africa
IUCN STATUS	Endangered 2020
CITES	Not listed
MLRA	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	JSE Lea

SPECIES SUMMARY and RECOMMENDATIONS

Carcharhinus amblyrhynchos is a medium-sized pelagic shark and is one of the most common coral-reef associated sharks in the Indo-Pacific Ocean, usually frequenting reef drop-offs. Historically *C. spallanzani*, later renamed *C. wheeleri*, was described as a distinctive species, found only in the W Indian Ocean, but this species was synonymised with *C. amblyrhynchos.* There were no records of local fishery catches (DFFE records: 2010–2012). It only occurs in the iSimangaliso MPA in the far north, with fisheries in Mozambique being the only regional catch source. It is particularly susceptible to coastal fisheries as it occurs in shallow water and readily takes a baited hook. Localised declines in abundance, together with destruction of coral reef habitat, resulted in this species being assessed globally as Endangered in 2020 on the IUCN Red List. This species will derive protection from the iSimangaliso MPA where it has been reported as being common but only as solitary individuals. Given its absence in local catches is must be regarded as a low priority species and it seems unlikely that any management intervention in South Africa will improve the conservation status of this species. Any opportunistic sampling should be used to collect life history information and tissue samples for genetic studies.

TAXONOMIC and IDENTIFICATION ISSUES

This species has a complicated nomenclatural history. D'Aubrey (1964) described it as *C. spallanzani*. In a study of sharks of southern Africa Bass *et al*. (1973) listed *C. amblyrhynchos* and *C. spallanzani* as separate species, based on different snout lengths and the presence (*C. spallanzan*i) or absence (*C. amblyrhynchos*) of a white tip on the first dorsal fin. These authors concluded that the two species were largely allopatric, with *C. spallanzani* dominant in the W Indian Ocean and Red Sea and *C. amblyrhynchos* dominant in the rest of the Indian Ocean and W Pacific. Garrick (1982) reviewed the situation and described *C. spallanzani* as a new species *C. wheeleri*, based on a type specimen from the Red Sea. The name *C. wheeleri* was considered valid by subsequent authors (Compagno *et al*. 1989), but was later synonymized with *C. amblyrhynchos* (Bonfil and Abdallah 2004, cited by Ebert *et al.* 2021). Naylor *et al*. (2012) found molecular support for reviving *C. wheeleri* as a separate species. The use of *C. amblyrhynchos* is retained for South African specimens, but with the caveat that the validity of *C. wheeleri* should be investigated (Ebert *et al.* 2021).

SOUTH AFRICAN DISTRIBUTION

This species only occurs in the extreme northern part of the east coast as far south as Sodwana Bay (Ebert *et al*. 2021). Within this region, which all falls inside the iSimangaliso MPA, this species is described as common, with solitary adults spotted at Two Mile Reef in summer (Grant Smith, SharkLife, pers. comm.). Rob Kyle (South African Association of Marine Biological Research, pers. comm.) describes this species as common in the MPA, but with solitary individuals of different sizes observed year-round.

REGIONAL DISTRIBUTION

It is present in Mozambique and the entire Western Indian Ocean as well as the tropical Indo-Pacific.

SYNOPSIS OF RESEARCH

In southern Africa Bass *et al.* (1975) provided a taxonomic overview of the genus *Carcharhinus*, with only a single specimen of *C. amblyrhynchos* but gave morphometric and biological information from approximately 15 specimens of *C. spallanzani,* which, in view of its apparent synonymy with *C. amblyrhynchos*, have been included in this report. No further research has been undertaken on this species in South Africa. In Seychelles movement/residency patterns were investigated using conventional tagging (Stevens 1984) and acoustic tracking (Lea *et al*. 2016). Extensive research has been conducted elsewhere in its range, particularly in the tropical Pacific Ocean (see Simpfendorfer *et al.* 2020a for references cited therein).

ECOLOGY

Depth

This fast-moving, pelagic species occurs in clear tropical waters from the surface to depths of 280 m (Last and Stevens 1994) but is most common in waters shallower than 100 m (Bass *et al*. 1973 and references cited therein).

Habitat: Adults

The adults are associated with coral reefs, occurring along the reef edge, on the reef flat and in or near the edge of the deep water passes and the mouths of channels running into atolls that are exposed to the prevailing currents (Anderson and Ahmed 1993, Simpfendorfer *et al.* 2020a).

Habitat: Juveniles/Nursery Grounds

This species appears to segregate based on size, with juveniles showing long-term use of shallower coral-associated habitats, such as lagoons and coastal reefs (Stevens 1984, Lea *et al.* 2016).

Synopsis of tag deployments

No individuals have been tagged in the ORI Cooperative Fish Tagging Project 1984-2018 inclusive. Within the broader W Indian Ocean, 33 individuals, comprising both juveniles and adults (67–182 cm) were tagged with external roto tags at Aldabra in Seychelles. Of these, 18% were recaptured, all being neonates (Stevens 1984). A total of 22 individuals, also comprising both juveniles and adults (84–158 cm), were fitted with acoustic tags off the islands of D'Arros and St Joseph in the Amirantes, Seychelles (Lea *et al.* 2016).

Movements

In Seychelles the neonates were recaptured where they were tagged, indicating site fidelity (Stevens 1984). Individuals were largely recorded along the coastal reefs and drop-offs but not inside atolls (Lea *et al.* 2016). In Maldives this species displayed seasonal changes in distribution around the atolls in relation to the prevailing monsoon currents, favouring the western side of the atolls in the SW Monsoon (May–November) and the eastern side in the NE Monsoon (December–April) (Anderson and Ahmed 1993).

Diet/feeding: adults

This species, including *C. wheeleri*, feeds primarily on small surface- and bottom-dwelling teleosts and to a lesser extent cephalopods and crustaceans (Bass *et al.* 1973, Last and Stevens 1994). In Hawaii teleosts dominated the diet of the larger individuals but there was an increase in the cephalopod component in comparison to the juveniles (Wetherbee *et al.* 1997).

Diet/feeding: juveniles

The diet of juveniles in Hawaii was dominated by small teleosts, with an extremely low incidence of cephalopods (Wetherbee *et al.* 1997).

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Placental viviparity
DURATION OF REPRO CYCLE	2 years
MATING	July–September (SW Indian Ocean)
GESTATION	About 1 year (SW Indian Ocean)
LITTER SIZE	1–4; mean 2.5 (n=95) (SW Indian Ocean)
PUPPING/NURSERY GROUND	July–September (SW Indian Ocean)
LENGTH AT BIRTH	65–75 cm (SW Indian Ocean)
LENGTH AT MATURITY	F: 120 cm; M: 110-120 cm (SW Indian Ocean)
MAXIMUM LENGTH	255 cm, but rarely >200 cm
GENERATION LENGTH	14.5 years (W Pacific)

Mode

This species, like all members of the genus *Carcharhinus*, exhibits placental viviparity.

Duration of reproductive cycle

This is 2 years (Simpfendorfer *et al.* 2020a and references cited therein).

Mating season and location

In the SW Indian Ocean mating in *C. spallanzani/wheeleri* takes place from July to September (Bass *et al.* 1973 and references cited therein). In Seychelles there was limited evidence of mating in *C. wheeleri* in March (Stevens 1984).

Gestation

In the SW Indian Ocean birth in *C. spallanzani/wheeleri* is about a year after mating (Bass *et al.* 1973 and references cited therein). In Hawaii gestation is about 12 months (Wetherbee *et al.* 1997).

Litter size

The litter size in *C. spallananzi/wheeleri* is 1–4, with a mean of 2.5 from 95 litters (Bass *et al.* 1973 and references cited therein). In *C. amblyrhynchos* litter size is 1–6 (Simpfendorfer *et al.* 2020a and references cited therein).

Length at birth

Length at birth in *C. spallanzani/wheeleri* is 65–75 cm (Bass *et al.* 1973 and references cited therein; Stevens 1984). In Australia size at birth is commonly 50–60 cm (Last and Stevens 1994), just over 60 cm in Hawaii (Wetherbee *et al.* 1997) and 67–70 cm in Indonesia (White 2007).

Pupping season and nursery ground

Pupping in *C. spallanzani/wheeleri* takes place approximately one year after mating, which is from July to September (Bass *et al.* 1973). These authors report that little is known about nursery areas, except that young specimens live in shallower waters than adults. In Seychelles neonates were caught in lagoons between November and March (Stevens 1984). In the Maldives mature female *C. amblyrhynchos* leave some sites for a few weeks each year between March and May, possibly associated with breeding (Anderson and Ahmed (1997).

Length at maturity
In *C. spallananzi/wheeleri* females mature by about 120 cm and most males mature at 110–120 cm (Bass *et al.* 1973). In Australia females and males mature at 130–140 cm (Last and Stevens 1994). In Hawaii females mature at about 125 cm and males 120–40 cm (Wetherbee *et al.* 1997).

Maximum length
This species reportedly reaches a maximum length of 255 cm (Last and Stevens 1994), but rarely exceeds 180 cm. White (2007) reported an individual of 232 cm in Indonesia.

Age and growth
In Papua New Guinea females mature at 9 years, and they reach a maximum age of at least 20 years on the Great Barrier Reef (Simpfendorfer *et al.* 2020a and references cited therein).

Generation length
Based on the age and growth data presented above, generation length is estimated to be 14.5 years (Simpfendorfer *et al.* 2020a).

FISHERIES MANAGEMENT
SA catch sources, quantities and characteristics
This species was not reported in local catch estimates (DFFE records: 2010-2012; da Silva *et al.* 2015). No individuals have been caught in the KZN bather protection nets (KZN Sharks Board, unpublished data).

Fishing outside South Africa
This species is caught as target and bycatch through much of its range in industrial and small-scale fisheries using longline, gillnet, handline and demersal trawls, and is often retained for its fins, flesh, skin, teeth and liver (Simpfendorfer *et al.* 2020a). It has been reported in the catches of Mozambican artisanal fisheries (Pierce *et al.* 2008) and is the most common species in the Seychelles artisanal fishery (http://seatizens.sc/species/carcharhinus-amblyrhynchos-bleeker-1856/).

Population trends
Genetic and telemetry studies support a population structure that is characterised by isolation-by-distance, that results in significant structuring in the population. A lack of sampling throughout its range means the number and boundaries of these populations cannot yet be determined (Simpfendorfer *et al.* 2020a and references cited therein).

Steep declines in population abundance have been reported in some parts of its range, while in others it appears to be abundant. Based on baited remote underwater video station data from 254 reef locations in 40 regions throughout its range, the estimated global population reduction is 59% over three generation lengths (44 years). Therefore, this species is estimated to have undergone a population reduction of 50–79% over the last three generation lengths (44 years) due to levels of exploitation and declines in habitat quality, and it was globally assessed as Endangered in 2020 on the IUCN Red List (Simpfendorfer *et al.* 2020a and references cited therein).

ECOTOURISM
As individuals of this species are commonly sighted by divers in and around Sodwana Bay, this species must be regarded as an ecotourism species.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations
There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
This species will derive benefit from the iSimangaliso MPA, its only known location in South African waters.

Additional local comment

IUCN Red List Status
Endangered 2020 A2bcd

Previous IUCN assessments
Near Threatened 2009
Near Threatened 2000

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

International comments
This species is one of the three most common sharks on the Indo-Pacific coral reefs. MPAs are common in coral reef areas throughout its range, but only those that are well enforced and sufficiently large (>20 km of coral reef) provide significant protection for this strong-swimming species (Simpfendorfer *et al.* 2020a and references cited therein).

MANAGEMENT CONSIDERATIONS
This species is confined to the extreme northern section of the east coast, all of which falls inside the iSimangaliso MPA. It has not been recorded in South African catches. Although it is caught in Mozambican artisanal fisheries, it must be regarded as a very low priority species in South Africa. It seems unlikely that any management intervention in South Africa will improve the status of *C. amblyrhynchos* from that of Endangered.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
As this species is only found in the far northern region of the east coast, research opportunities will be extremely limited. Any opportunistic catches should be used to obtain life history information and genetic material to assess any regional population structure. Sightings should be recorded to document any seasonality in its occurrence in the iSimangaliso MPA.

Carcharhinus amboinensis

SCIENTIFIC NAME	*Carcharhinus amboinensis* (Müller & Henle 1839)
COMMON NAME	Pigeye/Java shark
FAMILY	Carcharhinidae
ENDEMIC	No
SIZE RANGE	75–280 cm TL
SA DISTRIBUTION	E coast: Mozambique border to Algoa Bay
HABITAT	Benthopelagic close to sand bottoms and in turbid water
DEPTH RANGE	0–60 m
MAJOR FISHERIES	KZN bather protection nets and KZN inshore prawn trawl fishery
IUCN STATUS	Vulnerable 2020
CITES	Not listed
MLRA	Daily bag limit of one in recreational fishery
COMPILER	G Cliff
REVIEWER	ST Fennessy

SPECIES SUMMARY and RECOMMENDATIONS

Carcharhinus amboinensis is a medium-sized, little-known pelagic shark with a cosmopolitan distribution in the shallow, coastal tropical waters of the Indo-Pacific Ocean. In South Africa it occurs on the entire east coast and is most common in central KZN in the turbid waters between Richards Bay and the uThukela River. It is found in Mozambique northwards, along the entire east African coast. Local catch was estimated at <1 ton per annum (DFFE records: 2010–2012). Highest catches were listed in the KZN bather protection programme and the now-closed KZN inshore prawn trawl fishery. It is easily mistaken for the more common and better-known Zambezi/bull shark *C. leucas.* It was assessed globally as Vulnerable on the IUCN Red List in 2020. Little is known of its local movement patterns, other than it is more common in central KZN waters in summer, where it will derive some protection from the uThukela Banks MPA. In winter it possibly moves northwards into Mozambique waters. The location of the nursery grounds, which are likely to be inshore, is unknown and this is of concern as they are possibly in southern Mozambique. More insight into movement patterns is needed, especially if a part of the population is moving northwards into Mozambique. An investigation of regional population structure would also benefit management of this little-known species.

TAXONOMIC and IDENTIFICATION ISSUES

This species is one of 17 members of the genus *Carcharhinus* found on the southern African east coast. Many are very similar in overall appearance, with features such snout shape, dentition, the position of the first dorsal fin relative to the pectoral fins, the presence or absence of an interdorsal ridge and fin pigmentation used to separate the species. There are only two members of this genus in the SW Indian Ocean which lack an interdorsal ridge and strong fin markings and possess an extremely blunt snout, stocky body and heavily serrated, broad-cusped upper teeth. They are *C. amboinensis* and the bull/Zambezi shark *C. leucas*, which can only be separated in the field by the relative heights of the two dorsal fins and the tooth count, but not tooth shape. *C. amboinensis* has a taller first dorsal and lower second dorsal fin and usually only 11 teeth on each side of the lower jaw (Bass *et al.* 1973). These authors provided detailed comments on the taxonomic history of these two species, noting that they "resemble one another closely and have only been recognised as two distinct species in the last decade". Awareness levels among anglers of *C. amboinensis* are not high and it is likely that individuals are still mistaken for *C. leucas.*

SOUTH AFRICAN DISTRIBUTION

This species occurs along the entire east coast, from the Mozambique border to Algoa Bay (Ebert *et al.* 2021).

REGIONAL DISTRIBUTION

This species is present in Mozambique and Madagascar and the coastal waters of the entire W Indian Ocean (Simpfendorfer *et al.* 2021b).

SYNOPSIS OF RESEARCH

It is not a well-studied species in South Africa. Bass *et al.* (1973) reviewed the taxonomy of the genus and provided detailed morphometric and biological information from approximately 50 individuals, including adults but no pregnant females from southern Africa. An analysis of catch statistics and general biology of 200 individuals, which included five pregnant females, caught in the KZN bather protection programme between 1978 and 1990, was undertaken by Cliff and Dudley (1991), followed by a more detailed analysis of catch trends (Dudley and Simpfendorfer 2006). These individuals were also used for a study of the trophic ecology and muscle mercury levels (McKinney *et al.* 2016). Very little comparative information on the biology and ecology of this species is available from studies elsewhere in its range, apart from Australia (see Simpfendorfer *et al*. 2021b and references cited therein).

ECOLOGY

Depth

This is an inshore species found in almost equal frequencies in the 0–30 and 30–60 m depth ranges on the KZN coast, where it may be caught by shore anglers (Bass 1968, cited by Bass *et al.* 1973). Elsewhere it occurs from the surf zone to depths of 60 m (Simpfendorfer *et al.* 2021b).

Habitat: Adults

They occur throughout the water column close inshore, but predominantly near the bottom. There is no local evidence that this species enters brackish water (Bass *et al*. 1973), although in Australia it occasionally does so (Last and Stevens 1996). Catches of adults in the KZN bather protection programme were highest in the north (Richards Bay, Mtunzini and Zinkwazi) where water turbidity is high (Cliff and Dudley 1991). Seoula Point, 5 km south of the mouth of the large uThukela River and 2 km north of Zinkwazi, is known to competitive shore anglers as a location where this shark may be caught at times (Barry Wareham, KZN Coastal Anglers Union, pers. comm.).

Habitat: Juveniles/Nursery Grounds

Catches of juveniles (no neonates were caught) in the KZN bather protection programme were also highest in the north (Richards Bay, Mtunzini and Zinkwazi) where water turbidity is high (Cliff and Dudley 1991), suggesting that juveniles also favour turbid water. This was confirmed in Australian waters by Knip *et al.* (2011) who found that juveniles associated strongly with shallow turbid habitats areas adjacent to creek and river mouths. There was no evidence of a nursery ground on the central and southern KZN coast between Richards Bay and Port Edward (Cliff and Dudley 1991).

Synopsis of tag deployments

A total of 60 individuals were tagged in the ORI Cooperative Fish Tagging Project 1984-2018 inclusive. There were two recaptures (3% of those tagged), with the mean distance travelled of 14 km (maximum 18 km) and mean time at liberty of 2.3 months (maximum 2.5 months) (Jordaan *et al.* 2020). A total of 15 individuals were tagged and released from the KZN bather protection nets, with a single recapture 84 km to the south of the tagging location after 11 months at liberty (Cliff and Dudley 1991).

Movements

It is difficult to assess the movement patterns of this species, based on very limited recapture data and in the absence of any local acoustic tagging. As a benthopelagic species, it would appear to be capable of moving long distances along the coast but there is no local evidence of this. There is some indication of site fidelity. Although individuals were caught throughout the year in the KZN bather protection programme, there were strong seasonal and geographic variations in abundance (Cliff and

Dudley 1991). Catches were highest in summer and lowest in winter, suggesting a northward movement, possibly into Mozambique waters with decreasing water temperatures. Tag returns from juveniles in Australia were indicative of localised movements (up to 60 km) while two larger individuals were recaptured 240 and 1080 km from the tagging site (Last and Stevens 1994).

Diet/feeding: adults

Majority of the individuals examined by Cliff and Dudley (1991) were immature and there was no evidence of a change in diet with increasing predator size. Teleosts were dominant, followed by elasmobranchs; the latter comprised equal frequencies of small sharks and batoids. Crustaceans and cephalopods were occasionally taken (Cliff and Dudley 1991).

Diet/feeding: juveniles

Teleosts were the most frequently encountered prey, followed by elasmobranchs, with a low incidence of crustaceans and cephalopods. Prey was taken throughout the water column but with an emphasis on bottom-dwelling species found on soft substrates (Cliff and Dudley 1991). Bass *et al*. (1973) found that this species feeds predominantly on bottom-dwelling teleosts, crustaceans and molluscs.

South African toxicological studies

One toxological study has been conducted on this species in South Africa, using specimens caught in the KZN bather protection nets. Levels of total mercury in the muscle tissue of nine juveniles and subadults (140-200 cm) showed a positive correlation with body length. Values for a number of local shark species, including *C. amboinensis*, were higher than those from other regions and, in many cases, they were far higher than international regulatory guidelines for human and fish health (McKinney *et al.* 2016 and references cited therein).

REPRODUCTION

REPRODUCTIVE MODE	Placental viviparity
DURATION OF REPRO CYCLE	2 years
MATING	Summer
GESTATION	12 months
LITTER SIZE	Mean of 5; maximum 7
PUPPING/NURSERY GROUND	Unknown, north of central KZN
LENGTH AT BIRTH	75 cm
LENGTH AT MATURITY	50% maturity F: 210 cm, M: 205 cm
MAXIMUM LENGTH	F: 235 cm; M: 225 cm
GENERATION LENGTH	21.5 years (Australia)

Mode

This species exhibits placental viviparity (Bass *et al*. 1973).

Duration of reproductive cycle

In South Africa this is two years, (Cliff and Dudley 1991). Elsewhere this species also has a biennial cycle (Simpfendorfer *et al*. 2021b and references cited therein).

Mating season and location

The mating season is in late summer (January–February), based on a female with recently fertilised ova *in utero* (Cliff and Dudley 1991).

Gestation

In South Africa this is in the region of 12 months (Cliff and Dudley 1991).

Litter size
In South Africa the median litter size from five litters was five, with a range of 3–7 (Cliff and Dudley 1991). Elsewhere litter size was 3–13 (Simpfendorfer *et al*. 2021b and references cited therein).

Length at birth
In South Africa this is about 75 cm (Bass *et al.* 1973, Cliff and Dudley 1991). Elsewhere size-at-birth is 48–72 cm (Simpfendorfer *et al*. 2021b and references cited therein).

Pupping season and nursery ground
Pupping appears to take place in summer, with the largest embryos found in January. There was no evidence of a nursery ground in the KZN netted region and, given the distribution of catches, such grounds must lie to the north (Cliff and Dudley 1991). In Australia neonates associate strongly with shallow turbid habitats and consistently remain in areas adjacent to creek and river mouths (Knip *et al.* 2011).

Length at maturity
In South Africa females attain 50% maturity at about 210 cm and males at 205 cm (Dudley and Simpfendorfer 2006). There is regional variation in length at maturity, ranging from 195–224 cm for females and 195–227 cm for males (see Simpfendorfer *et al.* 2021b and references cited therein).

Maximum length
The largest female recorded on the east coast of South Africa was 235 cm and the largest male 225 cm (Cliff and Dudley 1991). Bass *et al.* (1973) cited Fourmanior (1961) who reported a record of a 280 cm individual from west Madagascar.

Age and growth
No age and growth studies have been undertaken on the South African population. In Australia female age-at-maturity is 13 years and maximum age is at least 30 years, with corresponding values for males being 12 years and >24 years (Tillett *et al*. 2011).

Generation length
Based on the age and growth data of Australian individuals as stated above, generation length is 21.5 years (Simpfendorfer *et al.* 2021b).

FISHERIES MANAGEMENT
SA catch sources
Local catch was estimated at <1 ton per annum (DFFE records: 2010–2012), with the KZN bather protection programme and the KZN inshore prawn trawl fishery listed as the biggest contributors. It is a suspected catch in the pelagic longline fishery and the recreational linefishery (da Silva *et al.* 2015). This species was not recorded in the catches of KZN competition shore anglers (Pradervand *et al.* 2007), but this could be the result of its close similarity to the better-known *C. leucas.*

SA catch quantities and characteristics
KZN bather protection nets
The mean annual catch in the KZN bather protection nets was 16 (range 6–42) for the period 1978–1990. This species constituted 0.5% of the total shark catch for that period. There was no significant linear trend in catch or catch rate with time (Cliff and Dudley 1991). Subsequent analysis for the period 1978–2003 showed a significant decline in median and mean size of both males and females (Dudley and Simpfendorfer 2006). Mean annual catch in the period 2000-2009 was down to 10, largely due to the widespread replacement of shark nets with baited drumlines, which have an extremely low catch of *C. amboinensis* (Cliff and Dudley 2011). The catch was essentially unimodal (Cliff and Dudley 1991), with 8% of females and 12% of males mature (Dudley and Simpfendorfer 2006).

KZN prawn trawl fishery

This species was caught in very small numbers in the KZN inshore (<50m depth) prawn trawl industry on the uThukela Banks. The extrapolated annual catch for the period 1989 and 1992 was 10 (range 7–14) (Fennessy 1994). This fishery was dormant for nearly two decades due to the extended closure of the mouth of Lake St Lucia, resulting in poor prawn recruitment and diminishing prawn catches on the uThukela Banks. The fishing grounds have been closed to trawling since the declaration of the uThukela Banks MPA in August 2019.

Fishing outside South Africa

C. amboinensis is taken in coastal waters throughout its range as bycatch in industrial and small-scale fisheries by a variety of fishing gears, including gillnet, longline, trawl, and handline. Its large size makes it a frequently retained species due to the high value of its fins and meat (Simpfendorfer *et al*. 2021b). This species is listed as one likely to be taken in coastal artisanal fisheries in Mozambique but no further information is provided (Pierce *et al.* 2008). It was one of the least-common sharks (5 individuals out of 1208) noted by observers at eight landing sites for artisanal fishers in Kenya between April 2016 and March 2017 (BYCAM 2019).

Population trends

Species-specific population data are not available in most of its range (Simpfendorfer *et al.* 2021b). There was evidence of some global genetic structure from two studies (Tillett *et al.* 2012, Naylor *et al.* 2012) which included samples from South Africa.

While there is limited information available on this species, its size, increasing demand for the fin trade, and the presence of intensive fisheries mean that, like many other medium-sized carcharhinid sharks, it will have undergone population declines. It is still reported to be commonly caught in some parts of its range, though declines are suspected. Overall, it is suspected that globally *C. amboinensis* has undergone a population reduction of 30–49% over the past three generation lengths (65 years) due to levels of exploitation and it was assessed as Vulnerable on the IUCN Red List in 2020 (Simpfendorfer *et al.* 2021b). The only species-specific, long-term dataset of catches, that of the KZN bather protection programme, was not used in this global assessment.

ECOTOURISM

C. amboinensis is rarely seen, possibly because it favours turbid water, therefore it cannot be regarded as an ecotourism species. The only grounds for recognising it as such would be its extremely close resemblance to *C. leucas.*

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

There is a daily bag limit of one individual in the recreational linefishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)

This species is not listed.

Marine Protected Areas

This species appears to be most common in the turbid waters on the KZN north coast between Richards Bay and Zinkwazi and therefore will derive considerable protection from the uThukela Banks MPA.

Additional local comment

Current IUCN Status
Vulnerable 2020: A2d

Previous IUCN assessments
Data Deficient 2009
Data Deficient 2000

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

International comments
There are few species-specific regulations in place to protect this species. Its presence in mangrove habitats in other parts of its global range means it is also threatened by extensive habitat degradation (Simpfendorfer *et al.* 2021b). The global Red List assessment of Vulnerable was not based on any species-specific catch data, but was strongly driven by the low productivity of the species.

MANAGEMENT CONSIDERATIONS
Given its known inshore habit and based on the low catches in the KZN bather protection programme, the now closed KZN inshore prawn trawl fishery, and its absence from the KZN-based competition recreational angling catches, this species does not appear to be common on the east coast of South Africa. As a result, it must be regarded as being of low management priority. On the other hand, this species may be subject to considerable fishing pressure in the coastal fisheries of Mozambique, particularly in winter when individuals leave the central and southern KZN coast. This is likely to have a detrimental effect on local stocks.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
This is not a well-studied species. Knowledge of its biology and life history is fair but the location of the nursery ground and the whereabouts of the adults, including pregnant females, is largely unknown. Insufficient numbers have been tagged to ascertain movement patterns and levels of residency or site fidelity. The location of a nursery ground and the possibility of it being in Mozambique should be investigated. A regional/W Indian Ocean genetic study to investigate population structure would be beneficial. The KZN Sharks Board has collected a small number of tissue samples for this purpose.

Carcharhinus brachyurus

SCIENTIFIC NAME	*Carcharhinus brachyurus* (Günther 1870)
COMMON NAME	Copper shark/bronze whaler
FAMILY	Carcharhinidae
ENDEMIC	No, patchy global distribution in warm temperate and subtropical waters
SIZE RANGE	60–313 cm TL
SA DISTRIBUTION	E, S, W coasts: Central KZN to Orange River mouth
HABITAT	Pelagic in coastal waters over sand bottoms and rocky reef areas
DEPTH RANGE	0–150 m
MAJOR FISHERIES	Commercial linefishery, pelagic and demersal longline fisheries, gill and beach seine net fisheries, small pelagic fishery, inshore trawl fishery, recreational linefishery, and KZN bather safety programme
IUCN STATUS	Vulnerable 2020
CITES	Not listed
MLRA	Slot limit of 70–130 cm in demersal shark longline fishery; daily bag limit of one in recreational fishery
COMPILER	G Cliff
REVIEWER	T Rogers

SPECIES SUMMARY and RECOMMENDATIONS

Carcharhinus brachyurus is a large pelagic shark with a cosmopolitan but patchy distribution. It is the only member of the genus with a preference for warm temperate waters. In South Africa it occurs on southern part of the east coast and the entire south and west coasts, extending northwards into Namibia and Angola. Local catch was estimated at 101–200 tons per annum, with highest catches in the commercial linefishery, followed by the pelagic and demersal longline fisheries (DFFE records: 2010–2012). It is also frequently caught by recreational fishers and several other fisheries. Significant identification issues exist in several fisheries, especially the large pelagic fishery. Catches for the period 2009–2017 averaged 53 tons *per annum* (range: 14–103 tons) across all fisheries (DFFE unpublished data). Its fins are regarded as highly valuable and it is heavily fished in most its range. It was assessed globally as Vulnerable on the IUCN Red List in 2020, with fishing being the greatest threat, due to its low productivity through slow growth, late maturity and low reproductive output. As a highly mobile species, it derives limited protection from all the Marine Protected Areas throughout its range. The sustainability of catches in the commercial linefishery and demersal longline fishery should be investigated. Understanding ontogenetic changes in movement patterns and identifying mating and nursery grounds are considered a priority.

TAXONOMIC and IDENTIFICATION ISSUES

There are no current taxonomic issues, but this species has endured a convoluted nomenclatural history, with details provided by Bass *et al*. (1973) and a recent update by Ebert *et al.* (2021). This species is one of 17 members of the genus *Carcharhinus* found on the southern African east coast. Many are very similar in overall appearance, with features such snout shape, dentition, the position of the first dorsal fin relative to the pectoral fins, the presence or absence of an interdorsal ridge and fin pigmentation used to separate the species. *C. brachyurus* is commonly confused with the dusky *C. obscurus*, because their overall body shape is similar and their distributions show considerable overlap. The most striking distinguishing features are the interdorsal ridge and dentition. *C. brachyurus* lack this ridge, although it is present on a small number of individuals, and it has oblique cusps to the upper teeth (Bass *et al.* 1973). Often as a result of these interspecific similarities, commercial catches of carcharhinids are grouped together as whaler sharks or requiem sharks, making it impossible to ascertain total catch at species level.

SOUTH AFRICAN DISTRIBUTION

This species is present throughout the entire south and west coasts, and the southern part of the east coast as far north as central KZN (Ebert *et al.* 2021).

REGIONAL DISTRIBUTION

This species is present in Namibia and southern Angola (Compagno *et al.* 1989), with regional connectivity between South Africa and Namibia (Toby Rogers, University of Cape Town, unpublished data).

SYNOPSIS OF RESEARCH

This is a moderately well-studied species in South Africa. Bass *et al.* (1973) reviewed the taxonomy of the genus and provided morphometric and biological information from about 60 individuals, including adults and pregnant females. Smale (1991) described the occurrence and diet of this species in the Eastern Cape. Walter and Ebert (1991) determined age and growth rates and proposed the existence of two separate populations: South African and Namibian. Global genetic studies, which included samples from South Africa, demonstrated genetic connectivity between South Africa and Namibia, but genetic separation with other global regions (Benavides *et al.* 2011). An analysis of catch statistics and general biology of 1800 individuals caught in the KZN bather protection programme was undertaken by Cliff and Dudley (1992), followed by an update on population catch trends (Dudley and Simpfendorfer 2006). This species is an important component of the annual sardine run along the east coast (Dudley and Cliff 2010). McKinney *et al.* (2016) assessed trophic ecology and the incidence of mercury in muscle tissue of this species and 16 other large shark species on the east coast. Wintner and Dudley (2013) provided a concise overview of life history and fishery-related information on this species. Comparative information on the biology and ecology of this species is available from studies largely conducted in southern Australia, New Zealand, and the SW Atlantic (see Huveneers *et al*. 2020 and references cited therein).

ECOLOGY

Depth

This pelagic species occurs from the surf zone to water depths of 150 m (Ebert *et al*. 2013).

Habitat: Adults

The adults are pelagic and highly mobile on the continental shelf (Bass *et al*. 1973). There is strong evidence of sexual segregation of the adults outside of the sardine run in southern KZN, with very few females present (Cliff and Dudley 1992). While highly mobile, adults have been shown to exhibit high levels of site fidelity in Southern African waters (Toby Rogers, unpublished data). Globally they are known to segregate by size and sex, with adults occurring around offshore islands, banks and shelf waters throughout the year and moving inshore during spring and summer (Huveneers *et al*. 2020 and references cited therein).

Habitat: Juveniles/Nursery Grounds

Smale (1991) identified the south coast as important for the juveniles. Tag-recapture data has shown high incidences of juveniles caught in sheltered inshore bays ranging from Cape Point to Port Elizabeth, with the highest catches between Cape Agulhas and Mossel Bay (Toby Rogers, unpublished data).

Synopsis of tag deployments

From 1984–2020, 10 069 *C. brachyurus* were tagged between Cape Vidal on the northern KZN coast and Namibe in southern Angola, with a total of 331 (3.3%) recaptures (Toby Rogers, unpublished data). It is the second most tagged shark and sixth most tagged fish in South African waters (Jordaan *et al.*

2020). The majority of recaptured sharks showed strong site fidelity and 230 individuals (70%) were recaptured within 100 km of their tagging location. Adult sharks demonstrated significantly higher site fidelity compared with juveniles and subadults. Large-scale inter-regional movement was evident in 6% of recaptures (n=21) and supported genetic evidence for the connectivity of the southern African *C. brachyurus* population. Longest time at liberty was recorded at 10.9 years, and maximum displacement was 1790 km.

Movements
This is a highly mobile species across all life history stages which also demonstrates high levels of site fidelity, especially the adults. Seasonal shifts in prey availability and water temperature are hypothesised to drive spring/summer aggregations on the south coast to winter aggregations on the east coast. The annual sardine run appears to be a key driver determining these movements. In the absence of a detailed study of movements, this highly mobile species should be regarded as nomadic. Recently, internal acoustic tags have been inserted into 63 individuals. The tagging locations include False Bay, Gansbaai, De Hoop, Mossel Bay, Plettenberg Bay, Port Elizabeth and Port St. Johns (Toby Rogers, unpublished data). Analysis of this long-term acoustic tagging data will allow for a greater understanding of broad and fine scale movement patterns of *C. brachyurus* as well as the potential anthropogenic overlaps.

Diet/feeding: adults
In the Eastern Cape the adults and other large individuals (> 2m) fed mainly on shoaling teleosts, with a high incidence of sardine, anchovy and horse mackerel. Cephalopods and small chondrichthyans were also eaten (Smale 1991). In KZN the prey was almost exclusively sardine (Cliff and Dudley 1992, Dudley and Cliff 2010), with an extremely low incidence of elasmobranchs and cephalopods.

Diet/feeding: juveniles
The juveniles fed mainly on the inshore chokka squid *Loligo*, with a low incidence of the same shoaling teleosts species found in the adults (Smale 1991).

South African toxicological studies
A single study has been conducted on this species in South Africa, using specimens caught in the KZN bather protection nets. Levels of total mercury in the muscle tissue of 5 large individuals (216–272 cm TL) were determined and, like other species of *Carcharhinus*, were found to be high (McKinney *et al.* 2016).

REPRODUCTION

REPRODUCTIVE MODE	Placental viviparity
DURATION OF REPRO CYCLE	Likely 2 years
MATING	Unknown location, soon after June–July
GESTATION	2 years
LITTER SIZE	Median of 15 (range: 8–20) n=46
PUPPING/NURSERY GROUND	Prolonged pupping, mainly October and November: south coast and southern part of east coast
LENGTH AT BIRTH	65–80 cm
LENGTH AT MATURITY	50% maturity F: 285 cm, M: 243 cm
MAXIMUM LENGTH	F: 313 cm; M: 302 cm
GENERATION LENGTH	23.5 years

Mode
This species exhibits placental viviparity (Bass *et al*. 1973).

Duration of reproductive cycle
Females do not reproduce every year (Cliff and Dudley 1992). The duration of the reproductive cycle has not been conclusively established in South Africa or elsewhere, but it is likely to be biennial (Huveneers *et al.* 2020).

Mating season and location
Mating appears to take place after July with no evidence of its location (Cliff and Dudley 1992), but females with mating scars have been observed in Gansbaai in spring (Toby Rogers, unpublished data).

Gestation
Gestation appears to be approximately 12 months or slightly longer (Smale 1991, Cliff and Dudley 1992).

Litter size
In South Africa the mean litter size was 15 (range 8–20; n=46) (Cliff and Dudley 1992).

Length at birth
The largest embryos from southern KZN were 71 cm, from a litter with a mean length 69 cm (Cliff and Dudley 1992). The smallest free-swimming individual was 64 cm (Smith 1952, cited by Bass *et al.* 1973). Smale (1991) observed juveniles with open umbilical scars ranging from 67 to 83 cm (mean = 76 cm, n = 23), while most of those with closed umbilical scars were over 82 cm. It is therefore likely that size at birth is 65–80 cm.

Pupping season and nursery ground
Combining embryo length data from all the pregnant females examined by Bass *et al.* (1973), Smale (1991) and Cliff and Dudley (1992), it would appear that pupping takes place over an extended period from July to February. Juveniles with open umbilical scars were found largely on the south coast in October and November (Smale 1991).

Length at maturity
In South Africa females attain 50% maturity at 285 cm and males at 243 cm (Dudley and Simpfendorfer 2006). There is regional variation in length at maturity, ranging from 215–270 cm for females and 200–255 cm for males (see Huveneers *et al*. 2020 and references cited therein).

Maximum length
The largest female was an individual of 313 cm recently tagged on the south coast (Toby Rogers, unpubl. data) and the largest male was 302 cm (Cliff and Dudley 1992), with 325 cm given as the global maximum (Huveneers *al*. 2020).

Age and growth
This species is regarded as slow-growing and long-lived; a maximum likelihood growth model based on 107 individuals (sexes combined) predicted slow annual growth rates (7.6 cm year^{-1}–2.1 cm year^{-1} for reference lengths 70 cm and 200 cm PCL respectively) (Toby Rogers, unpublished data). For the South African population, based on the median length at 50% maturity, as determined by Dudley and Simpfendorfer (2006), and the growth curve provided by Walter and Ebert (1991), age at 50% maturity for females was 23 years and 20 years for males (Wintner and Dudley 2013). In Australia female age-at-maturity was 16 years and maximum age was 31 years, with a maximum of 24 years for males (Drew *et al.* 2017).

Generation length

Based on a female age-at-maturity of 16 years and a maximum age of 31 years in the Australian population (Drew *et al*. 2017), the generation length was determined at 23.5 years (Huveneers *al*. 2020).

FISHERIES MANAGEMENT

SA catch sources

Local catch was estimated at 101–200 tons per annum (DFFE records: 2010–2012). Highest catches were listed in the commercial linefishery, followed by the pelagic and demersal longline fisheries. It was also caught in the KZN bather protection programme, recreational linefishery and beach-seine and gill net fisheries (da Silva *et al.* 2015). More recent statistics indicate an annual average catch of 53 tons (range 14–103 tons) in the period 2007–2019 (DFFE unpublished data). Identification of morphologically similar species, such as those of the genus *Carcharhinus*, remains an issue, especially in the large pelagic fishery.

SA catch quantities and characteristics

Pelagic longline fishery

This species is one of the large pelagic sharks caught in the southern African tuna and swordfish longline fisheries. It represented 2.6% of the total shark bycatch by number in the period 1998-2005, which equates to about 1000–1800 individuals per year. Most of this catch was retained (Petersen *et al.* 2009).

Demersal shark longline fishery

In the mid-1990s shark exports from South Africa started to increase, with a new directed demersal shark fishery moving into the fin trade and subsequently into the shark fillet export industry to Australia, where local supply cannot meet the demand. *C. brachyurus* is the third most important shark species taken in the demersal shark longline fishery, with a mean annual dressed weight of 2.3 tons (range 1.7–3.1 tons: 2001–2005) (da Silva and Bürgener 2007).

KZN bather protection nets

The mean annual catch in the KZN bather protection nets was 138 (range 9-365) for the period 1978-1991; 14% of the catch was found alive and much of it released. The catch comprised mainly adults and large subadults of both sexes and included a small number of pregnant females (Cliff and Dudley 1992). Measures to reduce catches of sharks associated with the sardine run were introduced and proved increasingly successful, with a mean annual catch of only 25 individuals (2000-2009) (Cliff and Dudley, 2011).

Recreational shore angling

This species is rarely caught by KZN shore anglers outside of the annual sardine run. In all the regions to the south of KZN, catches of *C. obscurus* and *C. brachyurus* were combined in the records kept by competitive recreational shore anglers, due to an inability of many anglers to easily distinguish between the two species. As a result, it was not possible to quantify the catches, suffice to say those of the two species combined were not high, numbering less than 50 individuals per annum (Pradervand and Govender 2003, Pradervand 2004 and Dicken *et al.* 2012). On the south coast, *C. brachyurus* is a popular target during the spring and summer.

Other fisheries

Of the chondrichthyan species recorded in False Bay, based on all known available catch and survey records (1897–2011), similar numbers of individuals (±1300 sharks) were reported in the commercial and recreational linefisheries, with a slight increase in CPUE in the former between 1985 and 2010 (Best *et al.* 2013). This species was recorded in 15% of the beach-seine net deployments in False Bay. Almost all the catch was between November and May, with over 3000 individuals caught over a 35-year period (Lamberth 2006).

Fishing outside South Africa
This species is caught globally as target and retained bycatch of industrial, small-scale, and recreational fisheries, using a range of gears, mainly demersal longline and gillnet and to a lesser extent, pelagic longline and demersal trawl. Under-reporting of catches is likely due to misidentification with the dusky shark *C. obscurus* and spinner shark *C. brevipinna*. At vessel mortality ranged from 0–36% for commercial gillnets and 0–67% for commercial longline fisheries. See Huveneers *et al.* (2020) and references cited therein for more details.

Population trends
Walter and Ebert (1991) suggested the presence of two southern African populations: one on the South African coast and the other in Namibia from Walvis Bay northwards. It has been established that there is no difference in population genetic structure between the two regions (Benavides *et al.* 2011). Tag-recapture data further supports the genetic study, with two individuals tagged in False Bay and recaptured in Namibia, and one individual tagged in Namibia and recaptured on the west coast of South Africa (Toby Rogers, unpublished data). In a global context, despite being a widespread species with long distance movements, there is little genetic connectivity between geographically isolated subpopulations inhabiting distinct continental shelves (Benavides *et al.* 2011).

The CPUE from the KZN bather protection netting program fluctuated considerably but it was considered stable from 1978–2003, and appeared to be increasing (Dudley and Simpfendorfer 2006). These same trend data (up to 2003) were reanalysed over three generation lengths (71 years) and revealed an annual rate of increase of 4.8%, consistent with an estimated median increase of 420% over three generation lengths (71 years). From 2003–2018, the CPUE showed far less fluctuation but has steadily declined (Matt Dicken, KZN Sharks Board, unpublished data, cited by Huveneers *et al.* 2020).

There is a high level of uncertainty with the estimated population trends from other regions, and over most of its range, this species appears to be declining. Taking a precautionary approach, it is suspected that *C. brachyurus* has undergone a population reduction of 30–49% over the past three generation lengths (71 years) due to levels of exploitation, and it was assessed as Vulnerable on the IUCN Red List in 2020 (Huveneers *et al.* (2020).

ECOTOURISM
This species is strongly associated with the winter sardine run along the east coast, with individuals using the run to optimise access to this prey species (Dudley and Cliff 2010). On the south coast, particularly in the vicinity of seal colonies, this species has become the focus of cage dive operators in the absence of white sharks over the last five years (T Rogers, unpublished data). As a result, it must be recognised as an important ecotourism species.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
This species may be targeted in the demersal shark longline fishery, with a generic slot limit of 70–130 cm. There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
This pelagic species appears to be highly mobile, with the sardine run being a major driver of movement. It will therefore derive very limited protection from all the coastal MPAs in its range. Very

little is known of the whereabouts of sensitive life history phases, such as the mating, gestation and nursery grounds, to ascertain if these areas fall inside any MPAs.

Additional local comment

Current IUCN Status
<u>Vulnerable 2020 A2bd</u>

Previous IUCN assessments
Near Threatened 2003

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

International comments
There are no species-specific management or conservation measures known to be in place. In 2003, the European Commission (EC) prohibited EC vessels and non-EC vessels from removing all shark fins and subsequent discarding of the body, and all landed sharks needed to have a fin-to-carcass ratio of 5% for the shark's whole-body weight (Huveneers *et al.* (2020).

MANAGEMENT CONSIDERATIONS
The life history characteristics of this species suggest that it cannot sustain high levels of exploitation. The sustainability of catches in the major fisheries needs to be assessed but fishers and fisheries observers first need to be able to confidently distinguish this species from its congeners, especially *C. obscurus.* An assessment of these fisheries may necessitate some capping of the catches, despite the recently introduced slot limit in the demersal longline fishery. The southern African distribution of this species extends into Namibia, which necessitates international research collaboration and an insight into the various Namibian fisheries that exploit *C. brachyurus*, either as a target or bycatch. A better understanding of movement between the two countries is needed. Restrictions in various commercial fishery catches should be considered in proximity to important eco-tourism locations, such as Gansbaai. Toxicological studies to determine levels of heavy metals and organochlorines should be conducted on the individuals which are caught on the south coast in the commercial linefishery and demersal longline fishery and are known to be sold for human consumption.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
This is a moderately well-studied species, with more information needed on several aspects of its life history, in particular, the location of mating and nursery grounds and the whereabouts of pregnant females. A detailed analysis of existing tagging data will yield important baseline information on the general seasonal movements and site fidelity of *C. brachyurus*. The current acoustic tagging effort will improve understanding of the movements and habitat use (specifically in relation to MPAs) of the various life history stages, especially the neonates and pregnant females. A collaborative effort to understand transboundary movements between South Africa and Namibia is needed but this would require the use of satellite tags due to the paucity of acoustic receivers on the west coast of South Africa.

Carcharhinus brevipinna

SCIENTIFIC NAME	*Carcharhinus brevipinna* (Müller & Henle 1839)
COMMON NAME	Spinner shark
FAMILY	Carcharhinidae
ENDEMIC	No
SIZE RANGE	60–278 cm TL
SA DISTRIBUTION	E, S coasts: Mozambique border to Mossel Bay, possibly Struis Bay
HABITAT	Pelagic over sand bottoms and rocky reef areas
DEPTH RANGE	0–200 m; usually < 30 m
MAJOR FISHERIES	KZN bather protection nets, KZN prawn trawl fishery and possibly linefishery
IUCN STATUS	Vulnerable 2020
CITES	Not listed
MLRA	Daily bag limit of one in recreational fishery
COMPILER	G Cliff
REVIEWER	GL Jordaan

SPECIES SUMMARY and RECOMMENDATIONS

Carcharhinus brevipinna is a medium-sized pelagic shark with a cosmopolitan distribution in tropical and warm temperate seas. In South Africa it occurs on the entire east coast and the northern part of the south coast and is most common in central and southern KZN, with a nursery ground inshore of the productive uThukela Banks. It is found in Mozambique and countries to the north. Local catch was estimated at 1–10 tons per annum (DFFE records: 2010–2012). Highest catches were listed in the KZN bather protection programme and the now closed KZN prawn trawl fishery. Internationally its fins are regarded as valuable and it is heavily fished in most its range. It was assessed globally as Vulnerable on the IUCN Red List in 2020. By contrast, the trend analysis of the catches in the bather protection nets was indicative of a population which must be regarded as Least Concern in South Africa. As a highly mobile species, it will derive limited protection from all the Marine Protected Areas on the east and south coasts. The most important of these is the uThukela Banks MPA, as many term pregnant females have been caught in the bather protection nets nearby and there is a nursery ground close inshore. Quantifying the catch in fisheries such as the commercial linefishery and demersal longline fishery is needed. It is conceivable that, despite its nomadic behaviour, this species is able to complete its life cycle within South African territorial waters. This would simplify any management considerations, but there is likely to be some emigration into Mozambique waters. This should be addressed by an investigation of movement patterns utilising acoustic tracking. An assessment of regional population structure would also benefit management of this active species.

TAXONOMIC and IDENTIFICATION ISSUES

There are no current taxonomic issues, but this species has endured a convoluted nomenclatural history, with details provided by Bass *et al*. (1973) and a recent update by Ebert *et al.* (2021). This species was first described in South Africa in 1951 by Smith as *C. johnsoni*, despite its acknowledged similarity to *C. maculipinnis* of the NW Atlantic. In 1964 it was listed as a junior synonym of *C. maculipinnis* (D'Aubrey 1964), but Bass *et al*. (1973) decided that these two names were all synonymous with *C. brevipinna.* This species is one of 17 members of the genus *Carcharhinus* found on the southern African east coast. Many are very similar in overall appearance, with features such snout shape, dentition, the position of the first dorsal fin relative to the pectoral fins, the presence or absence of an interdorsal ridge and fin pigmentation used to separate the species. *C. brevipinna* is most likely to be confused with the blacktip shark *C. limbatus* in that both species lack an interdorsal ridge and have a long, pointed snout and narrow, erect upper jaw teeth. These two species are easily separated by snout length, the height and position of the dorsal fin relative to the pectoral fins and the size of the teeth. *C. brevipinna* has a longer snout and smaller teeth and its first dorsal fin is lower and positioned further back along the body (Bass *et al.* 1973). Unlike the adults, the neonates of *C. brevipinna* (65–75 cm), lack any fin pigmentation, which, together with their slender body and long snouts, has resulted in them being confused with milk sharks *Rhizoprionodon acutus* which attain a maximum length of 110 cm. This is a problem among the KZN shore anglers, many of whom may be unaware that *C. brevipinna* has a nursery ground inshore of the uThukela Banks (Allen and Cliff 2000) and that many of their catches may be newborn *C. brevipinna* rather than *R. acutus*.

SOUTH AFRICAN DISTRIBUTION

This species occurs along the entire east coast and part of the south coast, from the Mozambique border to Mossel Bay (Ebert *et al.* 2021). This should be extended to Struis Bay, as an individual was tagged by a recreational angler at Stilbaai, 100 km to the west of Mossel Bay and another at Struis Bay 230 km to the west (Gareth Jordaan, Oceanographic Research Institute Tagging Programme). The identity of these two individuals cannot be confirmed.

REGIONAL DISTRIBUTION

This species is present in Mozambique and Madagascar but not further north in Tanzania (Rigby *et al.* 2020c).

SYNOPSIS OF RESEARCH

This is a well-studied species in South Africa. Bass *et al.* (1973) reviewed the taxonomy of the genus and provided detailed morphometric and biological information from several hundred individuals, including adults and pregnant females. An analysis of catch statistics and general biology of 2728 individuals caught in the KZN bather protection programme was undertaken by Allen and Cliff (2000), followed by a more detailed analysis of catch trends (Dudley and Simpfendorfer 2006). These individuals were used for an ageing study (Allen and Wintner 2002). Davidson and Cliff (2002) and Davidson *et al.* (2011a) investigated liver lipid content and Davidson *et al.* (2011b) investigated heart and muscle lipids. This species takes advantage of the seasonal influx of sardines along the east coast (Dudley and Cliff 2010). Maternal investment in the reproductive output was investigated by Hussey *et al.* (2010). The genetic structure of individuals from the east coast of South Africa was compared with those from Australia (Geraghty *et al.* 2013). McKinney *et al.* (2016) examined the trophic ecology and muscle mercury content of this species and several other large sharks from KZN coastal waters. Comparative information on the biology and ecology of this species is available from studies in the Gulf of Mexico, NW and SW Atlantic and W Pacific (see Allen and Cliff 2000 and Rigby *et al*. 2020c and references cited in both publications).

ECOLOGY

Depth

This pelagic species occurs from the surfzone, where the neonates are seasonally abundant, out to water depths of at least 30 m (Bass *et al*. 1973). Off Madagascar this species has been recorded at depths of up to 75 m (Fourmanior 1961 cited by Bass *et al*. 1973). Elsewhere in its range it occurs to depths of 200 m (Rigby *et al.* 2020c).

Habitat: Adults

The adults are pelagic and highly mobile; they occur in the coastal waters, with most individuals caught in water shallower than 30 m; the females move inshore to mate and pup (Bass *et al*. 1973, Allen and Cliff 2000).

Habitat: Juveniles/Nursery Grounds

They occur in the surfzone on the KZN coast, with evidence of a nursery ground inshore of the uThukela Banks (Bass *et al.* 1973, Allen and Cliff 2000).

Synopsis of tag deployments
A total of 681 individuals were tagged in the ORI Cooperative Fish Tagging Project (CFTP) 1984-2018 inclusive. There were 24 recaptures (4%), with the mean distance travelled of 92 km (maximum 1055 km) and mean time at liberty of 3.5 months (maximum 3.5 years) (Jordaan *et al.* 2020).

Movements
This pelagic species is highly mobile, given that their catches in the KZN bather protection nets show a distinct seasonality (Allen and Cliff 2000). In addition, there are long-distance movements of individuals tagged in the ORI CFTP (Jordaan *et al.* 2020). There was evidence of a southward shift in the distribution of adults in response to the winter sardine run (Dudley and Cliff 2010). No local acoustic tagging has been undertaken, nor has a detailed analysis been undertaken of the tag-recaptures mentioned above. This species is migratory in the Gulf of Mexico (Compagno 1984).

Diet/feeding: adults
The adults fed mainly on small (<30 cm) shoaling teleosts, with a high incidence of sardines *Sardinops sagax* in winter and a very low incidence of cephalopods throughout the year (Allen and Cliff 2000, Dudley and Cliff 2010).

Diet/feeding: juveniles
Immature individuals also fed mainly on small (<30 cm) shoaling teleosts, with a much lower incidence of sardines *S. sagax* (Allen and Cliff 2000). There was a higher incidence of bottom-dwelling teleosts than found in adults (Allen and Cliff 2000).

South African toxicological studies
One toxological study has been conducted on this species in South Africa, using specimens caught in the KZN bather protection nets. Levels of total mercury in the muscle tissue of 19 juveniles and adults (74–250 cm) showed a positive correlation with body length. Although the values for *C. brevipinna* were lower than most of the other species tested, they were far higher than international regulatory guidelines for human and fish health (McKinney *et al.* 2016 and references cited therein).

REPRODUCTION

REPRODUCTIVE MODE	Placental viviparity
DURATION OF REPRO CYCLE	2 years
MATING	Late summer, KZN waters
GESTATION	13–18 months
LITTER SIZE	Mean of 9; maximum 17; n=273
PUPPING/NURSERY GROUND	Prolonged pupping season March to August inshore on central KZN coast
LENGTH AT BIRTH	65–80 cm
LENGTH AT MATURITY	50% maturity F: 200 cm, M: 195 cm
MAXIMUM LENGTH	F: 266 cm; M: 233 cm
GENERATION LENGTH	13-20 years (Australia and Gulf of Mexico)

Mode
This species exhibits placental viviparity (Bass *et al*. 1973).

Duration of reproductive cycle
In South Africa there is a biennial reproductive cycle (Allen and Cliff 2000), as has been reported elsewhere (Rigby *et al*. 2020c and references cited therein).

Mating season and location

The mating season is in February and March in inshore waters of central and southern KZN (Allen and Cliff 2000).

Gestation

In South Africa this is in the region of 13–18 months (Allen and Cliff 2000).

Litter size

In South Africa the mean litter size from 273 litters was nine embryos, with a maximum of 17 (Allen and Cliff 2000).

Length at birth

In South Africa this is 65–80 cm (Bass *et al.* 1973, Allen and Cliff 2000). Elsewhere size-at-birth is 48–80 cm (Rigby *et al*. 2020c and references cited therein).

Pupping season and nursery ground

In South Africa the pupping season is prolonged, with term embryos present in pregnant females between March and August. Catches of pregnant sharks in the KZN bather protection programme were highest at Zinkwazi and Richards Bay, the two northernmost protected localities (Allen and Cliff 2000). They are inshore of the productive uThukela Banks (Fennessy 1994), which appears to be a preferred pupping ground.

Length at maturity

In South Africa females attain 50% maturity at 200 cm and males at 195 cm (Allen and Cliff 2000). There is regional variation in length at maturity, ranging from 257–310 cm for females and 265–280 cm for males (see Allen and Cliff 2000 and references cited therein).

Maximum length

The largest female recorded on the east coast of South Africa was 266 cm and the largest male 233 cm (Bass *et al*. 1973).

Age and growth

Assuming annual growth band deposition, both females and males matured at 8–10 years; the oldest individuals were a 17-year-old female and a 19-year-old male (Allen and Wintner 2000). In Australia, verified female age-at-maturity was 8.5 years and maximum age 31 years; in the Gulf of Mexico, verified female age-at-maturity was 7.6 years with a maximum age of 17.5 years (Rigby *et al*. 2020c and references cited therein).

Generation length

Based on the age and growth data presented above, generation length in South Africa is 10 years (Dudley and Simpfendorfer 2006), but, based on verified ages, it was 13 years in the Gulf of Mexico and 20 years in Australia, hence the decision to use the value 13-20 (Rigby *et al*. 2020c and references cited therein).

FISHERIES MANAGEMENT

SA catch sources

Local catch was estimated at 1–10 tons per annum (DFFE records: 2010-2012), with the KZN bather protection programme listed as the biggest contributor, followed by the prawn trawl fishery. It was also listed as a suspected catch in the commercial and recreational linefisheries and the pelagic longline fishery (da Silva *et al.* 2015).

SA catch quantities and characteristics

KZN bather protection nets

The mean annual catch in the KZN bather protection nets was 136 (range 62–234) for the period 1978-1997; 9% of the catch was released alive. This species constituted 10% of the total shark catch for that period and, despite considerable interannual variation, there was no significant linear trend in catch or catch rate with time. Mean annual catch in the period 2000-2009 was down to 51, largely due to judicious management of net deployment during the annual sardine run and the widespread replacement of shark nets with baited drumlines, which have an extremely low catch of *C. brevipinna* (Cliff and Dudley 2011). The catch was unimodal (Allen and Cliff 2000), with 74% of females and 71% of males mature (Dudley and Simpfendorfer 2006). Catch rates for the period 1978-2019 were stable (KZN Sharks Board unpubl. data, cited by Rigby *et al*. 2020c).

KZN prawn trawl fishery
This species was caught in large numbers in the KZN prawn trawl industry on the uThukela Banks. The extrapolated annual catch for the period 1989 and 1992 was 441 (range 334–630). Although it was based on an extremely small sample size, survival rates were poor (44%), with 11 out of 25 individuals released alive. Size range was 0.6–1.6 m, with a mean of 0.9 m, which would comprise largely neonates and other juveniles (Fennessy 1994).

Recreational shore angling
This species is not an uncommon catch by shore anglers in KZN, especially inshore of the uThukela Banks, but catch statistics are marred by the inability to distinguish juveniles of this species from *R. acutus.* In KZN competitive shore anglers caught only 1351 individuals over a 24-year period (1977–2000), at a rate of 56 per annum and with a mean individual mass of 2.3 kg, which is that of a neonate. By comparison, 38071 *R. acutus* were caught by these anglers over the same period (Pradervand *et al.* 2007).

In the Transkei/Wild Coast regions to the south of KZN, only 35 *C. brevipinna* were reported in catches of competitive shore anglers over the same 24-year period (1977–2000; Pradervand 2004).

Pelagic longline fishery
This species has not been reported in the southern African tuna and swordfish longline fisheries (Petersen *et al.* 2009; Jordaan *et al*. 2020). This fishery is not permitted within 12 nautical miles of the coast and 24 nm in KZN (da Silva *et al*. 2015) and as *C. brevipinna* is generally restricted to water shallower than 30 m (Bass *et al*. 1973), it is highly unlikely to be caught in this fishery.

Commercial linefishery
In the mid-1990s shark exports from South Africa started to increase, with a new directed demersal shark fishery moving into the fin trade and subsequently into the shark fillet export industry to Australia, where local supply cannot meet the demand (da Silva and Bürgener, 2007). There is no evidence that *C. brevipinna* is one of the species involved, but with the seasonal abundance of the neonates, especially inshore of the uThukela Banks, it is possible that some juveniles are taken in this fishery for export to Australia. Small sharks are preferred in this industry to avoid the problems of accumulation of high levels of contaminants, such as mercury, found in larger individuals (da Silva and Burgener 2007).

Fishing outside South Africa
C. brevipinna is caught globally as target and retained bycatch of industrial, small-scale, and recreational fisheries using a range of gears, including trawl, longline, and gillnet. There are also under-reporting issues due to possible misidentification with *C. limbatus.* At-vessel mortality (AVM) was estimated as 56% in a commercial prawn trawl fishery and 4–97% in commercial longline fisheries. The longer soak times in the longline fisheries result in a much higher AVM (Rigby *et al*. 2020c and references cited therein).

In Mozambique and Madagascar, mostly unregulated small-scale fisheries that target sharks, including *C. brevipinna*, are intense with 45,805 and 78,787 vessels, respectively operating in these countries in 2013 and 2012, respectively (Rigby *et al*. 2020c and references cited therein).

The life history of this species indicates that it can sustain high levels of fishing mortality of juveniles as part of a gauntlet fishery, which only catches sub-adults and minimises mortalities of the breeding stock (Rigby *et al*. 2020c and references cited therein).

Population trends
No population estimates have been attempted in South Africa. There is strong genetic structure between the South African population and that from Australia but with no sampling of individuals from elsewhere in the Indo-Pacific (Geraghty *et al.* 2013).

An analysis of catches, which were predominantly adults, in the KZN bather protection nets over the 26-year period 1978-2003 indicated that potential effects of the nets was low and there was no significant decline in catch rate over time but there was a significant increase in the size of males (Dudley and Simpfendorfer 2006). The data were recently reassessed for the period 1978 to 2019, with the nominal CPUE showing fluctuations but considered stable. The trend analysis in CPUE for this 42-year period revealed annual rates of reduction of 0.2%, consistent with an estimated median reduction of 3.0% over three generation lengths (38 years), with the highest probability of <20% reduction over three generation lengths (Matt Dicken, KZN Sharks Board, unpubl. data, cited by Rigby *et al*. 2020c). Based on these findings, the South African population of *C. brevipinna* must be regarded as Least Concern.

C. brevipinna has low biological productivity and although there is less fishing pressure and there are managed fisheries in some parts of its range, most of its range occurs in areas of intensive and unregulated fisheries. It is suspected that this species has undergone a population reduction of 30–49% over the past three generation lengths (38–59 years) due to exploitation, and it was globally assessed as Vulnerable on the IUCN Red List in 2020 (Rigby *et al*. 2020c).

ECOTOURISM
This species is strongly associated with the winter sardine run along the east coast, with individuals following the sardine run to optimise access to this prey species (Dudley and Cliff 2010). Outside of the sardine run, there are few reports of regular sightings by divers. It must be recognised as an ecotourism species.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
This pelagic species is highly mobile. It will therefore derive very limited protection from all the MPAs on the east and south coasts. Most of the term pregnant females caught in the KZN bather protection programme were taken at Richards Bay and Zinkwazi. Neonates are caught seasonally by shore anglers between these two locations. Much of these inshore waters are within the uThukela Banks MPA, which therefore potentially offers considerable protection to two important life history stages of this species.

Additional local comment

Current IUCN Status
Vulnerable: A2bd

Previous IUCN assessments
Near Threatened 2009
Near Threatened 2000

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

International comments

MANAGEMENT CONSIDERATIONS

The life history characteristics of this species suggest that the adult component of the population cannot sustain high levels of exploitation, although it can sustain high levels of fishing mortality of juveniles as part of a gauntlet fishery. Quantification of catches in other fisheries, especially the commercial linefishery, is needed. Fishers and fisheries observers need to be able to confidently distinguish this species from its congener *C. limbatus* and the milk shark *R. acutus.*

The nursery grounds of this species are on the central KZN coast, of which part falls inside the uThukela Banks MPA. With mating males and females caught in the KZN bather protection programme, it is possible that this species can complete its life cycle entirely in South African territorial waters, which would simplify management of this species. There is likely to be some emigration into Mozambique waters and it is important to quantify this, given the high artisanal catches of nearshore sharks in that country and the potentially high impact on species such as *C. brevipinna*. Given that the local population status is one of Least Concern, based on long-term catch trends in the KZN bather protection programme, this species must be regarded as being of fairly low management priority.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

This is a well-studied species. Knowledge of its biology and life history is good with the location of the pupping grounds known to be in the vicinity of the uThukela Banks MPA. Far less is known of its movement patterns; this could be rectified by a detailed analysis of the existing tag-recapture data generated by the ORI Cooperative Fish Tagging Project, supplemented by the deployment of long term (10-year) acoustic tags. This would quantify the degree of movement between South Africa and Mozambique, where its exploitation is likely to be a lot greater. A regional genetic study to investigate population structure would be beneficial. The KZN Sharks Board has collected a large number of tissue samples for this purpose.

Carcharhinus falciformis

SCIENTIFIC NAME	*Carcharhinus falciformis* (Müller and Henle 1839)
COMMON NAME	Silky shark
FAMILY	Carcharhinidae
ENDEMIC	No, circumglobal in tropical waters
SIZE RANGE	78–330 cm TL
SA DISTRIBUTION	E, S coasts: northern and central KZN and Agulhas Banks
HABITAT	Pelagic in oceanic and shelf edge waters
DEPTH RANGE	20–500 m
MAJOR FISHERIES	Pelagic longline fishery (purse seine fisheries elsewhere)
IUCN STATUS	Vulnerable 2017
CITES	Appendix II (2017)
MLRA	No retention in pelagic longline fishery; daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	JD Filmalter

SPECIES SUMMARY and RECOMMENDATIONS

Carcharhinus falciformis is a large pelagic shark with circumglobal distribution in tropical oceanic waters. Local catch was estimated at 1-10 tons per annum (DFFE records: 2010–2012), with pelagic longlining being the major component. In the Indian Ocean there are no reliable stock indicators, but extrapolated annual mortalities in the tuna purse seine fishery through entanglement in FADs (fish aggregating devices) alone were historically in the region of 500,000 sharks; this was prior to the requirement for non-entangling FADs. It is one of the three most traded shark species on the international market. Regional declines outside the Indian Ocean resulted in this species being assessed as Vulnerable in 2017. A number of international initiatives have been introduced to control or reduce exploitation, including listing on Appendix II of CITES and, as such, it may not be retained in the local pelagic longline fishery. Given its possibly low catches and limited distribution in South African waters, it must be regarded as a low priority species. Illegal exploitation within the South African EEZ could be a problem. Survival rates following release from pelagic longlines need to be investigated.

TAXONOMIC and IDENTIFICATION ISSUES

There are no taxonomic issues, although there are 16 other species in the genus *Carcharhinus* on the east coast of South Africa. Many are very similar in overall appearance, with features such snout shape, dentition, the position of the first dorsal fin relative to the pectoral fins, the presence or absence of an interdorsal ridge and fin pigmentation used to separate the species. The silky shark may be confused with the bignose shark *C altimus*, Galapagos shark *C. galapagensis*, dusky shark *C. obscurus* and sandbar shark *C. plumbeus.* All have an interdorsal ridge and similar shaped snout and erect upper jaw teeth. These species are largely separated by the position of the dorsal fin relative to the pectoral fins (Bass *et al*. 1973). *C. falciformis* can be identified *inter alia* by its falcate first dorsal and pectoral fins (hence its name *falciformis*, meaning sickle-shaped); relatively small first dorsal fin with its origin behind the free tips of the pectoral fins; small and low second dorsal fin with long trailing edge and the shape of the teeth in the upper jaw (Bonfil 2008).

SOUTH AFRICAN DISTRIBUTION

This species occurs in the northern part of the east coast (central KZN) to the Mozambique border (Ebert *et al.* 2021), but there are recent confirmed reports of tuna longline catches of this species off the Agulhas Bank on the south coast (Gareth Jordaan, Oceanographic Research Institute pers. comm.).

This is not surprising as Petersen *et al.* (2009) suspected that catches in this fishery may include *C. falciformis*, mistakenly identified as *C. obscurus.*

REGIONAL DISTRIBUTION
It is present in Mozambique northwards to Kenya, Madagacar and several islands in the Western Indian Ocean and from Angola northwards in the Atlantic Ocean (Compagno 1984a).

SYNOPSIS OF RESEARCH
In South Africa Bass *et al.* (1973) provided taxonomic, morphometric and biological information but only had direct access to about 10 individuals. Despite its wide distribution and its prominence in oceanic fisheries, no research has been conducted on this species in the South African waters. Bonfil (2008) provided an overview of the global state of knowledge of this species. In the equatorial waters of the Western Indian Ocean (Filmalter *et al.* 2011, 2013 and Filmalter 2015) studied the behaviour of this species around FADs and quantified the levels of entanglement in these FADs.

ECOLOGY
Depth
This is a pelagic, oceanic species which also occurs offshore in coastal tropical waters from the surface to at least 500 m (Ebert *et al*. 2013), but appears to be most common between the surface and a depth of 35 m (Filmalter *et al*. 2011).

Habitat: Adults
The adults inhabit tropical oceanic waters and off the continental and insular shelves (Bonfil 2008).

Habitat: Juveniles/Nursery Grounds
In the Atlantic and possibly elsewhere neonates have a more demersal lifestyle occupying nursery grounds in shelf waters (Bonfil 2008). In the western Indian Ocean juveniles regularly associate with floating objects in the pelagic environment and are found in oceanic waters between 20°S and 15°N. There is no evidence of spatially explicit nursery areas in the Indian Ocean (Filmalter 2015).

Synopsis of tag deployments
As this species occurs far offshore, no individuals have been tagged in the ORI Cooperative Fish Tagging Project 1984-2018 inclusive. Stevens (1984a) deployed only two dart tags in adult silky sharks at Aldabra in the Seychelles and recaptured one individual 140 days later, 11 km from its tagging site. Filmalter (2015) deployed 45 pop-up archival tags and four archival tags on juvenile silky sharks in the Mozambique Channel and the equatorial waters of the western Indian Ocean. Acoustic tracking has also been undertaken in the same region areas (Filmalter *et al*. 2011) and indicated considerable fidelity to FADs (fish aggregating devices).

Movements
Satellite-tagged individuals in the Western Indian Ocean displayed a diverse range of movement patterns, with some individuals undertaking large-scale movements exceeding 4700 km (Curnick *et al*. 2020). Others showed more restricted movements, especially in the northern Mozambique channel, however once they left this area, they also moved extensively. Some movements were correlated with major currents which may reflect association with drifting objects, however Bonnin *et al*. (2020) showed that juvenile silky sharks move independently of surface currents for at least 30% of their time. Filmalter *et al*. (2011) tracked the movement of juveniles in relation to drifting FADs and found an average residence time of 15 days at the same floating object.

Diet/feeding: adults
This species feeds in the water column and near the bottom, forming large aggregations when food is abundant. It feeds primarily on pelagic and inshore teleosts, squid and pelagic crabs (Bonfil 2008).

Diet/feeding: juveniles

The diet of juveniles associated with floating objects in the Western Indian Ocean was found to consist primarily of teleosts, followed by pelagic crustaceans and cephalopods (Filmalter *et al*. 2017). Evidence of diel feeding patterns was also apparent both from behavioural data and the diet, which contains many species known to follow diel vertical migrations in the pelagic environment.

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Placental viviparity
DURATION OF REPRO CYCLE	2 years
MATING	Generally aseasonal
GESTATION	12 months
LITTER SIZE	9–14, average 11
PUPPING/NURSERY GROUND	Generally aseasonal
LENGTH AT BIRTH	78–87 cm
LENGTH AT MATURITY	F: 200–260 cm; M: 210–240 cm
MAXIMUM LENGTH	330 cm
GENERATION LENGTH	15 years

Mode

This species exhibits placental viviparity (Bass *et al.* 1973).

Duration of reproductive cycle

This is 2 years (Bonfil 2008) but more recent research suggests that it can vary regionally from 1-2 years and somewhere in between (Rigby *et al.* 2017 and references cited therein).

Mating season and location

In the SW Indian Ocean there was no evidence of a seasonal pattern (Bass *et al.* 1973); the same applies to other regions, except in the Gulf of Mexico, where mating occurs in late spring and summer (Bonfil 2008).

Gestation

This is 12 months (Bass *et al.* 1973).

Litter size

In the SW Indian Ocean litter size average 11, with a range of 9–14 (Bass *et al.* 1973). Globally this range is more commonly 6-12, with a maximum of 16 (Bonfil 2008).

Length at birth

In the SW Indian Ocean size at birth is possibly 78-87 cm (Bass *et al.* 1973), but elsewhere it varies regionally from 56 to 84 cm (Bonfil 2008).

Pupping season and nursery grounds

There is no correlation in the SW Indian Ocean between embryo length and time of the year (Bass *et al.* 1973). The location of nursery grounds in the region has not been documented and the wide-ranging movements of tagged juveniles suggests that no defined nursery area exists (Filmalter *et al.* in press).

Length at maturity
Rabehagasoa *et al*. (2014) found the size at 50% maturity was 170 cm for both sexes combined from samples collected across the western Indian Ocean. Elsewhere there are regional variations in these sizes (Bonfil 2008), ranging from 180–246 cm for females and 180–230 cm for males (Rigby *et al.* 2017).

Maximum length
This species reaches a maximum length of 330 cm (Compagno 1984a).

Age and growth
Age at 50% maturity was found to be 8 years for both sexes combined in the Western Indian Ocean (Rabehagasoa *et al*. 2014). Research elsewhere indicates large regional variation in age estimates, with age-at-maturity ranging from 6–15 years for females and 5–13 years for males, and maximum ages of 11–36 years for females and 8–29 years for males. (Rigby *et al.* 2017).

Generation length
This is 15 years (Rigby *et al.* 2017).

FISHERIES MANAGEMENT
SA catch sources
Local catch was estimated at 1–10 tons (DFFE records: 2010–2012). It is primarily caught in pelagic longline fisheries elsewhere and was listed as a possible catch in the South African fishery (da Silva *et al.* 2015). The annual catch of 1-10 tons seems high, given that no catch numbers were attributed to this species in the pelagic longline fishery (see below).

SA catch quantities and characteristics
Pelagic longline fishery
This species is possibly one of the large pelagic sharks caught in the Southern African tuna and swordfish longline fisheries. The dusky shark *C. obscurus* represented 0.9% of the total shark bycatch by number in the period 1998-2005, which equates to about 400-500 individuals per year, although this possibly included misidentified *C. falciformis* (Petersen *et al.* 2009).

Fishing outside South Africa
This species is the second most caught species of shark globally, after the blue shark *Prionace glauca. C. falciformis* is both a target and bycatch by longline fisheries. It forms the primary elasmobranch bycatch in tropical tuna purse seine fisheries, especially those using drifting FADs, occurring in 48% of FAD fishing sets (Amandè *et al*. 2011). The vast majority of individuals caught in the purse seine fishery are early juveniles, with an average size of approximately 1 m (González *et al*. 2007; Amandè *et al*. 2008). FADs are constructed of a floating structure, typically a bamboo raft with additional flotation, and a structure, traditionally made of netting hanging below the surface, which "anchors" the FAD in the current, preventing wind drift. Sharks are easily entangled in the nets. There have been large increases in the use of FADs in the past 20–30 years. *C. falciformis* is highly vulnerable to entanglement due to its preference for surface waters and its propensity to associate with floating objects. Filmalter *et al.* (2013) quantified the entanglement mortalities, which historically were largely ignored because they were difficult to monitor. In the tropical Indian Ocean, where there are 3750–7500 active FADs, estimated entanglement mortality of this species is between 480 000 and 960 000 sharks per annum. These entanglements may be 5-10 times higher than the bycatch of this species in the tuna purse seine fishery. Recent management interventions have banned the use of "entangling" FADs which is likely to significantly reduce this source of mortality. Mortality rates are also high in longline and other purse seine fisheries (Rigby *et al.* 2017 and references cited therein). The species is also regularly captured in artisanal fisheries along the African East Coast (Rhett Bennett Wildlife Conservation Society, pers. comm.).

Where regulations allow, *C. falciformis* is often retained for its meat and fins, or released. This species represented at least 3–4% of the fins auctioned in Hong Kong, the world's largest shark fin trading centre, after the Blue Shark and all species of Hammerhead Shark grouped together. The fins are not among the most valuable (Rigby *et al.* 2017).

Population trends
The population structure is poorly understood. Genetic studies found that there are potentially three stocks in the Pacific; one in the W Pacific and two stocks in the E Pacific (north and south) separated by the equator. The degree of genetic separation is slight and may not be sufficient to consider them separate subpopulations (Rigby *et al.* 2017).

In the Indian Ocean there was no stock assessment or any reliable fishery indicators of status, therefore the stock status remains highly uncertain (Rigby *et al.* 2017). Elsewhere, estimates of trends in abundance over three generations (45 years) from standardized catch rate and spawning biomass indices showed declines in the E Central and SE Pacific Ocean, W Central Pacific Ocean and the Atlantic Ocean. Across all three ocean regions, there were major uncertainties in estimates of catch rate and population changes, and an inability to conclusively attribute any declines solely to fishing mortality as there was some potential for environmental influences on catchability and sampling artefacts. The weighted global population trend estimated a 47–54% decline over three generations. This reflected the proportionate contribution of each region. The estimated level of decline and the uncertainties in the data warranted a global status of Vulnerable in 2017, with the caveat that this assessment should be revisited when more definitive catch data and stock assessments become available.

ECOTOURISM
This species commonly occurs offshore although near the surface, and cannot be regarded as an ecotourism species.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
As a CITES Appendix II species, its retention in the pelagic longline fishery is prohibited. There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
This species will potentially only benefit from offshore MPAs such as the iSimangaliso MPA, but this particular MPA may still be too close inshore. Furthermore, this species is likely to be nomadic or migratory and is unlikely to remain in such a small area for any length of time.

Additional local comment

IUCN Red List Status
Vulnerable 2017: A2bd

Previous IUCN assessments
Near Threatened 2016
Near Threatened 2009
Least Concern 2000

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

This species was added to Appendix II of the Convention on International Trade in Endangered Species (CITES) in 2017.

Convention on Migratory Species (CMS)
This species was added to Annex 1 of the Convention on Migratory Species (CMS) Memorandum of Understanding (MoU) for Migratory Sharks in 2018, even though the species is not (yet) included on the CMS Appendices (Rigby *et al.* 2017).

International comments
This species is protected in several countries that have either banned all targeting of sharks in commercial fisheries or shark finning bans, which often require fins to be attached to the carcass until landed operating in their waters. Bans on the retention of this species are in place for all vessels operating under ICCAT International Commission for the Conservation of Atlantic Tunas and WCPFC (Western Central Pacific Fisheries Commission). No management arrangements are in place for *C. falciformis* in the IOTC region (Rigby *et al.* 2017).

This species has a high level of post-release mortality (>84% in tropical tuna purse seines) and high level of hooking mortality (~56% on tropical longlines). The mandatory use of circle hooks in 2004 in the US pelagic longline fishery greatly improved post-release survival (41% to 56%) (Rigby *et al.* 2017 and references cited therein).

MANAGEMENT CONSIDERATIONS
The ability of the South African fisheries authorities to protect its entire EEZ, particularly its outer limits where *C. falciformis* is likely to occur, is of concern. Fisheries observers need to be trained to be able to distinguish this species from *C. obscurus,* which appears to be fairly common in the pelagic longline industry, and other species in the genus. The *modus operandi* of the pelagic longline industry needs to ensure the maximum chances of survival of this and other large pelagic shark species without severely jeopardising catches of the target species. Mortality/survival levels in this fishery need to be quantified. In the absence of any regional genetic structure, it is highly likely that the individuals caught in the FADs used by tuna purse seine vessels in the tropical Western Indian Ocean are part of the same stock occurring off the KZN coast. South African fisheries authorities must support efforts to curb the high levels of mortality reported for this species as a result of accidental entanglement in the FADs and as bycatch in purse seine and longline fisheries.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
As this species is oceanic, research opportunities are limited. Very little is known of the mating and nursery grounds and movement patterns of this species, especially regionally. Satellite tracking of mature females could potentially shed light on these activities, albeit an expensive tool. Any opportunistic sampling opportunities should be used to collect more life history information and tissue samples for genetic studies.

Carcharhinus leucas

SCIENTIFIC NAME	*Carcharhinus leucas* (Müller & Henle 1839)
COMMON NAME	Zambezi/bull shark
FAMILY	Carcharhinidae
ENDEMIC	No
SIZE RANGE	60–400 cm TL
SA DISTRIBUTION	E and S coasts: Mozambique border to Breede River
HABITAT	Open water close to sand bottoms and rocky reef areas, as well as estuaries
DEPTH RANGE	0–250 m
MAJOR FISHERIES	KZN bather protection nets and KZN prawn trawl fishery, recreation and commercial linefisheries
IUCN STATUS	Vulnerable 2020
CITES	Not listed
MLRA	Daily bag limit of one in recreational fishery
COMPILER	G Cliff
REVIEWER	R Daly

SPECIES SUMMARY and RECOMMENDATIONS

Carcharhinus leucas is a large pelagic shark with a cosmopolitan distribution in coastal tropical and subtropical waters and occasionally freshwater. In South Africa it occurs on the entire east coast and part of the south coast. It is found in Mozambique northwards, along the entire African east coast. Local catch was estimated at 1–10 ton per annum (DFFE records: 2010–2012). It was listed as a catch in the KZN bather protection programme and a suspected catch in several other fisheries. It was assessed globally as Vulnerable on the IUCN Red List in 2020, with the long-term decline in catches in the KZN bather protection programme being a major factor in this global assessment. It is a well-studied species with extensive research undertaken in the Lake St Lucia system which was the major nursery ground prior to its prolonged closure to the sea. In winter there is a northward emigration from the east coast into Mozambique waters, where the species is vulnerable to extensive artisanal fishing pressure. Estuarine degradation could be adversely impacting recruitment. The location of the mating grounds and the recently pregnant females appears to be in Mozambique and is therefore of concern.

TAXONOMIC and IDENTIFICATION ISSUES

This species is one of 17 members of the genus *Carcharhinus* found on the southern African east coast. Many are very similar in overall appearance, with features such snout shape, dentition, the position of the first dorsal fin relative to the pectoral fins, the presence or absence of an interdorsal ridge and fin pigmentation used to separate the species. There are only two members of this genus in the SW Indian Ocean which lack an interdorsal ridge and strong fin markings and possess an extremely blunt snout, stocky body and heavily serrated, broad-cusped upper teeth. They are *C. leucas* and the pigeye/Java shark *C. amboinensis*, which can only be separated in the field by the relative heights of the two dorsal fins and the tooth count, but not tooth shape. *C. leucas* has a lower first dorsal and higher second dorsal fin and usually 12 teeth on each side of the lower jaw (Bass *et al.* 1973). These authors provided a detailed comment on the taxonomic history of these two species, noting that “the two species resemble one another closely and have only been recognised as two distinct species in the last decade”. Awareness levels of *C. amboinensis* are not high and it is likely that individuals are still mistaken for *C. leucas.*

SOUTH AFRICAN DISTRIBUTION

This species occurs along the entire east coast and part of the south coast, from the Mozambique border to the Breede River (Ebert *et al.* 2021). The discovery of a very large female in the Breede River in 2009 represented a southward range extension of 366 km (McCord and Lamberth 2009).

REGIONAL DISTRIBUTION

This species is present in Mozambique and Madagascar and the coastal waters of the entire W Indian Ocean (Rigby *et al.* 2021a).

SYNOPSIS OF RESEARCH

This is a well-studied species in South Africa. Bass *et al.* (1973) reviewed the taxonomy of the genus and provided detailed morphometric and biological information from over 400 individuals, including adults and a small number of pregnant females from southern Africa. This study included a detailed investigation of the use of the St Lucia Lake system by *C. leucas.* An analysis of catch statistics and general biology of 772 individuals caught in the KZN bather protection programme between 1978 and 1990 was undertaken by Cliff and Dudley (1991), followed by a more detailed analysis of catch trends (Dudley and Simpfendorfer 2006). These individuals were also used for a study of age and growth (Wintner *et al.* 2002), liver lipids (Davidson and Cliff 2011), heart and muscle lipids (Davidson *et al.* 2011) and mercury concentrations (McKinney *et al*. 2016). Daly *et al.* (2013) further investigated trophic ecology and Daly *et al.* (2014) documented regional movement patterns. High genetic connectivity was found within the W Indian Ocean, which included individuals from the KZN coast (Pirog *et al.* 2019). There is recent evidence of recruitment into the Lake St Lucia system following prolonged closure to the sea and of neonate predation by the Nile crocodile *Crocodylus niloticus* (Daly *et al.* 2021). McCord and Cliff (2013) provided an overview of the life history and fisheries details of this species. Comparative information on the biology and ecology of this species is available from studies elsewhere in its extensive range (see Rigby *et al*. 2021a and references cited therein).

ECOLOGY

Depth

This is an inshore species, often caught by shore anglers and in the KZN bather protection nets. The maximum depth attained by 18 adult sharks fitted with satellite archival tags in South Africa and Mozambique was 256 m with a mean maximum depth of 152 m. In daylight hours they were mostly found at depths of 25–50 m and 0–5 m at night (Ryan Daly, Oceanographic Research Institute and JD Filmalter, South African Institute of Aquatic Biodiversity, unpublished data).

Habitat: Adults

They occur throughout the water column close inshore, but predominantly near the bottom. This species is well known for its ability to penetrate into fresh water and an unsized individual was found over 1000 km from the sea in the Zambezi River in central Mozambique (Bass *et al.* 1973). Pregnant females enter the mouths of estuaries, including the Lake St Lucia system, to give birth (Bass *et al.* 1973). A very large female was tracked in the Breede River system and moved 20 km upstream and 2 km out to sea over a 2-day period and appeared to be pregnant (McCord and Lamberth 2009). While there was previously no evidence of adult males moving into South African estuaries (Bass *et al.* 1973), six individuals were recently tagged in the Breede River, with the furthest record upstream of 36 km (R Daly, ORI, unpublished data).

Catches of both adults and juveniles (excluding neonates) in the KZN bather protection programme were highest in the north (Richards Bay, Mtunzini and Zinkwazi) where water turbidity is high, but this was less marked in the case of the adults (Cliff and Dudley 1991). Despite being tolerant of turbid waters, they also occur on deeper coastal reefs 3–8 km offshore, where the water is usually very clear; these locations include Protea Banks on the KZN south coast and The Pinnacles in southern Mozambique, both inside Marine Protected Areas.

Habitat: Juveniles/Nursery Grounds

Neonates and slightly larger juveniles (60–90 cm) were common in the estuary and The Narrows of the Lake St Lucia system. Hypersaline conditions are not uncommon in this system when evaporation exceeds freshwater inflow and juveniles were often caught in water with a salinity of close to 50 parts per thousand. Many of the smaller individuals had open or recently healed umbilical slits, indicating that they had been born not long before capture (Bass *et al.* 1973). There is evidence that other larger estuarine systems on the east coast are nursery grounds for this species, including the Umzimvubu River at Port St Johns (Paul Cowley, South African Institute of Aquatic Biodiversity; KZN Sharks Board unpublished data). The prolonged closure of the mouth of the Lake St Lucia system for two decades (Daly *et al.* 2021) may have forced this species to utilise these other large estuarine systems as nursery grounds, but there is no evidence of any neonates in the Breede River, a large estuarine system at the southern/western limit of its distribution (Meag McCord, formerly South African Shark Conservancy, pers. comm.). Larger juveniles of 90–190 cm are also present in the Lake St Lucia system, but in the lake itself, which is well upstream of the Narrows and the estuary (Bass *et al.* 1973).

Catches of juveniles in the KZN bather protection programme excluded neonates and were highest in the north (Richards Bay, Mtunzini and Zinkwazi) where water turbidity is high (Cliff and Dudley 1991), due to the presence of large river systems.

Synopsis of tag deployments

A total of 481 individuals were tagged in the ORI Cooperative Fish Tagging Project 1984-2018 inclusive of which there were 31 recaptures (6%), with the mean distance travelled of 75 km (maximum 540 km) and mean time at liberty of 11 months (maximum 8.6 months) (Jordaan *et al.* 2020). A total of 60 individuals were tagged and released from the KZN bather protection nets, with two recaptures (Cliff and Dudley 1991). In a separate tagging programme, all but one recapture from individuals tagged in the Lake St Lucia system by Bass *et al.* (1973) were made within the system or at sea, less than 5 km from the mouth.

Movements

C. leucas is a highly mobile species which also shows residency. Although individuals were caught throughout the year in the KZN bather protection programme, there were strong seasonal and geographic variations in abundance (Cliff and Dudley Cliff 1991). Catches were highest in summer and lowest in winter, suggesting a northward emigration, probably into Mozambique waters, as a result of declining water temperatures with the onset of winter. McCord and Lamberth (2009) tracked the movements of a very large adult female, which appeared to be pregnant, in the Breede River for nearly two days, during which time it moved 2 km out to sea and 20 km upstream.

More recently, Daly *et al.* (2014) investigated regional movement patterns of 18 adults fitted with acoustic tags in southern Mozambique. Most of the sharks exhibited temporally and spatially variable residency patterns, interspersed with long distance, seasonal emigration events of 500–3000 km, that were postulated to be the result of a drop in water temperature with the onset of winter. The drivers of bull shark movements appear to be context driven. They are known to time their arrival at sites with spawning fish aggregations to make the most of foraging opportunities. However, when such events occur at the edge of their range the timing appears to be influenced by environmental conditions such as temperature, as individuals appear to have a low tolerance for water consistently below 19°C. Mating and reproduction are also important drivers of their movements as they may transit otherwise ideal foraging and temperature conditions to travel over 6000 km from the Breede River to northern Mozambique.

Diet/feeding: adults

Elasmobranchs, especially rays/batoids, dominated the diet, followed closely by teleosts; marine mammals were also taken. This species fed throughout the water column but concentrated on prey most often found on or near soft bottoms (Cliff and Dudley 1991).

Diet/feeding: juveniles

Teleosts were the most frequently encountered prey, with a decline in incidence with increasing predator length, accompanied by an increase in the incidence of rays/batoids (Cliff and Dudley 1991). Bass *et al.* (1973) provided a comparison in the diet of juveniles which were largely caught in inland systems and those of individuals caught in the sea, which included many adults. These juveniles fed mainly on shoaling teleosts.

South African toxicological studies

One toxological study has been conducted on this species in South Africa, using specimens caught in the KZN bather protection nets. Levels of total mercury in the muscle tissue of 11 individuals, which included adults, showed a positive correlation with body length. Values for a number of local pelagic shark species, were higher than those from other regions and, in many cases, including *C. leucas*, they were far higher than international regulatory guidelines for human and fish health (McKinney *et al.* 2016 and references cited therein).

REPRODUCTION

REPRODUCTIVE MODE	Placental viviparity
DURATION OF REPRO CYCLE	2 years (outside South Africa)
MATING	Possibly summer
GESTATION	Approx. 12 months
LITTER SIZE	9–12; range 6–12
PUPPING/NURSERY GROUND	Estuaries such as Lake St Lucia
LENGTH AT BIRTH	60–80 cm
LENGTH AT MATURITY	50% maturity F: 250 cm, M: 244 cm
MAXIMUM LENGTH	F: 400 cm; M: 299 cm
GENERATION LENGTH	26.5 years (only South Africa)

Mode

This species exhibits placental viviparity (Bass *et al*. 1973).

Duration of reproductive cycle

In South Africa there is insufficient information, but in a global context the reproductive cycle is likely a biennial one (Rigby *et al.* 2021a and references cited therein).

Mating season and location

Bass *et al.* (1973) did not find a female with ripe ova or small embryos in KZN and concluded that mating and early pregnancy occurs to the north. The mating season appears to be in summer, based on the capture of a sexually active male in November, a female with enlarged ovarian eggs in December and a pregnant female with 30 cm embryos in March (Cliff and Dudley 1991).

Gestation

Neonates with open or newly closed umbilical slits were common in the St Lucia system from December to February, suggesting that pupping is in summer (Bass *et al.* 1973). In South Africa gestation appears to be in the region of 12 months, as the young are probably dropped in summer although Cliff and Dudley (1991) found embryos of similar sizes in both summer and winter. In Florida the gestation is 10–11 months (Clark and von Schmidt 1965, cited by McCord and Cliff 2013).

Litter size
In South Africa the median litter size was 12 from four litters (range: 10–12 or 13; Bass *et al.* 1973) and nine from seven litters (range: 6–12 (Cliff and Dudley 1991). Elsewhere litter size was 1–15, usually 6–8 (Rigby *et al*. 2021a and references cited therein).

Length at birth
In South Africa this is 60–70 cm (Bass *et al.* 1973) and up to 80 cm (Cliff and Dudley 1991). Elsewhere size-at-birth is 56–81 cm (Rigby *et al*. 2021a and references cited therein).

Pupping season and nursery ground
This species is well known for using rivers and lakes on the east African coast as nursery areas. Neonates with open or newly closed umbilical slits were common in the St Lucia system from December to February, suggesting that pupping is in summer (Bass *et al.* 1973). Preliminary data from the Umzimvubu River system suggests that juveniles may remain in the estuary for at least three years, venturing into the sea for increasing periods of time and then not returning (Geremy Cliff, KZNB Board and Paul Cowley, SAIAB, unpublished data). Other important nursery habitats for the species in South Africa include Richards Bay, Mtentu River and Mtakayti River (Ryan Daly, ORI, unpublished data).

Length at maturity
In South Africa females attain 50% maturity at about 250 cm and males at 244 cm TL (Dudley and Simpfendorfer 2006). There is regional variation in length at maturity, ranging from 180–230 cm TL cm for females and 157–226 cm for males (Rigby *et al.* 2021a and references cited therein).

Maximum length
The largest female recorded on the east coast of South Africa was 400 cm (McCord and Lamberth 2009) and the largest male 299 cm (Bass *et al.* 1973). The 400 cm individual appears to be excessive, as prior to this the largest individuals in South Africa were 300 cm (Bass *et al.* 1973) and 308 cm (Malcolm Smale, Port Elizabeth Museum, cited by Cliff and Dudley, 1991) and more recently 310 cm (Ryan Daly, ORI, unpublished data).

Age and growth
Age at maturity for females was 21 years and 20 years for males, based on annual growth ring deposition; the oldest female was 32 years and male 29 years (Wintner *et al.* 2002). There are regional differences in age at maturity, ranging from 9.5 years for females in Australia to 10–18 years in the Gulf of Mexico.

Generation length
Based on female age at maturity of 21 years and a maximum age of 32 years (Wintner *et al.* 2002), South African individuals have a generation length of 26.5 years (Rigby *et al.* 2021a). Elsewhere generation length ranges from 18–21 years (Rigby *et al.* 2021a and references cited therein).

FISHERIES MANAGEMENT
SA catch sources
Local catch was estimated at 1–10 tons per annum (DFFE records: 2010-2012), with the KZN bather protection programme listed as the only confirmed source of catches. It is a suspected catch in the pelagic and demersal longline fisheries, the recreational and commercial linefisheries and the KZN prawn trawl fishery (da Silva *et al.* 2015), although this species was not listed among the catches in the last-named fishery (Fennessy 1994).

SA catch quantities and characteristics
KZN bather protection nets

The mean annual catch in the KZN bather protection nets was 59 for the period 1978–1990. This species constituted 0.5% of the total shark catch for that period. There was no significant linear trend in catch rate with time (Cliff and Dudley 1991). Subsequent analysis for the period 1978–2003 showed a significant decline in catch rate (Dudley and Simpfendorfer 2006), which has persisted (Dicken and Winker unpublished data, cited by Rigby *et al.* 2021a). Mean annual catch in the period 2000-2009 was down to 17, largely due to the widespread replacement of shark nets with baited drumlines, which have an extremely low catch of *C. leucas* (Cliff and Dudley 2011). The catch was essentially unimodal (Cliff and Dudley 1991), with 8% of females and 13% of males mature (Dudley and Simpfendorfer 2006).

Recreational shore angling
In KZN competitive shore anglers caught 30 *C. leucas* over a 24-year period (±1 per annum), with a mean individual mass of 30 kg (Pradervand *et al.* 2007). On the Wild Coast (northern part of the Eastern Cape) annual catches were rare (0.2 per annum) (Pradervand 2004). Most shark catches by these competitive shore anglers are returned alive to the water.

Fishing outside South Africa
C. leucas is It is caught as target and bycatch in artisanal, industrial, and recreational fisheries across its range with multiple fishing gears including gillnet, longline, and trawl. It is retained for its meat and fins (Rigby *et al.* 2021a). This species is listed as one likely to be taken in coastal artisanal fisheries in Mozambique but no further information is provided (Pierce *et al.* 2008).

Population trends
An analysis of mitochondrial DNA yielded three potential subclusters, one consisting of the specimens from the western Atlantic, Belize, Senegal, and Sierra Leone, a second consisting of the three specimens from South Africa, and a third consisting of the seven specimens from Borneo. These results suggest that *C. leucas* may represent a complex of closely related species (Naylor *et al.* 2012).

A more recent investigation of the global population structure using microsatellite loci and mitochondrial DNA revealed three regional populations, one of which is from the W Indian Ocean, which included samples from the east coast of South Africa. Furthermore, there was high genetic connectivity within this region (Pirog *et al*. 2019).

Population trends were based on a dataset from the NW Atlantic, where the population appears to be growing, and that of catches in the KZN bather protection programme (Rigby *et al.* 2021a). In the latter, the trend analysis for the 39-year period, 1981–2019, revealed annual rates of reduction of 2%, consistent with an estimated median reduction of 68% over three generation lengths (80 years), with the highest probability of 50–79% reduction over three generation lengths. As a result of several mitigating factors, which include the continued presence of bull sharks within the region but away from protected beaches, it was concluded that the population decline was overestimated and that it was suspected to be 30–49% over the past three generation lengths due to declines in habitat quality and levels of exploitation, and it was assessed as Vulnerable on the IUCN Red List in 2020 (Rigby *et al.* 2021a).

ECOTOURISM
C. leucas is a popular ecotourism species, particularly at Protea Banks and in the Ponta do Ouro Partial Marine Reserve in southern Mozambique, where large individuals are regularly sighted in the summer months. There are appears to be some seasonal site fidelity to these and other high profile coastal reefs.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations

There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
As this species does show some form of residency it will benefit from all the inshore Marine Protected areas on the east coast. Small aggregations of large individuals are repeatedly observed during the summer in the Protea Banks and Aliwal Shoal MPAs and the Ponta do Ouro Partial Marine Reserve in southern Mozambique. Some individuals are highly mobile and most move northwards out of these protected waters into Mozambique waters in response to falling water temperatures in winter.

Additional local comment
Current IUCN Status
<u>Vulnerable 2020: A2bcd</u>

Previous IUCN assessments
Near Threatened 2009
Near Threatened 2000

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

International comments
A preference for inshore coastal waters, estuarine, and riverine habitats means that *C. leucas* is also threatened by habitat loss and degradation in addition to fishing pressures (Rigby *et al.* 2021a).

MANAGEMENT CONSIDERATIONS
Given the importance of large estuaries as nursery grounds, habitat loss through the extended closure to the sea of the Lake St Lucia system and the heavy siltation of other large estuaries on the east coast is likely to have adversely impacted the local population. The recent decision to artificially open the St Lucia system to the sea will benefit this species, but the duration of this scenario, whereby pregnant females are able to enter the moth of the system to pup, is dependent on freshwater outflows to prevent the natural closure of the mouth by wave action on the shore. Another concern is the northward movement, driven by declining water temperatures with the onset of winter, of individuals into Mozambique waters, where artisanal fishing pressures are high. The removal of extensive illegal gillnetting in estuarine systems such as Richards Bay will reduce catches of neonates and larger juveniles utilising these habitats.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
This is a well-studied species. Monitoring of large estuarine systems as nursery grounds should be undertaken, particularly in view of the prolonged closure to the sea of the Lake St Lucia system and its recent artificial opening. Knowledge of its biology and life history is good but the location of the mating grounds and recently mated females is unknown and appears to be in Mozambique.

Carcharhinus limbatus

SCIENTIFIC NAME	*Carcharhinus limbatus* (Müller & Henle 1839)
COMMON NAME	Blacktip shark/common blacktip shark
FAMILY	Carcharhinidae
ENDEMIC	No
SIZE RANGE	50–288 cm TL
SA DISTRIBUTION	E, S coasts: Mozambique border to Cape Point
HABITAT	Pelagic over sand bottoms and rocky reef areas
DEPTH RANGE	0–140 m, usually < 30 m
MAJOR FISHERIES	Commercial and recreational linefishery, KZN bather protection nets
IUCN STATUS	Vulnerable 2020
CITES	Not listed
MLRA	Daily bag limit of one in recreational fishery
COMPILER	G Cliff
REVIEWER	R Daly

SPECIES SUMMARY and RECOMMENDATIONS

Carcharhinus limbatus is a medium-sized pelagic shark with a cosmopolitan distribution in tropical and warm temperate seas. In South Africa it occurs on the entire east coast, where it is most common in central and southern KZN and occasionally the entire south coast. It is found in Mozambique northwards, along the entire African coast. Local annual catch was estimated at 1–10 tons (DFFE records: 2010–2012). Highest catches were listed in the commercial linefishery, followed by the recreational fishery and the KZN bather protection programme. Internationally it is retained for its valuable fins and meat and it is heavily fished in most its range. It was assessed globally as Vulnerable on the IUCN Red List in 2020. By contrast, the trend analysis of the catches in the bather protection nets was indicative of a population which must be regarded as Least Concern in South Africa. As a highly mobile species, it will derive limited protection from all the Marine Protected Areas on the east and south coasts. The most important of these appears to be Aliwal Shoal MPA where adults are seen year-round in baited shark dives. Quantifying the catch in the commercial linefishery is much needed. The location of the nursery grounds, which is likely to be inshore, is unknown and this is of concern as it appears to be in southern Mozambique. More insight into movement patterns is needed, especially if a part of the population is moving northwards into Mozambique. An investigation of regional population structure would also benefit management of this highly mobile shoaling species.

TAXONOMIC and IDENTIFICATION ISSUES

This species has been long known as *C. limbatus.* It is one of 17 members of the genus *Carcharhinus* found on the southern African east coast. Many are very similar in overall appearance, with features such snout shape, dentition, the position of the first dorsal fin relative to the pectoral fins, the presence or absence of an interdorsal ridge and fin pigmentation used to separate the species. There are several black-finned members of the genus which lack an interdorsal ridge and of these, *C. limbatus* is most likely to be confused with the spinner shark *C. brevipinna* in that both species have a long, pointed snout and narrow, erect upper jaw teeth. These two species are easily separated by snout length, the height and position of the dorsal fin relative to the pectoral fins and the size of the teeth. *C. limbatus* has a shorter snout and longer teeth and a much taller first dorsal fin which is positioned well forward over the pectoral fins (Bass *et al.* 1973). The fins, except the anal, which is plain or may have a dusky tip, are usually black tipped. These markings are not clearly demarcated, except on the pelvic fins where the black tips are distinct, and are generally more defined on the juveniles as they fade with age (Bass *et al.* 1973). This confusion with *C. brevipinna* is exacerbated by the fact that many shore anglers in KZN refer to the latter as blackfin shark.

SOUTH AFRICAN DISTRIBUTION

This species occurs along the entire east and south coasts, from the Mozambique border to Cape Point (Bass *et al.* 1973, Compagno *et al.* 1989). It is regarded as uncommon south of East London and occurrence as far south as Cape Point are rare (Bass *et al.* 1973, Ebert *et al.* 2021).

REGIONAL DISTRIBUTION

This species is present in Mozambique and Madagascar and the coastal waters of the entire W Indian Ocean (Rigby *et al.* 2021b).

SYNOPSIS OF RESEARCH

This is a well-studied species in South Africa. Bass *et al.* (1973) reviewed the taxonomy of the genus and provided detailed morphometric and biological information from over 100 individuals, including adults and pregnant females from southern Africa. An analysis of catch statistics and general biology of 1836 individuals caught in the KZN bather protection programme was undertaken by Dudley and Cliff (1993), followed by a more detailed analysis of catch trends (Dudley and Simpfendorfer 2006). These individuals were also used for several studies: an ageing assessment (Wintner and Cliff 1996); lipid composition of the liver (Davidson and Cliff 2002; Davidson *et al.* 2011a) and lipid composition of the heart and muscles (Davidson *et al.* 2011b) a study of the trophic ecology and muscle mercury levels (McKinney *et al.* 2016) and an investigation of population structure in the W Indian Ocean (Almojil *et al*. 2019). This species takes advantage of the seasonal influx of sardines along the east coast (Dudley and Cliff 2010). Bester-van der Merwe *et al.* (2019) investigated population structure and also found evidence of multiple paternity. Dudley and Wintner (2013) provided an overview of the life history and fisheries details of this species. Comparative information on the biology and ecology of this species is available from studies elsewhere in its range (see Rigby *et al*. 2021b and references cited therein).

ECOLOGY

Depth

This pelagic shoaling species is most common inshore, where it may be caught by shore anglers. It was rarely caught in KZN waters deeper than 30 m (Bass 1968, cited by Bass *et al.* 1973). Elsewhere it occurs from the surfzone to depths of 140 m (Rigby *et al.* 2021b).

Habitat: Adults

The adults are pelagic and highly mobile; they occur in the coastal waters, including the surf zone, estuaries and lagoons (Ebert *et al.* 2013). In KZN they have been known to swim a short distance up the St Lucia Estuary (Bass *et al*. 1973). Tolerant of reduced salinities, they do not penetrate far into fresh water (Compagno 1984).

Habitat: Juveniles/Nursery Grounds

They appear to occur inshore but very little is known, with no evidence of a nursery ground on the KZN coast (Bass *et al*. 1973, Dudley and Cliff 1997). It is likely that the nursery ground is north of Inhambane in Mozambique (Ryan Daly, Oceanographic Research Institute, unpublished data).

Synopsis of tag deployments

A total of 1064 individuals were tagged in the ORI Cooperative Fish Tagging Project 1984-2018 inclusive. There were 40 recaptures (4%), with the mean distance travelled of 90 km (maximum 1288 km) and mean time at liberty of 7.1 months (maximum 3.1 years) (Jordaan *et al.* 2020).

Movements

This pelagic species is highly mobile, moving long distances along the coast but there was some evidence of site fidelity. Although individuals were caught throughout the year in the KZN bather protection programme, there were seasonal and geographic variation in abundance of both immature and mature individuals (Dudley and Cliff 1993). Twenty-five adults have been fitted with acoustic tags and in southern Mozambique and South Africa and monitored for up to four years. Both males and females have been tracked moving between northern Bazaruto Island, Mozambique and Algoa Bay. They are capable of rapid coastal migrations swimming up to 70 km per day and covering distances of over 1700 km within a month (Ryan Daly, unpublished data). This species is migratory off Florida (Compagno 1984).

Diet/feeding: adults
The adults fed mainly on small (<35 cm) shoaling teleosts, with a high incidence of horse mackerel *Trachurus delagoa* in summer and sardines *Sardinops sagax* in winter. Some of the shoaling species were bottom dwelling, indicating that *C. limbatus* does not only feed at the surface. Elasmobranchs, mainly small sharks, and cephalopods were also ingested (Dudley and Cliff 1993). *C. limbatus* feeds opportunistically on sardines (Dudley and Cliff 2010). Mostly males were encountered or caught during the sardine run, suggesting that their winter movements may be more strongly influenced by sardines (Ryan Daly, unpublished data).

Diet/feeding: juveniles
The juveniles also fed mainly on small (<35 cm) shoaling teleosts, with a high incidence of horse mackerel *Trachurus delagoa* in summer and sardines *Sardinops sagax* in winter. The incidence of elasmobranchs, mainly small sharks, was very low; cephalopods were also ingested (Dudley and Cliff 1993, Dudley and Cliff 2010).

South African toxicological studies
One toxological study has been conducted on this species in South Africa, using specimens caught in the KZN bather protection nets. Levels of total mercury in the muscle tissue of 32 juveniles and adults (150–248 cm) showed a positive correlation with body length. Values for a number of local pelagic shark species, including *C. limbatus*, were higher than those from other regions and, in many cases, they were far higher than international regulatory guidelines for human and fish health (McKinney *et al.* 2016 and references cited therein).

REPRODUCTION

REPRODUCTIVE MODE	Placental viviparity
DURATION OF REPRO CYCLE	2 years
MATING	Summer
GESTATION	12 months
LITTER SIZE	Mean of 6; maximum 11
PUPPING/NURSERY GROUND	Unknown
LENGTH AT BIRTH	60–65 cm
LENGTH AT MATURITY	50% maturity F: 205 cm, M: 200 cm
MAXIMUM LENGTH	F: 288 cm; M: 255 cm
GENERATION LENGTH	13-20 years (Australia and Gulf of Mexico)

Mode
This species exhibits placental viviparity (Bass *et al*. 1973).

Duration of reproductive cycle
In South Africa this is two years, with some evidence of triennial reproductive cycle (Dudley and Cliff 1993). It is a biennial cycle elsewhere (Rigby *et al*. 2021b and references cited therein).

Mating season and location

The mating season is in early summer (November–December), with evidence of mating in the inshore waters of central and southern KZN (Dudley and Cliff 1993).

Gestation
In South Africa this is in the region of 12 months, with much of the pregnancy spent in the inshore waters of central and southern KZN (Bass *et al.* 1975, Dudley and Cliff 1993).

Litter size
In South Africa the median litter size from 151 litters was six embryos, with a maximum of 11 (Dudley and Cliff 1993).

Length at birth
In South Africa this is 60–65 cm (Bass *et al.* 1973). Elsewhere size-at-birth is 38–72 cm (Rigby *et al*. 2021b and references cited therein).

Pupping season and nursery ground
No pregnant females with very small embryos (<15 cm) and only three with term embryos (>60 cm) were caught in the KZN bather protection programme. This indicates that females move out of the study area at the beginning and end of the gestation period (Dudley and Cliff 1993). The whereabouts of the nursery ground is not known and as there is no evidence that it is to the south of KZN, Bass *et al.* (1973) concluded that it may be off the southern Mozambique coast. The capture of juveniles from Pomene northwards in Mozambique suggests that nursery ground is in the region of Bazaruto Island. Elsewhere, the nursery grounds are known to be close inshore (Rigby *et al*. 2021b and references cited therein).

Length at maturity
In South Africa females attain 50% maturity at about 205 cm and males at 200 cm (Dudley and Simpfendorfer 2006). There is regional variation in length at maturity, ranging from 145–207 cm for females and 125–201 cm for males (Rigby *et al.* 2021b and references cited therein).

Maximum length
The largest female recorded on the east coast of South Africa was 288 cm (Ryan Daly, unpublished data) and the largest male 255 cm (Dudley and Cliff 1993).

Age and growth
Assuming annual growth band deposition, females matured at 7 years and males at 6 years; the oldest individuals were a 11-year-old female and a 10-year-old male (Wintner and Cliff 1996). Elsewhere female age-at-maturity was 6–8 years, with maximum female ages of 17–23 years (Rigby *et al*. 2021b and references cited therein).

Generation length
Based on the age and growth data of Wintner and Cliff (1996), generation length in South Africa is 9 years (Dudley and Simpfendorfer 2006). Elsewhere generation length was much higher at 12–16 years (Rigby *et al*. 2021b and references cited therein). With very similar female age-at-maturity from the various populations, the lower generation length in South Africa can be attributed to the far lower maximum female age of only 11 years.

FISHERIES MANAGEMENT
SA catch sources
Local catch was estimated at 1–10 tons per annum (DFFE records: 2010-2012), with the commercial linefishery listed as the biggest contributor, followed by the recreational linefishery and the KZN bather protection programme. It was also listed as a suspected catch in the demersal shark longline

and pelagic longline fisheries and the KZN prawn trawl fishery (da Silva *et al.* 2015). This species was not recorded in the prawn trawl catches (Fennessy 1994).

SA catch quantities and characteristics
Commercial linefishery
In the mid-1990s shark exports from South Africa started to increase, with a new directed demersal shark fishery moving into the fin trade and subsequently into the shark fillet export industry to Australia, where local supply cannot meet the demand (da Silva and Bürgener, 2007). There is no evidence that *C. limbatus* is one of the species involved, but it is possible that some juveniles are taken in this fishery for export to Australia. Small sharks are preferred in this industry to avoid problems of accumulation of high levels of contaminants, such as mercury, found in larger individuals (da Silva and Bürgener, 2007).

KZN bather protection nets
The mean annual catch in the KZN bather protection nets was 131 (range 58–195) for the period 1978–1991; 7% of the catch was alive and released. This species constituted 9% of the total shark catch for that period and, despite considerable interannual variation, there was no significant linear trend in catch or catch rate with time (Dudley and Cliff 1993). Subsequent analysis for the period 1978–2003 showed a significant decline in catch rate (Dudley and Simpfendorfer 2006). Mean annual catch in the period 2000-2009 was down to 64, largely due to judicious management of net deployment during the annual sardine run and the widespread replacement of shark nets with baited drumlines, which have an extremely low catch of *C. limbatus* (Cliff and Dudley 2011). The catch was unimodal (Dudley and Cliff 1993), with 61% of females and 64% of males mature (Dudley and Simpfendorfer 2006). More recent analysis showed that catch rates fluctuated but steadily declined from 1981 to 2019 (KZN Sharks Board unpubl. data, cited by Rigby *et al*. 2021b).

Recreational shore angling
This species is not an uncommon catch by shore anglers in KZN, but catch statistics are marred by the inability to distinguish juveniles of this species from those of *C. brevipinna.* In KZN competitive shore anglers caught 1316 individuals over a 24-year period (1977–2000), at a rate of 128 per annum and with a mean individual mass of 6.2 kg, which is that of juvenile but not a neonate. By comparison, 1351*C. brevipinna* were caught by these anglers over the same period (Pradervand *et al.* 2007).

In the Transkei/Wild Coast regions to the immediate south of KZN, only 137 *C. limbatus* were reported in catches of competitive shore anglers over the same 24-year period (1977–2000; Pradervand 2004). The mean weight was 19 kg, which confirms the findings of Bass *et el.* (1973) that the nursery area is not inshore and to the south of KZN.

Fishing outside South Africa
C. limbatus is subject to fishing pressure across its range. It is captured as target and bycatch in artisanal and industrial fisheries with multiple fishing gears including gillnet, longline, and trawl. It is retained for its valuable meat and fins, unless regulations prohibit retention. Its preference for inshore coastal waters means it is also threatened by habitat loss and degradation, including pollution and clearing, and climate change (Rigby *et al*. 2021b). There is evidence that the complex of black-finned sharks of the genus *Carcharhinus,* which includes *C. limbatus,* make up a large proportion of the fin trade in Hong Kong (Jorgensen *et al*. 2022).

Population trends
Population genetic studies, which included two local assessments (Almojil *et al.* 2018 and Bester-van der Merwe *et al.* 2019), revealed genetic structuring between ocean basins, within ocean basins, and likely global male-biased dispersal and female philopatry (Naylor *et al.* 2012; Rigby *et al*. 2021b and references cited therein). Population trend data from the KZN bather protection programme revealed

an estimated median reduction of 20% over three generation lengths (27 years) (Matt Dicken, KZN Sharks Board and Henning Winker unpubl. data 2020, cited by Rigby *et al.* 2021). Based on these findings, and the frequent sightings by divers in the Aliwal Shoal MPA, the South African population of *C. limbatus* must be regarded as Least Concern.

This is in contrast with fisheries in other regions which showed a wide range of different trends. In N Australia the population trend was stable; in the Gulf of Mexico there was an estimated median reduction of 7% over three generation lengths (45 years); in the N Atlantic there was an estimated median reduction of 59% over three generation lengths (36 years) (Rigby *et al*. 2021b and references cited therein).

Across the Arabian Seas region, this species is suspected to have undergone a population reduction of 30–49% over the past three generation lengths (~39 years). Overall, it is suspected that *C. limbatus* has undergone a population reduction of 30–49% over the past three generations lengths (27–49 years) due to levels of exploitation and it was globally assessed as Vulnerable on the IUCN Red List in 2021 (Rigby *et al*. 2021b and references cited therein).

ECOTOURISM

C. limbatus is a very popular ecotourism species as it is commonly sighted during the sardine run. Packs of 20–30 adults are consistently encountered in the Aliwal Shoal MPA, where open water baited shark diving (without a cage) has been undertaken for the last two decades. This industry commenced with the intention of attracting tiger sharks *Galeocerdo cuvier*, but this species is only a summer visitor to the area, while *C. limbatus* is present year-round.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act

Threatened or Protected Species (TOPS)

This species is not listed.

Marine Protected Areas

This pelagic, shallow water species appears to be highly mobile. It will therefore derive very limited protection from all the MPAs on the east and south coasts. Adults are common in Aliwal Shoal MPA. The nursery grounds appear to be in southern Mozambique, with juveniles, including neonates, caught at Pomene but it is uncertain as to what protection they will derive in the Bazaruto Archipelago National Park, which is just north of Pomene (Ryan Daly, unpublished data).

Additional local comment

Current IUCN Status

<u>Vulnerable 2020: A2bd</u>

Previous IUCN assessments

Near Threatened 2009
Near Threatened 2000
Vulnerable 1996

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

This species is not listed.

Convention on Migratory Species (CMS)

This species is not listed.

International comments

MANAGEMENT CONSIDERATIONS

The decline in catch rates in the KZN bather protection programme is in the region of 20% over the last three generation lengths. This decline is likely to be lower if the generation length in other regions of 12–16 years proves to be more appropriate; this value is low, considering that the location of the nursery ground is in Mozambique where exploitation is likely to be high. It would be beneficial to formalise this reduction by producing a regional assessment including Mozambique and possibly Tanzania. Given that the local population status is one of Least Concern, based on long-term catch trends in the KZN bather protection programme, this species must be regarded as being of fairly low management priority.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

This is a well-studied species. Knowledge of its biology and life history is good but the location of the nursery ground and the whereabouts of females in the very early stages of pregnancy in Mozambique should be investigated further. An analysis of the existing tag-recapture data generated by the ORI Cooperative Fish Tagging Project, together with the results obtained from the deployment of long term (±10-year) acoustic tags (currently four years of data from 25 adults) will improve understanding of the movement patterns of this species. It would also quantify the degree of movement between South Africa and Mozambique, where the nursery grounds are located and where exploitation of this species is likely to be a lot greater. A regional W Indian Ocean genetic study to investigate population structure would be beneficial. The KZN Sharks Board has collected a large number of tissue samples for this purpose.

Carcharhinus longimanus

SCIENTIFIC NAME	*Carcharhinus longimanus* (Poey 1861)
COMMON NAME	Oceanic whitetip shark
FAMILY	Carcharhinidae
ENDEMIC	No, Indo-Pacific
SIZE RANGE	60–350 cm, possibly 395 cm TL
SA DISTRIBUTION	E, S coasts: Mozambique border to south off Cape Point
HABITAT	Pelagic in oceanic waters
DEPTH RANGE	0–1000 m
MAJOR FISHERIES	Pelagic longline and small pelagic fisheries
IUCN STATUS	Critically Endangered 2018
CITES	Appendix II (2013)
MLRA	No retention in pelagic or demersal longline fishery; daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	JD Filmalter

SPECIES SUMMARY and RECOMMENDATIONS

Carcharhinus longimanus is a large pelagic shark with circumglobal distribution in tropical and warm-temperate oceanic waters. Local catch was estimated at <1 ton per annum (DFFE records: 2010–2012), with pelagic longlining being the major component, followed by the small pelagic fishery. Historically, this species was regarded as the most abundant pelagic shark in its range, but globally it has experienced enormous and prolonged fishing pressure and is rare in many places. These declines, together with its slow growth and low fecundity, have resulted in this species being assessed as Critically Endangered in 2018. A number of international initiatives have been introduced to control or reduce exploitation, including listing on Appendix II of CITES and a ban on retention in all four international tuna commissions. Locally it may not be retained in the pelagic longline fishery. Given its low catches and lack of evidence of mating aggregations or nursery grounds in South African waters, it must be regarded as a low priority species. Illegal exploitation within the South African EEZ could be a problem. Survival rates following release from pelagic longlines need to be investigated.

TAXONOMIC and IDENTIFICATION ISSUES

There are no taxonomic issues, although there are 16 other species in the genus *Carcharhinus* on the east coast of South Africa. The large, broadly rounded fins, some with white tips, distinguish this species from all other members of this genus except *C. albimarginatus,* which has only pointed fins, with more prominent white tips.

SOUTH AFRICAN DISTRIBUTION

It occurs on the east and south coasts of South Africa (Ebert *et al.* 2021), but more common in warmer water (Bass *et al.* 1973).

REGIONAL DISTRIBUTION

It is present in Mozambique and up the entire east African coast and around Madagascar and other islands in Western Indian Ocean.

SYNOPSIS OF RESEARCH

In southern Africa published information on the life history, taxonomy and morphometrics of this species is limited to a study of approximately 50 individuals (Bass *et al.* 1973). Despite its wide distribution and its prominence in oceanic fisheries, no further research has been conducted on this species in the region. Bonfil *et al.* (2008) provided an overview of the state of knowledge of this species, which includes several studies undertaken elsewhere in its range.

ECOLOGY

Depth

This is a pelagic, oceanic species which is often found at the surface and rarely close to shore. It has been recorded at depths of 1000 m (Bonfil *et al.* 2008).

Habitat: Adults

The adults inhabit deep water far offshore but may enter shallower water in close proximity to oceanic islands and at locations where the continental shelf is extremely narrow (Rigby *et al.* 2019h).

Habitat: Juveniles/Nursery Grounds

Like many other shark species there is apparently size and sexual aggregation, but with no details listed (Compagno 1984a). Neonates and juveniles are rarely caught, suggesting that they inhabit waters away from any fishing grounds (Bass *et al.* 1973), and their whereabouts remains undocumented.

Synopsis of tag deployments

As this species occurs far offshore, no individuals have been tagged in the ORI Cooperative Fish Tagging Project 1984-2018 inclusive. No other tagging programme involving this species has been undertaken in the region.

Movements

Little information exists on the movements of this species in the Indian Ocean. A limited number of *C. longimanus* tagged with satellite tags in the Mozambique Channel have shown wide ranging movements. One individual moved northwards over 6500 km towards Somalia and the Seychelles during its 100-day track, while a second individual moved 1100 km south to the bottom of the Mozambique Channel in 19 days (Filmalter *et al.* 2012).

Diet/feeding: adults

This species feeds primarily on oceanic teleosts and cephalopods, but elasmobranchs and marine mammals are also taken. Harpooned whales were often scavenged while being towed into Durban harbour for processing (Bass *et al.* 1973).

Diet/feeding: juveniles

The diet of juveniles is assumed to be similar to that of adults but possibly without the larger prey items.

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Placental viviparity
DURATION OF REPRO CYCLE	Probably 2 years
MATING	Summer: December and January
GESTATION	12 months
LITTER SIZE	1–15; but 6–8 (n=5) in KZN
PUPPING/NURSERY GROUND	Summer: December and January
LENGTH AT BIRTH	60-65 cm
LENGTH AT MATURITY	F:180–190 cm; M: >190 cm

MAXIMUM LENGTH	350 cm, possibly 395 cm
GENERATION LENGTH	20.4 years

Mode
This species exhibits placental viviparity (Bass *et al.* 1973).

Duration of reproductive cycle
This is apparently 2 years (Bonfil *et al.* 2008).

Mating season and location
In the SW Indian Ocean mating appears to be seasonal in December and January (Bass *et al.* 1973). There is no documentation of any regional mating aggregations.

Gestation
Gestation is about 12 months (Bass *et al.* 1973).

Litter size
Litter size ranged from 6–8 with a mean of 7 from 5 local litters. Elsewhere the range was 1–15. Larger females carried larger litters (Bass *et al.* 1973).

Length at birth
In the SW Indian Ocean length at birth is possibly 60–65 cm (Bass *et al.* 1973), but it may as high as 75 cm elsewhere (Rigby *et al*. 2019h).

Pupping season and nursery grounds
In the SW Indian Ocean pupping appears to take place in spring and early summer; the whereabouts of a regional nursery ground in unknown (Bass *et al.* 1973), possibly because it is away from the fishing grounds.

Length at maturity
In the SW Indian Ocean males mature at 170–180 cm and females at 175–190 cm. There are regional variations in these sizes (Bass *et al.* 1973, Bonfil *et al.* 2008).

Maximum length
This species reaches a maximum length of 350 cm, possibly as large as 395 cm (Ebert *et al*. 2013).

Age and growth
No age and growth studies have been undertaken in the SW Indian Ocean. Research elsewhere indicates large regional variation in age estimates, with female age-at-maturity ranging from 5–9 years to 16 years and maximum ages ranging from 11 years to 25 years (Rigby *et al.* 2019h and references cited therein). This is based on verified annual periodicity of band formation.

Generation length
Adopting a precautionary approach, the older age-at-maturity of 16 years and maximum age of 25 years listed above were used to calculate a global generation length of 20.4 years (Rigby *et al.* 2019h).

FISHERIES MANAGEMENT
SA catch sources
Local catch was estimated at <1 tons (DFFE records: 2010–2012). It is primarily caught in pelagic longline fisheries, with a small component taken in the small pelagic fishery (da Silva *et al.* 2015).

SA catch quantities and characteristics
Pelagic longline fishery

This species is one of the large pelagic sharks caught in the Southern African tuna and swordfish longline fisheries. It represented 1,2% of the total shark bycatch by number in the period 1998-2005, in a fishery, where the estimated annual catch is 40,000-70,000 sharks per annum. This equates to about 450–550 *C. longimanus* per year (Petersen *et al.* 2009). As it has been a CITES-listed species (Appendix II) since 2013, catches in this fishery can no longer be retained.

Fishing outside South Africa
This species is caught globally as target and bycatch in pelagic longlines, purse seine and gillnet fisheries. The species has a high catchability due to its preference for surface waters and its inquisitive nature (Rigby *et al.* 2019h). This species was historically one of the most abundant shark species in tropical seas worldwide. Regional trends indicate it has experienced significant declines across its range which are likely to continue and as a result it is now rare in some regions (Rigby *et al.* 2019h).

Population trends
There are no data available on the global population size of this species. There is restricted gene flow between the W and E Atlantic Ocean, and a strong relationship between the latter region and the Indian Ocean. The latter finding is based on a very small number of samples available from the Indian Ocean (Camargo *et al.* 2016).

Catch and effort data are available from fisheries in the Atlantic, Pacific and Indian Oceans. To estimate a global population trend, the regional trends were weighted according to the relative size of each region. The overall estimated median reduction was 98–100%, with the highest probability of >80% reduction over three generation lengths (61.2 years), and therefore the species was assessed as Critically Endangered in 2015 (Rigby *et al.* 2019h).

ECOTOURISM
This species occurs too far offshore on the South African coast to be regarded as an ecotourism species.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
As a CITES Appendix II species, its retention in the local pelagic and demersal longline fisheries is prohibited. There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
This species will largely only benefit from offshore MPAs, but given its highly migratory nature, it is unlikely to benefit from the current South African MPA network.

Additional local comment

IUCN Red List Status
<u>Critically Endangered 2018 A2bd</u>

Previous IUCN assessments
Vulnerable 2015
Vulnerable 2006
Near Threatened 2000

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

This species was added to Appendix II in 2013, which requires exports from CITES Parties to be accompanied by permits based on findings that parts are sourced from legal and sustainable fisheries.

Convention on Migratory Species (CMS)
This species was added to Annex 1 of the Convention on Migratory Species (CMS) Memorandum of Understanding (MoU) for Migratory Sharks in 2018, even though the species is not (yet) included on the CMS Appendices (Rigby *et al.* 2019h). The MoU is aimed at facilitating regional conservation of listed shark and ray species.

International comments
This species was the first (and is still currently the only) shark species to be subject to prohibitions on retention, transhipment, storage, and landing by all four major Regional Fishery Management Organizations (RFMOs) focused on tuna fisheries: the International Commission for the Conservation of Atlantic Tunas (2010), the Inter-American Tropical Tuna Commission (2011), the Western and Central Pacific Fisheries Commission (2012), and the Indian Ocean Tuna Commission (2013) (Rigby *et al.* 2019h).

In view of its Critically Endangered status and to allow recovery, it is recommended that any retention and landings be prohibited, in line with tuna RFMO obligations. Initiatives to prevent capture, minimize bycatch mortality, promote safe release, and improve catch (including discard) reporting are also urgently needed, as is full implementation of additional commitments agreed through international treaties (Rigby *et al.* 2019h).

MANAGEMENT CONSIDERATIONS
The ability of the South African fisheries authorities to protect its entire EEZ, particularly its outer limits where *C. longimanus* is likely to occur, is of concern. The *modus operandi* of the pelagic longline industry needs to ensure the maximum chances of survival of this species without severely jeopardising catches of the target species. Mortality/survival levels in this fishery need to be quantified. In view of its Critically Endangered status and the fact that it is caught in South Africa's pelagic longline fishery, this species must be regarded as of high management priority.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
As this species is oceanic, research opportunities are limited. Very little is known of the mating and nursery grounds and movement patterns of this species. Satellite tracking of mature females could potentially shed light on these activities, albeit being an expensive tool. Any opportunistic sampling opportunities should be used to collect more life history information and tissue samples for genetic studies.

Carcharhinus melanopterus

SCIENTIFIC NAME	*Carcharhinus melanopterus* (Quoy and Gaimard 1824)
COMMON NAME	Blacktip reef shark
FAMILY	Carcharhinidae
ENDEMIC	No, Indo-Pacific
SIZE RANGE	30–180 cm TL
SA DISTRIBUTION	Unconfirmed but likely E coast: Mozambique border to Sodwana
HABITAT	Coral reef environments
DEPTH RANGE	0–75 m
MAJOR FISHERIES	Not listed in South African fisheries
IUCN STATUS	Vulnerable 2020
CITES	Not listed
MLRA	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	BQ Mann

SPECIES SUMMARY and RECOMMENDATIONS

Carcharhinus melanopterus is a medium-sized, reef-associated shark which is widely distributed in tropical coastal waters of the Indo-Pacific Ocean. It is associated with coral reefs and lagoons. Its presence in South Africa has not been confirmed, but it is most likely to be found in the northernmost coral reef environment of the iSimangaliso Wetland Park. For obvious reasons, it was not listed in estimated catches/landings recorded by DFFE for the period 2010–2012. Elsewhere it is widely taken as target and bycatch in commercial and artisanal fisheries through most of its range. It is regarded as a low productivity species, primarily as a result of its relatively low fecundity and was assessed globally as Vulnerable on the IUCN Red List in 2020. Fishing and destruction of coral reef habitats are the major threats. In the absence of any records from South African waters, it must be regarded as an extremely low priority species. Any sightings should be documented. Live individuals should be tagged and any dead specimens should be used to collect life history information and tissue samples for genetic studies.

TAXONOMIC and IDENTIFICATION ISSUES

There are no taxonomic issues, although there are 16 other species in the genus *Carcharhinus* on the east coast of South Africa. The distinctive lemon-brown body colouration and clearly demarcated black markings on all the fins easily distinguishes this species from all other members of this genus (Bass *et al.* 1973). Historically the reference to blacktip in the common name may have been a source of confusion as there are several other species within the genus *Carcharhinus* (e.g. *C. limbatus*), which have black tipped fins and occur in South Africa, and as a result the name has been used rather indiscriminately by South African researchers (Bass *et al.* 1973).

SOUTH AFRICAN DISTRIBUTION

The presence of this species in South African waters has not been confirmed, but Ebert *et al.* (2021) state that as it occurs in southern Mozambique it would not be unexpected if it ranged into the far northern waters of KZN. On the other hand, this species has not been seen at either Sodwana or Kosi Bay (Rob Kyle, South African Association of Marine Biological Research, pers comm).

REGIONAL DISTRIBUTION

It is present throughout the SW Indian Ocean from Mozambique northwards, including Madagascar and other islands in W Indian Ocean (Bass *et al.* 1973, Compagno 1984). Bass *et al.* (1973) stated that no specimens of this distinctive species have been recorded south of 22°S on the east African coast. Two Mozambique sightings, at Tofo and Zavora (Stephanie Venables, Marine Megafauna Foundation, pers. comm.) suggest that this species is rare south of Barazuto. There are reports of diver sightings at Ponta d'Ouro, (Stephanie Venables, Marine Megafauna Foundation, pers. comm.) but, in the absence of confirmatory images, the presence of this species so close to the South African border remains unconfirmed.

SYNOPSIS OF RESEARCH

Bass *et at.* (1973) reported on the taxonomy of the family Carcharhinidae and provided morphometric and biological information on approximately 15 individuals from southern Africa. There is no other regional research on this species. Stevens (1984) investigated the life history of this species from Aldabra, Seychelles. Movement patterns were monitored in Seychelles using acoustic tracking (Lea *et al.* 2016), which provided insight into habitat partitioning (Lea *et al.* 2020). Considerable research has been undertaken on the Great Barrier Reef and elsewhere in the Pacific Ocean (Simpfendorfer *et al.* 2020b and references cited therein).

ECOLOGY

Depth

This species occurs inside and around coral atolls and lagoons from the surface to depths of about 85 m (Compagno *et al.* 1989). It is commonly associated with coral reefs and is not oceanic (Ebert *et al.* 2013).

Habitat: Adults

Adults are generally found in and around coral reefs, often venturing into the vicinity of reef drop offs.

Habitat: Juveniles/Nursery Grounds

As this species is generally associated with coral reefs, juveniles are most common in shallow coral lagoons, but in many locations mangrove systems are also used as nursery grounds (Chin *et al*. 2013, cited by Simpfendorfer *et al.* 2020b).

Synopsis of tag deployments

No individuals have been tagged in the ORI Cooperative Fish Tagging Project 1984-2018 inclusive. In Aldabra, Seychelles, over 1000 individuals, comprising neonates, juveniles and adults, were tagged with external roto tags (Stevens 1984).

Movements

Based on tag-recapture data from Aldabra, there was considerable site fidelity within the coral lagoon and small-distance movements were undertaken, often in response to tidal changes (Stevens 1984). Elsewhere in the Seychelles 25 individuals, also comprising juveniles and adults, were fitted with acoustic tags. They showed very restricted movements with almost all detections occurring within the confines of St Joseph Atoll (Lea *et al.* 2016).

Diet/feeding: adults

This species is reported to feed on a variety of small teleosts, crustaceans and gastropods, but with no noted difference in the diets of adults and juveniles (Bass *et al.* 1973, Compagno 1984, Stevens 1984).

Diet/feeding: juveniles

See comments on the adult diet.

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Placental viviparity

DURATION OF REPRO CYCLE	2 years (Seychelles)
MATING	Spring: October and November (Seychelles)
GESTATION	12 months (Seychelles)
LITTER SIZE	2–5, mean 4 from ±18 litters (W Indian Ocean)
PUPPING/NURSERY GROUND	Spring: October and November (Seychelles)
LENGTH AT BIRTH	50–70 cm (W Indian Ocean)
LENGTH AT MATURITY	F: 110 cm; M: 105 cm (W Indian Ocean)
MAXIMUM LENGTH	180 cm; usually < 160 cm (W Indian Ocean)
GENERATION LENGTH	±14 years (W Pacific)

Mode
This species exhibits placental viviparity (Bass *et al.* 1973).

Duration of reproductive cycle
This is 2 years in Seychelles (Stevens 1984).

Mating season and location
In the Seychelles mating is in October–November (Stevens 1984).

Gestation
This is 12 months in Seychelles (Stevens 1984).

Litter size
Litter size is 2–5 with a mean of 4 in the W Indian Ocean and Red Sea (Bass *et al.* 1973 and references cited therein; Stevens 1984).

Length at birth
Length at birth in the W Indian Ocean and Red Sea ranges from 50–70 cm (Bass *et al.* 1973 and references cited therein, Stevens 1984).

Pupping season and nursery grounds
In Seychelles pupping is seasonal in October (Stevens 1984).

Length at maturity
Females mature at 110 cm and males at 105 cm in the W Indian Ocean (Bass *et al.* 1973, and references cited therein, Stevens 1984).

Maximum length
In the SW Indian Ocean this species reaches a maximum length of 180 cm, with most individuals smaller than 160 cm (Bass *et al.* 1973). In Seychelles the largest individual, a female, was 140 cm, and the largest male was 130 cm (Stevens 1984).

Age and growth
On the Great Barrier Reef males mature at 4.2 years and females at 8.5 years. Longevity was estimated as 15 years, but this is acknowledged as an underestimation and captive animals have lived for over 25 years (Chin *et al*. 2013, cited by Simpfendorfer *et al.* 2020b).

Generation length
Based on the above data from the Great Barrier Reef, generation length is estimated to be between 12–17 years (average of 14.5 years) (Simpfendorfer *et al.* 2020b).

FISHERIES MANAGEMENT

SA catch sources, quantities and characteristics
This species was not listed in estimated catches/landings recorded by DFFE for the period 2010–2012 (da Silva *et al.* 2015).

Fishing outside South Africa
This species is caught throughout its range in industrial and small-scale longline, gillnet, trawl and handline fisheries that occur in continental shelf waters and those around oceanic islands and reefs, especially those around coral reefs. Most are taken as incidental catch in general reef fisheries targeting teleost fishes. It is a common display species in aquaria worldwide and is regularly exported from countries such as Australia and Indonesia (Simpfendorfer *et al.* 2020b). Specimens caught in east African waters have been exported via South Africa.

Population trends
Genetic studies support the presence of multiple subpopulations throughout its range, with structure detected between and within island groups in the Pacific (Vignaud *et al.* 2014, cited by Simpfendorfer *et al.* 2020). The number of subpopulations is likely to be high but is currently unknown because of limited sampling at most locations (Simpfendorfer *et al.* 2020b).

This species is common in tropical and subtropical waters but there is little information on population status and trends. Given the high level of population structuring, localised studies are unlikely to provide a good indication of overall population trend of his species (Simpfendorfer *et al.* 2020b).

Severe localized depletions in reef sharks, that include *C. melanopterus*, have been recorded from several areas, with densities higher at remote locations with very limited or no human presence. In parts of south and east Asia this is the only reef shark species that remains, following the loss of species such as *C. amblyrhynchos* and *Triaenodon obesus*, suggesting that population declines are not as severe as reported for these other species. To account for spatial differences in population trends in *C. melanopterus*, an index of population abundance was constructed using data from the Global Finprint project (MacNeil *et al*. 2020). This initiative sampled in nations containing 88.6% of the coral reefs within the species' historic range and is by far the largest and most recent data set available to assess the status of this species. The results indicated that *C. melanopterus* has undergone a population reduction of 30–49% over the past three generation lengths (44 years) and, as a result, it was globally assessed as Vulnerable on the IUCN Red List in 2020 (Simpfendorfer *et al.* 2020b).

ECOTOURISM
This species is an extremely popular ecotourism species in coral reef environments.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
This species has not been formally recorded in South African waters and will only possibly benefit from the Bazaruto Archipelago National Park central Mozambique. As there is evidence of some degree of residence elsewhere in the W Indian Ocean, the potential benefits of any MPAs are likely to be high.

Additional local comment

IUCN Red List Status
Vulnerable 2020: A2bcd

Previous IUCN assessments
Near Threatened 2009
Near Threatened 2000

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed on any of the appendices of CITES.

Convention on Migratory Species (CMS)
This species is not listed.

International comments
There are currently no species-specific conservation or management plans in place. There are many general measures that contribute to conserving this species in parts of its range. Marine Protected Areas (MPAs) that incorporate >20 km^2 of coral reef can provide significant protection because of the limited movements observed in this species. MPAs are common in coral environments but only those that are sufficiently large and well managed will provide refuge for *C. melanopterus* (MacNeil *et al.* 2020).

MANAGEMENT CONSIDERATIONS
The species is vulnerable to overexploitation in coral reef habitats due to its limited dispersal and localised movement patterns, relatively slow growth and low fecundity. In the absence of any records from South African waters, it must be regarded as an extremely low priority species. If it is shown to occur locally, it will be in the extreme north, which is all within the iSimangaliso Wetland Park. As a result, *C. melanopterus* is an extremely low priority species.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
The life history of this widely distributed species has been extremely well studied in Seychelles. As its presence in South African waters has not been confirmed, research opportunities in South Africa are extremely limited. Any sightings should be documented; live individuals should be tagged and any dead specimens should be used to collect life history information and tissue samples for genetic studies.

Carcharhinus obscurus

SCIENTIFIC NAME	*Carcharhinus obscurus* (Lesueur 1818)
COMMON NAME	Dusky shark
FAMILY	Carcharhinidae
ENDEMIC	No
SIZE RANGE	85–377 cm TL
SA DISTRIBUTION	E, S coasts: Mozambique border to False Bay
HABITAT	Pelagic over sand bottoms and rocky reef areas
DEPTH RANGE	0–400 m; juveniles common close inshore, adults off shelf edge
MAJOR FISHERIES	KZN bather protection nets, line and longline fisheries, KZN prawn trawl fishery
IUCN STATUS	Endangered 2018
CITES	Not listed
MLRA	No retention in pelagic longline fishery; slot limits of 70–130 cm in demersal shark longline fishery; daily bag limit of one in recreational fishery
COMPILER	G Cliff
REVIEWER	R Daly

SPECIES SUMMARY and RECOMMENDATIONS

Carcharhinus obscurus is a large pelagic shark with a cosmopolitan but patchy distribution in tropical and warm temperate seas. In South Africa it occurs on the entire east and south coasts, extending northwards into Mozambique. It is most common in central and southern KZN, with a nursery ground in the shallow coastal waters; the adults live further offshore, associated with the continental shelf edge. Local catch was estimated at 11–100 tons per annum (DFFE records: 2010–2012). Highest catches were listed in the recreational linefishery, the KZN bather protection programme, the pelagic longline fishery and the now closed KZN prawn trawl fishery. Its fins are regarded as highly valuable and it is heavily fished in most its range. It was assessed globally as Endangered in 2018, with fishing being the greatest threat, due to its low productivity through slow growth, late maturity and low reproductive output. As a highly mobile species, it derives limited protection from all the Marine Protected Areas on the east and south coasts, the most important of which is the uThukela Banks MPA, as many term pregnant females have been caught in the bather protection nets there. Research into the extent of the nursery grounds on the uThukela Banks and how they overlap with the MPA is needed. It is conceivable that, despite its nomadic behaviour, this species is able to complete its life cycle within South African territorial waters. The whereabouts of the mating grounds and those of the females in early pregnancy are in need of investigation.

TAXONOMIC and IDENTIFICATION ISSUES

There are no taxonomic issues. This species is one of 17 members of the genus *Carcharhinus* found on the southern African east coast. Many are very similar in overall appearance, with features such snout shape, dentition, the position of the first dorsal fin relative to the pectoral fins, the presence or absence of an interdorsal ridge and fin pigmentation used to separate the species. The dusky shark may be confused with the bignose shark *C. altimus*, Galapagos shark *C. galapagensis*, silky shark *C. falciformis* and sandbar shark *C. plumbeus.* All have an interdorsal ridge and similar shaped (rounded) snout and erect upper jaw teeth. These species are largely separated by the position of the dorsal fin relative to the pectoral fins and tooth counts. *C. obscurus* is by the most common pelagic shark in shallow coastal waters of the east coast (Bass *et al*. 1973). These authors regarded the external differences between *C. obscurus* and *G. galapagensis* as being *difficult to describe*, with small differences in the height of the first dorsal fin and its origin in relation to the pectoral fins and the shape of the latter fins. These two species are also extremely similar genetically, in that they share mitochondrial DNA haplotypes but are distinguishable based on single nuclear polymorphisms (SNPs) (*Corrigan et al.* 2017). The most striking difference lies in their habitat, with *C. obscurus* occupying coastal waters and *C. galapagensis* found around islands and offshore shoals (Bass *et al*. 1973).

SOUTH AFRICAN DISTRIBUTION

This species is confined to the entire east and south coasts (Mozambique border to False Bay (Ebert *et al.* 2021).

REGIONAL DISTRIBUTION

This species is present in Mozambique and Madagascar but not further north in Tanzania (Rigby *et al.* 2019i).

SYNOPSIS OF RESEARCH

This is a well-studied species. In South Africa Bass *et al.* (1973) provided detailed taxonomic, morphometric and biological information from several hundred individuals, including adults and pregnant females. Smale (1991) described the occurrence and diet of this species in the Eastern Cape. An analysis of catch statistics and general biology of 5626 individuals caught in the KZN bather protection programme was undertaken by Dudley *et al*. (2005). Several movement studies have been undertaken, primarily through the tagging of neonates on the east coast (Davies and Joubert 1966, Bass *et al*. 1973 and Dicken 2011). More recent advances in understanding the ecology of this species have resulted from opportunistic tagging by recreational and scientific shore anglers affiliated to the ORI Cooperative Fish Tagging Project. An analysis of these data was undertaken by Govender and Birnie (1997) and Hussey *et al.* (2009a). Cliff *et al.* (2002) documented the incidence of entanglement in fibre packing case bands used to seal bait boxes. Body condition factors (Hussey *et al.* 2009b) and reproductive output (Hussey *et al.* 2010) were investigated. Hussey *et al.* (2011) examined the trophic ecology of this species along with other large sharks present in KZN coastal waters. Rossouw *et al.* (2016) found evidence of multiple paternity. Dudley and Dicken (2013b) provided a concise overview of life history and fishery-related information on this species. Comparative information on the biology and ecology of this species is available from studies in the Gulf of Mexico, Western Pacific, North Atlantic and South Atlantic (see Rigby *et al*. 2019i and references cited therein).

ECOLOGY

Depth

This pelagic species occurs from the surfzone, where the neonates are seasonally abundant, out to water depths of 200–400 m (Bass *et al*. 1973).

Habitat: Adults

The adults are pelagic and highly mobile; they occur in the warm waters of the outer continental shelf (depths of 200-400 m); the females move inshore to pup (Bass *et al*. 1973).

Habitat: Juveniles/Nursery Grounds

They occur in the surfzone off sandy beaches along the KZN coast and in shallow bays in the Eastern Cape (Bass *et al.* 1973, Smale 1991).

Synopsis of tag deployments

A total of 14516 individuals were tagged in the ORI Cooperative Fish Tagging Project 1984-2018 inclusive. There were 1235 recaptures (9%), with the mean distance travelled of 60 km (maximum 1374 km) and mean time at liberty of 3 months (maximum 7.6 years) (Jordaan *et al.* 2020). These data were analysed in detail by Hussey *et al.* (2009a). Govender and Birnie (1997) used the tagging data to calculate mortality rates. Other local tagging studies include Bass *et al.* (1973) and Dicken (2011), with a large majority of individuals tagged being neonates and other juveniles, which are the most common component of the population and easy to catch in shallow, coastal waters.

Movements
This species is migratory (Dudley and Dicken 2013b), with a large portion of the neonate population moving southwards from their core nursery areas on the central and southern KZN coast to waters of the south coast, where they do not appear to remain for winter (Hussey *et al.* 2009a). Seasonally, large sharks, including pregnant females, move inshore from the outer shelf (Bass *et al.* 1973), often in pursuit of sardines during the annual sardine run (Dudley and Cliff 2010).

Diet/feeding: adults
The adults and other large individuals feed mainly on teleosts, with a high seasonal incidence of sardines (Dudley and Cliff 2010), and elasmobranchs (more sharks than batoids). The diet also includes cephalopods. Elasmobranchs dominate the prey of pregnant females (Dudley *et al.* 2005).

Diet/feeding: juveniles
The juveniles feed mainly on demersal and pelagic teleosts, but not sardines, followed by elasmobranchs and cephalopods (Dudley *et al.* 2005).

South African toxicological studies
Three studies have been conducted on this species in South Africa, all using specimens caught in the KZN bather protection nets. Concentrations of 10 metals, which included mercury, lead and cadmium, were measured in the liver and muscle tissues of 32 individuals, including an undisclosed number of pregnant females and eight embryos (Watling *et al.* 1982). Organochlorine levels in the muscle tissue of 42 juvenile and adults (143-258 cm) were also determined (Beaudry *et al.* 2015).

Levels of total mercury in the muscle tissue of 64 juveniles and adults (96–370 cm) from KZN waters showed a positive correlation with body length. No comparative values were available for this species from other parts of its range. Values for a number of local pelagic shark species were higher than those from other regions and in many cases, they were far higher than international regulatory guidelines for human and fish health (McKinney *et al.* 2016 and references cited therein).

REPRODUCTION

REPRODUCTIVE MODE	Placental viviparity
DURATION OF REPRO CYCLE	3 years
MATING	Unknown location and time of the year
GESTATION	2 years
LITTER SIZE	Median of 10; maximum 16; n=285
PUPPING/NURSERY GROUND	Prolonged pupping season, but mostly March to July inshore on central and southern KZN coast
LENGTH AT BIRTH	85-100 cm
LENGTH AT MATURITY	50% maturity F: 285 cm, M: 280 cm
MAXIMUM LENGTH	F: 377 cm; M: 343 cm
GENERATION LENGTH	38 years

Mode
This species exhibits placental viviparity (Bass *et al*. 1973). Rossouw *et al.* (2016) found evidence of multiple paternity in 35% of litters.

Duration of reproductive cycle
In South Africa there is a triennial reproductive cycle (Dudley *et al.* 2005).

Mating season and location

There is a prolonged mating season, but little is known about it and early gestation as these activities occur away from KZN coastal waters (Bass *et al.* 1973, Dudley *et al.* 2005).

Gestation
In South Africa this is in the region of two years (Dudley *et al*. 2005).

Litter size
In South Africa the median litter size of 285 litters was 10 embryos, with a maximum of 16 (Dudley *et al*. 2005).

Length at birth
In South Africa this is 85–100 cm; the largest embryos recorded together in a litter had a mean length of 100 cm (Dudley *et al.* 2005). Most neonates with open or newly closed umbilical slits were 80–90 cm (Bass *et al.* 1973).

Pupping season and nursery ground
In South Africa the pupping season is prolonged, with term embryos present between February and December, although 82% (213 litters) were caught between early March and early July. Pupping probably occurs throughout central and southern KZN (the span of the KZN bather protection programme) and neonates are caught by shore anglers along this entire section of the coast. Catches of pregnant sharks in the KZN bather protection programme were highest at Zinkwazi and Richards Bay, the two northernmost protected localities. They are inshore of the productive uThukela Banks (Fennessy 1994), which may be a preferred pupping ground (Dudley *et al.* 2005). Some of the neonates move south into waters of the Eastern Cape (Smale 1991, Dicken 2011), and others move north, with one tagged individual recaptured in southern Mozambique (Bass *et al.* 1973).

Length at maturity
In South Africa females attain 50% maturity at 285 cm and males at 280 cm (Dudley and Simpfendorfer 2006). There is regional variation in length at maturity, ranging from 257–310 cm for females and 265–280 cm for males (see Rigby *et al*. 2019i and references cited therein).

Maximum length
The largest female recorded on the east coast of South Africa was 377 cm and the largest male 343 cm TL (Dudley *et al*. 2005).

Age and growth
This species is regarded as slow-growing and long-lived. Using the growth curves of Natanson and Kohler (1996) and Hussey *et al.* (2009b), 50% maturity was attained in females at 17–21 years and males at 17–20 years for South African specimens (Dudley and Dicken 2013b). Older ages were validated in Western Australia (Eastern Indian Ocean), with female age-at-maturity of 27–32 years and maximum age of 40–53 years (Rigby *et al.* 2019i and references cited therein). Natanson *et al.* (2014) confirmed that the maximum validated age was between 38 and 42 years.

Generation length
Using the age parameters from the Eastern Indian Ocean population, generation length is 38 years (Rigby *et al.* 2019i).

FISHERIES MANAGEMENT
SA catch sources
Local catch was estimated at 11–100 tons per annum (DFFE records: 2010-2012), from a number of fisheries, with the KZN bather protection programme listed as the biggest contributor, followed by the

recreational line fishery and the prawn trawl fishery. It was also caught in the commercial linefishery and the demersal and pelagic longline fisheries (da Silva *et al.* 2015).

SA catch quantities and characteristics

KZN bather protection nets

The mean annual catch in the KZN bather protection nets was 256 (range 129–571) for the period 1978-1999; 12% of the catch was found alive and much of it released. This species constituted 20% of the total shark catch for that period and there was no significant linear trend in catch or catch rate with time. The catch was trimodal; the modes comprised small (mostly neonate), medium (adolescent) and large (mostly mature) sharks, respectively. There were geographical and seasonal distribution patterns for each of these size categories. Females significantly outnumbered males in all size categories, the greatest disparity (2.72:1) being in large animals. Catches of medium and large sharks were highest during the annual sardine run, a seasonal influx of *Sardinops sagax* (Dudley *et al.* 2005, Dudley and Cliff 2010). A more recent analysis (2000–2009) revealed that the annual catch had dropped to around 150, in part due to gear removal for extended periods during the sardine run (Cliff and Dudley 2011).

KZN prawn trawl fishery

This species was caught in small numbers in the KZN prawn trawl industry on the uThukela Banks. The 10 individuals caught in 169 (2%) trawls between 1989 and 1992 would extrapolate to an annual catch of 167 sharks over that period. Although it was based on an extremely small sample size, survival rates were good in that seven of eight individuals were released alive. Size range was 0.7–1.3 m, with a mean of 1.0 m, which would be largely neonates and other juveniles (Fennessy 1994).

Recreational shore angling

This species is one of the most common catches by shore anglers in KZN, with a proliferation of individuals documented by van der Elst (1979). In KZN competitive shore anglers caught 54,821 individuals over a 24-year period (1977-2000), at a rate of 2,284 per annum and with a mean individual mass of 5.7 kg, which is that of a neonate. This species was the most common catch, constituting 26% by number and 34% by weight. Since 1995 there has been a strong emphasis on catch-and-release, therefore mortalities are likely to be very low (Pradervand *et al.* 2007). In the early 2000's advances in recreational shore fishing techniques and equipment (stronger braid line and better reels) also allowed these anglers to consistently land larger sharks, including adults (upwards of 270 cm) during winter months. Although the majority of these sharks are released, there have been cases of depredation of hooked sharks by other large dusky sharks.

In all the regions to the south of KZN, catches of *C. obscurus* and *C. brachyurus* were lumped together in the records kept by competitive recreational shore anglers, due to an inability to easily distinguish between the two species (Pradervand and Govender 2003, Pradervand 2004 and Dicken *et al.* 2012). As a result, it is not possible to quantify the catches, suffice to say that they were not nearly as high as those in KZN fishery, as reported by Pradervand *et al.* (2007). There was also an emphasis on catch-and-release in these more southerly regions.

Pelagic longline fishery

This species is one of the large pelagic sharks caught in the Southern African tuna and swordfish longline fisheries. It represented 0.9% of the total shark bycatch by number in the period 1998-2005, which equates to about 400-500 individuals per year. Some of this catch, which was either discarded or released, possibly included misidentified silky sharks *Carcharhinus falciformis* (Petersen *et al.* 2009). Retention of *C. obscurus* in the pelagic longline fishery is prohibited due to its similarity with *C. falciformis* (da Silva *et al.* 2018).

Commercial linefishery

In the mid-1990s shark exports from South Africa started to increase, with a new directed demersal shark fishery moving into the fin trade and subsequently into the shark fillet export industry to Australia, where local supply cannot meet the demand (da Silva and Burgener, 2007). *C. obscurus* is one of the species involved, with reports of large but unknown numbers of neonates on the KZN south coast being exported.

Fishing outside South Africa

This species is caught globally as target and bycatch in commercial and small-scale pelagic longline, purse seine, and gillnet fisheries. Most is taken as bycatch of commercial pelagic fleets in offshore waters, with varying levels of survival. Under-reporting of catches in pelagic and domestic fisheries is likely. Unless regulations prohibit retention, the species is often kept for the meat and fins, which are highly valued. The fins accounted for around 1% of that traded in Hong Kong (see Rigby *et al.* 2019i and references cited therein for more details).

Population trends

No population estimates have been attempted in South Africa. According to Rigby (*et al.* 2019i and references cited therein), genetic studies support two subpopulations, the NW Atlantic and the Indo-Pacific, although where other parts of the Atlantic fit into this structuring is unknown. In the Indo-Pacific no genetic substructure was found between South Africa, Australia and Indonesia (Junge *et al*. 2019).

An analysis of catches in the KZN bather protection nets over the 26-year period 1978-2003 indicated that potential effects of the nets was high due to the very low intrinsic rates of population increase, however there was no significant decline in catch rate or body length over time (Dudley and Simpfendorfer 2006). The data were recently reassessed and revealed annual rates of reduction of 0.9%, consistent with an estimated median reduction of 61% over three generation lengths (114 years), with the highest probability of 50–79% reduction over three generation lengths. This regional population trend was used in conjunction with those for populations in the eastern Atlantic and Indian Oceans and which were weighted according to the relative size of each region. The global estimated median reduction was 76%, with the highest probability of >80% reduction over three generation lengths (89–114 years). Therefore, this species was assessed as Endangered in 2018 (see Rigby *et al.* 2019, and references cited therein for more information).

ECOTOURISM

This species commonly seen during the annual winter sardine run and is occasionally sighted in baited dives in the Aliwal Shoal MPA, therefore it should be regarded as an ecotourism species.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

Retention of this species in the pelagic longline fishery is prohibited due its close similarly to the silky shark *C. falciformis.* This species may be targeted in the demersal shark longline fishery, with slot limits of 70–130 cm. There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)

This species is not listed.

Marine Protected Areas

This pelagic species is highly mobile, with the neonates in particular moving large distances southwards along the east coast to the south coast. It will therefore derive very limited protection from all the MPAs on the east and south coasts. Most of the term pregnant females caught in the KZN bather protection were taken at Richards Bay and Zinkwazi. Neonates are caught in small numbers by shore anglers at Richards Bay. Both locations are inshore of the uThukela Banks MPA, which therefore potentially offers considerable protection to two important life history stages of this species.

Additional local comment
This species will benefit from the ban on any demersal shark longlining east of the Kei mouth (this excludes the entire KZN and Wild Coast), which usually occurs at depths of 50–100 m, which does overlap slightly with its depth range.

Current IUCN Status
Endangered 2018: A2bd

Previous IUCN assessments
Vulnerable 2009
Near Threatened 2000
Endangered 1996

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
In 2017, this species was listed on Appendix II of the Convention on Migratory Species (CMS). As of 2018, the species was also covered by the CMS Memorandum of Understanding for Migratory Sharks (Rigby *et al.* 2019i).

International comments
At-vessel mortality was estimated at 34% in the US pelagic longline fishery, 81% in the northwest Atlantic bottom longline fishery, and 1.3% on Western Australia demersal longlines (McCandless *et al*. 2014, Braccini and Waltrick 2019). Post-release mortality was estimated as being as high as 67% in the northwest Atlantic bottom longline fishery (see Rigby *et al.* 2019i and references cited therein).

MANAGEMENT CONSIDERATIONS
The life history characteristics of this species suggest that it cannot sustain high levels of exploitation. The catches of juveniles made in both the demersal shark longline industry and the commercial linefishery in KZN for export to Australia need to be quantified. An assessment of these fisheries may necessitate some capping of the catches. Quantification of bycatch in the demersal and pelagic longline fisheries is also needed. Fishers and fisheries observers need to be able to distinguish this species from its congeners, especially *C. falciformis* and the copper shark *C. brachyurus. C. obscurus* is now a prohibited species in the pelagic longline fishery, but some indication of post-capture survival or mortality is needed to establish the effectiveness of this measure. The ramifications of the absence of genetic substructure among individuals from South Africa, Australia and Indonesia needs to be assessed.

The nursery grounds of this species are in central and southern KZN and many of the neonates move south into the Eastern Cape and on to the south coast. Adolescents are present on the KZN south coast and the Wild Coast during the sardine run. Term pregnant females are caught in the KZN bather protection programme. It is possible that this species can complete its life cycle entirely in South African territorial waters, which would simplify management of this species. There may be some emigration into Mozambique waters and it is important to quantify this. Because it is a common catch in several fisheries, and given its Endangered status, management of this species must be regarded as being of high priority.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

This is an extremely well-studied species. Knowledge of its basic biology and life history is good, but the whereabouts of the mating grounds and those of early gestation are unknown. It would be of some concern if these where to be in southern Mozambique, where commercial fisheries are known to operate. Additionally, adult habitat use is poorly understood. Satellite tracking would help to elucidate this and other large-scale movements in the region. Although large numbers of juvenile sharks, especially neonates, have been part of the long-term tag-recapture program which confirmed some of the movements of these sharks along the South African coast, there is still little known about these sharks return migration patterns, site fidelity and transboundary movements. The use of long term (10–year) acoustic tags could help to improve our understanding of the migrations and habitat use (specifically in relation to MPAs) and transboundary movements of the species in South Africa.

Carcharhinus plumbeus

SCIENTIFIC NAME	*Carcharhinus plumbeus* (Nardo 1827)
COMMON NAME	Sandbar shark
FAMILY	Carcharhinidae
ENDEMIC	No
SIZE RANGE	60–240 cm TL
SA DISTRIBUTION	E coast: Mozambique border to Algoa Bay
HABITAT	Demersal and pelagic on sand bottoms and rocky reef areas in coastal waters
DEPTH RANGE	0–280 m but more commonly 5–50 m
MAJOR SA FISHERIES	KZN prawn trawl fishery, KZN bather protection nets, recreational linefishery
IUCN STATUS	Endangered 2020
CITES	Not listed
MLRA	Slot limits of 70–130 cm in the demersal shark longline fishery; daily bag limit of one in recreational fishery
COMPILER	G Cliff
REVIEWER	SFJ Dudley

SPECIES SUMMARY and RECOMMENDATIONS

Carcharhinus plumbeus is a medium-sized pelagic shark which has a circumglobal distribution in tropical and warm-temperate, coastal waters. Locally it occurs on the east coast of South Africa and along the entire east coast of Africa. Local catch was estimated at 1–10 tons per annum (DFFE records: 2010–2012), from a small number of fisheries, namely the now-closed KZN prawn trawl fishery, the KZN bather protection programme and recreational linefishery. Internationally its fins are regarded as highly valuable and it is heavily fished in most of the regions where it occurs. It was assessed globally as Endangered in 2020, with fishing being the greatest threat. As a nomadic species, it derives limited protection from the Marine Protected Areas on the east coast, the most important of which is the uThukela Banks MPA, as in this region neonates have been caught by shore anglers and recently mated and term pregnant females have been caught in the bather protection nets at Richards Bay. Research into the extent of the nursery grounds on the uThukela Banks and how they overlap with the MPA is needed. It is conceivable that, despite its nomadic behaviour, this species is able to complete its life cycle within South African territorial waters. Tissue samples from specimens caught in the KZN bather protection nets are available for genetic studies to assess the connectivity with sharks from Mozambique and further north.

TAXONOMIC and IDENTIFICATION ISSUES

There are no taxonomic issues. This species is one of 17 members of the genus *Carcharhinus* found on the South African east coast. Many are very similar in overall appearance, with features such as snout shape, dentition, the position of the first dorsal fin relative to the pectoral fins, the presence or absence of an interdorsal ridge and fin pigmentation used to separate the species. The sandbar shark may be confused with the more common dusky shark *Carcharhinus obscurus*. Both species occur in inshore waters of the east coast and have a similar shaped snout and dentition, a lack of fin pigmentation and the presence of an interdorsal ridge. *C. plumbeus* has a much taller first dorsal fin with its origin further forward than that of *C. obscurus*, in that it is on or over the pectoral axil rather than over the pectoral inner corner (Bass *et al.* 1973).

SOUTH AFRICAN DISTRIBUTION

This species is confined to the east coast. It is most common in KZN waters but extends its range southwards as far as Algoa Bay in summer (Ebert *et al.* 2021

REGIONAL DISTRIBUTION

This tropical species is present in Mozambique and northward along the entire east coast of Africa.

SYNOPSIS OF RESEARCH

This is not a well-studied species in South Africa. Bass *et al.* (1973) provided detailed taxonomic, morphometric and biological information from approximately 100 individuals, including adults and pregnant females. This was followed by an analysis of catch statistics and general biology of 291 individuals caught in the KZN bather protection programme (Cliff *et al.* 1988). No subsequent dedicated scientific study has been conducted on this species. Comparative information on the biology and ecology of this species is available from studies in the Mediterranean Sea, Gulf of Mexico, NW and SW Atlantic, NW and SE Pacific Oceans (see Musick *et al.* 2009 and Rigby *et al.* 2021c and references cited therein).

ECOLOGY

Depth

It is a coastal species and in KZN it occurs in water depths of 0–60 m, but is most common shallower than 30 m. Despite being most common inshore, it is not often caught by shore anglers. In Mozambique a neonate of 63 cm was caught at a depth of 280 m (Bass *et al.* 1973).

Habitat: Adults

Adults are highly mobile and are often found close to the bottom in areas with sand or mud substrates (Springer 1960). They also feed on rocky reefs (Bass *et al.* 1973).

Habitat: Juveniles/Nursery Grounds

There is no evidence that juveniles occupy a different habitat to the adults, although adults appear to be more widespread.

Synopsis of tag deployments

A total of 331 individuals were tagged in the ORI Cooperative Fish Tagging Project 1984-2018, inclusive. There have been 6 recaptures (2%), with a mean distance travelled of 186 km (maximum 345 km) and mean time at liberty of 7 months (maximum 1.5 years) (Jordaan *et al.* 2020).

Movements

These tagging results are indicative of a nomadic species but there is no evidence of regular breeding or feeding migrations.

Diet/feeding: adults

This species feeds mainly on small teleosts and cephalopods (octopus and cuttlefish). Less common prey items include small sharks and crustaceans. Some of the prey items are benthic (soles) and reef associated (eels) (Cliff *et al.* 1988).

Diet/feeding: juveniles

The study by Cliff *et al.* (1988) did not investigate size-related changes in the diet of sandbar sharks. In the NW Atlantic neonates consume mostly crabs and other large crustaceans and then shift towards a fish-dominated diet with age (Ellis and Musick 2007).

South African toxicological studies

Levels of total mercury in the muscle tissue of six juveniles and adults from KZN waters were determined. No comparative values were available for this species from other parts of its range. Values for a number of local pelagic shark species were higher than those from other regions and in many cases, they were far higher than international regulatory guidelines for human and fish health (McKinney *et al.* 2016 and references cited therein).

REPRODUCTION

REPRODUCTIVE MODE	Placental viviparity
DURATION OF REPRO CYCLE	2 years
MATING	Late October to January
GESTATION	12 months
LITTER SIZE	Mean of 7; range 4–10; n=42
PUPPING/NURSERY GROUND	December and January, possibly uThukela Banks region, or inshore thereof
LENGTH AT BIRTH	60–65 cm
LENGTH AT MATURITY	50% maturity F: 168 cm; M: 164 cm
MAXIMUM LENGTH	F: 218 cm; M: 213 cm
GENERATION LENGTH	Not calculated

Mode
This species exhibits placental viviparity (Bass *et al.* 1973).

Duration of reproductive cycle
There is a biennial reproductive cycle (Cliff *et al.* 1988). It is also biennial, possibly triennial, elsewhere in this species' range (Musick *et al.* 2009).

Mating season and location
Mating appears to take place in extreme northern KZN waters, including Richards Bay, between late October and January (Cliff *et al.* 1988).

Gestation
Gestation is in the region of 12 months (Cliff *et al.* 1988).

Litter size
Mean litter size is 7 (range 4–10, n=42), with a positive correlation between maternal length and the number of embryos (Cliff *et al.* 1988).

Length at birth
length at birth is 60–65 cm (Bass *et al.* 1973; Cliff *et al.* 1988) and varies regionally from about 45 cm to 60 cm (Musick *et al.* 2009).

Pupping season and nursery ground
Pupping occurs between December and February (Bass *et al.* 1973; Cliff *et al.* 1988). Most of the pregnant females with term embryos were caught inshore of the uThukela Banks (KZN bather protection nets deployed at Zinkwazi, eMthunzini and Richards Bay). Bass *et al*. (1973) postulated that the nursery grounds were in southern Mozambique. Pupping is known to take place inshore of the uThukela Banks as neonates of approximately 65 cm are caught in small numbers from the piers and beaches at Richards Bay (Cliff *et al*. 1988).

Length at maturity
Females attain 50% maturity at 168 cm and males at 164 cm (Dudley and Simpfendorfer 2006).

Maximum length
The largest female recorded on the east coast was 218 cm and male 213 cm (Bass *et al*. 1973). There is considerable regional variation in maximum length, ranging from 191 to 234 cm for females from 173 to 224 cm for males (Bass *et al.* 1973 and references cited therein).

Age and growth

This species has not been aged in the SW Indian Ocean. It is regarded as slow growing, based on several studies conducted elsewhere where the range in female age-at-maturity is 8–16 years, with a maximum age of 21–27 years (Rigby *et al.* 2021c and references cited therein).

Generation length

In the NW Atlantic and Gulf of Mexico female age-at-maturity is 13 years and maximum age is 27 years, resulting in a generation length of 20 years. In W Australia female age-at-maturity is 16 years and maximum age is suggested as 36 years, resulting in a generation length of 26 years (Rigby *et al.* 2021c and references cited therein).

FISHERIES MANAGEMENT

SA catch sources

Local catch was estimated at 1–10 tons per annum (DFFE records: 2010–2012), from a number of fisheries, with the KZN bather protection program listed as the biggest contributor, followed by the prawn trawl fishery. It was listed as a suspected catch in the pelagic longline fishery (da Silva *et al.* 2015). It is also caught in small numbers by recreational shore anglers (Pradervand 2004; Pradervand *et al.* 2007)

SA catch quantities and characteristics

KZN prawn trawl fishery

This species was caught in small numbers in the inshore KZN prawn trawl industry on the uThukela Banks, with a mean annual estimated catch of 88 (range 67–126: 1989–1992). Based on an extremely small sample size, survival rates were good, in that four of six individuals were released alive. Size range was 1.0–1.4 m, with a mean of 1.1 m, which would represent immature individuals but not neonates (Fennessy 1994). This fishery was dormant for nearly two decades due to the extended closure of the mouth of Lake St Lucia, resulting in poor prawn recruitment and diminishing prawn catches on the uThukela Banks. The fishing grounds were closed to trawling following the declaration of the uThukela MPA in August 2019.

KZN bather protection nets

The mean annual catch in the KZN bather protection nets was 29 (range 8–58) for the period 1978–1987, with a 10% release rate. The catch was bimodal and included both immature and mature individuals. No neonates were caught but this is because of the relatively small size at birth (60–65 cm) and the large mesh size of the nets (51 cm stretched). The sex ratio was 0.5:1 males to females. Catches of both immature and mature individuals were strongly seasonal, peaking between December and March. There was a dichotomous pattern in the geographic distribution of the catches, with a peak in the extreme north (Richards Bay and Zinkwazi, which are both close to the uThukela Banks) and another less pronounced peak in southern KZN (Umzumbe to Port Edward) (Cliff *et al.* 1988). A more recent analysis (2000–2009) revealed that the annual catch had dropped to around 10 (Cliff and Dudley 2011).

Recreational shore angling

In KZN competitive shore anglers caught 86 individuals over a 24-year period (1977–2000), at a rate of 3.6 per annum and with a mean individual mass of 4 kg (Pradervand *et al.* 2007); as this equates to a length of approximately 90 cm, these individuals would be juveniles (Cliff *et al.* 1988). On the Wild Coast (northern part of the Eastern Cape), over a similar period, competitive shore anglers caught 24 sandbar sharks at a rate of 1 per annum and with a mean mass of 12 kg (Pradervand 2004); this equates to a length of approximately 120 cm, also immature individuals (Cliff *et al.* 1988).

Fishing outside South Africa

It is an important commercial species in Mozambique, but with no further details (Pierce *et al.* 2008).

The species is captured as target and bycatch in artisanal, industrial, and recreational fisheries and is retained for the high value meat and fins, unless regulations prohibit retention. This species is a significant component of coastal shark fisheries worldwide and is caught in most areas that it occurs. Gear used includes longlines, hook-and-line and bottom-set nets; it is also popular with sports anglers in some areas. It represented at least 2–3% of the fins auctioned in Hong Kong, the world's largest shark fin trading hub. The fins are generally considered to be of high value, comparable to those of dusky and hammerhead sharks (Musick *et al.* 2009).

Population trends
No population estimates have been attempted in South Africa. An analysis of catches in the KZN bather protection nets over the 26-year period 1978–2003 indicated that the catch rate was stable and there was no evidence of a decline in the median size of either males or females caught over time (Dudley and Simpfendorfer 2006). Over the period 1981–2019 the standardized catch-per-unit-effort (CPUE) in this fishery fluctuated but steadily declined; trend analysis revealed annual rates of reduction of 3.0%, consistent with an estimated median reduction of 89% over three generation lengths (78 years), with the highest probability of >80% reduction over the same time period (Matt Dicken, KZN Sharks Board and Henning Winker, unpubl. data, cited by Rigby *et al.* 2021c). It is unlikely that the observed decline is due to the KZNSB bather protection programme alone, as catches are low. Elsewhere in South Africa, this species is not targeted by any commercial or recreational fisheries. It is likely that the declines are influenced by the heavy fishing pressure in the adjacent waters of Mozambique and Tanzania. Over the past 10 years, the CPUE in this fishery has been stable and possibly increasing slightly which may be a reflection of the management changes in the bather protection program which has seen a reduction in effort in order to reduce captures of species (Rigby *et al.* 2021c).

Elsewhere, genetic data indicate likely global male-biased dispersal and female philopatry (Portnoy *et al*. 2010, cited by Rigby *et al.* 2021c). A molecular study suggested distinct differences between the species in the Indo-Pacific and W Atlantic, however, a wider geographic range of samples is required (Naylor *et al*. 2012). Species-specific population trend data indicate reductions of >50% in the W Atlantic population and about 60% in Australia over the past three generation lengths (60–78 years). Similarly large reductions of 50–79% in the Mediterranean and the Arabian Seas region have been detected. All of these declines are attributed to fisheries exploitation. There are signs of population recovery in areas where management measures are in place. Overall, it is suspected that *C. plumbeus* has undergone a population reduction of 50–79% over the past three generations lengths (60–78 years) due to levels of exploitation, and globally this species was assessed as Endangered in 2020 (Rigby *et al.* 2021c).

ECOTOURISM
This inshore species is rarely encountered by scuba divers and therefore cannot be regarded as an ecotourism species.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
This species may be targeted in the demersal shark longline fishery, with slot limits of 70–130 cm. There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
This species does derive some protection from all the MPAs on the east coast. Most of the term pregnant females caught in the KZN bather protection were taken at Richards Bay and Zinkwazi.

Neonates are caught in small numbers by shore anglers at Richards Bay. Both locations are inshore of the MPA on the highly productive uThukela Banks, which therefore potentially offers considerable protection to two important life history stages.

Additional local comment
This species will benefit from the ban on any demersal shark longlining east of the Kei River mouth (this includes the entire KZN and Wild Coast), which usually occurs at depths of 50–100 m, which does overlap slightly with the species' depth range.

Current IUCN Red List Status
Endangered 2020: A2bd

Previous IUCN assessments
Vulnerable 2007
Near Threatened 2000
Vulnerable 1996

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
A proposal to include this species on Appendix II failed in 2010.

Convention on Migratory Species (CMS)
This species is not listed.

International comments
Specific management measures are in place in a few countries. In US Atlantic waters it is a prohibited species (outside of the shark research fishery) (Musick *et al.* 2009). To conserve the population and to permit recovery, a suite of measures will be required which may include species protection, spatial management, bycatch mitigation, and harvest and trade management measures (including international trade measures). Effective enforcement of measures will require ongoing training and capacity-building (including in the area of species identification). Catch monitoring is needed to help understand population trends and inform management (Rigby *et al.* 2021c).

MANAGEMENT CONSIDERATIONS
This is a long-lived species with low fecundity; it has proved to be vulnerable to overfishing. Although it is not fished commercially in South African waters, it is taken in Mozambique, and it is plausible that the two countries share stocks. If so, fishing effort to the north would have a direct effect on the South African segment of the population. With evidence, albeit limited, of neonates being caught by shore anglers in the Richards Bay region, together with the presence of newly mated and term pregnant females at the same location, it is possible that this species is able to complete its life cycle within South African territorial waters. Subject to confirmation of the above, and in the absence of any commercial fishery on the east coast, this species should be regarded as being of low management priority.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
Knowledge of its basic biology and life history in South Africa is good, but the extent to which the inshore waters around Richards Bay may be a nursery area should be investigated. South Africa may share stocks with neighbouring Mozambique; this could be confirmed through genetic and tracking studies. No age and growth study has been completed in the SW Indian Ocean, but the KZN Sharks Board has archived a number of vertebral samples. Any age estimates would need to be validated; traditionally this is done by injecting tagged individuals with oxytetracycline, which is taken up in the current growth ring in the vertebrae. A detailed analysis of the diet of specimens caught in the KZN bather protection programme has yet to be completed, although archived data are available.

Negaprion acutidens

SCIENTIFIC NAME	*Negaprion acutidens* (Rüppell 1837)
COMMON NAME	Sicklefin lemon shark/Longtooth lemon shark
FAMILY	Carcharhinidae
ENDEMIC	No, Indo-Pacific
SIZE RANGE	60–340 cm TL
SA DISTRIBUTION	Northern part of E coast: Mozambique border to Richards Bay
HABITAT	Shallow inshore waters, associated with coral reefs and mangroves
DEPTH RANGE	0–90 m
MAJOR FISHERIES	None in South Africa
IUCN STATUS	Endangered 2020
CITES	Not listed
MLRA	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	R Daly

SPECIES SUMMARY and RECOMMENDATIONS

Negaprion acutidens is a large, slow-moving shallow water shark with a wide distribution in tropical, continental and insular waters of the Indo-Pacific. It is primarily associated with coral reefs and mangroves. There were no records of local fishery catches (DFFE records: 2010–2012), with artisanal fisheries in Mozambique being the only regional catch source. It is particularly susceptible to coastal fisheries as it occurs in shallow water and readily takes a baited hook. Elsewhere in its range it has experienced heavy fishing pressure, particularly in SE Asia. These declines together with destruction of coral reef and mangrove habitat resulted in this species being assessed globally as Endangered in 2020. Potentially it will derive some protection from the iSimangaliso MPA but it appears to be rare there. Given its apparent absence in local catches is must be regarded as an extremely low priority species. Any opportunistic sampling should be used to collect life history information and tissue samples for genetic studies.

TAXONOMIC and IDENTIFICATION ISSUES

There are no taxonomic issues. There are two species of *Negaprion. N. acutidens* is found in the Indo-Pacific; *N. brevirostris* occurs in the Atlantic Ocean (Compagno 1984b).

SOUTH AFRICAN DISTRIBUTION

This species only occurs in the extreme northern part of the east coast (Ebert *et al*. 2021), as far south as Richards Bay (KZN Sharks Board, unpublished data).

REGIONAL DISTRIBUTION

It is present in Mozambique, northwards along the entire East African coast and around Madagascar and other islands, including Seychelles in the Western Indian Ocean (WIO).

SYNOPSIS OF RESEARCH

In southern Africa published information on the life history, taxonomy and morphometrics of this species is limited to a study of approximately 10 individuals (Bass *et al.* 1975c). Considerable work has been conducted on this species in Seychelles. Stevens (1984a) examined the life history and movement patterns using external tags at Aldabra Atoll. Other tagging studies involved monitoring the movements of sub-adults and adults fitted with acoustic tags (Filmalter *et al*. 2013, Lea *et al*. 2016). More recently, biologging tags were used to investigate bioenergetics (Byrnes *et a*l.2021) and more juveniles were the subject of tag-recapture and dietary studies in Seychelles (O Weideli, Save Our Seas Foundation, unpublished report.)

ECOLOGY

Depth

This slow-moving species occurs in shallow water down to depths of about 30 m on continental coastlines and those of islands and atolls (Pillans 2003b).

Habitat: Adults

The adults are often associated with coral reefs and lagoons, reef flats and edges and mangrove estuaries and swim close to the bottom (Pillans 2003b). In coral lagoons they are tolerant of turbid water (Stevens 1984a).

Habitat: Juveniles/Nursery Grounds

The juveniles are more common in shallower water inside coral lagoons and will also make use of sheltered embayments (Stevens 1984a).

Synopsis of tag deployments

No individuals have been tagged in the ORI Cooperative Fish Tagging Project 1984-2018 inclusive. Within the broader WIO, individuals ranging from neonates to adults were fitted with external dorsal fin disc tags around Aldabra Atoll, Seychelles (Stevens 1984a). Also in Seychelles, sub-adults and adults were fitted with acoustic tags (Filmalter *et al.* 2013, Lea *et al*. 2016) and juveniles were the subject of tag-recapture studies at St Joseph Atoll (O Weideli, unpublished report).

Movements

Juveniles appear to exhibit high levels of site fidelity and restricted movement patterns. Of 143 individuals tagged at 43 sites around Aldabra Atoll, 19 (14.5%) were recaptured, of which all but one individual were smaller than 130 cm. Of the recaptures, 52% were made at the tagging site and 91% within 2 km. The mean distance moved was 1.3 km (maximum 5 km) (Stevens 1984a). Weideli (unpubl. rep.) reported similar results in her study conducted between 2014 and 2017 at St Joseph Atoll, with 62 out of 302 (26.8%) juveniles recaptured. The distance moved by these tagged individuals ranged between 13 m and 3.4 km, with the majority (53%) recaptured within 500 m of their initial tagging location. This indicates that juveniles exhibit high site fidelity to nursery habitats and show very limited movements.

While juveniles and adults appear to exhibit high levels of site fidelity in the Seychelles, they are capable of some medium range movements (10–85 km) (Filmalter *et al*. 2013, Lea *et al*. 2016). However, movement may be linked to available habitat and further investigations are required to confirm the movement patterns that occur along continental coastlines.

In general, this species displays diel and tidal related movements and are able to forage in very shallow water thus exploiting favourable habitats at high tides (Lea *et al*. 2020). Activity levels also appear to be elevated at night when foraging-related movements may be greatest (Byrnes *et al*. in press).

Diet/feeding: adults

This species feeds primarily on coral reef-associated teleosts; octopod cephalopods and a stingray were also found in a very small number of stomachs (Bass *et al.* 1975c, Stevens 1984a).

Diet/feeding: juveniles

Dietary analysis of juveniles from St. Joseph Atoll, Seychelles, showed that they are capable of eating a wide diversity of small prey items (at least 47 species), consisting mainly of small teleosts (primarily members of the family Mugilidae) and also eels (*Gymnothorax* spp) (Weideli unpub. rep.). Diet was dependent on prey availability and varied between sites used as nursery habitat.

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Placental viviparity
DURATION OF REPRO CYCLE	2 years
MATING	October-November
GESTATION	10–11 months
LITTER SIZE	6–12; mean 9 (n=4)
PUPPING/NURSERY GROUND	Spring: October
LENGTH AT BIRTH	60–65 cm
LENGTH AT MATURITY	F 220 cm; M 220 cm
MAXIMUM LENGTH	310 cm
GENERATION LENGTH	16.5 years, based on *Negaprion brevirostris*

Mode
This species exhibits placental viviparity (Stevens 1984).

Duration of reproductive cycle
This is 2 years (Simpfendorfer *et al.* 2021c)

Mating season and location
In Seychelles mating takes place in October-November (Stevens 1984a).

Gestation
In Seychelles gestation is 10–11 months (Stevens 1984a).

Litter size
In Seychelles litter size is 6–12, with a mean of 9 (Stevens 1984a).

Length at birth
In Seychelles length at birth is 60-65 cm (Stevens 1984a).

Pupping season and nursery ground
In Seychelles pupping takes place in October (Stevens 1984a).

Length at maturity
In Seychelles females and males mature at 220 cm (Stevens 1984a).

Maximum length
This species reaches a maximum length of 340 cm (Simpfendorfer *et al.* 2021c).

Age and growth
Two age and growth studies were undertaken in the Seychelles. Stevens (1984a) obtained juvenile growth rates of 12.5 to 15.5 cm yr^{-1} at Aldabra and growth rates of 0.2 to 32.2 cm yr^{-1} were reported at St. Joseph Atoll (O Weideli, unpublished report).

Generation length
The generation length is suspected to be around 16.5 years, based on its congener *Negaprion brevirostris* which reaches a similar maximum size (Brown and Gruber 1988, cited by Simpfendorfer *et al.* 2021c).

FISHERIES MANAGEMENT

SA catch sources, quantities and characteristics

This species was not been reported in local catch estimates (DFFE records: 2010-2012). A single specimen was caught at Richards Bay in the KZN bather protection nets.

Fishing outside South Africa

It is caught as target and bycatch through much of its range in industrial and small-scale fisheries using longline, gillnet, handline, and demersal trawl. The meat is used fresh, dried, salted, frozen, or smoked and made up 0.6% of fin trimmings sold in Hong Kong (Fields *et al*. 2018, cited by Simpfendorfer *et al.* 2021c).

No details of catches in Mozambican artisanal fisheries are available (Pierce *et al.* 2008) but it is likely that this species is captured in small scale artisanal fisheries which overlap with the shallow coastal distribution of the species.

Population trends

There are no data available on the global or any regional population sizes of this species. There do not appear to have been any studies of the genetic structure within its Indo-Pacific range.

Heavy fishing pressure throughout most of its range, together with its narrow habitat range, marred by widespread damage and destruction of coral reefs and mangrove habitats are causes for concern.

This species is no longer observed in many parts of its range and has undergone large population reductions in mainland environments, but limited reduction in island environments. The overall level of population reduction is likely to be large and *N. acutidens* is suspected to have undergone a population reduction of 50-79% over the past three generation lengths (50 years) and was therefore globally assessed as Endangered in 2020 (Simpfendorfer *et al.* 2021c).

ECOTOURISM

This species is associated with coral reef environments but it is rarely encountered by scuba divers in South Africa and therefore cannot be regarded as a local ecotourism species. In the Western and Central Pacific, the species is a key component of the tourism industry with regular diver interactions (Simpfendorfer *et al.* 2021c).

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act

Threatened or Protected Species (TOPS)

This species is not listed.

Marine Protected Areas

This species will derive some benefit from the iSimangaliso MPA, although it is rarely seen in these waters (Grant Smith, Sharklife and Rob Kyle, SAAMBR pers. comm.)

Additional local comment

IUCN Red List Status

Endangered 2020: A2bd

Previous IUCN assessments

Vulnerable 2003

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

International comments
The species is occasionally displayed in aquaria. There are few species-specific regulations in place to protect this species. To conserve the population and to permit recovery, a suite of measures will be required which may include species protection, spatial management, bycatch mitigation, and harvest and trade management measures (Simpfendorfer *et al.* 2021c).

MANAGEMENT CONSIDERATIONS

This species is confined to the northern section of the east coast, where it is apparently rare. It has not been recorded in South African catches, apart from a single specimen caught in the KZN bather protection nets. Although it is possibly caught in Mozambican artisanal fisheries, it must be regarded as a very low priority species in South Africa.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

As this species is only found in the far northern region of the east coast, research opportunities will be extremely limited. Any opportunistic catches should be used to obtain life history information and genetic material to assess any regional population structure.

Rhizoprionodon acutus

SCIENTIFIC NAME	*Rhizoprionodon acutus* (Rüppell 1837)
COMMON NAME	Milk shark
FAMILY	Carcharhinidae
ENDEMIC	No, Indo-Pacific and possibly E Atlantic
SIZE RANGE	30–110 cm TL
SA DISTRIBUTION	E coast: Mozambique border to Algoa Bay
HABITAT	Sandy beaches
DEPTH RANGE	1–200 m
MAJOR FISHERIES	Bycatch in KZN prawn trawl fishery and recreational linefishery
IUCN STATUS	Vulnerable 2020
CITES	Not listed
MLRA	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	S Viana

SPECIES SUMMARY and RECOMMENDATIONS

Rhizoprionodon acutus is one of the most common, small, inshore sharks in the tropics of the eastern hemisphere. Estimated total catch was <1 ton per annum (DFFE records: 2010–2012), which was almost exclusively as bycatch in the now closed KZN inshore prawn trawl fishery. It is also caught in recreational shore-based linefishery and the commercial linefishery. Despite being a highly productive species that possibly breeds annually and matures early, it is heavily fished throughout almost all of its range in mostly unregulated fisheries and was assessed globally as Vulnerable on the IUCN Red List in 2020. This nomadic species will derive some protection from the uThukela Banks MPA where there is evidence of a nursery ground close inshore. The taxonomy of this species requires investigation, with molecular evidence that it is a complex of at least four species throughout its global distribution. Its life history characteristics suggest that it can withstand a high level of exploitation. Discard rather than release by anglers who regard catches as a nuisance needs to be addressed. Its life history is not well understood. Any opportunistic sampling should be used to collect life history information and tissue samples for regional and global genetic studies.

TAXONOMIC and IDENTIFICATION ISSUES

R. acutus is one of seven species recognised in the genus Springer (1964), but it is the only one which occurs in the SW Indian Ocean. These seven species are still considered valid (Weigmann 2016) but molecular evidence indicates that *R. acutus* is a complex of at least four species that needs further taxonomic investigation (Naylor *et al*. 2012). This species is easily confused with the sliteye shark *Loxodon macrorhinus*, which is also a small, slender-bodied species with the anal fin positioned well forward of the second dorsal fin and having a similar shallow-water, tropical distribution. Fin pigmentation, relative length of the labial furrows and the shape of the first dorsal fin and vertebral counts can be used to separate the two species but the most conclusive feature is the shape of the eye orbit which lacks a notch in the hind rim in *R. acutus* (Bass *et al.* 1975). There is also confusion with juvenile spinner sharks *Carcharhinus brevipinna* which have a nursery ground close inshore on the KZN coast around the Uthukela Banks MPA. Both species have plain fins but *C. brevipinna* has a second dorsal fin which is directly above the anal fin and the neonates are the size of adult *R. acutus*.

SOUTH AFRICAN DISTRIBUTION

This species is confined to the east coast and is most common on the KZN coast. It occurs as far south as Algoa Bay (Ebert *et al.* 2021).

REGIONAL DISTRIBUTION

It is present in Mozambique, northwards along the entire East African coast, as well as Madagascar, Seychelles and Mauritius. It is widespread in the tropical Indo-W Pacific, as well as the E Atlantic (Compagno 1984), although genetic evidence indicates that this is a complex of at least four species (Naylor *et al.* 2012).

SYNOPSIS OF RESEARCH

This species is one of the most common, small inshore sharks in the tropics of the eastern hemisphere (Compagno *et al.* 1989). In southern Africa published information on the life history, taxonomy and morphometrics of this species is based on a large number of individuals from KZN and S Mozambique (Bass *et al.* 1975). Proliferation of this species in shore-based anglers' catches was documented by van der Elst (1979). McKinney *et al.* (2016) reported on muscle tissue mercury levels and stable isotope levels in two individuals caught in the KZN bather protection programme. There has been no other species-specific research in South Africa. Dunlop and Mann (2013f) provided an overview of the life history and fisheries details of this species. Considerable research has been conducted on this species elsewhere in its range, but apparently not in the SW Indian Ocean (Rigby *et al.* 2020d and references cited therein).

ECOLOGY

Depth

This species inhabits continental shelves from inshore (1 m) to a depth of 200 m (Compagno 1984) but may occasionally be found as deep as 350 m (Manilo and Bogorodsky 2003). It is found throughout the water column but mainly near the sea floor.

Habitat: Adults

Adults are most common off sandy beaches and occasionally in estuaries (Bass *et al.* 1975), but are not tolerant of low salinities (van der Elst 1993). This species occurs throughout the year in KwaZulu-Natal but it is more abundant during early summer (Bass *et al*. 1975). Elsewhere this species may use mangroves areas and estuaries as nursery grounds (Gallo *et al.* 2010). In Australia, individuals are often found over seagrass meadows (White *et al.* 2004, cited by Dunlop and Mann 2013f).

Habitat: Juveniles/Nursery Grounds

The juveniles appear to occupy the same habitat as the adults.

Synopsis of tag deployments

A total of 939 individuals have been tagged in the ORI Cooperative Fish Tagging Project 1984-2018 inclusive, almost all by shore anglers (Jordaan *et al.* 2020), with 25 (3%) recaptures. Mean distance travelled was 90 km; mean time at liberty was 0.5 years (max: 363 km and 2.1 years) (Jordaan *et al*. 2020).

Movements

This species is regarded as nomadic (Dunlop and Mann 2013f) but these authors state that the results presented above should be interpreted with circumspection, given its similarity to other carcharhinid sharks commonly caught by KZN shore anglers, in particular newborn spinner sharks *C. brevipinna.*

Diet/feeding: adults

This species feeds mainly small teleosts, cephalopods, gastropods and crustaceans (Bass *et al.* 1975).

Diet/feeding: juveniles

The diet is similar to that of adults. There is evidence of an ontogenetic shift to reduce intraspecific competition in a dietary study of this species in W Australia (White *et al.* 2004, cited by Dunlop and Mann 2013f).

South African toxicological studies
No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Placental viviparity
DURATION OF REPRO CYCLE	Possibly 1 year locally; > 1 year: Arabian Seas
MATING	Early summer
GESTATION	12 months
LITTER SIZE	2–8, usually 3–6
PUPPING/NURSERY GROUND	November–January
LENGTH AT BIRTH	30–35 cm
LENGTH AT MATURITY	F: 70–80 cm; M: 68–72 cm
MAXIMUM LENGTH	F: 102 cm; M 89 cm
GENERATION LENGTH	5 years: Australia, Arabian Sea

Mode
This species exhibits placental viviparity.

Duration of reproductive cycle
The duration of the reproductive cycle in southern African waters has not been confirmed, but the gestation is known to be about one year (Bass *et al.* 1975). In the Arabian Sea, full-term embryos and post-partum females were observed throughout the year (Henderson *et al.* 2006), making it difficult to ascertain the gestation period. Pregnant females were encountered with developing ova, suggesting that they mate soon after giving birth (Sen *et al.* 2018). If gestation is about 12 months, as it is in South Africa, then the reproductive cycle in the Arabian Sea is likely to be a little over one year. The reproductive cycle is annual in Senegal (Ba *et al*. 2013), but this is likely to be a different species, based on genetic evidence (Naylor *et al.* 2012).

Mating season and location
Mating takes place in November and December and less commonly in January in southern African waters (Bass *et al.* 1975) and in spring and summer elsewhere (Compagno 1984; Dunlop and Mann 2013f and references cited therein). In the Arabian Sea, large and ripe follicles and full-term embryos and post-partum females were observed throughout the year indicating year-round breeding. There were spring-summer peaks in the incidence of full-term embryos and post-partum females (Sen *et al.* 2018).

Gestation
This is about 12 months in southern African waters (Bass *et al.* 1975). With year-round breeding in the Arabian Sea, Sen *et al.* (2018) were unable to determine the length of the gestation period.

Litter size
Litter size in southern African waters ranges from 2–8, usually 3–6, with a mean of 4.7 (Bass *et al.* 1975). In the Arabian Sea the litter size is 1-6 (Henderson *et al.* 2006) and 3–7 (Sen *et al.* 2018).

Length at birth
In southern Africa length at birth is about 30–35 cm (Bass *at al.* 1975), 32–37 cm in the Arabian Sea (Henderson *et al.* 2006, Sen *et al.* 2018) and elsewhere 25–45 cm (Rigby *et al.* 2020d and references cited therein).

Pupping season and nursery ground

In southern Africa pupping is from November to January in shallow embayments such as Richards Bay (Bass *at al.* 1975) and the adjacent coastline south to the uMlalalazi River mouth (Nic Maitland, Fishing Mtunzini, pers. comm.). In the Arabian Sea pupping is also mainly in spring–summer but term embryos may be found throughout the year (Henderson *et al.* 2006, Sen *et al.* 2018). In Australia pupping takes place in shallow muddy embayments (Dunlop and Mann 2013f and references cited therein).

Length at maturity

The size at maturity in southern Africa is 70–80 cm for females and 68–72 cm for males (Bass *et al.* 1975). These life history traits vary regionally and overall females mature at 62–92 cm and males at 54–82 cm (Rigby *et al.* 2020d and references cited therein).

Maximum length

In southern Africa the largest female was 102 cm and the largest male 89 cm (Bass *et al.* 1975). Elsewhere this species rarely exceeds 110 cm, but a maximum length of 178 cm is widely reported in the literature (Compagno 1984, Ebert *et al.* 2013, Weigmann 2016, Rigby *et al.* 2020d). This apparent outlier was caught on the W African coast (Cadenat and Blache 1981) but is likely to be a different species, based on genetic evidence (Naylor *et al.* 2012).

Age and growth

Females mature at 2.3 years and males 1.8 years based on the length: age curve of van der Est (1993) and the length at maturity (Bass *et al.* 1975, although these ages require verification (Dunlop and Mann 2013f). In both the Arabian Sea (Sen *et al.* 2018) and NE Australia (Harry *et al.* 2010, cited by Rigby *et al.* 2020d), female age-at-maturity is 2 years and maximum age is 8 years.

Generation length

Using the age and growth results from both Australia and the Arabian Sea, generation length is 5 years (Sen *et al.* 2018; Harry *et al.* 2010, cited by Rigby *et al.* 2020d). The values for females from Senegal (age-at-maturity of 5.8 years and maximum age of nine years), resulting in a generation length of 7.4 years (Ba *et al*. 2015) may not be applicable as this is likely to be another species (Naylor *et al.* 2012).

FISHERIES MANAGEMENT

SA catch sources

Estimated total catch was <1 ton per annum (DFFE records: 2010–2012; da Silva *et al.* 2015), which comprised almost exclusively bycatch in the now closed KZN prawn trawl fishery, with suspected catches in the recreational and commercial linefisheries.

SA catch quantities and characteristics

KZN prawn trawl industry

This species was a bycatch in the KZN prawn trawl industry on the uThukela Banks. The size range was 0.3–1,0 m, with a mean of 0.5 m, which comprised largely immature individuals, including neonates. Based on the observer-recorded catches, the extrapolated average annual catch between 1989 and 1992 was 506 (range 383–723). Mortality of this bycatch species was around 30%, based on a subsample of 24 individuals (Fennessy 1994. This fishery was dormant for nearly two decades due to the extended closure of the mouth of Lake St Lucia, resulting in poor prawn recruitment and diminishing prawn catches on the uThukela Banks. The fishing grounds have been closed to trawling since the declaration of the uThukela MPA in August 2019.

Recreational shore angling

Shore anglers catch this species. In most cases, the catch is released, especially by anglers belonging to angling clubs. In some cases, the catch will be discarded on the shore because it poses a nuisance. Drone anglers will use this and other small elasmobranch species as live bait for large sharks. In the KZN competitive shore angling fishery it was the second most common chondrichthyan caught

(Pradervand *et al*. 2007). The catch rate rose from <1 per 100 angling hours in 1956 to a maximum of nearly 4 per 100 angling hours in 1976, with a summer peak in catches. Most individuals were 1–2 kg (van der Elst 1979). An analysis of the same dataset for the period 1977–2000, with a fishing effort of nearly 947 000 fishing hours, revealed a mean annual catch of 1586 individuals and a mean individual weight of 1.9 kg. There was a significant decrease in CPUE but a significant increase in mean individual weight. Catches were also highly seasonal (November to May) with 46% of the catch comprising immature individuals (Pradervand *et al*. 2007). Misidentification of this species with other small sharks, neonate *C. brevipinna* in particular, remains an issue.

On the Wild Coast (northernmost section of the Eastern Cape) the mean annual catch was 7, with a mean individual weight of 2.0 kg for the period 1977–2000 (Pradervand 2004). In the Border (region immediately south the Wild Coast) competitive shore fishery there was only a single individual recorded for the period 1982–1998 (Pradervand and Govender 2003).

Fishing outside South Africa
R. acutus is caught globally as target and bycatch in industrial, small-scale, and recreational fisheries by multiple fishing gears including trawl, gillnet, trawl, hook and line, and longline. The species is generally retained for the meat and fins and is one of the most consumed sharks in tropical and subtropical coastal waters globally. The flesh is consumed fresh or dried, salted, and smoked and used as fishmeal. The fins are of limited value due to their small size, although trade in small, low-value fins has increased in SE Asia in recent years ((Rigby *et al.* 2020d and references cited therein).

Extensive artisanal fisheries operate in coastal waters of the SW Indian Ocean. *R. acutus* is an important component of commercial and artisanal shark fisheries in mainland Tanzania and Zanzibar where it has been recorded as the most abundant in market surveys. The species is also an important component of artisanal shark fisheries in Madagascan waters (Rigby *et al*. 2020d and references cited therein). It is caught in artisanal fisheries in Mozambique (Pierce *et al*. 2008).

Population trends
Genetic data suggest that *R. acutus* is a complex of four species. This requires further taxonomic investigation, with four distinct subclusters: west coast of Africa; Gulf of Oman and most of the specimens from India; Australia; Borneo and the Philippines and two specimens from India (Naylor *et al*. 2012). Although there were no specimens from the SW Indian Ocean in this analysis, southern Africa individuals are most likely to be conspecific with those from the Red Sea, which is the type-locality of *R. acutus*, and Gulf of Oman. Geographical variations in size and vertebral counts (Springer 1964) corroborate these findings.

R. acutus is a highly productive species that possibly breeds annually and matures early. It is heavily fished throughout its range (except in Australia) in mostly unregulated fisheries, and steep declines over the past three generation lengths have been reported. It is suspected that it has undergone a population reduction of 30–49% over the past three generation lengths (15–22 years), and was globally assessed as Vulnerable on the IUCN Red List in 2020 (Rigby *et al.* 2020d).

ECOTOURISM
R. acutus cannot be regarded as an ecotourism species as it is often associated with turbid water in the vicinity of estuaries and is rarely seen by divers.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act

Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
This nomadic species will benefit from the uThukela MPA as it was often caught in the now closed KZN prawn trawl fishery (Fennessy 1994). The inshore waters in this region, in particular Richards Bay and the adjacent coastline south to the uMlalalazi River mouth appear to be a nursery ground. This species has not been detected on BRUVs deployed in the iSimangaliso MPA, (Grant Smith, Sharklife pers. comm.).

Additional local comment

IUCN Red List Status
Vulnerable 2020 A2bd

Previous IUCN assessments
Least Concern 2003

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

International comments

MANAGEMENT CONSIDERATIONS
This species is most common on the section of the east coast north of Durban. The formal closure of the KZN prawn trawl fishery as a result of the establishment of uThukela banks MPA in 2019 has removed the main source of fishery-related mortality in South Africa. An education campaign is needed to convince those recreational anglers who discard their catches to release them alive. The extent of trans-boundary movements between South Africa, where there is little exploitation, and Mozambique, where fishing pressure is likely to be high, should be investigated. The life history characteristics of this species suggest that it can withstand a high level of exploitation.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
Limited information has been accumulated on the biology of this species in southern Africa, with no species-specific studies undertaken. Gaps include several aspects of the reproductive biology and a validated age-and-growth study. More information is needed on the location of nursery areas, which are known to include Richards Bay and the adjacent coastline south to the uMlalalazi River mouth. The extent of any trans-boundary movements required investigation. Tissue samples should be collected for both a global and regional population study as well clarification of the taxonomy within the species complex.

Triaenodon obesus

SCIENTIFIC NAME	*Triaenodon obesus* (Rüppell 1837)
COMMON NAME	Whitetip reef shark
FAMILY	Carcharhinidae
ENDEMIC	No, Indo-Pacific
SIZE RANGE	50–200 cm TL
SA DISTRIBUTION	E coast: Mozambique border to southern KZN
HABITAT	Coral and occasionally rocky reefs
DEPTH RANGE	5–40 m, occasionally as deep as 330 m
MAJOR FISHERIES	None in South Africa
IUCN STATUS	Vulnerable 2020
CITES	Not listed
MLRA	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	N Cullain

SPECIES SUMMARY and RECOMMENDATIONS

Triaenodon obesus is a slender, medium-sized shark with a wide distribution in shallow tropical, continental and insular waters of the Indo-Pacific. This slow-moving species is one of the three most common sharks on coral reefs. There were no records of local fishery catches (DFFE records: 2010–2012), with artisanal fisheries in Mozambique being the only regional catch source. Elsewhere in its range most individuals are an incidental catch in general reef fisheries targeting teleosts. It will derive some protection from the iSimangaliso MPA where it is sighted year-round and the Aliwal Shoal MPA. Given its apparent absence in local catches, is must be regarded as an extremely low priority species and it is unlikely that any management intervention in South Africa will improve the global status of *T. obesus* from that of Vulnerable on the IUCN Red List. Any opportunistic sampling should be used to collect life history information and tissue samples for genetic studies.

TAXONOMIC and IDENTIFICATION ISSUES

There are currently no taxonomic issues. Historically there were claims of at least two, possibly three species, but most modern authors regard *Triaenodon* as a monotypic genus (Bass *et al.* 1975). Formerly classified in the family Triakidae, it is now regarded as a member of the family Carcharhinidae (Randall 1977). This species has a slender body, blunt snout and very distinctive white tips to the first dorsal (sometimes the second dorsal) and upper caudal fins. Its general appearance and behaviour of resting in caves during the day distinguish it from other carcharhinid sharks with white fin tips, namely *Carcharhinus albimarginatus* and *C. longimanus*, which are both pelagic species.

SOUTH AFRICAN DISTRIBUTION

This species is documented as only occurring in northern KZN on the east coast (Ebert *et al*. 2021), but has been observed occasionally on Aliwal Shoal in southern KZN (Geremy Cliff, formerly KZN Sharks Board, pers. obs.).

REGIONAL DISTRIBUTION

It is present in Mozambique, northwards along the entire East African coast, as well as Madagascar and other islands, including Seychelles, in the W Indian Ocean (Compagno 1984).

SYNOPSIS OF RESEARCH

In southern Africa published information on the life history, taxonomy and morphometrics of this species is based on a single individual, a male of 139 cm from northern KZN, supplemented with several other records from the W Indian Ocean (Bass *et al.* 1975). Considerable research has been conducted on this species elsewhere in its Indo-Pacific range, particularly in Hawaii and Oceania. Randall (1977) provided an extensive global overview of its distribution, ecology and biology. Tricas and Le Feuvre (1985), Robbins (2006, cited by Whitney *et al.* (2012a) and Whitney *et al.* (2004, 2012a) documented aspects of reproduction. Whitney *et al.* (2012b) conducted a population genetic study with samples from 25 locations in the tropical Indo-Pacific. *T. obesus* is a popular aquarium species which has provided a platform for studies on aspects of physiology, endocrinology, activity patterns and captive breeding. For comparative information on the biology and ecology of this species from recent studies elsewhere in its range, see (Simpfendorfer *et al.* 2020b).

ECOLOGY

Depth

This slow-moving species occurs on or very close to the bottom in shallow coastal waters, most commonly 5–40 m deep, but there is a single record from 330 m in Japan. It may occur at depths of 1 m or less, but seldom penetrates very shallow reef and sand flats (Randall 1977).

Habitat: Adults

This species is one of the three most common sharks on coral reefs of the tropical and subtropical Indo-Pacific region. The adults are associated with high profile reefs, both coral and rock structures, in clear tropical waters. They rest in small groups in caves and under overhangs during the day and move off to forage at night (Randall 1977).

Habitat: Juveniles/Nursery Grounds

The juveniles appear to occupy the same habitat as the adults. Small groups inhabiting caves during the day include both large and small individuals (Randall 1977).

Synopsis of tag deployments

No individuals have been tagged in the ORI Cooperative Fish Tagging Project 1984-2018 inclusive (Jordaan *et al.* 2020). Tagging at Johnson Island in the tropical N Pacific resulted in seven recaptures of the 124 sharks tagged, two where they were released and the others 0.3–2.9 km from the tagging sites (Randall 1977).

Movements

This species showed high site fidelity as Individuals often return to a home cave for periods of days, weeks or more (Randall 1977). Five individuals tracked using acoustic telemetry showed a tendency to use the same "home cave" and remained in an area of approximately 1 km^2 over several days, with 9 km being the longest movement observed over 3 years of study (Nelson and Johnson 1980, cited by Whitney *et al.* 2012b). A tagged shark in Hawaii was resighted 4 years after it was tagged, 27 km from the tagging site; some tagged individuals moved distances of up to 10 km within a few days (Whitney *et al.* 2012b).

Diet/feeding: adults

This species feeds mainly on crustaceans in Madagascar (Fourmanoir 1961, cited by Bass *et al.* 1975) but no crustaceans were found in individuals from the tropical Pacific islands where reef-associated teleosts and octopus were the prey (Randal 1977). *T. obesus* is adept at hunting prey in tight and narrow crevices in the reef.

Diet/feeding: juveniles

It is possible that the diet of the juveniles is the same as that of the adults, but no size-related information was provided in the two dietary studies listed above.

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Placental viviparity
DURATION OF REPRO CYCLE	1 year, possibly 2 (Pacific)
MATING	Unknown
GESTATION	10-12 months (Pacific)
LITTER SIZE	2–3 (W Indian Ocean); 1–5 elsewhere
PUPPING/NURSERY GROUND	Spring: October (Pacific)
LENGTH AT BIRTH	52–60 cm (Madagascar)
LENGTH AT MATURITY	F 105 cm; M 105 cm
MAXIMUM LENGTH	200 cm, rarely over 160 cm
GENERATION LENGTH	12.3 years

Mode
This species exhibits placental viviparity.

Duration of reproductive cycle
Simpfendorfer *et al.* (2020b) referred to an annual reproductive cycle, however, of the 31 large females in the Hawaiian region examined by Randall (1977), 13 were pregnant, 3 contained large ova and 11 were neither pregnant, nor with large ova. In the absence of any details on the seasonality of these observations, and assuming a gestation of 10–12 months, as was noted by Robbins (2006; cited by Whitney *et al.* 2012a) on the Great Barrier Reef, the observations by Randall (1977) suggest a 2-year reproductive cycle. Whitney *et al.* (2012a) reported two females in the Hawaiian Islands that were noticeably pregnant in successive years, suggesting that the reproductive cycle may be annual in some individuals or regions.

Mating season and location
Nothing is known in the W Indian Ocean. In Hawaii the difficulty in assessing the freshness of mating scars prevented clear delineation of mating seasonality (Whitney *et al.* 2012a).

Gestation
This was estimated to be at least 5 months (Randall 1977), but subsequent research on the Great Barrier Reef has shown that gestation is 10-12 months (Robbins 2006, cited by Whitney *et al.* 2012).

Litter size
Litter size from three litters in the W Indian Ocean was 2–3 (Bass *et al.* 1975 and references cited therein). Elsewhere it was 1–5, with a mean of 2.8 (Randall 1977).

Length at birth
In the W Indian Ocean length at birth is 52–60 cm (Bass *at al.* 1975 and references cited therein) and these figures are still used globally for this species (Ebert *et al.* 2013, Simpfendorfer *et al.* 2020b).

Pupping season and nursery ground
There is insufficient information to determine any seasonality in the breeding habits in the W Indian Ocean (Bass *et al.* 1975). There is clearly seasonality elsewhere. In the Great Barrier Reef pupping is in October (Robbins 2006, cited by Whitney *et al.* 2012a). In the Hawaiian Islands there was a peak in sightings of late-term females followed by an abrupt decline which suggests that pupping season is May into early June (Whitney *et al.* 2012a).

Length at maturity
The size at maturity for this species is in the region of 105 cm (Bass *et al.* 1975; Randall 1977; Robbins 2006, cited by Whitney *et al.* 2012a).

Maximum length
This species reaches a maximum length of 200 cm but adults over 160 cm are very rare (Randall 1977).

Age and growth
Growth is slow and estimated at 2–4 cm year^{-1}; sexual maturity is attained at 8–9 years and longevity about 16 years (Randall 1977).

Generation length
This is 12.3 years, based on the age and growth information presented by Randall (1977) (Simpfendorfer *et al.* 2020b).

FISHERIES MANAGEMENT

SA catch sources, quantities and characteristics
This species was not reported in local catch estimates (DFFE records: 2010-2012; da Silva *et al.* 2015). There were no catches in the KZN bather protection programme (KZN Sharks Board, unpublished data), the KZN prawn trawl fishery (Fennessy 1994) or the competitive recreational shore angling fishery (Pradervand *et al.* 2007).

Fishing outside South Africa
T. obesus is caught throughout its range in industrial and small-scale longline, gillnet, trawl and handline fisheries that occur in the waters around coral reefs. Most individuals are taken as incidental catch in general reef fisheries targeting teleosts. The species is often retained for its meat, fins, and liver. The species is also taken in small amounts by recreational fishers in some countries (Simpfendorfer *et al.* 2020b). It has been recorded in artisanal catches in southern Mozambique (Pierce *et al.* 2008).

Population trends
Genetic studies support multiple subpopulations of *T. obesus*, with the clearest separation between the Pacific and Indian Oceans. There is also evidence for population structure within the Pacific Ocean, possibly driven by distance, with individuals from the northern and southern Great Barrier Reef showed differentiation across short distances of contiguous habitat. On the other hand, there is high connectivity among archipelagos of the central Pacific (Whitney *et al*. 2012b).

The species exhibits moderately slow life history characteristics. It is caught as target and bycatch through much of its range in industrial and small-scale fisheries using longline, gillnet, handline, and trawls, and is often retained for its fins, flesh, skin, teeth, and liver. This species is also threatened by declines in quality of coral reefs due to climate change, destructive fishing practices and poor water quality. Steep declines in population abundance have been reported in some parts of its range, while in others it appears to remain abundant. Based on baited remote underwater video station data from 250 reefs in 39 jurisdictions throughout its range, the estimated global population reduction is 49% over three generation lengths (37 years)(MacNeil *et al.* 2020). Therefore, this species was assessed as having undergone a population reduction of 30–49% over the past three generation lengths (37 years) due to levels of exploitation and declines in habitat quality, and it was assessed as Vulnerable on the IUCN Red List in 2020. (Simpfendorfer 2020b).

ECOTOURISM
As one of the most common sharks found in coral reefs, it should be recognised as an ecotourism species. It is most likely to be seen by divers in the iSimangaliso Wetland Park and occasionally the Aliwal Shoal MPA.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations
There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
In view of its limited mobility, this species will derive considerable benefit from the iSimangaliso MPA, as this species is seen year-round in pairs or as individuals by scuba divers in the Sodwana Bay region (Grant Smith, Sharklife pers. obs.). It has also been seen on occasion in the Aliwal Shoal MPA (G Cliff, pers. obs.).

Additional local comment

IUCN Red List Status
<u>Vulnerable 2020 A2bcd</u>

Previous IUCN assessments
Near Threatened 2009
Near Threatened 2000

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

International comments

MANAGEMENT CONSIDERATIONS
This species is largely confined to the coral reefs of the iSimangaliso MPA, where the only indication of its abundance is year-round sightings by recreational scuba divers. It has not been recorded in catches in any South African fisheries. Although it is caught in Mozambican artisanal fisheries, it must be regarded as a very low priority species in South Africa. It seems unlikely that any management intervention in South Africa will improve the status of *T. obesus* from that of Vulnerable.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
As this species is only regularly found in the far northern region of the east coast, research opportunities will be extremely limited. Any opportunistic catches should be used to obtain life history information and genetic material to assess any regional population structure.

FAMILY SPHYRNIDAE

Sphyrna lewini

SCIENTIFIC NAME	*Sphyrna lewini* (Griffith and Smith 1834)
COMMON NAME	Scalloped hammerhead
FAMILY	Sphyrnidae
ENDEMIC	No, circumglobal in tropical and warm temperate waters
SIZE RANGE	40–325 cm TL
SA DISTRIBUTION	E coast: Mozambique border to Port St Johns
HABITAT	Pelagic in coastal and semi-oceanic waters
DEPTH RANGE	0–275 m, but down to 1000 m around seamounts
MAJOR FISHERIES	Pelagic longlines; trawl netting; bather protection nets
IUCN STATUS	Critically Endangered 2018
CITES REGS	Appendix II (2013)
MLRA REGS	No retention in any longline fisheries; daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	R Daly

SPECIES SUMMARY and RECOMMENDATIONS

Sphyrna lewini is a large, pelagic species and is the most studied of all the hammerheads. It has a circumglobal distribution in tropical and warm-temperate, coastal and semi-oceanic waters. It occurs on the east coast of South Africa and up the entire east coast of Africa. Local catch was estimated at 1-10 tons per annum (DFFE records: 2010–2012), from a number of fisheries, with the KZN bather protection program listed as the biggest contributor, followed by demersal trawling. It was listed as a suspected catch in several other hook-based fisheries, based on its piscivorous diet. Fins of all hammerheads are among the most valuable and popular and the meat is also prized. It was assessed globally as Critically Endangered in 2018, with fishing being the greatest threat. As a nomadic or migratory species, it derives limited protection from all the Marine Protected Areas on the east coast. The most important is the Thukela Banks MPA, as this region is a nursery ground for this species. It is listed in CITES Appendix II and as a result no retention in the demersal and pelagic longline fisheries is permitted. The species has one of the lowest post-capture survival rates of all sharks. With its vulnerability to capture stress, any individuals released in these fisheries will have a poor survival rate. Research into the extent of the nursery grounds on the Thukela Banks and how they overlap with the MPA is needed. The aggregations of adults in the Protea and Thukela Banks MPAs should be studied to understand the dynamics (sex ratios, seasonality etc) and motives for these aggregations. It is conceivable that, despite its nomadic behaviour, this species is able to complete its life cycle within South African territorial waters. Tissue samples from specimens caught in the KZN bather protection nets are available for genetic studies to assess the connectivity with scalloped hammerheads from Mozambique and further north.

TAXONOMIC and IDENTIFICATION ISSUES

There are no taxonomic issues. It is one of three species of large hammerhead, all of the genus *Sphyrna*, found on the South African coast. It is easily confused with the smooth hammerhead *S. zygaena* which also occurs in coastal waters along the east coast of South Africa, but is more common further south in warm temperate waters. The juveniles of the two species overlap on the southern KZN coast and the Wild Coast (northern part of the Eastern Cape Province). It could be confused with the great hammerhead *S. mokarran*, a solitary, more tropical species, which has larger and more falcate fins, but its juveniles are rare on the KZN coast. In many fisheries, including the recreational linefishery, hammerhead catches are lumped together.

SOUTH AFRICAN DISTRIBUTION

This large, pelagic species occurs in coastal and semi-oceanic waters along the east coast of South Africa, from the Mozambique border to Port St Johns on the Wild Coast (Ebert *et al.* 2021).

REGIONAL DISTRIBUTION

It occurs on the entire east coast of Africa, with circumglobal distribution in all tropical and warm temperate coastal waters (Compagno 1984b).

SYNOPSIS OF RESEARCH

This is a well-studied species in South Africa. Bass *et al.* (1975c) provided detailed taxonomic, morphometric and biological information from over 100 individuals, including adults and pregnant females. This was followed by an analysis of catch statistics and general biology of 291 individuals caught in the KZN bather protection programme (de Bruyn *et al.* 2005). The latter was supplemented by a detailed analysis of the cephalopod component of the diet (Smale and Cliff 1998). An analysis of the movement patterns of tagged juveniles was undertaken by Diemer *et al.* (2011). Dunlop and Mann (2013a) provided a concise overview of life history and fishery-related information. Rossouw *et al.* (2016) found evidence of multiple paternity. Gallagher and Klimley (2018) reviewed the biology and conservation status of the three species of large hammerheads internationally. They documented the varying rates of biological productivity and high degree of regional variation in maximum size and size at maturity in scalloped hammerheads. Comparative information on the biology and ecology of this species is available from studies in the Gulf of Mexico, Western Pacific, North Atlantic and South Atlantic (see Rigby *et al*. 2019j).

ECOLOGY

Depth

It occurs inshore from the shoreline to 275 m (Compagno 1984b), but it has been reported at depths of 1000 m in the vicinity of sea-mounts (Gallagher and Klimley 2018).

Habitat: Adults

They occur offshore in deeper water, often aggregating around sea-mounts. They do venture inshore for mating and pupping (Gallagher and Klimley 2018). Two known local aggregations sites are Protea Banks MPA on the KZN south coast and High Points about 35 km off Mtunzini on the Thukela Banks.

Habitat: Juveniles/Nursery Grounds

The uThukela Banks is a known nursery ground (Fennessy 1994). Ebert *et al*. (2021) suggested that there is a nursery ground in the Port St Johns area on the Wild Coast, but very few of the sharks tagged there were smaller than 70 cm (Diemer *et al.* 2011) and size at birth is 40–50 cm (Bass *et al.* 1975c). The larger juveniles are common in shallow, inshore areas of central and southern KZN and the Wild Coast, where they are often occur at the surface and are regularly caught by shore anglers (Dunlop and Mann 2012). Females appear to occur slightly further offshore than males, based on the sex ratios of individuals caught in the KZN shark nets (de Bruyn *et al.* 2005).

Synopsis of tag deployments

A total of 1006 individuals, most of which were juveniles of 70–140 cm, were tagged (ORI Cooperative Fish Tagging Project, 1984-2018) with 2% recaptured. Mean distance travelled was 128 km; mean time at liberty 0.3 years (max: 629 km and 8.1 years) (Jordaan *et al.* 2020). Diemer *et al.* (2011) conducted a detailed analysis of the movements of the 641 individuals tagged up till 2009.

Movements

This species is regarded as migratory/nomadic. There are coastwise movements of larger juveniles (very few neonates tagged) tagged by shore anglers in response to seasonal sea surface temperatures. There were no reported recaptures from Mozambique of the 641 sharks tagged on the east coast; the northernmost recapture locality was Richards Bay (Diemer *et al.* 2011). Internationally males move across ocean basins, while females only move regionally and not between discontinuous continental coastlines (Duncan *et al*. 2006). Sharks fitted with acoustic tags (n = 2) in the southern extent of the Ponta do Ouro Partial Marine Reserve in southern Mozambique have shown transboundary movements between the neighbouring iSimangaliso Wetland Park. Additionally, although the species can be highly migratory, these tagged individuals have exhibited site fidelity to the offshore reef systems at which they were tagged (R Daly, Oceanographic Research Institute, unpublished data).

Diet/feeding: adults
The diet of larger individuals, not all of which were mature, was dominated by small teleosts, followed by cephalopods (octopus, squid and cuttlefish) and small sharks and batoids (de Bruyn *et al.* 2005). Cephalopods included pelagic and epibenthic species (Smale and Cliff 1998).

Diet/feeding: juveniles
The diet was similar to that of the larger individuals but with fewer sharks and batoids (de Bruyn *et al.* 2005). The cephalopods were largely neritic species (Smale and Cliff 1998).

South African toxicological studies
Levels of total mercury in the muscle tissue of juveniles (50–150 cm) from the east coast were 2.7 mg kg^{-1} wet weight, which was far higher than comparable values from juveniles on the Pacific Coast of Mexico (0.8 mg kg^{-1}) and northern Australia (1.2 mg kg^{-1}). These local values were far higher than various international regulatory guidelines for human and fish health. In general, higher values were found in a number of local pelagic shark species (McKinney *et al.* 2016 and references cited therein).

REPRODUCTION

REPRODUCTIVE MODE	Placental viviparity
DURATION OF REPRO CYCLE	Possibly 1 year
MATING	Spring and summer
GESTATION	9–12 months
LITTER SIZE	2–19, median=10 from 11 litters
PUPPING/NURSERY GROUND	Spring, summer; Thukela Banks
LENGTH AT BIRTH	40–50 cm
LENGTH AT MATURITY	F:245 cm; M:215 cm
MAXIMUM LENGTH	F: at least 324 cm; M: at least 306 cm
GENERATION LENGTH	18.3 years

Mode
This species exhibits placental viviparity (Bass *et al.* 1975c). Rossouw *et al.* (2016) found evidence of multiple paternity in 46% of litters.

Duration of reproductive cycle
This is assumed to be one year, based on the presence of large eggs (30–40 mm) in term pregnant females, suggesting that they may mate again soon after parturition (de Bruyn *et al.* 2005). Data indicate both an annual and a biennial reproductive cycle in other regions (Gallagher and Klimley (2018).

Mating season and location

This occurs in spring and summer, with small numbers of mature males and females caught in KZN bather protection nets in November and December, inshore of the Thukela Banks showing signs of sexual activity (de Bruyn *et al.* 2005).

Gestation
Gestation is 9-12 months (de Bruyn *et al.* 2005).

Litter size
The median litter size is 10 (range: 2-19; n=11 litters; median lengths: 43–51 cm; (de Bruyn *et al.* 2005). This value of 10 in the KZN bather protection programme is low in comparison with other regions, and is possibly due to some abortion during capture. The only other pregnant female sampled in the region had a litter size of 30 (average pup length 23 cm; Bass *et al*. 1975c). A global review of this species gives an overall mean litter size of 20 and a maximum of 40 (Gallagher and Klimley 2018).

Length at birth
This is 40-50 cm (Bass *et al*. 1975c).

Pupping season and nursery ground
Pupping takes place in spring and summer (de Bruyn *et al.* 2005), with the Thukela Banks as a nursery ground (Fennessy 1994).

Length at maturity
Length at 50% maturity for males and females is 215 cm and 245 cm respectively, based on specimens caught in the KZN bather protection program (de Bruyn *et al.* 2005).

Maximum length
The largest male and female sampled in the KZN bather protection program were 306 and 324 cm respectively. This species is known to attain 420 cm (Rigby *et al*. 2019j).

Age and growth
Individuals caught in the KZN bather protection programme were used to determine age at maturity of 11 years, a growth value *k* of 0,057 and a maximum age of 30 years (de Bruyn 2000). In other regions the age at maturity is 4–10 years, with *k* values ranging between 0.05–0.09 and 2.2–2.5 and respective maximum ages of 31 and 14 years (Branstetter 1987, Chen *et al*. 1988, Harry *et al*. 2011).

Generation length
This is 18.3 years (Rigby *et al*. 2019j).

FISHERIES MANAGEMENT
SA catch sources
Local catch was estimated at 1–10 tons per annum (DFFE records: 2010-2012; da Silva *et al*. 2015), from a number of fisheries, with the KZN bather protection program listed as the biggest contributor, followed by demersal trawling and the prawn trawl fishery. It was listed as a suspected catch in the following fisheries: pelagic longline, demersal longline and commercial linefishery. It is highly likely that it is caught in all these fisheries because of its piscivorous diet. It is also caught in the recreational linefishery, but this was also not reflected in the catch records (da Silva *et al*. 2015).

SA catch quantities and characteristics
KZN prawn trawl fishery
This species was the most common elasmobranch bycatch in the KZN prawn trawl industry on the Thukela Banks (Fennessy 1994). Based on observer records of trawls undertaken between 1989 and 1992, the annual extrapolated catch was some 2,300 individuals (range 1742–3288), largely neonates

and young juveniles of 40–60 cm. Survival of this bycatch species was extremely low, around 2%. This species benefitted from the introduction of an extended closed trawl season between August and February, which spanned the pupping season around December. This fishery was dormant for nearly two decades due to the extended closure of the mouth of Lake St Lucia, resulting in poor prawn recruitment and diminishing prawn catches on the uThukela Banks. The fishing grounds were closed to trawling following the declaration of the uThukela Banks MPA in August 2019.

Longline fisheries
It is one of the large pelagic sharks caught in the Southern African tuna and swordfish longline fisheries. Collectively *S. lewini* and *S. zygaena* represented 0,6% of the total shark bycatch by number in the period 1998-2005, which equates to about 200-400 individuals per year. These catches were usually retained (Petersen *et al.* 2009).

KZN bather protection nets
The annual catch in the KZN bather protection nets was 166 individuals, of which 91% were immature (1978-1998). Juveniles were caught throughout the year, with a peak in summer and males outnumbering females by 2,2:1. Catches of larger individuals, predominantly adult males (sex ratio 3.6:1), were far lower and mostly in November and December and at Zinkwazi and Richards Bay (the two northernmost locations, which are closest to the uThukela Banks pupping ground); they included 11 term pregnant females in this 22-year period. There was a significant decline in catch rate over the sampling period. Survival rates were extremely low with only 1% of the catch found alive. The widespread reduction in netting (from 45 km at 44 locations in 1992 to 16 km at 37 locations in 2020), accompanied by the installation of drumlines in the early 2000s (177 at 36 locations in 2020), has reduced the catches of this species. In 2018 56 scalloped hammerheads were caught in these nets (one released) and two in drumlines.

Recreational shore angling
In KZN competitive shore anglers caught 1086 unidentified hammerheads (*S. lewini* and *S. zygaena*) over a 24-year period, at a rate of 45 per annum and 1 per 1000 angling hours, with a mean individual mass of 7.0 kg and comprising 0.5% of the total number of fish caught (Pradervand *et al.* 2007). On the WiId Coast (northern part of the Eastern Cape), over a similar period, competitive shore anglers caught 1920 unidentified hammerheads, at a rate of 80 per annum and 33 per 1000 angling hours, with a mean size of 13.7 kg and comprising 10.6% of the total number of fish caught. The Wild Coast sharks were double the weight of those from KZN (Pradervand 2004). These two species were also caught by competitive shore anglers from the Border region (Kei River to Fish River; 146 km of coastline immediately south of Wild Coast). Over a 17-year period, 31 unidentified hammerheads were caught at a rate of 1.8 per annum and 0.3 per 1000 angling hours, each with a mean weight 7.4 kg and comprising 0,2% of all fish caught (Pradervand and Govender 2003). In the region to the south of the Border (Port Alfred to Plettenberg Bay) all hammerhead catches by competitive shore anglers were reported as *S. zygaena* (Dicken *et al.* 2012).

This species is also occasionally caught by commercial and recreational skiboaters but it is not a target species. It also occasionally caught in estuarine embayments, such as Richards Bay harbour (Everett and Fennessy 2007).

Fishing outside South Africa
In Mozambique both artisanal fisheries inshore and commercial foreign longliners target this species for its fins and meat (Pierce *et al.* 2008). Elsewhere it is caught in pelagic and demersal longlines and it taken as a bycatch, especially the juveniles, in trawl, driftnet, purse-seine and artisanal fisheries. It has undergone steep declines wherever it is fished commercially, with some signs of stabilisation and possible recovery where management interventions have been implemented (Rigby *et al.* 2019j).

Population trends

Duncan *et al.* (2006) used genetic analyses to determine a number of population statistics from samples taken from a number of different global locations, including sharks caught on the east coast of South Africa.

An analysis of catches in the KZN bather protection nets over the 26-year period 1978–2003 yielded annual rates of reduction of 4.0%, consistent with an estimated median reduction of 93.4% over three generation lengths (72.3 years), with the highest probability of >80% reduction over three generation lengths (Rigby *et al*. 2019j).

In four separate regional assessments this species was estimated to have undergone steep declines in all oceans, with some signs of stabilization and possible recovery in response to management only in the NW Atlantic and Gulf of Mexico. An estimated global population trend resulted in a median reduction of 77–97%, with the highest probability of >80% reduction over three generation lengths (72.3 years), and therefore it was assessed as Critically Endangered A2bd in 2018 (Rigby *et al*. 2019j).

ECOTOURISM

Large packs of adults are often seen in summer in the Protea Banks MPA where they are a popular drawcard for divers and therefore this species should be regarded as an ecotourism species.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

As this species is on CITES Appendix II, no retention is permitted in either the pelagic or demersal longline fisheries. There is a daily bag limit of one individual in the recreational line fishery, but the intention is to make it a no-take species in this fishery (C da Silva, DFFE, pers. comm).

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)

This species is listed as Endangered.

Marine Protected Areas

The uThukela Banks MPA offers protection to the most important sectors of the population, namely mating individuals and pregnant females and their newborn. This is the only known nursery ground on the South African coast. The Protea Banks MPA will protect the seasonal aggregations of adults. Individuals are commonly encountered in the iSimangaliso Wetland Park where they frequent the shelf edge and are seen and caught by anglers targeting bill fish. In summer, they are also often seen in aggregations at offshore reef systems along the KZN coast such as at Aliwal Shoal and The Pinnacles reef in the Ponta do Ouro Partial Marine Reserve in southern Mozambique. Although all the coastal MPAs on the east coast will protect the juveniles and larger subadults which spend a lot of time close inshore, tagging studies have shown that this sector of the population is highly mobile and these individuals will regularly move in and out of these protected areas.

Additional local comment

This species will benefit from the restrictions imposed on the pelagic and demersal shark longlining on the east coast. The former is only permitted more than 12 nm off the KZN coast, due to its narrow continental shelf, and more than 20 nm on the southern part of the east coast. No demersal shark longlining is permitted east of the Kei mouth, which means that there is no fishing on the entire KZN and Wild Coasts, which usually occurs at depths of 50–100 m.

IUCN Red List Status

<u>Critically Endangered 2018: A2bd</u>

Previous IUCN assessments
Endangered 2009
Near Threatened 2000

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species was placed on Appendix II in 2013.

Convention on Migratory Species (CMS)
This species was placed on Appendix II in 2014.

International comments
In 2010, the International Commission for the Conservation of Atlantic Tunas (ICCAT) prohibited retention, landing, and sale of hammerheads for ICCAT fisheries operating in the Convention Area. There are exceptions for local consumption in developing countries, provided they cap catches, meet catch data reporting requirements, and ensure fins are not traded internationally. Several proposals to ban hammerhead landings and/or set regional hammerhead fishing limits through the Inter-American Tropical Tuna Commission (IATTC) have been defeated (Rigby *et al*. 2019j).

MANAGEMENT CONSIDERATIONS
Any ban on landings in South African pelagic longline fisheries will have limited benefit, given the high susceptibility to capture stress (Gulak *et al.* 2015). A number of modifications to the longline and other line fishing techniques would be beneficial, but they may jeopardise catches of target species. These include seasonal and time-area closures. A continuation in the shift from nets to drumlines in the KZN bather protection program will also reduce catches. The 2018 IUCN Red List assessment states that the Indian Ocean Tuna Commission (IOTC) has yet to act on 2018 scientific advice to adopt *S. lewini* fishery management measures.

Although this is a migratory/nomadic species, it is conceivable that it is able to complete its entire life cycle in South African waters. The uThukela Banks is a nursery area; juveniles are common inshore along the southern KZN and Wild Coasts. Packs of larger individuals are seen on Protea Banks off the southern KZN coast and High Points off Mtunzini on the northern KZN coast. There is likely to be some emigration and immigration between South Africa and neighbouring Mozambique, where the species is vulnerable to a variety of fisheries. Indeed, transboundary movements confined to the Maputaland coastline have been confirmed and the neighbouring Ponta do Ouro Partial Marine Reserve remains an important buffer to fisheries in Mozambique.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
This is a very well-studied species. Locally its biology has been well researched using animals caught by anglers and in the KZN bather protection nets. A large number have been tagged by shore anglers and the results have been analysed in detail. It is interesting to note the large regional variations in length and age at maturity, reproductive cycles and maximum length and age. Protea Banks is a known adult aggregation site but seasonality, sex ratios and factors which influence these aggregations are not known. This is an obvious research opportunity, but strong surface currents may hamper such efforts. It would be beneficial to establish the level of transboundary movement between South Africa and neighbouring Mozambique, where protection levels for the species are likely to be much lower and where the species is subject to heavy artisanal and commercial fishing pressures. Existing acoustic telemetry studies have been successful in recording transboundary movements and site fidelity and with an expanded coastal receiver array focussed on offshore reef systems this will continue to provide key information about the species spatial ecology in South Africa. Satellite telemetry is a potential future avenue of study but the tag fitment of SPOT satellite tags remains challenging due to the species sensitivity to capture and handling stress. Genetic analysis could also provide information about population connectivity in the region and tissue samples for such genetic studies have already been collected from individuals caught in the bather protection program as well as from Mozambique.

Sphyrna mokarran

SCIENTIFIC NAME	*Sphyrna mokarran* (Rüppell 1837)
COMMON NAME	Great hammerhead shark
FAMILY	Sphyrnidae
ENDEMIC	No, circumglobal in tropical and subtropical waters
SIZE RANGE	50–610 cm TL (rare >400 cm)
DISTRIBUTION	E coast: KZN
HABITAT	Pelagic in coastal and semi-oceanic waters
DEPTH RANGE	1–300 m
MAJOR FISHERIES	Pelagic longlines, linefishery, bather protection nets
IUCN STATUS	Critically Endangered 2018
CITES	Appendix II (2013)
MLRA	No retention in any longline fisheries; daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	A Kock

SPECIES SUMMARY and RECOMMENDATIONS

Sphyrna mokarran is a large pelagic shark which is circumglobal in tropical and subtropical coastal and semi-oceanic waters. It is only found in KZN waters on the east coast, where it appears to be uncommon. The local catch was estimated at 1–10 tons per annum (DFFE records: 2010–2012), from several fisheries, with the KZN bather protection program listed as the only definite contributor. It is a suspected catch in the following fisheries: pelagic longline, and commercial and recreational line fisheries. Because of its piscivorous diet, it is vulnerable to any hook and line fishery. Fins of all hammerheads are among the most valuable and popular. It was assessed globally as Critically Endangered in 2018, with fishing being the greatest threat. This species, and hammerheads in general, have one of the lowest post-capture survival rates of all sharks. It is not known to mate or pup on the KZN coast and, as a nomadic or migratory species, it derives little protection from all the Marine Protected Areas on the east coast. It is listed in CITES Appendix II, and as a result, no retention in any South African longline fisheries is permitted. Based on extremely low documented catches in local fisheries, it must be regarded as being of low management priority. Its scarcity limits research opportunities to improve knowledge of its life history and reproductive biology in KZN waters.

TAXONOMIC and IDENTIFICATION ISSUES

There are no taxonomic issues. It is one of three species of large hammerhead shark, all of the genus *Sphyrna*, found on the South Africa coast. It is the largest of the three species, but it is also by far the least abundant. It could be confused with adult *S. lewini* as both species have a central notch in the leading edge of the hammer, but *S. mokarran* is solitary, and it has larger, more falcate fins and is uncommon on the KZN coast. In many fisheries, both locally and globally, all the hammerhead catches are lumped and recorded as *Sphyrna* spp. or unidentified hammerheads.

SOUTH AFRICAN DISTRIBUTION

It is confined to KZN waters on the east coast of South Africa (Ebert *et al.* 2021).

REGIONAL DISTRIBUTION

It occurs in Mozambique and the entire east coast of Africa. It is circumglobal in its distribution and is found in most tropical and subtropical waters (Compagno 1984b).

SYNPOSIS OF RESEARCH

This species is not well studied. Bass *et al.* (1975c) provided detailed taxonomic, morphometric and biological information from 14 individuals. General biology, including diet, and catch trends from individuals caught in the KZN bather protection programme were analysed (Cliff 1995). This included a separate, detailed analysis of the cephalopod component of the diet (Smale and Cliff 1998). No sexually active females were examined in this study. Life history and age and growth studies have been conducted elsewhere in the range of this species (Stevens and Lyle 1989; Passerotti *et al.* 2010; Piercy *et al.* 2010; Harry *et al*. 2011). Miller *et al.* (2014) and Gallagher and Klimley (2018) provided international reviews of the biology and conservation status of this species.

ECOLOGY

Depth

A solitary, pelagic species, it occurs in coastal and semi-oceanic waters to depths of 300 m (Rigby *et al.* 2019k).

Habitat: Adults

Adults are found over continental shelves and in many parts of their range, they are is associated with coral reefs or lagoons. They appear to prefer waters warmer than 20 °C (Cliff 1995).

Habitat: Juveniles/Nursery Grounds

This is unknown. No sharks smaller than 145 cm have been recorded in the KZN bather protection programme (Cliff 1995).

Synopsis of tag deployments

Shore anglers rarely catch this species; thus, there are no tagging statistics from the ORI Cooperative Fish Tagging Project.

Movements

This species is regarded as nomadic and migratory in other parts of its range (Gallagher and Klimley 2018). It is likely to behave in the same way on the east coast of South Africa.

Diet/feeding: adults

Very few adults were sampled, but the prey included elasmobranchs, teleost fishes and cephalopods (Cliff 1995).

Diet/feeding: juveniles

Larger juveniles fed mainly on elasmobranchs including small sharks and batoids, teleosts and cephalopods. There was both pelagic and benthic prey (Cliff 1995). The smaller individuals fed more on neritic cephalopods, while the epibenthic and pelagic prey species were more important in larger individuals (Smale and Cliff 1998).

South African toxicological studies

No local studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Placental viviparity
DURATION OF REPRO CYCLE	Possibly 2 years (northern Australia)
MATING	Summer (northern Australia)
GESTATION	10–11 months (northern Australia)
LITTER SIZE	6–42, mean 30 (northern Australia)
PUPPING/NURSERY GROUND	location unknown; summer (Australia)
LENGTH AT BIRTH	50–70 cm (Australia)

LENGTH AT MATURITY	F: 320 cm; M: 290 cm (South Africa)
AGE AT MATURITY	F and M: 5–8 years (NW Atlantic, W Pacific)
MAXIMUM LENGTH	F: 442 cm; M: 364 cm (South Africa); 610 cm elsewhere
GENERATION LENGTH	24.8 years (NW Atlantic; W Pacific)

Mode
This species exhibits placental viviparity (Compagno 1984b).

Duration of reproductive cycle
Nothing is known locally. The reproductive cycle is two years, with a 10–11-month gestation in northern Australia (Stevens and Lyle 1989).

Mating season and location
In South Africa two males were found in late November and January with large quantities of seminal fluid, indicating that mating takes place during this period. No sexually active females have been examined, and the mating location is unknown (Cliff 1995). In N Australia, mating takes place in November and December (Stevens and Lyle 1989).

Gestation
Gestation in N Australia is about 10–11 months (Stevens and Lyle 1989).

Litter size
Mean litter size is 15, with a range of 6–42 from 30 litters in N Australia (Stevens and Lyle 1989, Miller *et al*. 2014).

Length at birth
This occurs at about 50–65 cm in N Australia (Compagno 1984b, Stevens and Lyle 1989).

Pupping season and nursery ground
Pupping takes place in December and January (summer) in N Australia (Stevens and Lyle 1989). It occurs in late spring and summer in the northern hemisphere (Gallagher and Klimley 2018).

Length at maturity
Male and female lengths at 50% maturity were 290 cm and 320 cm, respectively (Cliff 1995). Elsewhere in its range males mature at 225–270 cm and females at 210–300 cm (Gallagher and Klimley 2018).

Maximum length
This species is reported to reach 610 cm or more (Compagno 1984b), but sharks greater than 400 cm are rare. The largest male examined locally was 364 cm and female 442 cm (Cliff 1995). These are similar to the maximum sizes reported from northern Australia by Stevens and Lyle)1989).

Age and growth
No age and growth studies have been conducted in the SW Indian Ocean. In the NW Atlantic and the W Pacific males and females mature at 5–8 years, with a maximum age of 39–44 years for females and 32 years for males, and generation lengths of 24–25 years (Passerotti *et al.* 2010, Piercy *et al.* 2010, Harry *et al.* 2011).

Generation length
This was estimated at 24.8 years (Rigby *et al.* 2019k).

FISHERIES MANAGEMENT

SA catch sources

The local catch was estimated at 1–10 tons per annum (DFFE records: 2010-2012), from several fisheries, with the KZN bather protection program listed as the only definite contributor. It is listed as a suspected catch in the following fisheries: pelagic longline and commercial and recreational line fisheries. Because it is known to feed on bottom-dwelling rays and guitarfish, it may be prone to capture on demersal shark longlines, but these are prohibited east of the Kei River mouth and therefore occur outside the range of this species (da Silva *et al.* 2015). It is unlikely to be landed in the recreational linefishery because of its large size.

SA catch quantities and characteristics

KZN bather protection nets

The mean annual catch in the KZN bather protection nets was 13 (range 4-26) in the period 1978–1993. Based on an average weight of 100 kg, this equated to 1.3 tons per annum. The sex ratio of the catch was not significantly different from 1:1 and included a large percentage of mature individuals, but no sharks under 145 cm. Catches were highest in the period January to May, suggesting an influx from more tropical waters to the north. Catches rates showed a significant negative trend (Cliff 1995), which continued until 2003 (Dudley and Simpfendorfer 2006). No individuals were caught in 2018 (KZNSB, unpublished data).

Linefisheries

This species was not reported in the catches of recreational competition shore anglers in KZN. Despite confusion with the far more common *S.lewini*, it is an unlikely catch, given its scarcity and larger size.

Pelagic longlines

This species is only found in KZN waters, where the pelagic longline fishery is restricted to fishing more than 12 nm offshore and is therefore likely to catch this semi-oceanic species. Any hammerhead catches in this fishery are likely to be recorded as *Sphyrna* spp. and lumped with *S. lewini* and *S. zygaena*, both of which are far more common. As a result, any catch data from this fishery will be misleading.

Fishing outside South Africa

It is caught globally as target and bycatch in commercial and small-scale pelagic longline, purse seine, and gillnet fisheries. It is also captured in coastal longlines, gillnets, trammel nets and sometimes trawls, particularly in areas with narrow continental shelves. The large fins are highly prized (Rigby *et al.* 2019k), but in most countries the meat is considered unpalatable because of its high urea content (Miller *et al.* 2014).

Population trends

There is no population estimate for this species in the SW Indian Ocean. An analysis of population abundance from the KZN bather protection nets for the 26-year period, 1978–2003, yielded annual rates of reduction of 6.5%, consistent with a median reduction of 99% over three generation lengths (71 years), with the highest probability of >80% reduction over three generation lengths (Rigby *et al.* 2019k).

This species appears to have undergone steep declines in the Indian Ocean, Mediterranean Sea, and in the Atlantic (for a review, see Miller *et al*. 2014). The global population is estimated to have undergone reductions of 50–60%, with the highest probability of >80% reduction over three generation lengths (71–74 years). As a result of management intervention, there is evidence of slow recovery in the NW Atlantic. Based on a precautionary approach a global population reduction of >80% over three generation lengths (71.1–74.4 years) was inferred, and this species was assessed as Critically Endangered in 2018 (Rigby *et al.* 2019k).

ECOTOURISM
This solitary species is rarely encountered by scuba divers and therefore cannot be regarded as an ecotourism species.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
As this species is on CITES Appendix II, no retention is permitted in either the pelagic or demersal longline fisheries. There is a daily bag limit of one individual in the recreational line fishery, but the intention is to make it a no-take species in this fishery (C da Silva, DFFE, pers. comm).

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is listed as Endangered.

Marine Protected Areas
S. mokarran is a migratory/nomadic species. There is no evidence that this species completes any critical phases of its life history, such as mating or pupping, on the KZN coast. As a result, it is unlikely to derive benefit from the MPAs on this section of the east coast.

Additional local comment
This species may derive some benefit from a ban on pelagic longlining within 12 nm of the KZN coast and the ban on demersal shark longlining east of the Kei River.

Current IUCN Status
Critically Endangered 2018: A2bd

Previous IUCN assessments
Endangered 2007
Data Deficient 2000

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species was placed on Appendix II in 2013, based on its similarity to *S. lewini.*

Convention on Migratory Species (CMS)
This species was listed in Appendix II of the Convention on Migratory Species in 2014.

International comments
In 2010, the International Commission for the Conservation of Atlantic Tunas (ICCAT) prohibited retention, trans-shipment, landing, and sale of this and other hammerhead species in ICCAT fisheries operating in the Convention Area (Rigby *et al.* 2019k). There are limited great hammerhead-specific RFMO management measures in place for the Indian Ocean populations (Miller *et al.* 2014).

MANAGEMENT CONSIDERATIONS
Catches in the large pelagic longline fishery has not been quantified but legislation precludes the landing of this species, based on its status as a CITES Appendix II species. It is highly susceptible to capture stress, with high at-vessel and post-release mortalities in demersal longlines (Gulak *et al.* 2015) elsewhere in its range. The same is likely to apply to pelagic longlines. As a result, the prohibition on retention of catches will have very little benefit. Modifications to the soak time or other aspects of fishing procedures to minimise catches of this species should be considered but may adversely affect landings of the target species. The restrictions imposed by prohibiting pelagic longlining shallower than 12 nm off the KZN coast and a total ban on demersal shark longlining in KZN waters will benefit this species. It does not appear to undertake critical phases in its life history, such as mating and

pupping in South African waters. Based on extremely low documented catches in local fisheries, it must be regarded as being of low management priority.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

The limited local knowledge of the life history and general biology of this species is based mainly on catches in the KZN bather protection programme. This species has not been aged in South Africa, and very little is known of its reproductive biology in the SW Indian Ocean. Future research opportunities are greatly hampered by the extremely low catches currently experienced in this programme (nil in 2018 and 2019). Tissue samples from previous catches are available for genetic studies to assess the connectivity with *S. mokarran* from elsewhere in the SW Indian Ocean.

Sphyrna zygaena

SCIENTIFIC NAME	*Sphyrna zygaena* (Linnaeus 1758)
COMMON NAME	Smooth hammerhead shark
FAMILY	Sphyrnidae
ENDEMIC	No; circumglobal in temperate and tropical seas
SIZE RANGE	60–400 cm TL
SA DISTRIBUTION	E, S, W coasts: Mozambique border to St Helena Bay
HABITAT	Pelagic in coastal and semi-oceanic waters
DEPTH RANGE	0–200 m, but as deep as 500 m
MAJOR FISHERIES	Commercial linefishery, demersal shark longlines, pelagic longlines, inshore trawl fishery, bather protection nets and recreational linefishery
IUCN STATUS	Vulnerable 2018
CITES	Appendix II (2013)
MLRA	No retention in any longline fisheries; daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	A Kock

SPECIES SUMMARY and RECOMMENDATIONS

Sphyrna zygaena is a large, pelagic species that is poorly studied in comparison to the other two large hammerheads. It has a circumglobal distribution in temperate and tropical, coastal and semi-oceanic waters. It occurs on the entire east and south coasts and as far north as St Helena Bay on the west coast. Juveniles are known to occur in large aggregations. The local catch was estimated at 1–10 tons per annum (DFFE records: 2010-2012), from several fisheries. The commercial linefishery and demersal shark longline fishery were listed as the biggest contributors, followed by pelagic longlines and the KZN bather protection programme. As a nomadic or migratory species, it derives limited protection from the Marine Protected Areas on the east and south coasts, although De Hoop MPA provides some benefit for juveniles that aggregate there in large numbers. Fins of all hammerheads are among the most valuable and popular. It was assessed globally as Vulnerable in 2018, with fishing being the greatest threat. It is listed in CITES Appendix II, and as a result, no retention in South African demersal and pelagic longline fisheries is permitted. With its high vulnerability to capture stress, any individuals released in these fisheries will have a low survival rate. As the regional population is almost entirely confined to South African waters, the impact of fisheries outside the South African EEZ is likely to be minimal. Research is needed on most aspects of its life history and reproductive biology, including the location of nursery areas.

TAXONOMIC and IDENTIFICATION ISSUES

There are no taxonomic issues. It is one of three species of large hammerhead, all of the genus *Sphyrna*, found on the South African coast. It is easily confused with the scalloped hammerhead *S. lewini* which also occurs in coastal waters along the east coast of South Africa. The juveniles of the two species overlap on the southern KZN coast and the Wild Coast (northern part of the Eastern Cape Province). It is less likely to be confused with the great hammerhead *S. mokarran*, a solitary, more tropical species, which has larger and more falcate fins and whose juveniles are rare on the KZN coast and absent elsewhere on the east coast of South Africa. Hammerhead catches are lumped together in many fisheries, including the local recreational linefishery and pelagic longline fishery.

SOUTH AFRICAN DISTRIBUTION

This species occurs around almost the entire South African coast from the Mozambique border up the west coast as far north as St Helena Bay (Compagno *et al.* 1989). It favours cooler water than the other two species of large hammerheads.

REGIONAL DISTRIBUTION

It is also present in the southern parts of Mozambique. It is circumglobal in temperate and tropical waters (Compagno 1984b).

SYNOPSIS OF RESEARCH

This species is the least studied of the three large, circumglobal hammerhead species. In South Africa, Bass *et al.* (1975) provided detailed morphometric and biological information from about 60 individuals, including a single pregnant female. Dicken *et al.* (2018) conducted an analysis of the general biology, including diet, and catch trends from individuals caught in the KZN bather protection programme but no mature animals were caught or examined in this study. Smale and Cliff (1998) analysed the cephalopod component of the diet of these sharks. Movements of tagged individuals, mostly juveniles tagged with external dart tags by shore anglers, were analysed (Diemer *et al.* 2011). In a study of catches and their diet in the Eastern Cape, only two mature females were examined (Smale 1991). Dunlop and Mann (2013b) provided a concise overview of life history and fishery-related information on this species. Miller (2016) and Gallagher and Klimley (2018) provided an international review of the biology and conservation status of this species. Kuguru *et al.* (2019) investigated genetic differentiation within the South African population. Very little is known both locally and internationally on the reproductive biology or age and growth of *S. zygaena*.

ECOLOGY

Depth

This pelagic species is found in coastal and semi-oceanic waters from the surface to at least 200 m (Compagno *et al.* 1989). Research conducted elsewhere in its range indicated that it is the most oceanic of the three species of *Sphyrna* (Gallagher and Klimley 2018).

Habitat: Adults

The adults occur over deep reefs (100 m+) towards the edge of the continental shelf. Term females may move inshore to pup (Smale 1991).

Habitat: Juveniles/Nursery Grounds

The larger juveniles are present close inshore over sand bottoms along much of the east coast and south coast (Heemstra and Heemstra 2004). Large aggregations of juveniles 1–1.5 m long have been seen close inshore in the Algoa Bay region of the Eastern Cape (Bass *et al.* 1975) and 1–2 m individuals along the Agulhas coastline, particularly near the De Hoop MPA from January to March (Cape Nature, 2016).

Synopsis of tag deployments

A total of 1650 individuals, almost all immature (110–175 cm), was tagged (ORI Cooperative Fish Tagging Project, 1984-2018) with 1% recaptured. Mean distance travelled was 139 km; mean time at liberty was 1.6 years (maximum: 384 km and 8.4 years) (Jordaan *et al.* 2020). Diemer *et al.* (2011) undertook a detailed analysis of the movements of 1342 of these sharks, mainly immature individuals of 70–200 cm tagged up till 2009.

Movements

The results of the tagging studies referred to above indicate that it is a nomadic species. Northward coastwise movement along the south and east coasts appears to be a seasonal range extension in response to falling water temperatures with the onset of winter (Diemer *et al.* 2011). Research elsewhere has shown that juveniles move offshore from their coastal habitats as they mature (Gallagher and Klimley 2018).

Diet/feeding: adults
The stomachs of very few adults have been examined. The diet comprised small, pelagic and demersal teleosts and oceanic cephalopods (largely squids and cuttlefish). It included a small number of small sharks and rays. Larger individuals (>125 cm PCL) have a higher incidence of oceanic cephalopods than smaller individuals, which is in keeping with their movement offshore as they become larger (Smale 1991).

Diet/feeding: juveniles
The diet of juveniles, most of which were 110–160 cm, and therefore not neonates, was dominated by teleosts, comprising largely small-sized, pelagic schooling species, as well as a lower incidence of inshore demersal species. This was followed by cephalopods, largely pelagic, neritic species of squids and cuttlefishes (Smale 1991; Dicken *et al.* 2018).

South African toxicological studies
Levels of total mercury in the muscle tissue of juveniles (50–150 cm) from the east coast were 0.5 mg kg^{-1} wet weight, which was similar to values from juveniles from the Pacific Coast of Mexico of 0.2 mg kg^{-1} wet weight, but far lower than the levels of 12.1 mg kg^{-1} wet weight from adults in the Mediterranean (McKinney *et al.* 2016 and references cited therein).

REPRODUCTION

REPRODUCTIVE MODE	Placental viviparity
DURATION OF REPRO CYCLE	Unknown locally; 1 year in W Atlantic
MATING	Unknown locally, includes February
GESTATION	About 12 months
LITTER SIZE	Mean: 32; max 49 (western Pacific)
PUPPING/NURSERY GROUND	Unconfirmed, includes February
LENGTH AT BIRTH	About 60 cm
LENGTH AT MATURITY	F: 265 cm; M: 250–260 cm (western Pacific)
AGE AT MATURITY	Unknown
MAXIMUM LENGTH	400 cm
GENERATION LENGTH	24.1 years

Mode
This species exhibits placental viviparity (Compagno 1984b)

Duration of reproductive cycle
This is not known locally but it is 1 year in the western Atlantic.

Mating season and location
This is unconfirmed locally, but includes summer, as a single female with large ova and fresh mating bites was caught near Durban in February (Bass *et al.* 1975).

Gestation
Locally this is possibly 12 months, based on a single mating female captured in February and another female with term pups also caught in February (Bass *et al.* 1975). In Indonesia it is about 11 months (White *et al.* 2006)

Litter size

A single pregnant female had 34 embryos (Bass *et al.* 1975). In New South Wales (Western Pacific), the average litter size was 32 (range: 20-49) from 7 litters (Stevens 1984b).

Length at birth

In South Africa is it about 60 cm, based on the capture of a single pregnant female with 34 term embryos of 57–61 cm and free-swimming sharks with open umbilical scars of 59-63 cm (Bass *et al.* 1975c, Smale 1991). It is also 60 cm in New South Wales (Western Pacific) (Stevens 1984b). Ebert *et al.* (2013) list size at birth as 50–61 cm.

Pupping season and nursery ground

This is unconfirmed locally. A pregnant female from Port Elizabeth caught in February contained 34 term embryos of 57–61 cm (Bass *et al.* 1975c). This is similar to the January to March (summer) pupping season in New South Wales (Western Pacific) (Stevens 1984b).

Length at maturity

There is no local information. Males mature at about 250–260 cm and females at 256 cm in New South Wales (Western Pacific) (Stevens 1984b).

Maximum length

Maximum recorded length is in the region of 400 cm (Compagno *et al.* 1989).

Age and growth

No age and growth studies have been undertaken in South Africa. Growth rates for smooth hammerhead sharks in the Eastern Atlantic Ocean suggest a growth coefficient *k* of 0.06 for both sexes combined (Coelho *et al*. 2011). New information using updated growth models suggested a *k* of 0.09 for both males and females, with maximum sizes of 285 cm and 293 cm, respectively (Rosa *et al.* 2017).

Generation length

This is 24.1 years (Rigby *et al.* 2019l).

FISHERIES MANAGEMENT

SA catch sources

The local catch was estimated at 1–10 tons per annum (DFFE records: 2010-2012; da Silva *et al.* 2015), from several fisheries, with the commercial linefishery and demersal shark longline fishery listed as the biggest contributors, followed by pelagic longlines and the KZN bather protection programme and then the recreational linefishery and small pelagic fishery. It is also caught as bycatch in the inshore trawl fishery. This species is likely to be caught in any linefishery within its geographic and depth range because of its piscivorous diet.

SA catch quantities and characteristics

Inshore trawl fishery

The average annual catch based on observer records in the inshore trawl fishery for the period 2003-2006 was 2.4 tons (Attwood *et al.* 2011). Assuming a mean body weight of 10 kg, this would equate to a catch of about 200 individuals per annum. This fishery targets shallow-water Cape hake *Merluccius capensis* and Agulhas sole *Austroglossus pectoralis*.

Longline fisheries

It is one of the large pelagic sharks caught in the Southern African tuna and swordfish longline fisheries. Collectively *S. lewini* and *S. zygaena* represented 0.6% of the total shark bycatch by number in the period 1998-2005, which equates to about 200-400 individuals per year. These catches were usually retained (Petersen *et al.* 2009). It is also caught in the demersal shark longline fishery (da Silva *et al.* 2015), but no published details are available.

Bather protection nets
The annual catch in the KZN bather protection programme was 68 individuals (range: 9–271; 1978-2014). The majority (93%) were juveniles of 110–160 cm, and included a 68 cm neonate. No mature sharks were caught or examined. The sharks were caught at all netted beaches but were far more common at beaches to the south of Durban and in the winter months. This is indicative of a cooler water species extending its range northwards from the south (Eastern Cape waters). The sex ratio of the catch was not significantly different from 1:1. The survival rate of this species was very low, at around 2%. There were 17 incidents of mass capture, defined as more than five individuals caught in the same location on the same day, which is indicative of aggregating behaviour in this species (Dicken *et al.* 2018).

Recreational shore angling
In KZN competitive shore anglers caught 1086 unidentified hammerheads *S. lewini* and *S. zygaena* over a 24-year period, at a rate of 45 per annum and 1 per 1000 angling hours, with a mean individual mass of 7 kg and comprising 0.5% of the total number of fish caught (Pradervand *et al.* 2007). On the Wild Coast (northern part of the Eastern Cape), over a similar period, competitive shore anglers caught 1920 unidentified hammerheads, at a rate of 80 per annum and 33 per 1000 angling hours, with a mean size of 13 kg and comprising 10.6% of the total number of fish caught. The Wild Coast sharks were double the weight of those from KZN (Pradervand 2004). There was a decreasing trend in CPUE in this fishery. Competitive shore anglers also caught these two species in the Border region (Kei River to Fish River; 146 km of coastline immediately south of Wild Coast). Over a 17-year period, 31 unidentified hammerheads were caught at a rate of 1.8 per annum and 0.3 per 1000 angling hours, each with a mean weight 7 kg and comprising 0.2% of all fish caught (Pradervand and Govender 2003). In the region to the south of the Border (Port Alfred to Plettenberg Bay) all catches by competitive shore anglers were reported as *S. zygaena*, with catches of approximately four individuals per annum, with a mean weight of 11 kg (range 5-18; Dicken *et al.* 2012).

Fishing outside South Africa
This species is heavily fished throughout most of its range and also features as bycatch. This is because the fins are amongst the most valuable in the international fin trade. The meat, liver oil, skin, cartilage, and jaws may also be used. In many parts of the world, catches are not identified to the species level and are lumped as *Sphyrna* spp. Its schooling behaviour renders it vulnerable to high catches. All hammerheads have low survival rates, with the result that few caught as bycatch can be released alive (Rigby *et al.* 2019l).

Population trends
This species is ranked among the most productive sharks (Cortes *et al.* 2012). No estimate of population size has been undertaken in South Africa. Catch rates in the KZN bather protection programme varied considerably over a 26-year period (1978–2003) but were stable (Dudley and Simpfendorfer 2006). Over a longer period (1978-2014) there a slight, but not significant, increasing trend (Dicken *et al.* 2018), suggesting a relatively healthy local population. This is in contrast to other fisheries elsewhere in the world which have shown declines, some marked. Kuguru *et al.* (2019) found significant genetic differentiation between individuals sampled from the warm temperate south coast and the subtropical east coast, with asymmetric gene flow between the two regions.

In the NW Atlantic, the population is showing signs of recovery after steep historic declines, as a result of management intervention. Globally, an inferred population reduction of 30–49% resulted in this species being assessed as Vulnerable in 2018. More robust species-specific data and monitoring of catches are required to improve the certainty of catch estimates for a future assessment of this species (Rigby *et al.* 2019l and references cited therein).

ECOTOURISM

This species commonly occurs in shallow coastal waters but it is rarely encountered by scuba divers and therefore cannot be regarded as an ecotourism species.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

As this species is on CITES Appendix II, no retention is permitted in either the pelagic or demersal longline fisheries. There is currently a bag limit of one per day in the recreational line fishery, but the intention is to make it a no-take species in this fishery (C da Silva, DFFE, pers. comm).

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)

This species is not listed.

Marine Protected Areas

The juveniles, which occur inshore, will derive some benefit from the coastal MPAs on the east and south coasts. In particular, the De Hoop MPA attracts large aggregations of up to 1500 individuals between January and March. These sharks are 1–2 m long and are generally seen congregating behind the backline (CapeNature 2014). The protective benefits will be limited as the sharks are known to be nomadic, and individuals will move in and out of these protected areas.

Additional local comment

This species will benefit from the restrictions imposed on the pelagic and demersal shark longlining on the east coast. The former is only permitted more than 12 nm off the KZN coast, due to its narrow continental shelf, and more than 20 nm on the southern part of the east coast. No demersal shark longlining is permitted east of the Kei mouth, which means that there is no fishing on the entire KZN and Wild Coasts, which usually occurs at depths of 50–100 m. There is a similar ban on inshore demersal trawling, but the benefit to this pelagic species is probably lower.

Current IUCN Status

<u>Vulnerable 2018: A2bd</u>

Previous IUCN assessments

Vulnerable 2009
Near Threatened 2000

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

This species was listed in Appendix II in 2013.

Convention on Migratory Species (CMS)

This species was listed in Appendix II of the Convention on Migratory Species in 2014.

International comments

In 2010, the International Commission for the Conservation of Atlantic Tunas (ICCAT) prohibited retention, landing, and sale of hammerheads for ICCAT fisheries operating in the Convention Area. There are exceptions for local consumption in developing countries, provided they cap catches, meet catch data reporting requirements, and ensure fins are not traded internationally. Several proposals to ban hammerhead landings or set regional hammerhead fishing limits through the Inter-American Tropical Tuna Commission (IATTC) have been defeated (Rigby *et al.* 2019l). This species is ranked among the most productive sharks (Cortes *et al.* 2012). In the USA current bioaccumulation rates and concentrations of environmental pollutants in the tissues of smooth hammerhead sharks do not indicate that they are significant threat to the species (Miller 2016).

MANAGEMENT CONSIDERATIONS

The absence of a decline in catch rates in the KZN bather protection nets is encouraging, even though this species is caught in several commercial fisheries, as well as the recreational linefishery. The high vulnerability to capture stress in both line and net fisheries is a major cause for concern. This greatly dilutes the value of current legislation which prevents the landing of smooth hammerheads caught in either pelagic or demersal longlines, as most of the individuals caught will either be dead or die due to capture stress. The use of illegal gill nets along the coast poses an emerging threat for this species. Once nursery grounds have been identified, consideration should be given to protecting some of these areas. As catches north of Durban in the KZN bather protection programme were low, it is unlikely that this species in common in southern Mozambique which is the eastern extremity of its range. This means that the risk of heavy exploitation outside the South African EEZ is very low and that any population decline is due to factors within South Africa.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

Despite its wide distribution, this species remains poorly studied. In South Africa, nothing is known of its reproductive biology, age and growth or the locations of nursery areas. Local and international knowledge of its life history and reproductive biology is also scant. Tissue samples have been collected from individuals caught in the KZN bather protection programme and are available for research.

SOUTH AFRICAN THREATENED AND ENDEMIC CHONDRICHTHYAN SPECIES REPORTS:

BATOIDS

FAMILY NARKIDAE

Electrolux addisoni

SCIENTIFIC NAME	*Electrolux addisoni* (Compagno and Heemstra 2007)
COMMON NAME	Ornate sleeper ray
FAMILY	Narkidae
ENDEMIC	Yes part of E coast
SIZE RANGE	At least 52 cm TL
DISTRIBUTION	E coast: Umhlanga to Coffee Bay
HABITAT	Sand patches adjacent to rocky reefs
DEPTH RANGE	5–50 m
MAJOR FISHERIES	None listed
IUCN STATUS	Least Concern 2018
CITES	Not listed
MLRA	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	DA Ebert

SPECIES SUMMARY and RECOMMENDATIONS

Electrolux addisoni is a very small demersal ray, endemic to the east coast of South Africa. The first of a handful of photographic records of this species date back to 1984, but it was only formerly described after two specimens were collected in 2003. Knowledge of the general biology and ecology of this species is extremely poor. There were no reported local catches (DFFE records: 2010–2012) and, as a result, this species was assessed as Least Concern on the IUCN Red List in 2018. It is likely to be a highly resident species and will therefore obtain considerable protection from the Aliwal Shoal and Protea Banks MPAs, where individuals have been sighted. Given its apparent scarcity and lack of catches, research opportunities are extremely limited and no management recommendations have been formulated.

TAXONOMIC and IDENTIFICATION ISSUES

Electrolux addisoni was first known from photographs taken in 1984, but the first specimens were only caught in 2003. This resulted in the creation of a new genus (Compagno and Heemstra 2007). This species is easily identified by its striking colour pattern and the presence of two dorsal fins. It is the largest member of the family Narkidae (Last *et al.* 2016), hence there are no taxonomic and identification issues.

SOUTH AFRICAN DISTRIBUTION

This species is only known to occur on the east coast of South Africa, from Umhlanga in KZN to Coffee Bay in the Eastern Cape (Compagno and Heemstra 2007).

REGIONAL Distribution

This endemic species does not occur outside of the east coast of South Africa (Ebert *et al.* 2021).

SYNOPSIS OF RESEARCH

This species was not reported in the batoid survey of the east coast of South Africa (Wallace 1967a). It was first photographed in 1984 and collected in 2003. It was only formally described in 2007 (Compagno and Heemstra 2007). Nothing has been published subsequently on the life history and ecology of this endemic species.

ECOLOGY

Depth
This demersal species is found close inshore in coastal waters of 5–50 m depth (Compagno and Heemstra 2007).

Habitat: Adults
They occur on sand patches adjacent to large reef structures, including ship wrecks (Compagno and Heemstra 2007).

Habitat: Juveniles/Nursery Grounds
No juveniles have been observed.

Synopsis of tag deployments
This species has not been tagged.

Movements
Nothing is known of the movement patterns of this species, but it is likely to be highly resident.

Diet/feeding: adults
Very little is known, but they are likely to feed crustaceans and polychaetes (Last *et al*. 2016).

Diet/feeding: juveniles
Nothing is known of the juveniles.

South African toxicological studies
No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Lecithotrophic viviparity
DURATION OF REPRO CYCLE	Unknown
MATING SEASON	Unknown
GESTATION	Unknown
LITTER SIZE	Unknown
PUPPING/NURSERY GROUND	Unknown
LENGTH AT BIRTH	Unknown
LENGTH AT MATURITY	Unknown
MAXIMUM LENGTH	52 cm TL
GENERATION LENGTH	Unknown

Mode
All members of the family Narkidae exhibit lecithotrophic viviparity in which embryos are dependent entirely on the nourishment supplied by the yolk-sac (Last *et al*. 2016). Nothing is known of the reproductive biology of *E. addisoni.*

Duration of reproductive cycle
The duration of the reproductive cycle is unknown.

Mating season and location
Nothing is known.

Gestation
This is unknown.

Litter size
This is unknown.

Length at birth
Nothing is known.

Pupping season and nursery ground
Nothing is known.

Length at maturity
Nothing is known.

Maximum length
The largest of the two males collected was 52 cm (Compagno and Heemstra 2007).

Age and growth
Nothing is known.

Generation length
Nothing is known.

FISHERIES MANAGEMENT

SA catch sources, quantities and characteristics
There were no reported local catches (DFFE records: 2010-2012; da Silva *et al.* 2015). This species has a very small mouth and it is designed to feed in the sediment, so it is unlikely to be caught in any line fishery (D Ebert, South African Institute for Aquatic Biodiversity, personal communication).

Fishing outside South Africa
Not applicable to this endemic species.

Population trends
Nothing is known of the local population, but it is unlikely to be declining because two of the five locations where it has been observed are protected areas. This species was assessed as Least Concern on the IUCN Red List in 2018 (Pollom *et al*. 2019d).

ECOTOURISM

This species has been detected by scuba divers in the Aliwal Shoal MPA (Compagno and Heemstra, 2007; Geremy Cliff, formerly KZN Sharks Board, personal observation) and Protea Banks (Compagno and Heemstra, 2007) and therefore should be regarded as an ecotourism species.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations
There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is listed as Critically Endangered.

Marine Protected Areas
This species is likely to be resident, based on the observation that members of this family are slow swimming (Last *et al.* 2016). It will benefit considerably from protection in the Protea Banks and Aliwal Shoal MPAs, where it is known to occur (Compagno and Heemstra 2007). It has not been recorded in the Pondoland MPA to the south of its range (Maggs *et al.* 2013), although it is likely to occur there.

Additional local comment
This species will benefit from a ban on inshore hake trawling east of the Kei River mouth.

IUCN Red List Status
Least Concern 2018

Although this ray meets the spatial threshold for Vulnerable under Criterion B1 and approaches that for Endangered, it does not fulfil the subcriteria. Therefore, *E. addisoni* was assessed as Least Concern in 2018. This is a non-genuine change from the previous assessment of Critically Endangered which was published in 2009, as that assessment had severely underestimated its range and it is not currently subject to any plausible threats (Pollom *et al*. 2019d).

Previous IUCN assessments
Critically Endangered 2009

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

International comments
Not applicable as it is an endemic species.

MANAGEMENT CONSIDERATIONS
Although it is an endemic, *E. addisoni* must be viewed as a low priority species, in view of its apparent scarcity and absence from catches and because it is protected in the Protea Banks and Aliwal Shoal MPAs, which are two of only five localities in which it has been sighted.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
In view of its apparent scarcity and absence from catches, research opportunities are extremely limited. It would be beneficial to invoke citizen-science involvement by asking diver photographers to submit images with location information to improve understanding of the distribution of this species along the east coast and its depth range.

Heteronarce garmani

SCIENTIFIC NAME	*Heteronarce garmani* (Regan 1921)
COMMON NAME	Natal sleeper ray
FAMILY	Narkidae
ENDEMIC	No, but only also occurs in Mozambique
SIZE RANGE	?–30 cm TL
DISTRIBUTION	E coast: Mozambique border to Algoa Bay
HABITAT	Soft substrates on outer shelf and upper slope
DEPTH RANGE	70–330 m
MAJOR FISHERIES	Demersal trawl fisheries
IUCN STATUS	Near Threatened 2019
CITES REGS	Not listed
MLRA REGS	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	DA Ebert

SPECIES SUMMARY and RECOMMENDATIONS

Heteronarce garmani is a very small demersal ray, restricted to the outer shelf and upper slope on the east coast of South Africa and southern Mozambique. Total annual catch was estimated at < 1 ton (DFFE records: 2010–2012), as bycatch in the demersal trawl fishery, but there is apparently no published information on these catches. This species was assessed globally as Near Threatened on the IUCN Red List in 2019 on the basis that trawling takes place over part of its range. The ban on hake trawling north of the Kei River and the closure of the KZN prawn trawl fishery will protect this species over much of its range on the South African coast. It is likely to be highly resident and will therefore potentially obtain protection in the deeper waters of the iSimangaliso and uThukela MPAs in South Africa and the Ponta do Ouro Partial MPA in southern Mozambique. Important management considerations include the better identification of members of the order Torpediniformes, monitoring of catches and of the levels of survival after release from the fishery. Almost nothing is known of the general biology and ecology of this species.

TAXONOMIC and IDENTIFICATION ISSUES

There are five genera in the family Narkidae, of which three occur locally. The number of dorsal fins is either none, one or two. The three species of *Heteronarce* all have two dorsal fins, but only one occurs in southern African waters. The relatively uniform colouration distinguishes *H. garmani* from *Electrolux addisoni* with its ornate dorsal surface. As a result, there are no taxonomic or identification issues.

SOUTH AFRICAN DISTRIBUTION

This species occurs from the Mozambique border to Algoa Bay (Compagno *et al.* 1989, Ebert *et al.* 2021).

REGIONAL DISTRIBUTION

This species is regarded as a southern African endemic at its distribution extends into southern Mozambique. Records from Madagascar are a species of *Narcine* (Last *et al*. 2016).

SYNOSIS OF RESEARCH

This species was recorded in the batoid survey of the east coast of South Africa, with a single male trawled off Durban; at the time it was regarded as a South African endemic (Wallace 1967a). Nothing has been published on the life history and ecology of this species in South Africa.

ECOLOGY

Depth

This demersal species is found on the outer shelf and upper slope at depths of 70–330 m (Compagno *et al.* 1989).

Habitat: Adults

They likely occur over soft substrates and have been recorded from canyons (100–200 m depth) near Sodwana Bay in northern KwaZulu-Natal (Heemstra *et al.* 2006, cited by Pollom *et al.* 2020i).

Habitat: Juveniles/Nursery Grounds

Nothing is known.

Synopsis of tag deployments

This species has not been tagged.

Movements

Nothing is known of the movement patterns of this species, but it is likely to be highly resident, given its extremely small size and that members of this family are slow swimming.

Diet/feeding: adults

Nothing is known of the diet.

Diet/feeding: juveniles

Nothing is known of the diet.

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Lecithotrophic viviparity
DURATION OF REPRO CYCLE	Unknown
MATING SEASON	Unknown
GESTATION	Unknown
LITTER SIZE	Unknown
PUPPING/NURSERY GROUND	Unknown
LENGTH AT BIRTH	Unknown
LENGTH AT MATURITY	M: ±9 cm
MAXIMUM LENGTH	16 cm
GENERATION LENGTH	Extrapolated to 5 years (see text below)

Mode

All members of the family Narkidae exhibit lecithotrophic viviparity in which embryos are dependent entirely on the nourishment supplied by the yolk-sac (Last *et al*. 2016). Nothing is known of the reproductive biology of this species.

Duration of reproductive cycle

The duration of the reproductive cycle is unknown.

Mating season and location

Nothing is known.

Gestation
This is not known.

Litter size
This is not known.

Length at birth
Nothing is known.

Pupping season and nursery ground
Nothing is known.

Length at maturity
Males mature at 17 cm; nothing is known of female length at maturity (Last *et al.* 2016).

Maximum length
This species attains 30 cm (Last *et al.* 2016).

Age and growth
Nothing is known.

Generation length
Nothing is known about this species. The Cortez numbfish *Narcine entemedor* has a generation length of 10.5 years (Villavicencio-Garayzar 2000, cited by Pollom *et al.* 2020i), and is larger than the Natal sleeper ray (75 cm vs 30 cm). Thus, based on scaled-size, the generation length of *H. garmani* is inferred as 5 years (Pollom *et al*.2020i). Poorly calcified vertebrae render ageing studies unreliable (DA Ebert, South African Institute for Aquatic Biodiversity, personal communication).

FISHERIES MANAGEMENT
SA catch sources and quantities
Total annual catch was estimated at < 1 ton per annum (DFFE records: 2010-2012; da Silva *et al.* 2015). The main contributor was the demersal trawl fishery, with the hake longline fishery a possible catch source.

Demersal trawl fishery
No catches of this species were reported in the inshore trawl fishery but there was an estimated annual catch of 25.7 tons of unidentified electric rays of the order Torpediniformes (Attwood *et al.* 2011). This fishery is only allowed to operate south of the Kei River mouth, which is well within the distributional range of *H. garmani.* This species was not recorded in the four research trawls spread out over the year on the south coast in 1980, which included Algoa Bay, the southern limit of this species (Wallace *et al.* 1984 and Buxton *et al.* 1984). It was not recorded in the KZN prawn trawl fishery (Fennessy 1994).

Fishing outside South Africa
Nothing is known of catches of this species in southern Mozambique, where intense small-scale trawling may threaten this species (Jacquet *et al*. 2010, Benkenstein 2013 cited by Pollom *et al.* 2020i), however it has not been noted from trawl fisheries in Mozambique (Sean Fennessy, Oceanographic Research Institute, pers. comm.).

Population trends
There are no population size or trend estimates for this species. Very few specimens have been caught in research surveys, despite extensive sampling on the shelf and upper slope within its known range,

and this species is considered rare (Compagno and Heemstra 2007). The demersal fisheries on the east coast of South Africa have decreased in effort over the last decade with the closure of the prawn trawl fishery on the uThukela Banks, however, this species may be affected by trawl fisheries operating off southern Mozambique (Pollom *et al.* 2020i).

The majority of the species range is exposed to trawl fishing pressure, though this has recently decreased in some areas. It is not captured in longline fisheries and it will obtain refuge in marine protected areas. Therefore, it is suspected that a population reduction of 20–29% has occurred over the past three generations (15 years) as a result of actual levels of exploitation (bycatch) and therefore the species was assessed as Near Threatened on the IUCN Red List in 2019, nearly meeting the criteria for Vulnerable (Pollom *et al*. 2020i).

ECOTOURISM
This species is not recognised as an ecotourism species as it only occurs in water deeper than 70 m.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
This species is likely to be highly resident, given its extremely small size and that members of this family are slow swimming. As a result, it is likely to derive potential benefit from protection in the deeper waters of the iSimangaliso and uThukela MPAs in South Africa and the Ponta do Ouro Partial MPA in southern Mozambique.

Additional local comment
This species is likely to benefit from the ban on hake trawling and demersal longlining east of the Kei River mouth. Many of these very small electric ray species tend to inhabit soft bottom areas between rocky reefs, which renders the area unsuitable for trawling, thereby providing the species with some protection from this fishery (D Ebert, South African Institute for Aquatic Biodiversity, personal communication).

IUCN Red List Status
<u>Near Threatened 2018: A2d</u>

Previous IUCN assessments
Vulnerable 2009

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

International comments
Not applicable as it is an endemic species.

MANAGEMENT CONSIDERATIONS

Catch rates of *H.garmani* in trawl fisheries should be monitored to assess population size and trends. This requires observers to be able to identify members of the Torpediniformes to species level, something that does not appear to have happened in the past. Survival of this and other bycatch species after capture needs to be investigated.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

Nothing is known of its life history and this can be addressed if individuals caught in the demersal trawl fishery are retained.

Narke capensis

SCIENTIFIC NAME	*Narke capensis* (Gmelin 1789)
COMMON NAME	Onefin sleeper ray
FAMILY	Narkidae
ENDEMIC	Yes, as records from Namibia, Madagascar and Mozambique require confirmation
SIZE RANGE	At least 38 cm TL
DISTRIBUTION	E, S coasts: central KZN to Cape Point
HABITAT	Sand patches adjacent to rocky reefs
DEPTH RANGE	20–115 m
MAJOR FISHERIES	Demersal trawl fisheries
IUCN STATUS	Least Concern 2018
CITES REGS	Not listed
MLRA REGS	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	DA Ebert

SPECIES SUMMARY and RECOMMENDATIONS

Narke capensis is a very small demersal endemic ray, found in coastal waters of the east and south coasts of South Africa. Total annual catch was estimated at 1–10 tons (DFFE records: 2010–2012), as bycatch in the demersal trawl fishery, but there is little published information on these catches. This species was assessed as Least Concern on the IUCN Red List in 2018 on the basis that it is caught in low numbers in demersal trawls and beach seine netting and all the catch is likely to be released. It appears to be a highly resident species and will therefore potentially obtain protection in the deeper waters of various MPAs on the east and south coasts. Important management considerations include the monitoring of catches and the levels of survival after release from the fishery. Almost nothing is known of the general biology and ecology of this species.

TAXONOMIC and IDENTIFICATION ISSUES

There are five genera in the family Narkidae, of which three occur locally. The number of dorsal fins is either none, one or two. *Narke* only has a single dorsal fin and *N. capensis* is the only representative in the region. The other local species in the family both have two dorsal fins. As a result, there are no taxonomic or identification issues.

South African Distribution

This species occurs from central KZN to Cape Point and is regarded as a South African endemic (Compagno *et al.* 1989, Ebert *et al.* 2021).

Regional Distribution

Records from Namibia, Madagascar and Mozambique require confirmation (Last *et al*. 2016).

SYNOPSIS OF RESEACH

This species was recorded in the batoid survey of the east coast of South Africa, with six males collected in Algoa Bay (Wallace 1967a). It was present in research trawls inshore on the south coast (Wallace *et al.* 1984 and Buxton *et al.* 1984). Nothing has been published subsequently on the life history and ecology of this endemic species.

ECOLOGY

Depth

This demersal species is found in close inshore in coastal waters of 20–115 m (Compagno *et al.* 1989) but may be found in water as shallow as 3 m (Pollom *et al.* 2019e).

Habitat: Adults
They occur on soft and rocky substrates (Compagno *et al.* 1989).

Habitat: Juveniles/Nursery Grounds
Nothing is known.

Synopsis of tag deployments
This species has not been tagged.

Movements
Nothing is known of the movement patterns of this species, but it is likely to be highly resident, given its very small size and the fact that members of this family are slow swimming.

Diet/feeding: adults
Very little is known, but they are likely to feed benthic invertebrates (Last *et al*. 2016).

Diet/feeding: juveniles
Nothing is known of the juveniles.

South African toxicological studies
No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Lecithotrophic viviparity
DURATION OF REPRO CYCLE	Unknown
MATING SEASON	Unknown
GESTATION	Unknown
LITTER SIZE	Unknown
PUPPING/NURSERY GROUND	Unknown
LENGTH AT BIRTH	Unknown
LENGTH AT MATURITY	F: 23 cm; M: 18–23 cm
MAXIMUM LENGTH	38 cm
GENERATION LENGTH	Unknown

Mode
All members of the family Narkidae exhibits lecithotrophic viviparity in which embryos are dependent entirely on the nourishment supplied by the yolk-sac (Last *et al*. 2016). Nothing is known of the reproductive biology of *N. capensis.*

Duration of reproductive cycle
The duration of the reproductive cycle is unknown.

Mating season and location
Nothing is known.

Pupping season and nursery ground
Nothing is known.

Length at birth
Nothing is known.

Length at maturity
Females mature at 23 cm and males 18–23 cm (Last *et al.* 2016).

Maximum length
This species attains 38 cm (Last *et al.* 2016).

Age and growth
Nothing is known.

Generation length
Nothing is known.

FISHERIES MANAGEMENT

SA catch sources and quantities
Total annual catch was estimated at 1–10 tons (DFFE records: 2010–2012; da Silva *et al.* 2015). The main contributor was the demersal trawl fishery, with the hake longline fishery a possible catch source.

Demersal trawl fishery
No catches of this species were reported in the inshore trawl fishery but there was an estimated annual catch of 25.7 tons of unidentified electric rays of the Order Torpediniformes (Attwood *et al.* 2011). It was not uncommon in the four research trawls spread out over the year on the south coast in 1980, where it was caught at depths of 7–45 m (Wallace *et al.* 1984 and Buxton *et al.* 1984).

Beach seine fisheries
This species was caught in 1% of beach seine hauls in False Bay. Catches were weakly seasonal, with a peak in August; the size range of catches was 6–17 cm DW (Lamberth 2006).

Fishing outside South Africa
Not applicable to this endemic species.

Population trends
There are no population estimates for this species. It is caught in low numbers as bycatch in demersal trawl fisheries and inshore beach seines. The catches are unlikely to be retained and are typically avoided as these rays produce electric shocks. Hence, such fisheries are not suspected of driving reductions in population size. There are no other major threats, therefore, this species was assessed as Least Concern on the IUCN Red List in 2018 (Pollom *et al*. 2019e).

ECOTOURISM
This species is rarely seen by scuba divers and therefore cannot recognised as an ecotourism species.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations
There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas

As this species is small and is likely to be a slow swimmer and highly resident, it potentially would benefit from all MPAs in its range.

Additional local comment
This species is likely to benefit from the ban on trawling and demersal longlining east of the Kei River mouth. Many of these very small electric ray species tend to inhabit soft bottom areas between rocky reefs, which renders the area unsuitable for trawling, thereby possibly providing the species with protection from this fishery (DA Ebert, South African Institute for Aquatic Biodiversity, personal communication).

IUCN Red List Status
Least Concern 2018

Previous IUCN assessments
Data Deficient 2009

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

International comments
Not applicable as it is an endemic species.

MANAGEMENT CONSIDERATIONS
Despite be an endemic, *N. capensis* must be viewed as a very low priority species because of its assessment as Least Concern, however species-level monitoring of bycatch in inshore trawl fisheries should be undertaken, given the high reported catches of unidentified electric rays. This should be undertaken in conjunction with monitoring of post-capture survival of animals released in this fishery. This requires observers to be able to identify members of the Torpediniformes to species level.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
Nothing is known of its life history; this is easily addressed if individuals caught in the demersal trawl fishery are retained.

FAMILY PRISTIDAE

Pristis pristis

SCIENTIFIC NAME	*Pristis pristis* (Linnaeus 1758)
COMMON NAME	Largetooth sawfish
FAMILY	Pristidae
ENDEMIC	No, circumglobal including much of Western Indian Ocean
SIZE RANGE	72–660 cm TL
DISTRIBUTION	E coast: Mozambique border to Port Alfred
HABITAT	Demersal on sand and mud bottoms, including estuaries and freshwater
DEPTH RANGE	0–10 m
MAJOR FISHERIES	KZN bather protection nets, illegal estuarine gillnet fisheries, recreational linefishery
IUCN STATUS	Critically Endangered 2013
CITES	Appendix II (2007), upgraded to Appendix I (2013)
MLRA	No targeted catch in any fishery
COMPILER	G Cliff
REVIEWER	BI Everett

SPECIES SUMMARY and RECOMMENDATIONS

Pristis pristis is a very large, demersal sawfish with a circumglobal distribution in very shallow, coastal tropical and subtropical waters. It is one of two species of sawfish found on the east coast of South Africa, both of which were caught in small numbers by recreational anglers and in the KZN bather protection programme. They were most likely also caught in the illegal gillnets set in KZN estuaries, but this has not been formally documented. There have been no recently reported local catches (DFFE records: 2010–2012), which is not surprising considering that the last known sawfish catch, which occurred in the KZN bather protection programme, was in 1999. Extinction probability analysis indicated that sawfish no longer occur in KZN waters; this can be extrapolated to the rest of the South African coast. Globally catches have declined in all regions, some to such an extent that this species is considered rare or even extirpated in areas where it was previously common. Australia remains the only stronghold for this species in the Indo-West Pacific. All sawfish are highly vulnerable to entanglement in netting, particularly gill nets laid in estuarine and riverine environments. They are also particularly susceptible to habitat degradation, particularly in their nursery areas, since they exhibit natal philopatry. *P. pristis* was globally assessed as Critically Endangered on the IUCN Red List in 2013, with fishing being the greatest threat. This species, which is now largely taken as bycatch is highly prized, mainly for its large, top-quality fins and trophy rostrums. This species has also suffered major habitat destruction and loss, particularly in mangroves and other estuarine areas which they also use as nursery areas. In view of its local extirpation, any management concerns or research recommendations are academic.

TAXONOMIC and IDENTIFICATION ISSUES

There are five species of sawfish in two genera, *Anoxypristis* and *Pristis*. The largetooth sawfish *Pristis pristis* is one of four species in this genus. Sawfish taxonomy was problematic, with three species recognised locally, all members of the genus *Pristis,* namely *P. microdon, P. pectinata* and *P. zijsron* (Compagno *et al.* 1989). Genetic studies have shown that *P. pectinata* does not occur in South Africa and that all specimens resembling this species are *P. zijsron.* The third species, *P. microdon* has been renamed *P. pristis.* The two valid species in South Africa, *P. pristis* and P. *zijsron,* appear superficially similar but can easily be separated by the number of lateral teeth in the saw, the position of the dorsal fin relative to the pectoral and pelvic fins and the prominence of the lower lobe of the caudal fin (Faria *et al.* 2013).

SOUTH AFRICAN DISTRIBUTION

P. pristis occurs along much of the east coast, from the Mozambique border to Port Alfred (Ebert *et al*. 2021), although this southern limit was only based on a single record (Everett *et al*. 2015).

REGIONAL DISTRIBUTION

This species occurs in Mozambique northwards and in Madagascar, with a global tropical and subtropical distribution (Faria *et al.* 2013, Kyne *et al*. 2013).

SYNOPSIS OF RESEARCH

There is very little published information on the life history of this species in South Africa and elsewhere in its West Indian Ocean range. In a study of batoid fishes of the east coast of southern Africa only three specimens of *P. pristis* (then known as *P. microdon),* were examined, all mature males of 360-392 cm, for their morphometrics and taxonomy (Wallace 1967b). Faria *et al.* (2013) investigated species delineation and global population structure of the family Pristidae; this study included genetic samples from South Africa. Everett *et al.* (2015) provided an overview of the status of sawfishes in South Africa, with details of catches in various fisheries on the KZN coast. They presented strong evidence of local extirpation of both species.

ECOLOGY

Depth

It is a demersal species which occurs in extremely shallow coastal waters of 0–10 m in depth and also utilises estuaries and river mouths as nursery grounds (Kyne *et al.* 2013, Last *et al.* 2016, Thorburn *et al.* 2007).

Habitat: Adults

They inhabit sand or mud bottoms in shallow, coastal, tropical waters. Females move into brackish water to pup (Kyne *et al.* 2013). A large individual was captured approximately 100 km from the sea in the Zambezi River, where this species was once regarded as common (Wallace 1967b).

Habitat: Juveniles/Nursery Grounds

Juveniles appear to spend the first few years of their lives in rivers and other freshwater environments (Kyne *et al.* 2013 and references cited therein, Thorburn *et al.* 2007).

Synopsis of tag deployments

Seven unidentified sawfish were caught and tagged between 1984 and 2013 as part of the ORI Cooperative Fish Tagging Project (Dunlop and Mann 2014). Two were tagged at the mouth of the St Lucia estuarine system, three just south of the mouth, two at Richards Bay and one at Park Rynie. Two of these tagged specimens were recaptured. The Park Rynie sawfish was recaptured two days later at Brighton Beach (Durban), 50 km to the north, while one of the sawfish tagged at Richards Bay was recaptured just south of the St Lucia mouth, a distance of about 55 km, five months later (Dunlop and Mann 2014).

Movements

It is impossible to conclude much from the recapture of two of the seven sawfish tagged along the KZN coast. In Australia genetic evidence suggests that females show strong reproductive philopatry and return to sites previously used for reproduction (Kyne *et al.* 2013). Any movements will be coastwise as deep oceanic water is a barrier to any offshore movements (Faria *et al.* 2013). In a riverine nursery habitat, juveniles were most active during night-time and twilight hours when foraging in shallow water, while they were least active in deeper water where they sought refuge. This behaviour is linked to diurnal light availability (Whitty *et al.* 2017).

Diet/feeding: adults
They are benthic opportunists that feed on a variety of benthic invertebrates and fish (Thorburn *et al*. 2007, Last *et al*. 2016,).

Diet/feeding: juveniles
Juveniles are likely to have different diets to adults as they are found mostly in freshwater habitats, while adults are predominantly found in the sea.

South African toxicological studies
No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Lecithotrophic viviparity
DURATION OF REPRO CYCLE	Possibly 1 (W Atlantic) or 2 (N Australia) years
MATING SEASON	Unknown
GESTATION	5 months (Lake Nicaragua)
LITTER SIZE	1–13, mean 7 (Lake Nicaragua)
PUPPING/NURSERY GROUND	Unknown
LENGTH AT BIRTH	72–90 cm (N Australia)
LENGTH AT MATURITY	F: 300 cm; M: 280–300 cm (N Australia)
MAXIMUM LENGTH	At least 660 cm, possibly over 700 cm
GENERATION LENGTH	14.6 years

Mode
This species exhibits lecithotrophic viviparity in which embryos are dependent entirely on the nourishment supplied by the yolk-sac.

Duration of reproductive cycle
No pregnant females have been documented from South Africa. The reproductive cycle is possibly biennial in the W Atlantic (Thorson 1976, cited by Kyne *et al.* 2013) but it appears to be annual in N Australia (Peverell 2008, cited by Kyne *et al.* 2013).

Mating season and location
This is unknown locally, but in Lake Nicaragua mating takes place from May to July (Thorson 1976, cited by Kyne *et al.* 2013).

Gestation
In Lake Nicaragua gestation is about five months (Thorson 1976, cited by Kyne *et al.* 2013).

Litter size
In Lake Nicaragua litter size is 1–13 (mean 7) (Thorson 1976, cited by Kyne *et al.* 2013).

Length at birth
There is no information on length at birth for *P. pristis* in South Africa but in northern Australia it is 72–90 cm (Peverell 2008, cited by Kyne *et al.* 2013) and 73–80 cm in Lake Nicaragua (Thorson 1976, cited by Kyne *et al.* 2013).

Pupping season and nursery ground

No local information is available; unlike its congener *P. zijsron*, there is no evidence that *P. pristis* uses the St Lucia estuarine system as a nursery ground. In Lake Nicaragua parturition occurs from early October into December (Thorson 1976, cited by Kyne *et al.* 2013), while a single record from Brazil showed that pupping may occur in May or the months shortly thereafter (Nunes *et al.* 2016).

Length at maturity

Length at maturity is estimated to be about 300 cm for females and 280–300 cm for males in northern Australia (Peverell 2008, cited by Kyne *et al.* 2013).

Maximum length

This species reaches at least 656 cm, but may exceed 700 cm. Such large individuals are exceedingly rare (Kyne *et al.* 2013, Last *et al.* 2016).

Age and growth

Age at maturity in N Australia has been estimated at 8–10 years using a preliminary vertebral growth ring analysis, with a maximum age of 35 years (Peverell 2008, cited by Kyne *et al.* 2013.

Generation length

The generation time is 14.6 years for the Indo-West Pacific sub-population and 17.2 years for the W Atlantic sub-population (Moreno Iturria, 2012, cited by Kyne *et al.* 2013).

FISHERIES MANAGEMENT

SA catch sources, quantities and characteristics

No recent local catches have been reported (DFFE records: 2010–2012; da Silva *et al*. 2015). A catch of 246 sawfish from various sources was documented on the KZN coast in the period 1951-2012, with the last in 1999. Of these, only 7 were identified as *P. pristis*, 150 were *P. zijsron* and 89 unidentified (Everett *et al*. 2015). No catches were reported in the KZN recreational shore angling competition fishery (Pradervand *et al.* 2007 or in the KZN prawn trawl fishery on the Thukela Banks (Fennessy 1994). These prawn trawling grounds are in a water depth of 20-45 m, which is outside the preferred depth of 0-10 m for this species.

KZN bather protection nets

There are 91 sawfish catch records, with only three identified as *P. pristis*, 14 *P. zijsron* and 77 unidentified sawfish, over the period 1964-2012. The three *P. pristis* captures were of the same animal which was caught off Durban in April 1985. Twice the animal was released alive but on the third occasion the animal was found dead in the nets (KZN Sharks Board, unpublished data). Sawfish catches peaked in 1966 (17) when there was a marked expansion of the programme. Prior to that there was only a single net installation in Durban from 1952. Catches became sporadic after the early 1970s. Highest catches were in May (none in July or August) and at Richards Bay, Mtunzini and Zinkwazi, which are all inshore of the highly productive uThukela Banks. The last catch was that of an unidentifed sawfish which was released alive in 1999 (Everett *et al.* 2015).

KZN Shark Fishery

In 1931 a shark fishing industry, known as Ocean Industries (Pty.) Ltd was established on Durban's Bluff, where the company established a factory for the treatment of products and hides. Details of this industry are restricted to a mention in the Report of The Natal Fisheries Department, 1931, which stated that turnover was satisfactory, particularly as to the number of sharks, rays and other predaceous species of this class netted. It is unclear as to what nets were used. The catches included 36 sawfish, with 6681 sharks among the total of 8609 animals caught. The 1932 Annual Report makes no mention of any catches, but does refer to the previous year's Shark Fishing experiments in the vicinity of the harbour. It is assumed that the fishery was a very short-lived one.

Fishing outside South Africa
This species was formerly targeted, but is now mostly taken incidentally in broad-spectrum fisheries. The toothed rostrums of sawfishes make them extraordinarily vulnerable to entanglement in any sort of net gear, gillnetting and trawling in particular. Unregulated and unmanaged fisheries, and habitat loss and degradation all threaten sawfish across large parts of their range (Kyne *et al.* 2013). The most recent record of sawfish catches in Mozambique was in 2014 (Leeney 2017).

Sawfish fins are highly favoured in Asian markets because of their large size and high fin needle content. Sawfish rostra are often traded as curios, ceremonial weapons, or for use in traditional medicines. Sawfish are highly prized as display animals in public aquariums due to their large size, bizarre shape, and shark-like features (Kyne *et al*. 2013).

Population trends
This species comprises four distinct subpopulations: E Atlantic, W Atlantic, E Pacific and Indo-West Pacific. The population size in all four regions remains unknown. There are no data or information on trends in abundance, thus the population status is inferred from capture records. Abundance of *P. pristis* has been continuously declining over the past few decades to the point that it can now be considered rare or even extirpated in some areas, where it was previously considered a common species (Kyne *et al.* 2013).

Catches are now extremely rare in former range states of the W and N Indian Ocean. The most recent captures of sawfishes in Mozambique occurred in 2014 (Leeney 2017) but catch rates have declined significantly including in areas such as the Zambezi River, where they were once regarded as common. Sawfish still exist in Nampula and Zambezia Provinces (Leeney 2017). Madagascar, the Seychelles, Pakistan and India have all experienced depletions of sawfish, including *P. pristis.* The Australian population of this species likely comprises a high proportion of the global population (Kyne *et al.* 2013 and references cited therein).

Across the Indo-West Pacific, a population reduction of ≥ 80% is inferred, based on a reduction in extent of occurrence (EOO) over a period of three generations (i.e., 1969 to present). This species was assessed globally as Critically Endangered on the IUCN Red List in 2013 (Kyne *et al.* 2013).

ECOTOURISM
This species is not regarded as an ecotourism species, although sawfish are sought after in the aquarium trade.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
By legislation this species may not be targeted in any South African fisheries.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
Both species of *Pristis* are listed as Critically Endangered.

Marine Protected Areas
This species potentially benefits from protection in all the nearshore MPAs in KZN, especially the those of iSimangaliso and uThukela Banks.

Additional local comment

IUCN Red List Status
<u>Critically Endangered 2013: A2cd</u>

Previous IUCN assessments
None

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species was included in Appendix II in 2007 and upgraded to Appendix I in 2013, which effectively bans commercial international trade in sawfish or their parts.

Convention on Migratory Species (CMS)
This species was listed in Appendix II in 2015.

MANAGEMENT CONSIDERATIONS
The last documented catch in the KZN bather protection nets was that of an unidentified sawfish in 1999. It is therefore not surprising that the two sawfish species have been shown to be locally extinct. No management considerations have been formulated.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
Given its total absence from KZN waters, there will be no opportunities for further research.

Pristis zijsron

SCIENTIFIC NAME	*Pristis zijsron* (Bleeker 1851)
COMMON NAME	Green sawfish
FAMILY	Pristidae
ENDEMIC	No, Indo-West Pacific Ocean
SIZE RANGE	75–730 cm TL
DISTRIBUTION	E coast: KZN and possibly further south
HABITAT	Demersal on sand and mud bottoms, including estuaries and freshwater
DEPTH RANGE	0–70 m
MAJOR FISHERIES	KZN bather protection nets, illegal estuarine gillnet fisheries, recreational linefishery
IUCN STATUS	Critically Endangered 2012
CITES	Appendix II (2007); Appendix I (2013)
MLRA	No targeted catch in any fishery
COMPILER	G Cliff
REVIEWER	BI Everett

SPECIES SUMMARY and RECOMMENDATIONS

Pristis zijsron is a very large, demersal sawfish which occurs in shallow, coastal tropical and subtropical waters of the Indo-West Pacific Ocean. It is one of two species of sawfish found on the east coast of South Africa, both of which were caught in small numbers by anglers and in the KZN bather protection programme. They were most likely also caught in the illegal gillnets set in KZN estuaries but this has not been formally documented. There have been no recently reported local catches (DFFE records: 2010–2012), which is not surprising considering that the last known sawfish catch, which occurred in the KZN bather protection programme, was in 1999. Extinction probability analysis indicated that sawfish no longer occur in KZN waters; this can be extrapolated to the rest of the South African coast. Globally, catches have declined in all regions, some to such an extent that this species is considered rare or even extirpated in areas where it was previously common. Australia remains the only stronghold for this species in the Indo-West Pacific Ocean. All sawfish are highly vulnerable to entanglement in netting, particularly gill nets laid in estuarine and riverine environments. They are also particularly susceptible to habitat degradation, particularly in their nursery areas, since sawfish exhibit natal philopatry. *P. zijsron* was assessed globally as Critically Endangered on the IUCN Red List in 2013, with fishing being the greatest threat. This species, which is now largely taken as bycatch, is highly prized, mainly for its large, top-quality fins and trophy rostrums. This species has suffered major habitat destruction and loss, particularly in mangroves and other estuarine areas which they also use as nursery areas. In view of its local extirpation, any management concerns or research recommendations are academic.

TAXONOMIC and IDENTIFICATION ISSUES

There are five species of sawfish in two genera, *Anoxypristis* and *Pristis*. The green sawfish *Pristis zijsron* is one of four species in the genus. Sawfish taxonomy was problematic, with three species recognised locally, all members of the genus *Pristis,* namely *P. microdon, P. pectinata* and *P. zijsron* (Compagno *et al.* 1989). Genetic studies have shown that *P. pectinata* does not occur in South Africa and that all specimens resembling this species are *P. zijsron.* The third species, *P. microdon* has been renamed *P. pristis.* The two valid species found in South Africa, *P. pristis* and P. *zijsron,* appear superficially similar but can easily be separated by the number of lateral teeth in the saw, the position of the dorsal fin relative to the pectoral and pelvic fins and the prominence of the lower lobe of the caudal fin (Faria *et al.* 2013).

SOUTH AFRICAN DISTRIBUTION

This species was found in KZN waters, the northern part of the east coast. Its exact southern limit was unknown, due to confusion with *P. pristis* (Ebert *et al*. 2021) and a scarcity of catches in the southern areas (Everett *et al.* 2015). Everett *et al.* (2015) regard the southern limit of this species as Port Alfred, as was the case with *P. pristis*. *P. zijsron* is the sawfish more tolerant of cooler water, and thus has a more poleward distribution, especially in the southern hemisphere (Simpfendorfer 2013).

REGIONAL DISTRIBUTION

This species occurs in Kenya, while its presence in Tanzania, Mozambique and Madagascar is uncertain. It does, however, have a widespread tropical and subtropical distribution in the Indo-West Pacific (Faria *et al.* 2013; Simpfendorfer 2013).

SYNOPSIS OF RESEARCH

There is very little published information on the life history of this species in South Africa and elsewhere in its West Indian Ocean range. In a study of batoid fishes of the east coast of southern Africa only 15 specimens of both sexes were examined for their morphometrics and taxonomy. They ranged in length from 103 to 457 cm, and at the time they were described as *P. pectinatus* (Wallace 1967b). Faria *et al.* (2013) investigated species delineation and global population structure of the family Pristidae; this study included genetic samples from South Africa. Everett *et al.* (2015) provided an overview of the status of sawfishes in South Africa, with details of catches in various fisheries on the KZN coast. They presented strong evidence of local extirpation of both species.

ECOLOGY

Depth

It is a demersal species which occurs in shallow, coastal waters, including estuaries and river mouths, usually in water down to depths of 70 m (Simpfendorfer 2013).

Habitat: Adults

Green sawfish occur mostly in inshore areas that include river mouths and estuaries over soft substrates. They remain in the extreme nearshore environment, are tidally influenced, and have a strong association with mudflats and mangroves (Peverell and Pillans 2004; Stevens *et al*. 2008; Phillips *et al.* 2011). Females move into brackish water to pup while other adults may remain in deeper water (van der Elst 1993; Smith and Heemstra 2003; Simpfendorfer 2013).

Habitat: Juveniles/Nursery Grounds

Juveniles appear to spend the first few years of their lives in rivers and other freshwater environments (Simpfendorfer 2013).

Synopsis of tag deployments

During a gillnetting project conducted by the Oceanographic Research Institute in the St Lucia Estuary between 1967 and 1970, 86 *P. zijsron* were tagged. Of these 24 were recaptured, with the shortest time at liberty being one day, the longest 2.4 years and the average 6 months. All the recaptures were at the tagging location, with 12 individuals recaptured more than once (Everett *et al.* 2015). Seven unidentified sawfish were caught and tagged between 1984 and 2013 as part of the ORI Cooperative Fish Tagging Project (Dunlop and Mann 2014). Two were tagged at the mouth of the St Lucia estuarine system, three just south of the mouth, two at Richards Bay and one at Park Rynie. Two of these tagged specimens were recaptured. The Park Rynie sawfish was recaptured two days later at Brighton Beach (Durban), a distance of 50 km, while one of the sawfish tagged at Richards Bay was recaptured just south of the St Lucia, a distance of about 55 km, mouth five months later (Dunlop and Mann 2014).

Movements

The tag data listed above is indicative of a high degree of residency within the St Lucia estuary.

Diet/feeding: adults
The diet of *P. zijsron* consists mostly of bony fishes and crustaceans that may be stunned and killed with the saw-like rostrum (Bray 2017).

Diet/feeding: juveniles
There is no evidence that it is different from that of the adults.

South African toxicological studies
No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Lecithotrophic viviparity
DURATION OF REPRO CYCLE	Unknown
MATING SEASON	Unknown
GESTATION	Unknown
LITTER SIZE	About 12 (N Australia)
PUPPING/NURSERY GROUND	St Lucia estuarine system
LENGTH AT BIRTH	76 cm (N Australia)
LENGTH AT MATURITY	340–380 cm (N Australia)
MAXIMUM LENGTH	At least 700 cm, possibly 730 cm
GENERATION LENGTH	14.6 years

Mode
This species exhibits lecithotrophic viviparity in which embryos are dependent entirely on the nourishment supplied by the yolk-sac.

Duration of reproductive cycle
No pregnant females have been documented from South Africa. The duration of the reproductive cycle is unknown.

Mating season and location
This is unknown.

Gestation
This is unknown.

Litter size
Litter size is about 12 (Simpfendorfer 2013).

Length at birth
The smallest individual caught in the St Lucia estuarine system was 73 cm. In N Australia size at birth is in the region of 76 cm (Peverell 2009, cited by Simpfendorfer 2013).

Pupping season and nursery ground
The St Lucia estuarine system is a known South African nursery ground, based on the capture of eight juveniles, all smaller than 100 cm (Everett *et al.* 2015 addendum). This and other sawfish species are known to use estuaries and mangrove habitats as nursery grounds (Simpfendorfer 2013 and references cited therein).

Length at maturity

In N Australia length at maturity for both sexes is 340–380 cm (Peverell 2009, cited by Simpfendorfer 2013).

Maximum length
This species reaches at least 700 cm, possibly 730 cm, but individuals over 600 cm are extremely rare (Simpfendorfer 2013, Last *et al.* 2016).

Age and growth
In N Australia age at maturity was estimated at 9 years, using a preliminary vertebral growth ring analysis, with a maximum age of > 50 years (Peverell 2009, cited by Simpfendorfer 2013.

Generation length
The generation length is 14.6 years in N Australia (Moreno Iturria, 2012, cited by Simpfendorfer 2013).

FISHERIES MANAGEMENT
SA catch sources, quantities and characteristics
No recent local catches have been reported (DFFE records: 2010–2012; da Silva *et al*. 2015). A catch of 246 sawfish from various sources was documented on the KZN coast in the period 1951-2012, with the last in 1999. Of these, 150 were identified as *P. zijsron* and 89 unidentified (Everett *et al.* 2015). No catches were reported in the KZN recreational shore angling competition fishery (Pradervand *et al.* 2007) or in the KZN prawn trawl fishery on the uThukela Banks (Fennessy 1994). The shallow-water prawn trawling grounds were in a water depth of 20-45 m, which is well inside the preferred depth range of 0-70 m for this species. This fishery is now closed due to the establishment of the Thukela MPA which prohibits all trawl operations.

KZN bather protection nets
The bather protection nets caught 91 sawfish, comprising three *P. pristis*, 14 *P. zijsron* and 77 unidentified over the period 1964-2012. The fate of 55 individuals was unknown, but 23 were released alive and 13 found dead. These catches peaked in 1966 (17) when there was a marked expansion of the programme. Catches became sporadic after the early 1970s. Highest catches were in May (none in July or August) and at Richards Bay, Mtunzini and Zinkwazi, which are all inshore of the highly productive uThukela Banks. The last catch was that of an unidentifed sawfish which was released alive in 1999 (Everett *et al.* 2015).

KZN estuarine research gill netting
All 115 sawfish caught in research gill net surveys by the Oceanographic Research Institute in the St Lucia estuarine system in 1967-1970 were *P. zijsron*, of which 112 were released alive. Two juveniles of this species were caught in similar surveys in the Mthlatuze estuary at Richards Bay (1975-1995), where a large female was observed swimming over the shallow sand banks. The individuals caught in the estuaries were significantly smaller than those caught in the sea (Everett *et al*. 2015).

In 1931 a shark fishing industry, known as Ocean Industries (Pty.) Ltd was established on Durban's Bluff, where the company established a factory for the treatment of products and hides. Details of this industry are restricted to a mention in the Report of The Natal Fisheries Department, 1931, which stated that turnover was satisfactory, particularly as to the number of sharks, rays and other predaceous species of this class netted. It is unclear as to what nets were used. The catches included 36 sawfish, with 6681 sharks among the total of 8609 animals caught. The 1932 Annual Report makes no mention of any catches, but does refer the previous year's Shark Fishing experiments in the vicinity of the harbour. It is assumed that the fishery was a very short-lived one.

Fishing outside South Africa

This species was formerly targeted, but is now mostly taken incidentally in broad-spectrum fisheries. The toothed rostrums of sawfishes make them extremely vulnerable to entanglement in any sort of net gear, gillnetting and trawling in particular. Unregulated and unmanaged fisheries, and habitat loss and degradation all threaten sawfish species across large parts of their range (Simpfendorfer 2013). The most recent record of sawfish catches in Mozambique was in 2014 (Leeney 2017).

Sawfish fins are highly favoured in Asian markets because of their large size and high fin needle content. Sawfish rostra are often traded as curios, ceremonial weapons, or for use in traditional medicines. Sawfish are highly prized as display animals in public aquariums due to their large size, bizarre shape, and shark-like features (Kyne *et al.* 2013).

Population trends

Genetic data is not available for the Indo-West Pacific population but it is likely to consist of a number of stocks. This is based on findings in Australia where populations in W Australia and the Gulf of Carpentaria are distinct genetic stocks, with the remnant east coast population potentially also forming a distinct population (Phillips *et al.* 2011, Phillips 2012, cited by Simpfendorfer 2013).

There are very limited data available on the size and trends of the *P. zijsron* population, either at the global or national scale. In South Africa both sawfish species are regarded as extinct (Everett *et al.* 2015). The most recent captures of sawfishes in Mozambique occurred in 2014 (Leeney 2017) but catch rates have declined significantly, including in areas such as the Zambezi River, where they were once regarded as common. They still exist in Nampula and Zambezia Provinces (Leeney 2017). In Australian waters, all sawfish species have undergone significant, albeit largely unquantified, declines; the southern extent of the range of *P. zijsron* on the Australian east coast has contracted. Extensive surveys of fish landing sites throughout Indonesia since 2001 have failed to observe this species, suggesting that its occurrence in this region is now questionable. There is some evidence from the Persian (Arabian) Gulf and Red Sea (Sudan) of small but extant populations. The lack of data from surveys and fisheries in much of the remainder of its range suggests that the abundance of this species has declined significantly in most, if not all, areas, and is now at only a small fraction of its historic abundance. A population decline of > 80% is suspected across the global range over the period of the last three generations and this species was assessed globally as Critically Endangered on the IUCN Red List in 2013 (Simpfendorfer 2013 and references cited therein).

ECOTOURISM

Despite its popularity as an aquarium species, it was historically found in turbid estuarine waters and therefore it cannot be recognised as an ecotourism species.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

By legislation this species may not be targeted in any South African fisheries.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)

Both species of *Pristis* are listed as Critically Endangered.

Marine Protected Areas

This species benefits from protection in all the nearshore MPAs in KZN, especially the iSimangaliso and uThukela Banks MPAs, where this species was historically encountered.

Additional local comment

IUCN Status

Critically Endangered 2012: A2cd

Previous IUCN assessments
Critically Endangered 2006
Endangered 2000

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species was included in Appendix II in 2007 and upgraded to Appendix I in 2013, which effectively bans commercial international trade in sawfish or their parts.

Convention on Migratory Species (CMS)
This species was listed in Appendix II in 2015.

MANAGEMENT CONSIDERATIONS
The last documented catch in the KZN bather protection nets was that of an unidentified sawfish in 1999. It is therefore not surprising that the two sawfish species have been declared to be locally extinct. The prolonged closure to the sea of the St Lucia estuarine system, clearly a critical local sawfish habitat, has not eased their plight. The mouth of the St Lucia estuary was breached in early 2021, but this is likely to be too late to save *P. zijsron.*

RESEARCH REQUIREMENTS AND OPPORTUNITIES
Given its total absence from KZN waters for over two decades, there will be no opportunities for further research.

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FAMILY RHINIDAE

Rhina ancylostomus

SCIENTIFIC NAME	*Rhina ancylostomus* (Bloch and Schneider 1801)
COMMON NAME	Bowmouth guitarfish (shark ray elsewhere)
FAMILY	Rhinidae
ENDEMIC	No, Indo-West Pacific Ocean
SIZE RANGE	46–270 cm TL
SA DISTRIBUTION	E coast: entire KZN
HABITAT	Demersal on coral and rocky reefs; sand and mud bottoms
DEPTH RANGE	0–70 m
MAJOR FISHERIES	KZN prawn trawl fishery, KZN bather protection programme, recreational linefishery
IUCN STATUS	Critically Endangered 2018
CITES	Appendix II (2019)
MLRA	No retention in pelagic and demersal longline fisheries; daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	AV Towner

SPECIES SUMMARY and RECOMMENDATIONS

This medium-sized demersal species is widely distributed in the shallow, coastal tropical waters of the Indo-West Pacific Ocean. It is the only species in the genus and has a very distinctive appearance. In South Africa, it is restricted to KZN waters on the east coast. Very little is known of its life history. It was not listed in estimated catches recorded by DFFE for the period 2010–2012. This species was a bycatch in the now closed KZN prawn trawl fishery on the uThukela Banks and is infrequently caught by the KZN bather protection nets and by shore anglers. There is no evidence of a mating or nursery area in South African waters. All this indicates that this species is uncommon. It was assessed globally as Critically Endangered on the IUCN Red List in 2018, due to decreasing population trends in other regions. This species, like all other wedgefishes is highly prized, mainly for its large, top-quality fins, resulting in heavy fishing pressure throughout the rest of its range. Given its association with coral reefs, it will derive some protection in the iSimangaliso MPA. This protection and very low local fishing pressure at the southern limit of its distribution is unlikely to aid in the recovery of the population. As a precaution, this species, like the whitespotted wedgefish *Rhyncobatus djiddensis*, should be decommercialised. Very little is known about its life history and any opportunistic sampling should be used to collect life history information and tissue samples for genetic studies.

TAXONOMIC and IDENTIFICATION ISSUES

There are no taxonomic or identification issues with this species. It was listed by Wallace (1967b) and Last *et al.* (2016) as *Rhina ancylostoma.* It is the only member of the genus *Rhina* and is easily distinguished from other members of the family Rhinidae by its broad, round snout and clusters of barnacle-like thorns around the head (Last *et al.* 2016). This species has been confused with angelsharks *Squatina* spp. (Last *et al*. 2016).

SOUTH AFRICAN DISTRIBUTION

It occurs along the entire KwaZulu-Natal coast (northern half of the east coast of South Africa) (Ebert *et al*. 2021).

REGIONAL DISTRIBUTION

It is widely distributed in tropical and subtropical waters of the Indo-West Pacific Ocean from South Africa northwards (Last *et al.* 2016).

SYNPOSIS OF RESEARCH

There is no published information on the life history of this species in South Africa. In the scientific study of batoid fishes of the east coast of southern Africa, only a single individual was examined (Wallace 1967b). No dedicated scientific study has been conducted on this species since then. Biological data and tissue samples have been collected from a small number of individuals caught in the KZN bather protection nets (KZN Sharks Board unpublished data). More recent publications of research conducted elsewhere are cited by Kyne *et al.* (2019a).

ECOLOGY

Depth

This demersal species occurs in coastal and continental shelf waters from close inshore to depths of 70 m. It is associated with coral reefs but may also be found on sand and mud bottoms (Last *et al.* 2016). It is far more active than other species in the family Rhinidae which spend long periods lying on the sand.

Habitat: Adults

The adults inhabit shallow, coastal, tropical and subtropical waters, especially coral reef areas.

Habitat: Juveniles/Nursery Grounds

They are possibly also associated with coral reefs.

Synopsis of tag deployments

Only six individuals have been tagged, all on the KZN south coast by the ORI Cooperative Fish Tagging Project (1984-2018), with a single recapture. This individual was at liberty for 237 days and travelled 104 km (Jordaan *et al.* 2020).

Movements

Nothing is known of the movements of this species in southern African waters, apart from the single tag recapture mentioned above.

Diet/feeding: adults

The diet comprises benthic molluscs and crustaceans, cephalopods and small fish (Last *et al.* 2016).

Diet/feeding: juveniles

There is no evidence that the diet is not similar to that of adults.

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Lecithotrophic viviparity
DURATION OF REPRO CYCLE	Unknown
MATING SEASON	Unknown
GESTATION	Unknown
LITTER SIZE	2–11 (W Pacific)
PUPPING/NURSERY GROUND	Unknown
LENGTH AT BIRTH	46–48 cm (W Pacific)
LENGTH AT MATURITY	F: ±180 cm; M: 150–175 cm (W Pacific)

MAXIMUM LENGTH	270 cm; not sexed (W Pacific)
GENERATION LENGTH	15 years

Mode
This species exhibits lecithotrophic viviparity in which embryos are dependent entirely on the nourishment supplied by the yolk-sac (Last *et al.* 2016).

Duration of reproductive cycle
This is unknown.

Mating season and location
This is unknown.

Gestation
This is unknown.

Litter size
Litter size is 2–11 in the W Pacific (Last *et al.* 2016).

Length at birth
This is 46-48 cm in the W Pacific (Last *et al.* 2016).

Pupping season and nursery grounds
This is unknown.

Length at maturity
Males mature at 150-175 cm and female at about 180 cm in the W Pacific (Last *et al.* 2016).

Maximum length
The largest individual, which was not sexed, is 270 cm in the W Pacific (Last *et al.* 2016).

Age and growth
No age and growth studies have been conducted on this species.

Generation length
This is estimated at 15 years (Kyne *et al.* 2019a).

FISHERIES MANAGEMENT
SA catch sources
This species was not listed in estimated catches recorded by DFFE for the period 2010–2012 (da Silva *et al.* 2015). It was a bycatch in the KZN prawn trawl fishery on the uThukela Banks and is infrequently caught by the KZN bather protection nets and by recreational shore anglers.

SA catch quantities and characteristics
KZN prawn trawl fishery
This species was recorded in the KZN prawn trawl industry on the uThukela Banks. Based on the observer-recorded catches, the extrapolated average annual catch between 1989 and 1992 was 16 (range 12-23). Sample size was too small to ascertain the survival rate. Only two individuals, 0.7 and 1.2 m, were measured (Fennessy 1994). This fishery was dormant for nearly two decades due to the extended closure of the mouth of Lake St Lucia, resulting in poor prawn recruitment and diminishing prawn catches on the uThukela Banks. The fishing grounds were closed to trawling following the declaration of the uThukela Banks MPA in August 2019.

KZN bather protection nets
Between 1983 and 2015 a total of 26 *R. ancylostomus* were caught in the KZN bather protection nets. The sex ratio of the catch was 2.1:1 (F:M), with the highest catches in summer (January-March) and only a single individual caught between June and October. Nine were caught on the north coast (from Durban northwards) and 15 on the south coast (south of Durban). Size range was 1.0-1.9 m.

Recreational shore angling
No *R. ancylostomus* were reported in any of the four east coast recreational shore angling fisheries (Pradervand and Govender 2003; Pradervand 2004; Pradervand *et al.* 2011). This is corroborated by the fact that shore anglers have only tagged two individuals since the ORI Cooperative Fish Tagging Project commenced in 1984 (Jordaan *et al.* 2020).

Fishing outside South Africa
Globally as a group, wedgefishes are subject to intense fishing pressure in their shallow-water, coastal habitats. They are caught in industrial, artisanal, and subsistence fisheries using multiple fishing gears, including gillnet, trawl, hook and line, trap, and seine net. They are generally retained for their highly valued meat and fins. There are limited species-specific conservation or management measures in place. These include localized trawl bans, bans on finning and the establishment marine protected areas, although effective enforcement in some areas is problematic (Kyne *et al.* 2019a,b). *R. ancylostomus* is landed throughout its range, with the exception of South Africa (Jabado 2018).

Anecdotal reports suggest that artisanal longline fishing in southern Mozambique has led to declines in this species which was abundant on reefs before longline fisheries began in the early 2000s and subsequently are only seen in low numbers (Pierce *et al*. 2008).

Population trends
In assessing population trends, there is a marked absence of species-specific data. Despite this, there are a number of relevant historical accounts and contemporary datasets for landings and catch rates. In the Indo-West Pacific, wedgefishes (sometimes lumped with guitarfishes Rhinobatidae) have showed declining catch rates in Iran, Pakistan, Red Sea, western and eastern India and Indonesia. Despite some protection in Australia, this species has undergone a >80% population reduction over the last three generations (45 years) and it was globally assessed as Critically Endangered on the IUCN Red List in 2019 (Kyne *et al.* 2019a).

The shallow, inshore soft-bottom habitat preferred by the species is threatened by habitat loss and environmental degradation. In the Arabian Sea and adjacent waters, dredging and coastal land reclamation has increased in recent years and has resulted in almost total loss of mangroves in some areas, such as Bahrain (Moore 2017, Kyne *et al.* 2019a).

ECOTOURISM
This species occurs in the iSimangaliso, Aliwal Shoal and Protea Banks MPAs, where scuba diving is extremely popular and is occasionally seen by scuba divers; therefore it should be regarded as an ecotourism species. It is a popular aquarium species.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
As a species listed in CITES Appendix II, it may not be retained in the pelagic and demersal longline fisheries. There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
This species will derive some benefit from all the inshore MPAs on the KZN coast, especially the iSimangaliso MPA, which is 220km long, has an abundance of coral reefs and is situated in the far north of KZN.

Additional local comment

IUCN Red List Status
Critically Endangered 2018: A2bd

Previous IUCN assessments
Vulnerable 2016
Vulnerable 2003

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
All of members of the family Rhinidae were included in Appendix II in 2019.

Convention on Migratory Species (CMS)
Not listed.

MANAGEMENT CONSIDERATIONS
Like all other wedgefishes, this species is heavily sought for its highly prized fins, as well as its meat, elsewhere in its range. Such demands, particularly in poor countries such as Mozambique, are only likely to intensify, therefore it is difficult to envisage that this species will recover, despite the protection and lack of exploitation afforded to it in South Africa. Furthermore, this species favours shallow, inshore-soft-bottom habitats, which are extremely vulnerable to either loss or degradation, through activities such as harbour development and coastal land reclamation, which have also occurred in many other parts of its range.

Given its tropical distribution, the two northernmost MPAs on the east coast provide some protection, although there is no evidence that the KZN coast serves as either a mating ground or a nursery area. Despite very low catches, its fins have a high commercial value. It is essential to ensure that *R. ancylostomus* is protected from exploitation, which could easily be achieved in the form of decommercialisation, whereby it may not be sold or traded.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
Almost nothing is known of the reproductive biology of this species globally, which include the locations of critical habitats such as nursery areas and mating aggregations and productivity. No ageing studies have been undertaken to ascertain growth rates and longevity. As this species is uncommon in KZN, research opportunities will be minimal. Tissue samples have been collected from a small number of individuals caught in the KZN bather protection programme. Opportunstic sampling should be used to collect life history information and tissue samples.

Rhynchobatus djiddensis

SCIENTIFIC NAME	*Rhynchobatus djiddensis* (Forsskål 1775)
COMMON NAME	Whitespotted wedgefish (formerly giant guitarfish)
FAMILY	Rhinidae
ENDEMIC	No, Western Indian Ocean
SIZE RANGE	65–310 cm TL
DISTRIBUTION	E, S coasts: Mozambique border to Knysna
HABITAT	Demersal on coral and rocky reefs; sand and mud bottoms
DEPTH RANGE	0–70 m, but most abundant 0–35 m
MAJOR FISHERIES	uThukela Banks prawn trawl fishery; bather protection nets; recreational shore angling
IUCN STATUS	Critically Endangered 2018
CITES	Appendix II (2019)
MLRA	No retention in pelagic and demersal longline fisheries; daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	R Daly

SPECIES SUMMARY and RECOMMENDATIONS

Rhynchobatus djiddensis is a large, demersal species which occurs in the shallow, coastal tropical and subtropical waters of the SW Indian Ocean. It is the only species of *Rhynchobatus* known to occur in South Africa, where it is largely confined to the east coast. Estimated total annual catch was <1 ton (DFFE records: 2010–2012), which comprised the recently closed KZN prawn trawl fishery, the KZN bather protection nets and the KZN recreational shore angling fishery. A detailed analysis of catches in the KZN bather protection nets and the KZN recreational shore angling fishery over the last four decades revealed that catch rates showed a marked decline, which was attributed primarily to overfishing in Mozambique. This decline was quantified and justified a local Red List assessment of Endangered. Globally this species was assessed as Critically Endangered on the IUCN Red List in 2018, with fishing being the greatest threat, but with some concern about degradation of its shallow water habitat. Like all other wedgefishes, it is highly prized, mainly for its large, valuable fins, resulting in heavy fishing pressure throughout the rest of its range. Given its status and the high demand for its fins, this species should be decommercialised in South Africa. Very little is known about its life history and reproductive biology, with only a single pregnant female reported from KZN and no evidence of a mating or nursery area in South African waters. It will derive protection from the inshore Marine Protected Areas on the east coast, especially the uThukela Banks MPA, but the northward movement of individuals in winter will expose them to various fisheries in Mozambique waters.

TAXONOMIC and IDENTIFICATION ISSUES

Rhynchobatus djiddensis is now known to be part of a species complex occurring in the Indo-West Pacific, which includes *R. australiae*, *R. djiddensis*, and *R. laevis* (Kyne *et al.* 2019b,c). These are all large wedgefish with white spots. Historically all such wedgefishes from the region were known as *R. djiddensis* but this is not correct and more attention is needed to resolve the taxonomy and distribution of the other species in the complex. It is possible that additional species occurring in the Indo-West Pacific will be described and the distribution of *R. djiddensis*, which is currently the only member of the genus in South Africa, will be further refined.

SOUTH AFRICAN DISTRIBUTION

It occurs along the entire east coast, from the Mozambican border south to Algoa Bay, with a single record from Knysna on the south coast (Heemstra and Heemstra 2004).

REGIONAL DISTRIBUTION

Initially it was thought to occur in much of the tropical Indian Ocean, but it is now confined to the West Indian Ocean, from South Africa to the Arabian/Persian Gulf (Last *et al.* 2016).

SYNOPSIS OF RESEARCH

There is very little published information on the life history of this species in South Africa and elsewhere in West Indian Ocean range. In a study of batoid fishes of the east coast of southern Africa 68 individuals were examined, primarily for their morphometrics and taxonomy, with a short section of biological comments (Wallace 1967b). Dunlop and Mann (2013c) provided a concise overview of life history and fishery-related information on this species. An analysis of catches in the recreational shore angling fishery and the KZN bather protection nets was undertaken (Daly *et al.* 2020). Much biological information from locations such as India and Indonesia is no longer relevant as recent taxonomic advances have shown that this species does not occur there. For recent studies on the biology and ecology of this species elsewhere in its range, see Kyne *et al.* (2019c) and references cited therein.

ECOLOGY

Depth

It is a demersal species which occurs in coastal and continental shelf waters from close inshore, including the surf zone, to depths of 70 m but is usually shallower than 35 m (Dunlop and Mann 2013c). It is likely that upwelling events in summer drive the species inshore where they become accessible to shore-based angling.

Habitat: Adults

Adults inhabit sand bottoms in shallow, coastal, tropical and subtropical waters (van der Elst 1993).

Habitat: Juveniles/Nursery Grounds

Juveniles may have a preference for sheltered bays and estuaries in parts of their range but they have been incidentally captured in deeper water alongside adults on the uThukela Banks (Fennessy 1994).

Synopsis of tag deployments

A total of 5095 individuals were tagged (ORI Cooperative Fish Tagging Project 1984-2018 inclusive) with 366 (7%) recaptures. Mean time at liberty was 0.9 years, with a maximum of 7.2 years (Jordaan *et al.* 2020). The majority (43%) of recaptures were recorded within 5 km of the tagging location. The mean distance travelled for juveniles was 26 km with a range from 0–171 km. Adults were recorded travelling a mean distance of 36 km with a range of 0–320 km (Jordaan *et al*. 2021).

Movements

It is a nomadic species. Larger individuals, including adults, are common in the coastal waters of KZN, particularly in summer, making localised movements, which would account for the low mean distance travelled (26–36 km; maximum 320 km). They appear to move northwards as water temperatures drop with the onset of winter (Dunlop and Mann, 2013c). The frequency and extent of transboundary movements between South Africa and neighbouring Mozambique is likely to be high but remains largely unknown with very few reports of the recapture of individuals tagged in KZN and there is little evidence to support the hypothesis of an offshore movement during winter (Jordaan *et al*. 2021).

Diet/feeding: adults

The diet comprises benthic molluscs, crustaceans, polychaetes, cephalopods and small fish (Wallace 1967b).

Diet/feeding: juveniles

The diet is thought to be similar to that of adults.

South African toxicological studies
No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Lecithotrophic viviparity
DURATION OF REPRO CYCLE	Unknown
MATING SEASON	Unknown
GESTATION	Unknown
LITTER SIZE	4, based on a single pregnant female
PUPPING/NURSERY GROUND	Possibly late summer; includes uThukela Banks
LENGTH AT BIRTH	65 cm
LENGTH AT MATURITY	F: ±180 cm; M: 155 cm
MAXIMUM LENGTH	F: 310 cm; M: 195 cm
GENERATION LENGTH	15 years

Mode
This species exhibits lecithotrophic viviparity in which embryos are dependent entirely on the nourishment supplied by the yolk-sac (Wallace, 1967b).

Duration of reproductive cycle
This is unknown

Mating season and location
This is unknown; although most of the shark net catches were large enough to be mature, none of the individuals examined in the laboratory were found to be in mating condition, pregnant or post partum (Daly *et al.* 2020).

Gestation
This is unknown.

Litter size
A single pregnant female was recorded in KZN in March, with four embryos, the largest of which was 55 cm (Wallace, 1967b).

Length at birth
This is about 65 cm, based on an individual of 67 cm with a conspicuous nidamental scar (Wallace, 1967b).

Pupping season and nursery ground
Pupping is possibly in late summer to early autumn, but this requires confirmation. Neonates were captured in the now-closed KZN prawn trawl fishery on the uThukela Banks, indicating that this area is a nursery ground (Fennessy 1994).

Length at maturity
The smallest mature female examined from KZN was 177 cm and the smallest male 156 cm (Wallace, 1967b).

Maximum length
The largest female from KZN was 310 cm and female 195 cm (Daly *et al*. 2020).

Age and growth

Age at maturity is estimated at 2–3 years for females and 1–2 years for males (van der Elst 1993), but these ages need verification (Dunlop and Mann 2013c). These ages appear to be too young for a species with a generation length of 15 years. Growth data from tag and recapture measurements showed that smaller individuals had a substantially faster growth rate of about 20 cm $year^{-1}$ which slowed considerably around the onset of maturity to about 6 cm $year^{-1}$ (Gareth Jordaan, Oceanographic Research Institute, unpublished data)

Generation length
This is estimated at 15 years (Kyne *et al.* 2019c).

FISHERIES MANAGEMENT

SA catch sources
Estimated total catch was <1 ton per annum (DFFE records: 2010–2012; da Silva *et al.* 2015), which comprised the now-closed KZN prawn trawl fishery, the KZN bather protection nets and the KZN recreational shore angling fishery.

SA catch quantities and characteristics

KZN prawn trawl fishery
This species was a not uncommon bycatch in the KZN prawn trawl industry on the uThukela Banks (Fennessy 1994). The size range was 0.5–2.0 m, with a mean of 0.9 m, which encompassed both neonates and adults. Based on the observer-recorded catches, the extrapolated average annual catch between 1989 and 1992 was 162 (range 123–231). Survival of this bycatch species was around 80%, based on a subsample of only 11 individuals. This fishery was dormant for nearly two decades due to the extended closure of the mouth of Lake St Lucia, resulting in poor prawn recruitment and diminishing prawn catches on the uThukela Banks. The fishing grounds were closed to trawling following the declaration of the uThukela MPA in August 2019.

KZN bather protection nets
From 1981 to 2017, a mean annual catch of 77 individuals (range: 5 (2017)–220 (1985) *R.djiddensis* were caught in the KZN bather protection nets (Daly *et al.* 2020). Of these, 72% were found alive and released. The net catches typically consisted of large individuals with a peak KDE probability density of 186 cm, with very few neonates or juveniles smaller than 100 cm. Median lengths were 172 cm and 191 cm for males and females, respectively, with no evidence of any change in size of either sex over time. There were significantly more females (1.8:1). Both sexes showed a distinctive seasonal pattern, with the highest catches in the summer months and lowest catches from July to September, which coincided with the coolest water temperatures. Females were most common in January, while the male catch peaked in March.

Recreational shore angling
Between 1977 and 2017 competition shore anglers captured 7 703 individuals (188 per annum*)* between the Mbashe River and the Mozambique border (Daly *et al.* 2020). There was a significant increase in size over this period, from 125 cm (1977–1998), peaking at 183 cm in 2006. Thereafter it fluctuated between 140 cm and 177 cm. Initially the adults constituted less than 10% of the catch, peaking at 65% in 2006, followed by a decline with high inter-annual variability. Catches peaked in austral summer months (October to May) and were lowest during winter (June to September). This species was not recorded in the catches of competitive shore anglers from the Border region (Kei River to Fish River; immediately south of Wild Coast (Pradervand and Govender 2003), which is indicative of its tropical distribution.

Fishing outside South Africa
Globally as a group, wedgefishes are subject to intense fishing pressure in their coastal habitats. They are caught in industrial, artisanal, and subsistence fisheries using multiple fishing gears, including

gillnets, trawls, hook and line, trap, and seine nets. They are generally retained for their highly valued meat and fins. There are limited species-specific conservation or management measures in place. These include localized trawl bans, bans on finning and the establishment marine protected areas, although effective enforcement in some areas is problematic (Kyne *et al.* 2019b,c).

R. djiddensis is targeted throughout its range, with the exception of South Africa, and its distribution includes Iran which ranks among the top 20 shark fishing nations globally (Jabado 2018). This shallow-water coastal species is heavily exploited in a number of artisanal, subsistence and industrial fisheries in Mozambique. The small-scale fishing sector (artisanal and subsistence fishers) in Mozambique is also extensive along most of the coastline, and accounted for an estimated 75% of total annual fishery catches in the country over the past five decades, with *R. djiddensis* considered to contribute a significant annual catch to this sector (Doherty *et al*. 2015). Bottom set longlines also represent an important gear in coastal fisheries in southern Mozambique, including several coastal "shark fishing camps" and targeting of carcharhinid shark species and *Rhynchobatus* species which reportedly had a major impact on the *R. djiddensis* population in Inhambane Province in the early 2000s (Pierce *et al*. 2008). A report on Illegal, Unreported and Unregulated (IUU) fisheries in Mozambique noted a catch of 20–30 tons of *R. djiddensis*, from northern Mozambique in one vessel confiscated in 2004 (Anon 2008). This catch would equate to 400–500 individuals of 50 kg each.

Population trends

In the 2019 Red List assessment there were no wedgefish species-specific time-series data that could be used to calculate population reduction. This was due to a lack of species-specific reporting as well as taxonomic and identification issues, particularly around the whitespotted wedgefish/*R djiddensis* species-complex. As a result, in the Western Indian Overall, it was inferred that this species has undergone a >80% population reduction over the last three generations (45 years) and it was assessed as Critically Endangered on the IUCN Red List in 2018 (Kyne *et al.* 2019c).

Recent evidence from South Africa showed that there was a significant ($p < 0.05$) fourfold decline in annual CPUE in the KZN bather protection nets over a 37-year study period from around 4 individuals per km-net to less than 1 (Daly *et al*. 2020). The standardized annual CPUE from catches made in competitions by recreational shore anglers from KZN also exhibited an overall significant ($p < 0.05$) decline from 1977 to 2017. The modelled CPUE estimates were used to develop a species risk assessment and indicated a 65% decline in the population over a period of 40 years, which represents almost three generation lengths. This indicates that the sampled population of *R. djiddensis* in South Africa should be assessed as Endangered, according to the IUCN Red List using criterion A2b. Given the high release rates in these two fisheries, 72% from the bather protection nets and close to 100% by recreational shore anglers, the population decline on the east coast of South Africa cannot be attributed to these two fisheries alone (Daly *et al*. 2020).

ECOTOURISM

This species is an ecotourism species. It occurs in shallow waters in the iSimangaliso, Aliwal Shoal and Protea Banks MPAs, where scuba diving is extremely popular.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

As a species listed in CITES Appendix II, it may not be retained in the pelagic and demersal longline fisheries. There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)

This species is listed as Vulnerable.

Marine Protected Areas
This species will benefit from protection in all the nearshore MPAs in KZN, specifically the Protea Banks, uThukela and iSimangaliso MPAs where it is known to be relatively abundant. Additionally, the Ponta do Ouro Partial Marine Reserve in southern Mozambique is a key MPA for the species that provides protection from nearby (Maputo-based) fisheries and acts as an important buffer for wedgefish that occur in neighbouring South Africa.

Additional local comment
This species will benefit from the ban on any demersal shark longlining east of the Kei mouth (this excludes the entire KZN and Wild Coast), which usually occurs at depths of 50–100 m.

IUCN Red List Status
Critically Endangered 2018: A2bd

Previous IUCN assessments
Vulnerable 2006

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species, along with all other members of the family Rhinidae, was included in Appendix II in 2019.

Convention on Migratory Species (CMS)
This species, along with two conspecifics, *R. australiae* and *R. laevis*, is listed in Annex 1 of the Memorandum of Understanding on the Conservation of Migratory Sharks (Sharks MOU). This annex consists of species that have an unfavourable conservation status and would significantly benefit from collaborative international conservation action.

MANAGEMENT CONSIDERATIONS
This species was caught in South Africa as a bycatch in the uThukela Banks prawn trawl industry and is still caught in the KZN bather protection nets. The closure of the uThukela Banks prawn trawl industry eliminated a major source of mortality, especially for the neonates, which utilise this region as a nursery area, the only known one on the east coast of South Africa. The widespread reduction in KZN bather protection effort and the shift away from nets to more selective drumlines has contributed to a marked reduction in catches. This, together with a survival rate of over 70% and a mandate to release all live *R. djiddensis*, means that potential impact on stocks is greatly reduced. Although prized and targeted by more skilful recreational shore anglers for its fighting qualities, all such catches are generally released alive and a very high survival rate is expected. As a result, current mortalities in these South African fisheries are likely to be low, but this is not the case for individuals moving into Mozambican waters.

Given its tropical distribution, the two northernmost MPAs on the east coast provide protection to this species. The waters within the iSimangaliso Wetland Park may serve as either a mating ground or a nursery area. Despite the presence of a known nursery ground on the uThukela Banks and the low levels of fishing-induced mortality in South Africa, the sharp declines in catch rates reported by Daly *et al.* (2020) strongly suggest that a large number of inviduals must move northwards and enter Mozambican waters where they are vulnerable to the diverse fisheries there. It is essential to ensure that this species does not become a target in any new demersal commercial fisheries inshore along the east coast of South Africa.

Like all other wedgefishes, this species is heavily targeted for its highly prized fins, as well as its meat. Decommercialisation of this species will eliminate any incentive to retain any line-caught individuals. Demand, particularly in poor countries such as Mozambique, is only likely to intensify, therefore it is difficult to envisage that this species will recover, despite the protection and lack of exploitation afforded it in South Africa, which lies at the southern extremity of its regional distribution. Furthermore, this species favours shallow, inshore-soft-bottom habitats, which are extremely vulnerable to either loss or degradation, through activities such as harbour development and coastal land reclamation, which have occurred in many parts of its Indian Ocean range.

While the global assessment of this species was one of Critically Endangered, the South African risk assessment showed a 65% decline in abundance over a period of three generation lengths, which indicates that the sampled population of *R. djiddensis* in South Africa should be classified as Endangered according to the IUCN Red List using criterion A2b (Daly *et al*. 2020). This difference highlights the merits of localised Red List assessments in comparison to global ones.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

Taxonomic clarity is needed on other potentially co-occuring *Rhynchobatus* species. Very little is known of the reproductive biology of this species. No validated ageing studies have been undertaken to ascertain growth rates and longevity. There is a need to understand the locations and movements of the most vulnerable components of the regional population, such as the reproductively active individuals and neonates, especially if some of these activities take place in the extreme northern waters of South Africa and overlap into Mozambican waters. It is essential to determine the geographic boundaries of the southern African or SW Indian Ocean population, which undoubtedly includes Mozambique. Tissue samples are available from individuals caught in the bather protection nets for comparison with individuals caught in countries to the north.

FAMILY RHINOBATIDAE

Acroteriobatus annulatus

SCIENTIFIC NAME	*Acroteriobatus annulatus* (Müller and Henle 1841)
COMMON NAME	Lesser guitarfish
FAMILY	Rhinobatidae
ENDEMIC	No, currently regarded as a southern African endemic
SIZE RANGE	20–140 cm TL
SA DISTRIBUTION	E, S, W coasts: central KZN to Langebaan (possibly into Namibia)
HABITAT	Demersal on sand bottoms
DEPTH RANGE	0–100 m, but most abundant 0–70 m
MAJOR FISHERIES	Inshore demersal trawl fishery, recreational shore angling and gill and beach seine net fisheries
IUCN STATUS	Vulnerable 2019
CITES	Not listed
MLRA	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	C Elston and PD Cowley

SPECIES SUMMARY and RECOMMENDATIONS

Acroteriobatus annulatus is a small, demersal species inhabiting shallow inshore waters along almost the entire South African coast. Its range reportedly extends into Namibia, but this may be due to misidentification, and therefore this regional endemic may turn out to be a South African endemic. It is by far the most common of the six species of guitarfish in the family Rhinobatidae in South Africa, but there are major problems of misidentification within this family. Estimated total annal catch was 11-100 tons (DFFE records: 2010–2012), which was almost exclusively in the inshore demersal trawl fishery, with annual catches in the region of 18 tons, almost all of which was discarded. There is a far smaller catch in the recreational shore-based linefishery and gill and beach seine net fisheries, most of which are returned to the water. This species was assessed as Vulnerable on the IUCN Red List in 2020, with fishing, largely the demersal trawl and recreational linefisheries, being the greatest threat. It is fast growing and matures within three years. As this species is largely taken as bycatch, a focus should be ensuring high survival rates of catches released from the inshore trawl industry. Identification challenges remain.

TAXONOMIC and IDENTIFICATION ISSUES

Acroteriobatus annulatus is one of four species in this genus occurring in South Africa. Previously the genus was known as *Rhinobatus* but, after revision in 2016, the former subgenus *Acroteriobatus* was elevated to generic status. There are also two guitarfish of the genus *Rhinobatus* in South Africa. *A. annulatus* is frequently misidentified with other South African guitarfish species, especially *A. blochii*, and *A. leucospilus*, *A. ocellatus*, and, more recently, *R. austini*, which occurs only in KZN on the east coast (Ebert and Gon 2017). A study of the diet of *A. annulatus* from the Langebaan lagoon in 1988 (Harris *et al*. 1988) was most likely *A. blochii* (Attwood and Mann 2013).

SOUTH AFRICAN DISTRIBUTION

This species occurs along most of the South African coast from at least Langebaan Lagoon on the west coast, where it is common, to central KZN on the east coast (Ebert *et al.* 2021). Compagno *et al.* (1989) described this species as occurring in Namibia and Burgess *et al.* (2016) included southern Angola but Ebert *et al.* (2021) state that these records may be *A. blochii* and therefore require confirmation. It is therefore possible that *A. annulatus* may be a South African endemic. It was thought there may be two separate stocks, one on the west coast including Angola and Namibia and the other along the SE coast of South Africa. The latter population has been shown to have two different colour variants, with those in KZN having simple dark spots, while those in rest of South Africa have brown spots ringed with white (Compagno *et al*. 1989). Ebert *et al.* (2021) stated that the Natal colour variant is *Rhinobatos austini.*

REGIONAL DISTRIBUTION
The presence of this species in southern Angola and Namibia requires confirmation (Ebert *et al.* 2021).

SYNOPSIS OF RESEARCH
In the scientific study of batoid fishes of the east coast of Southern Africa, 139 individuals were examined, but primarily for their morphometrics and taxonomy; a very short section of biological comments was included (Wallace 1967b). It is possible that some specimens may have included the recently described *R. austini.* The life history and reproductive biology of *A. annulatus* has been studied in Algoa Bay (Rossouw 1983a, 1983b, 1984). Attwood and Mann (2013) provided an overview of the life history and fisheries details of this species. The population genetics of this species has been investigated, with implications for regional fisheries and conservation (Bitalo 2016).

ECOLOGY
Depth
This demersal species occurs in coastal waters from close inshore, including the surf zone, estuaries and embayments to depths of 100 m, but is usually most abundant in water shallower than 70 m (Buxton *et al.* 1984).

Habitat: Adults
The adults inhabit sandy habitats in shallow coastal waters.

Habitat: Juveniles/Nursery Grounds
Inshore sandy habitats are used as nursery areas, where the young remain for at least one year (Rossouw 1983a, 1983b).

Synopsis of tag deployments
A total of 6483 individuals were tagged (ORI Cooperative Fish Tagging Project 1984-2018 inclusive) with 73 (1%) recaptures. Mean distance travelled was 44 km; mean time at liberty 0.9 years (max: 726 km and 7.0 years) (Jordaan *et al*. 2020).

Movements
Movements are not clearly understood. From the ORI Tagging Project there is evidence of a longshore movement of up to 726 km, but this must be tempered by the fact that in the early part of this project plastic disc tags were used. They were inserted into the dorsal fin and occasionally tore out, with the tag potentially floating a considerable distance before it washed ashore. It is therefore possible that the mean distance travelled of 44 km, as reported by Jordaan *et al*. (2020) may have been too high. There is also possible inshore-offshore movement. This species is common in the surf-zone of sandy beaches in Algoa Bay during summer, but not in winter (Rossouw 1983b), when they are assumed to move offshore.

Diet/feeding: adults
The diet comprises infaunal invertebrates such as swimming crabs, mole crabs, small fishes, polychaete annelid worms, amphipods, and isopods (Burgess *et al.* 2016). In Algoa Bay the primary prey items are the mysids, *Gastrosaccus psammodytes*, *Mesopodopsis slabberi* and the sand mussel, *Donax serra* (Rossouw 1983b).

Diet/feeding: juveniles
The diet is possibly similar to that of adults.

South African toxicological studies
No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Lecithotrophic viviparity
DURATION OF REPRO CYCLE	Annual
MATING SEASON	May-June
GESTATION	10 months
LITTER SIZE	2–10, mean of 5
PUPPING/NURSERY GROUND	Late summer (March-April) in shallows
LENGTH AT BIRTH	20–25 cm
LENGTH AT MATURITY	F: 61–65 cm; M: 58 cm (50% maturity)
MAXIMUM LENGTH	140 cm
GENERATION LENGTH	5 (4.76) years

Mode
This species exhibits lecithotrophic viviparity in which the embryo is dependent entirely on nourishment provided by the yolk-sac.

Duration of reproductive cycle
This is 1 year (Rossouw 1983a).

Mating season and location
Mating takes place from April to June in shallow inshore waters off sandy beaches (Rossouw 1983a).

Gestation
There is a 10-month gestation (Rossouw 1983a).

Litter size
This is 2–10, with a mean of 5 (Rossouw 1983a).

Length at birth
This is 20–25 cm (van der Elst 1993).

Pupping season and nursery ground
Pupping takes place in late summer (March–April) in shallow inshore waters off sandy beaches, where the young remain for at least one year (Rossouw 1983a).

Length at maturity
Males mature at 58 cm and females at 61–65 cm (Rossouw 1983a).

Maximum length
Maximum length for both males and females is listed as 140 cm, but individuals over 120 cm are rare (Attwood and Mann 2013).

Age and growth
Both males and females mature at 2–3 years, with maximum age of 7 years (Rossouw 1984).

Generation length
Generation length is 5 (4.76) years (Rossouw 1984).

FISHERIES MANAGEMENT
SA catch sources
Estimated total annual catch was 11-100 tons (DFFE records: 2010–2012; da Silva *et al.* 2015), which comprised almost exclusively bycatch in the inshore demersal trawl fishery. It was caught in the now closed KZN prawn trawl fishery, the recreational linefishery and gill and beach seine fisheries. It was listed as possibly occurring in the commercial linefishery and the hake longline fishery.

SA catch quantities and characteristics
Inshore trawl fishery
Approximately 18 tons was taken annually as bycatch in the inshore trawl grounds (2003–2006), most of which is discarded (Attwood *et al*. 2011). No assessment of survival rates appears to have been undertaken. Assuming a mean weight of 2 kg, this represents an annual catch of 900 individuals.

KZN prawn trawl industry
This species was a bycatch in the KZN prawn trawl industry on the uThukela Banks (Fennessy 1994). The size range was 0.3–0.6 m, with a mean of 0.6 m, which comprises largely immature individuals, including neonates. Based on observer-recorded catches, the extrapolated average annual catch between 1989 and 1992 was 108 (range 82–154). Survival of this bycatch species was around 90%, based on a subsample of only 9 individuals. This fishery was dormant for nearly two decades due to the extended closure of the mouth of Lake St Lucia, resulting in poor prawn recruitment and diminishing prawn catches on the uThukela Banks. The fishing grounds have been closed to trawling since the declaration of the uThukela MPA in August 2019.

Recreational shore angling
Shore anglers often catch this species. In most cases, the catch is released, especially by members of angling clubs. In some cases, an individual will be discarded on the shore and not returned alive to the water because it poses a nuisance. Drone anglers will use this and other small elasmobranch species as live bait for large sharks. In the KZN competitive shore fishery it was the third most common chondrichthyan, with a mean annual catch of 438 individuals and a mean weight of 1.3 kg. There was a non-significant increase in CPUE over the 24-year sampling period (1978–2001), during which there was a fishing effort of nearly 947 000 fishing hours (Pradervand *et al*. 2007). On the Wild Coast (northernmost section of the Eastern Cape) the mean annual catch was 98, with a mean weight of 2.2 kg. It was also the most common chondrichthyan caught and catch rates showed a slight decreasing trend (Pradervand 2004). In the Border (region immediately south the Wild Coast) competitive shore fishery the mean annual catch was 404, with a mean mass of 2.9 kg and a slight decreasing trend in CPUE (Pradervand and Govender 2003). In the Goukamma MPA on the south coast the mean annual catch was 15, with a mean weight of 2.3 kg, where it was also the most common chondrichthyan caught (Pradervand and Hiseman 2006).

Beach seine and gill net fisheries
This species was the most common chondrichthyan bycatch in the beach seine fishery in False Bay, with a total catch of 4607 in 311 hauls over 2 years (1991–1992), a frequency of occurrence of 73% and a mean catch per haul of 15 individuals (Lamberth *et al.* 1994). This species was caught throughout the year but with a strong peak in December and January (Lamberth 2006). The size range was 15–95 cm, with 89% regarded as immature, based on length at maturity of 70 cm. Most individuals were returned alive to the water. This species was caught in far smaller numbers in beach seine nets elsewhere in the Southwestern Cape (Hutchings and Lamberth 2002). All these seine netting operations target harder *Liza richardsoni* (teleost) and St Joseph *Callorhinchus capensis*. Some of the beach-seine permit-holders in the SW Cape reported catching up to 10 tons of this species annually

but this was regarded as highly unusual (Hutchings and Lamberth 2002). Bycatch of *A. annulatus* in the gillnet fishery targeting *C. capensis* on the west coast around St Helena Bay appeared to be negligible and the individuals caught were reportedly released alive (Freer and Griffiths 1993, Hutchings and Lamberth 2002); this catch may have comprised or included *R. blochii* as a result of misidentification.

Fishing outside South Africa

Many parts of the Namibian coast are remote with very little fishing pressure (Belhabib *et al.* 2015, cited by Pollom *et al.* 2020j). As a result, if this species does occur there, fishing pressure will be low.

Population trends

There are no estimates of population size for this species, although it is abundant where it occurs and is caught in large numbers in several fisheries. Significant genetic differentiation was observed over a small sampling range on the southeast coast, implying that the species might be highly structured throughout its geographical range. Overall, its effective population size was very low, which was not in accordance with its supposed high levels of abundance (Bitalo 2016). This is in line with the findings of extremely low genetic diversity estimates (Michaela van Staden, Stellenbosch University, unpubl. data).

Demersal research trawl surveys were conducted over 26 years (1991–2016) in fished areas of South Africa during autumn and spring along the south coast (DFFE, unpubl. data, 2018). The analysis revealed an annual rate of reduction of 7.5% over the trawled areas, consistent with a median reduction of 43.9% over three past generation lengths (15 years), with the highest probability (40.0%) of 50–79% reduction over three generation lengths. As a result, this species was assessed as Vulnerable in 2019. The estimated reduction was driven partly by a steep decline in catch rates during the early 1990s when fishing pressure in South Africa was substantially higher. Over the last two decades the population reduction has been less dramatic (Pollom *et al.* 2020j). Some reduction is possibly a result of a climate-driven northeast range shift of the species away from the core offshore trawl survey area into less-surveyed inshore habitats (Currie *et al.* 2019). The northeast range shift also likely represents a significant range contraction.

Research shore angling surveys (DFFE, unpubl. data, 2018) were undertaken in the De Hoop MPA over the period 1997–2017. The abundance of *A. annulatus* fluctuated considerably over this 21-year period. The trend analysis revealed an annual rate of increase of 1.2%, consistent with a median increase of 14.2% over three past generation lengths (15 years), with the highest probability (98.4%) of an increase over three generation lengths. The De Hoop MPA was established in 1985 and is a no-take reserve, and while this may not be representative of the population trends in fished areas of South Africa, the population increase may be a reflection of the inshore range shift of the species (Pollom *et al.* 2020j).

Overall, due to an estimated population reduction over most of its range and a substantial reduction in fishing effort in South Africa, combined with a suspected range shift due to climate change that could account for some of the estimated reduction but also likely represents a decline in area of occupancy, it is suspected that *A. annulatus* has undergone a population reduction of 30–49% over the past three generation lengths (15 years), and it was assessed as Vulnerable on the IUCN Red List in 2019 (Pollom *et al.* 2020j).

ECOTOURISM

This species is rarely seen by scuba divers and therefore cannot regarded as an ecotourism species.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

There is a daily bag limit of one individual in the recreational line fishery. There is a ban on the take of any elasmobranchs in the Breede River Estuary.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
This species will benefit from all the coastal MPAs along the South African coast. As this species appears to reproduce wherever it occurs, there is no evidence that any particular protected area is more important than others in protecting the sensitive sectors of the population. The recently proclaimed 1200 km^2 Addo Elephant National Park MPA in Algoa Bay will afford protection to the local population as this MPA includes a long stretch of sandy beach habitat.

Additional local comment
The ban on any demersal shark longlining east of the Kei mouth, which generally occurs at depths of 50–100 m (da Silva *et al*. 2015) will benefit this species. This species will benefit from the long-standing ban on trawling in False Bay.

IUCN Red List Status
<u>Vulnerable 2020: A2bcd</u>

Previous IUCN assessments
Least Concern 2016
Least Concern 2006

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

International comments
This is still some doubt as to whether this species occurs in Namibia and it is likely that it is a South African endemic (Ebert *et al.* 2021).

MANAGEMENT CONSIDERATIONS
In view of its recent upgrade to Vulnerable, careful monitoring of bycatch levels and their associated survival in the inshore trawl and commercial beach seine fisheries is required. The fact that almost all of the annual catch of 18 tons in the inshore demersal trawl fishery was discarded, with no knowledge of survival rates, is the most pressing management concern. There are two issues associated with the shore-based recreational fishery. Post-release mortality may be high, due to poor handling practices and there is increasing use of this and other small shark and ray species by drone anglers targeting larger sharks. The ongoing identification challenges need to be overcome to ensure sound management of this species. With the potential expansion of shark fisheries, this species could become increasingly important as fins from guitarfishes as whole command high prices in Asia. *A. annulatus* favours shallow, inshore-soft-bottom habitats, which are extremely vulnerable to either loss or degradation, through activities such as harbour development and coastal land reclamation.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
Clarification is required in terms of spatial delineation between *R. blochii* and *R. annulatus.* The apparent existence of two separate stocks in South Africa (east and south coasts vs west coast)

requires investigation. A detailed analysis of the tag-recapture data may shed insight into longshore movements and possible residence patterns. However, due to high tag shedding rates, longshore movement patterns inferred from acoustic telemetry are recommended. Further research is needed on population size and trends, and life history, and catch rates should be monitored.

Acroteriobatus leucospilus

SCIENTIFIC NAME	*Acroteriobatus leucospilus* (Norman 1926)
COMMON NAME	Greyspot guitarfish
FAMILY	Rhinobatidae
ENDEMIC	No, SW Indian Ocean
SIZE RANGE	25–120 cm TL
SA DISTRIBUTION	E coast only: Mozambique border to Kei River mouth
HABITAT	Demersal on sandy bottoms
DEPTH RANGE	0–100 m, but most abundant 0–40 m
MAJOR FISHERIES	KZN prawn trawl fishery, recreational shore angling and possibly other trawl fisheries
IUCN STATUS	Endangered 2018
CITES	Not listed
MLRA	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	GL Jordaan

SPECIES SUMMARY and RECOMMENDATIONS

Acroteriobatus leucospilus is a small, demersal species occurring in the shallow, coastal waters of the SW Indian Ocean. It is one of six species of guitarfish in South Africa, where it is confined to the east coast, which represents the southern limit of its range. Estimated annual total catch was <1 ton (DFFE records: 2010–2012), which historically comprised largely bycatch from the now-closed KZN prawn trawl fishery, with a small component caught in the KZN recreational shore angling fishery. It was assessed globally as Endangered on the IUCN Red List in 2018; this was a regional assessment as it only occurs in the SW Indian Ocean, with fishing being the greatest threat. It is conceivable that this small but little studied species is able to complete its entire life cycle within South African waters. The extent of trans-boundary movements between South Africa and Mozambique is unknown and a regional genetic study should be undertaken. Any specimens caught that cannot be released should be retained for life history studies and samples kept for genetic and other studies.

TAXONOMIC and IDENTIFICATION ISSUES

Acroteriobatus leucospilus is one of four species in this genus occurring in South Africa. Previously, the genus was known as *Rhinobatus/Rhinobatos* but, after revision in 2016, the former subgenus *Acroteriobatus* was elevated to generic status. There are also two guitarfish of the genus *Rhinobatos* in South Africa. Although *A. leucospilus* is relatively easy to identify and distinguish from other guitarfish species by the presence of characteristic blue-grey spots and blotches on the snout, pectoral and pelvic fins, this species is often mistaken for the more common lesser guitarfish *A. annulatus* and the only recently recognised *R. austini*, due to similarities in size and appearance and overlapping ranges (Ebert *et al.* 2021).

SOUTH AFRICAN DISTRIBUTION

It only occurs along much of the east coast, from the Mozambique border to the Kei River mouth (Ebert *et al.* 2021).

REGIONAL DISTRIBUTION

It is confined to the SW Indian Ocean, where it also occurs in Mozambique; records from Madagascar are another species (Ebert *et al.* 2021).

SYNOPSIS OF RESEARCH

There is very little published information on the life history of this species in South Africa or elsewhere in its SW Indian Ocean range. In the scientific study of batoid fishes of the east coast of southern Africa, 39 individuals were examined, but primarily for their morphometrics and taxonomy; a very short section of biological comments was included (Wallace 1967b). No dedicated scientific study has been conducted on this species since then. More recent publications of research conducted elsewhere are cited by Pollom *et al.* (2019f).

ECOLOGY

Depth

This demersal species occurs in coastal and continental shelf waters from close inshore, including the surf zone, to depths of 100 m, but is usually most abundant in water shallower than 40 m (van der Elst 1993).

Habitat: Adults

The adults inhabit sandy bottoms in shallow, coastal, tropical and subtropical waters (van der Elst 1993).

Habitat: Juveniles/Nursery Grounds

This is possibly the same as the adults.

Synopsis of tag deployments

A total of 182 individuals have been tagged (ORI Cooperative Fish Tagging Project 1984-2018 inclusive) with a single recapture. This individual travelled 6 km in 51 days (Jordaan *et al*. 2020).

Movements

These are unknown, but the single tag-recapture suggests that it may be a seasonal resident.

Diet/feeding: adults

The diet comprises benthic molluscs, crustaceans and small fish (van der Elst 1993).

Diet/feeding: juveniles

The diet is thought to be similar to that of adults.

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Lecithotrophic viviparity
DURATION OF REPRO CYCLE	Unknown
MATING SEASON	Unknown
GESTATION	Unknown
LITTER SIZE	2-9
PUPPING/NURSERY GROUND	uThukela Banks
LENGTH AT BIRTH	25 cm
LENGTH AT MATURITY	F: 55 cm; M: 55 cm
MAXIMUM LENGTH	F: 120 cm; M: 120 cm
GENERATION LENGTH	Possibly 5 years

Mode

This species exhibits lecithotrophic viviparity in which the embryo is dependent entirely on nourishment provided by the yolk-sac.

Duration of reproductive cycle
This is unknown

Mating season and location
This is unknown

Gestation
This is unknown.

Litter size
This is 2–9 (van der Elst 1993, Last *et al.* 2016).

Size at birth
This is 25 cm (van der Elst 1993).

Pupping season and nursery ground
Unknown; pregnant females have been recorded between November and May on the uThukela Banks and neonates of 0.2 m have been caught there, indicating that it is a nursery ground (Wallace 1967b, van der Elst 1993, Fennessy 1994).

Length at maturity
Males and females appear to mature at 55 cm (Last *et al.* 2016).

Maximum length
Maximum size for both males and females appears to be 120 cm (Last *et al.* 2016).

Age and growth
Age and growth data are not available for this species.

Generation length
In the absence of age and growth data for this species, generation length is likely similar to that of the closely-related and similarly-sized lesser guitarfish *Acroteriobatus annulatus* at five years (Rossouw 1984).

FISHERIES MANAGEMENT
SA catch sources
Estimated total annual catch was <1 ton (DFFE records: 2010–2012; da Siva *et al.* 2015), which comprised largely bycatch from the now-closed KZN prawn trawl fishery, with a small component caught in the KZN recreational shore angling fishery. It is listed as possibly occurring in the demersal trawl and hake longline fisheries but both these fisheries occur outside (south and west) of its distribution.

SA catch quantities and characteristics
KZN prawn trawl industry
This species was the most common guitarfish caught in the KZN prawn trawl industry on the uThukela Banks, with 23 individuals found in 169 trawls between 1989 and 1992 (Fennessy 1994). They were 0.2-0.5 m long, with a mean of 0.4 m and included neonates, indicating that this area is a nursery ground. Based on the observer-recorded catches, the extrapolated average annual catch between 1989 and 1992 was 269 (range 204-385). Survival of this bycatch species was around 50%, based on a subsample of 19 from 100 trawls. This fishery was dormant for nearly two decades due to the extended closure of the mouth of Lake St Lucia, resulting in poor prawn recruitment and diminishing prawn catches on the uThukela Banks. The fishing grounds were closed to trawling following the declaration of the uThukela MPA in August 2019.

Recreational shore angling
This species is caught in small numbers by shore anglers and comparative catch figures are available for three regions along the east coast of South Africa. In KZN, competitive shore anglers caught 339 *A. leucospilus* over a 24-year period (1977-2000), at an annual rate of 14, with a mean individual mass of 3 kg and comprising 0.2% of the total number of fish caught (Pradervand *et al.* 2007). On the adjacent Wild Coast to the south over a similar period, competitive shore anglers caught only 16 individuals at an annual rate of <1, with a mean mass of 3 kg (Pradervand 2004). This species was not recorded in the catches of competitive shore anglers in the Border region (Kei River to Fish River; immediately south of Wild Coast) (Pradervand and Govender 2003), which is indicative of its tropical distribution. Catches by non-competition shore anglers are likely to be low and individuals are generally returned to the water alive, but this species and other guitarfishes may be regarded as a nuisance by certain sectors of the angling community and discarded rather than returned alive to the water (Dunlop 2011).

Fishing outside South Africa
This species is captured by industrial trawl and gillnet fisheries as well as artisanal fisheries throughout its E African range. As a family, the guitarfishes are known to be susceptible to population depletion as a result of their limiting life-history characteristics and their presence in shallow coastal waters where they are easily accessed by all sectors of the fishing industry. They are often targeted for the high value of their fins (Pollom *et al.* 2019f).

Population trends
There are no population size estimates for this species. The presence of any population structure in the SW Indian Ocean has not been investigated. Heavy artisanal fishing pressure occurs throughout much of its range. Although it derives refuge from heavy fishing pressure in South Africa, it is suspected that *A. leucospilus* has undergone a population reduction of at least 50% over the past three generations (15 years) due to the levels of exploitation across most of its range. Therefore, it was assessed globally as Endangered on the IUCN Red List in 2018 (Pollom *et al.* 2019f).

ECOTOURISM
This species is seldom seen by scuba divers and therefore cannot regarded as an ecotourism species.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
This species will benefit considerably from the uThukela Banks MPA as this area is a known nursery ground, and the iSimangaliso MPA, which spans a coastline of 220 km and is situated in the far northeast of South Africa. This species is also likely to benefit from the other inshore MPAs in KZN.

Additional local comment
This species will derive benefit from the ban on any demersal shark longlining east of the Kei mouth.

IUCN Red List Status
Endangered 2018: A2d

Previous IUCN assessments
Data Deficient 2016

Data Deficient 2009

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

International comments
Like all other guitarfishes and wedgefishes, this species is retained for its highly prized fins, as well as its meat, elsewhere in its range. Such demands, particularly in poor countries such as Mozambique, are only likely to intensify, therefore it is difficult to envisage that this species will recover, despite the protection and lack of exploitation afforded it in South Africa, especially if there is very limited long distance/trans-border movement of individuals. Furthermore, this species favours shallow, inshore-soft-bottom habitats, which are extremely vulnerable to either loss or degradation, through activities such as harbour development and coastal land reclamation, which have also occurred in many other parts of its range.

MANAGEMENT CONSIDERATIONS
This species was taken as a bycatch in the uThukela Banks prawn trawl industry. The dormancy and then recent closure of this fishery has eliminated a major source of mortality. It will derive considerable protection from the uThukela Banks MPA, a known nursery ground, and from the far larger iSimangaliso MPA to the north. It is conceivable that this small but little studied species is able to complete its entire life cycle within South African waters, where fishing pressure is far lower than in Mozambique. This will have positive ramifications for its conservation status. The extent of trans-boundary movements between South Africa and Mozambique is unknown and a regional genetic study should be undertaken. If there is evidence of some genetic structure then a South African Red List assessment should be undertaken. It is essential to ensure that *A. leucospilus* is protected from exploitation, which could easily be achieved in the form of decommercialisation, whereby it may not be sold or traded.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
This is a poorly-studied species with very little known of its reproductive biology and ecology and nothing about its age and growth. The uThukela Banks is an important habitat, especially for pregnant females and neonates. Nothing is known of its movements, especially across international boundaries, but, being a small species, it is possible that animals born on the uThukela Banks may not leave South African waters. Tracking and genetic studies would address this. Any specimens caught that cannot be released should be retained for life history studies and samples kept for genetic and other studies. No ageing studies have been undertaken to ascertain growth rates and longevity. A collaborative effort to gather genetic and biological samples among neighbouring countries would be benefical.

FAMILY RAJIDAE

Leucoraja compagnoi

SCIENTIFIC NAME	*Leucoraja compagnoi* (Stehmann 1995)
COMMON NAME	Tigertail skate
FAMILY	Rajidae
ENDEMIC	Yes
SIZE RANGE	<14– >52 cm TL
DISTRIBUTION	E, S, W coasts: central KZN to Strandfontein
HABITAT	Unknown
DEPTH RANGE	480–625 m
MAJOR FISHERIES	None listed
IUCN STATUS	Data Deficient 2018
CITES	Not listed
MLRA	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	DA Ebert

SPECIES SUMMARY and RECOMMENDATIONS

Leucoraja compagnoi is a very small, endemic skate found on the continental slope along much of the South African coast. There were no reported local catches (DFFE records: 2010-2012). It is only known from about a dozen immature individuals from a handful of locations and was assessed as Data Deficient on the IUCN Red List in 2018. Its scarcity makes is difficult to formulate any management recommendations. Nothing is known of its life history and ecology.

TAXONOMIC and IDENTIFICATION ISSUES

The genus *Leucoraja* currently comprises 14 species, with a few more known but still undescribed species. Two species occur in southern Africa (Ebert and Mostardo 2013). *Leucoraja compagnoi* was described in 1995 from a specimen caught by a Russian research trawler on the west coast near Strandfontein. It is only known from a handful of specimens and is easily confused with its more common congener *L. wallacei* (Ebert *et al.* 2021). The two species are separated by the number of tooth rows and the relative sizes of the anterior and posterior pelvic fin lobes (Ebert and Mostardo 2013). The leading edge of the disc in *L. compagnoi* is relatively straight, with a slight bulge near the snout; in *L. wallacei* the leading edge of the disc has a marked bulge from the snout tip past the eyes, resulting in a unique and highly distinctive disc shape. The dark bands on the tail of *L. compagnoi* are also distinctive (Rob Leslie DFFE, pers. comm.).

SOUTH AFRICAN DISTRIBUTION

The South African distribution is based on about a dozen records. It has been found in a single location on both the east coast (central KZN) and on the south coast just south of Cape Recife. It has been recorded from four locations on the west coast close to the Orange River mouth (near Strandfontein) (Compagno and Ebert 2007).

REGIONAL DISTRIBUTION

L. compagnoi is a South African endemic (Ebert *et al.* 2021).

SYNOPSIS OF RESEARCH

Very little additional information is available on this apparently scarce species which was only described in 1995 after collection of a single specimen by a Soviet research vessel. Subsequently 10 other specimens, all immature, were caught in research trawls at three widely spaced locations (Compagno and Ebert 2007, Ebert *et al.* 2008).

ECOLOGY

Depth

This species inhabits the continental slope at depths of 480–625 m (Compagno and Ebert 2007**)**.

Habitat: Adults

Nothing is known of their habitat as no adults have been captured.

Habitat: Juveniles/Nursery Grounds

They inhabit soft bottoms on the continental slope.

Synopsis of tag deployments

No tagging has taken place in South Africa.

Movements

Nothing is known.

Diet/feeding: adults

Nothing is known.

Diet/feeding: juveniles

Nothing is known.

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Oviparity
DURATION OF REPRO CYCLE	Unknown
MATING SEASON	Unknown
GESTATION	Unknown
LITTER SIZE	Unknown
PUPPING/NURSERY GROUND	Unknown
LENGTH AT BIRTH	Unknown, < 14 cm
LENGTH AT MATURITY	Unknown
MAXIMUM LENGTH	At least 52 cm
GENERATION LENGTH	Unknown

Mode

Oviparity is assumed as this is the known reproductive mode of all skates. No egg cases have been found.

Duration of reproductive cycle

No pregnant females have been documented. The duration of the reproductive cycle is unknown.

Mating season and location

This is unknown.

Gestation

This is unknown.

Litter size
This is unknown.

Length at birth
Size at birth is unknown. The smallest specimen was 14 cm (Ebert *et al.* 2008).

Pupping season and nursery ground
This is unknown.

Length at maturity
This is unknown, as no mature individuals have been caught (Ebert *et al*. 2008).

Maximum length
This is unknown, as no mature individuals have been caught. The largest immature individual was 52 cm (Ebert *et al*. 2008).

Age and growth
This is unknown.

Generation length
This is unknown.

FISHERIES MANAGEMENT

SA catch sources, quantities and characteristics
No local catches were reported (DFFE records: 2010-2012; da Silva *et al*. 2015). This species is potentially caught in the deep-water hake trawl fishery (Pollom *et al.* 2019g).

Fishing outside South Africa
This species does not occur outside South Africa.

Population trends
Nothing is known and as a result it was assessed as Data Deficient on the IUCN Red List in 2018 (Pollom *et al.* 2019g).

ECOTOURISM
At it only occurs in very deep water, it cannot be regarded as an ecotourism species.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations
There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
Insufficient is known of the distribution of this species to ascertain which deep-water, if any, MPAs would provide protection to this species.

Additional local comment

IUCN Red List Status
Data Deficient 2018

Previous IUCN assessments
Data Deficient 2009

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

International comments

MANAGEMENT CONSIDERATIONS

This species is extremely scarce. This makes it difficult to formulate any management considerations and is likely to ensure that this species remains Data Deficient. Fisheries observers need to be made aware of the small differences between *L. compagnoi* and the far more common *L. wallacei.*

RESEARCH REQUIREMENTS AND OPPORTUNITIES

Nothing is known of this species, due to its apparent scacity. Any opportunistic sampling should be used to obtain life history information and tissue samples for genetic studies.

Leucoraja wallacei

SCIENTIFIC NAME	*Leucoraja wallacei* (Hulley 1970)
COMMON NAME	Yellowspotted skate
FAMILY	Rajidae
ENDEMIC	No, regional endemic also found in Mozambique and Namibia
SIZE RANGE	< 16–96 cm TL
DISTRIBUTION	E, S, W coasts: entire South African coast
HABITAT	Demersal on soft bottoms of outer shelf and upper slope
DEPTH RANGE	75–515 m, but most common at 150–300 cm
MAJOR FISHERIES	Demersal trawl fishery
IUCN STATUS	Vulnerable 2019
CITES	Not listed
MLRA	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	C da Silva and ST Fennessy

SPECIES SUMMARY and RECOMMENDATIONS

Leucoraja wallacei is a small skate found on the outer continental shelf and upper slope along the entire South African coast, but is most common on the south and west coasts. Local annual reported catch estimates were 11–100 tons (DFFE records: 2010-2012). This catch was predominantly in the demersal trawl fishery and the demersal shark longline fishery. Based on declines in research trawls, this species was assessed as Vulnerable on the IUCN Red List in 2019. It will benefit from protection in deep water MPAs on the south and west coast. Its diet, age and growth and reproductive biology have been studied, but female fecundity is unknown. Since the introduction of this species in identification guides, species-specific catches have been reported in logbooks. Another major step to improving accurate catch records would be the introduction of legislation that all skates must be landed whole; this would prohibit removal and retention of only the wings while discarding the trunk. As catches are relatively high, it is important to establish conversion ratios from dressed to total weight.

TAXONOMIC and IDENTIFICATION ISSUES

Leucoraja wallacei was originally assigned to the genus *Raja* (Hulley 1970). The genus *Leucoraja* currently comprises 14 species, with a few more known but undescribed species (Last *et al.* 2016). Two species occur in southern Africa, with *L. wallacei* far more abundant than *L. compagnoi* and one of the most common skate species off South Africa (Ebert *et al.* 2021). The two species are separated by the number of tooth rows and the relative sizes of the anterior and posterior pelvic fin lobes (Ebert 2014). In *L. wallacei* the leading edge of the disc has a marked bulge from the snout tip past the eyes, resulting in a unique and highly distinctive disc shape, whereas the leading edge of the disc in *L. compagnoi* is relatively straight, with a slight bulge near the snout (Rob Leslie DFFE, pers. comm).

SOUTH AFRICAN DISTRIBUTION

This species occurs along the entire South African coast but shows a distinctly bimodal geographic distribution off the west and southeast coasts, with most of the records concentrated in an area between the Orange River and Cape Columbine, and a second area between Cape Point and Cape Agulhas to Algoa Bay (Compagno and Ebert, 2007).

REGIONAL DISTRIBUTION

L. wallacei is a southern African endemic and is also found in southern Mozambique and southern Namibia (Ebert 2014).

SYNOPSIS OF RESEARCH

This species is one of the most common skates in South African waters. It has been relatively well studied. Distribution (Compagno and Ebert 2007), feeding ecology (Ebert *et al.* 1991; Smale and Cowley 1992, Walmsley-Hart *et al.* 1999) and life history (Ebert *et al.* 2008), including age and growth (Walmsley-Hart *et al.* 1999) have been investigated. Information on some aspects of reproduction is lacking.

ECOLOGY

Depth

This species inhabits the outer continental shelf and upper slope at depths of 75–515 m, with most records from 150–300 m (Smale and Cowley 1992, Compagno and Ebert 2007).

Habitat: Adults

It occurs on soft substrates (Last *et al.* 2016).

Habitat: Juveniles/Nursery Grounds

It is not known if juveniles utilise other habitats.

Synopsis of tag deployments

No tagging has taken place in South Africa.

Movements

Nothing is known.

Diet/feeding: adults

Teleosts and crustaceans were the most common prey groups, but teleosts which included *Gnathophis* eels and dragonets were more important in the larger size-group (> 35 cm) . There was an increase in prey size with increasing predator size (Smale and Cowley 1992).

Diet/feeding: juveniles

Crustaceans were major prey items of the small size-group (< 35 cm) and these included mysids and swimming prawns (Natantia) (Smale and Cowley 1992).

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Oviparity
DURATION OF REPRO CYCLE	Unknown
MATING SEASON	Unknown
GESTATION	Unknown
LITTER SIZE	Unknown
PUPPING/NURSERY GROUND	Possibly year round
LENGTH AT BIRTH	< 16 cm
LENGTH AT MATURITY	F: 67 cm, M: 66 cm (S coast); F: 80 cm, M: 77 cm (W coast)
MAXIMUM LENGTH	F: 70 cm, M: 78 cm (S coast); F: 96 cm, M: 87 cm (W coast)
GENERATION LENGTH	12 years

Mode

Oviparity is the known reproductive mode of all skates. Egg cases have been found (Warmsley-Hart *et al.* 1999, Ebert *et al.* 2007).

Duration of reproductive cycle
The duration of the reproductive cycle is unknown.

Mating season and location
This is unknown.

Gestation
This is unknown, but possibly year-round (see pupping season below)

Litter size
The number of egg cases laid is unknown (Pollom *et al.* 2020k).

Length at birth
Size at birth is smaller than 16 cm (Warmsley-Hart *et al.* 1999).

Pupping season and nursery ground
Of the 25 cases found, five were in March, seven in April and 13 in May, suggesting that they are laid in autumn (Warmsley-Hart *et al.* 1999). Four of 24 adult females (16.7%) examined from the south coast had egg cases *in utero*; all four were caught in spring (Ebert *et al.* 2008). When the two datasets are combined, egg laying could be year-round (Ebert 2014).

Length at maturity
The size-at-50% maturity was 67 cm for females and 66 cm for males on the south coast (Warmsley-Hart *et al.* 1999, Ebert *et al.* 2008). The sizes at maturity for both females and males were larger on the west coast, with values of 80 cm and 77 cm respectively (Ebert *et al.* 2008).

Maximum length
Females and males attained a larger maximum size on the west coast (96 and 87 cm respectively) than on the south coast (70 and 78 cm respectively) (Ebert *et al.* 2008).

Age and growth
Female age-at-maturity is 9 years and maximum age is 15 years (Walmsley-Hart *et al*. 1999).

Generation length
Based on female age-at-maturity of 9 years and maximum age of 15 years, generation length is 12 years (Walmsley-Hart *et al*. 1999).

FISHERIES MANAGEMENT
SA catch sources, quantities and characteristics
Local annual estimates were 11-100 tons (DFFE records: 2010-2012; da Silva *et al*. 2015). This species is caught in the demersal trawl fishery and the commercial linefishery, demersal shark longline fishery and possibly the hake longline fishery.

Inshore trawl fishery
Annual average catch estimates of unidentified skates in the inshore trawl fleet, based on unsorted samples by observers, was 833 tons for the period 2003-2006. This excluded catches of roughnose skate *Cruriraja parcomaculata* of 12.8 tons and African softnose skate *Bathyraja smithii* of 4.8 tons. These were the only two identified skate species (Attwood *et al.* 2011).

Fishing outside South Africa

While this species is abundant in South African waters, individuals were only observed in two of 508 research trawls in Mozambique from 2003 to 2012 (Sean Fennessy, Oceanographic Research Institute, unpubl. data 2018). There is some trawling in Namibia, but parts of it are remote with no fishing pressure (Pollom *et al.* 2020k).

Population trends

There are no estimates of population size for this species. Population trend data of annual density estimates (kg per nm² area swept) were available from demersal research trawl surveys conducted over 26 years (1991–2016) in commercially fished areas of South Africa during autumn and spring along the south coast (DFFE unpubl. data 2018). Trend analysis of these research trawl data estimated a population reduction of 46% over the past three generation lengths (36 years). The species has exhibited a southwest range shift with some potential loss of habitat area during 1981–2016, likely due to climate change. Overall, due to an estimated reduction in population size over part of its range, combined with some areas of its range with low fishing pressure that may offer refuge, it is suspected that it has undergone a population reduction of 30–49% over the past three generation lengths (36 years), and it was assessed as Vulnerable on the IUCN Red List in 2019 (Pollom *et al.* 2020k).

ECOTOURISM

As it occurs in deep water, it cannot be regarded as an ecotourism species.

CCONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act

Threatened or Protected Species (TOPS)

This species is not listed.

Marine Protected Areas

Insufficient is known of the distribution of this species to ascertain which deep-water, if any, MPAs would provide protection to this species. It could benefit from protection on the Agulhas Bank.

Additional local comment

IUCN Status

<u>Vulnerable 2019: A2bd</u>

Previous IUCN assessments

Least Concern 2009

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

This species is not listed.

Convention on Migratory Species (CMS)

This species is not listed.

MANAGEMENT CONSIDERATIONS

This species is caught in South African trawl fisheries, demersal shark longline fishery and commercial linefishery but is seldom identified to species. Therefore, very little species-specific data exists. This makes it difficult to formulate any management considerations. A major step to improving accurate catch records would be the introduction of legislation that all skates must be landed whole; this would prohibit removal and retention of only the wings while discarding the trunk. Fisheries observers need to be made aware of the slight anatomical differences between *L. wallacei* and the scarce and little-known *L. compagnoi*, as the geographical and depth distribution of these two species overlaps.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

This species has been well studied, but many aspects of the reproductive biology including female fecundity remain unknown. Given the regional (south coast vs west coast) differences in size at sexual maturity and maximum size, it is important to ascertain whether these are two gentically different sub-populations. Conversion ratios for dressed to total weight need to be investigated along with the life-history.

Neoraja stehmanni

SCIENTIFIC NAME	*Neoraja stehmanni* (Hulley 1972)
COMMON NAME	African pygmy skate, South African dwarf skate
FAMILY	Rajidae
ENDEMIC	Yes
SIZE RANGE	< 15–37 cm TL
DISTRIBUTION	E, S, W coasts: Algoa Bay to southwest of Orange River mouth
HABITAT	Demersal on shelf and upper slope
DEPTH RANGE	100–1025 m
MAJOR FISHERIES	Possibly the demersal trawl fishery
IUCN STATUS	Least Concern 2018
CITES REGS	Not listed
MLRA REGS	None
COMPILER	G Cliff
REVIEWER	DA Ebert

SPECIES SUMMARY and RECOMMENDATIONS

Neoraja stehmanni, an endemic, is one of the smallest skates in South Africa. It is found along the south and west coasts over a wide depth range but appears to be most common deeper than 600 m, where it is outside the range of most demersal trawlers. It was not included in local catch estimates (DFFE records: 2010–2012) and was assessed as Least Concern on the IUCN Red List in 2018. Species-specific catch records are essential to ensure that the local stocks are not overfished. The introduction of legislation that all skates must be landed whole, thereby prohibiting the retention of only the wings, is a priority. This species has not been well studied, with almost nothing known of its reproductive biology and life history. Conversion ratios for dressed to total weight are needed.

TAXONOMIC and IDENTIFICATION ISSUES

Neoraja stehmanni was originally described in the genus *Breviraja.* The Rajidae are very difficult to characterise using external features. Skeletal structures, particularly claspers, are more important and distributional ranges should be used in identifying species (Last *et al.* 2016). *N. stehmanni* is one of five species in the genus, but it is the only one which occurs in southern African waters. It can be distinguished by its extremely small size, being one of the smallest of southern African skates, its bluntly-pointed, soft snout, large eyes, very rounded wing tips and the arrangement of thorns on the upper surface (Compagno *et al.* 1989, Last *et al.* 2016).

SOUTH AFRICAN DISTRIBUTION

This deepwater endemic skate, has been recorded from southwest of the Orange River to south of Cape Point, and off St. Francis Bay and Algoa Bay in the Eastern Cape. Most records are concentrated in the region from off Saldanha Bay to south of Cape Point (Compagno *et al.* 2007).

REGIONAL DISTRIBUTION

N. stehmanni has not been recorded outside South Africa, but this species could be found in Namibia with more sampling (David Ebert, South African Institute for Aquatic Biodiversity, pers. comm.).

SYNOPSIS OF RESEARCH

Very little is known about this species. Stomach contents were identified from three individuals (Ebert *et al.* 1991). A sample of 63 females and 58 males was used to determine length-disc width and length-weight relationships and size at maturity for each sex. This species was included in an identification key to the egg cases of southern African skates (Ebert *et al.* 2007).

ECOLOGY

Depth

This species occurs in water 100–1025 m deep (Pollom *et al.* 2019h), usually below 600 m (Compagno *et al.* 2007).

Habitat: Adults

This is unknown.

Habitat: Juveniles/Nursery Grounds

It is not known if juveniles utilise other habitats.

Synopsis of tag deployments

This species has not been tagged.

Movements

Nothing is known of the movement patterns of this species.

Diet/feeding: adults

The only identifiable stomach contents from 10 individuals of unstated size were shrimps (Ebert *et al.* 1991).

Diet/feeding: juveniles

See comments on the diet of adults above.

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Oviparity
DURATION OF REPRO CYCLE	Unknown
MATING SEASON	Unknown
GESTATION	Unknown
LITTER SIZE	Possibly 2
PUPPING/NURSERY GROUND	Unknown
LENGTH AT BIRTH	< 15 cm
LENGTH AT MATURITY	F: 30 cm; M: 31 cm
MAXIMUM LENGTH	F: 37 cm; M: 38 cm
GENERATION LENGTH	Unknown

Mode

Oviparity is the known reproductive mode of all skates.

Duration of reproductive cycle

The duration of the reproductive cycle is unknown.

Mating season and location

Nothing is known.

Gestation

This is unknown.

Litter size

A single egg case was found in each uterus in a single female caught off Saldanha Bay on the west coast (Ebert *et al.* 2007).

Length at birth

This is not known but the smallest specimen was 15 cm (Ebert *et al.* 2007).

Pupping season and nursery ground

Nothing is known.

Length at maturity

The size at maturity was 30 cm for females and 31 cm for males (Ebert *et al.* 2007).

Maximum length

The largest female was 37 cm and the largest male was 38 cm (Ebert *et al.* 2007).

Age and growth

This species has not been aged.

Generation length

No inferred generation length was listed (Pollom *et al.* 2019h).

FISHERIES MANAGEMENT

SA catch sources, quantities and characteristics

There were no local catch estimates (DFFE records: 2010–2012; da Silva *et al*. 2015).

Trawl fishery

This species is most common deeper than 600 m (Compagno *et al.* 2007). The demersal trawl fishery fishes at much shallower depths.

Fishing outside South Africa

This species does not occur outside South Africa.

Population trends

There are no population size or trend estimates. The population may be declining slightly due to fishing pressure, but reductions are not suspected to be approaching thresholds to warrant a threatened assessment. Therefore, *N. stehmanni* was assessed as Least Concern on the IUCN Red List in 2018 (Pollom *et al.* 2019h).

ECOTOURISM

As it occurs in deep water, it is not regarded as an ecotourism species.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)

This species is not listed.

Marine Protected Areas

This species may benefit from deep water MPAs, especially on the west coast where it appears to be most common.

Additional local comment

IUCN Red List Status
Least Concern 2018

Previous IUCN assessments
Data Deficient 2004

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

Marine Protected Areas
This species could benefit from protection in the deep water MPAs off the South African west coast.

International comments
This species has not been recorded outside South Africa.

MANAGEMENT CONSIDERATIONS

This species was not included in DEFF catches in the period 2010–2012. It is uncertain whether this was due to an apparent scarcity or an inability to identify this species. Species-specific catch records are essential to ensure that the local stocks are not overfished. This involves improving observer coverage and the identification skills of the observers. A major step to improving accurate catch records would be the introduction of legislation that skates must be landed whole, which would prohibit removal and retention of the wings and discarding of the trunk. As *L. stehmanni* is such a small species, rendition of the wings is unlikely.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

This species has been very poorly studied, with very little known of its reproductive biology and life history. This can be remedied by retention of specimens from demersal trawls.

Raja ocellifera

SCIENTIFIC NAME	*Raja ocellifera* (Regan 1906)
COMMON NAME	Twineye skate
FAMILY	Rajidae
ENDEMIC	Yes, Namibian specimens appear to be another species
SIZE RANGE	53 cm TL
DISTRIBUTION	E, S coasts: Richards Bay to False Bay
HABITAT	Demersal on soft bottoms of outer shelf and upper slope
DEPTH RANGE	15–420 m, most <200 m
MAJOR FISHERIES	Demersal trawl fishery, commercial linefish and demersal shark longline
IUCN STATUS	Endangered 2019
CITES	Not listed
MLRA	Daily bag limit of one individual in recreational fishery
COMPILER	C da Silva
REVIEWER	G Cliff

SPECIES SUMMARY and RECOMMENDATIONS
Raja ocellifera is a very small skate which is possibly endemic to South Africa, as the identity of specimens from Namibia require confirmation, although they appear to be another species. It occurs on the inner continental shelf at depths of 15–420 m. Local annual catch estimates were 11–100 tons (DFFE records; 2010-2012), although skates are seldom identified to species. This catch was predominantly from the demersal trawl, demersal shark longline and commercial linefishery. Based on declines in the research trawl surveys, this species was assessed in 2019 as Endangered on the IUCN Red List. It may benefit from protection in some of the deeper portions of inshore MPAs on the south coast. Little is known of its diet, age and growth and reproductive biology. An important management consideration would be legislation to prohibiting the practice of removing the wings and discarding the trunk. This would allow accurate catch statistics and correct identification. It is important that conversion ratios from dressed to total weight be confirmed.

TAXONOMIC and IDENTIFICATION ISSUES
In 1906 Regan described the South African "blue-eye" skate as *Raja ocellifera*. It was subsequently regarded as distinct from *Raja miraletus* (Wallace 1967c). After a detailed examination of the structure of the claspers and consideration of the external anatomy, Hulley (1969) concluded that the two species were synonymous. Compagno *et al.* (1989) only listed *R. miraletus* as occurring in the southern African waters, with no reference to *R ocellifera*. More recently, *Raja ocellifera* was recognised as falling within the *Raja miraletus* species complex, which includes *R. miraletus* (wide-ranging in the Eastern Atlantic and Mediterranean Sea), *R. parva* (West Africa including Angola) and *R. ocellifera* (South Africa and Namibia) (Last and Séret 2016). Several skates have prominent eyespots, but *R. ocellifera* is the only South African species in which they are blue, encircled by a narrow dark central ring and pale-yellow outer ring (Last *et al.* 2016).

SOUTH AFRICAN DISTRIBUTION
R. ocellifera is a possible South African endemic found along the east and south coasts from Richards Bay to Durban and from Port Alfred to False Bay (Ebert *et al.* 2021). These authors state that records from Namibia, as indicated by Compagno *et al.* (1989), require confirmation. Last *et al*. (2016) regard the Namibian records as *R. parva* and describe *R. ocellifera* as a South African endemic.

REGIONAL DISTRIBUTION

R. miraletus was reported from Namibia (Compagno *et al.* 1989, Compagno and Ebert 2007) but this requires confirmation as these records may represent a different species (Ebert *et al.* in 2021).

SYNOPSIS OF RESEARCH

Despite the high catches, this is a very poorly studied species. The diet of 68 individuals caught on the south coast was described (Smale and Cowley, 1992). Compagno and Ebert (2007) mapped 148 station records of *R. miraletus* from research trawls and historical records from Namibia to the east coast, but with a noticeable absence on the entire South African west coast. A total of 118 individuals were caught in these research trawls, with no significant difference from parity in the sex ratio. Length-weight and length-disc width relationships were obtained, as well as other life history information (Ebert *et al.* 2007).

ECOLOGY

Depth

This species is demersal on the continental shelf at depths of 15–105 m, and possibly deeper (Last *et al*. 2016). The depth range for *R. miraletus* was 15–420 m with most records on the shelf at <200 m although this includes Namibian catches (Compagno and Ebert 2007). On the south coast 69 individuals were trawled from depths of 28–90 m, with catches in 76% of trawls undertaken in water shallower than 50 m.

Habitat: Adults

It is a benthic species (Last *et al.* 2016).

Habitat: Juveniles/Nursery Grounds

It is not known if juveniles utilise other habitats.

Synopsis of tag deployments

No tagging has taken place in South Africa.

Movements

Nothing is known.

Diet/feeding: adults

The diet of individuals of 30–54 cm TL, which included both juveniles and adults, was dominated by small crustaceans, brachyurans and small teleosts such as gobies (Smale and Cowley, 1992).

Diet/feeding: juveniles

See details above; it is not known if the diet is different from the adults.

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Oviparity
DURATION OF REPRO CYCLE	Unknown
MATING SEASON	Unknown
GESTATION	Unknown
LITTER SIZE	Unknown
PUPPING/NURSERY GROUND	Unknown
LENGTH AT BIRTH	Unknown
LENGTH AT MATURITY	Both sexes: 42 cm

MAXIMUM LENGTH	F: 53 cm; M: 52 cm
GENERATION LENGTH	9 years (inferred from congener *Raja ravidula*)

Mode
All skates exhibit oviparity.

Duration of reproductive cycle
The duration of the reproductive cycle is unknown.

Mating season and location
This is unknown. Three of 35 adult females examined had egg cases *in utero* and all were caught on the south coast during spring (Ebert *et al.* 2007).

Gestation
This is unknown.

Litter size
This is unknown.

Length at birth
This is unknown.

Pupping season and nursery ground
This is unknown.

Length at maturity
Both sexes attain 50% maturity at 42 cm (Ebert *et al.* 2007).

Maximum length
The largest male examined was 52 cm and female 53 cm (Ebert *et al.* 2007).

Age and growth
Unknown

Generation length
This is nine years, inferred from congener *Raja ravidula* (Pollom *et al.* 2020l).

FISHERIES MANAGEMENT
SA catch sources, quantities and characteristics
Local annual catch estimates were 11–100 tons (DFFE records: 2010-2012; da Silva *et al*. 2015) as *R. miraletus*. This species is caught in the demersal trawl fishery, commercial linefishery and the demersal shark longline fishery.

Inshore trawl fishery
Annual average catch estimates of unidentified skates in the inshore trawl fleet, based on unsorted samples by observers, was 833 tons for the period 2003-2006. This excluded catches of roughnose skate *Cruriraja parcomaculata* of 12.8 tons and African softnose skate *Bathyraja smithii* of 4.8 tons. These were the only two identified skate species (Attwood *et al.* 2011).

Fishing outside South Africa
This species appears to be endemic to South Africa.

Population trends

There are no estimates of population size for *R. ocellifera.* Population trend data of annual density estimates (kg per nm² area swept) were available from demersal research trawl surveys conducted over 26 years (1991–2016) in commercially fished areas of South Africa during autumn and spring along the south coast (DFFE, unpubl. data, 2018). The trend analysis revealed an annual rate of reduction of 4.6% over the trawl grounds, consistent with an estimated reduction of 70% over the past three generation lengths (27 years), with the highest probability (62%) of a reduction of 50–79% over the past three generation lengths. The research trawl survey gear was modified in recent years and is now very inefficient at catching skates, which could account for some of the recent decline in research catch rates (Rob Leslie, DFFE, unpubl. data, 2018). Despite this, given that most of this species' range occurs within the research survey area, and that the survey period (26 years) is very close to three generation lengths (27 years), the estimated population reduction is highly likely indicative of the level of actual reduction of this species. This species appears to have undergone a population reduction of 50–79% over the past three generation lengths (27 years), and it is assessed as Endangered on the IUCN Red List in 2019 (Pollom *et al.* 2020l).

ECOTOURISM
As it occurs mainly in deep waters, it should not be regarded as an ecotourism species.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
This species is not listed.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
This species may benefit from some protection from MPAs on the east and south coasts, but there is no evidence that it is common in any of these MPAs.

Additional local comment
This species will benefit from the long-standing ban on trawling in False Bay.

IUCN Red List Status
Endangered 2019: A2bd

Previous IUCN Red List assessments
None

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

International comments

MANAGEMENT CONSIDERATIONS
This species is one of the most common skates in South African trawl fisheries, however it is seldom identified to species level, which makes it difficult to formulate any management considerations. A major step to improving accurate catch records would be the introduction of legislation that all skates must be landed whole; this would prohibit removal and retention of only the wings while discarding the trunk.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

Very little is known about the biology of this species. Further research is needed on population size and trend, life history, and catch rates. Conversion rations for dressed to total weight need to be investigated.

Rostroraja alba

SCIENTIFIC NAME	*Rostroraja alba* (Lacepède 1803)
COMMON NAME	White skate, spearnose skate
FAMILY	Rajidae
ENDEMIC	No, also found in Mozambique and Namibia
SIZE RANGE	30–240 cm TL
DISTRIBUTION	E, S, W coasts: entire South African coast
HABITAT	Demersal on rock and sand bottoms of outer shelf and upper slope
DEPTH RANGE	5–470 m
MAJOR FISHERIES	Demersal trawl fishery, demersal shark longline fishery and recreational linefishery
IUCN STATUS	Endangered 2006
CITES	Not listed
MLRA	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	C da Silva

SPECIES SUMMARY and RECOMMENDATIONS

Rostroraja alba, the largest skate in southern Africa, is found over a wide range of depths along the entire South African coast, with the south and west coasts the centre of its distribution. Local annual reported catch estimates were 11-100 tons (DFFE records: 2010-2012). This catch was predominantly from the demersal trawl fishery, but species-specific records of catches are either poor or almost non-existent. It is also caught by the demersal shark longline fishery and occasionally caught by shore anglers in the recreational linefishery. Based on declines in catches in Europe and the Mediterranean Sea, this species was assessed globally as Endangered on the IUCN Red List in 2006. Despite its occurrence along the entire South African coast, this species does not appear to be common in catches. More species-specific catch records are essential to ensure that the local stocks are not overfished. The introduction of legislation that all skates must be landed whole, thereby prohibiting the retention of only the wings, is a priority. This species has not been well studied, with little known of its reproductive biology and life history. Conversion ratios for dressed to total weight are needed.

TAXONOMIC and IDENTIFICATION ISSUES

Rostroraja alba was originally described in the genus *Raja*, but it was assigned to a newly created genus *Rostroraja* (Hulley 1972b), of which there are eight species, with only *R. alba* found in the SE Atlantic and W Indian Ocean. The Rajidae are very difficult to characterise using external features. Skeletal structures, particularly claspers, are more important and distributional ranges should be used in identifying species (Last *et al.* 2016). *R. alba* can be distinguished by its large size (it is the largest of the Southern African skates), its sharply pointed snout, numerous small white spots on a grey dorsal surface (red-brown in juveniles) and absence of black pores on the ventral surface. Dorsal spines are present with malar and alar thorns on males (Compagno *et al.* 1989).

SOUTH AFRICAN DISTRIBUTION

This species occurs along the entire South African coast; the local population appears to be centred along the west and south coasts to Algoa Bay (Ebert *et al.* 2021).

REGIONAL DISTRIBUTION

R. alba also occurs in Mozambique and Madagascar, as well as from Namibia northwards up the entire west coast of Africa into European waters (Last *et al.* 2016).

SYNOPSIS OF RESEARCH

This species is the largest skate in South African waters and is not been well studied. The feeding ecology (Ebert *et al.* 1991; Smale and Cowley 1992) and reproductive biology (Ebert *et al.* 2007) have been investigated.

ECOLOGY

Depth

In South Africa this species occurs over a wide depth range. On the south and west coasts, it is occasionally taken by anglers from sandy beaches on the open coast and in shallow bays, such as Saldanha Bay. It occurs down to depths of about 250 m, but most records are shallower than 200 m. It occurs in deeper waters, down to 470 m, on the south and east coasts (Ebert *et al.* 1991, Compagno and Ebert 2007). On the south coast, based on inshore research trawl records, it was most common at depths of 5–85 m (Buxton *et al.* 1984).

Habitat: Adults

It a benthic species (Last *et al.* 2016).

Habitat: Juveniles/Nursery Grounds

It is not known if juveniles utilise other habitats.

Synopsis of tag deployments

This species is occasionally caught by shore anglers and 278 individuals were tagged (ORI Cooperative Fish Tagging Project 1984-2018 inclusive) with 9 (3%) recaptures. Mean distance travelled was 1 km; mean time at liberty 0.6 years (max: 3 km and 1.3 years)(Jordaan *et al*. 2020).

Movements

The tagging data presented above suggests that *R. alba* is a highly sedentary species.

Diet/feeding: adults

The adults feed predominantly on teleosts, and, to a lesser extent, cephalopods (Ebert 1991, Smale and Cowley 1992).

Diet/feeding: juveniles

The diet of the juveniles was also dominated by teleosts, but the prey species were smaller and less mobile (Ebert *et al.* 1991). Crustaceans and small cephalopods were also eaten (Smale and Cowley 1992).

South African toxicological studies

No study has been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Oviparity
DURATION OF REPRO CYCLE	Unknown
MATING SEASON	Unknown
GESTATION	Up to 18 months
LITTER SIZE	Unknown
PUPPING/NURSERY GROUND	Unknown, no seasonal pattern
LENGTH AT BIRTH	Unknown locally; 30 cm elsewhere
LENGTH AT MATURITY	F: 195 cm; M: 167 cm
MAXIMUM LENGTH	F: 240 cm; M: 198 cm
GENERATION LENGTH	25–30 years, based on *Raja clavata*

Mode
Oviparity is the known reproductive mode of all skates. Ebert *et al.* (2007) reported the presence of egg cases *in utero* in two females caught by shore anglers in South Africa.

Duration of reproductive cycle
The duration of the reproductive cycle is unknown. One to two egg capsules appear to be contained in each female's oviducts at one time (Ellis *et al.* 2016 and reference cited therein).

Mating season and location
Reproductive seasonality was difficult to determine, given the scarcity of gravid females in South Africa. Egg cases were found *in utero* in two specimens; one was caught in summer and one in autumn. A lack of reproductive seasonality has been reported in studies from elsewhere (Ebert *et al.* 2007).

Gestation
The eggs may take up to 8 months to hatch (Compagno *et al.* 1989). In the Mediterranean gestation is 15 months (Dulvy *et al.* 2006 and references cited therein).

Litter size
In the Mediterranean females produce 55–156 ova per year (Dulvy *et al.* 2006 and references cited therein).

Length at birth
This is not known locally, but is about 30 cm (Last *et al.* 2016).

Pupping season and nursery ground
Nothing is known. The two pregnant females were caught in False Bay and near East London (Ebert *et al.* 2007).

Length at maturity
In South Africa size at 50% maturity was 195 cm for females and 167 cm for males (Ebert *et al.* 2007). In the North-West Atlantic females mature at about 130 cm and males at about 120 cm (Last *et al.* 2016).

Maximum length
In South Africa females attain at least 240 cm and males 198 cm (Ebert *et al.* 2007).

Age and growth
This species has not been aged.

Generation length
This is inferred to be in the range of 25–30 years from *Raja clavata* (Ellis *et al.* 2016 and reference cited therein).

FISHERIES MANAGEMENT
SA catch sources
Local annual catch estimates were 11–100 tons (DFFE records: 2010-2012; da Silva *et al*. 2015). This species is caught in the demersal trawl fishery, demersal shark longline fishery and recreational linefishery. It is a suspected catch in the commercial linefishery and hake longline fisheries.

SA catch quantities and characteristics
Inshore trawl fishery

Annual average catch estimates of unidentified skates in the inshore trawl fleet, based on unsorted samples by observers, was 833 tons for the period 2003-2006. This excluded catches of roughnose skate *Cruriraja parcomaculata* of 12.8 tons and African softnose skate *Bathyraja smithii* of 4.8 tons. These were the only two identified skate species (Attwood *et al.* 2011).

Recreational shore angling
Shore anglers hook this species, but, because of its large size, landing the catch poses a considerable challenge. Anglers who are members of angling clubs are most likely to have the necessary skills and tackle to succeed and therefore there is a high likelihood that any *R. raja* landed will be returned alive to the water. This species was not recorded in the KZN and Wild Coast (northernmost section of the Eastern Cape) competitive shore fisheries (Pradervand *et al.* 2007, Pradervand 2004, respectively). In the Border (region immediately south the Wild Coast) competitive shore fishery the mean annual catch was 1, with a mean mass of 16 kg over a 17-year period (Pradervand and Govender 2003). This species was not reported in shore anglers' catches in the Goukamma MPA (Pradervand and Hiseman 2006) or Tsitsikamma MPA (Hanekom *et al.* 1997) on the south coast.

Beach seine and gill net fisheries
This species was a rare bycatch in the beach seine fishery in False Bay, occurring in 0.3% of hauls (1991–1992) (Lamberth *et al.* 1994).

Fishing outside South Africa
This species is likely to be caught as bycatch in multispecies trawl fisheries and demersal longline fisheries which operate on much of the continental shelf and slope. Some targeting of rajid skates does occur (Dulvy *et al.* 2006).

Population trends
Little information is available on the population size of this species. In South Africa, there was a temporal decline in the relative contribution of this species to catches of recreational shore anglers in False Bay (Best *et al*. 2013). Population trend data of annual density estimates (kg per nm^2 area swept) were available from demersal research trawl surveys conducted over 26 years (1991–2016) in commercially fished areas of South Africa during autumn and spring along the south coast (DFFE unpubl. data 2018). The risk analysis shows a decline in abundance, with a recommended listing as Vulnerable.

The collapse of a directed long-line targeted fishery in Brittany, France highlights the inability of this species to withstand fisheries exploitation. The available data indicates that this species has undergone a reduction in abundance and was considered rare in the NE Atlantic and the Mediterranean. This species was assessed globally as Endangered on the IUCN Red List in 2006 (Dulvy *et al.* 2006).

The species is suspected to have declined by >80% over the past three generations (75-90 years), therefore it was assessed as Critically Endangered in European waters in 2014 (Ellis *et al.* 2015b). It is suspected to have declined by > 50% over the past three generations, therefore it was assessed as Endangered in the Mediterranean Sea in 2016 (Ellis *et al.* 2016).

ECOTOURISM
As it occurs in deep water, it cannot be regarded as an ecotourism species.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
This species is not listed.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
It is unlikely that this species will derive much benefit from the current array of deep and shallow water MPAs along the South African coastline.

Additional local comment
This species will benefit from the long-standing ban on trawling in False Bay.

IUCN Red List Status
Endangered 2006: A2cd+4cd

Previous IUCN assessments
Least Concern 2009

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

International comments
R. alba is a protected species within the European Union. It is listed in Annex II of the Barcelona Convention, which prohibits any retention of this species, which must be released unharmed and alive, whenever possible. It derives similar protection in the Mediterranean Sea from its listing in Appendix III of the Bern Convention. Some individual European countries, as contracting parties to the Bern and Barcelona conventions, have also protected this species. In Israel all chondrichthyans (sharks, rays, skates and chimaeras) are protected. In Tunisia, the Gulf of Gabès, where this species is relatively abundant, is closed to trawling from July to September (Ellis *et al.* 2015b).

MANAGEMENT CONSIDERATIONS
Despite occurring along the entire South African coast, this species does not appear to be common in catches. Due to its large size and shape, it is difficult to release alive from gear such as trawl nets and demersal shark longlines. Post-release mortality is likely to be high. Although species-specific reporting is increasing, this species needs to be listed as a priority for research. Given its status globally, high suspected post-release mortality, research with the aim at eventually protecting the species is vital. This involves improving coverage by observers and their identification skills and monitoring discharges of several fisheries. A major step to improving accurate catch records would be the introduction of legislation that all skates must be landed whole; this would prohibit removal and retention of only the wings while discarding the trunk.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
This species has not been well studied, with little known of its reproductive biology and life history. Conversion ratios for dressed to total weight are needed.

FAMILY GURGESIELLIDAE

Cruriraja durbanensis

SCIENTIFIC NAME	*Cruriraja durbanensis* (von Bonde and Swart 1924)
COMMON NAME	Smoothnose pygmy skate
FAMILY	Gurgesiellidae
ENDEMIC	Yes
SIZE RANGE	At least 31 cm TL
DISTRIBUTION	W coast: Hondeklip Bay to Port Nolloth
HABITAT	Demersal on soft bottoms of outer shelf and upper slope
DEPTH RANGE	Around 860 m
MAJOR FISHERIES	Demersal trawl fishery
IUCN STATUS	Data Deficient 2019
CITES	Not listed
MLRA	None
COMPILER	C da Silva
REVIEWER	G Cliff

SPECIES SUMMARY and RECOMMENDATIONS
Cruriraja durbanensis is a very small, rare, endemic deep-water pygmy skate. It is only known from a single location off the west coast and from two samples taken nearly a century ago at 860 m, both of which have been lost. As it has not be caught again in research or commercial trawls on the west coast, is must be regarded as being of very low management priority. As a result, *C. durbanensis* was assessed as Data Deficient on the IUCN Red List in 2019. Nothing is known of its population size, habitat and ecology, life history, and threats, particularly the level of interaction with fisheries.

TAXONOMIC and IDENTIFICATION ISSUES
Contrary to its scientific name, this species does not occur off Durban in the SW Indian Ocean, but has only been found off a very short section of the west coast. It is one of three members of the genus in southern Africa. *C. durbanensis* has a pointed, thornless snout, but with large whitish thorns present on shoulders, around the eyes and a single row from the nape to the first dorsal fin. Colour above is uniform reddish brown, which in preservative may be artificial; lighter below. It differs from all other *Cruriraja* species in having unusually small eyes. The other two southern African species, *C. hulleyi* and *C. parcomaculata*, have prominent thorns on the snout and multiple rows of tail thorns in adults (Last *et al.* 2016).

SOUTH AFRICAN DISTRIBUTION
C. durbanensis has only been recorded on the west coast of South Africa in the vicinity of Port Nolloth and Hondeklip Bay (Compagno and Ebert 2007).

REGIONAL DISTRIBUTION
It has not been found outside South African waters.

SYNOPSIS OF RESEARCH
Since it was first described nearly a century ago, no additional specimens have been caught, despite extensive research trawling on the west coast to depths exceeding 1000 m (Compagno and Ebert 2007).

ECOLOGY

Depth
The two known specimens were caught at about 860 m off Hondeklip Bay/Port Nolloth on the west coast, about 200 km from the Namibian border.

Habitat: Adults
This is probably benthic (Last *et al*. 2016).

Habitat: Juveniles/Nursery Grounds
Unknown.

Synopsis of tag deployments
No tagging has taken place in South Africa.

Movements
Nothing is known.

Diet/feeding: adults
Unknown

Diet/feeding: juveniles
Unknown

South African toxicological studies
No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Oviparity
DURATION OF REPRO CYCLE	Unknown
MATING SEASON	Unknown
GESTATION	Unknown
LITTER SIZE	Unknown
PUPPING/NURSERY GROUND	Unknown
LENGTH AT BIRTH	Unknown
LENGTH AT MATURITY	Unknown
MAXIMUM LENGTH	At least 31 cm
GENERATION LENGTH	Unknown

Mode
All skates exhibit oviparity (Last *et al*. 2016).

Duration of reproductive cycle
Unknown

Mating season and location
Unknown

Length at birth
Unknown

Pupping season and nursery ground
Unknown

Length at maturity
Unknown

Maximum length
The largest individual was 31 cm.

Age and growth
Unknown

Generation length
Unknown

FISHERIES MANAGEMENT
SA catch sources, quantities and characteristics
No local catches were reported (DFFE records: 2010-2012; da Silva *et al*. 2015). It is likely that this species occurs deeper than the maximum operating depths of the demersal trawl fishery.

Fishing outside South Africa
There is none as this species is an endemic.

Population trends
There are no population size or trend estimates. This species is known from two type specimens, both of which are presumed lost (Last *et al.* 2016), therefore it was assessed as Data Deficient on the IUCN Red List in 2019 (Pollom *et al.* 2019).

ECOTOURISM
As it occurs in very deep water, it cannot be regarded as an ecotourism species.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
Insufficient is known of its distribution to determine if any South African MPAs will benefit this species.

Additional local comment

IUCN Red List Status
<u>Data Deficient: 2019</u>

Previous IUCN assessments
Data Deficient: 2009

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

MANAGEMENT CONSIDERATIONS
As so little is known of this species, it is impossible to formulate any management considerations. Furthermore, as there are no records of any specimens for close to a century, this species, despite being endemic, is of extremely low priority and is likely to remain as Data Deficient.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
Nothing is known about this species, therefore samples from commercial and research trawls are needed.

.

FAMILY DASYATIDAE

Bathytoshia lata

SCIENTIFIC NAME	*Bathytoshia lata* (Garman 1880)
COMMON NAME	Thorntail stingray/brown stingray
FAMILY	Dasyatidae
ENDEMIC	No, E Atlantic and Indo-Pacific
SIZE RANGE	35–260 cm DW
DISTRIBUTION	E, S and part of W coast: Mozambique border to St Helena Bay
HABITAT	Demersal on soft bottoms
DEPTH RANGE	0–800 m
MAJOR FISHERIES	None listed but caught in KZN prawn trawl fishery and recreational linefishery
IUCN STATUS	Vulnerable 2020
CITES REGS	Not listed
MLRA REGS	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	C Elston

SPECIES SUMMARY and RECOMMENDATIONS

Bathytoshia lata is a medium-sized demersal ray which is widely distributed geographically and occurs over a very wide depth range. It is associated with sandy and muddy substrates. There were no reported local catches (DFFE records: 2010-2012), although this species was not uncommon in the now closed KZN inshore prawn trawl fishery. It was globally assessed as Vulnerable on the IUCN Red List in 2020, as a result of heavy fishing pressure elsewhere in its range. An assessment of the genetic structure of the local/regional population is needed to place this global status in local perspective. Virtually nothing is known of its life history and ecology locally. Any opportunistic sampling should be used to collect biological information and tissue samples for genetic studies.

TAXONOMIC and IDENTIFICATION ISSUES

Bathytoshia lata was first described in South Africa as a new species *Dasyatis agulhensis* by Barnard (1925, cited by Ebert *et al.* 2021). Another new local species *Dasyatis lubricus* was described by Smith (1957, cited by Ebert *et al.* 2021), but the two were synonymised by Wallace (1967c) as *D. thetidis*, a species also found in Australia and New Zealand. Last *et al.* (2016) concluded that it is *Bathytoshia lata*, a wide-ranging species found in the Indo-Pacific and Eastern Atlantic, including the Mediterranean. This species is highly distinctive with its markedly thorny tail.

SOUTH AFRICAN DISTRIBUTION

This species occurs on the entire east coast and part of the south coast from the Mozambique border to Cape Agulhas (Ebert *et al.* 2021), although it is listed in the recreational shore angling fishery in False Bay (Best *et al.*2013). There are also reports from the Western Cape Shore Angling Association that this species is not only caught in angling competitions in False Bay but also further up the west coast around St. Helena Bay (South African Elasmobranch Monitoring (ELMO) citizen science project, unpublished data).

REGIONAL DISTRIBUTION

This species is not reported to occur in Mozambique or Namibia (Jabado *et al.* 2021a), although Wallace (1967c) examined specimens from Mozambique and Pierce *et al.* (2008) listed it as present in that country. It is widely distributed in the Eastern Atlantic and Indo-Pacific (Last *et al.* 2016).

SYNOPSIS OF RESEARCH
In a study of batoid fishes of the east coast of southern Africa nine individuals of this species, then referred to as *Dasyatis thetidis*, were examined by Wallace (1967c). Nothing has been published on the life history and ecology of this species in South Africa or the SW Indian Ocean.

ECOLOGY
Depth
It occurs close inshore, including Durban Bay (Port of Durban) out to the upper slope in depths of up to 400 m (Wallace 1967c) and deeper (800 m, Last *et al.* 2016).

Habitat: Adults
This species inhabits sandy and muddy substrates, based on the capture of small numbers of individuals of varying sizes in Durban Bay (Port of Durban) (Wallace 1967c) and in the prawn trawl fishery on the uThukela Banks (Fennessy 1994). This species was detected at 366 m in the iSimangaliso Wetland Park during coelacanth surveys (Heemstra *et al.* 2006). It is reported to be common in coastal rivers in New South Wales (Whitley 1940, cited by Wallace 1967c). On this basis and given the capture of an individual in Durban Bay, Wallace (1967c) stated that this species is likely to occur in other South African estuaries and lagoons.

Habitat: Juveniles/Nursery Grounds
It is not known if juveniles utilise other habitats.

Synopsis of tag deployments
This species is not listed in the table of individuals that have been tagged in the ORI Cooperative Fish Tagging Project 1984-2018 inclusive (Jordaan *et al.* 2018).

Movements
In the absence of any local tag deployments, it is not possible to ascertain anything of the movement patterns of this species.

Diet/feeding: adults
The diet comprises benthic crustaceans and small teleosts (Last *et al*. 2016).

Diet/feeding: juveniles
There is no evidence that it is different from that of the adults.

South African toxicological studies
No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Histotrophic viviparity
DURATION OF REPRO CYCLE	Unknown
MATING SEASON	Unknown
GESTATION	About 4 months (outside South Africa)
LITTER SIZE	2–6 (outside South Africa)
PUPPING/NURSERY GROUND	Unknown
DISC WIDTH AT BIRTH	34–37 cm (outside South Africa)
DISC WIDTH AT MATURITY	F: 110–160 cm; M: 80–150 cm (outside South Africa)
MAXIMUM DISC WIDTH	260 cm
GENERATION LENGTH	21.5 years (Hawaii)

Mode
This species exhibits histotrophic viviparity in which maternal uterine secretions supplement the nourishment provided by the yolk-sac.

Duration of reproductive cycle
This is unknown.

Gestation
This is about 4 months outside South Africa (Jabado *et al.* 2021a and references cited therein).

Mating season and location
This is unknown.

Litter size
Litter size is 2–6 outside South Africa (Jabado *et al.* 2021a and references cited therein).

Pupping season and nursery ground
This is unknown.

Disc width at birth
This is 34–37 cm outside South Africa (Jabado *et al.* 2021a and references cited therein).

Disc width at maturity
Female size at maturity is 110–160 cm; males mature at 80–150 cm outside South Africa (Jabado *et al.* 2021a and references cited therein).

Maximum disc width
This species attains 260 cm (Jabado *et al.* 2021a).

Age and growth
Age at maturity is 15 years and maximum age is 28 years in Hawaii (Dale and Holland 2012, cited by Jabado *et al.* 2021a).

Generation length
Generation length was estimated at 21.5 years, based on age at maturity of 15 years and maximum female longevity of 28 years in Hawaii (Dale and Holland 2012, cited by Jabado *et al.* 2021a).

FISHERIES MANAGEMENT

SA catch sources, quantities and characteristics
No local catches were reported (DFFE records: 2010-2012; da Silva *et al*. 2015), although this species was documented in the elasmobranch bycatch of the KZN prawn trawl fishery on the uThukela Banks (Fennessy 1994) and is caught by recreational anglers (Best *et al.* 2013).

KZN prawn trawl fishery
This species was not an uncommon bycatch in the KZN prawn trawl industry on the uThukela Banks. Based on the observer-recorded catches, the extrapolated average annual catch between 1989 and 1992 was 115 (range 87–164). The size range was 0.8–1.5 m, with a mean of 1.4 m, which encompassed larger juveniles and adults. Survival was around 30%, based on a subsample of 160 individuals (Fennessy 1994). This fishery was dormant for nearly two decades due to the extended closure of the mouth of Lake St Lucia, resulting in poor prawn recruitment and diminishing prawn catches on the uThukela Banks. The fishing grounds were closed to trawling following the declaration of the uThukela MPA in August 2019.

Recreational linefishery
This species was not listed in the catches by the KZN recreational competition shore anglers (Pradervand *et al.* 2007), although it was assigned a South African Anglers' Union record of 214 kg (Wallace 1967c). It was listed in the recreational angler catch in False Bay (Best *et al.* 2013). Catches have been reported by recreational anglers in KZN and on the south coast around Plettenberg Bay and on the west coast around St. Helena Bay (ELMO Africa, 2011–2019, unpublished data).

Fishing outside South Africa
This species is taken as an incidental catch in industrial and artisanal fisheries with multiple demersal fishing gears, including trawl, line gear, gillnet, and set net and is retained for its meat (Jabado *et al.* 2021a).

Population trends
Nothing is known of the current population size or structure, nor the extent of connectivity among subpopulations across the Indo-West Pacific.

There is no reason to suspect a population decline in locations like Australia, New Zealand, or the United States, given the levels of fishing effort across its known range in these countries. However, there are largely unmanaged fisheries that operate in other locations such as West Africa, India, and Indonesia, where the intense fishing pressure is a cause of concern. While declines in rays have been noted in these regions, this species also occurs deeper than most stingrays and this may offer some refuge from fishing (Jabado *et al.* 2021a).

Overall, it is suspected that *B. lata* has undergone a population reduction of 30–49% over the past three generation lengths (65 years) due to actual or potential levels of exploitation, and it was globally assessed as Vulnerable on the IUCN Red List in 2020 (Jabado *et al.* 2021a).

ECOTOURISM
Even though this species occurs in shallow waters, it is rarely seen by scuba divers and therefore it cannot be regarded as an ecotourism species,.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
As this species has been caught historically in the KZN prawn trawl fishery, it will benefit from protection in the uThukela Banks MPA. It has also been observed in the deep-water canyons of the iSimangaliso Wetland Park.

Additional local comment

IUCN Status
<u>Vulnerable 2020: A2d</u>

Previous IUCN assessments
Not evaluated.

MANAGEMENT CONSIDERATIONS

This species is poorly known in South Africa and in view of the now apparently low local catches, it is very difficult to make any management recommendations. It is likely that this species moves into Mozambique, where, despite its large size, is vulnerable to catches in various artisanal fisheries. An investigation of local/regional population genetic structure is needed to place the global Red List status of Vulnerable into local perspective. A regional assessment would therefore be beneficial, although the likely outcome is Data Deficient.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

Virtually nothing is known locally of the life history and ecology of this species. Opportunistic sampling to obtain life history information and tissues for genetic studies is recommended.

Himantura leoparda

SCIENTIFIC NAME	*Himantura leoparda* (Manjaji-Matsumoto and Last 2008)
COMMON NAME	Leopard whipray
FAMILY	Dasyatidae
ENDEMIC	No, Indo-West Pacific Ocean
SIZE RANGE	20–140 cm DW
DISTRIBUTION	E coast: Mozambique border to East London
HABITAT	Demersal on sand and mud bottoms
DEPTH RANGE	0–70 m
MAJOR FISHERIES	None listed but KZN prawn trawl fishery and recreational linefishery; possibly commercial linefishery, demersal trawl and hake longline fisheries
IUCN STATUS	Vulnerable 2015
CITES REGS	Not listed
MLRA REGS	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	C Elston and PD Cowley

SPECIES SUMMARY and RECOMMENDATIONS

Himantura leoparda was only identified in 2008. Prior to this *H. uarnak* was regarded as the only honeycomb-patterned stingray in the Indo-West Pacific. *H. leoparda* is now regarded as far more common than *H. uarnak* on the South African coast, but it is impossible to profile the two species separately. Estimated annual total catch was <1 ton (DFFE records: 2010–2012). It was a bycatch in the now-closed KZN prawn trawl fishery and is caught by the recreational shore anglers. This species appears to be resident and could derive considerable protection from several inshore MPAs on the east coast, especially the uThukela MPA, which is a possible nursery ground. It was assessed globally as Vulnerable on the IUCN Red List in 2015, due to decreasing population trends in other regions, with a variety of fisheries posing the greatest threat, particularly in SE Asia. Habitat degradation is also a major concern. An assessment of the genetic structure of the local/regional population is needed to place the global status in local perspective. Confusion over species identification remains an issue and until it is resolved this species and *H. uarnak* should be managed as one. Virtually nothing is known of its life history and ecology.

TAXONOMIC and IDENTIFICATION ISSUES

Himantura uarnak was long regarded as the only stingray in South Africa with a highly variable pattern on the upper surface, which Wallace (1967c) described as leopard, marbled or reticulated, scribbled or honeycombed. At the time this species was known as *Dasyatis uarnak* (Wallace 1967c; Compagno *et al.* 1989). Last *et al.* (2016) described Indo-Pacific forms identified as *H. uarnak* as a still unresolved complex of species. A second species with a similar pattern, *H. leoparda*, was described in 2008. Rigby *et al.* (2016) stated that *H. leoparda* is possibly widespread in the Indo-West Pacific, but currently considered absent from the W Indian Ocean. This situation has changed as Ebert *et al.* (2021) regard almost all references to a large, reticulate-patterned stingray species in KZN as *H. leoparda. H. uarnak* does occur, but is far scarcer than *H. leoparda*. The two species have subtle differences in colour patterns on the dorsal surface. This confusion between the species makes it impossible to assess them independently.

SOUTH AFRICAN DISTRIBUTION

Both species, *H. leoparda* and *H. uarnak*, occur on the east coast from the Mozambique border to East London (Ebert *et al.* 2021).

REGIONAL DISTRIBUTION
Both species occurs in Mozambique, Kenya and Madagascar, with a widespread tropical and subtropical distribution in the Indo-West Pacific and parts of the E Pacific (Manjaji-Matsumoto *et al.* 2016a, Last *et al.* 2016).

SYNOPSIS OF RESEARCH
In a study of batoid fishes of the east coast of southern Africa 52 *H. uarnak* and three embryos were examined (Wallace 1967c). Nothing has been published since on the life history and ecology of either species of reticulate-patterned stingray in South Africa or the SW Indian Ocean. Dunlop and Mann (2013d) provided an overview of life history and fishery-related information of *H. uarnak*. Both studies are likely to be reporting largely on *H. leoparda.*

ECOLOGY
Depth
It occurs inshore in the surf zone and low-salinity estuaries and in deeper coastal water down to 70 m (Manjaji-Matsumoto *et al.* 2016a, Last *et al.* 2016).

Habitat: Adults
They are often found off sandy beaches, in sandy areas of coral reefs, in shallow estuaries and lagoons, and may even enter freshwater (Dunlop and Mann 2013d and references cited therein).

Habitat: Juveniles/Nursery Grounds
Juveniles are found in estuaries and sheltered bays and also on banks in deeper water (Dunlop and Mann 2013d and references cited therein).

Synopsis of tag deployments
A total of 800 *H. uarnak* individuals were tagged (ORI Cooperative Fish Tagging Project 1984-2018 inclusive) with 18 (2%) recaptured. Mean distance travelled was 1 km; mean time at liberty 0.8 years (max: 8 km and 6.9 years) (Jordaan *et al.* 2020).

Movements
Even though recapture numbers are low, they indicate site fidelity (Dunlop and Mann 2013d). Individuals may also be seasonal migrants returning to the same location, as anglers catches peak in summer.

Diet/feeding: adults
The diet comprises benthic invertebrates including bivalves, crustaceans and polychaete worms and small teleosts (Compagno *et al.* 1989).

Diet/feeding: juveniles
Unknown, but possibly similar to adults.

South African toxicological studies
No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Histotrophic viviparity
DURATION OF REPRO CYCLE	Unknown
MATING SEASON	Unknown
GESTATION	12 months; pupping in summer
LITTER SIZE	3–5

PUPPING/NURSERY GROUND	Possibly uThukela Banks
DISC WIDTH AT BIRTH	±20 cm (outside South Africa)
DISC WIDTH AT MATURITY	F: ?; M: 70–80 cm (outside South Africa)
MAXIMUM DISC WIDTH	140 cm
GENERATION LENGTH	20 years (inferred from *Himatura astra*)

Mode
This species exhibits histotrophic viviparity, in which maternal uterine secretions supplement the nourishment provided by the yolk-sac.

Duration of reproductive cycle
The duration of the reproductive cycle is unknown.

Mating season and location
Mating appears to be in summer (van der Elst 1993).

Gestation
Gestation in *H. uarnak* is 12 months (van der Elst 1993).

Litter size
In South Africa the litter size of *H. uarnak* is 3–5 (van der Elst 1993).

Disc width at birth
In South Africa the size at birth of *H. uarnak* is 20 cm (van der Elst 1993) or 28–30 cm (Heemstra and Heemstra 2004). Outside South Africa size at birth in *H. leoparda* is about 20 cm (Last *et al.* 2016).

Pupping season and nursery ground
Neonate and larger juvenile *H. uarnak* were found on the uThukela Banks in water of 20–40 m (Fennessy 1994). Pupping is in summer (Compagno *et al.* 1989).

Disc width at maturity
Female size at maturity in *H. leoparda* is unknown; males from outside South Africa mature at 70–80 cm (Last *et al.* 2016).

Maximum disc width
H. leoparda attains 140 cm (Last *et al.* 2016).

Age and growth
Maturity of *H. uarnak* is attained at 4–5 years (van der Elst 1993) but ageing needs to be verified (Dunlop and Mann 2013d).

Generation length
There is no verified information on maximum age or age at maturity for this species, hence data from the blackspotted whipray *Himantura astra*, a related but far smaller species from the Pacific, was used as a proxy. *H. astra* has a maximum age of 29 years and an age at maturity of nine years. This gives a generation length of 20 years (Manjaji-Matsumoto *et al.* 2016a).

FISHERIES MANAGEMENT
SA catch sources
Estimated total catch was <1 ton per annum (DFFE records: 2010-2012; da Silva *et al.* 2015), which comprised the now-closed KZN prawn trawl fishery, with possible catches from the commercial linefishery, the demersal trawl and hake longline fisheries. It is also frequently caught by recreational

shore anglers, mainly in summer months. It was an extremely rare catch in the KZN bather protection programme at about 1 per annum.

SA catch quantities and characteristics

KZN prawn trawl fishery

This species was common bycatch in the KZN prawn trawl industry on the uThukela Banks. The size range was 0.3–0.8 m, with a mean of 0.5 m, which encompassed neonates and larger juveniles. Based on the observer-recorded catches, the extrapolated average annual catch between 1989 and 1992 was 296 individuals (range 224–422). Survival of this bycatch species was around 75%, based on a subsample of only 16 individuals (Fennessy 1994). This fishery was dormant for nearly two decades due to the extended closure of the mouth of Lake St Lucia, resulting in poor prawn recruitment and diminishing prawn catches on the uThukela Banks. The fishing grounds were closed to trawling following the declaration of the uThukela MPA in August 2019.

Recreational shore angling

In KZN competitive shore anglers caught 766 individuals in nearly 947 000 angling hours over a 24-year period (1977–2000), at a rate of 32 per annum and a mean weight of 25 kg; most were released (Pradervand *et al.* 2007). It is also occasionally caught in estuaries (Dunlop and Mann 2013d and references cited therein).

Fishing outside South Africa

This species is retained as a bycatch of tangle/gill net, trawl net, and dropline fisheries throughout Southeast Asia and parts of the Indian Ocean. Demersal fishing pressure has increased in both effort and capacity in many areas of its inshore range during recent decades (Manjaji-Matsumoto *et al.* 2016a). *H. leoparda* was the second most common ray species recorded in fisheries off the Andaman and Nicobar Islands (India), where they were captured in trawl nets, gillnet, hook and line and demersal longlines (Tyabji *et al*. 2020)

Demersal fishing pressure has increased in both effort and capacity in many areas of its inshore range during recent decades. Species-specific catch data are not collected, but aggregated landings data for 'Rays, stingrays, mantas, nei' are reported to FAO by some countries. Indonesian landings increased from ~10,000 t in 1975 to almost 60,000 t in 2003 (Rigby *et al.* 2016).

Population trends

Nothing is known of the current population size or structure, nor the extent of connectivity among subpopulations across the Indo-West Pacific. Although no species-specific data are available, overall catches of stingrays in SE Asia are reported to be declining, with fishermen having to travel further to sustain catch levels. This species' preference for inshore coastal waters means it is also threatened by extensive habitat degradation and destructive fishing practices throughout a large part of its range. Given the continuation of high levels of exploitation throughout most its range where the species is caught in multiple types of fisheries, along with evidence for declines in catches of rays, the level of decline (>30% over the last three generations) and exploitation can be inferred from overall declines in fish catches in the region, as well as from habitat loss. This species was assessed globally as Vulnerable on the IUCN Red List in 2015 (Rigby *et al.* 2016).

ECOTOURISM

This species occurs in shallow waters, particularly those of the iSimangaliso MPA, where scuba diving is extremely popular; therefore it should be regarded as an ecotourism species.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
This species appears to be resident and could benefit from protection in all the nearshore MPAs on the KZN coast, particularly the iSimangaliso MPA, and the uThukela MPA, where neonates and juveniles are known to occur.

Additional local comment
The ban on any demersal shark longlining east of the Kei mouth, which generally occurs at depths of 50–100 m (da Silva *et al*. 2015) will benefit this species.

IUCN Red List Status
<u>Vulnerable 2015: A2bd</u>

Previous IUCN assessments
Vulnerable 2009

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

International comments
Although this species is assessed as Vulnerable globally, based on inferred levels of decline and exploitation across a large part of its range, it is considered to be Least Concern in Australia (Manjaji-Matsumoto *et al.* 2016a).

MANAGEMENT CONSIDERATIONS
Species identification issues make it extremely difficult to formulate management considerations and until this is resolved the two species should therefore be managed as one. The closure to trawling through the recent establishment of the uThukela Banks MPA which is a possible nursery ground has removed the primary source of fishing mortality for this species and, as a result, has reduced the need for management intervention. An investigation of the genetic structure of the local/regional population is needed to place the global Red List status of Vulnerable into local perspective. With anglers' catches peaking in summer, it is possible that this species moves northwards in winter into Mozambique, where it is vulnerable to catches in various artisanal fisheries. A regional assessment would therefore be beneficial. In view of its strongly tropical distribution, it seems unlikely that any management intervention in South Africa will improve the global status of *H. leoparda* from that of Vulnerable. Post-release survival rates should be assessed.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
Virtually nothing is known of the life history and ecology of this species, a situation aggravated by confusion caused by species identification problems. An education programme to promote awareness of the differences between the two species of *Himantura* is needed. Since it is likely to move into Mozambique, improved knowledge of movement patterns, using acoustic telemetry, is recommended. Opportunistic sampling to obtain life history information and tissues for genetic studies would be beneficial.

Himantura uarnak

SCIENTIFIC NAME	*Himantura uarnak* (Forsskål 1775)
COMMON NAME	Reticulate whipray/stingray
FAMILY	Dasyatidae
ENDEMIC	No, Indo-West Pacific Ocean
SIZE RANGE	28–200 cm DW
DISTRIBUTION	E coast: Mozambique border to East London
HABITAT	Demersal on sand and mud bottoms
DEPTH RANGE	0–50 m
MAJOR FISHERIES	Thukela Banks (KZN) prawn trawl fishery and possibly commercial linefishery, demersal trawl and hake longline fisheries
IUCN STATUS	Vulnerable 2015
CITES REGS	Not listed
MLRA REGS	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	C Elston

SPECIES SUMMARY and RECOMMENDATIONS

Himantura uarnak is a medium-sized demersal ray which is confined to shallow soft substrates in the tropical waters of the Indo-West Pacific Ocean. Historically this was the only honeycomb-patterned/reticulated stingray in the region, but a second species *H. leoparda* was identified in 2008 and is regarded as far more common locally than *H. uarnak.* Therefore, most of the records on the South African coast are likely to be *H. leoparda* and not *H. uarnak.* Estimated annual total catch was <1 ton (DFFE records: 2010–2012), primarily as bycatch in the now-closed KZN prawn trawl fishery, which, according to observer records, caught only neonates and larger juveniles. This species appears to be resident and will derive considerable protection from several inshore MPAs on the east coast, especially the Thukela Banks MPA which is a nursery ground. It was assessed as Vulnerable on the IUCN Red List in 2015, due to heavy fishing pressure and habitat degradation, particularly in SE Asia. An assessment of the genetic structure of the local/regional population is needed to place the global status in local perspective. Confusion over species identification remains a problem and until it is resolved this species and *H. leoparda* should be managed as one. Virtually nothing is known of its life history and ecology.

TAXONOMIC and IDENTIFICATION ISSUES

Himantura uarnak was long regarded as the only stingray with a reticulated, marbled, leopard-like or honeycombed pattern on the upper surface. At the time it was known as *Dasyatis uarnak* (Wallace 1967c, Compagno *et al.* 1989). Last *et al.* (2016) describe forms provisionally identified as *H. uarnak* as one of an unresolved complex of species. A second species with a similar pattern and Indo-West Pacific distribution, *H. leoparda*, was described in 2008. Almost all references to a large, reticulate-patterned stingray species in KZN are now regarded as *H. leoparda*, although *H. uarnak* does occur, but is far scarcer than *H. leoparda* (Ebert *et al.* 2021). This confusion makes it impossible to assess the two species independently.

SOUTH AFRICAN DISTRIBUTION

Both species are restricted to the northern part of the east coast from the Mozambique border to East London (Ebert *et al.* 2021).

REGIONAL DISTRIBUTION

Both species occurs in Mozambique, Kenya and Madagascar, with a widespread tropical and subtropical distribution in the Indo-West Pacific and parts of the East Pacific (Manjaji-Matsumoto *et al.* 2016a, Last *et al.* 2016).

SYNOPSIS OF RESEARCH

In a study of batoid fishes of the east coast of southern Africa 52 mature individuals and three embryos were examined (Wallace 1967c). Nothing has been published since on the life history and ecology of either species of reticulate-patterned stingray in South Africa or the SW Indian Ocean. Dunlop and Mann (2013d) provided a concise overview of life history and fishery-related information of *H. uarnak*. Both these studies are likely to be reporting largely on *H. leoparda.*

ECOLOGY

Depth

It occurs inshore in the surf zone and low-salinity estuaries and in deeper water down to 45 m (Manjaji-Matsumoto *et al.* 2016a, Last *et al.* 2016).

Habitat: Adults

They are often found off sandy beaches, in sandy areas of coral reefs, in shallow estuaries and lagoons, and may even enter fresh water (Dunlop and Mann 2013d and references cited therein).

Habitat: Juveniles/Nursery Grounds

Juveniles are found in estuaries and sheltered bays and also on banks in deeper water (Dunlop and Mann 2013d and references cited therein).

Synopsis of tag deployments

A total of 800 individuals were tagged (ORI Cooperative Fish Tagging Project 1984-2018 inclusive) with 18 (2%) recaptured. Mean distance travelled was 1 km; mean time at liberty 0.8 years (max: 8 km and 6.9 years) (Jordaan *et al.* 2020). It is highly likely that many of those tagged were *H. leoparda.*

Movements

Even though recapture numbers are small, there is strong evidence of site fidelity (Dunlop and Mann 2013d) and possible philopatry with seasonal migrants returning to the same location, as anglers catches peak in summer.

Diet/feeding: adults

The diet comprises benthic invertebrates including bivalves, crustaceans and polychaete worms and small teleosts (Compagno *et al.* 1989).

Diet/feeding: juveniles

Unknown, but possibly similar to adults.

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Histotrophic viviparity
DURATION OF REPRO CYCLE	Unknown
MATING SEASON	Unknown
GESTATION	Unknown
LITTER SIZE	3–5
PUPPING/NURSERY GROUND	Unknown

DISC WIDTH AT BIRTH	28–30 cm; 21–28 cm outside South Africa
DISC WIDTH AT MATURITY	100 cm; 82–84 cm outside South Africa
MAXIMUM DISC WIDTH	200 cm; 160 cm outside South Africa
GENERATION LENGTH	20 years (inferred from *Himatura astra*)

Mode
This species exhibits histotrophic viviparity, in which maternal uterine secretions supplement the nourishment provided by the yolk-sac (Manjaji-Matsumoto *et al.* 2016a).

Duration of reproductive cycle
The duration of the reproductive cycle is unknown.

Mating season and location
This is unknown.

Gestation
This is 12 months (Dunlop and Mann 2013d and references cited therein), but this is likely to pertain to *H. leoparda.*

Litter size
This is 3–5 (Dunlop and Mann 2013d and references cited therein), but this is likely to pertain to *H. leoparda.* Outside South Africa, there is reference to a single pregnant female with 2 embryos (Manjaji-Matsumoto *et al.* 2016a).

Disc width at birth
This is given as 28–30 cm (Dunlop and Mann 2013d and references cited therein), but this is likely to pertain to *H. leoparda.* Outside South Africa, size at birth is 21–28 cm (Manjaji-Matsumoto *et al.* 2016a and references cited therein).

Pupping season and nursery ground
The Lake St Lucia estuarine system is an important nursery ground (Dunlop and Mann 2013d and references cited therein). Neonates and larger juveniles were also found on the uThukela Banks in deeper water of 20–40 m (Fennessy 1994). It is possible that these observations pertain to *H. leoparda.*

Disc width at maturity
This species matures at 100 cm (van der Elst 1993). Outside South Africa, female size at maturity is unknown; males mature at ±82 cm (Last *et al.* 2016).

Maximum disc width
This species attains 200 cm (van der Elst 1993) but outside South Africa this is 160 cm (Last *et al.* 2016).

Age and growth
This is unknown.

Generation length
There is no information on this species' maximum age and age at maturity, hence data from the Blackspotted Whipray *Himantura astra*, a related but far smaller species from the Pacific, was used as a proxy. *H. astra* has a maximum age of 29 years and an age at maturity of nine years. This gives a generation length of 20 years (Manjaji-Matsumoto *et al.* 2016a).

FISHERIES MANAGEMENT
SA catch sources, quantities and characteristics

Estimated total catch was <1 ton per annum (DFFE records: 2010-2012; da Silva *et al.* 2015), which comprised the now-closed KZN prawn trawl fishery, with possible catches from the commercial linefishery, the demersal trawl and hake longline fisheries. It is also caught by recreational shore anglers. It was a very rare catch in KZN bather protection programme at about 1 individual per annum. All these records are likely to be *H. leoparda.*

KZN prawn trawl fishery
This species was a common bycatch in the KZN prawn trawl industry on the uThukela Banks. Based on the observer-recorded catches, the extrapolated average annual catch between 1989 and 1992 was 296 (range 224-422). The size range was 0.3–0.8 m, with a mean of 0.5 m, which encompassed neonates and larger juveniles. Survival of this bycatch species was around 75%, based on a subsample of 16 individuals (Fennessy 1994). This fishery was dormant for nearly two decades due to the extended closure of the mouth of Lake St Lucia, resulting in poor prawn recruitment and diminishing prawn catches on the uThukela Banks. The fishing grounds were closed to trawling following the declaration of the uThukela MPA in August 2019.

Recreational shore angling
In KZN competitive shore anglers caught 766 individuals over a 24-year period (1977–2000), at a rate of 32 per annum and with a mean weight of 25 kg; most are released (Pradervand *et al.* 2007). It is also caught in estuaries (Dunlop and Mann 2013d and references cited therein).

Fishing outside South Africa
This species is retained as a bycatch of tangle/gill net, trawl net, and dropline fisheries throughout SE Asia and parts of the Indian Ocean. Demersal fishing pressure has increased in both effort and capacity in many areas of this species' inshore range during recent decades (Manjaji-Matsumoto *et al.* 2016a). Pierce *et al.* (2008) acknowledged its presence in Mozambique, but no details of any catches were reported.

Population trends
Nothing is known of the current population size or structure, nor the extent of connectivity among subpopulations across the Indo-West Pacific. Although no species-specific data are available, overall catches of stingrays in SE Asia are reported to be declining, with fishermen having to travel further and further to sustain catch levels. This species’ preference for inshore coastal waters means it is also threatened by extensive habitat degradation and destructive fishing practices throughout a large part of its range. Given the continuation of high levels of exploitation throughout most its range where the species is caught in multiple types of fisheries, along with evidence for declines in catches of rays, the level of decline (>30% over the last three generations) and exploitation can be inferred from overall declines in fish catches in the region, as well as from habitat loss. This species was assessed globally as Vulnerable on the IUCN Red List in 2015 (Manjaji-Matsumoto *et al.* 2016a).

ECOTOURISM
This species occurs in shallow waters, particularly those of the iSimangaliso MPA, where scuba diving is extremely popular; therefore it should be regarded as an ecotourism species.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
This species appears to be resident and could benefit from protection in all the nearshore MPAs on the KZN coast, particularly the iSimangaliso MPA, and the uThukela MPA, where neonates and juveniles are known to occur.

Additional local comment
The ban on any demersal shark longlining east of the Kei mouth, which generally occurs at depths of 50–100 m (da Silva *et al*. 2015) will benefit this species. The prolonged closure to the sea of the Lake St Lucia estuarine system has adversely impacted this species through the loss of an important nursery ground.

IUCN Red List Status
<u>Vulnerable 2015: A2bd</u>

Previous IUCN assessments
Vulnerable 2009

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
There is no mention of this species.

International comments
Although this species is assessed as Vulnerable globally, based on inferred levels of decline and exploitation across a large part of its range, it is considered to be Least Concern in Australia (Manjaji-Matsumoto *et al.* 2016a).

MANAGEMENT CONSIDERATIONS
Species identification issues and the confusion with *H. leoparda* make it extremely difficult to formulate species-specific management considerations and until this is resolved the two species should therefore be managed as one. The closure of the inshore KZN prawn trawl fishery on the uThukela Banks has removed a major portion of the catch, thereby reducing the need for management intervention. An investigation of the genetic structure of the local/regional population is needed to place the global Red List status of Vulnerable into local perspective. With anglers' catches peaking in summer, it is possible that this species moves northwards in winter into Mozambique, where it is vulnerable to catches in various artisanal fisheries. A regional assessment would therefore be beneficial. In view of its strongly tropical distribution, it seems unlikely that any management intervention in South Africa will improve the global status of *H. uarnak* from that of Vulnerable.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
Virtually nothing is known of the life history and ecology of this species, a situation aggravated by confusion caused by species identification problems. An education programme to promote awareness of the differences between the two species of *Himantura* would be beneficial, as would opportunistic sampling to obtain life history information and tissues for population genetic studies. Since *H. uarnak* is likely to move into Mozambique, improved knowledge of movement patterns, using acoustic telemetry, is recommended.

Pastinachus ater

SCIENTIFIC NAME	*Pastinachus ater* (Macleay 1883)
COMMON NAME	Broad cowtail ray/feathertail ray
FAMILY	Dasyatidae
ENDEMIC	No, tropical Indo-Pacific
SIZE RANGE	18–200 cm DW
DISTRIBUTION	E coast only: northern KZN
HABITAT	Demersal on soft bottoms
DEPTH RANGE	0–60 m
MAJOR FISHERIES	None listed
IUCN STATUS	Vulnerable 2020
CITES REGS	Not listed
MLRA REGS	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	C Elston

SPECIES SUMMARY and RECOMMENDATIONS

Pastinachus ater is a medium-sized, demersal ray which is widely distributed in the tropical Indo-Pacific but appears to be rare in South Africa. It occurs in inshore waters, including estuaries and rivers. There were no reported local catches (DFFE records: 2010-2012). In view of its tropical distribution, it is likely to move into Mozambican waters where it is vulnerable to capture in artisanal fisheries. It was globally assessed as Vulnerable on the IUCN Red List in 2020, as a result of heavy fishing pressure elsewhere in its range. An assessment of the genetic structure of the local/regional population is needed to place this global status in local perspective. Virtually nothing is known of its life history and ecology, both locally and internationally. Any opportunistic sampling should be used to collect biological information and tissue samples for genetic studies.

TAXONOMIC and IDENTIFICATION ISSUES

Smith (1957, cited by Wallace 1967c) first reported this stingray, as *Dasyatis sephen*, from northern KZN. It was reported as *Hypolophus sephen* (Compagno *et al.* 1989) and more recently as *Pastinachus sephen* (Last and Stevens 1994). Molecular data confirmed that the single, widespread Indo–Pacific species, *Pastinachus sephen* consists of two species, the widespread *P. ater* and *P. sephen* which is restricted to the NW Indian Ocean (Last *et al.* 2016, cited by Sherman *et al.* 2021). This species is easily recognised by its distinctive ventral tail fold.

SOUTH AFRICAN DISTRIBUTION

This species occurs on the northern part of the east coast, where it appears to be rare (Ebert *et al.* 2021).

REGIONAL DISTRIBUTION

This species occurs in Mozambique, northwards along the entire African coast (Sherman *et al.* 2021). It is widely distributed in the tropical Indo-Pacific (Last *et al.* 2016).

SYNOPSIS OF RESEARCH

In a study of batoid fishes of the east coast of southern Africa, Wallace (1967c) reports this species as occurring in northern KZN but was unable to obtain any specimens. Nothing has been published on the life history and ecology of this species in South Africa. Research conducted at an atoll in Seychelles identified movement patterns and diet (Elston *et al*. 2020, 2021, 2022). Very little is known on the biology of this species from elsewhere in its range (Sherman *et al.* 2021).

ECOLOGY

Depth

It is demersal in inshore and brackish waters from the surface to a depth of 60 m (Sherman *et al.* 2021).

Habitat: Adults

This species inhabits shallow sandy and muddy inshore substrates, including estuaries and coral lagoons (Last and Stevens 1994, Sherman *et al.* 2021) and may occurs in large rivers far from the sea (Compagno *et al.* 1989).

Habitat: Juveniles/Nursery Grounds

Evidence suggests that atolls are used as nursery habitats in the SW Indian Ocean (Elston *et al.* 2021). Juveniles were resident to an atoll in Seychelles, where they preferably remained on the shallow sand flats of the atoll, only moving into the deeper lagoon habitat at the lowest tides or when temperatures on the flats become too warm (Elston *et al.* 2022).

Synopsis of tag deployments

This species is not listed in the table of individuals that have been tagged in the ORI Cooperative Fish Tagging Project 1984-2018 inclusive (Jordaan *et al.* 2018).

Movements

In the absence of any local tag deployments, it is not possible to ascertain anything of the movement patterns of this species in South Africa. However, passive acoustic telemetry was used to monitor the movements of 20 individuals within and around the St. Joseph Atoll, Seychelles (Elston *et al.* 2021). Juveniles and adults were found to be resident to the atoll for a period of months to years. During that time, individuals displayed highly restricted movements with most detections occurring within 1 km of tagging locations. However, juveniles increased their range of movements with growth before dispersing to various locations on the Amirantes Bank, moving distances of up to 90 km.

Diet/feeding: adults

The diet of adults remains unknown, but stable isotope signatures reveal they have a significantly different diet to juveniles in Seychelles (Elston *et al.* 2020).

Diet/feeding: juveniles

The diet of juveniles was assessed by Elston *et al.* (2020), using stomach content and stable isotope analyses at an atoll in Seychelles. Stomach contents were dominated by bivalves, but annelids and polychaetes were also important components.

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Histotrophic viviparity
DURATION OF REPRO CYCLE	Unknown
MATING SEASON	Unknown
GESTATION	Unknown
LITTER SIZE	2 (outside South Africa)
PUPPING/NURSERY GROUND	Unknown
DISC WIDTH AT BIRTH	18 cm and larger (Australia)
DISC WIDTH AT MATURITY	Unknown
MAXIMUM DISC WIDTH	200 cm (outside South Africa)

GENERATION LENGTH	21.5 years, inferred from *Maculabatis astra*

Mode
This species exhibits histotrophic viviparity in which maternal uterine secretions supplement the nourishment provided by the yolk-sac.

Duration of reproductive cycle
This is unknown.

Gestation
This is unknown.

Mating season and location
This is unknown.

Litter size
Litter size is only 2 (outside South Africa, Sherman *et al.* 2021).

Pupping season and nursery ground
This is unknown.

Disc width at birth
This is about 18 cm and larger in Australia (Last and Stevens 1994).

Disc width at maturity
Female and male size-at-maturity are unknown (Sherman *et al.* 2021).

Maximum disc width
It reaches a maximum size of 200 cm (Sherman *et al.* 2021).

Age and growth
Age at maturity and maximum age is unknown (Sherman *et al.* 2021).

Generation length
Generation length is inferred from a similar species, the blackspotted whipray *Maculabatis astra* which has a generation length of 20 years (Jacobsen 2007, cited by Sherman *et al.* 2021), but is smaller (80 cm) than *P. ater* and thus the generation length for *P. ater* is inferred as 25 years (Sherman *et al.* 2021).

FISHERIES MANAGEMENT
SA catch sources, quantities and characteristics
No local catches were reported (DFFE records: 2010-2012; da Silva *et al*. 2015). It was not listed in the catches by the KZN recreational, competition shore anglers (Pradervand *et al*. 2007).

Fishing outside South Africa
Throughout its distribution, *P. ater* is caught in coastal fisheries by demersal trawl, tangle nets, set nets, gill nets, droplines, longlines and seine nets (Sherman *et al.* 2012 and references cited therein). This species was not listed in an assessment of artisanal fisheries in Mozambique (Pierce *et al.* 2008)

Population trends
There are no species-specific time series or population estimates for *P. ater*, although reconstructed landings data of all whiprays from both Malaysia and Indonesia can be used to infer declines of 50–99% over the past three generation lengths (75 years). It does have refuge in Australia, where it

remains abundant. It is suspected that *P. ater* has undergone a population reduction of 30–49% over the past three generation lengths (75 years) due to actual levels of exploitation and it was assessed globally as Vulnerable on the IUCN Red List in 2020 (Sherman *et al.* 2021).

ECOTOURISM

Even though it is known to occur in shallow waters, this species is rarely seen by scuba divers in South Africa and therefore it cannot be regarded as an ecotourism species,

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)

This species is not listed.

Marine Protected Areas

This species is only found in northern KZN where it will benefit from protection in the iSimangaliso Wetland Park.

Additional local comment

IUCN Status

<u>Vulnerable 2020: A2d</u>

Previous IUCN assessments

Not evaluated.

International comments

MANAGEMENT CONSIDERATIONS

This species is poorly known in South Africa and in the absence of any reported catches, it must be rated as being of very low management priority. Given its shallow water habitat, *P. ater* is extremely vulnerable to catches in various artisanal fisheries in Mozambique and further north. An investigation of local/regional population genetic structure is needed to place the global Red List status of Vulnerable into local perspective. A regional assessment would therefore be beneficial, although the likely outcome is Data Deficient.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

Very little is known of the life history and ecology of this species, both locally and internationally. Opportunistic sampling to obtain life history information and tissues for genetic studies is recommended.

Pateobatis fai

SCIENTIFIC NAME	*Pateobatis fai* (Jordan and Seale 1906)
COMMON NAME	Pink whipray
FAMILY	Dasyatidae
ENDEMIC	No, Indo-West Pacific Ocean
SIZE RANGE	30–180 cm DW
DISTRIBUTION	E coast: Mozambique border to Durban
HABITAT	Demersal on sandy bottoms and coral rubble
DEPTH RANGE	0–200 m
MAJOR FISHERIES	None listed
IUCN STATUS	Vulnerable 2015
CITES REGS	Not listed
MLRA REGS	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	C Elston

SPECIES SUMMARY and RECOMMENDATIONS

Pateobatis fai is a medium-sized demersal ray which occurs over a wide depth range in the tropical coastal waters of the Indo-West Pacific Ocean. Its distribution is poorly defined, as it is often misidentified as *P. jenkinsii* and possibly *Maculabatis* sp.. Inshore it is commonly found on sand in and around rock and coral reefs. There were no reported local catches (DFFE records: 2010–2012), but this could be because this species is so poorly known, especially among recreational anglers. In view of its tropical distribution, it is likely to move into Mozambique waters where it is vulnerable to capture in artisanal fisheries. It was globally assessed as Vulnerable on the IUCN Red List in 2015, as a result of heavy fishing pressure and habitat degradation elsewhere in its range. An assessment of the genetic structure of the local/regional population is needed to place this global status in local perspective. Virtually nothing is known of its life history and ecology. Any opportunistic sampling should be used to collect biological information and tissue samples for genetic studies.

TAXONOMIC and IDENTIFICATION ISSUES

Pateobatis fai was previously described as *Dasyatis pupureus* (Wallace 1967c) but listed as *Himantura* sp. by Compagno *et al.* (1989) who suspected that it may be *H. fai*. It is very similar in appearance to its congener *P. jenkinsii.* These two species are sympatric in much of the Indo-West Pacific Ocean, including South Africa. *P. fai* lacks the distinctive row of enlarged thorns along the mid-disc and tail, that are diagnostic of *P. jenkinsii* (Last *et al.* 2016). *P. fai* may also be mistaken for the brown or sharpnosed ray, known as *Himantura gerrardi* (van der Elst 1993, Heemstra and Heemstra 2004), a species which does not occur in South Africa (Last *et al.* 2016) but is likely to *Maculabatis* cf. *ambigua,* which has been recorded from Mozambique and Tanzania (Ebert *et al.* 2021).

SOUTH AFRICAN DISTRIBUTION

This species is restricted to northern and central KZN waters from the Mozambique border to Durban, (Ebert *et al.* 2021).

REGIONAL DISTRIBUTION

This species is not listed as present in Mozambique (Pierce *et al.* 2008), Kenya, Madagascar or any other country in the SW Indian Ocean, but this is likely to be an identification issue. It does occur in the eastern Indian Ocean (Manjaji-Matsumoto *et al.* 2016b).

SYNOPSIS OF RESEARCH

In a study of batoid fishes of the east coast of southern Africa six immature individuals of this species, all from Durban Bay (Port of Durban) and described as *Dasyatis pupureus*, were examined by Wallace (1967c), who described it as not common in the region. Nothing has been published on the life history and ecology of *P. fai* in South Africa. It does not feature in two popular local fish guides (van der Elst 1993, Heemstra and Heemstra 2004).

ECOLOGY

Depth

It occurs from the intertidal zone to depths of up to 200 m (Manjaji-Matsumoto *et al.* 2016b).

Habitat: Adults

Inshore they have been observed on soft substrates, sometimes adjacent to rock and coral reefs (Manjaji-Matsumoto *et al.* 2016b), as well as large embayments such as Durban Bay (Wallace 1967c).

Habitat: Juveniles/Nursery Grounds

It is not known if juveniles utilise other habitats.

Synopsis of tag deployments

Although this species does occur close inshore, including Durban Bay, it is so poorly known that any individuals tagged would be assigned to other species of stingray such as *P. jenkinsii* or *Himantura gerrardi* (now *Maculabatis* sp).

Movements

These are not known.

Diet/feeding: adults

The diet of *P. fai* comprises prawns and small teleosts (Last *et al*. 2016).

Diet/feeding: juveniles

There is no evidence that it is different from that of the adults.

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Histotrophic viviparity
DURATION OF REPRO CYCLE	Unknown
MATING SEASON	Unknown
GESTATION	Unknown
LITTER SIZE	Unknown
PUPPING/NURSERY GROUND	Unknown
DISC WIDTH AT BIRTH	30–55 cm (outside South Africa)
DISC WIDTH AT MATURITY	F: ?; M: 108-122 cm (outside South Africa)
MAXIMUM DISC WIDTH	At least 180 cm (outside South Africa)
GENERATION LENGTH	20 years (inferred from *Himatura astra*)

Mode

This species exhibits histotrophic viviparity in which maternal uterine secretions supplement the nourishment provided by the yolk-sac (Manjaji-Matsumoto *et al.* 2016b).

Duration of reproductive cycle

No pregnant females have been documented from South Africa. The duration of the reproductive cycle and litter size are unknown.

Mating season and location
This is unknown.

Gestation
This is unknown.

Litter size
This is unknown.

Disc width at birth
This species is born at 30-55 cm (Manjaji-Matsumoto *et al.* 2016b).

Pupping season and nursery ground
This is unknown.

Disc width at maturity
Female size at maturity is unknown; males mature at 108-122 cm (Manjaji-Matsumoto *et al.* 2016b).

Maximum disc width
This species attains at least 180 cm (Manjaji-Matsumoto *et al.* 2016b).

Age and growth
This is unknown.

Generation length
There is no information on this species' maximum age and age at maturity, hence data from the blackspotted whipray *Himantura astra*, a related but far smaller species from the Pacific was used as a proxy. *H. astra* have a maximum age of 29 years and an age at maturity of nine years. This gives a generation length of 20 years (Manjaji-Matsumoto *et al.* 2016b).

FISHERIES MANAGEMENT

SA catch sources, quantities and characteristics
No local catches were reported (DFFE records: 2010-2012; da Silva *et al*. 2015). This species is so poorly known that it is not likely to be included in any fishery catch statistics. It was not reported in the elasmobranch bycatch of the KZN prawn trawl fishery on the Thukela Banks (Fennessy 1994) or the KZN bather protection programme. It was not listed in the catches by the KZN recreational, competition shore anglers (Pradervand *et al.* 2007).

Fishing outside South Africa
This species is caught by demersal tangle net, bottom trawl, commercial gillnet and, to a lesser extent, longline fisheries throughout its range. Throughout SE Asia there is significant fishing pressure on large batoids, and whether targeted or taken as bycatch, all are landed and utilised. Overall, fishing pressure is significant, and generally unregulated, over most of the species' distribution in the Indo-West Pacific (Manjaji-Matsumoto *et al.* 2016b). Pierce *et al.* (2008) did not include this species in their provisional list of elasmobranchs of Mozambique.

Population trends
Nothing is known of the current population size or structure, nor the extent of connectivity among subpopulations across the Indo-West Pacific. Habitat degradation imposes additional pressure on this inshore species. This species was assessed globally as Vulnerable on the IUCN Red List in 2015, based

on inferred levels of decline and exploitation across a large part of its range, but was considered to be Least Concern in Australia (Manjaji-Matsumoto *et al.* 2016b).

ECOTOURISM

This species is an ecotourism species as it occurs in shallow waters, including those of the iSimangaliso MPA, where scuba diving is extremely popular and individiduals are not uncommon (Grant Smith, Sharklife, pers. comm.).

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act

Threatened or Protected Species (TOPS)

This species is not listed.

Marine Protected Areas

Until more is known of this species it is difficult to determine which MPAs are the most beneficial to this species, but it does occur in the iSimangaliso MPA.

Additional local comment

It is interesting to note that the local presence of this species was recognised by Wallace (1967c) as *D. purpureus* and Compagno *et al.* (1989) as *Himantura* sp., but it was not included in two popular local fish guides (van der Elst 1993; Heemstra and Heemstra 2004). This could explain why this species has not been recorded in shore anglers' catches.

IUCN Red List Status

<u>Vulnerable 2015: A2bd</u>

This is an amended version of the 2015 assessment to accommodate the change in genus name from *Himatura* to *Pateobatis.*

Previous IUCN assessments

Least Concern 2009

MANAGEMENT CONSIDERATIONS

This species is poorly known and in view of the apparently low catches of this species, it is very difficult to make any management recommendations. It is highly likely that this species moves into Mozambique, where it is vulnerable to catches in various artisanal fisheries. An investigation of local/regional population genetic structure is needed to place the global Red List status of Vulnerable into local perspective. A regional assessment would therefore be beneficial. In view of its strongly tropical distribution, it seems unlikely that any management intervention in South Africa will improve the global status of *P. fai* from that of Vulnerable.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

Virtually nothing is known of the life history and ecology of this species, a situation aggravated by the apparent lack of awareness of the existence of this species. It would be beneficial to educate KZN shore anglers on its presence, with a view to at least obtaining distributional, seasonal and size records for this species. Since it is likely to move into Mozambique, improved knowledge of movement patterns, using acoustic telemetry, would be beneficial. Opportunistic sampling to obtain life history information and tissues for genetic studies is needed.

Pateobatis jenkinsii

SCIENTIFIC NAME	*Pateobatis jenkinsii* (Annandale 1909)
COMMON NAME	Jenkins whipray
FAMILY	Dasyatidae
ENDEMIC	No, Indo-West Pacific Ocean
SIZE RANGE	30–150 cm DW
DISTRIBUTION	E coast: Mozambique border to Durban
HABITAT	Demersal on sandy bottoms and coral rubble
DEPTH RANGE	0–50 m, possibly 90 m
MAJOR FISHERIES	None listed
IUCN STATUS	Vulnerable 2015
CITES REGS	Not listed
MLRA REGS	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	C Elston

SPECIES SUMMARY and RECOMMENDATIONS

Pateobatis jenkinsii is a medium-sized demersal ray with a patchy distribution in the coastal, tropical waters of the Indo-West Pacific Ocean. Inshore it is commonly found on sand in and around rock and coral reefs. There were no reported local catches (DFFE records: 2010–2012), but this could be because this species is so poorly known, especially among recreational anglers. In view of its tropical distribution, it is likely to move into Mozambique waters where it is vulnerable to capture in artisanal fisheries. It was globally assessed as Vulnerable on the IUCN Red List in 2015, as a result of heavy fishing pressure and habitat degradation elsewhere in its range. An assessment of the genetic structure of the local/regional population is needed to place this global status in local perspective. Virtually nothing is known of its life history and ecology. Any opportunistic sampling should be used to collect biological information and tissue samples for genetic studies.

TAXONOMIC and IDENTIFICATION ISSUES

The genus *Pateobatis*, consisting of five medium-size to very large, marine whiprays, was previously known as *Himantura*, including *H. jenkinsii* (Last *et al.* (2016). The presence of this species was recognised by Wallace (1967c) but in his description of this species as *Dasyatis jenkinsii* he makes no mention of the presence of any enlarged thorns on the midline, a highly characteristic feature. It is therefore likely that this particular species may be an unidentified species of *Maculabatis*, which was referred to in popular fish guides as *Himantura gerrardi* (van der Elst 1993, Heemstra and Heemstra 2004).

Compagno *et al.* (1989) listed this species as *H. draco*, which is now regarded as a synonym of *P. jenkinsii*. The South African specimens have dark spots along the posterior margin of the disc. *P. jenkinsii* may be mistaken for *P. fai*, with both species sympatric over much of their Indo-West Pacific range (Manjaji-Matsumoto *et al.* 2016c and references cited therein). *P. jenkinsii* has a distinct band of enlarged, erect, hooked thorns on the midline of the disc; these thorns are absent in *P. fai* (Compagno *et al.* 1989).

SOUTH AFRICAN DISTRIBUTION

This species is restricted to northern and central KZN waters from the Mozambique border to Durban, in the northern part of the east coast (Ebert *et al.* 2021).

REGIONAL DISTRIBUTION

This species is present in Mozambique and Madagascar and is widespread in the eastern Indian Ocean (Manjaji-Matsumoto *et al.* 2016c).

SYNOPSIS OF RESEARCH

In a study of batoid fishes of the east coast of southern Africa 50 specimens of *Dasyatis jenkinsii*, comprising both sexes, embryos and adults, were examined (Wallace 1967c) who described it as most abundant inshore in the surf zone, estuaries and lagoons in summer months and very common in Durban Bay. Nothing has been published subsequently on the life history and ecology in South Africa. The presence of this and three other stingray species was documented by citizen scientists while scuba diving at selected dive locations in southern Mozambique (Keeping *et al.* 2021).

ECOLOGY

Depth

It occurs from the intertidal zone to depths of 50 m, possibly 90 m (Manjaji Matsumoto *et al.* 2016 and references cited therein).

Habitat: Adults

Inshore they have been observed on soft substrates, sometimes adjacent to rock and coral reefs (Manjaji Matsumoto *et al.* 2016) as well as large embayments such as the Port of Durban, known locally as Durban Bay (Wallace 1967c).

Habitat: Juveniles/Nursery Grounds

It is not known if juveniles utilise other habitats.

Synopsis of tag deployments

Although this species does occur close inshore, including Durban Bay, it is so poorly known that any individuals tagged appear to have been assigned to other species of stingray. A likely candidate is *Himantura gerrardi* or sharpnose ray which has now been tentatively identified as *Maculabatis* cf *ambigua*, as *H. gerrardi* does not occur in South Africa (Ebert *et al.* 2021).

Movements

Unknown.

Diet/feeding: adults

The diet of *P. jenkinsii* comprises prawns and small teleosts (Last *et al*. 2016).

Diet/feeding: juveniles

There is no evidence that it is different from that of the adults.

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Histotrophic viviparity
DURATION OF REPRO CYCLE	Unknown
MATING SEASON	Unknown
GESTATION	Unknown
LITTER SIZE	2 (n=1; Durban Bay)
PUPPING/NURSERY GROUND	Unknown
DISC WIDTH AT BIRTH	23 cm
DISC WIDTH AT MATURITY	F: 80 ±cm; M: 70-85 cm

MAXIMUM DISC WIDTH	150 cm
GENERATION LENGTH	20 years (inferred from *Himantura astra*)

Mode
This species exhibits histotrophic viviparity in which maternal uterine secretions supplement the nourishment provided by the yolk-sac (Manjaji-Matsumoto *et al.* 2016c).

Duration of reproductive cycle
The duration of the reproductive cycle is unknown.

Mating season and location
This is unknown.

Gestation
This is unknown.

Litter size
One pregnant female was captured in Durban Bay, with two pups (Wallace 1967c).

Disc width at birth
This species is born at ±23 cm (Manjaji-Matsumoto *et al.* 2016c).

Pupping season and nursery ground
This is unknown.

Disc width at maturity
A single pregnant female of 80 cm and two mature males of 71-73 cm were caught in Durban Bay (Wallace 1967c). Elsewhere in its range, males mature at 75-85 cm (Manjaji-Matsumoto *et al.* 2016c).

Maximum disc width
This species attains at least 150 cm (Manjaji Matsumoto *et al.* 2016).

Age and growth
This is unknown.

Generation length
There is no information on this species' maximum age and age at maturity, hence data from the blackspotted whipray *Himantura astra*, a related but far smaller species from the Pacific was used as a proxy. *H. astra* has a maximum age of 29 years and an age at maturity of nine years. This gives a generation length of 20 years (Manjaji-Matsumoto *et al.* 2016c).

FISHERIES MANAGEMENT
SA catch sources, quantities and characteristics
No local catch estimates were reported (DFFE records: 2010-2012; da Silva *et al*. 2015). This species is so poorly known that it is not likely to be included in any fishery catch statistics. It was not reported in the elasmobranch bycatch of the KZN prawn trawl fishery on the Thukela Banks (Fennessy 1994) or the KZN bather protection programme. It was not listed in the catches by the KZN recreational, competition shore anglers (Pradervand *et al.* 2007).

Fishing outside South Africa
This species is caught by demersal tangle net, bottom trawl, commercial gillnet and, to a lesser extent, longline fisheries throughout its range. Throughout SE Asia there is significant fishing pressure on large batoids, and whether targeted or taken as bycatch, all are landed and utilised. Overall, fishing pressure

is significant, and generally unregulated, over most of the species' distribution in the Indo-West Pacific (Manjaji Matsumoto *et al.* 2016). Pierce *et al.* (2008) included this species in their provisional list of elasmobranchs of Mozambique, but with no detail of any catches.

Population trends
Nothing is known of the current population size or structure, nor the extent of connectivity among subpopulations across the Indo-West Pacific. Given the continued high levels of exploitation throughout its range in SE Asia, where the species is caught in multiple types of fisheries, along with evidence for declines in catches of rays, the level of decline (>30% over the last three generations) and exploitation can be inferred from overall declines in fish catches in the region, as well as from habitat loss. *P. jenkinsii* was assessed globally as Vulnerable on the IUCN Red List in 2015, based on inferred levels of decline and exploitation across a large part of its range. It was considered to be Least Concern in Australia (Manjaji-Matsumoto *et al.* 2016c).

ECOTOURISM
This species should be considered as an ecotourism species as it occurs in shallow waters, including those of the iSimangaliso MPA, where scuba diving is extremely popular.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
Until more is known of this species and its distribution, it is difficult to determine whether any of the existing MPAs are beneficial to this species. Given its tropical distribution and shallow water habitat, the iSimangaliso MPA is likely to offer the most protection.

Additional local comment
This species will benefit from the current ban on any demersal shark longlining east of the Kei River mouth (this excludes the entire KZN and Wild Coast), which usually occurs at depths of 10–100 m.

IUCN Red List Status
<u>Vulnerable 2015: A2bd</u>
This is an amended version of the 2015 assessment to accommodate the change in genus name from *Himantura* to *Pateobatis.*

Previous IUCN assessments
Least Concern 2009, assessed as *H. jenkinsii.*

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

International comments

Additional local comment

MANAGEMENT CONSIDERATIONS

This species is poorly known and in view of the apparently low catches of this species, it is very difficult to make any management recommendations. It is highly likely that this species moves into Mozambique, where it is vulnerable to catches in various artisanal fisheries. An investigation of local/regional population genetic structure is needed to place the global Red List status of Vulnerable into local perspective. A regional assessment would therefore be beneficial. In view of its strongly tropical distribution, it seems unlikely that any management intervention in South Africa will improve the global status of *P. jenkinsii* from that of Vulnerable.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

Virtually nothing is known of the life history and ecology of this species, a situation aggravated by the apparent lack of awareness of the existence of this species. It would be beneficial to educate KZN shore anglers on its presence, with a view to at least obtaining distributional, seasonal and size records of this species. Since it is likely to move into Mozambique, improved knowledge of movement patterns, using acoustic telemetry, would be beneficial. Opportunistic sampling to obtain life history information and tissues for genetic studies is needed.

Taeniurops meyeni

SCIENTIFIC NAME	*Taeniurops meyeni* (Müller and Henle 1841)
COMMON NAME	Round ribbontail ray/Blotched stingray/Fantail ray
FAMILY	Dasyatidae
ENDEMIC	No, Indo-West Pacific Ocean
SIZE RANGE	30–180 cm DW
DISTRIBUTION	E coast only: KZN
HABITAT	Demersal on sand patches in or close to rock reefs
DEPTH RANGE	0–440 m
MAJOR FISHERIES	None listed
IUCN STATUS	Vulnerable 2015
CITES REGS	Not listed
MLRA REGS	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	C Elston

SPECIES SUMMARY and RECOMMENDATIONS

Taeniurops meyeni is a medium-sized demersal ray which occurs over a wide depth range in the tropical waters of the Indo-West Pacific Ocean. Inshore it is commonly found on sand in and around rock and coral reefs. There were no reported local catches (DFFE records: 2010-2012). In view of its tropical distribution, it is likely to move into Mozambique waters where it is vulnerable to capture in artisanal fisheries. It was globally assessed as Vulnerable on the IUCN Red List in 2015, as a result of heavy fishing pressure and habitat degradation elsewhere in its range. An assessment of the genetic structure of the local/regional population is needed to place this global status in local perspective. Virtually nothing is known locally of its life history and ecology. Any opportunistic sampling should be used to collect biological information and tissue samples for genetic studies.

TAXONOMIC and IDENTIFICATION ISSUES

Taeniurops meyeni was long known as *Taeniura melanospila* (Wallace 1967c) and then *Taeniura melanospilos* (Compagno *et al.* 1989) and more recently *Taeniura meyeni (*Last and Stephens 1994). There are two species in the genus *Taeniurops*, but only one occurs in the West Indian Ocean (Last *et al.* 2016).

SOUTH AFRICAN DISTRIBUTION

This species is restricted to KZN waters (Ebert *et al.* 2021).

REGIONAL DISTRIBUTION

This species also occurs in Mozambique, Kenya and Madagascar, with a widespread tropical and subtropical distribution in the Indo-West Pacific and parts of the East Pacific (Kyne and White 2015).

SYNOPSIS OF RESEARCH

In a study of batoid fishes of the east coast of southern Africa five mature individuals of this species, then referred to as *Taeinura melanospila*, were examined (Wallace 1967c). Nothing has been published on the life history and ecology of this species in South Africa, despite being described as common (Compagno *et al.* 1989). The presence of this and three other stingray species was documented by citizen scientists while scuba diving at selected dive locations in southern Mozambique (Keeping *et al.* 2021).

ECOLOGY

Depth

It occurs inshore in the surf zone out to the upper slope in depths of up to 440 m (Compagno *et al.* 1989).

Habitat: Adults
Inshore they have been observed on sand in association with rock and coral reefs (Kyne and White 2015).

Habitat: Juveniles/Nursery Grounds
It is not known if juveniles utilise other habitats.

Synopsis of tag deployments
A total of 56 individuals were tagged (ORI Cooperative Fish Tagging Project 1984-2018 inclusive) with 2 (4%) recaptured. Mean distance travelled was 4 km; mean time at liberty 0.12 years (max: 8 km and 0.2 years) (Jordaan *et al.* 2020).

Movements
It is difficult to draw conclusions from only two recaptures, but both indicate short-term site affinity.

Diet/feeding: adults
The diet comprises benthic invertebrates and small teleosts (Last *et al*. 2016).

Diet/feeding: juveniles
There is no evidence that it is different from that of the adults.

South African toxicological studies
No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Histotrophic viviparity
DURATION OF REPRO CYCLE	10 months (in captivity)
MATING SEASON	Unknown
GESTATION	Well under 10 months (in captivity)
LITTER SIZE	Up to 7
PUPPING/NURSERY GROUND	Unknown
DISC WIDTH AT BIRTH	36 cm (in captivity); 30–35 cm (outside South Africa)
DISC WIDTH AT MATURITY	F: ?; M: 100-110 cm (outside South Africa)
MAXIMUM DISC WIDTH	180 cm
GENERATION LENGTH	21.5 years inferred from *Dasyatis lata*

Mode
This species exhibits histotrophic viviparity in which maternal uterine secretions supplement the nourishment provided by the yolk-sac.

Duration of reproductive cycle
This appears to be about 10 months from a single captive female which gave birth in January 2020, in October 2020 and again in July 2021 at uShaka Sea World, Durban (Simon Chater, SAAMBR, unpubl. data). No other pregnant females have been documented from South Africa.

Gestation

This is less than 10 months, based on the captive situation at uShaka Sea World. The female gave birth in early January; in mid-April the male was observed chasing the female; mating bites were present in mid-June; in mid-July the female appeared pregnant; in mid-September there were clear signs of embryo movement; birth took place in early October (Simon Chater, unpubl. data)

Mating season and location
This is unknown in the wild, but there was no seasonal pattern evident from the captive pair at uShaka Sea World.

Litter size
Litter size is up to seven (Compagno *et al.* 1989; Last *et al.* 2016). The litters of the three captive births at uShaka Sea World were 3, 5 and 5 (Simon Chater, unpubl. data)

Pupping season and nursery ground
This is unknown in South Africa.

Disc width at birth
The mean size of those born in captivity at uShaka Sea World, Durban was 36 cm (Simon Chater, unpubl. data). This species is born at 30–35 cm elsewhere (Last *et al.* 2016).

Disc width at maturity
Female size at maturity is unknown; males mature at 100–110 cm (Last *et al.* 2016).

Maximum disc width
This species attains 180 cm (Last and Stevens 2009).

Age and growth
This is unknown.

Generation length
Using data from the brown stingray *Dasyatis lata*, a related species of similar size from the Pacific as a proxy, generation length for *T. meyeni* is inferred to be 21.5 years (Kyne and White 2015).

FISHERIES MANAGEMENT
SA catch sources, quantities and characteristics
No local catches were reported (DFFE records: 2010-2012; da Silva *et al*. 2015). This species was not documented in the elasmobranch bycatch of the KZN prawn trawl fishery on the Thukela Banks (Fennessy 1994) or caught in the KZN bather protection programme (KZN Sharks Board, unpublished data). It was not listed in the catches by the KZN recreational, competition shore anglers (Pradervand *et al.* 2007), although it is caught and usually released (Compagno *et al.* 1989) and sometimes tagged (Jordaan *et al.* 2020).

Fishing outside South Africa
This species is caught by line gear and trawl throughout its range. Throughout SE Asia there is significant fishing pressure on large batoids, and whether targeted or taken as bycatch, all are landed and utilised. Overall, fishing pressure is significant, and generally unregulated, over most of the species' distribution in the Indo-West Pacific. Additional regional pressure on its habitat due to destructive fishing practices (dynamite fishing) and run-off affecting coral reef systems, the main habitat of the species. In Australia, the species is a discarded bycatch in demersal prawn trawl fisheries (Kyne and White 2015). Pierce *et al.* 2008) acknowledged its presence in Mozambique, but no details of any catches were reported.

Population trends

Nothing is known of the current population size or structure, nor the extent of connectivity among subpopulations across the Indo-West Pacific.

Species-specific data on long-term declines in elasmobranchs in the SE Asian waters, which is one of the most heavily fished regions globally, are lacking. The species is inferred to have undergone a population size reduction of at least 30% across its global range over the past 65 years (three generations). This was based on the intense and unregulated fishing pressure across much of its range, especially in SE Asia, and its sensitivity to various fishing methods, and the general declining health of coral reef ecosystems (its main habitat) throughout its Indo-West Pacific distribution. This species was globally assessed as Vulnerable on the IUCN Red List in 2015 (White and Kyne 2015).

ECOTOURISM

This species is an important ecotourism species as it occurs in shallow waters, and is the most common stingray on the Aliwal Shoal (Geremy Cliff, formerly KZN Sharks Board, pers. obs.), where scuba diving is extremely popular.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)

This species is not listed.

Marine Protected Areas

This species would benefit from protection in the iSimangaliso and Aliwal Shoal MPAs, given its tropical distribution and evidence of site affinity from very limited tag-recapture data.

Additional local comment

IUCN Status

<u>Vulnerable 2015: A2bd</u>

Previous IUCN assessments

Vulnerable 2006 as *Taeniura meyeni*

MANAGEMENT CONSIDERATIONS

This species is poorly known and in view of the apparently low catches of this species, it is very difficult to make any management recommendations. It is possible that this species moves into Mozambique, where it is vulnerable to catches in various artisanal fisheries. An investigation of local/regional population genetic structure is needed to place the global Red List status of Vulnerable into local perspective. A regional assessment would therefore be beneficial. In view of its strongly tropical distribution, it seems unlikely that any management intervention in South Africa will improve the global status of *T. meyeni* from that of Vulnerable.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

Virtually nothing is known of the life history and ecology of this species, even though it is regarded as common. Aliwal Shoal would a good study site, possibly through the deployment of Baited Remote Underwater Video (BRUV) or the use of photo-identification. These animals are large (>100 kg) which would make capture for acoustic tagging difficult. Opportunistic sampling to obtain life history information and tissues for genetic studies is recommended.

Urogymnus asperrimus

SCIENTIFIC NAME	*Urogymnus asperrimus* (Bloch and Schneider 1801)
COMMON NAME	Porcupine whipray, porcupine ray
FAMILY	Dasyatidae
ENDEMIC	No, Indo-West Pacific Ocean
SIZE RANGE	Attains at least 115 cm DW
DISTRIBUTION	E coast: KZN
HABITAT	Demersal on sand and coral reefs
DEPTH RANGE	0–30 m
MAJOR FISHERIES	None listed
IUCN STATUS	Vulnerable 2015
MLRA REGS	Daily bag limit of one individual in recreational fishery
AUTHOR	G Cliff
REVIEWER	C Elston

SPECIES SUMMARY and RECOMMENDATIONS

Urogymnus asperrimus is a medium-sized, demersal ray which occurs in shallow, coastal tropical waters of the Indo-West Pacific Ocean. It is most often associated with coral reefs and sandy habitats. There were no reported local catches (DFFE records: 2010–2012). It was assessed as Vulnerable on the IUCN Red List in 2015, as a result of heavy fishing and habitat degradation, particularly mangrove forests and shallow-water lagoons, elsewhere in its range. In view of its apparent scarcity in South African waters, it must be regarded as being of very low management priority, with very few research opportunities. Any opportunistic sampling should be used to collect biological information and tissue samples for genetic studies.

TAXONOMIC and IDENTIFICATION ISSUES

Urogymnus asperrimus is one of six members of this genus, but is the only one in the SW Indian Ocean. A combination of a rounded disc with a very spiny upper surface and a short tail lacking a caudal sting make it distinct from all other stingrays (Last *et al.* 2016), hence there are no local taxonomic and identification issues.

SOUTH AFRICAN DISTRIBUTION

This species is restricted to KZN waters, but with no southern limit defined (Ebert *et al.* 2021).

REGIONAL DISTRIBUTION

This species occurs in Mozambique, Kenya and Madagascar, with a widespread tropical and subtropical distribution in the Indo-West Pacific and possibly the NE Atlantic (Chin and Compagno 2016, Last *et al.* 2016).

SYNOPSIS OF RESEARCH

In a study of batoid fishes of the east coast of southern Africa this species was not listed (Wallace 1967c). Nothing has been published on the life history and ecology of this species in South Africa or the SW Indian Ocean. It is described as rare in South Africa (Compagno *et al.* 1989) and throughout its range (Chin 2014), despite occurring in relatively shallow coastal water. Regionally, studies have been conducted on the diet and movement patterns of juveniles in Seychelles (Elston *et al.* 2017, Elston *et al.* 2019, Elston *et al.* 2020, Elston *et al.* 2021).

ECOLOGY

Depth

It occurs in shallow continental and island chain waters at depths of 1–30 m (Chin and Compagno 2016 and references cited therein).

Habitat: Adults
They have been observed in coral reefs, sandy reef lagoons, beaches, mud flats and mangroves (Chin and Compagno 2016 and references cited therein).

Habitat: Juveniles/Nursery Grounds
Juveniles appear to be site-attached, and highly resident in small areas of shallow coastal mud and mangrove habitats (Chin and Compagno 2016 and reference cited therein) or shallow atoll sand flats (Elston *at al.* 2019, Elston *et al*. 2021).

Synopsis of tag deployments
Acoustic tracking of juveniles at St Joseph Atoll, Seychelles (Elston *et al.* 2019) appears to be the only documented tagging study of this species undertaken in SW Indian Ocean.

Movements
Juveniles tracked at St Joseph Atoll, Seychelles showed high levels of residency for many months. Movements were restricted as most detections occurred within 1 km of the tagging site on this offshore atoll (Elston *et al.* 2019).

Diet/feeding: adults
The diet of *U. asperrimus* comprises polychaete worms, crabs and molluscs (Last *et al*. 2016). Their feeding behaviour is notable, as they plough up sediment creating significant sand plumes.

Diet/feeding: juveniles
The diet of the juveniles was dominated by polychaete worms, but included crustaceans (Elston *et al.* 2017). Carbon and nitrogen isotope signatures changed with size, suggesting ontogenetic shifts in diet (Elston *et al*. 2020).

South African toxicological studies
No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Histotrophic viviparity
DURATION OF REPRO CYCLE	Unknown
MATING SEASON	Unknown
GESTATION	Unknown
LITTER SIZE	Unknown
PUPPING/NURSERY GROUND	St. Joseph Atoll, Seychelles
DISC WIDTH AT BIRTH	Unknown
DISC WIDTH AT MATURITY	F: ±110cm; M: 90 ±cm
MAXIMUM DISC WIDTH	115 cm
GENERATION LENGTH	21.5 years inferred from *Dasyatis lata*

Mode
This species exhibits histotrophic viviparity in which maternal uterine secretions supplement the nourishment provided by the yolk-sac.

Duration of reproductive cycle

No pregnant females have been documented from South Africa. The duration of the reproductive cycle is unknown.

Mating season and location
This is unknown.

Gestation
This is unknown.

Litter size
This is unknown.

Disc width at birth
This is unknown.

Pupping season and nursery ground
There is a nursery ground in the St Joseph Atoll, Seychelles (Elston *et al.* 2019). Adults were largely absent from the atoll, although one tagged adult was found to return on rare occasions (Chantel Elston, SAIAB, unpublished data). Given that size-at-birth is unknown, it is uncertain if this atoll is a pupping ground, but high levels of long-term juvenile residency confirm the nursery role of this ecosystem (Elston *et al*. 2019).

Disc width at maturity
Females mature at ±110 cm and males at ±90 cm (Last *et al.* 2016).

Maximum disc width
This species attains at least 115 cm (Last *et al.* 2016).

Age and growth
This is unknown; attempts to count growth rings have proved difficult due to the fragile nature of the vertebrae (Chin and Compagno 2016 and reference cited therein).

Generation length
Using data from the brown stingray *Dasyatis lata*, a related species of similar size from the Pacific as a proxy, generation length for *U. asperrimus* is inferred to be 21.5 years (Chin and Compagno 2016).

FISHERIES MANAGEMENT

SA catch sources, quantities and characteristics
No local catches were reported (DFFE records: 2010–2012; da Silva *et al*. 2015).

Fishing outside South Africa
The species is presumably largely taken as bycatch in unregulated fisheries in nearshore waters. Fishing pressure is heavy in its known, shallow-water habitat in SE Asia. This species is caught in net fisheries in Indonesia and used for its meat, and the skin is considered very valuable (Chin and Compagno 2016 and reference cited therein). Pierce *et al.* (2008) acknowledged its presence in Mozambique, but no details of any catches were reported.

Population trends
Although very wide ranging, this ray appears to be uncommon compared to other species of sympatric stingrays. Occurrence appears to be patchy with localised hotspots (Chin and Compagno 2016). Little is known about its population status, trends or structure.

Many shark and ray stocks in SE Asia and other parts of the northern Indian Ocean are known to be over-exploited, with catches declining. Market surveys indicate that this species has decreased in abundance in parts in the centre of its range for which comparative data are available, such as the Gulf of Thailand. It is also a common catch in Indonesia which is a global centre for intense shark and ray fishing and over-exploitation (Chin and Compagno 2106).

Based on its shallow water habitat preferences, long estimated generation length and the fact that the Indo-West Pacific is a region with some of the most poorly managed and intensely fished waters, a population reduction of greater than 30% over three generations was inferred, resulting in a global assessment of Vulnerable on the IUCN Red List in 2015. In Australia, the species was assessed as Least Concern as it has no commercial value and is seldom caught (Chin and Compagno 2016).

Furthermore, the extensive loss and degradation of habitats such as coastal mangroves are another key threat to coastal and inshore species, such as *U. asperrimus*; Southeast Asia has seen an estimated 30% reduction in mangrove area since 1980 (Chin and Compagno 2016 and references cited therein).

ECOTOURISM

Although it is uncommon in the shallow waters of the iSimangaliso MPA, it is occasionally seen by divers (Grant Smith, Sharklife, pers. obs.), and therefore should be regarded as an ecotourism species.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act

Threatened or Protected Species (TOPS)

This species is not listed.

Marine Protected Areas

This species would benefit from protection in the iSimangaliso MPA, given its tropical distribution, site affinity and association with coral reef habitats.

Additional local comment

This species will benefit from the current ban on any demersal shark longlining east of the Kei River mouth (this excludes the entire KZN and Wild Coast), which usually occurs at depths of 10–100 m.

IUCN Red List Status

<u>Vulnerable 2015: A2bd</u>

Previous IUCN assessments

Vulnerable 2005

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

This species is not listed.

Convention on Migratory Species (CMS)

This species is not listed.

International comments

MANAGEMENT CONSIDERATIONS

This species appears to be rare in South Africa, even around the coral reefs in the far north (Sodwana Bay and surrounds). Its absence from the batoid survey of the east coast of southern Africa five decades ago strongly suggests that its regional scarcity is not a recent phenomenon. It must therefore be considered of very low management priority. An investigation of local/regional population genetic structure is needed to place the global Red List status of Vulnerable into local perspective. It is unlikely that any management intervention in South Africa will improve the global status of *U. asperrimus* from that of Vulnerable.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

Considerable knowledge of the life history and ecology of this species has been obtained regionally, from the Seychelles, but its apparent scarcity in KZN waters mean that there will be very few opportunities for local research. As it is extremely easy to identify, any sightings by scuba divers in the iSimagaliso MPA should be documented. Opportunistic sampling to obtain life history information and tissues for genetic studies is recommended.

FAMILY AETOBATIDAE

Aetobatus ocellatus

SCIENTIFIC NAME	*Aetobatus ocellatus* (Kuhl 1823)
COMMON NAME	Spotted eagle ray, ocellated eagle ray
FAMILY	Aetobatidae
ENDEMIC	No, Indo-Pacific Ocean
SIZE RANGE	33–330 cm DW, but generally < 160 cm DW
DISTRIBUTION	E, S coasts: Mozambique border to Knysna
HABITAT	Pelagic, coastal and estuarine waters, often near coral and rock reefs
DEPTH RANGE	0–60 m, possibly 100 m
MAJOR FISHERIES	Demersal trawls, including KZN prawn fishery; KZN bather protection programme
IUCN STATUS	Vulnerable 2015
CITES REGS	Not listed
MLRA REGS	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	A Towner

SPECIES SUMMARY and RECOMMENDATIONS

Aetobatus ocellatus is a large pelagic ray which occurs close inshore in the tropical waters of the Indo-Pacific Oceans. It is commonly found over sandy bottoms near rock and coral reefs and enters estuaries and lagoons. Total annual catch was estimated at 1–10 tons (DFFE records: 2010–2012). The major South African fishery was the demersal trawl fishery, with small catches in the KZN prawn trawl fishery and KZN bather protection programme. It is heavily fished elsewhere in its range, especially SE Asia and in artisanal fisheries in Madagascar. This species was globally assessed as Vulnerable on the IUCN Red List in 2015, with fishing being the greatest threat. Habitat degradation, especially in estuaries and lagoons, is also a major concern. Survival rates of individuals discarded from trawl nets need to be assessed. There are still large gaps in our knowledge of the life history and ecology of this species. Any opportunistic sampling should be used to collect biological information as well as tissue samples to investigate any regional or global population structure.

TAXONOMIC and IDENTIFICATION ISSUES

Aetobatus ocellatus was previously considered to be an Indo-West and Central Pacific form of the wider ranging *Aetobatus narinari*. Comparative analysis of the morphology, molecular and parasite diversity has resulted in the resurrection of *A. ocellatus* as the valid name for the Indo-Pacific individuals, with *A. narinari* restricted to the Atlantic Ocean, from Angola northwards. Molecular analyses suggest greater levels of speciation within the genus, with distinguishable groups in the Western Indian Ocean and NW Pacific, which requires further examination to delineate species boundaries (Naylor *et al.* 2012; Kyne *et al.* 2016 and references cited therein).

SOUTH AFRICAN DISTRIBUTION

This species occurs along the entire east coast to Knysna on the south coast (Ebert *et al.* 2021).

REGIONAL DISTRIBUTION

This species is widely distributed in the tropical Indo-Pacific. It occurs in Madgascar and Mozambique (Kyne *et al.* 2016).

SYNOPSIS OF RESEARCH

In a study of batoid fishes of the east coast of southern Africa 15 individuals of both sexes, including a pregnant female, were examined by Wallace (1967c) who described it as *A. narinari.* Nothing has been published subsequently on the biology and ecology of *A. ocellatus* in South Africa.

ECOLOGY

Depth

It occurs in shallow inshore waters and further offshore to depths of 60 m (Kyne *et al.* 2016) but has been reported to depths of 100 m at Easter Island in the southeast Pacific (Randall and Cea 2011).

Habitat: Adults

They are active swimmers found over sandy bottoms, often near coral and rock reefs. They may venture into estuaries and lagoons (Kyne *et al.* 2016).

Habitat: Juveniles/Nursery Grounds

It is not known if juveniles utilise other habitats.

Synopsis of tag deployments

This species is occasionally hooked by shore anglers in KZN but it was not included in the list of species tagged (ORI Cooperative Fish Tagging Project 1984-2018 inclusive) (Jordaan *et al.* 2020).

Movements

These are not known, but this species is an active swimmer, so it is capable of moving large distances. Although it is present off the KZN coast throughout the year, it is more abundant in summer (Wallace 1967c), suggesting that individuals move in response to seasonal changes in water temperatures.

Diet/feeding: adults

The diet comprises bivalves, crustaceans, gastropods, polychaete worms, octopus and teleosts (Compagno *et al.* 1989, Randall 2011).

Diet/feeding: juveniles

There is no evidence that it is different from that of the adults.

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Histotrophic viviparity
DURATION OF REPRO CYCLE	Possibly not annual
MATING SEASON	Unknown
GESTATION	Unknown
LITTER SIZE	Up to 10, but usually 4 or less
PUPPING/NURSERY GROUND	Unknown
DISC WIDTH AT BIRTH	18–50 cm
DISC WIDTH AT MATURITY	F: 150–160 cm; M: 100–130 cm
MAXIMUM DISC WIDTH	At least 300 cm
GENERATION LENGTH	Approximately 12 years

Mode

This species exhibits histotrophic viviparity in which maternal uterine secretions supplement the nourishment provided by the yolk-sac (Kyne *et al*. 2016 and references cited therein).

Duration of reproductive cycle
Wallace (1967c) documented a single pregnant female from KZN with three embryos of 11-17 cm which were still obtaining nourishment from their yolk sacs. Litter size may be as high as 10 but is usually 4 or less (Last *et al.* 2016), with the possibility of only the left uterus being functional. Gestation has been reported at 12 months and reproductive periodicity may not be annual (Kyne *et al*. 2016 and references cited therein).

Mating season and location
This is unknown.

Gestation
This is unknown.

Litter size
This is usually 4 or less, but may be as high as 10 (Last *et al*. 2016).

Disc width at birth
This species is born at 33–36 cm (Kyne *et al*. 2016 and references cited therein) or 18–50 cm (Last *et al*. 2016).

Pupping season and nursery ground
This is unknown.

Disc width at maturity
Size at maturity is 150–160 cm for females and 100–130 cm (Last *et al*. 2016).

Maximum disc width
Maximum disc width is 300 cm (Last *et al*. 2016).

Age and growth
This species is reported to reach sexual maturity after 4–6 years (Last and Stevens 2009).

Generation length
This is approximately 12 years (Kyne *et al*. 2016).

FISHERIES MANAGEMENT

SA catch sources, quantities and characteristics
Total annual catch was estimated at 1–10 tons (DFFE records: 2010–2012; da Silva *et al*. 2015). The major fishery listed was the demersal trawl fishery, followed by the KZN prawn trawl fishery, with possible catches in the commercial linefishery and the hake longline fishery. This species is also caught in the KZN bather protection programme.

Demersal trawl fishery
The mean annual catch of this species in the demersal trawl fishery was 1.6 tons for the period 2003-2006; this component of the catch was discarded (Attwood *et al.* 2011). Assuming a mean weight of 10 kg per individual, which is a disc width of about 90 cm, this would equate to an annual catch of about 160. This species was not reported in research trawls (Wallace *et al*. 1984) or commercial trawls (Warmsley *et al.* 2007) from Algoa Bay to Mossel Bay, although it may have been lumped into the category Other Chondrichthyans in the latter study.

KZN prawn trawl fishery
This species was an occasional bycatch in the KZN prawn trawl industry on the uThukela Banks. Based on observer records of trawls undertaken between 1989 and 1992, the extrapolated annual catch was

some 45 individuals (range 34-64), comprising largely neonates and young juveniles of 0.4–0.8 m. There was 100% survival of this bycatch species in a subsample of only 3 individuals (Fennessy 1994). This fishery was dormant for nearly two decades due to the extended closure of the mouth of Lake St Lucia, resulting in poor prawn recruitment and diminishing prawn catches on the uThukela Banks. The fishing grounds were closed to trawling following the declaration of the uThukela Banks MPA in August 2019.

KZN bather protection programme

The annual catch in this programme was 16, with a 76% release rate in the period 1978–2017. Catches were highest in the summer (January and February) at the northern beaches, which is suggestive of a seasonal range extension by this tropical species. The recent replacement of a large propoprtion of the nets with baited drumlines will reduce this annual catch, as this species is rarely caught on a baited drumline. In 2018 only 4 individuals were caught, of which 3 were released.

Recreational shore angling

In KZN competitive shore anglers caught 41 *A. ocellatus* over a 24-year period, at a rate of <2 per year, with a mean individual mass of 12 kg (Pradervand *et al.* 2007). On the WiId Coast (northern part of the Eastern Cape), over the same time period, competitive shore anglers only caught a total of three *A. ocellatus*, also with a mean size of 12 kg (Pradervand 2004).

Fishing outside South Africa

This species occurs in coastal inshore waters where fishing pressure is typically very heavy, especially in SE Asia. Details of catches are scant but it is recorded from landing sites across much of its range. It is susceptible to capture in a variety of fishing gear. The species also enters estuarine waters where fishing pressure is extremely high and where, in SE Asia at least, pollution is also a major factor for all marine life. It is commonly caught by artisanal fishermen, in bottom set gillnets, trawls, and longlines in Tanzania and by artisanal gillnet fisheries off northern Madagascar (Kyne *et al*. 2016 and references cited therein). There is a large artisanal fishing industry in Mozambique (Pierce *et al.* 2008) which is also likely to catch *A. ocellatus.*

There are a few parts of its range where this species faces lower levels of threat, including the Maldives, where the exportation of ray products is banned, Australia, and parts of Oceania where human populations are small (Kyne *et al*. 2016 and references cited therein).

Population trends

Molecular studies demonstrate considerable population structuring within the Indo-Pacific region, suggesting limited recruitment to exploited populations (Schluessel *et al.* 2010). Based on inferred population declines of >30% across much of its range, with ongoing threats due to largely unregulated fishing pressure and habitat degradation and destruction, this species was globally assessed as Vulnerable on the IUCN Red List in 2015. In Australian and Oceania waters (Pacific Island nations) where there is limited fishing pressure and some conservation measures in place through the use of marine reserves, this species was assessed as Least Concern (Kyne *et al*. 2016).

ECOTOURISM

This species occurs in shallow waters, including those of the iSimangaliso MPA, where scuba diving is extremely popular; therefore it should be regarded as an ecotourism species.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act

Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
This species would derive limited protection in all the inshore MPAs on the KZN coast, especially the iSimangaliso MPA, as it is in the far north and encompasses most of South Africa's coral reef habitat. *A. ocellatus* is an active swimmer and is likely to move in and out of these MPAs on a regular basis.

Additional local comment

IUCN Red List Status
Vulnerable 2015: A2bd

Previous IUCN assessments
None

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species is not listed.

Convention on Migratory Species (CMS)
This species is not listed.

MANAGEMENT CONSIDERATIONS
This species is easily recognised and is unlikely to be confused with any other species. Survival rates after discarding/release from trawl nets should be investigated. The seasonality in catches in the KZN bather protection programme is suggestive of a summer influx from the north, possibly from as far as Mozambique, where this species is vulnerable to capture in coastal artisanal fisheries. It is possible that catches in the inshore demersal trawl fishery on the south coast, a considerable distance from KZN, may be from a different population. This should be investigated as part of a study of the regional and global population structure.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
There are still gaps in our knowledge of the life history and ecology of this species. It is common in the clear inshore waters of the iSimangaliso MPA. Its spotting pattern may make it suitable for photo identification studies to learn more about movement patterns and residency and the levels of protection offered by the iSimangaliso MPA. A priority is the resolution of taxonomic issues to better define the actual ranges of the various forms/species within the 'spotted eagle ray' species-complex. Any opportunistic sampling should be used to collect biological information and tissue samples for genetic studies.

FAMILY MYLIOBATIDAE

Aetomylaeus bovinus

SCIENTIFIC NAME	*Aetomylaeus bovinus* (Geoffroy St. Hilaire 1817)
COMMON NAME	Bullray/duckbill (eagle) ray
FAMILY	Myliobatidae
ENDEMIC	No, widely distributed in the E Atlantic and Mediterranean
SIZE RANGE	25–180 cm DW, possibly 220 cm
SA DISTRIBUTION	E, S, W coasts: entire South African coast
HABITAT	Active swimmer, near the bottom of coastal waters; usually over sand but also feeds on rocky reefs
DEPTH RANGE	0–55 m, 150 m outside South Africa
MAJOR FISHERIES	Trawl fisheries, KZN bather protection programme, commercial and recreational linefisheries
IUCN STATUS	Critically Endangered 2020
CITES	Nil
MLRA	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	C Elston

SPECIES SUMMARY and RECOMMENDATIONS

Aetomylaeus bovinus is a medium-sized ray which occurs close inshore along the entire South African coast and much of the E Atlantic and the Mediterranean Sea. It is an active swimmer, commonly found over sandy bottoms, but also near rock and coral reefs and in estuaries and lagoons. Local catches were estimated at 1–10 tons per annum (DFFE records: 2010–2012), with the major South African fishery being the demersal trawl industry, in the form of the now closed KZN prawn trawl fishery, followed by the KZN bather protection programme. It is taken as a bycatch over much of its African and Mediterranean range. This species was assessed globally as Critically Endangered on the IUCN Red List in 2020. Catches in South Africa are extremely low in comparison with other countries in its range and it is possible that the status of the South/ern African population is not as heavily threatened as elsewhere. In South Africa it frequently moves hundreds of kilometres along the coastline, but returns to specific locations, thus exhibiting site fidelity. Very little is known of its distribution, ecology, life history and population genetics.

TAXONOMIC and IDENTIFICATION ISSUES

Aetomylaeus bovinus was previously listed in the genus *Pteromylaeus* but White (2014) placed this genus into synonymy with *Aetomylaeus.* It is one of two members of the genus in southern Africa waters, with *A. vespertilio* only recently reported from the northern part of the east coast of South Africa (Ebert *et al.* 2021). *A. bovinus* has been confused with another common eagle ray found along much of the South African coast, *Myliobatis aquila*, in both its appearance and common name. *A. bovinus* has a far longer, fleshy snout and the small dorsal fin is located between the pelvic fins. Historically the common name bullray was used for *A. bovinus* and *Myliobatis aquila* was referred to as eagle ray (Compagno 1986, van der Elst 1993, Heemstra and Heemstra 2004), presumably based on their scientific names. Compagno *et al.* (1989) departed from this tradition and named *A. bovinus* duckbill ray and *M. aquila* bullray and Ebert *et al.* (2021) have continued with the use of these common names. Last *et al.* (2016) have dropped the term bullray completely and refer to *A. bovinus* as duckbill eagle ray and *M. aquila* as common eagle ray. Fishbase has retained the traditional names and refers to *A. bovinus* as bullray and *M. aquila* as common eagle ray; this convention will be followed in these reports.

SOUTH AFRICAN DISTRIBUTION
This species occurs along the entire South African coast from the Mozambique border in the east and the Orange River mouth in the west (Ebert *et al.* 2021).

REGIONAL DISTRIBUTION
It occurs in Mozambique and Namibia and up the entire African west coast and into the Mediterranean Sea (Last *et al.* 2016). Its presence in Tanzania has recently been confirmed (Rhett Bennett, World Conservation Society, unpublished data).

SYNOPSIS OF RESEARCH
In the scientific study of batoid fishes of the east coast of Southern Africa, 38 individuals were examined, but primarily for their morphometrics and taxonomy, supplemented by a very short section of biological comments (Wallace 1967c). No dedicated research has been conducted on this species in South Africa and, as a result, very little is known of its life history and ecology in South Africa and neighbouring countries. Currently, an acoustic telemetry study is underway, with the movements of 25 individuals being tracked along the South African coastline using the Acoustic Tracking Array Platform (ATAP) (Chantel Elston, SA Institute of Aquatic Biodiversity, pers. comm.).

ECOLOGY
Depth
This demersal to semi-pelagic species occurs in coastal waters from close inshore, including the surf zone, estuaries and embayments to depths 56 m (Compagno *et al.* 1989); elsewhere it has been reported as occurring as deep as 150 m (Last *et al.* 2016).

Habitat: Adults
They are active swimmers found over sandy bottoms, often near coral and rock reefs. They have been reported to venture into estuaries and lagoons (van der Elst 1993). Recent data have confirmed what appears to be a seasonal phenomenon, with individuals occurring in the Breede river estuary and Keurbooms estuary from late spring to early autumn (Chantel Elston, unpublished data).

Habitat: Juveniles/Nursery Grounds
It is not known if juveniles utilise other habitats.

Synopsis of tag deployments
A total of 1159 individuals was tagged (ORI Cooperative Fish Tagging Project, 1984-2018) with 1% recaptured. Mean distance travelled was 17 km; mean time at liberty 1,6 years, with a maximum of 123 km and 3.9 years (Jordaan *et al.* 2020).

Acoustic tags were deployed on 25 adults between 2016 and 2020 along the south coast of South Africa (Acoustic Tracking Array Platform). Preliminary analyses have been conducted on these data, for which individuals were monitored for a mean period of 360 days (range 35–1071 days). During this monitoring period, individuals were detected on a receiver for a mean of 31% of days (range 0.001–100%). Individuals were most often detected on receivers that were less than 100 km away from the tagging location, but frequent longer-distance trips were undertaken, with individuals traveling to receivers up to 800 km away (Chantel Elston and Paul Cowley, SAIAB, unpublished data).

Movements
The limited results from the tag-recapture study are indicative of a largely residential species that undertake short-distance movements along the coast. Conversely, acoustic telemetry data highlight that whilst individuals display site fidelity by returning to their specific tagging location, they are in fact quite wide roaming, often traveling long distances (hundreds of kilometres) along the coast. There

appears to be some seasonality associated with these large-scale movements, as individuals tagged in and around the De Hoop Marine Protected Area and Mossel Bay on the south coast moved up the east coast as far as southern KZN in winter months. Males and those individuals tagged in the vicinity of Algoa Bay appeared to display higher levels of site attachment to their tagging areas than the females and those tagged on the south coast, suggesting some intra-specific differences in movements. Two individuals were found to frequently move into the Breede River estuary on the south coast from late spring to early autumn, where they were detected for 30% and 44% of the days that they were monitored. Inshore-offshore movements remain unknown, but the high rates of detections by coastal receivers suggest offshore movements are not important to this species (Elston and Cowley, SAIAB, unpublished data).

Diet/feeding: adults
The diet includes crabs, gastropod molluscs, bivalves, squid and teleosts (Wallace 1967c).

Diet/feeding: juveniles
The diet is possibly similar to that of adults.

South African toxicological studies
No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Histotrophic viviparity
DURATION OF REPRO CYCLE	Unknown
MATING SEASON	Unknown
GESTATION	Possibly 12 months
LITTER SIZE	At least 3; 3-6 elsewhere
PUPPING/NURSERY GROUND	Unknown
DISC WIDTH AT BIRTH	25 cm
DISC WIDTH AT MATURITY	95 cm
MAXIMUM DISC WIDTH	180 cm, 220 cm elsewhere
GENERATION LENGTH	17 years, based on *Myliobatis californicus*

Mode
This species exhibits histotrophic viviparity in which maternal uterine secretions supplement the nourishment provided by the yolk-sac.

Duration of reproductive cycle
This is unknown.

Mating season and location
Nothing is known of South African individuals.

Gestation
There is a 12-month gestation in South Africa (van der Elst 1993) but a 5–6-month gestation in individuals from the Senegalese coast (Jabado *et al.* 2021b and references cited therein).

Litter size
One female was found with three embryos (Wallace 1967c). Litter size in South Africa is given as 3–4 (van der Elst 1993), and 3–6 elsewhere (Last *et al.* 2016). No pregnant females were recorded amongst those examined from the KZN bather protection programme (KZN Sharks Board, unpublished data).

Disc width at birth
This is in the region of 25 cm, as the three embryos of 23 cm from the single litter were in an advanced stage of development (Wallace 1967c). Size at birth is given as 25–45 cm elsewhere (Last *et al.* 2016).

Pupping season and nursery ground
This is unknown in South Africa.

Disc width at maturity
This is about 95 cm in South Africa for males with no information for females, other than that a female of 120 cm was pregnant (Wallace 1967c). The smallest mature male examined at the KZN Sharks Board was 104 cm and the smallest mature female was 105 cm (Wintner 2016). Elsewhere females mature at 90–100 cm and males 80-95 cm (Last *et al.* 2016).

Maximum disc width
Maximum size is listed as 180 cm (Compagno *et al.* 1989) for South African individuals but may be as high as 220 cm elsewhere (Last *et al.* 2016).

Age and growth
There is no information on age-at-maturity and maximum age of this species.

Generation length
As nothing is known on age-at-maturity and maximum age, generation length was inferred from the bat eagle ray *Myliobatis californicus* at 14.5 years. This species has an age-at-maturity of five years, maximum age of 24 years, maximum disc width of 180 cm and a generation length of 14.5 years. *A. bovinus* has a larger maximum size of 222 cm, and, based on scaled-size, its generation length is inferred to be 17 years (Jabado *et al.* 2021b).

FISHERIES MANAGEMENT
SA catch sources
Local catch was estimated at 1–10 tons per annum (DFFE records: 2010-2012; da Silva *et al*. 2015), with the trawl fisheries as the major contributor, followed by the KZN bather protection programme and recreational and commercial linefisheries.

SA catch quantities and characteristics
Demersal trawl fishery
This species was not reported in catches in the South African inshore trawl (hake) fleet, 2003–2006 (Attwood *et al.* 2011).

KZN prawn trawl industry
This species was caught in the KZN prawn trawl industry on the uThukela Banks, with an extrapolated average annual catch between 1989 and 1992 of 105 (range 79–150). The six individuals found in 169 trawls were 0.4–1.2 m, with a mean of 0.7 m. From the observer-recorded catches, the survival of this bycatch species was around 25%, based on a subsample of four individuals from 100 trawls (Fennessy 1994). In the last two decades the prolonged closure of Lake St Lucia has resulted in very poor recruitment and diminishing prawn catches on the uThukela Banks. The fishing grounds have been closed to trawling since the declaration of the uThukela MPA in August 2019.

KZN bather protection programme
A total of 1602 individuals were caught in the 40-year period 1978–2017, with a 46% release rate. This equates to an annual catch of 40 individuals, with a minimum annual mortality of 22. There was no significant trend in catch rates over the period 1978-2000 and catches were highest in summer and lowest in winter (Young 2001). The widespread replacement of nets by drumlines (baited lines) in the

last 13 years has reduced the bycatch, including all species of rays (Cliff and Dudley 2011). In 2018 the catch of *A. bovinus* was 15, with 6 released alive (KZN Sharks Board unpublished data).

Recreational shore angling

In KZN competitive shore anglers caught 246 *A. bovinus* over a 24-year period (1977–2000) at a rate of 10 per annum, with a mean individual mass of 14 kg (Pradervand *et al.* 2007). On the Wild Coast (northern part of the Eastern Cape) and in the Border region (Kei River to Fish River; 146 km of coastline immediately south of Wild Coast), anglers were unable to distinguish this species from *M. aquila* and, as a result, catches of these two species were combined. Annual catches in these two regions were 2 and 31 respectively (Pradervand 2004, Pradervand and Govender 2003). Most ray catches by shore anglers are returned alive to the water.

Recreational shore anglers have submitted their catches to the South African Elasmobranch Monitoring (ELMO) citizen science project and these catches are verified by a trained scientist. Thirteen *A. bovinus* were caught from 2020-2021 along the south coast from Struisbaai to Plettenberg Bay. Most of these catches were returned alive to the water (Chantel Elston, unpublished data).

Beach seine and gill net fisheries

This species was an infrequent catch (1% of hauls) in the beach seine fishery targeting harder/mullet *Liza richardsoni* in False Bay (Lamberth *et al.* 1994), with all catches between November and March. The size range was 50–114 cm. Most individuals were returned alive to the water.

Fishing outside South Africa

A. bovinus is taken as bycatch in industrial and artisanal fisheries with multiple fishing gears, including trawl, gillnet, set net, tangle net, and trammel net, and is retained for human consumption. It is no longer exploited or traded commercially in the Mediterranean region. In West Africa, it is heavily utilized for its meat, with little species-specific information available (Jabado *et al.* 2021b).

Population trends

Nothing has been published on population genetics of this species. Given that in South Africa *A. bovinus* appears to strongly residential, there are likely to be several global subpopulations. There are no population size or trend estimates for this species.

There is a high level of fisheries resource use and increasing fishing pressure across the range of this species. It has largely not been documented from trawl surveys in the Mediterranean Sea and very few records are available from its remaining range across the E Central Atlantic, SE Atlantic and W Indian Ocean, despite ongoing artisanal fisheries monitoring projects. It was historically common in many locations across W Africa, but contemporary data of landings indicate that, with the exception of Mauritanian waters, there have been limited records of this species in the past decade from across the E Central Atlantic region (Jabado *et al*. 2021b).

Overall, considering these declining catch trends and limited number of specimens recorded in trawl surveys and fisheries in several localities where it previously occurred, the level of intense and large unmanaged fisheries that operate throughout its range, its lack of refuge at depth, its limited productivity, and noted declines in eagle rays in general in several parts of its range, it is suspected that this species has undergone a global population reduction of >80% over the past three generation lengths (51 years) due to actual or potential levels of exploitation and it was assessed as Critically Endangered on the IUCN Red List in 2020 (Jabado *et al*. 2021b).

ECOTOURISM

This species is not often seen by scuba divers despite being a coastal inhabitant. Aggregations of 15–20 individuals have been encountered moving through Plettenberg Bay in spring and summer (Chantel

Elston pers. comm.), but these events are too infrequent to be regarded as promotable ecotourism opportunities.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act

Threatened or Protected Species (TOPS)

This species is not listed.

Marine Protected Areas

This species may potentially benefit from all the coastal MPAs along the South African coast. Whilst individuals travel widely along the coast, they display site fidelity and return to specific locations where they may benefit from spatial protection. There is insufficient known of the coastwise distribution of this species to ascertain which of these MPAs will provide protection to the various life history stages, particularly the most vulnerable components, such as the pregnant females and the neonates.

Additional local comment

IUCN Red List Status

Critically Endangered 2020: A2d

Previous IUCN assessments

Data Deficient 2016 (as *Pteromylaeus bovinus)*
Data Deficient 2006 (as *Pteromylaeus bovinus)*

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

This species is not listed.

Convention on Migratory Species (CMS)

This species is not listed.

International comments

In Turkey, fisheries for all species belonging to the family Myliobatidae have been banned since April 2018 (Jabado *et al*. 2021b and references cited therein). Elsewhere there are no known conservation measures in place for this species. Although countries across its range have legislation concerning fisheries activities (including gear restrictions, and no-trawling zones in coastal waters), fisheries taking *A. bovinus* are generally unmanaged throughout large parts of the species' range and it is unlikely that pressure will decrease in the near future (Jabado *et al*. 2021b).

MANAGEMENT CONSIDERATIONS

Its recent upgrade to Critically Endangered status indicates that careful monitoring of any bycatch in the inshore hake trawl fishery is required, even though it has not been documented in the catches. Misidentification with *Myliobatis aquila*, which is commonly caught in this fishery, is a confounding factor. Catches of *A. bovinus* in South Africa appear to be very low in comparison with other countries in its range and it is possible that the status of the South/ern African population is not as threatened as elsewhere. Such a scenario has been confirmed for the closely related common eagle ray *Myliobatus aquila.* A local/regional Red List assessment for *A. bovinus* is imperative.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

More information is needed on the ecology, distribution, life history and reproductive biology of this relatively common but poorly studied species. A number of individuals caught in the KZN bather protection programme have been examined and information has been collected on stomach contents and reproductive biology, but reproductively active individuals are rarely encountered. Further research is also needed to investigate any local or regional population structure. Tissue samples from the KZN bather protection programme are available for a genetic study.

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Aetomylaeus vespertilio

SCIENTIFIC NAME	*Aetomylaeus vespertilio* (Bleeker 1852)
COMMON NAME	Ornate eagle ray
FAMILY	Myliobatidae
ENDEMIC	No, Indo-Pacific Ocean
SIZE RANGE	?–300 cm DW, possibly 350 cm
DISTRIBUTION	E coast: Mozambique border to Richards Bay
HABITAT	Pelagic over coral reefs and inshore muddy bays
DEPTH RANGE	0–110 m
MAJOR FISHERIES	None listed
IUCN STATUS	Endangered 2015
CITES REGS	Not listed
MLRA REGS	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	A Towner

SPECIES SUMMARY and RECOMMENDATIONS

Aetomylaeus vespertilio is a large pelagic ray which occurs close inshore in the tropical waters of the Indo-Pacific Ocean. It is commonly found over coral reefs and mud banks. It has not been recorded in local catches (DFFE records: 2010-2012) as its presence in South Africa was only confirmed in 2018, with the capture of single specimen at Richards Bay. Other members of the family Myliobatidae have low fecundity. This, together with heavy coastal fishing pressure throughout much of its range, resulted in this species being assessed globally as Endangered on the IUCN Red List in 2015. The iSimangaliso MPA with its coral reef habitat should offer limited protection to this mobile species. Given its rarity, it is impossible to formulate any management considerations and this species must be regarded as being of very low priority. Any opportunistic sampling should be used to collect biological information and tissue samples for genetic studies.

TAXONOMIC and IDENTIFICATION ISSUES

Smith (1961) described *Aetomylus huletti* sp. nova from northern KZN but states that "few details are known". Wallace (1967c) suspected it to be a synonym of *Pteromylaeus* (now *Aetomylaeus*) *bovinus* based on the overall shape and the alternating dark and light bands across the dorsal surface. The holotype of *A. huletti* was lost, precluding further examination of the specimen, but it is likely to be *A. vespertilio* (Ebert *et al.* 2021 and references cited therein), which has a distinctive colour pattern on the dorsal surface to distinguish it from other eagle rays and pelagic eagle rays in the SW Indian Ocean. This species is poorly represented in collections and the lack of specimens has caused some nomenclatural problems that have not been fully resolved (White and Kyne 2016).

SOUTH AFRICAN DISTRIBUTION

This species occurs on the northern part of the east coast as far south as Richards Bay, based on a single record of a shore angler's catch (Ebert *et al.* 2021), with no subsequent reports of this species (Rob Kyle, SAAMBR, pers. comm).

REGIONAL DISTRIBUTION

This species has a patchy distribution in the tropical Indo-Pacific. It occurs in Mozambique, where it appears to be rare (Venables *et al.* 2022), but its presence in countries to the north and in Madagascar has not been recorded (Last *et al.* 2016, White and Kyne 2016).

SYNPOSIS OF RESEARCH

This species was not listed in a study of batoid fishes of the east coast of southern Africa (Wallace 1967c). It is known locally from a single specimen caught, photographed and released at Richards Bay in April 2018 (Ebert *et al.* 2021) and more recently from two sightings in the Inhambane Province, Mozambique (Venables *et al.* 2022) and another two from Tofo, Mozambique (Stephanie Venables, Marine Megafauna Foundation pers. comm.). It was described as a poorly known species (Last *et al.* 2016).

ECOLOGY

Depth

It occurs in coastal waters to a depth of at least 110 m (Last *et al.* 2016).

Habitat: Adults

They are pelagic over coral reefs and inshore muddy bays (Last *et al.* 2016).

Habitat: Juveniles/Nursery Grounds

It is not known if juveniles utilise other habitats.

Synopsis of tag deployments

This species was not included in the list of species tagged (ORI Cooperative Fish Tagging Project 1984-2018 inclusive) (Jordaan *et al.* 2020).

Movements

These are not known, but appears capable of swimming considerable distances.

Diet/feeding: adults

The diet is unknown but probably consists of mainly of hard-shelled, bottom-dwelling invertebrates (Last *et al.* 2016).

Diet/feeding: juveniles

There is no evidence that it is different from that of the adults.

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Histotrophic viviparity
DURATION OF REPRO CYCLE	Unknown
MATING SEASON	Unknown
GESTATION	Unknown
LITTER SIZE	Up to 4
PUPPING/NURSERY GROUND	Unknown
DISC WIDTH AT BIRTH	Unknown
DISC WIDTH AT MATURITY	F: ? cm; M: ±170 cm
MAXIMUM DISC WIDTH	At least 300 cm, possibly 350 cm
GENERATION LENGTH	15 years; inferred from *Myliobatis californicus*

Mode

The reproductive mode of members of the family Myliobatidae is histotrophic viviparity in which maternal uterine secretions supplement the nourishment provided by the yolk-sac (Last *et al.* 2016).

Duration of reproductive cycle

This is unknown.

Mating season and location
This is unknown.

Gestation
This is unknown.

Litter size
This is up to 4 (Kyne and White 2016 and references cited therein).

Disc width at birth
This unknown.

Pupping season and nursery ground
This is unknown.

Disc width at maturity
Size at maturity is unknown for females and ±170 cm for males (Last *et al*. 2016).

Maximum disc width
Maximum disc width is at least 300 cm, possibly 350 cm (Last *et al*. 2016).

Age and growth
There are no age and growth estimates.

Generation length
This was inferred to be approximately 15 years, based on parameters from the bat ray *Myliobatis californicus*, which matures at five years and reaches a maximum age of 24 years (White and Kyne 2016 and reference cited therein).

FISHERIES MANAGEMENT

SA catch sources and quantities
This species was not recorded in local catches (DFFE records: 2010–2012; da Silva *et al*. 2015).

Fishing outside South Africa
This species is highly susceptible to a variety of inshore demersal fisheries, including trawls, gillnets and trammel nets which operate intensively throughout most of its range, in particular, India, Thailand, Taiwan, and Indonesia, but with the exception of northern Australia. In most areas all individuals caught are retained (White and Kyne 2016). Its presence in Mozambique was acknowledged, with no details of any catches (Pierce *et al.* 2018).

Population trends
The species appears to be naturally uncommon and is rarely observed (Venables *et al.* 2022). Nothing is known of its overall population size or structure. However, based on its intrinsic sensitivity to overexploitation and the presence of unregulated fisheries throughout its entire range, the species was suspected to have undergone a population decline exceeding 50% over the past three generations (45 years). As a result, it was assessed globally as Endangered on the IUCN Red List in 2015 (White and Kyne 2016).

ECOTOURISM
This species is very uncommon and therefore cannot be regarded as an ecotourism species.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)

This species is not listed.

Marine Protected Areas

Based on only a single specimen reported in South Africa it difficult to ascertain which if any MPAs would offer protection to this species. This species would potentially benefit from protection in the iSimangaliso MPA, as it is in the far north and encompasses most of South Africa's coral reef habitat. It will also derive protection from the uThukela MPA, which is close to Richards Bay, where the only individual recorded was caught and which includes considerable soft sediment habitat, including mud. A single individual was recently observed in the Bazaruto Archipelago National Park. *A. vespertilio* is an active swimmer and is likely to move in and out of these MPAs on a regular basis.

Additional local comment

IUCN Status

Endangered 2015: A2d

Previous IUCN assessments

Endangered 2006

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

This species is not listed.

Convention on Migratory Species (CMS)

This species is not listed.

MANAGEMENT CONSIDERATIONS

This species is apparently uncommon wherever it occurs. As its presence in South Africa is based on one individual, it must be regarded as rare. This makes it extremely difficult to formulate any management considerations and this species must be rated as being of very low management priority. In view of its strongly tropical distribution and local rarity, it is unlikely that any intervention at the extreme southern end of its range in South Africa will improve its Endangered status.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

Very little is known of the life history or ecology of this species throughout its Indo-West Pacific range. Any opportunitistic sampling should be used to collect as much biological information as possible, including tissue samples for genetic studies. A campaign to promote awareness of this species among scuba divers visiting the iSimangaliso MPA should be considered.

Myliobatis aquila

SCIENTIFIC NAME	*Myliobatis aquila* (Linnaeus 1758)
COMMON NAME	Common eagle ray
FAMILY	Myliobatidae
ENDEMIC	No, widely distributed in the E Atlantic and Mediterranean
SIZE RANGE	<20-150 cm DW
SA DISTRIBUTION	E, S and W coasts: Durban to Orange River mouth
HABITAT	Active swimmer, near the bottom of coastal waters; usually over sand but also feeds on rocky reefs
DEPTH RANGE	0-100 m
MAJOR FISHERIES	Trawl fisheries, beach seine nets, commercial and recreational linefisheries, KZN bather protection programme
IUCN STATUS	Critically Endangered 2020 (global); Least Concern (South Africa)
CITES	Nil
MLRA	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	C Elston

SPECIES SUMMARY and RECOMMENDATIONS

Myliobatis aquila is a small ray which occurs close inshore along almost the entire South African coast and much of the E Atlantic and Mediterranean Sea. It is an active swimmer commonly found over sandy bottoms and near rock and coral reefs and enters estuaries and lagoons. Local catches were estimated at 1–10 tons per annum (DFFE records: 2010–2012), with the major South African fishery being the inshore demersal trawl industry where the estimated annual bycatch in the period 2003–2006 was in the region of 26 tons. It is taken as bycatch over much of its global range. This species was assessed globally as Critically Endangered on the IUCN Red List in 2020, but Least Concern in South Africa based on long-term research trawl data. It is nevertheless important to monitor bycatch in the inshore hake trawl fishery and to use catches to improve the currently low level of knowledge of the life history, distribution, ecology and population genetics of this little-studied species.

TAXONOMIC and IDENTIFICATION ISSUES

Myliobatis aquila is one of three species in the family Myliobatidae in South African waters. It is the only South African member of the genus, although Smith (1934, cited by Ebert *et al.* 2021) described a second local species *M. cervus* in which the males have a distinctive short, blunt horn above each eye. Wallace (1967c) regarded these orbital horns as a secondary feature and could not find a satisfactory criterion to distinguish between the two species. As a result, *M. cervus* is synonymous with *M. aquila. M. aquila* has been confused with another common myliobatid ray found along the entire South African coast, *Aetomylaeus bovinus*, in both its appearance and common name. *M. aquila* has a far shorter fleshy snout and the small dorsal fin is located well behind the pelvic fins. Historically *Myliobatis aquila* was referred to as eagle ray and *A. bovinus* as bullray, presumably based on their scientific names (Compagno 1986, van der Elst 1993, Heemstra and Heemstra 2004). Compagno *et al.* (1989) departed from this tradition and applied the name bullray to *M. aquila* and duckbill ray to *A. bovinus*; Ebert *et al.* (2021) have continued with the use of these common names. Last *et al.* (2016) refer to *M. aquila* as common eagle ray and *A. bovinus* as duckbill eagle ray, having dropped the term bullray completely. Fishbase has retained the traditional names and refers to *M. aquila* as common eagle ray and *A. bovinus* as bullray; this convention will be followed in these reports.

SOUTH AFRICAN DISTRIBUTION

This species occurs along most of the South African coast from Durban in the east and the Orange River mouth in the west (Ebert *et al.* 2021), but is more common in cooler waters of the south and west coasts than the warmer east coast (Wallace 1967c).

REGIONAL DISTRIBUTION

Its distribution on the E African coast extends as far north as Kenya, although Ebert *et al.* (2021) give Durban as the northern limit of the east coast of South Africa. It occurs up the entire W African coast and into the Mediterranean Sea and further north (Last *et al.* 2016).

SYNOPSIS OF RESEARCH

In the scientific study of batoid fishes of the east coast of Southern Africa, only five individuals, described as *Myliobatus aquila,* were examined, but primarily for their morphometrics and taxonomy (Wallace 1967c). Very little dedicated research has been conducted on this species in South Africa and, as a result, very little is known of its life history and ecology in South Africa and neighbouring countries. Dunlop and Mann (2013e) provided a concise overview of the life history and fishery-related information on this species. Six individuals were tagged with acoustic transmitters in 2016 however, there have been few detections. Additional individuals will be tagged in 2022, forming part of a dedicated project on this species (Chantel Elston, SA Institute of Aquatic Biodiversity, pers. comm.).

ECOLOGY

Depth

This demersal to semi-pelagic species occurs in coastal waters from close inshore, including the surf zone, estuaries and embayments to depths of at least 95 m (Compagno *et al.* 1989, Last *et al.* 2016), but also as deep as 530 m outside South Africa (Dunlop and Mann 2013e and reference therein).

Habitat: Adults

They are active swimmers generally found over sand and mud bottoms but also feed near rock reefs. They may venture into estuaries and lagoons (van der Elst 1993).

Habitat: Juveniles/Nursery Grounds

It is not known if juveniles utilise other habitats, but estuaries may be important habitats for juveniles. In a Baited Remote Underwater Video System study currently being conducted in the Keurbooms estuary, juveniles smaller than 30 cm were encountered every month except September, whilst adults were not encountered (C Elston, unpublished data). Further research in other estuaries would be needed to confirm if this was indeed an important habitat type for juveniles.

Synopsis of tag deployments

A total of 693 individuals was tagged (ORI Cooperative Fish Tagging Project, 1984-2018) with 1% recaptured. Mean distance travelled was 10 km; mean time at liberty 1,4 years, with a maximum of 49 km and 4.3 years (Jordaan *et al.* 2020).

Six individuals were tagged with acoustic transmitters in 2016 and monitored with the Acoustic Tracking Array Platform (ATAP). However, only three individuals were ever detected, and of those three, only one had more than 20 detections. This individual was tagged just outside of Mossel Bay, and it was only detected within Mossel Bay for a few days every second summer (2016, 2018, 2020). The other two individuals were tagged in Algoa Bay, and were only detected on three and 17 occasions, all in Algoa Bay months and years after tagging (Elston and Cowley, unpublished data).

Movements

Limited results from the tag-recapture study are indicative of a largely residential species, undertaking short-distance movements along the coast. Conversely, limited results from acoustic telemetry suggest site fidelity, with individuals returning to specific locations, rather than residency, given the paucity of detections with large gaps between them. It is possible that this species may travel further offshore where acoustic receivers are absent, however, nothing is known of such inshore-offshore movements.

Diet/feeding: adults
The diet includes bivalves, gastropods, crustaceans (crabs, mole crabs and hermit crabs) worms, tunicates and bony fish (Heemstra and Heemstra 2004).

Diet/feeding: juveniles
The diet is possibly similar to that of adults.

South African toxicological studies
No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Histotrophic viviparity
DURATION OF REPRO CYCLE	Unknown
MATING SEASON	Unknown
GESTATION	Unknown locally; 6–8 months elsewhere
LITTER SIZE	7 (1 local female); 3–7 elsewhere
PUPPING/NURSERY GROUND	Unknown
DISC WIDTH AT BIRTH	20–23 cm locally; ±19 cm elsewhere
DISC WIDTH AT MATURITY	F: 42–70 cm; M: 32–50 cm
MAXIMUM DISC WIDTH	150 cm
GENERATION LENGTH	12 years, based on *Myliobatis californicus*

Mode
This species exhibits histotrophic viviparity in which maternal uterine secretions supplement the nourishment provided by the egg (White and Sommerville 2012).

Duration of reproductive cycle
This is unknown.

Mating season and location
Nothing is known of South African individuals. Small individuals (< 30 cm) are seen year-round in the Keurbooms estuary, with a peak during summer. This location is being investigated as a possible nursery area (C Elston unpubl. data).

Gestation
This in unknown locally but there is a 6–8-month gestation in the NE Atlantic and Mediterranean Sea (Jabado *et al.* 2021c and references cited therein).

Litter size
One female was found with seven embryos (Wallace 1967c and reference cited therein). Litter size in the NE Atlantic and Mediterranean Sea is 3–7 (Jabado *et al.* 2021c and reference cited therein).

Disc width at birth
This is in the region of 20–23 cm locally, based on a single pregnant female (Wallace 1967c and reference cited therein). In the NE Atlantic and Mediterranean Sea size at birth is about 19 cm (Jabado *et al.* 2021c and reference cited therein).

Pupping season and nursery ground
This is unknown in South Africa.

Length at maturity
Like the other life-history parameters, length at maturity appears to vary regionally. Locally females mature at 60–70 cm females and males 40–50 cm (Dunlop and Mann 2013e and reference cited therein). Globally females mature at 43–60 cm and males at 32–40 cm (Last *et al*. 2016).

Maximum disc width
Maximum size is 150 cm for South African individuals (Compagno *et al.* 1989) and elsewhere (Last *et al.* 2016).

Age and growth
There is no information on age-at-maturity and maximum age of this species.

Generation length
As nothing is known on age-at-maturity and maximum age, generation length was inferred from the bat eagle ray *Myliobatis californicus* at 14.5 years. This species has an age-at-maturity of five years, maximum age of 24 years, maximum size of 180 cm and a generation length of 14.5 years. *M. aquila* has a smaller maximum size of 150 cm, and, based on scaled-size, its generation length is inferred to be 12 years (Jabado *et al.* 2021c).

FISHERIES MANAGEMENT
SA catch sources
Local catch was estimated at 1-10 tons per annum (DFFE records: 2010-2012; da Silva *et al*. 2015), with the trawl fisheries as the major contributor, followed by the KZN bather protection programme and recreational and commercial linefisheries.

SA catch quantities and characteristics
Demersal trawl fishery
Annual average catch estimates in the South African inshore trawl (hake) fleet, 2003–2006, based on unsorted samples by observers, was 26 tons, which varies considerably from the total estimated catch of 1-10 tons, as reported above. It would appear that most of this catch was discarded, with no information presented on survival rates (Attwood *et al.* 2011). Based on an estimated individual mass of 10 kg, this would amount to an annual catch of 2600 individuals.

KZN prawn trawl industry
This species was caught in the KZN prawn trawl industry on the uThukela Banks, with four individuals found in 169 trawls between 1989 and 1992 (Fennessy 1994). They were 0.2–0.8 m long, with a mean of 0.5 m and included neonates, suggesting this area may be a nursery ground. Based on the observer-recorded catches, the extrapolated average annual catch between 1989 and 1992 was 50 (range 38-71). Survival of this bycatch species was around 50%, based on a subsample of four individuals from 100 trawls. In the last two decades the prolonged closure of Lake St Lucia has resulted in very poor recruitment and diminishing prawn catches on the uThukela Banks. The fishing grounds have been closed to trawling since the declaration of the uThukela MPA in August 2019.

KZN bather protection programme
A total of 136 individuals were caught in the 40-year period (1978-2017), with a 69% release rate. This equates to 4 individuals per annum, with a mortality of <2 per annum. Annual catches were too low to detect any significant trend in catch rates (KZN Sharks Board unpublished data). The widespread replacement of nets by drumlines (baited lines) in the last 13 years has reduced the bycatch, including

that of all species of rays (Cliff and Dudley 2011). In 2018 3 *M. aquila* were caught, with 2 released (KZN Sharks Board unpublished data).

Recreational shore angling
In KZN competitive shore anglers caught 20 *M. aquila* over a 24-year period (<1 per annum), with a mean individual mass of 8 kg (Pradervand *et al.* 2007). On the Wild Coast (northern part of the Eastern Cape) and in the Border region (Kei River to Fish River; 146 km of coastline immediately south of Wild Coast), anglers were unable to distinguish this species from *M. aquila* and, as a result, catches for these two regions were combined. Annual catches in these two regions were 2 and 31 respectively (Pradervand 2004, Pradervand and Govender 2003). Most ray catches by these competitive shore anglers are returned alive to the water.

Recreational shore anglers have submitted catches to the South African Elasmobranch Monitoring (ELMO) citizen science project and these catches are verified by a trained scientist. A total of 21 individuals were caught in 2020-2021 from Veldrift on the west coast to the Sundays River mouth on the south coast. Most of these catches were returned alive to the water (Elston, unpublished data).

Beach seine (treknet fishery)
M. aquila was a common catch over several decades in the beach seine (trek net) fishery, which targets harder/mullet *Liza richardsoni* in False Bay. It was present in 35% of hauls, with 5 individuals of a size range of 14-116 cm taken per haul and 1524 individuals caught over a two-year period (1991–1992) (Lamberth *et al.* 1994). This species was caught throughout the year, with a peak in catches between January and May (Lamberth 2006). Retention of any elasmobranchs is not permitted in this fishery.

Fishing outside South Africa
M. aquila is taken as bycatch in industrial and artisanal fisheries with multiple fishing gears including trawl, gillnet, set net, tangle net, and trammel net, and is retained for human consumption. There is a high level of fisheries resource use across its range and the schooling behaviour of this species means that large numbers could be fished out in one haul (Jabado *et al.* 2021c).

Population trends
Nothing has been published on the population genetics of this species. Given that in South Africa *M. aquila* appears to strongly residential, there are likely to be several global subpopulations. Last *et al.* (2016) noted that molecular barcoding does not support the suggestion that the Mediterranean and South African populations may be separate species.

Population trend data are available for *M. aquila* from demersal research trawl surveys conducted during autumn and spring along the South Africa south coast over the period 1991–2019 (DFFE, unpubl. data 2020). The trend data were analysed over three generation lengths (36 years). Standardized catch-per-unit-effort (CPUE) estimates revealed an annual rate of decrease of 0.48%, consistent with an estimated 11.1% decrease and the highest probability of being Least Concern over the past three generation lengths (36 years) (Jabado *et al.* 2021c and references cited therein).

Looking at the species globally, the situation is not nearly as positive. Considering the declining catch trends and limited number of specimens recorded in trawl surveys and fisheries in several localities where is previously occurred, the level of intense and large unmanaged fisheries that operate throughout its range, its aggregating behaviour, its limited productivity, and noted declines in eagle rays in general in several parts of its range, it was suspected in 2020 that *M. aquila* has undergone a global population reduction of >80% over the past three generation lengths (36 years), based on abundance data and actual levels of exploitation and it was assessed as Critically Endangered on the IUCN Red List in 2020 (Jabado *et al*. 2021c).

ECOTOURISM

This species is not often seen by scuba divers, despite being a coastal inhabitant. There are two known ecotourism opportunities. Aggregations of up to 40 individuals are frequently observed in the Strand tidal pool in False Bay on spring tides in spring and summer (Tinus Beukes Two Oceans Aquarium, pers. Comm). There are also regular year-round sightings, mainly of small individuals (<30 cm) in the Keurbooms estuary which has shallow waters with good water clarity.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)

This species is not listed.

Marine Protected Areas

This species will potentially benefit from all the coastal MPAs along the South African coast. Limited tag-recapture and acoustic data are indicative of site fidelity, with individuals returning to specific locations. There is insufficient known of the coastwise distribution of this species to ascertain which of these MPAs will provide protection to the various life history stages, particularly the most vulnerable components, such as the pregnant females and the neonates. There is some evidence of neonates occurring in the vicinity of the uThukela Banks MPA and that certain estuaries, such as Keurbooms, may be important for juveniles.

Additional local comment

IUCN Red List Status

Critically Endangered 2020: A2d

Previous IUCN assessments

Data Deficient 2009

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

This species is not listed.

Convention on Migratory Species (CMS)

This species is not listed.

International comments

In Turkey, fisheries for all species belonging to the family Myliobatidae have been banned since April 2018 (Jabado *et al*. 2021c and references cited therein). Elsewhere there are no known conservation measures in place for this species. Although countries across its range have legislation concerning fisheries activities (including gear restrictions, and no-trawling zones in coastal waters), fisheries taking *M. aquila* are generally unmanaged throughout large parts of the species' range and it is unlikely that pressure will decrease in the near future (Jabado *et al*. 2021c).

MANAGEMENT CONSIDERATIONS

In view of its recent upgrade to Critically Endangered status, careful monitoring of the bycatch in the inshore hake trawl fishery is required, considering that annual catch estimates were in the region of 27 tons, admittedly several years ago (2003–2006). On the other hand, this species has been assessed as Least Concern in South African waters using a long-term data series from demersal research trawl surveys. This is another case in which the status of the South/ern African population is not as threatened as elsewhere and highlights both the benefits of and the need for local/regional assessments for widely distributed species such as *M. aquila*.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

More information is needed on the life history and reproductive biology of this relatively common but poorly studied species. Specimens should be retained from the demersal trawl fishery for this purpose. Further research is also needed to investigate any local or regional population structure. A very limited number of tissue samples from the KZN bather protection programme are available for such a genetic study.

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FAMILY MOBULIDAE

Mobula alfredi

SCIENTIFIC NAME	*Mobula alfredi* (Krefft 1868)
COMMON NAME	Reef manta ray
FAMILY	Mobulidae
ENDEMIC	No, circumtropical in the Indo-West Pacific
SIZE RANGE	130–500 cm disc width (DW)
DISTRIBUTION	E coast: KZN
HABITAT	Pelagic in coastal continental waters and around islands and seamounts
DEPTH RANGE	0–430 m
MAJOR FISHERIES	KZN bather protection nets and small pelagic fishery
IUCN STATUS	Vulnerable 2018
CITES	Appendix II (2013) upgraded to Appendix I (2016)
MLRA	Retention prohibited in linefishery and longline fishery; daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	AD Marshall

SPECIES SUMMARY and RECOMMENDATIONS

Mobula alfredi is a very large, pelagic ray found in coastal and oceanic waters of the tropical and sub-tropical Indo-West Pacific. It is one of two species of manta ray, both of which occur on the east coast of South Africa. Distinguishing the two species is difficult to the untrained eye. *M. alfredi* was only formally recognised in 2009 and therefore almost all general records should be regarded as unidentified manta ray. Like all other species in the family Mobulidae, this species has an extremely low fecundity, producing a single large offspring. Both manta ray species are caught as bycatch in the KZN bather protection programme, which was the major contributor to the total estimated local catch of 1–10 tons per annum (DFFE records: 2010–2012). Globally, manta rays are taken in targeted fisheries and as bycatch in much of their range; their gill plates are highly sought after. Catches and sightings have declined in all regions, where the species are not protected. In southern Mozambique sightings of *M. alfredi* declined by 98%. This species was assessed globally as Vulnerable on the IUCN Red List in 2018, with fishing highlighted as the single greatest threat. The change in the *modus operandi* of the KZN bather protection programme from all gill nets to a combination of nets and drumlines has greatly reduced the bycatch of *Mobula* spp. There are still large gaps in the knowledge of life history and ecology of these two species. Sightings in South Africa are not regular or predictable which has hampered research efforts. A standardised code of conduct for opportunistic diver interactions with manta rays should be mandatory in all regional MPAs.

TAXONOMIC and IDENTIFICATION ISSUES

It was long thought that *Manta birostris* was the only species of manta ray. Marshall *et al.* (2009) resurrected a second species, *Manta alfredi*, as distinct from *M. birostris*. Genetic evidence confirmed the existence of two separate species (Kashiwagi *et al*. 2008, Ito and Kashiwagi 2010, cited by Marshall *et al.* 2018). White *et al*. (2018), using morphological and molecular data, concluded that there was no significant difference between the genus *Mobula* and *Manta* and, as the older name *Mobula* takes precedence, the two *Manta* species were reassigned to the genus *Mobula.* Prior to the resurrection of *M. alfredi*, the name *M. birostris* was widely used throughout the Western Indian Ocean, with historical records referring to both species (Ebert *et al.* 2021). The two species are sympatric in many locations, including South Africa but *M. alfredi* is confined to the Indo-West Pacific (Marshall *et al.*

2018). The two species are separated by mouth colour, the position and shape of the shoulder patches on the dorsal surface, the presence or absence of black spotting on the ventral surface and the presence or absence of a tail spine. Despite these differences, the two species are difficult to tell apart. The situation is aggravated by the presence of melanistic (black) and leucistic (white) colour morphs in both species (Marshall *et al*. 2009). There is evidence of a possible third species in the Atlantic (Marshall *et al.* 2018 and references cited therein).

SOUTH AFRICAN DISTRIBUTION

M. alfredi only occurs on the northern part of the east coast, spanning the province of KZN. Of the two manta species, it is far more tropical. *M. birostris* is also found in the colder waters of the south coast and part of the west coast (Ebert *et al*. 2021).

REGIONAL DISTRIBUTION

This species occurs along the entire east coast of Africa; it is absent from Namibia (Marshall *et al.* 2019a).

SYNPOSIS OF RESEARCH

M. alfredi was only recognised in 2009. In a study of batoid fishes of the east coast of southern Africa no manta ray specimens were available (Wallace 1967c). Nothing has been published subsequently on the life history and ecology of this species in South Africa. The discovery of an aggregating site for this species in southern Mozambique provided a catalyst for research (Marshall 2009), which continues to the present, covering aspects of the reproductive biology, behaviour and residency patterns (Marshall and Bennett 2010, Marshall *et al.* 2011), habitat use (Venables *et al.* 2020), genetics (Venables 2021), fishery-related declines (Rohner *et al.* 2013, 2017) and economic value to tourism (Venables *et al*. 2016).

ECOLOGY

Depth

This pelagic species is more common in productive, near-shore environments, such as coral and rocky reefs, of continental coastlines, island groups and atolls, where it is often seen at the surface. It ventures into deeper water offshore and has been recorded at depths of 430 m (Marshall *et al.* 2019a).

Habitat: Adults

They are most often sighted inshore around coral and rocky reefs and areas associated with upwelling (Last *et al.* 2016). They spend time at coastal aggregation sites, where they feed, mate and pup nearby (Marshall *et al.* 2019a).

Habitat: Juveniles/Nursery Grounds

There is increasing evidence from long-term monitoring studies that the neonates occupy discrete nursery areas and that their preferred habitat may differ from that of the adults (Andrea Marshall, Marine Megafauna Foundation, unpublished data).

Synopsis of tag deployments

No tagging, including satellite tracking, has been undertaken in southern Africa.

Movements

While individuals are capable of long-distance movements, they do so infrequently (Marshall *et al.* 2019a, Randall *et al.* 2019). This species is less nomadic/migratory than *M. birostris* (Marshall *et al.* 2018). There is movement between South Africa and Mozambique and there is evidence that these individuals constitute a single breeding population (Venables *et al.* 2021).

Diet/feeding: adults

The diet comprises mainly planktonic organisms and small teleosts (Last *et al*. 2016).

Diet/feeding: juveniles
There is no evidence that it is different from that of the adults.

South African toxicological studies
No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Histotrophic viviparity
DURATION OF REPRO CYCLE	Mostly biennial in southern Mozambique
MATING SEASON	Very little seasonality in southern Mozambique
GESTATION	Approximately 1 year
LITTER SIZE	1
PUPPING/NURSERY GROUND	Summer in southern Mozambique
DISC WIDTH AT BIRTH	130–150 cm (several locations)
DISC WIDTH AT MATURITY	F: 400 cm; M: 280-300 cm (Mozambique)
MAXIMUM DISC WIDTH	500 cm, but rarely exceeds 400 cm
GENERATION LENGTH	29 years

Mode
This species exhibits histotrophic viviparity in which maternal uterine secretions supplement the nourishment provided by the yolk-sac.

Duration of reproductive cycle
The duration of the reproductive cycle is usually biennial, but some females fell pregnant in successive years and others had a two-year interval between pregnancies in southern Mozambique (Marshall and Bennett 2010). Elsewhere the reproductive cycle is generally 4–5 years Marshall *et al.* 2019a and references cited therein).

Mating season and location
In the Inhambane Province in southern Mozambique, where large aggregations of mantas are regularly seen, mating has been observed from October to January (Marshall and Bennett 2010), although more recent observations indicate significant courtship events also take place in winter (A Marshall, unpublished data).

Gestation
This is approximately 1 year.

Litter size
This is a single embryo, although on occasion two pups were found (Marshall and Bennett 2010, Marshall *et al.* 2019a).

Disc width at birth
A single foetus, originally described as *M. birostris* from southern Mozambique, was 133 cm and was considered close to term as the smallest free-swimming individuals observed there were 130–170 cm (Marshall *et al.* 2008).

Pupping season and nursery ground
Pupping takes place in the summer months in southern Mozambique (Marshall and Bennett 2010). Heavily pregnant females typically disappear from the area for a few days to give birth. With only a

few young-of-the-year observed at inshore reefs in the summer months, the location of pupping or nursery grounds remains unclear (Marshall and Bennett 2010). A disproportionate number of young of the year and small juveniles are seen along the South African coast, particularly off Sodwana and Port St. Johns (A Marshall, unpublished data).

Disc width at maturity
Females mature at about 400 cm and males at 280–300 cm in southern Mozambique (Marshall and Bennett 2010).

Maximum disc width
This species attains a maximum size of 500 cm, however, it rarely exceeds 400 cm (Marshall *et al.* 2019a and references cited therein).

Age and growth
Female age-at-maturity is 8–17 years, depending on region and food availability, and maximum age is estimated at 45 years (Marshall *et al.* 2019a and references cited therein).

Generation length
Generation length is 29 years (Marshall *et al.* 2019a and references cited therein).

FISHERIES MANAGEMENT

SA catch sources, quantities and characteristics
Estimated total catch for both species was 1–10 tons per annum (DFFE records: 2010–2012; da Silva *et al.* 2015), which comprised the KZN bather protection nets and small pelagic fishery.

KZN bather protection nets
These nets caught 46 manta rays annually, with 30 (65%) released alive between 1978 and 2017. Of those identified, nine individuals were *M. birostris* and 13 *M. alfredi.* They were caught throughout the year, with a peak in summer. The widespread replacement of nets with drumlines has greatly reduced catches. In 2018 13 manta rays were caught, with 8 released alive; one was entanged in a drumline, the remainder caught in the nets (KZN Sharks Board, unpublsihed data).

Fishing outside South Africa
The main threat to both manta ray species is fishing, both targeted and incidental. Individuals are caught by a variety of methods including harpooning, netting and trawling. They are an easy target because of their large size, slow swimming speed, aggregative behaviour, predictable habitat use and lack of human avoidance (Marshall *et al.* 2018). Globally, catches of *Mobula* spp*.* increased from 900 tonnes to over 3,300 tonnes in the period 2000–2007 (FAO 2009, Lack and Sant 2009, cited by Marshall *et al.*2018).

Prior to receiving full protection in 2020, *M. alfredi* was caught in artisanal fisheries in southern Mozambique, most often for consumption, but the harvesting of gill plates has also been observed. They were typically harpooned but also caught in nets using motorized boats. Historically approximately 50 individuals were taken annually from a 50 km-stretch of coastline along the Inhambane coastline (Marshall *et al.* 2018).

Manta rays have a high value in international trade markets. Their gill plates are highly sought in Asian medicinal products. This market has resulted in directed fisheries which are currently targeting them in unsustainable numbers. Over 1,000 individuals are caught annually in some areas. In some areas high percentages of individuals have evidence of entanglement or are dragging lines or nets. Boat strikes are also a problem (Marshall *et al.* 2018 and references cited therein).

Population trends

The global population size is not known, but some local and regional population sizes have been estimated and are mostly small, at less than 1,000 individuals, with the exception of the Maldives where the population is estimated at ~10,000. While individuals are capable of long-distance movements they do so infrequently, consequently aggregations are widely separated with low connectivity, resulting in a high likelihood of local depletion. The species has an extremely low productivity, producing only 1 pup on average every 4–5 years, and consequently is likely to have one of the lowest maximum rates of population increase among elasmobranchs (Marshall *et al.* 2019a).

In over a dozen countries and territories where *M. alfredi* are protected from fishing, the sighting trends appear stable. Where significant fisheries for manta rays exist in Madagascar, Tanzania, Kenya, Somalia, Pakistan, India, Sri Lanka, Bangladesh, Myanmar, China, and Indonesia and based on historical sightings, distribution data, and habitat suitability, it is suspected that any resident aggregations of this species have been depleted, possibly to the point of local extinction (Marshall *et al.* 2019a). In southern Mozambique, a recognised global hotspot for manta rays, there was a 98% decline in sightings of *M. alfredi* along the Inhambane Province, a well monitored coastline, over a 14-year period (Rohner *et al.* 2017).

Globally, the suspected population reduction is 30–49% over the past three generation lengths (87 years) with further population reduction suspected over the next three generation lengths (2018–2105). *M. alfredi* was therefore assessed as Vulnerable on the IUCN Red List in 2018 (Marshall *et al.* 2018).

ECOTOURISM

Manta rays are regarded as iconic ecotourism species wherever they occur, including Mozambique. They are opportunistically encountered in the iSimangaliso, Aliwal Shoal and Protea Banks MPAs, where scuba diving is extremely popular.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

Retention is prohibited in both the linefishery and the longline fisheries.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)

Both manta species are listed as Vulnerable.

Marine Protected Areas

This species potentially benefits from protection in all the MPAs on the KZN coast, especially the largest and most northern iSimangaliso MPA, which includes coral reef habitats. As there are no known aggregation sites in this MPA or anywhere else in its South African distribution, individuals are unlikely to spend large amounts of time in any of these protected areas.

Additional local comment

IUCN Red List Status

Vulnerable 2018: A2bcd+3d

Previous IUCN assessments

Vulnerable 2011

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

This species was included in Appendix II in 2016.

Convention on Migratory Species (CMS)

This species was listed in Appendix II and Appendix I in 2014.

International comments

In 2015, the International Commission for the Conservation of Atlantic Tunas (ICCAT) banned retention of all mobulid rays, which must be released alive under strict non-detrimental protocols. ICCAT is the only Regional Fishing Management Organization (RFMO) that has formally prohibited the retention of manta rays as bycatch. Manta rays are protected in some form in several countries which include USA (Hawaii), Australia and its territories, the Maldives, the United Arab Emirates, the Federated States of Micronesia (Yap), Thailand, Mozambique, Indonesia, and the Philippines (Marshall *et al.* 2018 and references cited therein).

In Mozambique this species and its congeners were fully protected in terms of Article 146 in the Boletim Da República Publicação Oficial Da República De Moçambique: Regulamento da Pesca Marítima (REPMAR) on 8 October 2020 (Issue 192).

MANAGEMENT CONSIDERATIONS

The major source of South African catches of both species of manta rays is the KZN bather protection programme, in which the length of netting dropped from a maximum of 45 km in 1992 to 16 km, supplemented with 177 drumlines, in 2020. This has greatly reduced the bycatch, including that of *Mobula* spp.. Diver encounters occur mainly in the iSimangaliso and Aliwal Shoal MPAs, because recreational diving is concentrated in these two areas. These interactions are opportunistic and not predictable, hence manta ray tourism has not developed locally, and there is no legislation and control through permitting systems to ensure that operators and tourists are adhering to best practice protocols. Nevertheless, some form of code of conduct for manta ray interactions should be mandatory for all dive operators in any South African MPA. Considering that South Africa shares its manta population with Mozambique, where unregulated and illegal fishing for this species still occurs, any engagement with a view to developing cooperative agreements between the two countries may improve the conservation status of this species.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

Despite the intensive research undertaken on this species in southern Mozambique, there are still gaps in our knowledge of its life history and ecology. The presence of this species in South African waters is too unpredictable to establish any dedicated research projects. Diver photographers should be encouraged to submit photographic images, particularly of the spotting pattern on the ventral surface of individuals they may encounter, to the regional database maintained by Marine Megafauna Foundation (www.marinemegafauna.org), based in southern Mozambique or the global database for manta rays, Manta Matcher (www.mantamatcher.org) for photo-identification purposes. Futher investigation into the potential nursery grounds along the east coast of South Africa is warranted as are telemetry studies to better determine habitat use in the region.

Mobula birostris

SCIENTIFIC NAME	*Mobula birostris* (Walbaum 1792)
COMMON NAME	Giant manta ray
FAMILY	Mobulidae
ENDEMIC	No, circumglobal in tropical and temperate waters
SIZE RANGE	?–700 cm disc width (DW)
DISTRIBUTION	E, S, W coasts: Mozambique border to Table Bay
HABITAT	Pelagic in coastal and oceanic waters
DEPTH RANGE	0–1000 m
MAJOR FISHERIES	KZN bather protection nets and small pelagic fishery
IUCN STATUS	Endangered 2019
CITES	Appendix II (2013)
MLRA	Retention prohibited in linefishery and longline fishery; daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	AD Marshall

SPECIES SUMMARY and RECOMMENDATIONS
Mobula birostris is the largest ray; it is pelagic and circumglobal in coastal and oceanic waters of tropical and temperate seas. It is one of two species of manta ray, both of which occur on the east coast of South Africa. Distinguishing the two species is difficult to the untrained eye. The second species, *M. alfredi,* was only formally recognised in 2009 and therefore almost all general records of these two species should be regarded as unidentified manta ray. These species have an extremely low fecundity, producing a single large offspring. They are both caught as bycatch in the KZN bather protection programme, which was the major contributor to the total estimated local catch of 1-10 tons *per annum* (DFFE records: 2010-2012). Globally, manta rays are taken in targeted fisheries and as bycatch in much of their range; their gill plates are highly sought after. Catches and sightings have declined in all regions, where the species are not protected. In southern Mozambique, a recognised global hotspot for manta rays, sightings of *M. birostris* declined by 94% over a 14-year period. This species was assessed as Endangered on the IUCN Red List in 2019, with fishing being the greatest threat. The change in the modus operandi of the KZN bather protection programme from all gill nets to a combination of nets and drumlines has greatly reduced catches of *Mobula* spp.. Considerable research has been conducted there, but there are still large gaps in the knowledge of life history and ecology of these two species. Sightings in South Africa are not as regular or predictable, which has hampered research efforts. A standardised code of conduct for opportunistic diver interactions with manta rays should be mandatory in all regional MPAs.

TAXONOMIC and IDENTIFICATION ISSUES
It was long thought that *Manta birostris* was the only species of manta ray. Marshall *et al.* (2009) resurrected a second species, *Manta alfredi*, as distinct from *M. birostris*. Genetic evidence confirmed the existence of two separate species (Kashiwagi *et al*. 2008, Ito and Kashiwagi 2010, cited by Marshall *et al.* 2018). White *et al*. (2018), using morphological and molecular data, concluded that there was no significant difference between the genus *Mobula* and *Manta* and, as the older name *Mobula* takes precedence, the two *Manta* species were reassigned to the genus *Mobula.* Prior to the resurrection of *M. alfredi*, the name *M. birostris* was widely used throughout the Western Indian Ocean, with historical records referring to both species (Ebert *et al.* 2021). The two species are sympatric in many locations, including South Africa but *M. birostris* is circumglobal unlike *M. alfredi*, which is confined to the Indo-West Pacific (Marshall *et al.* 2020). The two species are separated by mouth colour, the position and shape of the light-coloured shoulder patches on the dorsal surface, the presence or

absence of black spotting on the ventral surface and the presence or absence of a tail spine. Despite these differences, the two species are difficult to tell apart. The situation is aggravated by the presence of melanistic (black) and leucistic (white) colour morphs in both species (Marshall *et al*. 2009). There is evidence of a possible third species in the Atlantic (Marshall *et al.* 2020 and references cited therein).

SOUTH AFRICAN DISTRIBUTION

This species occurs on the entire east and south coasts. It also occurs up to Table Bay on the southern part of the west coast and is far more tolerant of the more temperate waters of the south and west coasts. *M. alfredi* is restricted to the warmer waters of the KZN coast (Ebert *et al*. 2021).

REGIONAL DISTRIBUTION

This species occurs along the entire east coast of Africa; it is absent from Namibia (Marshall *et al.* 2018).

SYNOPSIS OF RESEARCH

In a study of batoid fishes of the east coast of southern Africa no specimens were available (Wallace 1967c). Nothing has been published subsequently on the life history and ecology of this species in South Africa. The discovery of a manta ray aggregating site in southern Mozambique provided a catalyst for regional research on the two species (Marshall 2009). Recently, seasonal sightings in the Port St Johns area on the east coast have provided opportunities for aerial and boat-based surveys, photo-identification, collection of genetic samples and satellite tagging (A Marshall, Marine Megafauna Foundation, unpublished data).

ECOLOGY

Depth

This species is found close inshore on shallow reefs as well as far offshore, frequently near oceanic islands, seamounts and pinnacles. It spends a lot of time at the surface, particularly when feeding, but has been tracked to depths exceeding 1,000 m (Marshall *et al.* 2018).

Habitat: Adults

They are most often sighted along productive coastlines with regular upwelling and around oceanic island groups, particularly offshore pinnacles and seamounts. They may be encountered on shallow reefs, where they visit cleaning stations, or at the surface in both coastal and oceanic waters. They are occasionally observed over sand bottom areas (Marshall *et al.* 2018).

Habitat: Juveniles/Nursery Grounds

There is increasing evidence from long-term monitoring studies that the neonates occupy discrete nursery areas and that their preferred habitat may different from that of the adults.

Synopsis of tag deployments

Satellite tracking has revealed that this species is capable of large migrations (over 1,100 km straight line distance) both coastwise and inshore/offshore, including from Mozambique to South Africa (Marshall *et al.* 2018).

Movements

A global investigation of major aggregation sites revealed that this species is not only more oceanic, but also more migratory than its congener. Rare or seasonal sightings at various locations in all three oceans suggests that this species undergoes significant seasonal migrations (Marshall *et al.* 2018). On the other hand, the consistent agreement between satellite tracking, stable isotope and genetic results strongly suggests that *M. birostris* forms well-structured, regional subpopulations and exhibit a high degree of residency (Stewart *et al*. 2016). In summary, this species is both migratory and nomadic but regularly returns to particular locations, often on a seasonal basis.

Diet/feeding: adults
The diet comprises planktonic organisms and small teleosts (Last *et al*. 2016).

Diet/feeding: juveniles
There is no evidence that it is different from that of the adults.

South African toxicological studies
No local studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Histotrophic viviparity
DURATION OF REPRO CYCLE	Unknown
MATING SEASON	Summer (Japan)
GESTATION	Unknown
LITTER SIZE	1
PUPPING/NURSERY GROUND	Unknown
DISC WIDTH AT BIRTH	120–200 cm
DISC WIDTH AT MATURITY	F: >400 cm; M: 400 cm (Mozambique)
MAXIMUM DISC WIDTH	At least 700 cm
GENERATION LENGTH	±29 years, inferred from *M. alfredi*

Mode
This species exhibits histotrophic viviparity in which maternal uterine secretions supplement the nourishment provided by the yolk-sac.

Duration of reproductive cycle
The duration of the reproductive cycle is unknown, with little information on the reproductive biology of this species.

Mating season and location
Two pregnant individuals were photographed in southern Mozambique, but the breeding season at this location has not been established (Marshall 2009). Copulation has been documented off the Ogasawara Islands, Japan in the summer months (Yano *et al*. 1999b cited by Marshall *et al.* 2018).

Gestation
This is unknown.

Litter size
There are several reports of the litter comprising a single offspring (Marshall *et al.* 2018 and references cited therein).

Disc width at birth
Size at birth is 120–200 cm (Marshall *et al.* 2018 and references cited therein). A foetus of 133 cm originally described as *M. birostris* (Marshall *et al*. 2008) was *M. alfredi.*

Pupping season and nursery ground
Two pregnant individuals were photographed in southern Mozambique, but the breeding season at this location has not been established (Marshall 2009).

Disc width at maturity

Size at maturity varies slightly across its range. In southern Mozambique females appear to mature at well over 400 cm and males at approximately 400 cm (Marshall 2009). In Indonesia, data from fisheries dissections suggest that females mature by approximately 410 cm and males mature at 375 cm (White *et al*. 2006, cited by Marshall *et al.* 2018).

Maximum disc width
This species attains at least 700 cm with unconfirmed reports of at least 910 cm (Compagno 1999, Alava *et al*. 2002, cited by Marshall *et al.* 2018).

Age and growth
Females are thought to mature at 8–10 years of age and longevity is estimated to be at least 40 years (Marshall *et al.* 2009).

Generation length
Generation time is suspected to be 29 years, based on conservative estimates of life history parameters from *M. alfredi* (Marshall *et al.* 2018).

FISHERIES MANAGEMENT

SA catch sources, quantities and characteristics
Estimated total catch for both manta species was 1–10 tons per annum (DFFE records: 2010-2012; da Silva *et al.* 2015), which comprised the KZN bather protection nets and small pelagic fishery.

KZN bather protection nets
These nets caught 46 manta rays annually, with 30 (65%) released alive between 1978 and 2017. Of those identified, nine individuals were *M. birostris* and 13 *M. alfredi.* They were caught throughout the year, with a peak in summer. The widespread replacement of nets with drumlines has greatly reduced the catch. In 2018 13 individuals were caught, with 8 released alive; one was entanged in a drumline, the remainder in nets (KZN Sharks Board, unpublished data).

Fishing outside South Africa
The main threat to both manta ray species is fishing, both targeted and incidental. They are caught by a variety of methods including harpooning, netting and trawling. They are an easy target because of their large size, slow swimming speed, aggregative behaviour, predictable habitat use, and lack of human avoidance (Marshall *et al.*2018). Globally, catches of all *Mobula* spp. increased from 900 tonnes to over 3,300 tonnes in the period 2000–2007 (FAO 2009, Lack and Sant 2009, cited by Marshall *et al.*2018).

Proir to full protection in 2020, both manta species were caught in artisanal fisheries in southern Mozambique for consumption. They were typically harpooned but also caught in nets deployed from motorized boats, with approximately 50 individuals, mainly smaller ones, taken annually from a 50 km-stretch of coastline (Marshall *et al.*2018).

Manta rays have a high value in international trade markets. Their gill plates are highly sought after for use in Asian medicinal products. This market has resulted in directed fisheries which are currently targeting them in unsustainable numbers. Over 1,000 manta rays are caught annually in some areas. In some areas high percentages of individuals have evidence of entanglement or are dragging lines or nets. Boat strikes are also a problem (Marshall *et al.* 2018 and references cited therein).

Population trends
There are no data available on the global population size of *M. birostris*. Preliminary satellite tracking studies and international photo-identification matching projects have suggested a high degree of fragmentation between regional populations of this species, suggesting that movements across ocean

basins may be rare (Marshall *et al.* 2018). Local and regional abundance has been estimated and is mostly small, numbering less than 500 individuals, except for Ecuador where abundance is estimated at more than 2,000 individuals (Marshall *et al.* 2020).

In the small number of locations (over a dozen countries and territories), where the species is protected, sighting trends appear stable. In southern Mozambique, a recognised global hotspot for manta rays, there was a 94% decline in sightings of *M. birostris* along the Inhambane Province, a well monitored coastline, over a 14-year period (Rohner *et al.* 2017). Elsewhere, very rapid declines in both sightings and landings in both targeted and bycatch fisheries have ranged from 71–95% over periods of less than one generation length (29 years). It is suspected that *M. birostris* has undergone a population reduction of 50–79% over the past three generation lengths (87 years). As a result, this species was assessed globally as Endangered on the IUCN Red List in 2019 (Marshall *et al.* 2020).

ECOTOURISM
Manta rays are regarded as iconic ecotourism species wherever they occur, including Mozambique. They are opportunistically encountered in the iSimangaliso, Aliwal Shoal and Protea Banks MPAs, where scuba diving is extremely popular.

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
Retention is prohibited in both the linefishery and the longline fisheries.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
Both manta species are listed as Vulnerable.

Marine Protected Areas
This species benefits from protection in all the MPAs on the KZN coast, especially the largest and most northern one, the iSimangaliso MPA, which includes coral reef habitats and also extends 5,5 km offshore. As there are no known aggregation sites in this MPA or anywhere else in its South African distribution, this species is unlikely to spend large amounts of time in any of these protected areas.

Additional local comment

IUCN Red List Status
Endangered 2019: A2bcd+3d

Previous IUCN assessments
Vulnerable 2018
Vulnerable 2011

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
This species was included in Appendix II in 2013.

Convention on Migratory Species (CMS)
This species was listed in Appendix II and Appendix I in 2011.

International comments
In 2015, the International Commission for the Conservation of Atlantic Tunas (ICCAT) banned retention of all mobulid rays, which must be released alive under strict non-detrimental protocols. ICCAT is the only Regional Fishing Management Organization (RFMO) that has formally prohibited the retention of manta rays as bycatch (Marshall *et al*. 2018 and references cited therein). Manta rays are protected in some form in several countries which include USA (Hawaii), Australia and its territories,

the Maldives, the United Arab Emirates, the Federated States of Micronesia (Yap), Thailand, Mozambique, Indonesia, and the Philippines (Marshall *et al.* 2020 and references cited therein).

In Mozambique this species and its congeners were fully protected in terms of Article 146 in the Boletim Da República Publicação Oficial Da República De Moçambique: Regulamento da Pesca Marítima (REPMAR) on 8 October 2020 (Issue 192).

MANAGEMENT CONSIDERATIONS

The major source of South African catches of both species of manta rays is the KZN bather protection programme in which the length of netting dropped from a maximum of 45 km in 1992 to 16 km, supplemented with 177 drumlines, in 2020. This has greatly reduced the bycatch, including all *Mobula* spp. Historically diver encounters have been opportunistic, occurring mainly in the iSimangaliso and Aliwal Shoal MPAs, because recreational diving is concentrated in these two areas. As a result, manta ray tourism has not developed locally, and there is no legislation and control through permitting systems to ensure that operators and tourists are adhering to best practice protocols. The recent discovery of a seasonal aggregating site at Port St Johns, albeit *M. alfredi*, highlights the need for some form of code of conduct for any diver-manta ray interactions. Considering that SA shares its manta population with Mozambique, where unregulated fishing for this species still occurs, any engagement with a view to developing cooperative agreements between the two countries may improve the conservation status of this species.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

The discovery of a seasonal aggregation site at Port St Johns has provided a catalyst for local research on the life history and ecology of this species. Futher investigation into the potential nursery grounds along the east coast of South Africa is warranted as are telemetry studies to better determine their habitat use in the region. Diver photographers should be encouraged to submit photographic images, particularly of the spotting pattern on the ventral surface of individuals they may encounter, to the regional database maintained by Marine Megafauna Foundation (www.marinemegafauna.org), based in southern Mozambique or the global database for manta rays, Manta Matcher (www.mantamatcher.org) for photo-identification purposes.

Mobula eregoodoo

SCIENTIFIC NAME	*Mobula eregoodoo* (Bleeker 1859)
COMMON NAME	Longhorned pygmy devilray/pygmy devilray
FAMILY	Mobulidae
ENDEMIC	No, tropical in the Indo-West Pacific
SIZE RANGE	43–130 cm disc width (DW)
DISTRIBUTION	E coast: Mozambique border to Durban
HABITAT	Pelagic in coastal waters
DEPTH RANGE	0–50 m
MAJOR FISHERIES	KZN bather protection nets and small pelagic fishery
IUCN STATUS	Endangered 2020
CITES	Appendix II (2017)
MLRA	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	AD Marshall

SPECIES SUMMARY and RECOMMENDATIONS

Mobula eregoodoo is a very small, pelagic ray which occurs in coastal waters of the tropical and sub-tropical Indo-West Pacific Ocean. It is one of five species of devilrays, which are difficult to tell apart, in South African waters and, as a result, catches are often lumped. The total estimated annual local catch of devilrays was <1 ton (DFFE records: 2010–2012), with the KZN bather protection programme a major contributor. Of the devilrays caught in this programme and identified to species, 2% were *M. eregoodoo.* Globally, devilrays are taken in targeted fisheries and as bycatch in much of their range. Their gill plates are highly sought after. Catches and sightings have declined in all regions, where the species are not protected. Devilrays have an extremely low fecundity, producing a single large offspring every 1-3 years. *M. eregoodoo* was assessed globally as Endangered on the IUCN Red List in 2020. This species appears to be uncommon in South African waters, making it difficult to formulate management considerations. Catches of all devilray species in the small-pelagic fishery should be quantified and monitored. Very little is known about its life history and any opportunistic sampling should be used to collect biological information and tissue samples for genetic studies.

TAXONOMIC and IDENTIFICATION ISSUES

Historically at least 29 different species in the genus *Mobula* have been proposed. In a global review of the genus, Notarbartolo-di-Sciara (1987) utilised morphometrics, external morphology, colouration, and tooth and denticle morphology to identify nine extant species, excluding the manta rays which were not then regarded as members of the genus *Mobula*. Last *et al.* (2016) regarded *M. eregoodootenke* as a junior synonym of *M. kuhlii*, but this has been disproved and the name clarified as *M. eregoodoo*, with seven species of devilrays now recognised globally (Notarbartolo-di-Sciara *et al.* 2019). In South African waters the genus *Mobula* is poorly known due to revisions to the genus and misidentification of individual species; a comprehensive review of species present and their distributional limits is needed. Of the seven species, five occur in South African waters (Ebert *et al.* 2021). To the inexperienced, they are difficult to tell apart. Features such as disc width, the length of the cephalic horns, skin texture (smooth or rough), wing shape and the presence or absence of a tail spine are used to distinguish the individual species. All devilrays have a ventral mouth, which is terminal in manta rays. *M. eregoodoo* has a more elongated head and longer cephalic fins than the other four species.

SOUTH AFRICAN DISTRIBUTION

M. eregoodoo only occurs in the extreme north of the east coast, from the Mozambique border to Durban (Ebert *et al*. 2021).

REGIONAL DISTRIBUTION
This species occurs along parts of the east coast of Africa, but its presence in Mozambique, Tanzania and Madagascar has not been confirmed (Rigby *et al.* 2020a).

SYNPOSIS OF RESEARCH
In a study of batoid fishes of the east coast of southern Africa the presence of a single species *Mobula diabolus* was acknowledged, with 11 specimens examined (Wallace 1967c). Nothing has been published subsequently on the life history and ecology of any devilrays in South Africa. Couturier *et al.* (2012) provided a global review of the biology, ecology and conservation of the family Mobulidae. For recent studies on the biology and ecology of this species from elsewhere in its range, see Rigby *et al.* (2020a) and references cited therein.

ECOLOGY
Depth
This pelagic species occurs in coastal waters, often close to shore, down to depths of 50 m (Rigby *et al.* 2020a).

Habitat: Adults
They are often gregarious in and around coastal reefs, including coral reefs (Notobartolo-di-Sciara *et al.* 2019, Rigby *et al.* 2020a and reference cited therein).

Habitat: Juveniles/Nursery Grounds
There is no published evidence that juveniles occupy different habitats from the adults.

Synopsis of tag deployments
There are no records of any tagging or satellite or acoustic tracking.

Movements
Movement patterns and swimming capacities of most devilray species are poorly understood, but they appear to undertake relatively large-scale movements, travelling from one productive area to another (Couturier *et al.* 2012).

Diet/feeding: adults
The diet consists of zooplanktonic organisms but with no further details (Couturier *et al.* 2012).

Diet/feeding: juveniles
There is no evidence that it is different from that of the adults.

South African toxicological studies
No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Histotrophic viviparity
DURATION OF REPRO CYCLE	Unknown, but possibly 1–3 years
MATING SEASON	Unknown
GESTATION	>10 months
LITTER SIZE	1
PUPPING/NURSERY GROUND	Unknown
DISC WIDTH AT BIRTH	43 cm
DISC WIDTH AT MATURITY	F: 92 cm; M: 99 cm
MAXIMUM DISC WIDTH	130 cm

GENERATION LENGTH	12.8 years, inferred from *M. mobular*

Mode
All mobulid rays exhibit histotrophic viviparity in which maternal uterine secretions supplement the nourishment provided by the yolk-sac (Couturier *et al.* 2012 and references cited therein).

Duration of reproductive cycle
This is unknown, but other *Mobula* species have a resting period of 1–3 years between pregnancies (Rambahiniarison *et al*. 2018, cited by Rigby *et al.* 2020a).

Mating season and location
This is unknown.

Gestation
Gestation in *M. eregoodoo* is at least 10 months, possibly more than 12 months (Broadhurst *et al*. 2018, Broadhurst *et al.* 2019, cited by Rigby *et al.* 2020a).

Litter size
There is a single offspring, occasionally two (Couturier *et al.* 2012 and references cited therein).

Disc width at birth
Disc width at birth is 43 cm (Broadhurst *et al*. 2018, Broadhurst *et al*. 2019, cited by Rigby *et al.* 2020a).

Pupping season and nursery ground
This is unknown.

Disc width at maturity
Females mature at about 92 cm and males at 99 cm (Notobartolo-di-Sciara *et al*. 2019; Broadhurst *et al.* 2018, cited by Rigby *et al.* 2020a).

Maximum disc width
This species attains a maximum disc width of 130 cm (Rigby *et al.* 2020a).

Age and growth
This is unknown.

Generation length
Generation length is assumed to be 12.8 years, based on *M. mobular*, that has an estimated age-at-maturity of 5–6 years and maximum age of 20 years. As *M. mobular* reaches a considerably larger size than *M. eregoodoo* (520 vs 130 cm), this generation length is likely to be overestimated (Rigby *et al.* 2020a).

FISHERIES MANAGEMENT
SA catch sources, quantities and characteristics
Estimated total annual catch for all devilrays was <1 ton (DFFE records: 2010–2012; da Silva *et al.* 2015), which comprised the KZN bather protection nets and small-pelagic fishery. In the latter fishery the chondrichthyan bycatch is discarded once the main catch has been sorted, with 100% mortality of all chondrichthyans (DFFE unpublished data, cited by da Silva *et al.* 21015).

KZN bather protection nets
These nets caught an annual average of 26 devilrays, with 10 (38%) released alive, between 1978 and 2017. Of the devilrays that were identified, 2% (10 indviduals) were *M. eregoodoo.* The widespread replacement of many of the nets (45 km of nets in 1992) with drumlines (16 km of nets and 177

drumlines in 2020) has greatly reduced captures of all *Mobula* spp. and in 2018 seven devilrays were caught, of which one was *M. eregoodoo.*

Fishing outside South Africa

Devilrays, including *M. eregoodoo*, are targeted and caught incidentally in industrial and artisanal fisheries. They are captured in a wide range of gear types including harpoons, drift nets, purse seine nets, gillnets, traps, trawls, and longlines. They are easy to target because of their slow swimming speed, tendency to aggregate and their general lack of human avoidance (Couturier *et al.* 2012). There are intensive inshore fisheries in many parts of its range, including Pakistan, India, Sri Lanka, Indonesia and elsewhere. This species is used for its meat, skin, cartilage, liver oil, and gill plates. The gill plates, in particular, fetch high prices in Asia and are used for Chinese health tonics (O'Malley *et al*. 2017 cited by Rigby *et al.* 2020a).

Population trends

Globally, there is evidence of severe localised population reductions of devilrays in several regions, and specifically at major known aggregation areas for *M. eregoodoo*. Much of the data applies to devilrays as a group, rather than specific species and caution is needed in extrapolating regional declines. Nonetheless, based on current and future potential levels of exploitation, steep declining trends in monitored populations, and the uncertainty of data in some regions, it is suspected that the population of *M. eregoodoo* has undergone a reduction of 50–79% over the past three generation lengths (38 years), with the result that this species globally was assessed as Endangered on the IUCN Red List in 2020. Further population declines are likely, due to ongoing demand for high-value products (Rigby *et al.* 2020a).

ECOTOURISM

As all devilrays close resemble small manta rays, it is tempting to regard all members of the genus as ecotourism species. *M. eregoodoo* is uncommon close inshore and is unlikely to be encountered by divers.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)

This species is not listed.

Marine Protected Areas

This species could benefit from protection in the two MPAs in its South African range. They are the iSimangaliso and uThukela Banks MPAs. As there are no known aggregation sites in either of these MPAs, or anywhere else in South Africa, this species it is unlikely to spend large amounts of time in either of these protected areas.

Additional local comment

IUCN Red List Status

Endangered 2020: A2bd+3bd

Previous IUCN assessments

Near Threatened 2003

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

This species, along with other devilrays, was included in Appendix II in 2017.

Convention on Migratory Species (CMS)
This species was listed in Appendix II and Appendix I in 2014.

International comments
In Mozambique this species and its congeners were fully protected in terms of Article 146 in the Boletim Da República Publicação Oficial Da República De Moçambique: Regulamento da Pesca Marítima (REPMAR) on 8 October 2020 (Issue 192).

In 2019 the Western and Central Pacific Fisheries Commission (WCPFC) adopted measures to ban targeted fishing and retention of *Mobula* spp. which will come into force in 2021. This allows retention and donation for domestic human consumption of any species unintentionally captured and landed by purse seine vessels. The Indian Ocean Tuna Commission (IOTC) adopted a ban on retention of *Mobula* species in 2019 with guidelines for safe release; artisanal fisheries are exempted from this ban but only for accidental catches and until 2022 (Rigby *et al*. 2020a).

Devilrays are protected in some countries (Rigby *et al*. 2020a). The IUCN SSC SSG Global Devil and Manta Ray Conservation Strategy provides more detailed information regarding priority conservation actions; see Lawson *et al*. (2017).

MANAGEMENT CONSIDERATIONS
The major source of South African catches of devilrays appears to be the KZN bather protection programme, but *M. eregoodoo* is rarely caught. Bycatch in other fisheries, such as the small-pelagic fishery, should be quantified and monitored, given the low reproductive output of all members of the genus *Mobula*, but it is likely that this species is uncommon in South African waters. There are no other obvious management interventions and this species must be regarded as being of low priority.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
Very little is known of the life history and ecology of this species. A very small amount of unpublished information has been accumulated from specimens caught in the KZN bather protection programme, given the rarity of comfirmed catches. Any opportunistic sampling, regardless of the fishery, should be used to collect biological information and tissue samples for genetic studies.

Mobula kuhlii

SCIENTIFIC NAME	*Mobula kuhlii* (Müller and Henle 1841)
COMMON NAME	Shorthorn pygmy devilray/shortfin devilray
FAMILY	Mobulidae
ENDEMIC	No, tropical in the Indo-West Pacific
SIZE RANGE	31–>135 cm disc width (DW)
DISTRIBUTION	E coast: Mozambique border to Port Alfred
HABITAT	Pelagic in coastal waters
DEPTH RANGE	0–50 m
MAJOR FISHERIES	KZN bather protection nets and small pelagic fishery
IUCN STATUS	Endangered 2020
CITES	Appendix II (2017)
MLRA	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	AD Marshall

SPECIES SUMMARY and RECOMMENDATIONS

Mobula kuhlii is a very small, gregarious, pelagic ray which occurs in coastal waters of the tropical and sub-tropical Indo-West Pacific Ocean. It is one of five species of devilrays, which are difficult to tell apart, in South African waters and, as a result, catches are often lumped. The total estimated annual local catch of devilrays was <1 ton (DFFE records: 2010–2012), with the KZN bather protection programme a major contributor. Of the devilrays caught in this programme and identified to species, 97% were *M. kuhlii*, indicating that it is the most common species in KZN coastal waters. Globally, devilrays are taken in targeted fisheries and as bycatch in much of their range. Their gill plates are highly sought after. Catches and sightings have declined in all regions where the species are not protected. In southern Mozambique, sightings of *M. kuhlii* declined by 94% over a 14-year period. Devilrays have an extremely low fecundity, producing a single large offspring every 1-3 years. *M. kuhlii* was assessed globally as Endangered on the IUCN Red List in 2020. The change in the *modus operandi* of the KZN bather protection programme from all gill nets to a combination of nets and drumlines has greatly reduced the bycatch of all devilrays. Catches of all devilrays in the small-pelagic fishery should be quantified and monitored. A code of conduct should be introduced for divers visiting the recently discovered cleaning station ulitised by *M. kuhlii* on the southern end of Aliwal Shoal. Very little is known about the life history of this species, although unpublished information has been collected on individuals caught in the KZN bather protection netting programme, including tissue samples for genetic studies.

TAXONOMIC and IDENTIFICATION ISSUES

Historically at least 29 different species have been proposed in the genus *Mobula*. In a global review of the genus, Notarbartolo-di-Sciara (1987) utilised morphometrics, external morphology, colouration, and tooth and denticle morphology to identify nine extant species, excluding the manta rays which were not then regarded as members of the genus *Mobula*. Subsequent research has shown that there are seven species (Notarbartolo-di-Sciara *et al.* 2019). In South African waters the genus *Mobula* is poorly known due to revisions to the genus and misidentification of individual species; a comprehensive review of species present (currently five) and their distributional limits is needed (Ebert *et al.* 2021). To the inexperienced, they are difficult to tell apart. Features such as disc width, the length of the cephalic horns, skin texture (smooth or rough), wing shape and the presence or absence of a tail spine are used to identify the individual species. All devilrays have a ventral mouth, which is terminal in manta rays.

SOUTH AFRICAN DISTRIBUTION

M. kuhlii only occurs on the northern part of the east coast, from the Mozambique border to Port Alfred (Ebert *et al*. 2021).

REGIONAL DISTRIBUTION

This species occurs along the entire east coast of Africa, but not Madagascar (Rigby *et al.* 2020b).

SYNOPSIS OF RESEARCH

In a study of batoid fishes of the east coast of southern Africa the presence of a single species *Mobula diabolus* was acknowledged, with 11 specimens examined (Wallace 1967c), probably including some *M. kuhlii*, but the larger individuals of up to 179 cm were far larger than the maximum disc width of this species. Nothing has been published subsequently on the life history and ecology of any devilrays in South Africa. Couturier *et al.* (2012) provided a global review of the biology, ecology and conservation of the family Mobulidae. In southern Mozambique Murie and Marshall (2016) documented this species visiting an inshore cleaning station and Rohner *et al.* (2017) found significant declines in sightings by divers, which were attributed to fishery-related activities. For recent studies on the biology and ecology of this species from elsewhere in its range, see Rigby *et al.* (2020b) and references cited therein.

ECOLOGY

Depth

This pelagic species occurs in coastal waters, often close to shore, down to depths of 50 m (Last *et al.* 2016, Rigby *et al.* 2020b).

Habitat: Adults

They are often gregarious, with up to 200 individuals in and around coastal reefs in southern Mozambique (Rohner *et al.* 2017). There is evidence of this species, like manta rays, visiting cleaning stations there (Murie and Marshall 2016).

Habitat: Juveniles/Nursery Grounds

There is no published evidence that juveniles occupy different habitats from the adults.

Synopsis of tag deployments

There are no records of any tagging or satellite or acoustic tracking.

Movements

Movement patterns and swimming capacities of most devilrays species are poorly understood, but they appear to undertake relatively large-scale movements, travelling from one productive area to another (Couturier *et al.* 2012).

Diet/feeding: adults

The diet consists of zooplanktonic organisms but with no further details (Couturier *et al.* 2012).

Diet/feeding: juveniles

There is no evidence that it is different from that of the adults.

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Histotrophic viviparity
DURATION OF REPRO CYCLE	Unknown, but possibly 1–3 years

MATING SEASON	Unknown
GESTATION	Unknown
LITTER SIZE	1, occasionally 2
PUPPING/NURSERY GROUND	Unknown
DISC WIDTH AT BIRTH	31–34 cm
DISC WIDTH AT MATURITY	F: 134 cm; M: 115 cm
MAXIMUM DISC WIDTH	>135 cm
GENERATION LENGTH	12.8 years inferred from *M. mobular*

Mode
This species exhibits histotrophic viviparity in which maternal uterine secretions supplement the nourishment provided by the yolk-sac (Couturier *et al.* 2012 and references cited therein).

Duration of reproductive cycle
This is unknown, but other *Mobula* species have a resting period of 1–3 years between pregnancies (Rigby *et al.* 2020b and reference cited therein).

Mating season and location
Unknown. Mating behaviour was observed at a recently discovered cleaning station on Aliwal Shoal (Michelle Carpenter, University of Cape Town, unpublished data).

Gestation
This is unknown.

Litter size
There is a single offspring, occasionally two (Couturier *et al.* 2012 and references cited therein).

Disc width at birth
Disc width at birth is 31–34 cm (Last *et al*. 2016).

Pupping season and nursery ground
Unknown, but near-term pregnant females are regularly sighted in southern Mozambique along the Inhambane Coastline (Marine Megafauna Foundation, unpublished data).

Disc width at maturity
Females mature at about 116 cm and males at 115 cm (Last *et al*. 2016; Rigby *et al.* 2020b and reference cited therein).

Maximum disc width
This species attains a maximum disc width of at least 135 cm (Last *et al*. 2016).

Age and growth
This is unknown.

Generation length
Generation length is assumed to be 12.8 years, based on *M. mobular*, that has an estimated age-at-maturity of 5–6 years and maximum age of 20 years. As *M. mobular* reaches a considerably larger size than *M. kuhlii* (520 vs 135 cm), this generation length is likely overestimated (Rigby *et al.* 2020b and references cited therein).

FISHERIES MANAGEMENT
SA catch sources, quantities and characteristics

Estimated total annual catch for all devilrays was <1 ton (DFFE records: 2010–2012; da Silva *et al.* 2015), which comprised the KZN bather protection nets and small-pelagic fishery. In the latter fishery the chondrichthyan bycatch is discarded once the main catch has been sorted, with 100% mortality of all chondrichthyans (DFFE unpublished data, cited by da Silva *et al.* 21015).

KZN bather protection nets
These nets caught an annual average of 26 devilrays, with 10 (38%) released alive, between 1978 and 2017. Of the devilrays that were identified, 97% were *M. kuhlii.* The widespread replacement of many of the nets (45 km of nets in 1992) with drumlines (16 km of nets and 177 drumlines in 2020) has greatly reduced captures of mobulid rays. In 2018 seven devilrays were caught, of which five were *M. kuhlii.*

Fishing outside South Africa
Devilrays, including *M. kuhlii*, are targeted and caught incidentally in industrial and artisanal fisheries. They are captured in a wide range of gear types including harpoons, drift nets, purse seine nets, gillnets, traps, trawls, and longlines. They are easy to target because of their slow swimming speed, tendency to aggregate and their general lack of human avoidance (Couturier *et al.* 2012). There are intensive inshore fisheries in many parts of its range, including Pakistan, India, Sri Lanka, Indonesia and elsewhere. This species is used for its meat, skin, cartilage, liver oil, and gill plates. The gill plates in particular fetch high prices in Asia and are used for Chinese health tonics (Rigby *et al.* 2020b and references cited therein).

Population trends
In southern Mozambique Rohner *et al.* (2017) found that standardised diver sightings declined by over 98% in a 14-year period. Globally, there is evidence of severe localised population reductions of devilrays in several regions, and specifically at major known aggregation areas for *M. kuhlii*. Much of the data applies to devilrays as a group, rather than specific species and caution is needed in extrapolating regional declines. Nonetheless, based on current and future potential levels of exploitation, steep declining trends in monitored populations, and the uncertainty of data in some regions, it is suspected that the population of *M. kuhlii* has undergone a reduction of 50–79% over the past three generation lengths (38 years), with the result that this species was globally assessed as Endangered on the IUCN Red List in 2020. Further population declines are likely, due to ongoing demand for high-value products (Rigby *et al.* 2020b and references cited therein).

ECOTOURISM
As all devilrays close resemble small manta rays, it is tempting to regard all members of the genus as ecotourism species. *M. kuhlii* has recently been found to aggregate at a cleaning station on the southern end of Aliwal Shoal although this site is not currently visited by recreational scuba divers (Michelle Carpenter, University of Cape Town, unpublished data).

CONSERVATION MEASURES
Marine Living Resources Act (MLRA) Regulations
There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)
This species is not listed.

Marine Protected Areas
This coastal species may benefit from protection in all the MPAs on east coast. There are reports of sightings at popular recreational scuba diving locations of Ponta D'Ouro (southern Mozambique), Aliwal Shoal, Landers Reef and Protea Banks on the KZN south coast, all of which are inside MPAs. Of

these, Aliwal Shoal is likely to be the most important, given that it has recently been identified having a cleaning station and possibly a mating location for *M. kuhlii.*

Additional local comment

IUCN Red List Status
Endangered 2020: A2bd+3d

Previous IUCN assessments
Data Deficient 2009

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
All Mobulidae were included in Appendix II in 2017.

Convention on Migratory Species (CMS)
This species was listed in Appendix II and Appendix I in 2014.

International comments
In 2019 the Western and Central Pacific Fisheries Commission (WCPFC) adopted measures to ban targeted fishing and retention of *Mobula* spp. which will come into force in 2021. This allows retention and donation for domestic human consumption of any species unintentionally captured and landed by purse seine vessels. The Indian Ocean Tuna Commission (IOTC) adopted a ban on retention of *Mobula* species in 2019 with guidelines for safe release; artisanal fisheries are exempted from this ban but only for accidental catches and until 2022 (Rigby *et al*. 2020b).

On national and local scales, manta rays tend to receive greater protection than devilrays. There is protection of devilrays in some countries including Australia, Indonesia, and Pakistan (Lawson *et al*. 2017, Khan 2018 cited by Rigby *et al*. 2020b).

In Mozambique this species and its congeners were fully protected in terms of Article 146 in the Boletim Da República Publicação Oficial Da República De Moçambique: Regulamento da Pesca Marítima (REPMAR) on 8 October 2020 (Issue 192).

MANAGEMENT CONSIDERATIONS
The major source of South African catches of devilrays, especially *M. kuhlii*, appears to be the KZN bather protection programme, but the marked change in effort has greatly reduced the bycatch, including devilrays. Bycatch in other fisheries, such as the small-pelagic fishery, should be quantified and monitored, given the low reproductive output of all members of the genus *Mobula.* A code of conduct should be introduced for divers who may visit the recently discovered cleaning station on the southern end of Aliwal Shoal.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
Very little is known of the life history and ecology of this species. The discovery of an inshore cleaning station used by this species on the Aliwal Shoal could be a catalyst for further research. A considerable amount of unpublished information has been accumulated from specimens caught in the KZN bather protection programme and should be analysed. Tissue samples have been collected from these specimens for genetic studies.

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Mobula mobular

SCIENTIFIC NAME	*Mobula mobular* (Bonnaterre 1788)
COMMON NAME	Giant devilray/spinetail devilray
FAMILY	Mobulidae
ENDEMIC	No, patchy but circumglobal
SIZE RANGE	90–520 cm disc width (DW)
DISTRIBUTION	E coast: Mozambique border to Port Alfred
HABITAT	Pelagic in coastal and oceanic waters
DEPTH RANGE	0–1100 m
MAJOR FISHERIES	KZN bather protection nets and small pelagic fishery
IUCN STATUS	Endangered 2018
CITES	Appendix II (2017)
MLRA	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	AD Marshall

SPECIES SUMMARY and RECOMMENDATIONS

Mobula mobular is a large pelagic ray which had patchy circumglobal distribution in coastal and shelf waters. It is by far the largest devilray. It is one of five species, which are difficult to tell apart, in South African waters and, as a result, catches are often lumped. The total estimated local annual catch of devilrays was <1 ton (DFFE records: 2010-2012), with the KZN bather protection programme a major contributor. Of the devilrays caught in this programme and identified to species, only 2% were *M. mobular.* Globally, devilrays are taken in targeted fisheries and as bycatch in much of their range. Their gill plates are highly sought after. Catches and sightings have declined in all regions, where the species are not protected. Devilrays have an extremely low fecundity, producing a single large offspring every 1-3 years. *M. mobular* was assessed globally as Endangered on the IUCN Red List in 2018. This species appears to be rare in South African waters, making it difficult to formulate management considerations. Catches of all devilrays in the small-pelagic fishery should be monitored. Very little is known about the life history of this species and opportunistic sampling should be used to collect life history information and tissue samples for genetic studies.

TAXONOMIC and IDENTIFICATION ISSUES

Historically at least 29 different species have been proposed in the genus *Mobula*. In a global review of the genus, Notarbartolo-di-Sciara (1987) utilised morphometrics, external morphology, colouration, and tooth and denticle morphology to identify nine extant species, excluding the manta rays which were not then regarded as members of the genus. This has been reduced to seven species of devilrays (Notarbartolo-di-Sciara *et al.* 2019). *M. mobular* is now regarded as conspecific with *M. japanica*, with *M. mobular* being the valid name (Last *et al.* 2016). In South African waters the genus *Mobula* is poorly known due to revisions to the genus and misidentification of individual species; a comprehensive review of species present and their distributional limits is needed, with five species in South African waters (Ebert *et al.* 2021). To the inexperienced, they are difficult to tell apart. Features such as disc width, the length of the cephalic horns, skin texture (smooth or rough), wing shape and the presence or absence of a tail spine are used to identify the individual species. All devilrays have a ventral mouth, which is terminal in manta rays. *M. mobular* is by far the largest of the devilrays and is the only species which has a caudal spine.

SOUTH AFRICAN DISTRIBUTION

M. mobular occurs along most of the entire east coast as far as Port Alfred (Ebert *et al*. 2021).

REGIONAL DISTRIBUTION

This species is also found in Mozambique and Tanzania, but its presence in Madagascar in the Indian Ocean and Namibia in the Atlantic has not been confirmed (Marshall *et al.* 2019b).

SYNPOSIS OF RESEARCH

In a study of batoid fishes of the east coast of southern Africa the presence of a single species *Mobula diabolus* was acknowledged, with 11 specimens examined (Wallace 1967c). Nothing has been published subsequently on the life history and ecology of any devilrays in South Africa. Couturier *et al.* (2012) provided a global review of the biology, ecology and conservation of the family Mobulidae. For recent studies on the biology and ecology of this species from elsewhere in its range, see Marshall *et al.* (2019b) and references cited therein.

ECOLOGY

Depth

This epipelagic, offshore species generally occurs from the surface down to 50 m, but has been shown to dive to depths of 1100 m (Marshall *et al.* 2019b and references cited therein).

Habitat: Adults

They inhabit offshore waters and occasionally frequent coastal waters (Couturier *et al.* 2012). They are seasonal visitors to areas with high upwelling-related productivity. They are not considered to be a schooling species, but individuals do aggregate seasonally in productive areas or to mate (Marshall *et al.* 2019b and references cited therein).

Habitat: Juveniles/Nursery Grounds

There is no published evidence that juveniles occupy different habitats from the adults.

Synopsis of tag deployments

No tagging or tracking has been undertaken locally but satellite tracking has been undertaken in New Zealand and the Mediterranean (Marshall *et al.* 2019b and references cited therein).

Movements

The species exhibits large-scale movements of up to 1800 km, at minimum speeds of 63 km per day. They are probably driven by seasonal patterns in prey availability (Marshall *et al.* 2019b and references cited therein).

Diet/feeding: adults

The diet consists mainly of planktonic crustaceans, especially euphausiids, and small teleosts (Last *et al.* 2016).

Diet/feeding: juveniles

There is no evidence that it is different from that of the adults.

South African toxicological studies

No local studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Histotrophic viviparity
DURATION OF REPRO CYCLE	Unknown, but possibly 1-3 years
MATING SEASON	Unknown
GESTATION	12 months
LITTER SIZE	1, occasionally 2
PUPPING/NURSERY GROUND	Unknown

DISC WIDTH AT BIRTH	90–160 cm
DISC WIDTH AT MATURITY	F: 215–240 cm; M: 150–158 cm
MAXIMUM DISC WIDTH	520 cm
GENERATION LENGTH	12.8 years

Mode
All mobulid rays exhibit histotrophic viviparity in which maternal uterine secretions supplement the nourishment provided by the yolk-sac (Couturier *et al.* 2012 and references cited therein).

Duration of reproductive cycle
Like other species of *Mobula*, it has a resting period of 1–3 years between pregnancies (Marshall *et al.* 2019b and references cited therein).

Mating season and location
Unknown.

Gestation
Gestation is 12 months (Marshall *et al.* 2019b and references cited therein).

Litter size
There is a single offspring, occasionally two (Couturier *et al.* 2012 and references cited therein).

Disc width at birth
Disc width at birth is 90–160 cm (Marshall *et al.* 2019b and references cited therein).

Pupping season and nursery ground
Unknown.

Disc width at maturity
Females mature at about 215–240 cm and males at 200–220 cm (Marshall *et al.* 2019b and references cited therein).

Maximum disc width
This species attains a maximum disc width of 520 cm (Marshall *et al.* 2019b and references cited therein).

Age and growth
Age at maturity is 5–6 years and the maximum age is 20 years (Marshall *et al.* 2019b and references cited therein).

Generation length
Generation length is 12.8 years (Marshall *et al.* 2019b and references cited therein).

FISHERIES MANAGEMENT

SA catch sources, quantities and characteristics
Estimated total annual catch for all devil rays was <1 ton (DFFE records: 2010–2012; da Silva *et al.* 2015), which comprised the KZN bather protection nets and small-pelagic fishery. In the latter fishery the chondrichthyan bycatch is discarded once the main catch has been sorted, with 100% mortality of all chondrichthyans (DFFE unpublished data, cited by da Silva *et al.* 21015).

KZN bather protection nets
These nets caught an annual average of 26 devilrays, with 10 (38%) released alive between 1978 and 2017. Of the devilrays that were identified, only 2% (8 individuals) were *M. mobular.* The widespread

replacement of many of the nets (45 km of nets in 1992) with drumlines (16 km of nets and 177 drumlines in 2020) has greatly reduced captures of all *Mobula* spp. and in 2018 seven devilrays were caught, none of which was *M. mobular.*

Fishing outside South Africa

Mobulid rays are both targeted and caught incidentally in industrial and artisanal fisheries. When taken as bycatch, they are typically kept because of their high trade value and even when discarded alive, they are often injured and have high post-release mortality. There is a directed fishery for *M. mobular* in parts of the Mediterranean Sea, where purse seiners target seasonal aggregations. In Pakistan, this species represented 60% of number of mobulids caught in tuna gillnet fisheries. In parts of India, this species represents 75-95% of devilrays landed. It is the most common species landed in Sri Lanka, representing 87% of devilray landings by number (Marshall *et al.* 2019b and references cited therein).

Population trends

There are no current or historical estimates of the global abundance of *M. mobular.* Despite a broad worldwide distribution, populations appear to be patchily distributed. Abundance also appears to vary substantially and may be based on food availability and fishing pressure. Abundance estimates have been attempted with aerial surveys in some areas. Globally, there is evidence of severe localised population reductions of devilrays in several regions. Much of the data applies to devilrays as a group, rather than specific species and caution is needed in extrapolating regional declines. Nonetheless, based on current and future potential levels of exploitation, steep declining trends in monitored populations, and the uncertainty of data in some regions, it is suspected that the global population of *M. mobular* has undergone a reduction of 50–79% over the past three generation lengths (38 years), with the result that this species was assessed globally as Endangered on the IUCN Red List in 2018. Further population declines are likely, due to ongoing demand for high-value products (Marshall *et al.* 2019b and references cited therein).

ECOTOURISM

As all devilrays close resemble small manta rays, it is tempting to regard all members of the genus as ecotourism species. *M. mobular* appears to be uncommon in coastal waters and therefore rarely encountered by divers.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act
Threatened or Protected Species (TOPS)

This species is not listed.

Marine Protected Areas

Being coastal, this species will derive some protection in the MPAs on east coast of South Africa, but none of these MPAs are known to be favoured by this highly mobile species.

Additional local comment

IUCN Red List Status

Endangered 2018: A2bd+3d

Previous IUCN assessments

None

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
All Mobulidae were included in Appendix II in 2017.

Convention on Migratory Species (CMS)
This species was listed in Appendix II and Appendix I in 2014.

International comments
In 2015, the Inter-American Tropical Tuna Commission (IATTC) prohibited *Mobula* species caught by large-scale fisheries in the IATTC Convention Area from being retained and sold, with mandated prompt, careful release; exceptions were granted to small-scale Eastern Pacific fisheries for domestic consumption only. In 2019 the Western and Central Pacific Fisheries Commission (WCPFC) adopted measures to ban targeted fishing and retention of *Mobula* spp. which will come into force in 2021. This allows retention and donation for domestic human consumption of any species unintentionally captured and landed by purse seine vessels. The Indian Ocean Tuna Commission (IOTC) adopted a ban on retention of *Mobula* species in 2019 with guidelines for safe release; artisanal fisheries are exempted from this ban but only for accidental catches and until 2022 (Rigby *et al*. 2020b). On national and local scales, manta rays tend to receive greater protection than devilrays (Marshall *et al*. 2019b and references cited therein).

In Mozambique this species and its congeners were fully protected in terms of Article 146 in the Boletim Da República Publicação Oficial Da República De Moçambique: Regulamento da Pesca Marítima (REPMAR) on 8 October 2020 (Issue 192).

MANAGEMENT CONSIDERATIONS
The major source of South African catches of devilrays appears to be the KZN bather protection programme, but *M. mobular* was a very rare catch. Bycatch in other fisheries, such as the small-pelagic fishery, should be monitored, given the low reproductive output of all members of the genus *Mobula*, but it is likely that this species is uncommon in South African waters. There are no other obvious management interventions and this species must be regarded as being of low priority.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
Very little is known of the life history and ecology of this species both globally and in South Africa, where this species appears to be uncommon. Any opportunistic sampling should be used to collect biological information and tissue samples for genetic studies.

Mobula tarapacana

SCIENTIFIC NAME	*Mobula tarapacana* (Philippi 1892)
COMMON NAME	Sicklefin devilray
FAMILY	Mobulidae
ENDEMIC	No, patchy but circumglobal
SIZE RANGE	120–370 cm disc width (DW)
DISTRIBUTION	E, S coasts: Mozambique border to Jeffreys Bay
HABITAT	Pelagic in oceanic, occasionally coastal waters
DEPTH RANGE	0–1900 m
MAJOR FISHERIES	KZN bather protection nets and small pelagic fishery
IUCN STATUS	Endangered 2018
CITES	Appendix II 2017
MLRA	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	N Cullain

SPECIES SUMMARY and RECOMMENDATIONS

Mobula tarapacana is a large pelagic ray with a patchy circumglobal distribution in oceanic and occasionally coastal waters. It is one of five species of devilrays, which are difficult to tell apart, in South African waters and, as a result, catches are often lumped. The total estimated annual local catch of devilrays was <1 ton (DFFE records: 2010–2012), with the KZN bather protection programme a major contributor. Of the devilrays caught in this programme and identified to species level, no *M. tarapacana* were recorded*.* Globally, devilrays are taken in targeted fisheries and as bycatch in much of their range. Their gill plates are highly sought after. Catches and sightings have declined in all regions, where the species are not protected. Devilrays have an extremely low fecundity, producing a single large offspring every 1-3 years. *M. tarapacana* was assessed globally as Endangered on the IUCN Red List in 2018. This species appears to be uncommon in South African waters, making it difficult to formulate management considerations. Catches of all devilrays in the small-pelagic fishery should be monitored. Very little is known about the life history of this species and any opportunistic sampling should be used to collect biological information and tissue samples for genetic studies.

TAXONOMIC and IDENTIFICATION ISSUES

Historically at least 29 different species in the genus *Mobula* have been proposed. In a global review of the genus, Notarbartolo-di-Sciara (1987) utilised morphometrics, external morphology, colouration, and tooth and denticle morphology to identify nine extant species, excluding the manta rays which were not then regarded as members of the genus *Mobula*. Subsequent research has shown that there are only seven species (Notarbartolo-di-Sciara *et al.* 2019). In South African waters the genus *Mobula* is poorly known due to revisions to the genus and misidentification of individual species; a comprehensive review of species present and their distributional limits is needed. Of the seven species, five occur in South African waters (Ebert *et al.* 2021). To the inexperienced, they are difficult to tell apart. Features such as disc width, the length of the cephalic horns, skin texture (smooth or rough), wing shape and the presence or absence of a tail spine are used to identify the individual species. All devilrays have a ventral mouth, which is terminal in manta rays. *M. tarapacana* is characterised by its strongly falcate pectoral fins, hence the name sicklefin devilray.

SOUTH AFRICAN DISTRIBUTION

M. tarapacana occurs along the entire east coast and a small part of the south coast as far as Jeffreys Bay (Ebert *et al*. 2021).

REGIONAL DISTRIBUTION
This species is circumglobal in distribution, but its presence in Mozambique, Tanzania and Madagascar in the Indian Ocean and Namibia in the Atlantic has not been confirmed (Marshall *et al.* 2019c).

SYNOPSIS OF RESEARCH
In a study of batoid fishes of the east coast of southern Africa the presence of a single species *Mobula diabolus* was acknowledged, with 11 specimens examined (Wallace 1967c). Nothing has been published subsequently on the life history and ecology of any devilrays in South Africa. Couturier *et al.* (2012) provided a global review of the biology, ecology and conservation of the family Mobulidae. For recent studies on the biology and ecology of this species from elsewhere in its range, see Rigby *et al.* (2020) and references cited therein.

ECOLOGY
Depth
This pelagic species is largely oceanic, but is also found in coastal waters. It occurs from the surface down to 1900 m (Marshall *et al.* 2019c).

Habitat: Adults
They are occasionally coastal but most populations occur offshore. They are seasonal visitors to areas with high upwelling-related productivity, which include islands, pinnacles and seamounts. They have been observed in schools and as solitary individuals (Marshall *et al.* 2019c and references cited therein).

Habitat: Juveniles/Nursery Grounds
There is no published evidence that juveniles occupy different habitats from the adults.

Synopsis of tag deployments
No local tagging or tracking has been undertaken. Pop-up archival satellite tags have been deployed in the Azores (Marshall *et al.* 2019c and reference cited therein).

Movements
The species is highly mobile and capable of significant migrations. Tagged individuals moved 3,800 km over seven months and dived to depths of 1,900 m. Seasonal aggregations take place in various locations (Marshall *et al.* 2019c and references cited therein).

Diet/feeding: adults
The diet comprises mainly small teleosts and, to a lesser extent, planktonic crustaceans (Last *et al.* 2016).

Diet/feeding: juveniles
There is no evidence that it is different from that of the adults.

South African toxicological studies
No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Histotrophic viviparity
DURATION OF REPRO CYCLE	Unknown, but possibly 1–3 years
MATING SEASON	January-June (W Atlantic)
GESTATION	Unknown
LITTER SIZE	1

PUPPING/NURSERY GROUND	August-September (Azores)
DISC WIDTH AT BIRTH	120–130 cm
DISC WIDTH AT MATURITY	F: 270–280 cm; M: 198–250 cm
MAXIMUM DISC WIDTH	370 cm
GENERATION LENGTH	12.8 years, inferred from *M. mobular*

Mode
All mobulid rays exhibit histotrophic viviparity in which maternal uterine secretions supplement the nourishment provided by the yolk-sac (Couturier *et al.* 2012 and references cited therein).

Duration of reproductive cycle
This is unknown, but other *Mobula* species have a resting period of 1–3 years between pregnancies.

Mating season and location
Courtship and mating were observed in Saint Peter and Saint Paul Archipelago in equatorial W Atlantic from January to June, particularly April and May (Mendonca *et al.* 2020).

Gestation
This is unknown.

Litter size
There is a single offspring (Marshall *et al.* 2019c and references cited therein).

Disc width at birth
Disc width at birth is 120–130 cm (Marshall *et al.* 2019c and references cited therein).

Pupping season and nursery ground
Pregnant females have been observed during August and September in the Azores (NE Atlantic Ocean) (Sobral and Afonso 2014).

Disc width at maturity
Females mature at about 270–280 cm and males at 195–250 cm (Marshall *et al.* 2019c and references cited therein).

Maximum disc width
This species attains a maximum disc width of 370 cm (Marshall *et al.* 2019c and references cited therein).

Age and growth
This is unknown.

Generation length
Generation length is assumed to be 12.8 years, based on *M. mobular*, that has an estimated age-at-maturity of 5–6 years and maximum age of 20 years. As *M. mobular* is larger than *M. tarapacana* (520 vs 370 cm), this generation length is likely overestimated (Marshall *et al.* 2019c and references cited therein).

FISHERIES MANAGEMENT
SA catch sources, quantities and characteristics
Estimated total annual catch for all devilrays was <1 ton (DFFE records: 2010–2012; da Silva *et al.* 2015), which comprised the KZN bather protection nets and small-pelagic fishery. In the latter fishery

the chondrichthyan bycatch is discarded once the main catch has been sorted, with 100% mortality of all chondrichthyans (DFFE unpublished data, cited by da Silva *et al.* 21015).

KZN bather protection nets

These nets caught an annual average of 26 devilrays, with 10 (38%) released alive, between 1978 and 2017. Of the devilrays that were identified, *M. tarapacana*, being an oceanic species, was not recorded.

Fishing outside South Africa

Devilrays, including *M. tarapacana*, are targeted and caught incidentally in industrial and artisanal fisheries. They are caught in at least 13 targeted artisanal fisheries in 12 countries. Being largely oceanic, this species is often caught in purse seine fisheries. *M. tarapacana* is a large component of targeted fisheries in India, Sri Lanka, and Indonesia (Marshall *et al.* 2019c and references cited therein). Devilrays are used for their meat, skin, cartilage, liver oil, and gill plates. The gill plates in particular fetch high prices in Asia and are used for Chinese health tonics (Rigby *et al.* 2020 and references cited therein).

Population trends

Globally, there is evidence of severe localised population reductions of devilrays in several regions. Much of the data applies to devilrays as a group, rather than specific species and caution is needed in extrapolating regional declines. Based on current and future potential levels of exploitation, steep declining trends in monitored populations, and the uncertainty of data in some regions, it is suspected that the *M. tarapacana* global population has undergone a reduction of 50–79% over the past three generation lengths (38 years), with a further population reduction likely, due to ongoing demand for high-value products. This species was therefore globally assessed as Endangered on the IUCN Red List in 2018 (Marshall *et al.* 2019c and references cited therein).

ECOTOURISM

As all devilrays close resemble small manta rays, it is tempting to regard all members of the genus as ecotourism species. *M. tarapacana* is uncommon in coastal waters and therefore rarely encountered by divers.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act

Threatened or Protected Species (TOPS)

This species is not listed.

Marine Protected Areas

Being primarily oceanic, this species will derive no protection in the MPAs on east coast of South Africa.

Additional local comment

IUCN Status

Endangered 2018: A2bd+3d

Previous IUCN assessments

Vulnerable 2016

Data Deficient 2006

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

All Mobulidae were included in Appendix II in 2017.

Convention on Migratory Species (CMS)
This species was listed in Appendix II and Appendix I in 2014.

International comments
In 2015, the Inter-American Tropical Tuna Commission (IATTC) prohibited *Mobula* species caught by large-scale fisheries in the IATTC Convention Area from being retained and sold, with mandated prompt, careful release; exceptions were granted to small-scale Eastern Pacific fisheries for domestic consumption only. In 2019 the Western and Central Pacific Fisheries Commission (WCPFC) adopted measures to ban targeted fishing and retention of *Mobula* spp. which will come into force in 2021. This allows retention and donation for domestic human consumption of any species unintentionally captured and landed by purse seine vessels. The Indian Ocean Tuna Commission (IOTC) adopted a ban on retention of *Mobula* species in 2019 with guidelines for safe release; artisanal fisheries are exempted from this ban but only for accidental catches and until 2022 (Rigby *et al*. 2020a).

In Mozambique this species and its congeners were fully protected in terms of Article 146 in the Boletim Da República Publicação Oficial Da República De Moçambique: Regulamento da Pesca Marítima (REPMAR) on 8 October 2020 (Issue 192).

MANAGEMENT CONSIDERATIONS
The major source of South African catches of devilrays is the KZN bather protection programme, but *M. tarapacana*, being oceanic, has not been identified among the catches. Bycatch in other fisheries, such as the small-pelagic fishery, should be qunatified and monitored, given the low reproductive output of all members of the genus *Mobula*, but this species appears to be rare in South African coastal waters. There are no other obvious management interventions and this species must be regarded as being of low priority.

RESEARCH REQUIREMENTS AND OPPORTUNITIES
Very little is known of the life history and ecology of this species globally, particularly in South Africa. Any opportunistic sampling should be used to obtain life history information and tissue samples for genetic studies.

Mobula thurstoni

SCIENTIFIC NAME	*Mobula thurstoni* (Lloyd 1908)
COMMON NAME	Bentfin devilray
FAMILY	Mobulidae
ENDEMIC	No, patchy but circumglobal
SIZE RANGE	70–200 cm disc width (DW)
DISTRIBUTION	E coast: Mozambique border to Algoa Bay
HABITAT	Pelagic in coastal and oceanic waters
DEPTH RANGE	0–100 m
MAJOR FISHERIES	KZN bather protection nets and small pelagic fishery
IUCN STATUS	Endangered 2018
CITES	Appendix II (2017)
MLRA	Daily bag limit of one individual in recreational fishery
COMPILER	G Cliff
REVIEWER	N Cullain

SPECIES SUMMARY and RECOMMENDATIONS

Mobula thurstoni is a medium-sized pelagic ray which has patchy circumglobal distribution in oceanic and occasionally coastal waters. It is one of five species of devilrays, which are difficult to tell apart, in South African waters and, as a result, catches are often lumped. The total estimated local annual catch of devilrays was <1 ton (DFFE records: 2010–2012), with the KZN bather protection programme a major contributor. Of the devilrays caught in this programme and identified to species level, only a single specimen of *M. thurstoni* was reported. Globally, devilrays are taken in targeted fisheries and as bycatch in much of their range. Their gill plates are highly sought after. Catches and sightings have declined in all regions, where the species are not protected. Devilrays have an extremely low fecundity, producing a single large offspring every 1-3 years. *M. thurstoni* was globally assessed as Endangered on the IUCN Red List in 2018. This species is rare in South African waters, making it difficult to formulate management considerations. Catches of all devilrays in the small-pelagic fishery should be monitored. Very little is known about the life history of this species and any opportunistic sampling should be used to collect biological information and tissue samples for genetic studies.

TAXONOMIC and IDENTIFICATION ISSUES

Historically at least 29 different species in the genus *Mobula* have been proposed. In a global review of the genus, Notarbartolo-di-Sciara (1987) utilised morphometrics, external morphology, colouration, and tooth and denticle morphology to identify nine extant species, excluding the manta rays which were not then regarded as members of the genus *Mobula*, but this has been reduced to seven devilray species (Notarbartolo-di-Sciara *et al.* 2019). In South African waters the genus *Mobula* is poorly known due to revisions to the genus and misidentification of individual species; a comprehensive review of the five species present and their distributional limits is needed (Ebert *et al.* 2021). To the inexperienced, they are difficult to tell apart. Features such as disc width, the length of the cephalic horns, skin texture (smooth or rough), wing shape and the presence or absence of a tail spine, are used to identify the individual species. All devilrays have a ventral mouth, which is terminal in manta rays. *M. thurstoni* is characterised by a distinct concavity in the anterior margins of the pectoral fins, hence the name bentfin devilray.

SOUTH AFRICAN DISTRIBUTION

M. thurstoni occurs along the entire east coast as far as Algoa Bay (Ebert *et al*. 2021).

REGIONAL DISTRIBUTION

This species is circumglobal in distribution, but its presence in Mozambique, Tanzania and Madagascar in the Indian Ocean and Namibia in the Atlantic has not been confirmed (Marshall *et al.* 2019d).

SYNOPSIS OF RESEARCH

In a study of batoid fishes of the east coast of southern Africa the presence of a single species *Mobula diabolus* was acknowledged, with 11 specimens examined (Wallace 1967c). Nothing has been published subsequently on the life history and ecology of any devilrays in South Africa. Couturier *et al.* (2012) provided a global review of the biology, ecology and conservation of the family Mobulidae. For recent studies information on the biology and ecology of this species elsewhere in its range, see Marshall *et al.* (2019d) and references cited therein.

ECOLOGY

Depth

This pelagic species is largely coastal and oceanic. It occurs from the surface down to 100 m (Marshall *et al.* 2019d).

Habitat: Adults

They are both coastal and oceanic. They are seasonal visitors to areas with high upwelling-related productivity, which include islands, pinnacles and seamounts. They are not considered to be a schooling species, but individuals do aggregate seasonally in productive areas (Marshall *et al.* 2019d and references cited therein).

Habitat: Juveniles/Nursery Grounds

There is no published evidence that juveniles occupy different habitats from the adults.

Synopsis of tag deployments

There are no records of any tagging or satellite or acoustic tracking.

Movements

Movement patterns and swimming capacities of most devilrays species are poorly understood, but they appear to undertake relatively large-scale movements, travelling from one productive area to another (Couturier *et al.* 2012).

Diet/feeding: adults

The diet is highly specialised with prey dominated by euphausiid and mysid shrimp (Last *et al.* 2016).

Diet/feeding: juveniles

There is no evidence that it is different from that of the adults.

South African toxicological studies

No studies have been undertaken.

REPRODUCTION

REPRODUCTIVE MODE	Histotrophic viviparity
DURATION OF REPRO CYCLE	Unknown, but possibly 1-3 years
MATING SEASON	Unknown
GESTATION	Unknown
LITTER SIZE	1, occasionally 2
PUPPING/NURSERY GROUND	Unknown
DISC WIDTH AT BIRTH	70–90 cm
DISC WIDTH AT MATURITY	F: 150–163 cm; M: 150–158 cm

MAXIMUM DISC WIDTH	197 cm, possibly 220 cm
GENERATION LENGTH	12.8 years, inferred from *M. mobular*

Mode
All mobulid rays exhibit histotrophic viviparity in which maternal uterine secretions supplement the nourishment provided by the yolk-sac (Couturier *et al.* 2012 and references cited therein).

Duration of reproductive cycle
Like other species of *Mobula*, it has a resting period of 1–3 years between pregnancies (Marshall *et al.* 2019d and references cited therein).

Mating season and location
A group of four individuals were observed engaging in pre-mating behaviour at the Archipelago of Saint Peter and Saint Paul, Brazil (McCallister *et al*. 2020).

Gestation
This is unknown.

Litter size
There is a single pup, occasionally two. Some 25% of females examined off the Republic of Guinea had two pups (Marshall *et al.* 2019d and references cited therein).

Disc width at birth
Disc width at birth is 70–90 cm (Marshall *et al.* 2019d and references cited therein).

Pupping season and nursery ground
This is unknown.

Disc width at maturity
Females mature at about 150–163 cm and males at 150–158 cm (Marshall *et al.* 2019d and references cited therein).

Maximum disc width
This species attains a maximum disc width of at least 197 cm, possibly 220 cm (Marshall *et al.* 2019d and references cited therein).

Age and growth
This is unknown.

Generation length
Generation length is assumed to be 12.8 years, based on *M. mobular*, that has an estimated age-at-maturity of 5–6 years and maximum age of 20 years. As *M. mobular* is larger than *M. thurstoni* (520 vs 197 cm), this generation length is likely to be overestimated (Marshall *et al.* 2019 and references cited therein).

FISHERIES MANAGEMENT
SA catch sources, quantities and characteristics
Estimated total annual catch for all devil rays was <1 ton (DFFE records: 2010–2012; da Silva *et al.* 2015), which comprised the KZN bather protection nets and small-pelagic fishery. In the latter fishery the chondrichthyan bycatch is discarded once the main catch has been sorted, with 100% mortality of all chondrichthyans (DFFE unpublished data, cited by da Silva *et al.* 21015).

KZN bather protection nets

These nets caught an annual average of 26 devilrays, with 10 (38%) released alive between 1978 and 2017. Of the devilrays that were identified, only a single individual was *M. thurstoni.*

Fishing outside South Africa

Mobulid rays, are both targeted and caught incidentally in industrial and artisanal fisheries. *M. thurstoni* has an epipelagic tropical distribution in regions of high productivity, which overlaps with that of tuna and other highly valued target teleost species. This means that it is exposed to multiple targeted and bycatch fisheries. Furthermore, this species' preference for coastal waters places it within the range of inshore fisheries, which are known to be intensive in many parts of its range, including Pakistan, India, and Sri Lanka ((Marshall *et al.* 2019d and references cited therein).

Population trends

Globally, there is evidence of severe localised population reductions of devilrays in several regions. Much of the data applies to devilrays as a group, rather than specific species and caution is needed in extrapolating regional declines. Nontheless, based on current and future potential levels of exploitation, steep declining trends in monitored populations, and the uncertainty of data in some regions, it is suspected that the global population of *M. thurstoni* has undergone a reduction of 50–79% over the past three generation lengths (38 years), with the result that this species was globally assessed as Endangered on the IUCN Red List in 2018. Further population declines are likely, due to ongoing demand for high-value products (Marshall *et al.* 2019d and references cited therein).

ECOTOURISM

As all devilrays close resemble small manta rays, it is tempting to regard all members of the genus as ecotourism species. *M. thurstoni* appears to be uncommon in coastal waters and therefore rarely encountered by divers.

CONSERVATION MEASURES

Marine Living Resources Act (MLRA) Regulations

There is a daily bag limit of one individual in the recreational line fishery.

National Environmental Management: Biodiversity (NEMBA) Act

Threatened or Protected Species (TOPS)

This species is not listed.

Marine Protected Areas

Being both coastal and oceanic, there is currently no evidence that this little-known species will derive protection in the MPAs on east coast of South Africa.

Additional local comment

IUCN Red List Status

Endangered 2018: A2bd+3d

Previous IUCN assessments

Near Threatened 2016

Near Threatened 2006

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

All Mobulidae were included in Appendix II in 2017.

Convention on Migratory Species (CMS)

This species was listed in Appendix II and Appendix I in 2014.

International comments

In 2015, the Inter-American Tropical Tuna Commission (IATTC) prohibited *Mobula* species caught by large-scale fisheries in the IATTC Convention Area from being retained and sold, with mandated prompt, careful release; exceptions were granted to small-scale Eastern Pacific fisheries for domestic consumption only. In 2019 the Western and Central Pacific Fisheries Commission (WCPFC) adopted measures to ban targeted fishing and retention of *Mobula* spp. which will come into force in 2021. This allows retention and donation for domestic human consumption of any species unintentionally captured and landed by purse seine vessels. The Indian Ocean Tuna Commission (IOTC) adopted a ban on retention of *Mobula* species in 2019 with guidelines for safe release; artisanal fisheries are exempted from this ban but only for accidental catches and until 2022 (Rigby *et al*. 2020a).

In Mozambique this species and its congeners were fully protected in terms of Article 146 in the Boletim Da República Publicação Oficial Da República De Moçambique: Regulamento da Pesca Marítima (REPMAR) on 8 October 2020 (Issue 192).

MANAGEMENT CONSIDERATIONS

The major source of South African catches of devilrays is the KZN bather protection programme, but *M. thurstoni* is an extremely rare catch. Bycatch in other fisheries, such as the smallpelagic fishery, should be monitored, given the low reproductive output of all members of the genus *Mobula.* There are no other obvious management interventions and this little-known species must be regarded as being of low priority.

RESEARCH REQUIREMENTS AND OPPORTUNITIES

Very little is known of the life history and ecology of *M. thurstoni* both globally and in South Africa. Biological information has been obtained from a single individual recorded in the KZN bather protection programme. Any opportunistic sampling should be used to collect biological information and tissue samples for genetic studies.

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