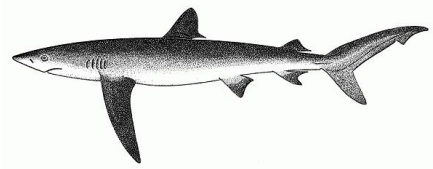
DRAFT EXECUTIVE SUMMARY: BLUE SHARK

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi



Status of the Indian Ocean blue shark (BSH: *Prionace glauca*)

TABLE 1. Blue shark: Status of blue shark (*Prionace glauca*) in the Indian Ocean.

Area[1]	Indicators		2015 stock status determination
Indian Ocean	Reported catch 2014[1]:	30,012 t	
	Not elsewhere included (nei) sharks[2]:	39,820 t	
	Average reported catch 2010–2014:	28,888 t	
	Not elsewhere included (nei) sharks[2]:	47,252 t	
	MSY (1,000 t) (80% CI):	Unknown	
	F_{MSY} (80% CI):	Unknown	
	SB_{MSY} (1,000 t) (80% CI):	Unknown	
	F_{2014}/F_{MSY} (range):	(0.44–4.84)[3]	
	SB_{2014}/SB_{MSY} (range):	(0.83–1.75)[3]	
	SB_{2014}/SB_0 (range):	Unknown	

[1]Boundaries for the Indian Ocean = IOTC area of competence
[2]Includes all other shark catches reported to the IOTC Secretariat, which may contain this species.

Colour key	Stock overfished($SB_{year}/SB_{MSY}< 1$)	Stock not overfished ($SB_{year}/SB_{MSY}\geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY}> 1$)		
Stock not subject to overfishing ($F_{year}/F_{MSY}\leq 1$)		
Not assessed/Uncertain		

TABLE 2. Blue shark: IUCN threat status of blue shark (*Prionace glauca*) in the Indian Ocean.

Common name	Scientific name	IUCN threat status[2]		
		Global status	WIO	EIO
Blue shark	*Prionace glauca*	Near Threatened	–	–

IUCN = International Union for Conservation of Nature; WIO = Western Indian Ocean; EIO = Eastern Indian Ocean
Sources: IUCN 2007, Stevens 2009

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. There remains considerable uncertainty about the relationship between abundance, CPUE series and total catches over the past decade (Table 1). Three stock assessment models were applied to the blue shark resource in 2015. Two models (SS3 and SRA) produced similar results suggesting the stock is currently subject to overfishing, but not yet overfished, while a third model (BSSPM) suggest the stock was close to MSY levels, but not yet subject to overfishing A best case model could not be selected and so the results represented the range of plausible model runs. The ecological risk assessment (ERA) conducted for the Indian Ocean by the WPEB and SC in 2012 (IOTC–2012–SC15–INF10 Rev_1) consisted of a semi-quantitative risk assessment analysis to evaluate the resilience of shark species to the impact of a given fishery, by combining the biological productivity of the species and its susceptibility to each fishing gear type. Blue sharks received a medium vulnerability ranking (No. 10) in the ERA rank for longline gear because it was estimated as the most productive shark species, but was also characterised by the second highest susceptibility to longline gear. Blue shark was estimated as not being susceptible thus not vulnerable to purse seine gear. The current IUCN threat status of 'Near Threatened' applies to blue sharks globally (Table 2). Information available on this species has been improving in recent years. Blue sharks are commonly taken by a range of fisheries in the Indian Ocean and in some areas they are fished in their nursery grounds. Because of their life history characteristics – they are relatively long lived (20–25 years), mature relatively late (at 4–6 years), and have relativity few offspring (25–50 pups every year), the blue shark is vulnerable to overfishing. However, blue shark assessments in the Atlantic and Pacific oceans seem to indicate that blue shark stocks can sustain relatively high fishing pressure.

[1] Nominal catch numbers have been updated since the working party meeting
[2] The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only

On the weight-of-evidence available in 2015, the stock status is determined to be **uncertain** (Table 1). However, total catches of this species should not exceed 2014 levels, while efforts are made to further evaluate stock status.

Outlook. Increasing effort could result in declines in biomass. The impact of piracy in the western Indian Ocean has resulted in the displacement and subsequent concentration of a substantial portion of longline fishing effort into certain areas in the southern and eastern Indian Ocean. It is therefore unlikely that catch and effort on blue shark will decline in these areas in the near future, and may result in localised depletion.

Management advice. A precautionary approach to the management of blue shark should be considered by the Commission, by ensuring that future catches do not exceed current catches. The stock should be closely monitored. Mechanisms need to be developed by the Commission to improve current statistics by encouraging CPCs to comply with their recording and reporting requirement on sharks, so as to better inform scientific advice.

The following key points should be noted:

- **Maximum Sustainable Yield (MSY)**: estimate for the whole Indian Ocean is unknown.
- **Reference points**: The Commission has not adopted reference points or harvest control rules for any shark species.
- **Main fishing gear** (2011–14): Longline
- **Main fleets** (2011–14): Indonesia; EU,Spain; Japan, Sri Lanka; Taiwan,China; EU,Portugal.

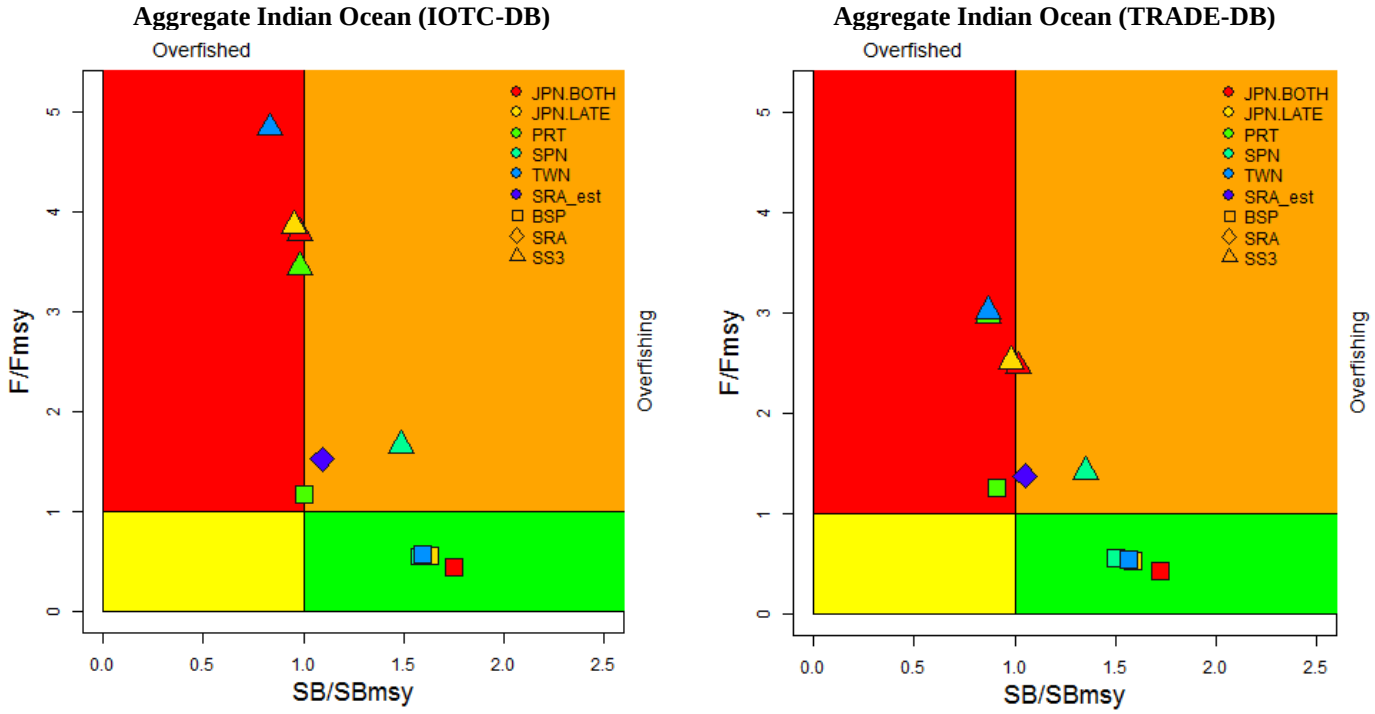


Fig. 1. Blue shark: Aggregated Indian Ocean stock assessment Kobe plot for the 2014 estimate based on a range of models explored with steepness = 0.5, and fits to CPUE series. Note that these are for different datasets, namely the IOTC DB and Trade based datasets (IOTC DB: left panel and TRADE DB: right panel). SS3: Stock Synthesis III; SRA: Stock Reduction Analysis; BSP: Bayesian State-Space Production Model.

Table 3a. Blue shark: Aggregated Indian Ocean assessment Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based reference points for nine constant catch projections using IOTC DB (average catch level from 2012–14 (31,759 t), ± 10%, ± 20%, ± 30% and ± 40%) projected for 3 and 10 years. **Note: K2MSM projections were not run due to large uncertainty in catch estimates.**

Reference point and projection timeframe	**Alternative catch projections (relative to the average catch level from 2012–2014, 31,759 t) and probability (%) of violating MSY-based target reference points ($B_{targ} = B_{MSY}$; $F_{targ} = F_{MSY}$)**								
	60% (19,055t)	**70%** (22,231 t)	**80%** (25,407 t)	**90%** (28,583 t)	**100%** (31,759 t)	**110%** (34,935 t)	**120%** (38,110 t)	**130%** (41,286 t)	**140%** (44,462 t)
$B_{2017} < B_{MSY}$	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
$F_{2017} > F_{MSY}$	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

$B_{2024} < B_{MSY}$	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
$F_{2024} > F_{MSY}$	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

Table 3b. Blue shark: Aggregated Indian Ocean assessment Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based reference points for nine constant catch projections using TRADE DB (average catch level from 2012–14 (134,212 t), ± 10%, ± 20%, ± 30% and ± 40%) projected for 3 and 10 years. **Note: K2MSM projections were not run due to large uncertainty in catch estimates.**

Reference point and projection timeframe	**Alternative catch projections (relative to the average catch level from 2012–2014, 134,212 t) and probability (%) of violating MSY-based target reference points ($B_{targ} = B_{MSY}$; $F_{targ} = F_{MSY}$)**								
	60% (80,527 t)	**70%** (93,948 t)	**80%** (107,369 t)	**90%** (120,790 t)	**100%** (134,212 t)	**110%** (147,663 t)	**120%** (161,054 t)	**130%** (174,475 t)	**140%** (187,896 t)
$B_{2017} < B_{MSY}$	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
$F_{2017} > F_{MSY}$	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
$B_{2024} < B_{MSY}$	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
$F_{2024} > F_{MSY}$	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

APPENDIX I

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Ecosystems and Bycatch and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Blue shark in the Indian Ocean are currently subject to a number of Conservation and Management Measures adopted by the Commission:

- Resolution 15/01 *on the recording of catch and effort data by fishing vessels in the IOTC area of competence* sets out the minimum logbook requirements for purse seine, longline, gillnet, pole and line, handline and trolling fishing vessels over 24 metres length overall and those under 24 metres if they fish outside the EEZs of their flag States within the IOTC area of competence. As per this Resolution, catch of all sharks must be recorded (retained and discarded).
- Resolution 11/04 *on a Regional Observer Scheme* requires data on blue shark interactions to be recorded by observers and reported to the IOTC within 150 days. The Regional Observer Scheme (ROS) started on 1st July 2010.
- Resolution 05/05 *Concerning the conservation of sharks caught in association with fisheries managed by IOTC* includes minimum reporting requirements for sharks, calls for full utilisation of sharks and includes a ratio of fin-to-body weight for shark fins retained onboard a vessel.
- Resolution 15/02 *Mandatory statistical reporting requirements for IOTC Contracting Parties and Cooperating Non-Contracting Parties (CPCs)* indicated that the provisions, applicable to tuna and tuna-like species, are applicable to shark species.

Extracts from Resolutions 15/01,15/02, 11/04 and 05/05

RESOLUTION 15/01 ON THE RECORDING OF CATCH AND EFFORT DATA BY FISHING VESSELS IN THE IOTC AREA OF COMPETENCE

Para. 1. Each flag CPC shall ensure that all purse seine, longline, gillnet, pole and line, handline and trolling fishing vessels flying its flag and authorized to fish species managed by IOTC be subject to a data recording system.

Para. 10 (start). The Flag State shall provide all the data for any given year to the IOTC Secretariat by June 30th of the following year on an aggregated basis.

RESOLUTION 11/04 ON A REGIONAL OBSERVER SCHEME

Para. 10. Observers shall:

b) Observe and estimate catches as far as possible with a view to identifying catch composition and monitoring discards, by-catches and size frequency

Resolution 15/02 MANDATORY STATISTICAL REPORTING REQUIREMENTS FOR IOTC CONTRACTING PARTIES AND COOPERATING NON-CONTRACTING PARTIES (CPCS)

Para. 2. Estimates of the total catch by species and gear, if possible quarterly, that shall be submitted annually as referred in paragraph 7 (separated, whenever possible, by retained catches in live weight and by discards in live weight or numbers) for all species under the IOTC mandate as well as the most commonly caught elasmobranch species according to records of catches and incidents as established in Resolution 15/01 *on the recording of catch*

and effort data by fishing vessels in the IOTC area of competence (or any subsequent superseding Resolution).

RESOLUTION 05/05 CONCERNING THE CONSERVATION OF SHARKS CAUGHT IN ASSOCIATION WITH FISHERIES MANAGED BY IOTC

Para. 1. CPCs shall annually report data for catches of sharks, in accordance with IOTC data reporting procedures, including available historical data.

Para. 3. CPCs shall take the necessary measures to require that their fishermen fully utilise their entire catches of sharks. Full utilisation is defined as retention by the fishing vessel of all parts of the shark excepting head, guts and skins, to the point of first landing.

FISHERIES INDICATORS

Blue shark: General

Blue shark (*Prionace glauca*) is the most common shark in pelagic oceanic waters throughout the tropical and temperate oceans worldwide (**Fig. 1**). It has one of the widest ranges of all the shark species and may also be found close inshore. Adult blue sharks have no known predators; however, subadults and juveniles may be preyed upon by shortfin makos, great white sharks, and adult blue sharks. Fishing is a major contributor to adult mortality. **Table 3** outlines some of the key life history traits of blue shark in the Indian Ocean.

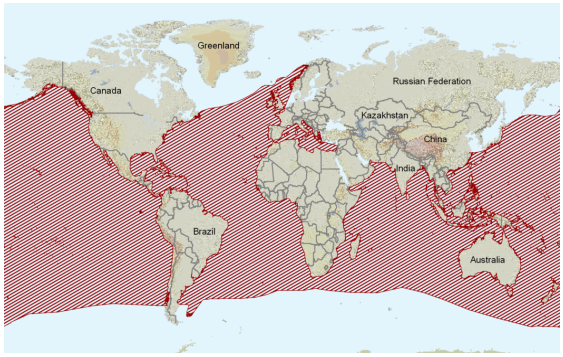


Fig. 1. Blue shark: The worldwide distribution of the blue shark (source: www.iucnredlist.org).

TABLE 3. Blue shark: Biology of Indian Ocean blue shark (*Prionace glauca*).

Parameter	Description
Range and stock structure	In the tropical Indian Ocean, the greatest abundance of blue sharks occurs at depths of 80 to 220 m, in temperatures ranging from 12 to 25°C. The distribution and movements of blue shark are strongly influenced by seasonal variations in water temperature, reproductive condition, and availability of prey. Long-distance movements have been observed for blue sharks, including transoceanic route from Australia to South Africa. The blue shark is often found in large single sex schools containing individuals of similar size. Subtropical waters south of 20°S and temperate waters appear to be nursery grounds where small blue sharks dominate, but where all range of sizes from 55 to 311 cm FL are recorded. In contrast mature fish (FL > 185cm) dominate in the off-shore equatorial waters. Area of overlap with IOTC management area = high. No information is available on stock structure.
Longevity	Bomb radiocarbon dating of Indian Ocean blue sharks showed that males of 270 cm FL may attain 23 years of age. Preliminary data for Indian Ocean shows that male may reach 25 and females 21 years old.
Maturity (50%)	Age: Sexual maturity is attained at about 4–7 years for males and 5–7 years for females. Size: Females mature at 194 cm TL and males at 201 cm TL. In the Atlantic 182–218 cm TL for males; 173–221 cm TL for females. In the South Pacific: 229–235 cm TL for males and 205–229 cm TL for females.
Reproduction	Blue shark is a viviparous species, with a yolk-sac placenta. Once the eggs have been fertilised there is a gestation period of between 9 and 12 months. Litter size is quite variable, ranging from four to 135 pups and may be dependent on the size of the female. The average litter size observed from the Indian Ocean is 38, very similar to the one reported in the Atlantic Ocean, 37. Generation time is about 8–10 years. In Indian Ocean, between latitude 2 ºN and 6 ºS, pregnant females are present for most of the year. • Fecundity: relatively high (25–55) • Generation time: 8–10 years • Gestation Period: 9–12 months • Annual reproductive cycle
Size (length and weight)	Maximum size is around 380 cm FL. New-born pups are around 40 to 51 cm TL. Length–weight relationship for both sexes combined in the Indian Ocean is $TW=0.159*10^{-4} * FL^{2.84554}$.

Sources: Gubanov & Gigor'yev 1975, Pratt 1979, Anderson & Ahmed 1993, ICES 1997, Scomal & Natansen 2003, Mejuto et al. 2005, Francis & Duffy 2005, Mejuto & Garcia-Cortes 2006, IOTC 2007, Matsunaga 2007, Nakano & Stevens 2008, Rabehagosoa et al. 2009, Romanov & Romanova 2009, Anon 2010, Romano & Campana 2011, Jolly et al. 013.

Blue shark: Fisheries

Blue sharks are often targeted by some semi-industrial and artisanal fisheries and are a bycatch of industrial fisheries (pelagic longline tuna and swordfish fisheries and anecdotally in the purse seine fishery). However, in recent years longliners are occasionally targeting this species, due to an increase in its commercial value worldwide. The blue shark appears to have a similar distribution to swordfish. Typically, the fisheries take blue sharks between 180–240 cm FL or 30 to 52 kg. Males are slightly smaller than the females. In other Oceans, angling clubs are known to organise shark fishing competitions where blue sharks and mako sharks are targeted. Sport fisheries for oceanic sharks are apparently not so common in the Indian Ocean.

There is little information on the fisheries prior to the early 1970s, and some countries continue not to collect shark data while others do collect them but do not report it to IOTC. It appears that substantial catches of sharks have gone unrecorded in several countries. Furthermore, many catch records probably under-represent the actual catches of sharks because they do not account for discards (i.e. do not record catches of sharks for which only the fins are kept or of sharks usually discarded because of their size or condition) or they reflect dressed weights instead of live weights. FAO also compiles landings data on elasmobranchs, but the statistics are limited by the lack of species-specific data and data from the major fleets.

The practice of shark finning is considered to be regularly occurring and on the increase for this species (Clarke et al. 2006, Clarke 2008) and the bycatch/release injury rate is unknown but probably high.

Preliminary estimations of at-haulback mortality showed that 24.7% of the blue shark specimens captured in longline fisheries targeting swordfish are captured dead at time of haulback (**Table 4**). Specimen size seems to be a significant factor, with larger specimens having a higher survival at-haulback (Coelho et al. 2011).

TABLE 4. Blue shark: Estimated frequency of occurrence and bycatch mortality in the Indian Ocean pelagic fisheries.

Gears	PS	LL		BB/TROL/HAND	GILL	UNCL
		SWO	TUNA			
Frequency	rare	abundant		rare	unknown	unknown
At vessel mortality	unknown	13 to 51 %	0 to 31%	unknown	unknown	unknown
Post release	unknown	19% (Atlantic)		unknown	unknown	unknown

Sources: Boggs 1992, Romanov 2002, 2008, Diaz & Serafy 2005, Ariz et al. 2006, Peterson et al. 2008, Romanov et al. 2008, Campana et al. 2009, Poisson et al. 2010, Coelho et al. (2011), Coelho et al. (2013a).

Blue shark: Catch trends

The catch estimates for blue shark (**Fig. 2**) are highly uncertain as is their utility in terms of minimum catch estimates. Sixteen CPCs have reported nominal catch data on sharks for the main species listed in Resolution 15/01 (i.e. Australia, Belize, China, EU (France, Spain, Portugal and United Kingdom), India, Indonesia, and I.R. Iran, Japan, Rep. of Korea, Madagascar, Maldives, Mauritius, Philippines, Seychelles, South Africa and Sri Lanka). For CPCs targeting swordfish, blue sharks formed 68% of catches.

Note that the catches recorded for sharks are thought incomplete. The catches of sharks are usually not reported and when they are they might not represent the total catches of this species but simply those retained on board. It is also likely that the amounts recorded refer to weights of processed specimens, not to live weights. In 2014 nineteen countries reported catches of blue sharks in the IOTC area of competence.

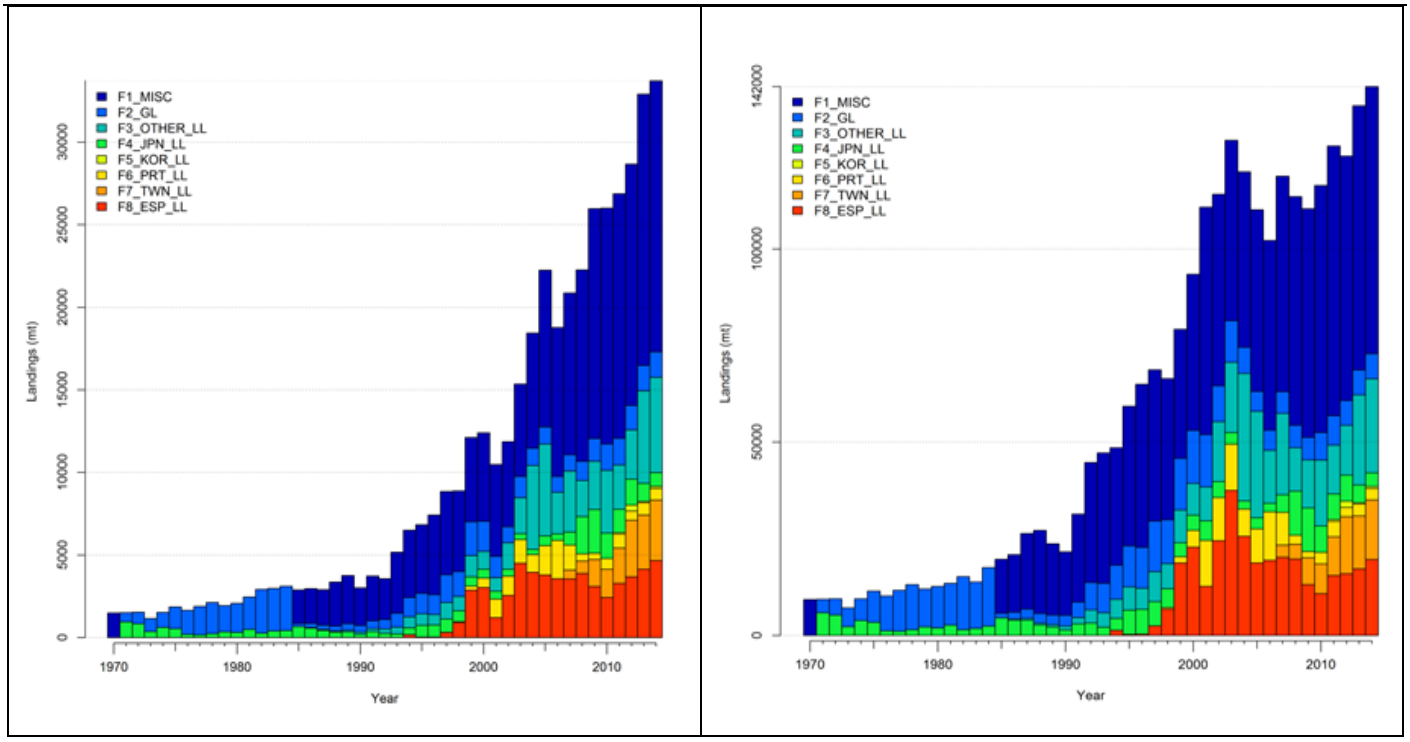


Fig. 2. Blue shark: Total reported catch estimates (Left: IOTC database; Right: Trade data) by fleet from 1970–2014 (MISC = other gears; GL = Gillnet; LL = Longline; JPN = Japan; KOR = Rep. of Korea; PRT = EU,Portugal; TWN = Taiwan,China; ESP = EU,Spain)

Blue shark: Nominal and standardised CPUE Trends

CPUE trends from the EU,Portugal, EU,Spain, Japan and Taiwan,China series were used in the final stock assessment models in 2015:

- EU,Spain (2001–2013) from document IOTC–2015–WPEB11–25.
- EU,Portugal (2000–2014) from document IOTC–2015–WPEB11–26.
- Japan (early 1975–1993; late 1992–2014) from documents IOTC–2015–WPEB11–30 Rev_1, IOTC–2015–WPEB11–51.
- Taiwan,China (2004–2012) from document IOTC–2015–WPEB11–52 Rev_1.

Differing trends were apparent from the standardised CPUE series, even for those fleets operating within the same areas (**Fig. 3**). There remains considerable uncertainty regarding the representativeness of the spatial coverage of the CPUE series that are available and appropriate spatial units for the CPUE standardisation for some fleets.

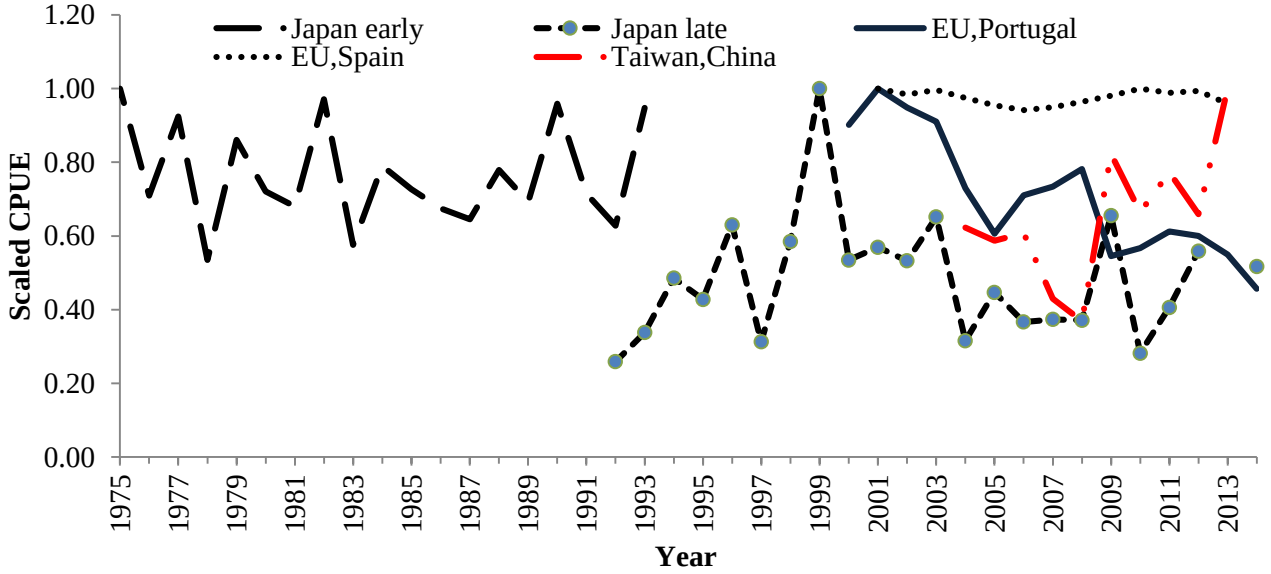


Fig. 3. Blue shark: Comparison of the blue shark standardised CPUE series for the longline fleets of Japan (early, 1975–1993), Japan (late, 1992–2014), EU,Portugal (2000–2014), EU,Spain (2001–2013), and Taiwan,China (2004–2012).

Blue shark: Average length of blue shark catches by fleet

Fig. 4 shows the aggregated fork length frequency distribution for the longline fleets reporting size information on blue sharks for all areas between 2005 and 2014. The data reported for vessels flagged for China, Japan, Rep. of Korea and EU,Portugal include data reported for longline fleets with observers onboard. The results highlight the difference in the selectivity of fleets for different sized specimens, with the EU fleets, on average, selecting larger blue sharks than the other fleets.

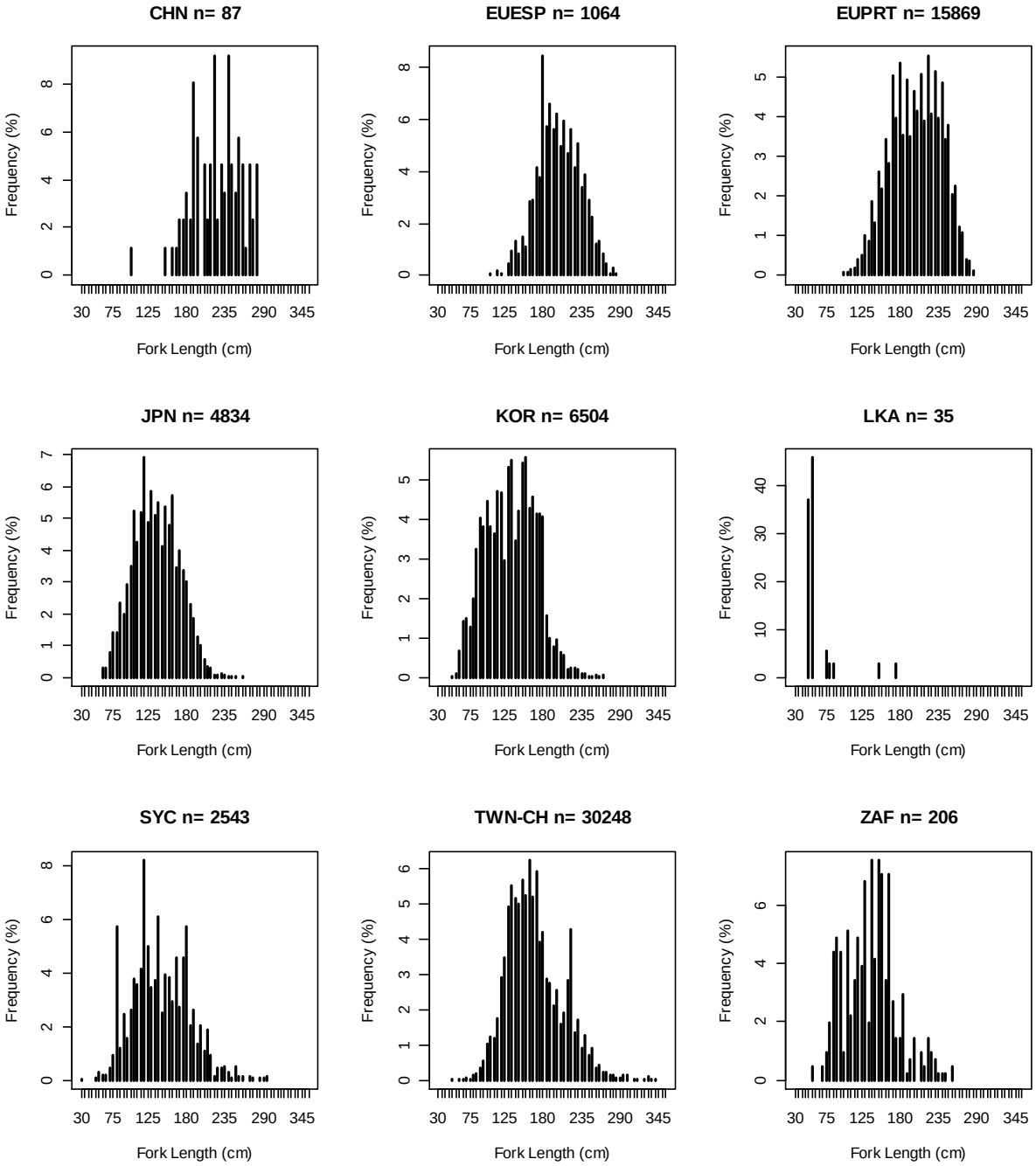


Fig. 4. Fork length frequency distributions (%) of blue shark derived from the samples reported for the longline fleets of China (CHN LL), EU,Spain (EUESP ELL), EU,Portugal (EUPRT ELL), Japan (JPN LL), Korea (KOR LL), Sri Lanka LKA (G/L), Seychelles (SYC LL), Taiwan,China (TWN FLL/LL) and South Africa (ZAF ELL) between 2005 and 2014 in 5 cm length classes.

Blue shark: Number of squares fished

Data not available.

STOCK ASSESSMENT

The first stock assessment of blue shark was carried out in 2015. Three methods were used: (i) a Bayesian State-Space Production Model (BSSPM), (ii) a Stock Reduction Analysis (SRA) and (iii) an integrated Stock Synthesis III (SS3) model. Each model was run using a catch series based on data in the IOTC database and a catch series developed from trade data. Results from each model and catch series are show in **Tables 5**. Given that the standardised CPUE series produced in 2015 were often conflicting, and that the catch series from the IOTC database were not considered realistic, a range of model runs were used to developing relative stock status advice, but not for absolute measures of biomass or yield.

TABLE 5. Blue shark: Indian Ocean-wide summary of key management quantities from the assessments undertaken in 2015, using IOTC data, as the basis for historical catch estimates. Point estimates are the median values across all models.

Management quantity	BSSPM (Doc# 27)	SRA (Doc# 49)	SS3 (Doc# 28 Rev_1)
2014 catch estimate (t)		33,714	
Mean catch from 2010–2014 (t)		29,629	
h (steepness) (base case)	n.a.	n.a.	0.5
MSY (1,000 t) (80% CI; range*)	33.20 (17.14–62.78)*	19.47 (12.1–28.2)	9.53 (4.61–15.64)*
Data period (catch)	1950–2014	1950–2014	1971-2014
CPUE series	LL: Japan; EU,Portugal; EU,Spain; Taiwan,China	n.a.	LL: Japan, EU,Portugal, EU,Spain, Taiwan,China
CPUE period	Japan (1992-2014); EU,Portugal (2000-2014); EU,Spain (2001-2013); Taiwan,China (2004-2014)	n.a.	Japan, early (1971-1992) Japan late (1992-2014) (2013 n.a.) EU,Portugal (2000-2014) EU,Spain (2001-2013) Taiwan,China (2004-2013)
F_{MSY} (80% CI; range*)	0.15 (0.10–0.24)*	0.12 (0.05–0.21)	0.14 (0.06–0.23)*
SB_{MSY} or $*B_{MSY}$ (1,000 t) (80% CI; range*)	226.15 (117.71–331.79)*	n.a.	16.50 (13.30–27.00)*
F_{2014}/F_{MSY} (80% CI; range*)	0.87 (0.30–2.48)*	1.53 (0.51–3.10)	3.53 (1.13–15.68)*
B_{2014}/B_{MSY} (80% CI; range*)	1.31 (0.70–2.15)*	1.09 (0.84–1.36)	n.a.
SB_{2014}/SB_{MSY} (80% CI; range*)	n.a.	n.a.	0.98 (0.58–1.66)*
B_{2014}/B_{1950} (80% CI; range*)	0.66 (0.35–1.08)*	0.55 (0.42–0.68)	n.a.
SB_{2014}/SB_{1971} (80% CI; range*)	n.a.	n.a.	0.42 (0.28–0.65)*
$B_{2014}/B_{1950, F=0}$ (80% CI; range*)	n.a.	n.a.	n.a.
$SB_{2014}/SB_{current, F=0}$ (80% CI; range*)	n.a.	n.a.	n.a.

* 'range' is a minimum and maximum value of models examined. LL = longline; n.a. = not available

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