# YELLOWFIN TUNA (*THUNNUS ALBACARES*)

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## Taxonomy

Yellowfin tuna (*Thunnus albacares*) is a species in the Kingdom Animalia. Yellowfin tuna was named *Thunnus albacares* in 1788 by Pierre Bonnaterre and is one of eight species of the genus *Thunnus* which itself is one of five genera which form the tribe Thunnini (collectively known as the tunas).

**Table 1**. Taxonomic hierarchy and nomenclature (source: ITIS)

| | |
|---|---|
| Kingdom | Animalia |
| Subkingdom | Bilateria |
| Infrakingdom | Deuterostomia |
| Phylum | Chordata |
| Subphylum | Vertebreta |
| Infraphylum | Gnathostomata |
| Superclass | Actinopterygii- ray-finned fishes |
| Class | Teleostei |
| Subclass | Acanthopterygii |
| Superorder | Perciformes - perch-like fishes |
| Order | Scombroidei - tunas, mackerels, bonitos, albacores, ribbonfishes |
| Family | Scombridae |
| Genus | Thunnus |
| Species | Thunnus albacares |

Common names: Yellowfin tuna [English]; albacore [French]; atún de aleta amarilla [Spanish]

Synonyms: There are over forty synonyms for the species (source: WoRMS)

# Distribution & habitat

## Geographic range

A cosmopolitan species distributed mainly in the tropical and subtropical oceanic waters of the three major oceans (**Fig. 1**), where it forms large schools, often associated with floating objects (Chassot et al. 2015). Longline catch data indicates that yellowfin tuna is distributed throughout the entire tropical Indian Ocean.

Archival tagging of yellowfin tuna has shown that this species can dive very deep (over 1000 m) probably to feed on meso-pelagic prey but spends most of the time at the top of the thermocline where phytoplankton production is higher and so epipelagic prey species are more concentrated (Sund et al. 1981, Block et al. 1997, Brill et al. 1999, Schaefer et al. 2009, 2011, Reygondeau et al. 2012).

Sea temperature is thought to be a very important factor limiting the spatial distribution and vertical movements of yellowfin tuna as below 15°C they are unable to control their heart rates resulting in a reduction in cardiac output which explains why they dive daily rather than spending large periods of time at depth (Brill et al. 1998, Brill & Lutcavage 2001, Brill & Bushnell 2001, Galli et al. 2009).

The local environmental and oceanographic conditions are thought to influence the distribution and survivorship of yellowfin tuna in their early life stages more than adults due to the endothermic capabilities which are acquired during these stages for which certain conditions are required meaning their range of habitats are much more confined (Reglero et al. 2014).

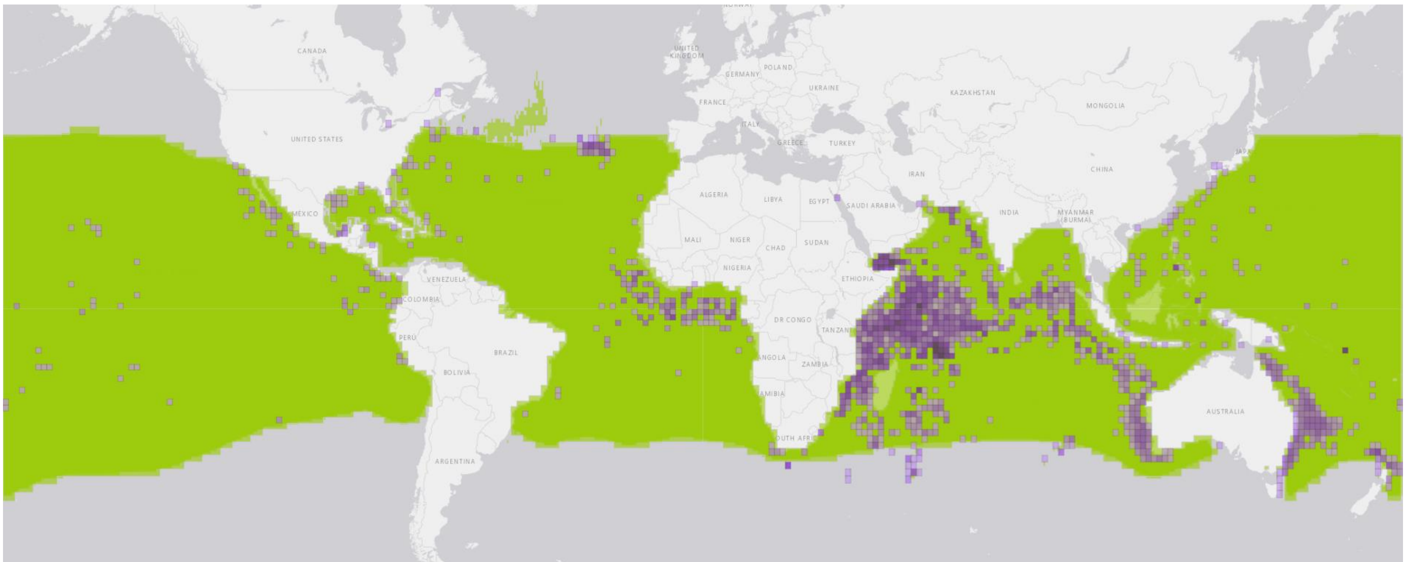


**Fig. 1.** Global distribution of yellowfin tuna according to IUCN expert range maps (green envelope) and observations (purple points) recorded in the Global Biodiversity Information Facility (purple squares). Source: www.mol.org

## Movements & migrations

Yellowfin tuna are a highly migratory species, making extensive migrations across entire oceans, occupying vast pelagic habitats (Block et al. 2011, Schaefer et al. 2015).

The tag recoveries of the RTTP-IO provided evidence of these large movements of yellowfin tuna, thus supporting the assumption of a single stock for the Indian Ocean. The average distance travelled by yellowfin between being tagged and recovered was 710 nautical miles and showed increasing distances as a function of time at sea. However, as the majority of tags were released close to the coasts of Tanzania and Mozambique and were mostly recovered in the western Indian Ocean by purse seiners operating in this region, there is a lack of data from the eastern Indian Ocean. It is unclear if this reflects the low rates of movement between the east and west of the Indian Ocean or if it is due to low reporting rates from fisheries operating in the eastern Indian Ocean (Langley & Million 2012).

**Yellowfin tuna: tagging data**

- A total of 66,543 yellowfin tuna (representing 30% of the total number of fish tagged) were tagged during the Indian Ocean Tuna Tagging Programme (IOTTP). Most of the tagged specimens (82%) were released during the main Regional Tuna Tagging Project-Indian Ocean (RTTP-IO) and were released around Seychelles, in the Mozambique Channel, along the coast of Oman and off the coast of Tanzania, between May 2005 and September 2007 (**Fig. 2**). The remaining specimens were tagged during small-scale tagging projects, and by other institutions with the support of IOTC Secretariat, in Maldives, India, and in the south west and the eastern Indian Ocean.
- To date, around 10,842 specimens (16% of releases for this species), have been recovered and reported to the IOTC Secretariat. More than 86% of these recoveries were made by the purse seine fleets operating in the Indian Ocean, while around 9% were made by pole-and-line and less than 1% by longline vessels. The addition of the data from the past projects in the Maldives (in 1990s) added 3,211 tagged yellowfin tuna to the databases, or which 151 were recovered, mainly from the Maldives.

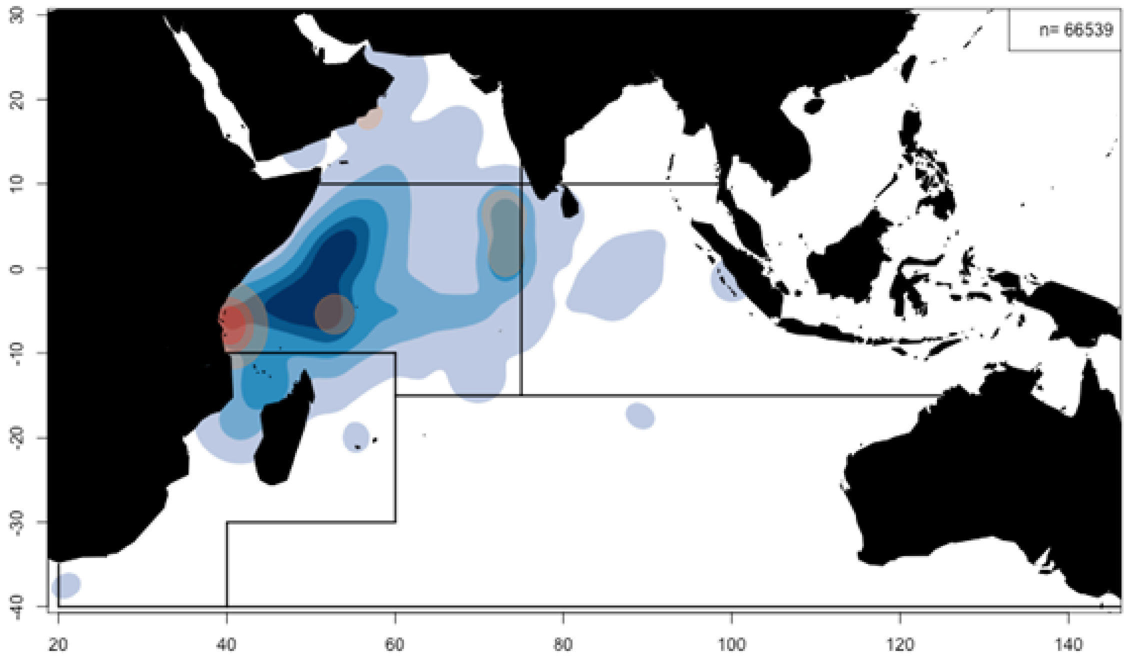


**Fig. 2**. Yellowfin tuna: Densities of releases (in red) and recoveries (in blue). The black line represents the stock assessment areas. Includes specimens tagged during the IOTTP and also Indian Ocean (Maldivian) tagging programmes during the 1990s. Source: Hallier & Million 2012

## Population structure

Numerous studies have been conducted to attempt to determine the population structure of yellowfin tuna both within the Indian Ocean and compared to other oceans. Results from the tagging study supported the hypothesis that there is one single well-mixed yellowfin tuna population in the Indian Ocean (Pecoraro et al. 2017).

However, genetic differentiations have been found between sites in the north-western Indian Ocean in studies using a variety of techniques (Dammannagoda et al. 2008, Kunal et al. 2013). The conclusion resulting from these studies is that there may be different sub-populations present in the northern Indian Ocean. Kunal et al. (2013) analysed the sequence of mtDNA D-loops and found at least three different genetic populations in Indian Ocean waters. These sub-populations could help to explain the fidelity to different spawning areas seen in the Indian Ocean (Pecoraro et al. 2017).

Results from a recent genetic study looking to determine the population structure of yellowfin tuna indicated that there are likely to be at least two genetic groupings in the Indian Ocean with genetic differentiation being most pronounced between groups sampled to the north and south of the equator. There was also some evidence to suggest the presence of two distinct genetic groups in the northern part of the Indian Ocean (Grewe et al. 2020). The study indicated that the Indian Ocean is genetically isolated from both the Atlantic and Pacific Oceans and suggested that this is likely to be the result of environmentally induced physiological barriers to migration (Grewe et al. 2020). The authors stated that analysis of further samples with a wider spatial distribution would be helpful to gain more confidence in these results.

# Biology

## Growth & morphometrics

The maximum recorded size of yellowfin tuna is 240 cm FL and the maximum recorded weight was 200 kg (Anonymous 1994, IGFA 2001).

Estimating yellowfin tuna age and growth parameters is challenging due of a number of issues: otoliths and other hard pieces used for fish aging are less marked in tropical environments compared with temperate waters; reproduction occurs year round making interpretation of otolith readings difficult; and there are several known biases and uncertainties which affect age estimates derived from reading micro-increments in otoliths (Sardenne et al. 2015). A number of different aging procedures have been used to determine yellowfin tuna growth. Most recently, the development of integrated modelling approaches which combine different data sources within a unifying statistical framework have been used to estimate growth in the Indian Ocean (Dortel et al. 2015, Eveson et al. 2015).

The von Bertalanffy model was first used to model yellowfin tuna growth, however, growth studies from the last few decades have provided support for the use of a two-stanza growth model with significant changes in the growth rates between juvenile and adult tunas (Fonteneau & Chassot 2012). In the Indian Ocean, it has been found that an initial slow growth phase with a rate of around 2 cm per month occurs in young yellowfin tuna until they reach the size 56-70 cm FL (Dortel et al. 2015, Eveson et al. 2015). When they reach the size of 145cm FL a second fast growth phase occurs (around 4 cm per month) followed by a progressive decrease of the growth rate at larger sizes (**Fig. 3)**.

There are thought to be differences in growth between male and female yellowfin tuna in all oceans with an increasing proportion of males making up the larger size classes (Capisano 1991, Schaefer 1998). In the Indian Ocean, males have been found to become dominant in the 145-154 cm FL size class while females dominate the 115-130 cm FL size class (Nootmorn et al. 2005, Zhu et al. 2008, Zudaire et al. 2013).

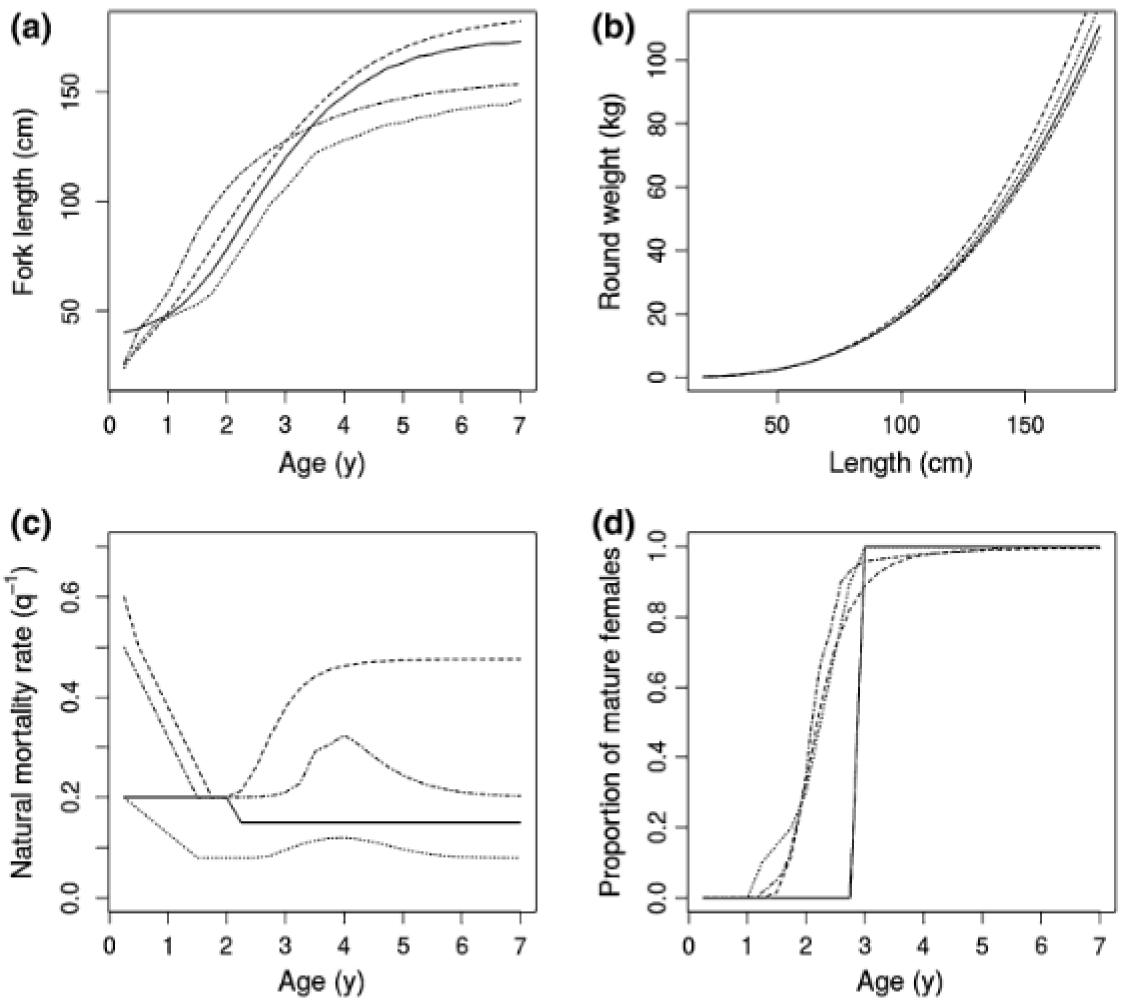


**Fig. 3.** Biological parameters currently used in stock assessments models of yellowfin (a) growth rate, (b) length-weight relationship, (c) natural mortality rates, (d) proportion of mature females. Different line types represent each Ocean: Atlantic Ocean (solid), Indian Ocean (dotted), Eastern Pacific Ocean (dashed), Western Pacific Ocean (dot-dash). Source: Pecoraro et al. 2017

Yellowfin tuna have several morphological characteristics which enable their enhanced swimming performance (Magnuson 1979, Brill & Bushnell 1991, Brill 1996). The fusiform and elongated body shape improves movement through the water and minimises hydrodynamic lift. The caudal peduncle includes three sets of bony keels that reduce drag and the anterior localisation of the muscle mass and insertion of myotomes over a greater number of vertebrae all contribute to yellowfin tuna's great ability to swim at high speeds for sustained periods of time (Westneat & Wainwright 2001).

## Reproduction

Yellowfin tuna is an iteroparous, gonochoristic and oviparous species (Pecoraro et al. 2017). The size at which 50% of the yellowfin tuna population reaches maturity ($L_{50}$) varies between oceans and is thought to relate to relevant environmental cues (Pecoraro et al. 2017). In the western Indian Ocean $L_{50}$ for females has been estimated at between 75-114 cm FL with the estimates varying due to different thresholds being taken to determine whether an individual has reached maturity (e.g., when displaying advanced vitellogenic oocytes or cortical alveolar stage oocytes) (Zhu et al. 2008, Zudaire et al. 2013). The age that 50% of females have reached maturity is estimated at 2.3 years of age (Zudaire et al. 2013, 2016, Grande et al. 2014).

While there is some seasonality in spawning, reproduction of yellowfin tuna occurs year round (Pecoraro et al. 2017). Spawning is thought to occur mainly between November and February in areas where surface temperature exceeds 24°C (Schaefer 2001, Stéquert et al. 2001, Zudaire et al. 2013). Spawning occurs mainly from December to March in the equatorial area (0-10°S), with the main spawning grounds west of 75°E (Schaefer 2001, Nootmorn et al. 2005, Zhu et al. 2008). Secondary spawning grounds exist off Sri Lanka and the Mozambique Channel and in the eastern Indian Ocean off Australia (Chassot et al. 2019). The relative importance of different spawning areas on total catches as well as the degree of connectivity and mixing rates of yellowfin tuna are still unknown for the Indian Ocean.

Fecundity is thought to relate only to the mass-at-age of the sexually mature portion of the stock, regardless of the demographic composition of adults and so is not accounted for when estimating reproductive potential in stock assessments (Kell et al. 2016). Fecundity of yellowfin tuna has been estimated at around 76 eggs/g (±40) but the number of eggs released may depend not only on body size, but also on recent energy intake by individuals (Zudaire et al. 2013, 2016, Grande et al. 2014). Spawning frequency is not known for tunas in the Indian Ocean but data from the Pacific Ocean indicate a close to daily frequency (every 1.1-2 days for yellowfin tuna) (Hunter et al. 1986, McPherson 1991, Schaefer 1996, Itano 2000, Sun et al. 2013).

Tropical tunas are thought to mostly be recruited into the purse seine fishery at sizes around 30 cm FL before they reach the first stages of maturity and recruitment to the fishery is thought to be influenced by a number of environmental and oceanographic factors (Chassot et al. 2019). Lan et al. (2020) investigated the relationship between catch rates by longline fleets in the Indian Ocean and climatic variability and found that sea surface temperature was the most influential environmental variable for recruitment, but that Chl-a is not a significant factor. The same study found that there was a greater variance in the influence of Indian Ocean Dipoles than that of ENSO events with the influence of ENSO events only being evident near the Arabian Sea. Positive Indian Ocean Dipole and El Niño events were found to result in lower catch rates in the northwestern Indian Ocean (Lan et al. 2020).

## Natural Mortality

The relationship between body size/age and natural mortality in tunas is generally assumed to decrease or follow a U-shaped relationship but there is thought to be a high level of variability between stocks of yellowfin tuna based on recent stock assessments (Hampton 2000). Mark-recapture experiments have been used to derive estimates of natural mortality but it is difficult to determine the contribution of natural mortality to total mortality affecting tuna stocks when selectivity patterns are considered (Pecoraro et al. 2017). Other issues resulting from these studies include the fact that low recovery rates of tagged individuals can cause biases with these data (Carruthers et al. 2014) and the time required for complete mixing of tagged individuals into the Indian Ocean population makes estimating natural mortality of juvenile yellowfin tuna very challenging (Kolody et al. 2016).

High natural mortality values (up to 0.33 per day) have been found for tuna in the early larval stages due to starvation and predation (Lang et al. 1994, Hampton 2000). Natural mortality during these early stages is thought to relate mostly to the size or age rather than the species of tuna (Hampton 2000, Fonteneau & Pallares 2005).

The longevity of yellowfin tuna in the Indian Ocean has been estimated at between 6-10 years (Kar et al. 2012, Rohit et al. 2012, Kaymaram et al. 2014, Nurdin et al. 2016).

## Trophic ecology

Tunas are opportunistic predators which sit at the top of short food chains (Roger 1994). Yellowfin tuna are considered to be 'energy speculators' due to their high rates of energy turnover in nutrient poor environments including the open ocean (Korsmeyer et al. 1997). They have a varied diet which includes crustaceans, fish, cephalopods and gelatinous organisms (Potier et al 2005). Preferred prey in the Indian Ocean are thought to include the nomeid *Cubiceps pauciradiatus* as well as the swimming crab *Charybdis smithii* (Potier et al. 2004, Zudaire et al. 2015). Habitat utilisation is thought to be strongly influenced by the presence of high prey densities with high prey densities being thought to be responsible for high levels of abundance and a degree of residency of yellowfin tuna (Itano & Holland 2000, Sibert & Hampton 2003, Schaefer & Fuller 2007).

Diet composition of yellowfin tuna is thought to be dependent on the size of the individuals with smaller fish (<40cm FL) feeding mainly on euphasiids and planktonic prey while larger fish (>50 cm FL) feed mainly on fishes, crustaceans and cephalopods (Ménard et al. 2006, Zudaire et al. 2015). These differences are thought to be a result of size associated increases in endothermic capability which allow larger individuals to dive to deeper depths which gives them access to a wider range of prey (Graham et al. 2007, Sardenne et al. 2016).

Yellowfin are thought to feed mostly during the day (displaying higher activity levels between sunrise and sunset) but have also been reported to feed at night (Reintjes & King 1953, Olson & Boggs 1986, Vaske-Júnior et al. 2003).

Analyses from a stable-isotope study conducted on yellowfin tuna in the Indian and Pacific Oceans estimated the average absolute trophic position of yellowfin tuna in the Indian Ocean to be around 2.7 compared with 2.6 for the Pacific Ocean (Lorrain et al. 2015). However, the same study also showed spatial variability in the absolute trophic position found within the Indian Ocean ranging from 2.6-3.0 (Lorrain et al. 2015). These estimates put the species in the tertiary consumer trophic level.

# Fisheries

Yellowfin tuna have been exploited in the Indian Ocean for more than 700 years (Adam 2004). The industrial fishery dates back to 1952 when longliners started operating in the eastern region followed by the western region in 1954 and by 1960s most areas of the Indian Ocean were being exploited (Pecoraro et al. 2017). Taiwanese and South Korean longliners led this initial gradual expansion (Pecoraro et al. 2017).

Catches of yellowfin tuna remained stable between the mid-1950s and the early-1980s, ranging between 30,000 t and 70,000 t, with longliners and gillnetters as the main gear types being used. The purse seine fishery started in the early 1980s following exploratory cruises by Japanese, Mauritian and French purse seiners in the 1970s and then later, large numbers of European purse seine vessels moved to the Indian Ocean from the Atlantic Ocean (Pecoraro et al. 2017). The expansion of this fleet was supported by the development of modern equipment, the increasing use of support vessels and FADs which improved the efficiency of the fishery (Miyake et al. 2010, Pecoraro et al. 2017). Catches increased rapidly in the early-1980s with the arrival of the purse seiners and increased activity of longliners and other fleets, reaching over 400,000 t by 1993.

Landings of yellowfin tuna increased throughout the 1990s, fluctuating around 400,000 t until 2002 after which landings increased further up to a peak of 525,000 t in 2004. In the following years, overall landings decreased significantly due to displacement of effort in the western Indian Ocean as a result of the threat of piracy in this region until the introduction of armed personnel onboard purse seine vessels since 2009 at which point the decline in landings was less pronounced (Chassot et al. 2010). In recent years the effort of all fleets has increased significantly leading to higher landings up to a peak of around 448,000 t in 2019 (IOTC 2021).

Contrary to other oceans, the artisanal fishery component of yellowfin catches in the Indian Ocean are substantial, accounting for catches of around 200,000 t per annum since 2012. The proportion of yellowfin catches from artisanal fisheries has increased from around 30% in 2000 to nearly 50% in recent years (**Fig. 4**).

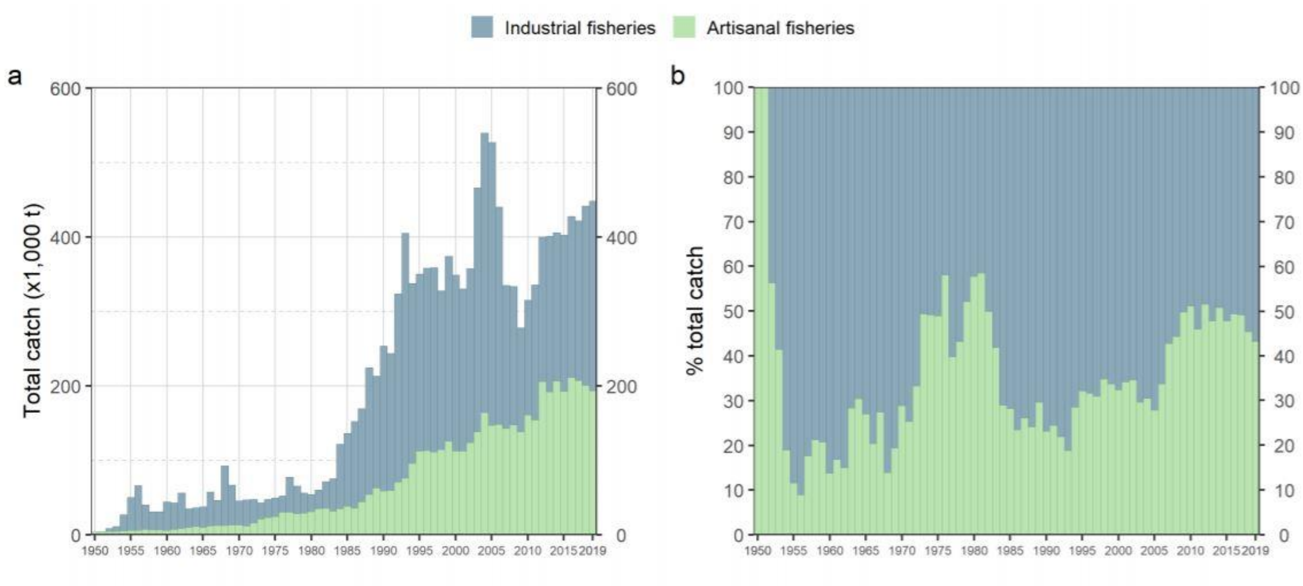


**Fig 4.** Annual time series of cumulative nominal absolute (a) and relative (b) catches of yellowfin tuna by type of fishery in metric tonnes (t) for the period 1950-2019. Source: IOTC 2021

Purse seiners (free and associated schools) and longline fisheries still account for around 36% of total catches, while catches from artisanal gears – namely handline, gillnet, and pole-and-line – have steadily increased since the 1980s (**Fig. 5**) (Pecoraro et al. 2017, IOTC 2021).

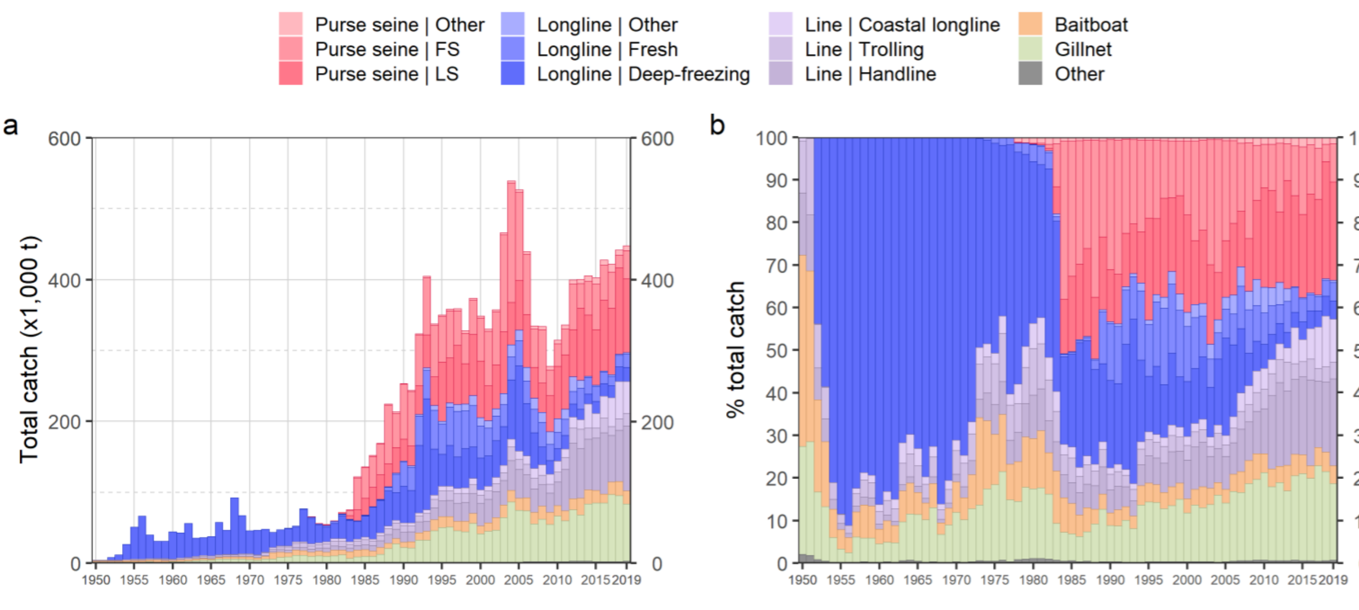


**Fig 5.** Annual time series of cumulative nominal absolute (a) and relative (b) catches of yellowfin tuna in metric tonnes (t) by fishery for the period 1950-2019. LS = schools associated with floating objects; FS = free swimming schools. Source: IOTC 2021

The purse seine fishery is characterized by the use of two different fishing modes: the fishery on floating objects (FADs) catches large numbers of small yellowfin tuna in association with skipjack tuna and juvenile bigeye tuna, compared to the fishery on free swimming schools, which catches larger yellowfin tuna on multi-specific or mono-specific sets. Catches of tuna associated with floating objects represented more than 80% of the total purse seine catch in the Indian Ocean between 2007-2016 (Chassot et al. 2019)

The longline fishery started in the early 1950s and expanded rapidly throughout the Indian Ocean. The longline fishery targets several tuna species in different parts of the Indian Ocean, with yellowfin tuna and bigeye tuna being the main target species in tropical waters. The longline fishery can be subdivided into a deep-freezing longline component (i.e., large scale deep-freezing longliners operating on the high seas from Japan, Korea and Taiwan,China) and a fresh-tuna longline component (i.e., small to medium scale fresh tuna longliners from Indonesia and Taiwan,China).

The size distribution of yellowfin tuna catches varies significantly between gear types (Pecoraro et al. 2017). The sizes exploited in the Indian Ocean range from 30 cm to 180 cm FL. Smaller fish (juveniles) form mixed schools with skipjack tuna and juvenile bigeye tuna and are mainly limited to surface tropical waters, while larger fish are found in surface and sub-surface waters. Small, newly recruited fish are primarily caught by the FAD purse seine fishery. Males are predominant in the catches of larger fish at sizes than 140 cm (this is also the case in other oceans). Intermediate age yellowfin tuna are seldom taken in the industrial fisheries, but are abundant in some artisanal fisheries, mainly in the Arabian Sea. Longliners mostly target larger adult yellowfin tuna (100 cm FL and greater) (Pecoraro et al. 2017).

**Markets**

There are two main tuna product types for catches of industrial fisheries: high value products such as loins and steaks, mostly fish caught by longline fleets; and smaller, lower-quality fish mostly caught by purse seiners and other gears which are sent to canneries.

Fish caught by longline fleets are generally frozen onboard the vessels at -40°C or lower and are exported to Asia, in particular Japan for the high-value sashimi market (Miyake et al. 2010). Chassot et al. (2019) estimated the annual average value of bigeye and yellowfin imports into Japan at more than US$ 54 million globally. Chassot et al. (2019) estimated the annual value of purse seine catches taken just from within the Northern Mozambique Channel region to be around US$ 40 million using Bangkok import prices as a proxy during the period 2009-2019.

The increased demand for canned tuna in the 1950s drove major changes in tuna fisheries globally moving to much more industrial fleets which allowed the species to be exploited more fully over its entire range (Fonteneau 1997, 2010). While there are canneries located in several countries around the Indian Ocean, Seychelles acts as a regional hub for industrial tuna fisheries in the region and so a large proportion of purse seine catches are landed there (Robinson et al. 2006).

Canned tuna is exported around the world to the European Union, United States and Japan among others (Miyake et al. 2010). In these countries, supermarkets comprise a very large proportion of the sales of canned tuna and increasingly, canneries produce products under direct contract with the retailers (Miyake et al. 2010).

There is not thought to be a clear uniformity of prices in the world market for canned yellowfin and bigeye tuna in comparison to skipjack tuna (Bose & McIlgorm 1996, Squires et al. 2006). For the period 1992-2007, the price per kg of large yellowfin tuna in the Indian Ocean represented around 1.54±-0.16 times the price of mixed tuna, while mixed tuna represented 1.52±-0.20 times the price of small skipjack. This price distinction made free-school catches of large yellowfin tuna more valuable than FAD associated mixed fish or small skipjack (Miyake et al. 2010). However, many purse seiners have chosen to focus more on efficiency (the catch quantity per unit of fuel is highest for FAD fishing) and now the majority (80% of purse seine catches) are taken on FADs (Miyake et al. 2010, Chassot et al. 2019).

# Stock status

## Stock status.

In 2018 a stock assessment was carried out for yellowfin tuna in the IOTC area of competence to update the stock status undertaken in 2016. The stock assessment was carried out using Stock Synthesis III (SS3), a fully integrated model that is currently used to provide scientific advice for the three tropical tunas stocks in the Indian Ocean. The model used in 2018 is based on the model developed in 2016 with a series of revisions that were noted during the WPTT. The model uses four types of data: catch, size frequency, tagging and joint longline CPUE indices.

The SS3 stock assessment gave overall similar results to the 2015/2016 assessment but was somewhat more pessimistic than the stock assessment undertaken in 2016 (but similar to the one done in 2015) due to the steeper declining trend of the composite longline CPUE series and sustained large catches in the most recent years. The assessment results were only based on a grid of 24 SS3 model runs which are recognized as insufficient to explore the spectrum of uncertainties and scenarios, noting the large uncertainty associated with data quality (e.g., spatial representativeness of CPUE coverage, estimation of catch and inconsistency in length-frequency) and lack of considering model statistical uncertainty.

Spawning stock biomass in 2017 was estimated to be 30.0% of the unfished levels. According to the information available for the stock assessment, the total catch has remained relatively stable at levels around the estimated MSY since 2012 (i.e., between 390,000 t and 410,000 t). The 2018 stock assessment estimates $SB_{2017}/SB_{MSY}$ at 0.83 (0.74-0.97) and $F_{2017}/F_{MSY}$ at 1.20 (1.00 -1.71). However, it was noted that the quantified uncertainty in stock status is likely underestimating the underlying uncertainty of the assessment. On the weight-of-evidence available in 2018, the yellowfin tuna stock was determined to remain **overfished** and subject to **overfishing** (**Fig. 6**).

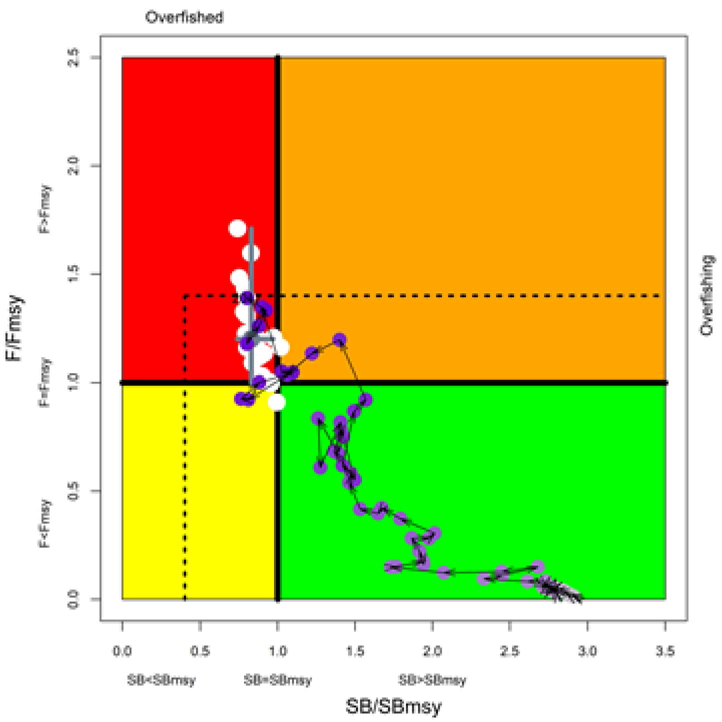


**Fig. 6.** Yellowfin tuna: Stock synthesis Kobe plot. Blue dots indicate the trajectory of the point estimates for the SB/SBMSY ratio and F/FMSY ratio for each year 1950–2017. The grey line represents the 80% confidence interval associated with the 2017 stock status. Dotted black lines are the interim limit reference points adopted by the Commission via Resolution 15/10. The white circles represent 2017 stock status for each grid run.

## Outlook

The increase in catches in recent years has substantially increased the pressure on the Indian Ocean stock, resulting in fishing mortality exceeding the MSY-related levels. There is a high risk of continuing to violate the MSY-based reference points if catches remain at around current levels (≈409,000 t in 2017). However, the projections do not adequately reflect known sources of uncertainty due to a series of issues with data and model performance and should be taken with caution given the issues identified by the IOTC Scientific Committee.

## Management advice

The decline in stock status to below MSY level is not well understood due to various uncertainties. As a precautionary measure, the IOTC Scientific Committee recommended that the Commission should ensure that catches are reduced to end overfishing and allow the SSB to recover to $SSB_{MSY}$ levels. Specific catch limits were not provided.

A workplan was been developed to address the issues identified in the assessment review, aimed at increasing the Committee's ability to provide more concrete and robust advice for future meetings of the Scientific Committee. The workplan was scheduled to start in January 2019 and aimed to addressing the issues identified by the WPTT and the external reviewer. The draft workplan is attached as Appendix 38 of the 2018 Scientific Committee report (IOTC-2018-SC21-R).

The IOTC has an interim plan for the rebuilding the yellowfin stock, with catch limitations based on 2014/2015 levels (Resolution 19/01). Some of the fisheries subject to catch reductions had fully achieved a decrease in catches in 2017 in accordance with the levels of reductions specified in the Resolution; however, these reductions were offset by increases in the catches from CPCs exempt and some CPCs subject to limitations on their catches of yellowfin tuna (see table 3 in IOTC-2018-SC21-R). Thus, the total catches of yellowfin in 2017 increased by around 3% from 2014/2015 levels. The Scientific Committee advised the Commission that they should ensure that any revision of the management measure can effectively achieve any prescribed catch reduction to ensure the effectiveness of the management measure.

The following key points should also be noted from the 2018 assessment:

- **Maximum Sustainable Yield (MSY):** estimate for the Indian Ocean stock is 403,000 t with a range between 339,000-436,000 t (Table 1). The 2013-2017 average catches (399,830 t) were below the estimated MSY level. However, the last two years of catches were slightly higher than the median MSY.
- **Interim reference points**: Noting that the Commission in 2015 agreed to Resolution 15/10 *on target and limit reference points and a decision framework*, the following should be noted:
  - **Fishing mortality**: Current fishing mortality is considered to be 20% above the interim target reference point of $F_{MSY}$, and below the interim limit reference point of 1.4*$F_{MSY}$ (**Fig. 2**).
  - **Biomass**: Current spawning biomass is considered to be 17 % below the interim target reference point of $SB_{MSY}$ and above the interim limit reference point of 0.4*$SB_{MSY}$ (**Fig. 2**).
- **Main fishing gear** (average catches 2013–17): Purse seine ≈35% (FAD associated school ≈23%; free swimming school ≈12%); Longline ≈16%; Gillnet ≈17%; All other gears ≈31% (**Fig. 1**).
- **Main fleets** (average catches 2013–17): European Union ≈22% (EU-Spain ≈14%; EU-France ≈8%); Maldives ≈13%; I.R. Iran ≈11%; Seychelles ≈9%; Sri Lanka ≈9%; All other fleets ≈37%.

A new stock assessment for yellowfin tuna will be conducted in 2021.

# Management Measures

## Conservation and Management Measures

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

- Resolution 19/01 and 18/01 *On an Interim Plan for Rebuilding the Indian Ocean Yellowfin Tuna Stock in the IOTC Area of Competence* set out measures including gear and CPC specific catch reductions required to rebuild the yellowfin tuna Indian Ocean stock
- Resolution 19/05 *On a ban on discards of bigeye tuna, skipjack tuna, yellowfin tuna and non-targeted species caught by purse seine vessels in the IOTC Area of Competence* set out the requirement for purse seiners to retain all catches of bigeye, skipjack and yellowfin tuna except those considered unfit for human consumption and ensure the safe release of any alive non-targeted species or the retention of all dead non-targeted species
- 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.
- Resolution 15/02 *Mandatory statistical reporting requirements for IOTC Contracting Parties and Cooperating Non-Contracting Parties (CPCs)* indicated that the provisions are applicable to tuna and tuna-like species

- Resolution 15/10 *On target and limit reference points and a decision framework* sets out procedures for the SC to follow when setting interim target and limit reference points when assessing stock status and providing recommendations to the Commission including the target and limit reference points for yellowfin tuna of $B_{TARGET}$ = $B_{MSY}$ and $B_{LIM}$ = 0.40 $B_{MSY}$ respectively
- Resolution 14/02 *For the conservation and management of tropical tunas stocks in the IOTC area of competence* states that CPCs shall implement an action plan consisting of the establishment of an allocation system for the main targeted IOTC species and advising on appropriate reporting requirements and data collection systems for artisanal tuna fisheries.
- Resolution 11/04 *On a Regional Observer Scheme* which details the observer programme which should be implemented by CPCs to improve the collection of verified catch data and other scientific data related to fisheries for tuna and tuna-like species in the IOTC Area of Competence

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## Identification guides

Identification of tuna and tuna-like species in the Indian Ocean: https://iotc.org/sites/default/files/documents/2014/04/IOTC_IDTuna_vfinal4%28E%29.pdf

A Handbook for the Identification of Yellowfin and Bigeye Tunas in Fresh Condition: https://static1.squarespace.com/static/52c1c633e4b035d7c738b56a/t/57ae16decd0f683c60a94498/1471026922046/1_BE-YF+ID+Fresh_ENGLISH_v2_logo.pdf

A Handbook for the Identification of Yellowfin and Bigeye Tunas in Brine Frozen Condition: https://static1.squarespace.com/static/52c1c633e4b035d7c738b56a/t/57ae1b94197aeaa4592427f6/1471028122626/2_BE-YF+ID+Frozen_ENGLISH_v5_logo.pdf

A Handbook for the Identification of Yellowfin and Bigeye Tunas in Fresh, but Less Than Ideal Condition: https://static1.squarespace.com/static/52c1c633e4b035d7c738b56a/t/57ae17b3be6594d28d9b3426/1471027174300/3_BE-YF+ID+Less+Ideal_ENGLISH_v6_logo.pdf

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SPC Offshore fish identification cards for small-scale fishermen: http://www.spc.int/DigitalLibrary/Doc/FAME/Manuals/Anon_13_TunaIDCards.pdf

Tuna caught in Indonesian waters: https://static1.squarespace.com/static/52c1c633e4b035d7c738b56a/t/5aaa8b93f9619ada929e0366/1521126295989/Tuna-Types-Caught-in-Indonesian-Waters.pdf

Identification of Atlantic tunas: https://media.fisheries.noaa.gov/dam-migration/identification-of-atlantic-tunas.pdf

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