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South Africa National Report to the Scientific Committee of the Indian Ocean Tuna Commission, 2021

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INFORMATION ON FISHERIES, RESEARCH AND STATISTICS

In accordance with IOTC Resolution 15/02, final scientific data for the previous year was provided to the IOTC Secretariat by 30 June of the current year, **for all fleets other than longline** [e.g. for a National Report submitted to the IOTC Secretariat in 2021, final data for the 2020 calendar year must be provided to the Secretariat by 30 June 2021)	YES 02/06/2021
In accordance with IOTC Resolution 15/02, provisional **longline data** for the previous year was provided to the IOTC Secretariat by 30 June of the current year [e.g. for a National Report submitted to the IOTC Secretariat in 2021, preliminary data for the 2020 calendar year was provided to the IOTC Secretariat by 30 June 2021). **REMINDER:** Final longline data for the previous year is due to the IOTC Secretariat by 30 Dec of the current year [e.g. for a National Report submitted to the IOTC Secretariat in 2021, final data for the 2020 calendar year must be provided to the Secretariat by 30 December 2021).	YES 02/06/2021
If no, please indicate the reason(s) and intended actions:	

Executive Summary

South Africa has two commercial fishing sectors that target tuna – the Large Pelagic Longline and the Tuna Pole-line (baitboat) sectors. The latter sector mainly targets (*Thunnus alalunga)* and to a lesser degree yellowfin tuna (*Thunnus albacares*) and rarely operates in the IOTC Area of Competence. The Large Pelagic Longline sector comprises two fleets with different histories: The South African-flagged Large Pelagic Longline vessels that traditionally used swordfish (*Xiphias gladius*) targeting methods, and the Japanese-flagged vessels that operate under joint-ventures and fish for South African right holders. The Japanese-flagged vessels typically target tropical tunas and southern bluefin tuna (*Thunnus maccoyii*) with their effort focused in the Indian Ocean. In 2020, a total of 15 longline vessels were active in the IOTC area of competence, which is less than in 2019. Effort decreased substantially - the number of hooks set in 2020 was 572 461, which is less than half that of number set in 2019 (1 355 677). Consequently, catches decreased from 2019 to 2020 for all species; albacore (23%), southern bluefin tuna (27%), bigeye tuna (49%), yellowfin tuna (56%), blue shark (58%), swordfish (74%) and shortfin mako shark (96%). There was no Tuna Pole-line effort in the Indian Ocean area of competence in 2020. Observer coverage exceeded IOTC requirements as 18% (100 179 hooks) of hooks set in the IOTC area of competence in 2020 were observed.

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1. BACKGROUND/GENERAL FISHERY INFORMATION

1.1. Large Pelagic Longline sector

The South African Large Pelagic Longline sector was commercialized in 2005. The sector was initially split into swordfish and tuna-directed sub-sectors due to the drastic declines in swordfish catch and CPUE experienced during the period of the experimental fishery from 1997 to 2005. South Africa amended its Large Pelagic Longline sector policy in 2008 after only 9 swordfish-directed longline vessels operated in 2006, resulting in the lowest annual catch since 2001.

The current domestic longline catch composition is split between swordfish and tropical tunas (bigeye and yellowfin tunas). The general method and gear are predominantly used to target swordfish and involves setting lines at night (to reduce seabird mortality) with squid bait using buoy - and branch lines of 20 m length. Depending on the vessel size, 700 – 1500 hooks are set per line. Stainless steel hooks are prohibited and as of 2017 wire traces are also prohibited. In addition, there is a precautionary upper catch limit (PUCL) of 2000 t for pelagic sharks. Once the PUCL is reached, no pelagic sharks are landed, and fishing is only allowed with the presence of an onboard observer. The larger vessels that target tropical tuna can fish further offshore and differ in their methodology. These vessels set up to 3000 hooks per set with a combination of fish and squid bait, using deeper branch lines and varying hook numbers per basket to influence the setting depth. The smaller longline vessels carry ice whereas the larger vessels have freezers. Fish are dressed at sea and no further at-sea processing is conducted. Swordfish are targeted in the north east of the South African EEZ and beyond in the Mozambique Channel, whereas tropical tunas are caught along the entire continental shelf edge.

South Africa submitted a bigeye tuna fishing plan (CoC 07/13) to the Commission meeting of the IOTC, thereby notifying the Commission of South Africa's intention to exceed 1000 t of bigeye tuna in future as the fishery develops. Prior to 2002 most of longline fishing effort was concentrated in the Atlantic Ocean. Fishing effort started increasing in the Indian Ocean from 2001 with the development of ice and processing facilities at Richards Bay, which is situated on the east coast of South Africa. The targeting and catching of tropical bigeye and yellowfin tunas has proven more successful in the Indian Ocean, resulting in a sizeable amount of the longline fishing effort being concentrated in the Indian Ocean. This sector is now the most important South African tuna sector operating in the Indian Ocean in terms of tonnage landed.

In 2005 the shark longline sector was split into a demersal shark longline component, which predominantly targets soupfin (*Galeorhinus galeus*) and hound sharks (*Mustelus mustelus*), and a pelagic shark longline component (seven vessels), which predominantly targets shortfin mako and blue sharks. The latter catches tunas and swordfish as bycatch. This sector was split as a precursor to phase out the targeting of pelagic sharks due to the concern over the local stock status of some species. The pelagic shark fishery operated under exemptions from 2005 until March 2011, when South Africa incorporated the pelagic shark fishery into the tuna/swordfish longline fishery. Six of the seven shark exemption holders were issued with tuna/swordfish rights in March 2011. These vessels are undergoing a phase-out period to reduce shark catch and improve tuna and/or swordfish catch performance. Pelagic sharks are now considered bycatch in the Large Pelagic Longline sector. Several management measures have also been introduced to reduce shark bycatch, such as the prohibition of wire traces and the prohibition of shark targeting.

In 2015 the decision was taken to no longer refer to the fleet as two different fishing strategies, tuna-directed and swordfish-directed, since the fishing behaviour of the local fleet has been shifting from exclusive swordfish targeting to include tunas and sharks. The sector is now referred to as the Large Pelagic Longline sector and includes vessels that target tunas, swordfish and sharks as bycatch. The 10-year long-term rights granted in 2005 expired in February 2015, and 15-year fishing rights have subsequently been allocated to 62 right holders. The sector is allowing an interim period for foreign vessels to be chartered in this sub-sector to expedite skills development and as a means of acquiring suitable vessels. Foreign vessel owners in the tuna-directed sub-sector are encouraged to reflag their vessels.

Foreign vessels, mainly from Japan and Chinese-Taipei, fished in South African waters through the issuing of bi-lateral agreements in the 1970s, and re-negotiated these agreements in the 1990s until 2002 (Sauer *et al*.,

2003). Joint-venture agreements with Japan have been underway since 2005, whereby these foreign-flagged fishing vessels are permitted to fish for a South African right holder. The vessel is required to adhere to South African legislation, including but not limited to, the Marine Living Resources Act (Act No. 18 of 1998) and Regulations promulgated thereunder, including Large Pelagic Longline sector specific policy. Importantly, each foreign fishing vessel is required to carry an observer onboard every trip. The catch, and observer coverage from these vessels accrues to South Africa.

1.2. Tuna Pole-line sector

Fishing for tunas using rod and reel and/or pole and line dates back to the 1970s in South Africa when they were caught in minimal quantities as bycatch in other fisheries. Interest sparked in 1979 when yellowfin tuna (*Thunnus albacares*) became available close inshore off Cape Point (Shannon, 1968). Operators from other sectors converted their vessels to ice vessels to fish for yellowfin tuna using Pole-line or purse-seine nets, resulting in catches of over 4 500 t (Penney and Punt, 1993). By 1980 the yellowfin tuna was no longer available close inshore, resulting in these vessels targeting albacore (*Thunnus alalunga*) instead on the south-west and west coasts of South Africa. Albacore catches peaked at 6000 t in 1989, although these catches were under-reported and were probably closer to 10 000 t (Penney and Punt, 1993). The sector has continued to exploit juveniles and sub-adult albacore of between 2 and 3 years old (average of 86 cm FL) and larger yellowfin tuna (average of 133 cm FL). Catches of albacore have remained relatively stable over the last decade, averaging approximately 3 500 t per year, but have recently decreased to below 2000 t. Yellowfin tuna are periodically available inshore with a frequency of 5 to 7 years and the fleet harvests this species opportunistically.

The sector operates along the south-west and west coasts of South Africa in the Atlantic Ocean where albacore is available close inshore from October to May, but vessels make forays into the Indian Ocean depending on target species distribution. Traditionally the South African fleet has been characterized into three different categories (1) Skiboats, (2) Pole-line and (3) Freezer vessels (Leslie *et al.*, 2004). Skiboats are less than 25 GRT and are mostly confined to day trips within a range of 50 nm. Pole-line boats, which represent the bulk of the fleet, are mainly older displacement-type vessels converted from other fisheries. These vessels can undertake multiday trips of limited duration and range, as the catch is kept on ice. Freezer vessels are mainly vessels up to 30 m and 230 GRT. Due to their large size and freezing facilities, these vessels can stay out at sea for long periods and reach the farthest fishing grounds (West *et al.*, 2013). In more recent years, improvements in navigational gear, the use of live bait and sonar equipment has improved the performance of these vessels (West *et al.*, 2013).

This sector is effort controlled, limiting the number of vessels and crew. Prior to 2006, the Tuna Pole-line sector was managed under the bracket of commercial linefishing. During the long-term rights allocation process in 2005, the commercial linefishery was divided into three separate sectors consisting of the traditional linefishery (452 vessels and 3 450 crew), the hake-handline sector (130 vessels and 785 crew) and the Tuna Pole-line sector (200 vessels and 3 600 crew) (Mann, 2013). Of the 200 vessels and 3 600 crew allocation available for 8 years, only 198 vessels and 2961 crew were allocated in 2005 (TAC/TAE, 2015). The reallocation of long-term rights in 2013 resulted in 164 fishing rights and a total of 165 vessels. This reduction was in response to the 2013 ICCAT albacore stock assessment outcome of large uncertainty around the estimates of albacore stock status in the south Atlantic. ICCAT has issued South Africa with a 4 400 t per annum albacore allocation for the period 2014 to 2018 (ICCAT, 2013), 90% of which is caught by the Tuna Pole-line sector. The Tuna Pole-line TAE for the 2020 fishing season was maintained at 165 vessels.

Since vessels are small and the nature of the operation requires the vessel to maximise on crew (who work in pairs to catch and haul albacore), scientific observers are currently not accommodated on the vessels and instead catches are monitored in port during offloading.

In 2014, after 6 years of experimental fishing, live-bait purse-seining was incorporated in the sector, allowing a limited number of vessels to cast a net and all vessels to hold live-bait. The live-bait are mostly anchovy (*Engraulis encrasicolus*) with sardine (*Sardinops sagax*) considered as accidental catch and are stored alive in tanks for up to 3 months. The vessels are authorised to use purse-seine nets that do not exceed 210 m in length and 35 m in depth.

The Tuna Pole-line sector is largely based in Cape Town and the fleet operates in the Atlantic Ocean along the west coast as far north as Namibia and as far west as Valdivia and Vema seamounts, where they have access to albacore and yellowfin tuna in these areas.

1.3. Commercial linefishery

South Africa also has a boat-based commercial Linefishery which opportunistically catches yellowfin tuna and eastern little tuna (*Euthynnus affinis*) (Everett, 2014), in addition to king mackerel and shark species in the Indian Ocean using rod and reel when other linefish species such as yellowtail (*Seriola lalandi*), snoek (*Thyrsites atun*), kob (*Argyrosomus spp*), geelbek (*Atractoscion aequidens*) and slinger (*Chrysoblephus puniceus*) are not available. These catches usually only contribute a negligible percentage of the total catch of the Linefishery due to the multispecies nature of this sector.

2. FLEET STRUCTURE

South Africa has two commercial fishing sectors which target tuna and tuna-like species in the Indian Ocean – the Large Pelagic Longline and the Tuna Pole-line. The Tuna Pole-line sector, which operates mainly in the Atlantic Ocean from September – May each year, only occasionally crosses over into the Indian Ocean in search of yellowfin tuna. These vessels are relatively small (< 24m), have a limited range and the duration of trips is short (< 16 days). In 2020, there was no Tuna Pole-line effort in the Indian Ocean area of competence. In contrast, 15 longline vessels were active in the IOTC area of competence, which is less than in 2019 (23).

South Africa currently has a commercial linefishery (artisanal) that is regulated through a TAE of 154 permits in the IOTC Area of Competence, and a recreational skiboat fishery open access (a recreational permit can be purchased). South Africa submitted a Fleet Development Plan (FDP) in 2007 and is yet to provide information on the implementation of the initial FDP and to consult with stakeholders to provide an updated FDP.

Table 1. Number of vessels operating in the IOTC area of competence, by gear type and size, for the period 2010 - 2020.

	Fleet Structure in 2020			Fleet Structure 2010 - 2019		
Fishing Sector	No. Active Permits	Vessel size range (m)	Trip duration (days)	No. Active Permits	Vessel size range (m)	Trip duration (days)
Large Pelagic Longline	15	20 - 32	1 - 94	2019: 23 2018: 25 2017: 16 2016: 19 2015: 19 2014: 15 2013: 22 2012: 24 2011: 29 2010: 21	2019: 16 - 49 2018: 16 - 49 2017: 20 - 49 2016: 20 - 49 2015: 20 - 49 2014: 20 - 49 2013: 20 - 50 2012: 22 - 50 2011: 22 - 50 2010: 21 - 50	1 - 123
Pole-line	0	0	0	2019: 1 2018: - 2017: 1 2016: 2 2015: 3 2014: 0 2013: 0 2012: 6 2011: 6 2010: 2	2019: 1 2018: - 2017: 16 - 19 2016: 16 - 19 2015: 16 - 19 2014: N/A 2013: N/A 2012: 14 - 20 2011: 13 - 22 2010: 13	1 - 19
Commercial Linefishery	154	4 - 10	1 - 2			
Recreational Linefishery	Unknown	4 - 10	1			

3. CATCH AND EFFORT (BY SPECIES AND GEAR)

In 2020, 15 longline vessels were active in the IOTC Area of Competence, which is less than in 2019. Effort decreased substantially (Table 2a) and the number of hooks set in 2020 (572 461) was less than half that of 2019 (1 355 677). This is as a result of Joint-Venture vessels not operating in South African waters in 2020. Consequently, catches decreased from 2019 to 2020 for all species; albacore (23%), southern bluefin tuna (27%), bigeye tuna (49%), yellowfin tuna (56%), blue shark (58%), swordfish (74%) and shortfin mako shark (96%) as shown in Figure 1a. There was no Tuna Pole-line effort in the Indian Ocean Area of Competence in 2020.

Table 2a. Annual Large Pelagic Longline sector catch (tons round weight excluding sharks and NEI) and effort (number of hooks) of primary species in the IOTC Area of Competence for the period 2010 - 2020.

Year	Total number of hooks	Bigeye tuna	Yellowfin tuna	Albacore	Southern bluefin tuna	Swordfish	Skipjack	Shortfin mako	Blue shark	NEI
2010	44 52 420	794.9	1207.3	60.3	7.8	467.6	0.7	41.9	90.9	98.8
2011	5 235 123	781.2	1063.2	254.7	60.2	488.2	3.0	341.1	193.8	180.5
2012	3 816 271	759.2	590.1	161.7	109.1	395.1	2.6	221.3	171.7	136.4
2013	3 872 846	590.4	1029.4	177.5	53.3	305.0	3.6	304.4	169.8	101.6
2014	1 828 671	339.2	383.0	28.2	15.3	102.8	0.8	249.3	102.9	38.2
2015	1 614 724	256.0	422.1	18.5	10.7	122.7	0.3	290.6	128.9	47.4
2016	1 284 756	203.6	331.5	19.9	17.8	93.4	0.1	543.6	171.7	28.7
2017	1 284 160	261.7	247.5	26.5	46.8	57.3	0.5	421.1	105.4	22.9
2018	1 325 446	212.1	331.4	17.9	58.2	123.3	0.1	367.0	178.8	19.1
2019	1 355 677	238.4	389.0	57.2	63.9	225.5	0.2	116.1	68.0	14.8
2020	572 461	118.0	216.6	13.2	17.1	166.0	0	111.7	39.5	6.9

Table 2b. Annual catch and effort (number of days) of primary species from the Tuna Pole-line in the IOTC Area of Competence for the period 2010 - 2020.

Year	Total number of catch days	Albacore	Yellowfin tuna	Skipjack	Bigeye tuna	Snoek	Yellowtail	NEI
2010	3	3.5	0	0	0	0	0	0.26
2011	25	45.7	0.69	0.002	0	0.02	0.88	0.85
2012	31	15.3	0.16	0.04	0.12	0.32	0.01	0.09
2013	2	0.06	0.01	0.01	0	0	0	0
2014	0	0	0	0	0	0	0	0
2015	3	0.13	0.11	0	0	0	0	0
2016	25	5.78	0	0	0	6.52	0	0
2017	1	0	0	0	0	0	0.04	0
2018	0	0	0	0	0	0	0	0
2019	1	0.25	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0

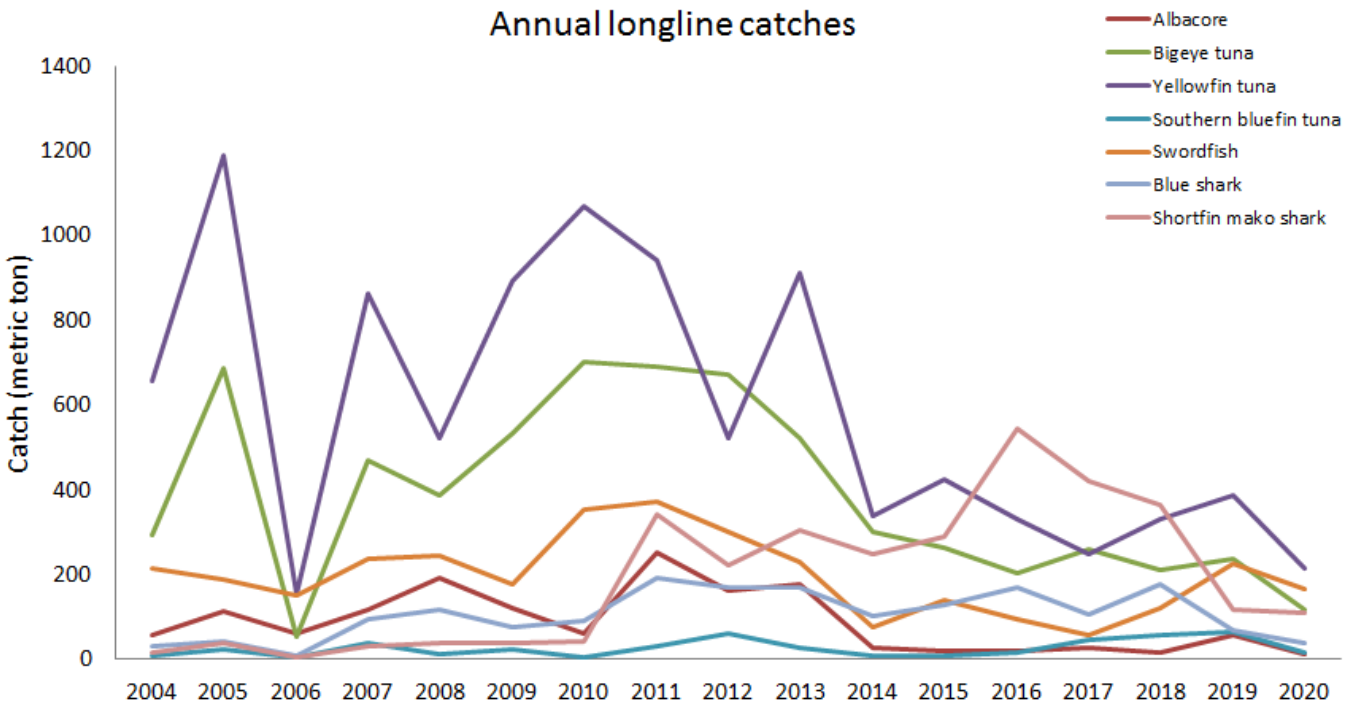

Figure 1a. Historical annual catch for the South African Large Pelagic Longline fleet for the IOTC Area of Competence of the period 2004 – 2020.

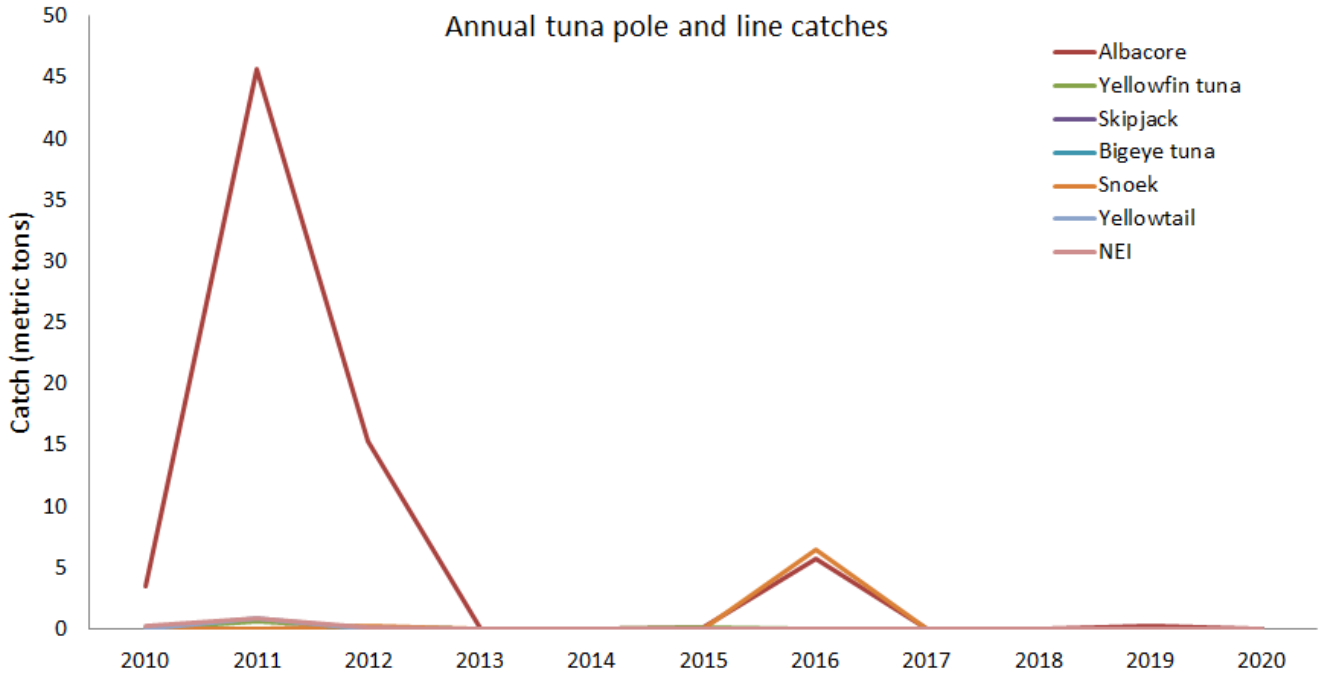

Figure 1b. Historical annual catch for the South African Tuna Pole-line fleet for the IOTC Area of Competence for the period 2010 – 2020. In 2020 there was zero Tuna Pole-line effort in the IOTC Area of Competence.

There are three areas of concentrated longline effort by the national fleet in the IOTC Area of Competence (Figure 2a): Agulhas Bank (~ 20-23 degrees longitude), Algoa Bay (~ 25-27 degrees longitude) and offshore of Richards Bay (~32 degrees longitude). In 2020, the fleet fished comparatively nearer to the shore than in previous years. The average spatial distribution of the fleet for the period 2016 to 2020 is shown in Figure 2b. The spatial distribution of species-specific catches is illustrated in Figure 3a, and the average species-specific catch distribution for the period 2016 to 2020 in shown in Figure 3b. In 2020, all species had catches in the three areas of high fishing pressure (described above), but high catches of tuna were restricted to offshore Richards Bay and sharks were predominantly caught around Algoa Bay.

While the effort distribution is relatively evenly spread along the South African coast, effort shifts nearshore or offshore. A vast amount of effort was further offshore in the past (2012 – 2015), particularly on the border of Mozambique. From 2016 to 2018, and again in 2020, there has been fishing closer to the mainland or on the Agulhas Bank. However, in 2019 there was an offshore trend in the fishing effort.

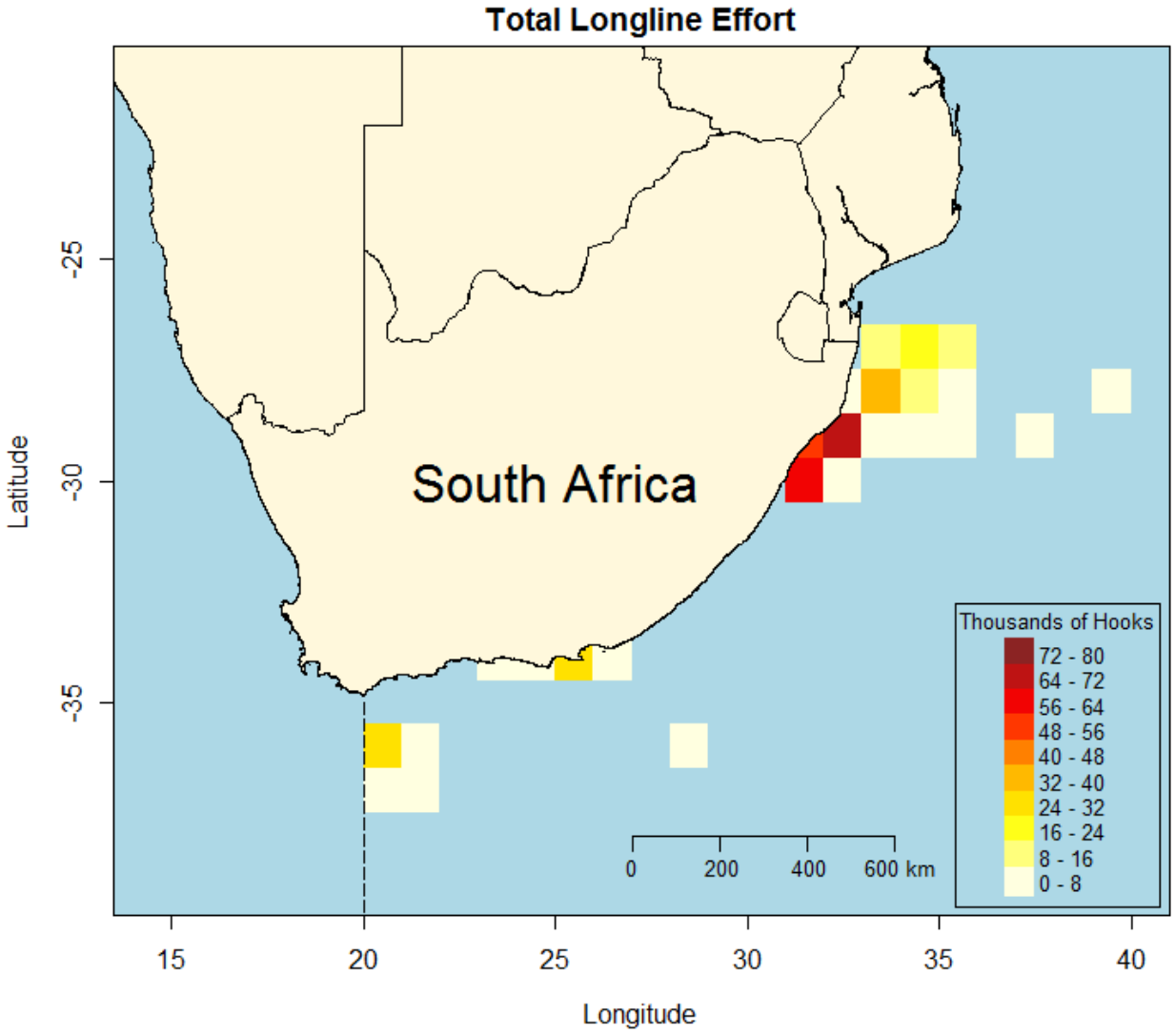

Figure 2a. Map of the distribution of effort of the South African Large Pelagic Longline fishing fleet in the IOTC Area of Competence for 2020.

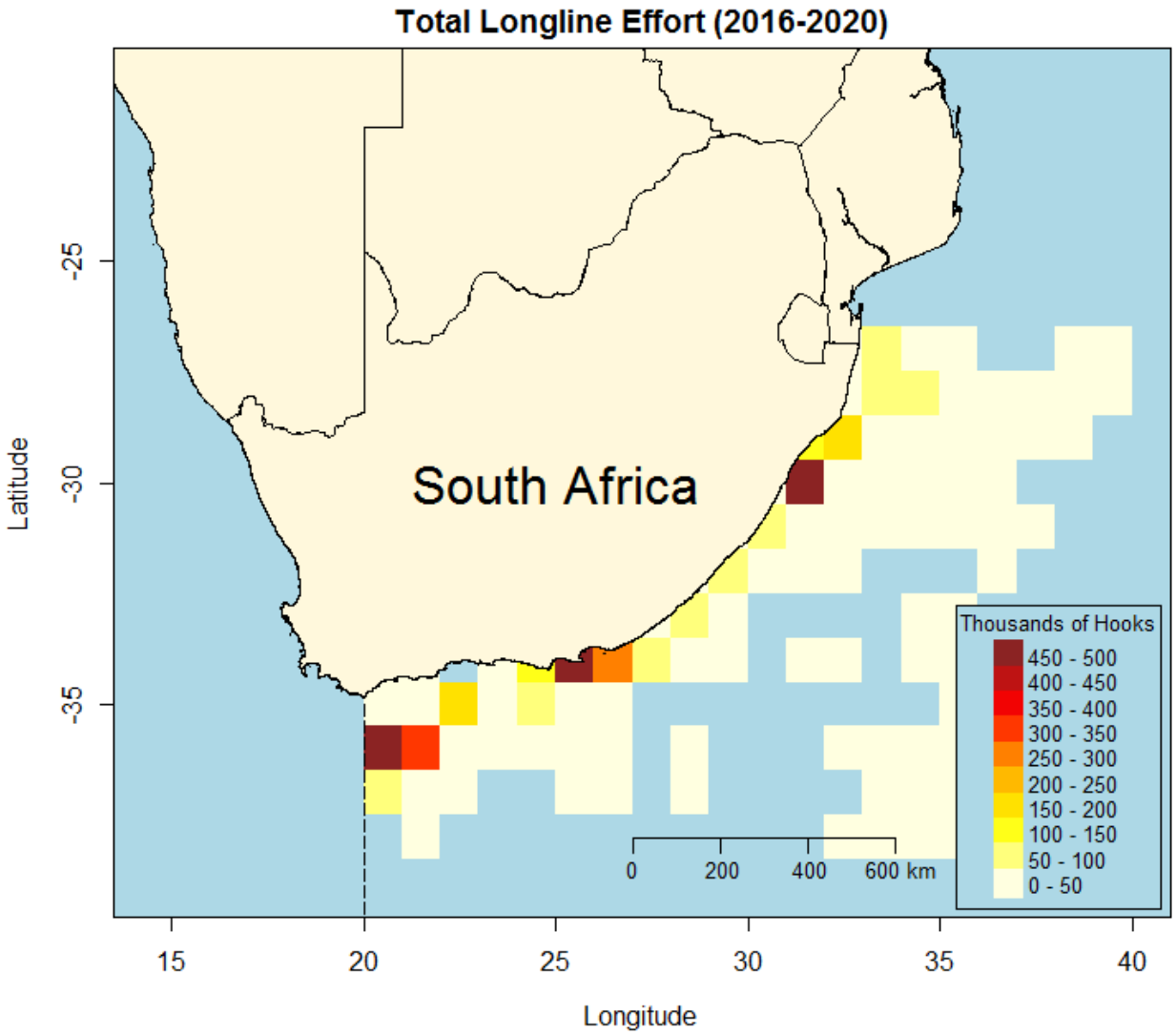

Figure 2b. Map of the distribution of average effort of the South African Large Pelagic Longline fishing fleet in the IOTC Area of Competence for the period 2016 – 2020.

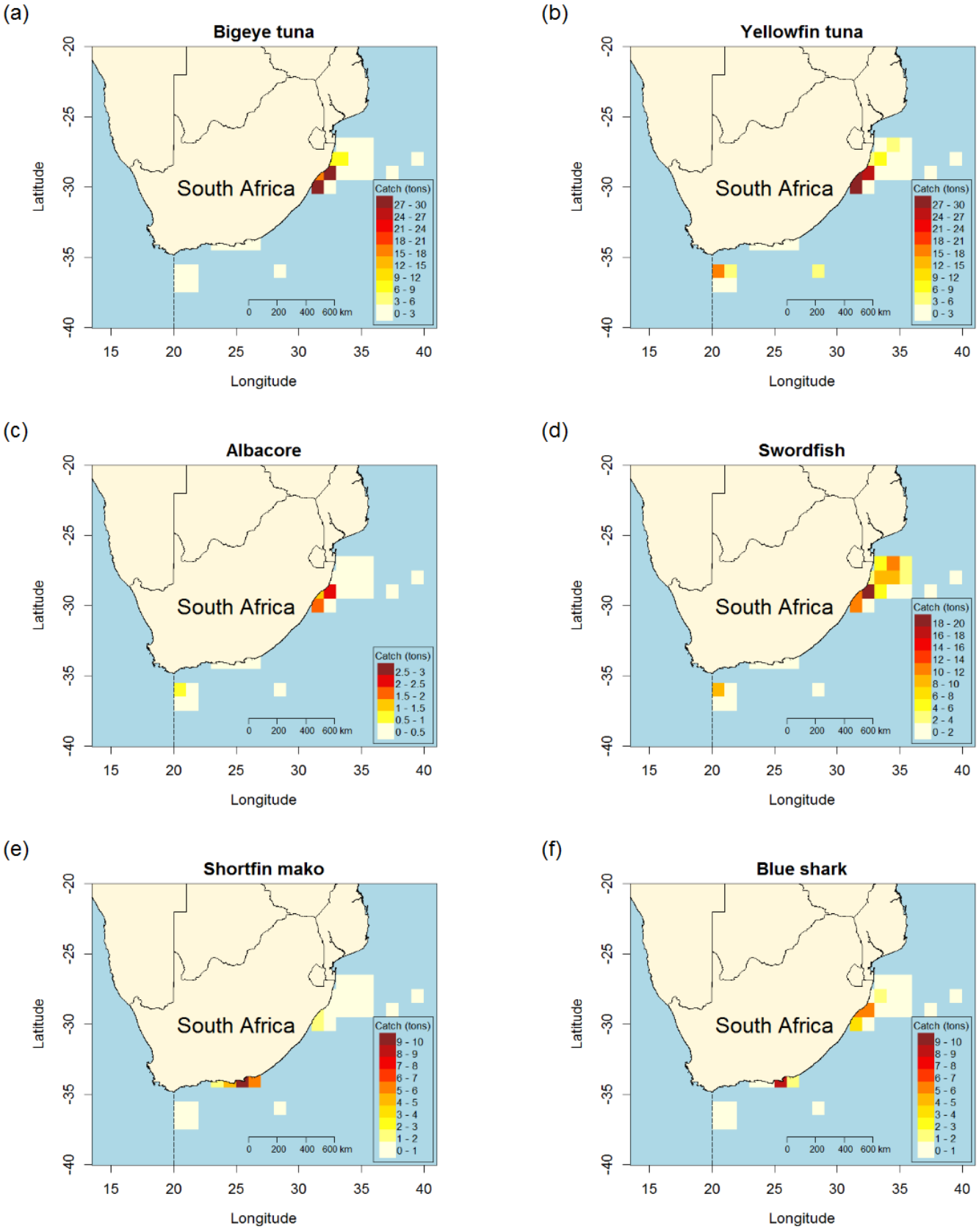

Figure 3a. Map of distribution of fishing catch (metric tons), for a) bigeye tuna, b) yellowfin tuna, c) albacore, d) swordfish, e) shortfin mako shark and f) blue shark for Large Pelagic Longline in South Africa, in the IOTC Area of Competence in 2020.

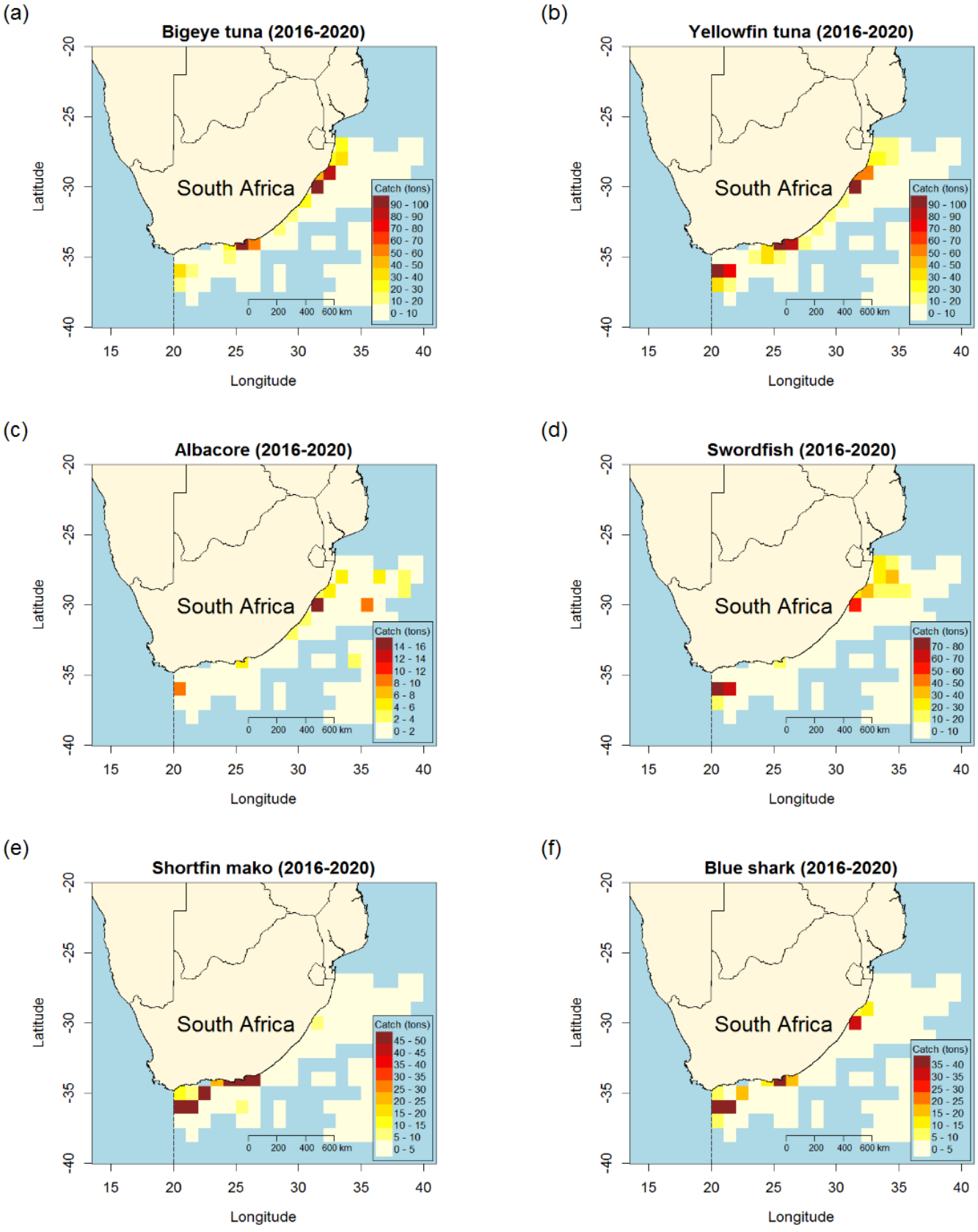

Figure 3b. Map of distribution of average fishing catch (metric tons), for a) bigeye tuna, b) yellowfin tuna, c) albacore, d) swordfish, e) shortfin mako shark and f) blue shark for Large Pelagic Longline in South Africa, in the IOTC Area of Competence for the period 2016 – 2020.

4. RECREATIONAL FISHERY

The boat-based recreational sector, including informal charter and sport fisheries using rod and reel and spear guns, also targets albacore, yellowfin, skipjack, bigeye tuna and marlins (blue marlin *Makaira nigricans* and black marlin *Makaira indica*), from small fishing vessels (on average 4 – 10 m in length). All recreational fishers are required to purchase a permit and are restricted to a bag-limit of 10 tunas, 5 swordfish and 5 billfish per day, with the sale of catch strictly prohibited. There are further minimum weight restrictions of 3.2 kg for yellowfin and bigeye, 6.4 kg for southern bluefin and 25 kg for swordfish caught. As there are no reporting requirements for this sector, catch and effort data are not consistently available. The angling associations have regular tuna and billfish competitions every year where they promote research (e.g. tagging), catch-and-release and responsible fishing. Most recreational fishing takes place in nearshore waters during holidays and relatively few anglers are equipped to target tuna.

The impact of the recreational fishing sector on South African large pelagic resources has resulted in a number of data collection initiatives being implemented. These are largely driven by NGOs, Government Research Institutes and Universities. One such initiative FishforLife (http://fishforlife.co.za/) is a citizen science initiative aimed at gathering relevant fisheries data in the recreational fishing sector via their online portal CatchReport (http://www.catchreport.co.za/). These projects also aim to collate all angling club and angling tournament catch and effort data which will be accessible for scientific research purposes.

5. ECOSYSTEM AND BYCATCH ISSUES

The World Wildlife Fund-South Africa (WWF-SA) Responsible Fisheries Programme, now the WWF Sustainable Fisheries, has worked since 2007 to facilitate the implementation of an Ecosystem Approach to Fisheries management (EAF) in Southern Africa. An Ecological Risk Assessment (ERA) was conducted in 2007 to identify the issues (e.g. ecological wellbeing, human wellbeing and ability to achieve) in the pelagic longline, shark longline and Tuna Pole-line fisheries (Petersen, 2007). The Performance Report identified the gaps amongst research, management, compliance and industry and has been used – and has continued relevance – as a tool to guide work plans and the implementation of EAF considerations in permit conditions.

5.1. Sharks

South Africa has one of the most diverse shark faunas in the world and many species are caught in appreciable quantities in directed and non-directed shark fisheries. South Africa has well developed fisheries management systems for most of its fisheries and many challenges regarding the sustainable management and conservation of sharks have already been identified and addressed in individual fisheries policies and management measures.

The permit conditions are amended regularly to include shark mitigation measures. As of 2017, the use of wire traces has been banned in the South African Large Pelagic Longline sector, as is the use of stainless-steel hooks. Furthermore, shark fins must be naturally attached to the body when landed. As of 2018, the targeting of sharks (defined as 50% or more sharks per fishing season by mass) is prohibited and if quarterly landings exceeded 60% shark, the vessel will require 100% observer coverage for the remainder of the fishing season.

In addition, a precautionary upper catch limit (PUCL) of 2000 t dressed weight of Chondrichthyans was enforced since 2012. Joint venture (foreign-flagged) vessels may not land Chondrichthyans that exceed 10% of the total dressed weight of tuna species per season. South African-flagged vessels are limited by the PUCL. When the PUCL has been reached, no shark shall be landed, and fishing will only be allowed with the presence of an observer onboard.

Thresher sharks belonging to the genus *Alopias*, hammerhead sharks (belonging to genus *Sphyrna*), oceanic whitetip sharks, porbeagle sharks, dusky sharks and silky sharks shall not be retained on board any vessel and

all releases of these species are noted on the logbooks. Furthermore, manta- and mobulid rays shall not be retained on board any vessel and all releases of these species are noted on the logbooks.

The trade of shark and ray products, including fins, fillets, gill rakers and other products should be carefully monitored to ensure CITES Appendix II listed species are not traded without the necessary permits.

5.1.1. NPOA sharks

The South African National Plan of Action for sharks (NPOA-Sharks) was finalised in 2013 and provided information on the status of chondrichthyans in South Africa and examined structure, mechanisms and regulatory framework related to research, management, monitoring, and enforcement associated with shark fishing and trade of shark product in the South African context. This information was used to identify, group and prioritize issues particular to South African chondrichthyan resources that require intervention in the forms of specific actions, associated responsibilities and time frames. It provides a guideline for identifying and resolving the outstanding issues around management and conservation of sharks to ensure their optimal, long term, sustainable use for the benefit of all South Africans.

Integral to the NPOA for Sharks -South Africa was the list of issues to be addressed in terms of improving sources of data, addressing scientific knowledge on common and cryptic species and thereby improving the management of chondrichthyan fisheries. In 2018, DFFE reviewed the NPOA which was presented at the IOTC WPEB14 (da Silva *et al*., 2018). The review indicated that progress was made in six of the seven "Issue Clusters" and within most 22 issues highlighted in the NPOA Sharks SA. Most notable progress was made within the *optimum use* (100% of listed actions completed) and *classification and assessment of species* (84% of listed actions completed) issue clusters. The least progress was made in the *data and reporting* and *regulatory tools* issue clusters. In May 2020, following public concern about shark populations along the South African coast, The Minister of Environment, Forestry and Fisheries, Ms Barbara Creecy, appointed an External Panel to formally review the NPOA Sharks SA. The Expert panel was tasked to provide an independent critical appraisal of the NPOA, to review the progress made with implementation of the plan and to provide input towards an updated and improved NPOA Sharks. The Expert panel scrutinised 60 background documents and reviewed the 62 actions of the current NPOA sharks and provided scores for each section. The external experts commended the external review process as a unique example of accountability and transparency that highlighted the Departments' commitment to conserve shark species and properly manage their long-term sustainable use. Overall the review of the Panel was positive and acknowledged good progress with the foundational sections of the plan relating to research. They noted that in this context, South Africa's plans and achievements compare well with the standard of developed countries such as the USA and Australia. To improve on sections where limited progress was made, specific recommendations were made for immediate implementation. These included but were not limited to effective communication and coordination from science to policy, the need for measurable indicators to track progress of the updated plan and a stronger focus on illegal, unregulated and unreported fishing (DEFF, 2020). The NPOA Sharks will be updated by end 2022.

5.1.2. Sharks finning regulation

South African Large Pelagic longline permit condition 6.1 (i) includes the following:

> *Fins may not be removed from the shark trunks (i.e. headed, gutted). Fins are to be kept attached to the specific trunk either through a partial cut and folded over or tethered to the trunk via a cord (any loop in the cord shall not exceed approximately 8 cm in diameter and shall follow similar specifications to permit condition 21.1 (b)).*

5.1.3. Blue shark

South African Large Pelagic longline permit condition 10.3 includes the following:

A Landing Declaration (Annexure 7 and electronic version available upon request from Large Pelagics Marine Research Technician, Table 2) is to be completed after every discharge and certified by a FCO or a DFFE appointed Monitor. The Landing Declaration is to be submitted by the right holder along with the monthly catch statistics forms (Clause 11.2).

And permit condition 16.1:

The Department shall require each Permit Holder to carry one or more Scientific observers on board its vessel on request (72 hours), a minimum of one per quarter so as to ensure that 20% of all fishing days per quarter are monitored. Failure to comply with this request shall result in the vessel being ordered to remain in port and may result in the initiation of proceedings under section 28 of the MLRA. Annual observer coverage per vessel is required to be spatially representative of annual fishing effort and needs to fulfil RFMO specific requirements. If coverage of observed trips is not temporally and spatially representative of effort, the Department shall require vessels to carry scientific observers on board additional trips.

Table 3. Total number and dressed weight (metric tons) of sharks retained by the South African national fleet in the IOTC Area of Competence for the period 2010 - 2020.

Year	Blue shark no.	Blue shark tons	Shortfin mako shark no.	Shortfin mako shark tons
2010	4 424	90.9	2 066	41.9
2011	10 844	193.8	14 734	341.1
2012	11 021	171.7	8 184	221.3
2013	11 588	169.8	11 620	304.4
2014	7 544	102.9	8 720	249.3
2015	10 609	128.9	10 856	289.4
2016	15 636	171.7	20 117	543.6
2017	7 017	105.4	14 704	421.1
2018	11 841	178.8	14 192	367.0
2019	3 972	68.0	4 385	116.1
2020	2 093	39.5	4 105	111.7

Table 4a: Total number of sharks, by species, released/discarded by the national fleet in the IOTC Area of Competence in 2020.

	Alive (released)	Discard, dead	Total
Common thresher shark *Alopias vulpinus*	12	2	14
Silky shark *Carcharhinus falciformis*	8	5	13
Manta and *Mobula* spp	1	0	1
Pelagic thresher shark *Alopias pelagicus*	-	-	-
Smooth hammerhead shark *Sphyrna zygaena*	-	-	-
Porbeagle shark *Lamna nasus*	-	-	-
Oceanic whitetip shark *Carcharhinus longimanus*	-	-	-
Big eye thresher shark *Alopias superciliosus*	8	0	8
Thresher shark *Alopias* spp	2	1	3
Scalloped hammerhead shark *Sphyrna lewini*	29	18	47
Tiger shark *Galeocerdo cuvier*	4	0	4
Silvertip shark *Carcharhinus albimarginatus*	1	0	1
Copper shark *Carcharhinus brachyurus*	266	78	344
Blue shark *Prionace glauca*	337	62	399
Blacktip shark *Carcharhinus limbatus*	55	37	92
Shortfin mako shark *Isurus oxyrinchus*	29	7	36

5.2. Seabirds

South Africa has been collecting data on seabird interaction with its longline sector since 1998. South Africa published its NPOA for seabirds in 2008 (NPOA-Seabirds, 2008). The NPOA-Seabirds specifies a maximum mortality rate of 0.05 birds/1000 hooks and lays out bycatch mitigation measures for use in longline fishing.

South Africa has introduced a number of bird mitigation measures through permit conditions since the start of its sector, including no daylight setting in conjunction with the compulsory flying of tori-lines or line weighting, and the use of thawed bait to improve sink rates, in the tuna fishery. South Africa does not consider the use of line shooters or offal discard management to be useful in reducing seabird incidental mortality. Furthermore, South Africa (with the Albatross Task Force of BirdLife South Africa) developed a management plan in 2008 to reduce seabird bycatch in its longline sector. This plan includes two seabird bycatch limits per vessel per year. The first limit stipulates that once a vessel reaches 25 birds killed in a year, it must adopt additional mitigation measures; it must fly a second tori line and it must place additional weights on to each branchline. If the vessel reaches the second limit of 50 seabird mortalities, the Department will review compliance with mitigation measures before deciding whether to permit further fishing by that vessel.

Since the implementation of seabird mitigation measures and the stringent monitoring thereof, seabird mortality has been reduced by more than an order of magnitude. For South Africa's entire coastline, the seabird mortality rate has declined from a maximum of 1.85 seabirds/1000 hooks^{-1} in 2011 to a catch rate of 0.051 seabirds/1000 hooks^{-1} in 2016, which is a vast improvement. The implementation of mitigation measures remains high priority for DFFE, the South African fisheries management authority. All South African vessels, or vessels operating

under a bi-lateral agreement with South Africa, are required to employ a combination of bird scaring lines, line weighting and night setting as bird bycatch mitigation measures. Vessels are encouraged to use 'hook shielding devices' (as approved by the Agreement on the Conservation of Albatross and Petrels), which in 2019 are limited to Smart Tuna Hooks® and Hookpods®. If either method is chosen, each hook set shall have the chosen device attached.

South African researchers have collaborated extensively with numerous NGOs, including BirdLife South Africa, to improve estimates of seabird mortality as a result of large pelagic longliners. Specifically, in 2019 a Collaborative workshop to assess seabird bycatch in pelagic longline fleets (South Atlantic and Indian Oceans) was held in Cape Town. This workshop hosted 7 scientists from 3 different countries and the following institutes: DEFF, Projeto Albatroz, IPMA, DINARA. The following paper was presented at the IOTC WPEB in 2019:

Jimenez S, Domingo A, Winker H, Parker D, Gianuca D, Neves T, Coelho R and Kerwath S (2020). Towards mitigation of seabird bycatch: Large-scale effectiveness of night setting and tori lines across multiple pelagic longline fleets. *Biological Conservation.* **247: 108642**

Furthermore, in May 2018, the Seabird Bycatch Small Working Group held a meeting in Cape Town with the sole aim of developing the most reliable methods of determining seabird mortality using catch statistics from numerous countries that access large pelagic resources in the southern Atlantic and Indian Oceans (Rice 2018).

Table 4b: Summary of amendments to seabird bycatch mitigation measures in South African permit conditions for South African within the South African EEZ.

Mitigation measure	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Night setting only	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes
Bird-scaring line	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Line weighting (achieving 0.3 $m.s^{-1}$)	No	No	No	No	No	No	No	No	No	No	No
Line weighting (60 g < 2m of hook)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Thawed bait before setting	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Reduced lighting	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Offal management	No	No	No	No	No	No	No	No	No	No	No
25 bird bycatch limit per year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

1. How many vessels operated south of 25˚S in the period covered by this report?
   - 100% of vessels operations reported in 2018 were south of 25˚S.

2. How many of those vessels used bird scaring lines (as a proportion of total effort)?
   - 100% of vessels flew tori lines.

3. How many of those vessels used line weighting (as a proportion of total effort)?
   - 100% of vessels employed line weighting.

4. How many of those vessels used night setting (as a proportion of total effort)?
   - 100% of vessels employed night setting. This is a mandatory regulation in South African waters.

5.3. Marine Turtles

The South African government has worked closely with WWF to educate skippers on release procedures for turtles. Skippers are provided with guidelines/instructions in their permit conditions on how to safely handle and release caught turtles. The use of circle hooks is encouraged as stated in the permit conditions, as well as the release of turtles using a de-hooker. As of 2014, skippers were required to record interactions with turtles, including the fate of the turtle, in the catch statistic logbooks on board the vessel. There is high awareness among

skippers on turtle handling protocols and release mortalities are thought to be low. In 2020, 7 turtle interactions were recorded, all of which were released alive (Table 5).

5.4. Other ecologically related species (e.g. marine mammals, whale sharks)

South Africa encourages vessels to take cognizance of sustainable fishing practices and impacts of tuna longline operations on the ecosystem. Given that South Africa does not allow purse-seine fishing tuna fishing and large pelagics are solely targeted by longliners and baitboats, interactions with marine mammals are negligible. However, a specific concern is the impact of lost "strops" (cords used to hang fish during freezing) during discharge procedures. Marine animals subsequently become entangled in these strops, resulting in mutilation and potential mortality of entangled animals. In order to solve this problem, the Permit Holder is to ensure that "strops" used during freezing and discharge do not exceed the stipulated 80 mm stretched length.

Table 5. Observed annual catch of seabirds, marine turtles and marine mammals in the national pelagic longline fleet from 2015 - 2020 in the IOTC area of competence.

	2015		2016		2017		2018		2019		2020	
	Dead	Alive	Dead	Alive	Dead	Alive	Dead	Alive	Dead	Alive	Dead	Alive
Seabirds												
Atlantic yellow-nosed albatross *Thalassarche chlororhynchos*	14	4	4	2	1	1	1		1			
Black-browed albatross *Thalassarche melanophris*	4	2							2			
Grey-headed albatross *Thalassarche chrysostoma*												
Indian yellow-nosed albatross *Thalassarche carteri*	14	2								3	5	29
Shy albatross *Thalassarche cauta*	1	1			6		1		1	1	1	1
Albatross unidentified		1										3
Cape gannet *Morus capensis*	4											
White-chinned petrel *Procellaria aequinoctialis*	6	38	3	25	21	1	6	2	18	1	13	
Petrel unidentified			1									
Cape petrel *Daption capense*												
Great skua *Stercorarius skua*												
Marine turtles												
Leatherback turtle *Dermochelys coriacea*	5	1						4		1		4
Loggerhead turtle *Caretta*	5		3		2			7		2		2
Green turtle *Chelonia mydas*										2		1
Hawksbill turtle *Eretmochelys imbricata*								1				
Turtle unidentified	2		2									
Marine mammals												
Common dolphin *Delphinus* spp												
Dolphin unidentified	1		1							2		
Bottlenose dolphin *Tursiops truncatus*						1						
Cape fur seal *Arctocephalus pusillus*								2				

6. NATIONAL DATA COLLECTION AND PROCESSING SYSTEMS

6.1. Logsheet data collection and verification

Vessels in the Large Pelagic Longline sector and Tuna Pole-line sector have been required to complete daily logs of catches since 1997 and 1985, respectively. The data are verified by comparing logs of catches with landing declarations that are overseen by South African Fisheries Compliance Officers and Fisheries Monitors. Right holders are required to submit these logsheets on a monthly basis.

6.2. Vessel Monitoring System

The Vessel Monitoring System (VMS) was implemented in 1998 for Large Pelagic Longline vessels and was subsequently followed by the Tuna Pole-line vessels. All longline and pole-line vessels are required to have a functional VMS system on board that transmits directly to the Department's VMS OPS Room. It is the Permit Holder's responsibility to ensure that the VMS transmits data continuously and uninterruptedly prior to and throughout the duration of the trip.

6.3. Observer programme

The observer program was established in 1998, at the start of the experimental phase of the Pelagic Longline sector, and a minimum 20% observer coverage was stipulated. The Offshore Resources Observer Programme (OROP) began in March 2002 and to date it still requires 100% observer coverage on foreign-flagged vessels. Up until March 2011, 11- 20% observer coverage was achieved on local vessels per year based on the total effort (number of hooks) deployed. The observer programme contract expired in March 2011. Since then the continuation of the observer coverage has been ensured by introducing measures within the fishing regulations that prescribe a minimum coverage per vessel and an overall coverage by fleet in order to meet the 5% observer coverage as specified by IOTC on the domestic longline vessels, whilst re-establishing the national observer programme by developing the specifications for the tender process. The observer programme for joint-venture (Japanese-flagged) vessels has continued with 100% of fishing trips observed. In 2020, the South African large pelagic longline fleet set 100 179 hooks in the IOTC Area of Competence with an observer onboard, which equates to 18% of all hooks set in the IOTC Area of Competence in 2020. There are no observers stationed on Pole-line vessels; however, increased inspections and sampling of Tuna Pole-line vessels is conducted during offloading in port by South Africa Fisheries Compliance Officers and Fisheries Monitors.

The observers collect all operational, catch (retained and discard), effort and length frequency data, and will collect biological material when required. The observers record data on the following forms:

- Form 1: Vessel and trip information sheet (IOTC Form I-GEN)
- Form 2D: Pelagic longline gear and operation information (IOTC Form 2-LL)
- Form 3D: Fishing effort pelagic long-line (IOTC Form 4-LL)
- Form 4: Marine mammal, sea turtle, and seabird incidental take form
- Form 6: Depredation
- Form 7: Fish biological sampling

Table 6. The number of hooks observed (local and foreign-flagged joint-venture vessels) per year from 2011 to 2020 in the IOTC Area of Competence.

Year	Total number of hooks observed	Percentage hooks observed of total hooks set in IOTC region
2011	3 126 357	29%
2012	2 615 568	26%
2013	2 235 366	25%
2014	1 263 727	30%
2015	1 037 222	64%
2016	680 000	28%
2017	939 835	30%
2018	744 415	37%
2019	804 121	59%
2020	100 179	18%

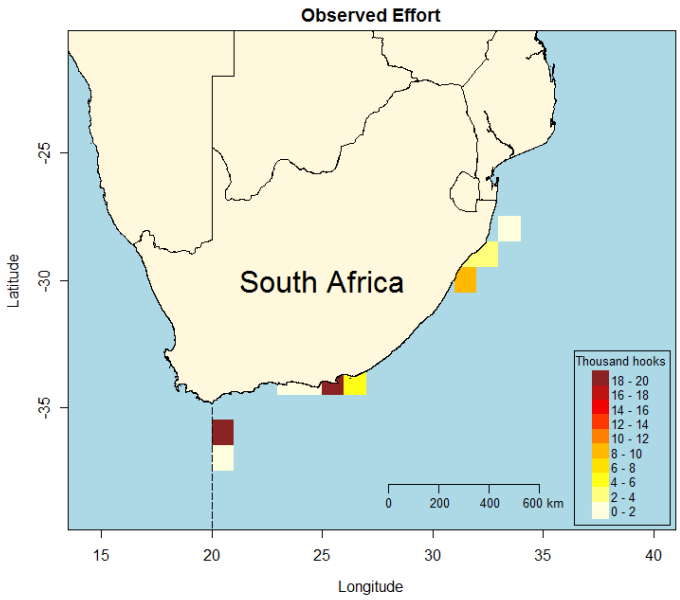

Figure 4. Map showing the spatial distribution of observer effort coverage for the IOTC Area of Competence in 2020.

6.4. Port sampling programme

Port sampling for tuna, swordfish and related species began in 1973 in the IOTC region. The collection of albacore length-frequency data through port sampling of Pole-line vessels has been undertaken by employees of the Department of Forestry, Fisheries and the Environment since 2011. The skippers are encouraged to collect yellowfin tuna length frequency measurements onboard Pole-line vessels prior to dressing the catch. All length frequency data on the pelagic longline vessels are collected at sea by observers prior to the fish being dressed.

6.5. Unloading/Transhipment

Unloading or discharging of fish from a longline vessel can only be undertaken in the presence of a monitor or a South African Fisheries Control Officer. Transhipment of fish is not permitted at sea. Transhipments of fish in port requires pre-authorisation. Tuna Pole-line discharges in port are monitored. These measures have been in place since 1998.

Table 7. Number of individuals measured by observers on Large Pelagic Longline vessels in the IOTC Area of Competence for the period 2015 - 2020. These fish are not necessarily retained.

English name	Scientific name	2015	2016	2017	2018	2019	2020
Albacore	*Thunnus alalunga*	311	324	655	777	1694	58
Atlantic pomfret	*Brama*	45	89	793	325	221	
Atlantic sailfish	*Istiophorus albicans*						
Bigeye tuna	*Thunnus obesus*	3046	1948	2624	1780	1494	126
Big-scale pomfret	*Taractichthys longipinnis*						
Black marlin	*Makaira indica*	26	19	21	13	10	
Blue marlin	*Makaira nigricans*	12	16	10	3	4	5
Blue shark	*Prionace glauca*	1142	514	686	1376	442	372
Brilliant pomfret	*Eumegistus illustris*						
Butterfly kingfish	*Gasterochisma melampus*					13	
Common dolphinfish	*Coryphaena hippurus*	83	40	93	85	46	8
Copper shark	*Carcharhinus brachyurus*	4	9	15	14		1
Crocodile shark	*P. kamoharai*	1				3	
Dorado	*Salminus brasiliensis*	9					
Escolar	*L. flavobrunneum*	747	353	304	381	191	
Indo-Pacific sailfish	*Istiophorus platypterus*	3		7	5	6	
L. snouted lancetfish	*Alepisaurus ferox*				3	6	
Longfin mako	*Isurus paucus*						
Mako sharks	*Isurus* spp					10	2139
Moonfish	*Mene maculate*					1	8
Ocean sunfish	*Mola*	2					
Oceanic whitetip shark	*Carcharhinus longimanus*	1					
Oilfish	*Ruvettus pretiosus*	418	140	300	203	178	1
Opah	*Lampris guttatus*	51	13	24	16	70	
Pelagic stingray	*Dasyatis violacea*	3				5	
Porbeagle	*Lamna nasus*						
Rudderfish/Black ruff	*Centrolophus niger*						
Shortbill spearfish	*Tetrapturus angustirostris*	7	3	9		8	
Shortfin mako	*Isurus oxyrinchus*	517	368	1170	842	121	1268
Silky shark	*Carcharhinus falciformis*	7				1	
Skipjack tuna	*Katsuwonus pelamis*	38	8	41	11	14	1
Southern bluefin tuna	*Thunnus maccoyii*	66	132	195	205	703	65
Striped marlin	*Tetrapturus audax*	2	6	13	6	3	
Swordfish	*Xiphias gladius*	239	83	257	534	612	132
Wahoo	*Acanthocybium solandri*	17	7	7		15	
Yellowfin tuna	*Thunnus albacares*	8814	1871	3998	4210	3682	707

6.5. Actions taken to monitor catches & manage fisheries for Striped Marlin, Black Marlin, Blue Marlin and Indo-pacific Sailfish

Catches of marlin species (Striped Marlin, Black Marlin, Blue Marlin and Indo-pacific Sailfish) in the South African large pelagic longline remains low (< 10 tons per annum for all species combined). The following permit conditions aim to further reduce catches for these species:

6.1 (a) - Billfishes of the genera Makaira, Tetrapturus, Istiophorus are designated as secondary species.

6.1 (h) - Marlins (Black, Blue, Stripped and White) shall not be retained on board the vessel, West of 20 degrees. The Permit Holder shall encourage the crew to release live marlins.

6.3 – The catching of ……. and marlins less than 120cm LJFL or less than 90 cm PFL is prohibited.

6.6. Gillnet observer coverage and monitoring

South African does not have a gillnet sector.

6.7. Sampling plans for mobulid rays

South African does not have a gillnet or purse seine Large Pelagic sector – only 1 interaction with a manta ray was reported in 2020 and the animal was released alive.

7. NATIONAL RESEARCH PROGRAMS

Stock Assessment software

JABBA

South African scientists (DFFE) in collaboration with CPC scientists from NOAA are leading the development and implementation of the new, open-source modelling framework JABBA (Just Another Bayesian Biomass Assessment). JABBA is a generalized Bayesian State-Space Surplus Production Model (SPM) and represents the next generation of biomass dynamic modelling. The motivation for developing JABBA was to provide a unified approach to SPM-based assessments that is reproducible, well-documented, and easily implemented for a variety of fisheries. By hosting JABBA in the open-source platform GitHub, the JABBA-Project provides a means for fisheries scientists to share, document, and improve assessment procedures in a standardized manner, greatly reducing time spent constructing redundant models, and democratizing modelling approaches across nations. Hosting such tools in a globally accessible repository also increases transparency in the assessment workflow; enables rapid, continuous modification of the code not limited to a single developer; and acts as an archive of model improvements over time. JABBA originates from a continuous development process of a Bayesian State-Space SPM software that has been rigorously tested that has been applied in the following RFMO assessments. Recently, JABBA was applied to the following IOTC assessments:

1. Parker D. (2021). Assessment of the Indian Ocean black marlin (*Makaira indica*) stock using JABBA. IOTC-2021-WPB19-18.

2. Parker D. (2021). Assessment of the Indian Ocean striped marlin (*Tetrapturus audax*) stock using JABBA. IOTC-2021-WPB19-15.
3. Parker D (2020). Preliminary stock assessment of the Indian Ocean Swordfish (*Xiphias gladius*) using the Bayesian state-space surplus production model JABBA. IOTC-2020-WPB18-18.
4. Parker D, Winker H, Kerwath SE (2019). Stock Assessment of blue marlin (*Makaira nigricans*) in the Indian Ocean using JABBA. IOTC-2019-WPB17-20b, p. 1-17
5. Parker D, Winker H, Kerwath SE (2019). Continuity runs of the Andrade (2016) Bayesian State-Space Surplus Production Model Assessment of Indian Ocean Blue Marlin (*Makaira nigricans*) stock using JABBA. IOTC-2019-WPB17-20a, p. 1-15

7.1. National research programs on blue shark

7.1.1. GERUNDIO project - The aim of the GERUNDIO project is to reduce the existing uncertainties in fish population dynamics models of the three tropical tuna stocks, as well as SWO and BSH across the Indian Ocean. For that matter, the current key objectives of the current are (1) to produce updated estimates of key biological parameters (i.e., age, growth and reproduction parameters), and (2) to provide recommendations for improving the range of biological information for the three tropical tuna species (BET, SKJ and YFT), SWO and BSH that they remain poorly documented in the Indian Ocean. The results will help improve the stock assessments and facilitate a better management of fishery resources in the Indian Ocean.
South Africa contributed Blue shark samples to the GERUNDIO project.

7.1.2. South Africa is a collaborator of the project, "Population structure of IOTC species in the Indian Ocean: Estimation with next generation sequencing technologies and otolith micro-chemistry". The overall aim of the project is to develop a better understanding of the stock structure of tuna, billfish and sharks of the Indian Ocean using two independent, complementary techniques: genetics and otolith (or vertebrae) chemistry. The project intends to determine the degree of population structure and connectivity of the priority species of tuna, billfish and shark over a wide geographical range. Furthermore, the project aims also to develop and extend research networks among partners and to contribute to technical capacity building in participating coastal states. To date, South Africa has provided the following samples for this project:

58 Albacore pairs of otoliths and 57 tissue samples
55 Yellowfin tuna pairs of otoliths and 55 tissue samples
60 Blue shark vertebrae samples and 60 tissue samples

The following paper was presented at the IOTC WPEB in 2020:

Nikolic N, Devloo-Delva F, Bailleul D, Noskova E, Rougeux C, Liautard-Haag C, Hassan M, Marie A, Borsa P, Feutry P, Grewe P, Davies C, Farley J, Fernando D, Biton Porsmoguer S Poisson F, Parker D, Aulich J, Lansdell M, Marsac F, Arnaud-Haond S. (2020). Genome scans discriminate independent populations of the blue shark *Prionace glauca*. IOTC-2020-WPEB16-14.

7.1.3. Movement of juvenile shortfin mako sharks (*Isurus oxyrinchus*) and blue sharks (*Prionace glauca*) around the Agulhas Bank shelf edge. This PhD project aims to investigate the horizontal and vertical movement shortfin mako blue sharks around the Agulhas Bank shelf. Furthermore, this project aims to investigate the hypothesis that the Agulhas shelf acts as a nursery ground for shortfin mako sharks. To date 19 shortfin mako and 8 blue sharks have been tagged with PSAT and SPOT tags in collaboration with DFFE, DEA (Department of Environmental affairs) and SWIOFP (South West Indian Fishery Project). One of the key research priorities involves investigating the movement of large pelagic sharks and fish between the Indian and Atlantic Ocean.

7.1.4. "World without borders- genetic population structure of a highly migratory marine predator, the blue shark (*Prionace glauca*)". This study proved insights into the genetic population structure of blue sharks, by sampling the least mobile component of the populations, i.e., the young-of-year and small juveniles (<2 year; N = 348 individuals), at three reported nursery areas, namely, western Iberia, Azores, and South Africa. Samples were collected in two different time periods (2002–2008 and 2012– 2015) and were screened at 12 nuclear microsatellites and at an 899-bp fragment of the mitochondrial control region. Results show temporally stable genetic homogeneity among three Atlantic nurseries at both nuclear and mitochondrial markers, suggesting basin-wide panmixia. In addition, comparison of mtDNA CR sequences from Atlantic and Indo-Pacific locations also indicated genetic homogeneity and unrestricted female-mediated gene flow between ocean basins. These results are discussed in light of the species' life history and ecology but suggest that blue shark populations may be connected by gene flow at the global scale. The implications of the present findings to the management of this important fisheries resource are also discussed. The findings have been published.

7.1.5. The heavy metal contamination of commercially important large pelagic species (blue shark (*Prionace glauca*), shortfin mako (*Isurus oxyrinchus*) and yellowfin tuna (*Thunnus albacares*) has been investigated by a PhD student in the Meat science, Processing & Product Development research team (Department of Animal Sciences) at Stellenbosch University. Levels of Mercury in South African caught mako sharks are a cause for concern as the maximum allowable limit was exceeded in 100% of samples. The findings have been published.

7.1.6. Distribution patterns and population structure of the blue shark (*Prionace glauca*) in the Atlantic and Indian Oceans." The blue shark is the most frequently captured shark in pelagic oceanic fisheries, especially pelagic longlines targeting swordfish and/or tunas. As part of cooperative scientific efforts for fisheries and biological data collection, information from fishery observers, scientific projects and surveys, and from recreational fisheries from several nations in the Atlantic and Indian Oceans was compiled. Data sets included information on location, size and sex, in a total of 478,220 blue shark records collected between 1966 and 2014. Sizes ranged from 36 to 394 cm fork length. Considerable variability was observed in the size distribution by region and season in both oceans. Larger blue sharks tend to occur in equatorial and tropical regions, and smaller specimens in higher latitudes in temperate waters. Differences in sex ratios were also detected spatially and seasonally. Nursery areas in the Atlantic seem to occur in the temperate south-east off South Africa and Namibia, in the south-west off southern Brazil and Uruguay, and in the north-east off the Iberian Peninsula and the Azores. Parturition may occur in the tropical north-east off West Africa. In the Indian Ocean, nursery areas also seem to occur in temperate waters, especially in the south-west Indian Ocean off South Africa, and in the south-east off south-western Australia. The distributional patterns presented in this study provide a better understanding of how blue sharks segregate by size and sex, spatially and temporally, and improve the scientific advice to help adopt more informed and efficient management and conservation measures for this cosmopolitan species. This project was a global initiative and was conducted by several CPCs with data and input provided by SA. This project was published.

7.1.7. Aspects of the biology and fishery of the blue shark (*Prionace glauca*) in South African waters". This project examined the blue shark fishery in South Africa as well as examining aspects of their biology. Spatio-temporal analyses on nominal CPUE, as well as a standardised CPUE series revealed seasonality in blue shark abundance with a high abundance during summer and autumn off the west coast of South Africa. Annual standardised CPUE revealed that blue shark abundance has remained relatively stable from 1998 to 2008, contradictory to previous findings. The findings from this study suggested that the blue sharks from South Africa are not being overfished, corroborating the findings of the 2008 ICCAT stock assessment. This study resulted in an MSc thesis, publication and IOTC document.

7.1.8. "First documented southern transatlantic migration of a blue shark *Prionace glauca* tagged off South Africa". This project aimed to describe the first documented recapture of a South African-tagged juvenile blue shark off Uruguay lending weight to the hypothesis of a single blue shark

population in the South Atlantic. Furthermore, this project aimed to identify a nursery area off Cape Town. The presence of neonate blue sharks with umbilical scars and females with post-parturition scars, as well as the high frequency of small juveniles in research longline catches, confirm the existence of a parturition and nursery area off South Africa. The final positions of three tagged sharks suggest that large-scale movement patterns in the South Atlantic are a mirror image of movements in the North Atlantic, with sharks using the north-westerly Benguela Drift to migrate into the tropics and ultimately across into South American waters. The confirmed existence of a parturition and nursery area off the south coast of South Africa and the movement of sharks into both adjacent ocean basins suggest that the southern African blue sharks are part of a single stock that straddles the South Atlantic and Indian oceans, and possibly the entire Southern Hemisphere. This project was published.

7.2. Research programs on Striped Marlin, Black Marlin, Blue Marlin and Indo-pacific Sailfish

South Africa does not currently have any research programs on marlin or sailfish species as catches are negligible. In 2020, the combined catches for all these species was less than 10 metric tons (6.8 tons).

7.3. National research programs on sharks

7.3.1. South Africa is currently in the process of updating the shark NPOA.

7.3.2. *JARA - A Red Listing support tool applied on sharks, rays, and chimaeras (chondrichthyans) abundance indices from South African demersal trawl surveys*

JARA represents a Bayesian state-space tool designed for trend analysis of abundance indices for IUCN Red List assessment purposes. The name 'Just Another Red List Assessment' is a reference to JAGS (Just Another Gibbs Sampler, Plummer, 2003), which is the Bayesian software that is called from R to run the Bayesian state-space model application. The name reference, together with user-friendly R interface and modulated coding structure of JARA also follows suit the example of the new open source fisheries stock assessment software "Just Another Bayesian Biomass Assessment" (JABBA; Winker et al. 2018). This project conducted trend analyses for 19 Chondrichthyan species off the south and west coasts of South Africa using the new Bayesian state-space framework 'JARA' (Just Another Redlist Assessment; Winker et al. in prep). The Bayesian state-space framework models are powerful tools for time series analysis, as they can allow accounting for both process error (environmental year-to-year variation) and observation (or reporting) error simultaneously. Moreover, the Bayesian posterior for the estimated population reduction decline provides a natural way to assign probabilities of that the rate of size reduction decrease falling falls within each of the Red Listing categories. For this purpose, we developed an easy to interpret graph, in which the posterior of the reduction estimates is plotted against the IUCN Red List criteria for each threat category. One of the main motivations for developing JARA was to provide a generalized and widely applicable tool that allows incorporation of both process and uncertainty into Red Listing assessment process based on population decline.

Reports:

1. Kyne PM, Barreto R, Carlson J, Fernando D, Francis MP, Fordham S, Jabado RW, Liu KM, Marshall A, Pacoureau N, Romanov E, Sherley RB & Winker H (2019). Pteroplatytrygon violacea (Pelagic Stingray). The IUCN Red List of Threatened Species 2019: e.T161731A896169
2. Rigby CL Barreto R, Carlson J, Fernando D, Fordham S, Francis MP, Jabado RW, Liu KM, Marshall, A, Pacoureau N, Romanov E, Sherley RB & Winker H (2019). Isurus oxyrinchus (Shortfin mako). The IUCN Red List of Threatened Species 2019: e.T39341A2903170.
3. Rigby CL Barreto R, Carlson J, Fernando D, Fordham S, Francis MP, Jabado RW, Liu KM, Marshall, A, Pacoureau N, Romanov E, Sherley RB & Winker H (2019). Isurus

paucus (Longfin mako). The IUCN Red List of Threatened Species 2019: e.T60225A3095898.
4. Cliff G, Bennett R, Da Silva C, Ebert DA, Fennessy S, Fernando S, Gledhill K, Jabado RW, Kuguru B, Leslie, R McCord ME, Samoilys M & Winker H (2019). Squatina africana. The IUCN Red List of Threatened Species 2019: e.T44996A113073072.

7.3.3. DFFE South Africa has partnered with Stellenbosch University Department of Genetics and the Wild Oceans Shark Conservation Programme to undertake large scale genetic sampling of Requiem sharks caught in South African Large Pelagic longline sector. The overall aim of the project is to identify the key requiem sharks caught by this sector historically reported as bronze whaler sharks. This data will be used to address historical datasets. In addition, next generation sequencing technologies will be used to identify cryptic shark species occasionally caught by this fleet and species identification from confiscated fin consignment.

7.4. National research programs on oceanic whitetip sharks

South Africa does not currently have any research programs on oceanic whitetip sharks as catches are negligible. In 2020, there were no observed catches of oceanic whitetip sharks.

7.5. National research programs on marine turtles

South Africa does not currently have any research programs on marine turtles as catches are negligible. In 2020, there were 7 observed interactions with marine turtles (4 Leatherback turtle, 2 Loggerhead and 1 Green), all of which were released alive.

7.6. National research programs on thresher shark

South Africa is currently involved in the IOTC research program that investigates post-release mortality of bigeye thresher sharks through the deployment of PSAT tags using observers on longline vessels.

8. IMPLEMENTATION OF SCIENTIFIC COMMITTEE RECOMMENDATIONS AND RESOLUTIONS OF THE IOTC RELEVANT TO THE SC.

Table 9. Scientific requirements contained in Resolutions of the Commission, adopted between 2012 and 2020.

Res. No.	Resolution	Scientific requirement	CPC progress
11/04	On a regional observer scheme	Paragraph 9	100% observer coverage is achieved on foreign flagged fishing vessels. The observer programme for domestic vessels expired in 2011 and the Department is currently in the process of re-establishing the programme which would require at least 5% coverage of domestic longline (at-sea observer coverage) and Tuna Pole-line (port observer coverage) fishing trips.
12/04	On the conservation of marine turtles	Paragraphs 3, 4, 6–10	The use of circle hooks is encouraged as stated in the permit conditions. The South African Government has worked closely with WWF to educate skippers on release procedures for turtles. According to the handling and release instructions provided

Res. No.	Resolution	Scientific requirement	CPC progress
			to vessels in their permit conditions, vessels are required, amongst others, to: • Remove the hook using a long-handled de-hooker on turtles too large to bring onboard and a de-hooker on turtles brought onboard. • Use a line-cutter when a de-hooker is not possible and to cut the line as close to the hook as possible. • Use net to bring the turtle onboard and to avoid pulling on the line. • Handle the turtle with gentle care. Release the turtle headfirst and away from fishing gear once it has recovered onboard. Trained observers are present on all foreign-flagged longline vessels and they record all interactions with marine turtles during the fishing operation. Since 2013, all vessels have been required to record interactions with marine turtles in their logbooks, and each vessel has been given a species guide to aid identification of turtles to species level.
12/06	On reducing the incidental bycatch of seabirds in longline fisheries.	Paragraphs 3–7	The start and completion of line setting has to be conducted at night, defined by the period between nautical dusk and nautical dawn. Vessels must fly a bird-scaring line (tori line) during the setting of each longline. • Instruction on the method of tori line construction and deployment is provided to each vessel to ensure that correct specifications and procedures are followed. Deck lighting is to be kept to a minimum. The beams of deck lights must be directed towards the deck. All bait must be appropriately thawed, and where necessary, the swim bladder punctured to ensure rapid sinking of the bait. All birds caught have to be brought onboard and, with the use of the release instructions provided, live birds are to be released. • The release instructions clearly outline the procedures to follow to ensure that a seabird has a good chance of survival after release. The NPOA-Seabirds was gazetted in 2008. The NPOA-SEABIRDS (2008) specifies a maximum bycatch rate of 0.05 birds/1000 hooks. Within this plan an initial seabird

Res. No.	Resolution	Scientific requirement	CPC progress
			bycatch limit of 25 birds killed per year is set per vessel. Once the vessel reaches this limit then: • a second tori line has to be flown and, • branch lines (snoods) have to be weighted by placing 60 g weights within 2 m of the hook to ensure optimal sinking rates. Where multiple weights are used then the first weight should be within 2 m of the hook and the last weight within 3 m of the hook. If a vessel reaches 50 birds killed in a year then the vessel has to stop fishing immediately. If the vessel has complied with all mitigation measures 100% of the time then it will be allowed to fish on condition that a trained onboard observer has to be present to investigate the nature of the high seabird mortality and that instructions given by the observer will be followed.
12/09	On the conservation of thresher sharks (family alopiidae) caught in association with fisheries in the IOTC area of competence	Paragraphs 4–8	Thresher sharks are not permitted to be retained; this is stated in the permit conditions.
13/04	On the conservation of cetaceans	Paragraphs 7– 9	There have been minimal encounters (i.e. incidental captures) with cetaceans by the longline vessels. South Africa will endeavour to have all skippers and onboard observers collect data on all encounters with cetaceans.
13/05	On the conservation of whale sharks (*Rhincodon typus*)	Paragraphs 7– 9	There have been no recorded encounters (i.e. incidental captures) with whale sharks by the longline vessels. South Africa will endeavour to have all skippers and onboard observers collect data on all encounters with whale sharks.
13/06	On a scientific and management framework on the conservation of shark species caught in association with IOTC managed fisheries	Paragraph 5–6	South Africa's NPOA-Sharks (2013) has grouped issues facing each fishery into clusters with proposed actions, responsibilities, priorities and timeframes (Pg 19-30 of the NPOA-Sharks, 2013)
15/01	On the recording of catch and effort by fishing vessels in the IOTC area of competence	Paragraphs 1–10	All Large Pelagic Longline and Tuna Pole-line vessels are required to complete a logbook of catch and effort and submit this on a monthly basis to the Department.
15/02	Mandatory statistical reporting requirements for IOTC Contracting Parties and Cooperating Non-Contracting Parties (CPCs)	Paragraphs 1–7	South Africa submits nominal catch data and catch and effort data for surface and longline fisheries. Size data are collected through the observer program and port sampling. Fleet characteristics are submitted annually.
17/05	On the conservation of sharks caught in association with fisheries managed by IOTC	Paragraphs 6, 9, 11	The following permit conditions (6.1) regulate shark catches in the South African Large Pelagic longline fishery:

Res. No.	Resolution	Scientific requirement	CPC progress
			(b) Targeting of sharks is prohibited. Targeting is defined as landing 50% or more sharks per fishing season in terms of landed total mass. (c) The Permit Holder is restricted to landings of less than 60% sharks in terms of landed total mass in any quarter. If quarterly landings exceed 60%, the Permit Holder will be required to have 100% observer coverage for the remainder of the fishing season. (d) A Precautionary Upper Catch Limit (PUCL) applies to the total landed shark mass. (e) Once 80% of the PUCL has been caught, the remaining 20% of the PUCL shall be subdivided equally among active right holders. This PUCL will, in line with the prohibition on targeting of sharks, be reduced seasonally over a five-year period. (f) Once the PUCL has been reached, no pelagic sharks shall be landed, and fishing will only be allowed with the presence of an onboard Observer. (g) Thresher sharks belonging to the genus Alopias, hammerhead sharks (belonging to genus Sphyrna), oceanic whitetip sharks, porbeagle sharks, dusky sharks and silky sharks shall not be retained on board the vessel. The Permit Holder shall encourage the crew to release live sharks. (i) Fins may not be removed from the shark trunks (i.e. headed, gutted). Fins are to be kept attached to the specific trunk either through a partial cut and folded over or tethered to the trunk via a cord (any loop in the cord shall not exceed approximately 8 cm in diameter and shall follow similar specifications to permit condition 21.1 (b)).
18/02	On management measures for the conservation of blue shark caught in association with IOTC fisheries	Paragraphs 2-5	The following permit conditions (6.1) regulate shark catches in the South African Large Pelagic Longline sector: (b) Targeting of sharks is prohibited. Targeting is defined as landing 50% or more sharks per fishing season in terms of landed total mass. (c) The Permit Holder is restricted to landings of less than 60% sharks in terms of landed total mass in any quarter. If quarterly landings exceed 60%, the Permit Holder will be required to have 100% observer coverage for the remainder of the fishing season. (d) A Precautionary Upper Catch Limit (PUCL) applies to the total landed shark mass.

Res. No.	Resolution	Scientific requirement	CPC progress
			(e) Once 80% of the PUCL has been caught, the remaining 20% of the PUCL shall be subdivided equally among active right holders. This PUCL will, in line with the prohibition on targeting of sharks, be reduced seasonally over a five-year period. (f) Once the PUCL has been reached, no pelagic sharks shall be landed, and fishing will only be allowed with the presence of an onboard Observer. (g) Thresher sharks belonging to the genus Alopias, hammerhead sharks (belonging to genus Sphyrna), oceanic whitetip sharks, porbeagle sharks, dusky sharks and silky sharks shall not be retained on board the vessel. The Permit Holder shall encourage the crew to release live sharks. (i) Fins may not be removed from the shark trunks (i.e. headed, gutted). Fins are to be kept attached to the specific trunk either through a partial cut and folded over or tethered to the trunk via a cord (any loop in the cord shall not exceed approximately 8 cm in diameter and shall follow similar specifications to permit condition 21.1 (b)).
18/05	On management measures for the conservation of the Billfishes: Striped marlin, black marlin, blue marlin and Indo-Pacific sailfish	Paragraphs 7 – 11	Catches of marlin species (Striped Marlin, Black Marlin, Blue Marlin and Indo-pacific Sailfish) in the South African large pelagic longline remains low (< 10 tons per annum for all species combined). The following permit conditions aim to further reduce catches for these species: 6.1 (a) - Billfishes of the genera Makaira, Tetrapturus, Istiophorus are designated as secondary species. 6.1 (h) - Marlins (Black, Blue, Stripped and White) shall not be retained on board the vessel, West of 20 degrees. The Permit Holder shall encourage the crew to release live marlins. 6.3 – The catching of ……. and marlins less than 120cm LJFL or less than 90 cm PFL is prohibited. No discarding of dead marlins is permitted.
18/07	On measures applicable in case of non-fulfilment of reporting obligations in the IOTC	Paragraphs 1, 4	South Africa submits nominal catch data and catch and effort data for surface and longline fisheries. Size data are collected through the observer program and port sampling. Fleet characteristics are submitted annually. 100% observer coverage is achieved on joint-venture foreign flagged vessels. Local vessels are required to take observers throughout the year, with a target of 20% observer coverage. The Department is currently in the process of re-

Res. No.	Resolution	Scientific requirement	CPC progress
			establishing the formal observer programme which would require at least 20% coverage of domestic longline (at-sea observer coverage) and Tuna Pole-line (port observer coverage) fishing trips. All Large Pelagic Longline and Tuna Pole-line vessels shall be fitted with a functional vessel monitoring system (VMS). The permit holder shall ensure the VMS is fully functional and continues to transmit to the Department's Operations room. Whilst at sea, the VMS shall report without interruption.
19/01	On an Interim Plan for Rebuilding the Indian Ocean Yellowfin Tuna Stock in the IOTC Area of Competence	Paragraph 22	South Africa has never exceeded 5,000 MT of yellowfin tuna landings since the inception of its tuna fisheries. South Africa only operates Longline and Pole-line vessels within the IOTC Area of Competence.
19/03	On the Conservation of Mobulid Rays Caught in Association with Fisheries in the IOTC Area of Competence	Paragraph 11	South African does not have a gillnet or purse seine.

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