Action 1.1.1

FISHERY IMPROVEMENT PROJECT

Mahi-Mahi (*Coryphaena hippurus*), Wahoo (*Acanthocybium solandri*), and Cobia (*Rachycentron canadum*) from Indonesian Waters WPP 718, 572 & 573, using Automatic Demersal Longline ("Handline Non-Tuna").

12 JULY 2022

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EXECUTIVE SUMMARY

A review and collation of the available data found catches of 36,695 t for Mahi Mahi, 3,462 t for Wahoo and 2,968 t for Cobia in the Indo-Pacific region. Catch data may be duplicated in some instances (i.e., same data reported to multiple organisations). However, these volumes are more likely to be under-estimates as they are considered as "non-target species" by the *Western Central Pacific Fisheries Commission* and *Indian Ocean Tuna Commission.* Whilst there is a definite paucity of data for Cobia catches in the Indo-Pacific region, this review uncovered bycatch data from several sources, and it is unlikely that any one fishery/nation is catching Cobia in very large volumes and not reporting it.

OBJECTIVES

In order to meet the requirement of Action 1.1.1 and improve the understanding of fishery mortality across the stock range for Mahi mahi, Wahoo and Cobia, the following FIP tasks were completed and compiled in this report.

Action	Tasks/ Milestones	Status
1.1.1 Define fishing mortality for all three UoAs (mahi mahi, cobia and wahoo) across stock range.	Review available catch data for all three UoA species taken by all Indonesian fisheries and close regional fisheries.	Complete. Section 1.
	Estimate of the removals from each stock by Indonesian fisheries other than the sub-fisheries under assessment	Complete Section 2.
	Develop catch-data time series, investigating catch trends for each species over a period of time.	Complete for Mahi Mahi and Wahoo. There is no catch time series data available for Cobia. Section 3.

1. REVIEW OF AVAILABLE CATCH DATA

In order to estimate the annual catch of Mahi Mahi, Wahoo and Cobia caught in and around Indonesia, the following data sources were interrogated:

- *Indonesian Centre of Data, Statistics and Information*
- *Regional Fisheries Management Organisations:*
  - *Western Central Pacific Fisheries Commission(WCPFC)*
  - *Indian Ocean Tuna Commission (IOTC)*
- *FishSource database*
- *Marine Stewardship Council (MSC) certification reports*
- *Fishery Improvement Project (FIP) reports within the Mahi Round Table.*
- *Unit of Assessment catch data.*

INDONESIAN FISHERIES DEPARTMENT

The Ministry of Marine and Fisheries Affairs (MMAF) is responsible for fisheries management in Indonesia through 11 Fisheries Management Areas (FMA), and Indonesia is a member of both the Western and Central Pacific Fisheries Commission (WCPFC) and Indian Ocean Tuna Commission (IOTC).

Prior to 2017, the *Directorate General of Capture Fisheries* was responsible for compiling annual catch estimates (and providing them to relevant RMFOs). Since 2017, the *Center of Data, Statistics and Information* has collected such data. Mahi Mahi (Lemadang), Wahoo (Ono) and Cobia (Badee) are caught by local Indonesian fisheries, although of these, the database only included Lemadang (Mahi Mahi).

Since 2015, Indonesian tuna fisheries have been restricted to the Indonesian EEZ and archipelagic waters (Figure 1; Table 1). As such, the Indonesian catch estimates presented to the WCPFC do not include other waters within the WCPFC Area (Figure 2). However, given the population of the three species includes waters outside of the Indonesian EEZ, catch estimates from the WCPO and Indian Ocean are relevant.

MMAF et al. (2021) provided the WCPFC with a comprehensive review of commercial fisheries operating in Indonesia, and included catch estimates for the three main tuna species (Skipjack, Yellowfin and Bigeye) but did not mention catches of mahi mahi, wahoo or cobia.

Abdi et al. (2022) reported to the FAO on the implementation of e-logbooks for Indonesian fisheries, and outlined the species composition of various gear-types:

- Mahi Mahi: Tuna longlines, Small pelagic purse seine and Large pelagic purse seine
- Wahoo: Tuna longlines, Small pelagic purse seine, boat lift net and drift gillnets.
- Cobia: Drift gillnets

CEA (2018) aggregated the best available data and provided light analysis on Indonesian marine fisheries statistics; unfortunately there was no mention of these three species.

Further catch data was provided by the UoA fishers, including drifting longline catches operating in the Indian Ocean (FAO 57) between 2019 and 2022.

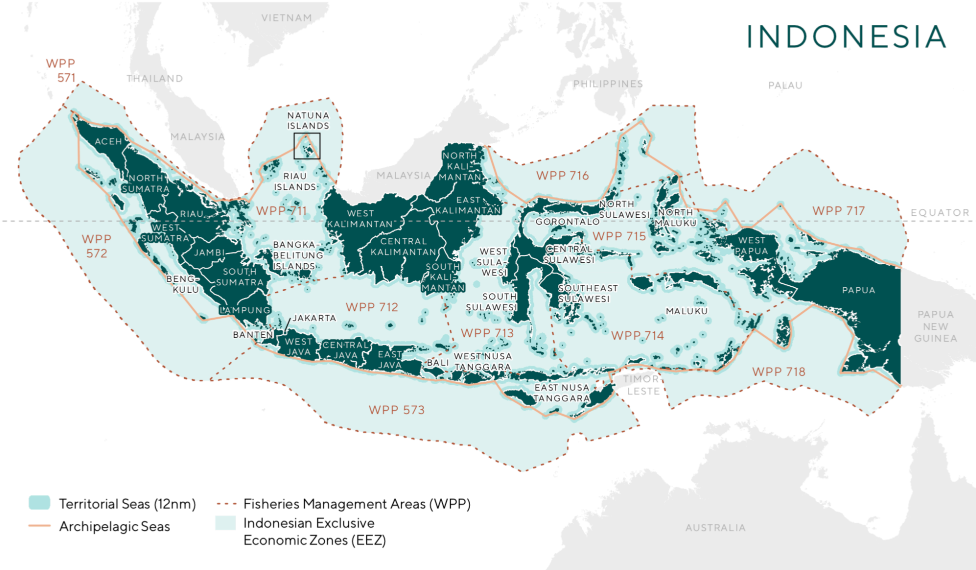

Figure 1. Fishery Management Areas of Indonesia. (Source: CEA 2018) Location names outlined in Table 1.

Table 1. Indonesian Fishery Management Area location names (Source: Pontoh et al. 2021).

FMA Number	Location
571	Malacca Strait – Andaman Sea
572	Indian Ocean (West of Sumatera) – Sunda Strait
573	Indian Ocean (South of Java) – South of Nusa Tenggara – Sawu Sea – West of Timor Sea
711	Karimata Strait – Natuna Island – South China Sea
712	Java Sea
713	Makassar Strait – Bone Bay – Flores Sea – Bali Sea
714	Tolo Bay – Banda Sea
715	Tomini Bay – Maluku Sea – Halmahera Sea – Seram Sea – Berau Bay
716	Sulawesi Sea – North of Halmahera
717	Cendrawasih Bay – Pacific Ocean
718	Aru Sea – Arafuru Sea – East of Timor Sea

FAO - United Nations Food and Agriculture Organisation of the United Nations

FishStatJ is a software database available to download online with annual fishery production data for numerous nations and species over many decades. WCPFC data does not match the data provided to FAO. For example, the Australian WCPO catch of Mahi Mahi in 2020 was 64.7 t, although no data was provided to FAO FishStatJ. As such FAO production data alone is highly likely to be an under-estimate of fishing mortality.

Western Central Pacific Fisheries Commission (WCPFC)

The Western and Central Pacific Fisheries Commission (WCPFC) is responsible for the conservation and management of Highly Migratory Fish Stocks, and the assessment of the impact of fishing on non-target species. There are a number of Conservation and Management Measures (CMMs) that have been implemented for non-target species, including a resolution to encourage avoiding the capture of all non-target fish species and encourage prompt release to the water, unharmed (Resolution 2005-03). Although Mahi Mahi, Wahoo and Cobia are not strictly "target" species, they may be a valuable byproduct and are regularly retained. The CMM most relevant to Mahi Mahi, Wahoo and Cobia involves the observer coverage and recording requirements.

The WCPFC maintains an open resource that focuses on bycatch mitigation and management in tuna and billfish fisheries: Bycatch Management Information System (BMIS). The most recent update of "Public Domain Bycatch Data" (BDEP) is now available, but these three species are not listed as bycatch.

Purse seine

For purse seine operators, CMM 2008-01 introduced a requirement for 100% observer coverage for purse seine operations between 10°S and 10°N from 2010 onwards, with CMM 2007-01 requiring a minimum of 5% observer coverage for purse seine fishing elsewhere. The high rates of available observer coverage offer the possibility of robust estimates of bycatch rates and quantities for non-target species caught in WCPO purse seine fisheries (Peatman et al. 2017; 2021). However, this coverage rate is not distributed evenly among the fisheries and in the WCPFC-Convention Area (CA). Lower observer coverage rates are noticeable in the enclosed high seas pockets and reflects the pre-2010 observer coverage; those pockets were closed from 1 January 2010 and re-opened with a limited number of fishing days from 2013.

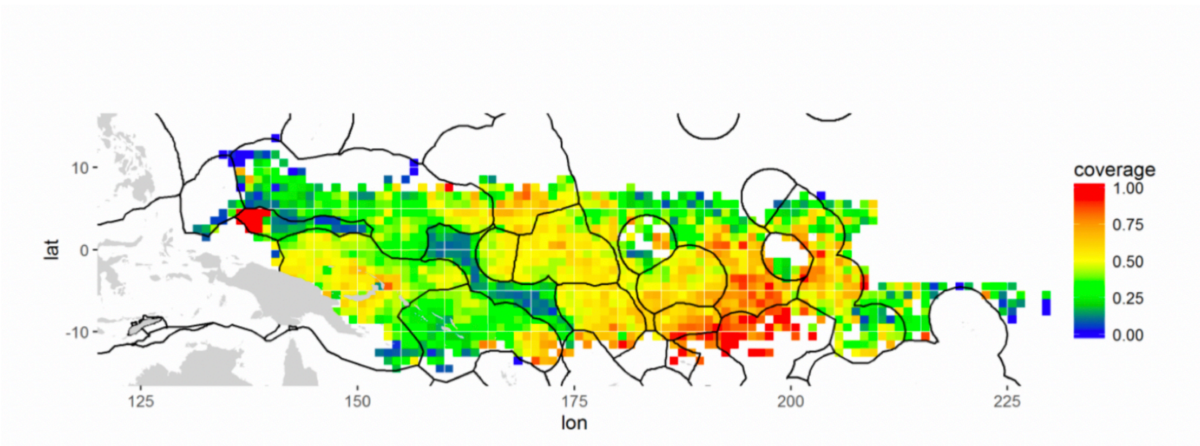

Figure 2. Observer coverage (as a proportion of all set types) of large-scale purse seine fleet I the WCPFC -CA from 2003 to 2015 (Source: Peatman & Nicol (2021))

Observer data suggests that, of the 45 species encountered, there were seven species that occurred in at least 5% of purse seine sets (Figure 3). Mahi Mahi is caught in > 10% of sets, Wahoo < 7% and Cobia is not recorded. The retention rate of bycatch differs by species (Figure 4). Of the 30,151 Mahi Mahi caught under observation, >60% were retained. Wahoo is more regularly discarded by purse seine operations with about 70% of the 18,224 wahoo being discarded.

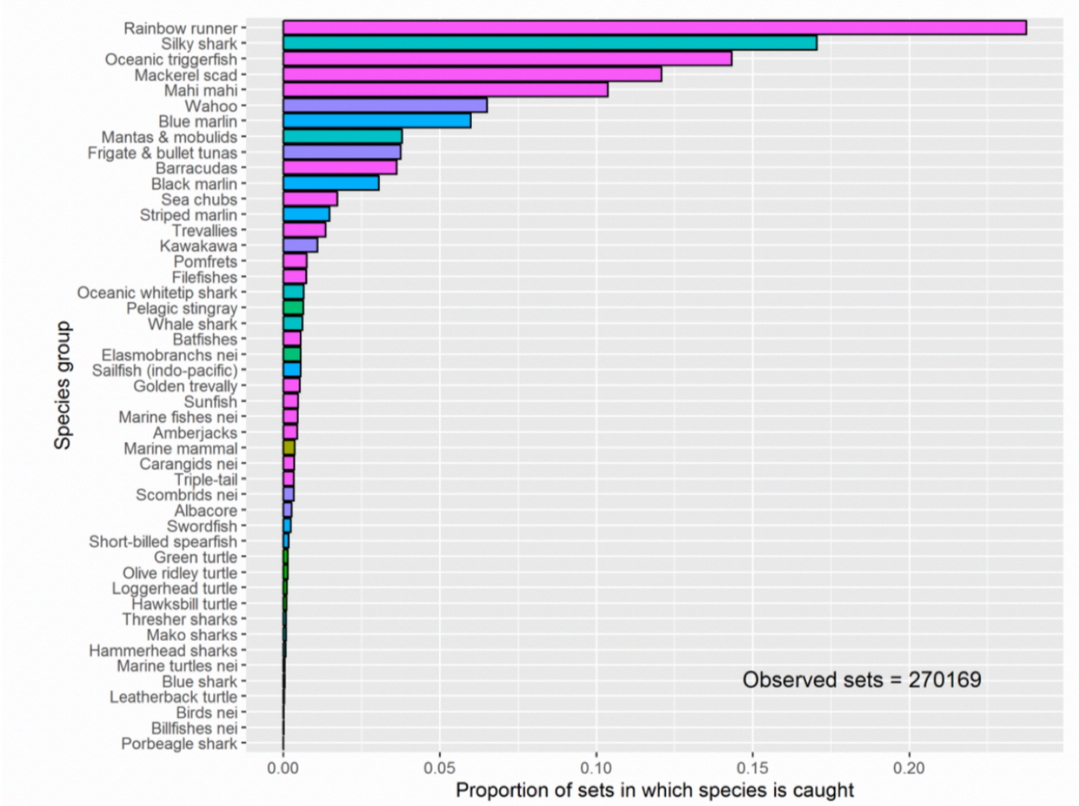

Figure 3. Bycatch species/species group as a proportion of observed purse seine sets in the WCPFC-CA (Peatman & Nicol, 2017).

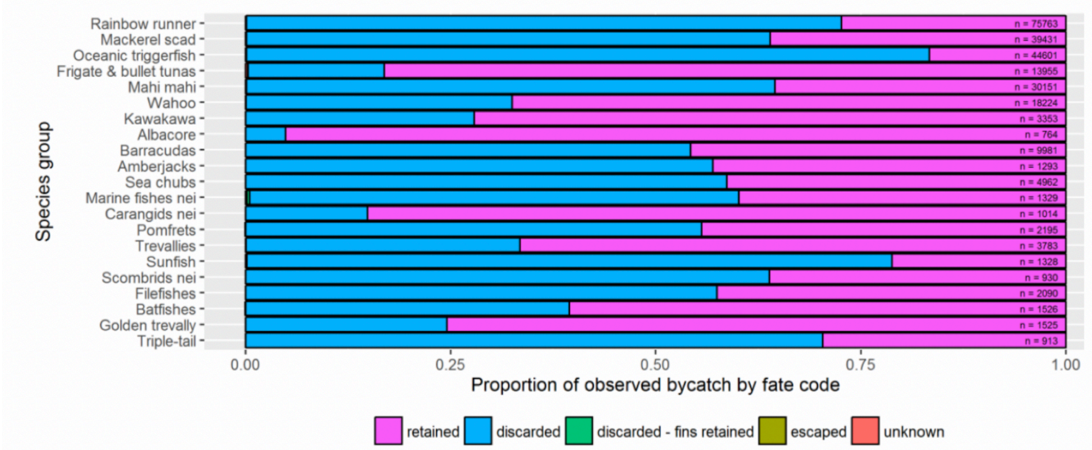

Figure 4. Recorded fate of finfish bycatch by species/species group taken by purse seine operations in the the WCFC-CA (Peatman & Nicol, 2017).

Longline

Between 2003 and 2010, observer coverage of the longline fleet over the whole WCPFC-CA was relatively consistent at 1% each year, and coverage increased to reach 6% in 2018. However, coverage is no longer distributed evenly throughout the WCPFC-CA. Coverage is highest around Hawaii and lowest in north-west Pacific. In 2016–18, there were 570 observed trips between 10°S and 20°N compared to 765 trips between 30°S and 10°S (Peatman & Nicol, 2020). Catches are reported as number of individuals rather than volume, and as such the average size (1.3 kg) of Mahi Mahi and Wahoo taken from an MSC certified tuna handline fishery was used to calculate a volume estimate. If Mahi Mahi and Wahoo size composition data is made available the WCPO longline fleet, these estimates can be recalculated with greater accuracy.

Each year, countries must provide catch data to the WCPFC Scientific Committee. Catch data primarily includes the managed tuna, billfish and sharks, although some countries provide Annual Reports that include bycatch such as Mahi Mahi, Wahoo and Cobia.

Indian Ocean Tuna Commission (IOTC)

The Indian Ocean Tuna Commission (IOTC) is an intergovernmental organisation responsible for the management of tuna and tuna-like species in the Indian Ocean. Indonesia is a contracting party (member) of the IOTC. The Secretariat sends periodic requests for data on the fisheries for tuna and tuna-like species in the Indian Ocean. These requests are not only addressed to Member of the Commission but to all countries involved in the different fisheries. IOTC holds a number of databases. The data, on a flag state basis, are supplied by both contracting and non-contracting parties fishing for tunas in the Indian Ocean (IOTC Resolution 15/02 On Mandatory Statistical Requirements). Mahi Mahi, Wahoo and Cobia are not considered "IOTC species" although a bycatch database is available.

Marine Stewardship Council (MSC) certification reports

At present there are no MSC certified fisheries that take Mahi Mahi, Wahoo or Cobia as a Principle 1 (assessment) species. The *Ecuador Mahi Mahi Longline Fishery* (Eastern Pacific Ocean) entered the MSC certification process in 2019, but withdrew from the process after 18 months due to administrative issues[1]. There are 21 tuna fisheries that are MSC certified in the Indo-Pacific region (Figure 5), and a further 11 are in the certification process. Many of these fisheries are likely to take Mahi Mahi, Wahoo and/or Cobia as Principle 2 (Primary or Secondary) species, although the lack of direct management and the very low catch rate, compared to the target tuna species, means they are often assessed as 'Secondary Minor' species. Sometimes, conditions are placed on the certification that requires better data collection in the future. For example, the Pan Pacific Yellowfin Tuna, Bigeye Tuna and Albacore Longline Fishery lists Mahi Mahi and Wahoo as secondary minor species (with no mention of Cobia); the certification has a condition at P2.2.3a that: "*By year 4 the information base for determining UoA interactions with secondary species should be improved so that some quantitative information is adequate to assess the impact of the UoA on secondary species with respect to status*."

[1] https://fisheries.msc.org/en/fisheries/ecuador-mahi-mahi-coryphaena-hippurus-longline-fishery/@@view

Figure 5. MSC Certified Tuna fisheries in the eastern Indian Ocean (FAO57), western central Pacific Ocean (FAO71) and southwest Pacific Ocean (FAO81) (Source: [MSC Track a Fishery](#))

Catch data for Mahi Mahi, Wahoo and Cobia was examined in the following MSC public certification reports:

1. American Samoa EEZ Albacore and Yellowfin Longline Fishery
2. Australia Eastern Tuna and Billfish Fishery (albacore tuna, yellowfin tuna, bigeye tuna and swordfish)
3. Echebastar Indian Ocean purse seine skipjack tuna
4. Fiji Albacore, Yellowfin and Bigeye Tuna longline
5. French Polynesia albacore, yellowfin and swordfish longline fishery
6. Indonesian pole and line and hand-line Skipjack, Yellowfin Tuna in WCP Archipelagic waters;
7. Kiribati albacore, bigeye and yellowfin tuna longline fishery
8. Maluku Indonesia Handline Yellowfin Tuna Fishery
9. Micronesia Skipjack, Yellowfin and Bigeye Tuna Purse Seine Fishery
10. MIFV RMI EEZ Longline Yellowfin and Bigeye Tuna
11. Pan Pacific yellowfin, bigeye and albacore longline fishery
12. Philippines Small Scale Yellowfin Tuna Handline Fishery
13. PNA Western and Central Pacific skipjack, yellowfin and bigeye tuna purse seine fishery (FAD and non-FAD sets)
14. PNG Fishing Industry Association’s purse seine Skipjack & Yellowfin Tuna Fishery
15. PT Citraraja Ampat Sorong Pole and Line SkipJack and Yellowfin Tuna Fishery
16. Solomon Islands longline albacore and yellowfin tuna fishery
17. Solomon Islands skipjack and yellowfin tuna purse seine and pole and line
18. SZLC CSFC & FZLC FSM EEZ Longline Yellowfin and Bigeye Tuna
19. SZLC, CSFC & FZLC Cook Islands EEZ South Pacific albacore, yellowfin and bigeye longline
20. Tri Marine Western and Central Pacific Skipjack and Yellowfin Tuna
21. Tropical Pacific yellowfin and skipjack free-school purse seine fishery
22. WPSTA Western and Central Pacific Skipjack and Yellowfin Purse Seine Fishery

FishSource

Since 2007, FishSource has been developing a database of species from different fisheries/gear types in order to ascertain stock health and effective management. Many of the profiles rely on MSC certification data or data from Fishery Improvement Projects (FIPs). As of 30 June 2022, the following relevant FishSource reports were available for fisheries that take Mahi Mahi, Wahoo and/or Cobia.

- Common Dolphinfish Indian Ocean (updated March 2022)
    - Indonesia (Drifting LL; Pole and Line; Set Longline)
    - Mauritius (Longline)
    - Mozambique (Longline)
    - Spain (Longline)
- Common Dolphinfish Western Central Pacific Ocean (updated March 2022)
    - Australia (set Longline)
    - Indonesia (Drifting LL; Handline)
    - Taiwan (Drifting LL; Trolling)
    - USA (Longline)
- Wahoo Indonesia (updated September 2017)
    - Indonesia (Set LL; Drifting LL)
- Wahoo Western Central Pacific Ocean (updated June 2021)
    - Taiwan (Longline)
- Cobia Indonesia (updated January 2022)
    - Indonesia (Set LL)

The Mahi Global Round-table lists five other FIPs that will provide catch data in the near future.

2. ESTIMATE OF REMOVALS

MAHI MAHI/ COMMON DOLPHINFISH – *Coryphaena hippurus*

Species overview

There are two species of Dolphinfish (Family Coryphaenidae): Common Dolphinfish/Mahi Mahi (*Coryphaena hippurus*) and Pompano Dolphinfish (*Coryphaena equiselis*). The Pompano Dolphinfish is a smaller species that is mistaken for juvenile Mahi Mahi, although as the name suggests, Mahi Mahi is the common dolphinfish.

Maukai et al. (2022) assessed the vulnerability of pelagic species to climate change and provided a summary of population and life history. Seafood Watch recently assessed this species from Indonesia and Taiwan. An overview of the Mahi Mahi ecology and life history is presented in Table 2 below using information from Maukai et al. (2022) and Fishbase unless otherwise referenced.

Table 2. State of the Knowledge for Mahi Mahi biology and ecology

	Common names	Scientific name	Local names
Species	Common Dolphinfish; Mahi Mahi	*Coryphaena hippurus*	Lemadang (Indonesia); Dorado (Taiwan)
Distribution	Tropical and temperate waters of the Atlantic, Indian and Pacific Oceans, and also recorded in the Mediterranean Sea. Inhabits both open and coastal waters to depths of 85 m with preferences for water temperatures of 21–30°C. Spawning occurs at > 21°C. To better understand habitat utilization, migration, and spawning behavior in wild mahi-mahi, Schlenker et al. (2019) used Wildlife Computers pop-up satellite archival tags (PSATs) to measure acceleration, depth, temperature, and light levels for geo-location modelling.		
Stock structure	Highly migratory. A genetic study indicated that mahi mahi presents a low population structure level, without observed genetic differentiation within the Indo-Pacific region (Díaz-Jaimes et al. 2010; Bayona-Vásquez et al. 2019). It is likely that mahi mahi is a single population for the Indo-Pacific region. Xu et al. (2018) provides a complete mitogenome for both Dolphinfish species from the South China Sea. In the Indian Ocean, the population sex ratio favours females, particularly in fish < 60 cm FL (Ghosh et al. 2022).		
Stock status	No indication of significant population declines. Resilience to fishing pressure is high as population doubling time is <15 months. A 2007 productivity-susceptibility analysis indicated medium risk for the effects of fishing in the WCPO (Kirby 2006). However, in 2020, a fishery improvement project (FIP) in Taiwan completed a full mahi mahi stock assessment in the northwest Pacific Ocean using a stock synthesis (SS) model[2]. The SS was implemented by incorporating historical catches, length-frequency data, and standardized catch per unit effort (CPUE) series. The results of all scenarios		

[2]https://fisheryprogress.org/system/files/action_proof_files/Study%20on%20the%20population%20dynamics%20of%20dolphinfish%20in%20the%20Taiwan%20waters.pdf#overlay-context=node/3151/actions-progress

	indicated that the stock of mahi mahi in the northwest Pacific Ocean might not be overfished. But, the current spawning stock biomass was close to the levels of maximum sustainable yield (MSY) and $0.4SSB_0$ (40% of unfished spawning biomass). In addition, the probability of the current spawning stock biomass dropping below the MSY level was estimated to be about 20% under the pessimistic scenario.		
Growth and size	Very fast growth rate. Attains 210 cm TL, more common at 100 cm TL.		
Longevity	4 years.		
Size of Maturity	Pacific Ocean: 52–56 cm FL (Chiang et al. 2019) Indian Ocean: females 54.57 cm FL and males 59.97 cm FL (Ghosh et al. 2022).		
Age of Maturity	4–7 months		
Natural mortality	0.6–0.8 per year.		
Diet and Trophic level	Opportunistic foragers, feeding on a wide variety of fishes, cephalopods, and crustaceans, as previously documented through morphological identification of prey items from dissected stomachs. Himmelsback et al. (2022) researched the diet of both *Coryphaena* species from nearshore Oahu (Hawaiian) waters in 2020-2021. Tropic level: 4.4		
Fecundity	Fecundity is size dependent. Pacific Ocean: 87,000–473,000 oocytes (Chiang et al. 2019) Atlantic Ocean: 58,000–1.5 million eggs (Seafood Watch, 2022)		
Vulnerability to Climate change	Larvae may be susceptible to ocean acidification by impaired swimming and hearing ability. Increase in sea surface temperature and reduced oxygen may affect habitat. Other stressors are unclear.		
Listings	Annex I of the 1982 Convention of the Law of the Sea	Least Concern IUCN RedList (2011)	
Additional information	There are currently seven active FIPs that include mahi-mahi in their scope. https://sustainablefish.org/roundtable/global-mahi/ The only Regional Fishery Management Organisations (RFMOs) that have formally addressed mahi-mahi are the Inter-American Tropical Tuna Commission (IATTC; Eastern Pacific Ocean) and the International Commission for the Conservation of Atlantic Tunas (ICCAT).		

Fishing mortality

Given the likelihood of a single Mahi Mahi population, reported catches in the Indo-Pacific were investigated and collated. CEA (2018) aggregated the best available data and provide light analysis on Indonesian marine fisheries statistics but unfortunately there is no estimate available Mahi Mahi. MMAF & OFP (2021) also presented an annual report to WCPFC about the availability of catch estimates from "other commercial fisheries" in Indonesia; Mahi Mahi was not mentioned in the report.

Indonesian Centre of Data, Statistics and Information database

In 2020, 18.5 mt of Mahi Mahi was reported from various fisheries within the Indonesian EEZ. No earlier data is available for Lemadang (Mahi Mahi). Gear data is not available, although regional data suggests that Sulawesi Selatan (South Sulawesi: WPP 713) produces the most Mahi Mahi, followed by Bali (also WPP 713) and Lampung (WPP 712).

FAO – FishStat J

In 2020, reported catch from the Indo-Pacific regions (FAO 57 and 71) was 18,765 t and has averaged 17,203 t over the most recent four years (Table 3). FAO data suggests that only ten nations caught Mahi Mahi in 2017–2020 in the IO or WCPO. Of these, Indonesia took almost all of the volume. However, the FAO data is highly likely to be incomplete given that reported catches to the WCPFC (Table 4) and IOTC (Table 5) differ to those reported to FAO. For example, Australia's reported catch to the FAO is nil, but in the WCPO Australia reported 64.7 t of Mahi Mahi in 2020 (retained), and a further 404 individual fish were discarded (Table 5). Furthermore, Indonesia claims 18.5 tonne in their fisheries database yet claims 18,375 t in the FAO database for the same year; clarification of correct units (kg/tonne) is required.

Table 3. FAO reported catch of Mahi Mahi between 2017 and 2020 in the Indo-Pacific [FAO 57 (Indian Ocean) and 71 (WCPO)].

	Annual reported catch (t)			
Nation	2017	2018	2019	2020
Australia	0	0	0	0
Guam	9.31	6.17	19.14	7.17
Indonesia	12573	15033	19902.06	18375.64
Japan	0	0	0	0
Northern Mariana Is.	4.26	7.2	9.18	5.62
Palau	0	0	0	0
Philippines	123	108	131	119.72
Portugal	2	0	0	0
Spain	3	0	0	0
Sri Lanka	1024.1	550.1	542.4	257.37
Grand Total	**13738.67**	**15704.47**	**20603.78**	**18765.52**

Western Central Pacific Fisheries Commission (WCPFC)

In the WCPO, Mahi Mahi is a retained bycatch species. Longline operations interact with Mahi Mahi more often than purse seine operations. Catches of Mahi Mahi from Longline vessels operating in the WCPO report their catch in number of fish (Peatman and Nicol, 2020). Between 2003 and 2018, an annual average of 656,068 individual fish were landed (Table 4) and when separated by region:

- Longliners north of 10° N took over 5 million Mahi Mahi;
- Longliners between the 10° N and 10° S took 2.5 million Mahi Mahi;
- Longliners south of 10° S took 2.6 million Mahi Mahi.

Large purse seine vessels operating in equatorial waters took an average of 367 mt each year between 2003 and 2020. Larcombe et al. (2021) suggested that recent reported catches have been predominantly from the northwest Pacific (FAO area 61, north of 20°N) and the western central Pacific (FAO area 71, 20°N–25°S), with minor commercial catches reported in the southwest Pacific (FAO area 81, south of 25°S). It is important to note that retained catches are recorded by weight (tonnes), but discarded catches are recorded by the number of fish.
Longline catches are also reported by number of fish (Table 4). Whilst it is difficult to get an average size for Mahi Mahi taken by all longline vessels, data from the MSC certified

Philippines handline fishery suggested that 695 Mahi Mahi weighed a total of 956kg; this is 1.3 kg per fish which equates to fish about 53 cm FL[3]. This 1.3 kg fish weight was used in Table 4 to estimate total longline catch for 2003–2018.

Table 4. WCPFC reported catch of Mahi Mahi from Longline and large scale equatorial Purse seine operations (Source: Peatman and Nicol, 2020; 2021)

Year	Longline catch (Number of fish)	Purse seine (t)
2003	518,100	396
2004	504,000	615
2005	458,100	460
2006	488,300	517
2007	705,500	467
2008	740,600	485
2009	916,100	541
2010	947,200	362
2011	1,099,400	332
2012	1,012,400	355
2013	771,800	479
2014	729,100	358
2015	557,000	419
2016	386,900	176
2017	417,400	205
2018	245,200	198
2019	NA	153
2020	NA	91
Grand Total	**10,497,100 fish Estimated 13,646 t**	**6,609 tonnes**

The data within each Annual Report for each country is presented in Table 5; these data may be already accounted for in WCPFC catch data, and it is significantly less than longline and purse seine catch data (Table 4). However, it is interesting to note the nations reporting this bycatch data even though it is outside their obligation, and also to note that those nations taking the vast majority are not including Mahi Mahi data in their annual reports.

Table 5. Mahi Mahi catches as reported in Annual Reports presented to the WCPFC Scientific Committee SC-17 (2021) {Longline LL)

Country	Gear Type	Catch (t)		
		2018	2019	2020
Australia	LL		96.9	64.7
Tonga	all		141	38
PNG	Purse seine		4.4	0.9
Samoa	LL			23
Palau	undefined	1.5	2.3	
EU	purse seine			2.54
Fiji	LL			90
	TOTAL		**244.6**	**196.14**

[3] Conversion table https://www.ansaqld.com.au/wp-content/uploads/2014/06/ansa_qld_length_weight.pdf

Indian Ocean Tuna Commission database

In the three years of 2018–2020, a total of 43,751 tonnes of Mahi Mahi was reported to the IOTC (Table 6); the average annual catch was 14,583 t. Indonesia's reported catch in 2020 (380.7 t) represented just 2.8% of the total reported catch for the Indian Ocean (13,482.6 t), and longline operations took 80% of Indonesia's Mahi Mahi catch.

The Iranian Gillnet fishery took the bulk (>62%) of the reported Mahi Mahi catch in 2020. In 2020, the Iranian fleet is composed of 6,837 vessels (down from 11,300 in 2015) which operate in coastal and offshore waters (IOTC 2021). In 2016, a total of 6,500 gillnetters yielded 95.9% of Mahi Mahi catches, compared to purse seiners 2.1%, and trolling boats 2%. Most of the Iranian gillnetters use smaller vessels (<3 GT) and operate in the western Indian Ocean (FAO 51) (Aranda, 2017) outside of the Indo-Pacific region. However, as Mahi Mahi might be a single population, catches in this region are also relevant, particularly given their catch size.

Table 6. Mahi Mahi annual catch by Nation and gear type for 2018–2020 as reported to the IOTC

Nation (Gear type)	Catch (t) 2018	2019	2020
AUSTRALIA			
COMOROS			
EU.FRANCE	**205.07**	**76.41**	**76.19**
Purse seine	205.07	76.41	76.19
EU.FRANCE.MAYOTTE	**3.88**	**2.15**	**2.41**
Coastal longline		0.23	0.12
Hand line	0.61		
Longline targeting swordfish	1.04		
Troll line	2.24	1.92	2.29
EU.FRANCE.REUNION	**206.60**	**120.95**	**70.59**
Coastal longline	22.38	8.52	7.57
Hand line and Troll line	157.49	104.25	52.83
Longline targeting swordfish	26.72	8.18	10.19
EU.ITALY			**0.22**
Purse seine			0.22
EU.PORTUGAL	**3.47**	**1.23**	**0.18**
Longline targeting swordfish	3.47	1.23	0.18
EU.SPAIN	**11.76**	**8.83**	**2.52**
Longline targeting swordfish	11.76	8.83	2.52
INDIA	**0.23**	**0.19**	**0.12**
Exploratory longline	0.23	0.19	0.12
INDONESIA	**468.26**	**1,106.72**	**380.75**
Longline Fresh	154.26	180.41	307.63
Purse seine	313.99	926.31	73.11
IRAN ISLAMIC REP.	**9,790.28**	**9,073**	**8,401.64**
Gillnet	4310.46	2234	3161.72
Offshore gillnet	5479.82	6839	5239.92
KENYA	**0.87**	**0.15**	**0.15**
Longline targeting swordfish	0.87	0.15	0.15
MALDIVES	**14.71**	**2.53**	**2.14**

Nation (Gear type)	Catch (t) 2018	2019	2020
Baitboat	4.81	0.77	0.56
Baitboat (offhsore)	8.67	1.11	0.89
Hand line	0.82	0.49	0.50
Hand line (offshore)	0.27	0.16	0.16
Troll line	0.14		
Trolling mechanized			0.03
MAURITIUS	**46.64**	**38.40**	**31.48**
Hand line and Troll line	17.83	16.57	15.26
Longline Fresh	28.02	21.70	
Longline targeting swordfish	0.79	0.13	0.045
Purse seine			16.17
MOZAMBIQUE	**8.14**	**3.56**	**14.99**
Longline targeting swordfish	8.14	3.56	14.99
OMAN			
PAKISTAN	**3515**	**4431**	**4226**
Gillnet	3515	4431	4189
Hand line and Troll line			37
SEYCHELLES		**0.17**	
Longline		0.17	
SOUTH AFRICA			
SRI LANKA	**550.10**	**542.99**	**257.37**
Coastal longline	12.69	3.80	30.48
Gillnet	43.40	74.20	43.70
Hand line	7.10	11.10	21.23
Longline Fresh	0.70	1.70	
Offshore gillnet	0.30		
Ring net	474.20	438	161.96
Ring net (offshore)	10.90	13.20	
Troll line	0.80	1.00	
TANZANIA		**0.021**	**0.02**
Longline		0.021	0.02
UK.TERRITORIES	**0.09**	**0.03**	**0.02**
Hand line	0.09	0.03	0.02
UN. ARAB EMIRATES	**15**	**15**	**15**
Unclassified	15	15	15
UNITED KINGDOM	**2.25**	**3.28**	**0.87**
Longline targeting swordfish	2.25	3.28	0.87
Grand Total	**14,842.37**	**15,426.63**	**13,482.66**

MSC certified tuna fisheries in Indo-Pacific

During the MSC certification process, the client supplies catch data for all target, primary and secondary species. In nearly every case, Mahi Mahi made up less than 2% of the total catch. The only exception was the *Philippines Small scale Yellowfin tuna handline fishery* which reported that Mahi Mahi made up 4.34% of the 2019 catch and the average fish size was 1.3 kg. Mahi Mahi was assessed as a secondary 'minor' species in each MSC assessment.

Table 7. Reported Mahi Mahi catch by MSC certified tuna fisheries operating in the Indo-Pacific region.

MSC certified fishery	Year	Reported Mahi Mahi catch (t)
American Samoa EEZ Albacore and Yellowfin Longline Fishery	2013	3.67
Australia Eastern Tuna and Billfish Fishery (albacore tuna, yellowfin tuna, bigeye tuna and swordfish)	2018	2.09
Echebastar Indian Ocean purse seine skipjack tuna		0.7
Fiji Albacore, Yellowfin and Bigeye Tuna longline	2016	11.5
French Polynesia albacore, yellowfin and swordfish longline fishery	2015	79
Indonesian pole and line and hand-line Skipjack, Yellowfin Tuna in WCP Archipelagic waters		1.4
Kiribati albacore, bigeye and yellowfin tuna longline fishery	no volume data, in 2017 10 DOL kept.	
Maluku Indonesia Handline Yellowfin Tuna Fishery		1.6
Micronesia Skipjack, Yellowfin and Bigeye Tuna Purse Seine Fishery	2019	1.4
MIFV RMI EEZ Longline Yellowfin and Bigeye Tuna	2017	33
Nauru skipjack, yellowfin, and bigeye tuna purse seine fishery	2019-20 season	0.927
Pan Pacific yellowfin, bigeye and albacore longline fishery	2016	5
Philippines Small Scale Yellowfin Tuna Handline Fishery	2019	0.056
PNA Western and Central Pacific skipjack, yellowfin and bigeye tuna purse seine fishery (FAD and non-FAD sets)	2015	5.8
PNG Fishing Industry Association's purse seine Skipjack & Yellowfin Tuna Fishery	average annual 2013-17	7.2
PT Citraraja Ampat Sorong Pole and Line Skipjack and Yellowfin Tuna Fishery	2017	0.7
Solomon Islands longline albacore and yellowfin tuna fishery	no catch data, only % of discards	

MSC certified fishery	Year	Reported Mahi Mahi catch (t)
Solomon Islands skipjack and yellowfin tuna purse seine and pole and line	average annual 2015-19	14.9
SZLC CSFC & FZLC FSM EEZ Longline Yellowfin and Bigeye Tuna	2020	7.64
SZLC, CSFC & FZLC Cook Islands EEZ South Pacific albacore, yellowfin and bigeye longline	2018	3.8
Tri Marine Western and Central Pacific Skipjack and Yellowfin Tuna	average annual 2015-19	21.6
Tropical Pacific yellowfin and skipjack free-school purse seine fishery	2020	0.33
WPSTA Western and Central Pacific Skipjack and Yellowfin Purse Seine Fishery	average of 2014 & 2015	15.5
Estimated annual catch reported from MSC certified tuna fisheries in Indo-Pacific region		**217.82 t**

Although there is likely to be some duplication (i.e., catches reported to multiple databases for the same catch), Table 8 collates the annual catch of Mahi Mahi from various tables above and the estimated fishing mortality is over 36,000 t. The UoA took 75.5 tonne of Mahi Mahi in 2019–20 and 67.9 t in 2021–22 using drifting longlines in the Indian Ocean (WPP 572/573; Figure 1); notably these volumes are higher than the reported Indonesian catch data (Table 8).

Table 8. Summary of Mahi Mahi catches in the Indian Ocean and western central Pacific Ocean

	Mahi Mahi Annual Catch		
Data source/region	**2018**	**2019**	**2020**
Indonesian Fisheries			18.5 t
FAO catch from Statistical Areas 57, 71)	15,704.5 t	20,603.8 t	18,675.0 t
Western Central Pacific Ocean			
WCPFC longlines	245,200 fish Estimate 318.76t	NA	NA
WCPO purse seine	198.0 t	153.0 t	91.0 t
Annual country reports to WCPFC		244.6 t	196.1 t
Indian Ocean (IO) - IOTC	14842.3 t	15426.6 t	13482.6 t
MSC certified fisheries	Various single years 217.8 t		
Taiwan Hsin-Kang mahi-mahi - longline FIP (FAO 61)	2600.0 t		
UoA Longline fishery	75.5 t in 2019/20; 67.9 t in 2021/22 (mean 71.1 t)		
Estimated annual catch (tonnes)	36,695 t		

WAHOO – *Acanthocybium solandri*

Species overview

Wahoo (*Acanthocybium solandri*) is a fast-growing and early-maturing species. Stock status and fishing mortality rates are poorly known, however, given its growth rates and fecundity the species is not thought to be particularly vulnerable to fishing pressure. The IUCN Red List rates wahoo as least concern. A 2007 productivity-susceptibility analysis indicates a medium risk for the effects of fishing in the WCPO (Kirby and Hobday, 2007). There is no stock assessment available for wahoo in the WCPO and there is no specific WCPFC CMM relating to wahoo. However, the productivity of wahoo suggests the species can withstand relatively high levels of fishing pressure.

Maukai et al. (2022) assessed the vulnerability of pelagic species to climate change and provide a summary of Wahoo population and life history. An overview of the Wahoo ecology and life history is presented in Table 9 using information from Maukai et al. (2022) and Fishbase unless otherwise referenced.

Table 9. State of the Knowledge for Wahoo biology and ecology

	Common names	Scientific name	Local names
Species	Wahoo	*Acanthocybium solandri*	Ono; Tenggiri laki; Tenggiri fajar
Distribution	Adult wahoo are oceanic/epipelagic species found to an average depth of 20 m, although they have been recorded to depths >250 m. Preferences for water temperatures of 18–28°C.		
Stock structure	High genetic connectivity globally. Adults are usually solitary and school to spawn. Zischke et al. (2013b) examined the stock structure of wahoo using morphometric characters and parasite fauna from fish collected in three regions of the western Pacific, and one region in each of the eastern Pacific and eastern Indian Oceans. Similar morphometric measurements and parasite abundance of wahoo collected off eastern Australia suggest they may form part of a single phenotypic stock in the western Pacific Ocean. However, significant differences among wahoo from the western Pacific and eastern Pacific Oceans, suggest multiple discrete phenotypic stocks despite genetic homogeneity.		
Stock status	A productivity-susceptibility analysis indicates a medium risk for the effects of fishing in the WCPO (Kirby 2006). There is no current stock assessment available for wahoo in the WCPO and there are no WCPFC CMM specifically relating to wahoo. However, the productivity of wahoo suggests the species can withstand relatively high levels of fishing pressure. Zischke & Griffiths (2015) performed a stock assessment incorporating sensitivity in biological parameters and potential fishery management strategies for wahoo in the south-west Pacific Ocean was undertaken to assess the stock status of this species for 2008–2010. The results of the assessment indicated that $F_{current}$ for wahoo is lower than limit reference points and the target reference point for Y/R and that it is slightly higher than the target reference point for SBB/R Medium resilience to fishing with minimum population doubling time of 1.4–4.4 years.		
Growth and size	The growth performance index for wahoo in the Coral Sea was one of the highest of all pelagic fish, with their growth and maximum size most similar to dolphinfish (Zischke et al. 2013a).		

	Wahoo in the Coral Sea exhibit rapid growth, particularly in the first year of life. Instantaneous growth rates of wahoo in the Coral Sea were between 1.0 and 3.7 mm per day during the first 12 months of life. Maximum size 250 cm TL, but more common at 170 cm TL. In the Australia Eastern Tuna and Billfish Fishery, 76% of wahoo caught were less than 2 years of age.
Longevity	Maximum age is 9 year, more common that 5–6 years is oldest cohort
Size of Maturity	95–105 cm FL (Zischke et al. 2013c).
Age of Maturity	7 months to 1 year
Diet and Trophic level	Different preferences relative to Wahoo size. Trophic level 4.3
Fecundity	The relative fecundity of wahoo appears to be at least twice that of other large tropical scombrids. Multiple batch spawners, spawning every 2–6 days and up 60 times in one season (~5 months). 0.65 and 5.12 million oocytes (Zischke et al. 2013c).
Vulnerability to Climate change	Overall vulnerability rank is 'moderate' with ocean acidification, sea surface temperature and reduced oxygen impacting all life stages.
Listings	Least Concern IUCN RedList (2011)

Fishing mortality

Reported catches in the Indo-Pacific were investigated and collated, although stock structure remains unresolved. CEA (2018) aggregated the best available data and provide light analysis on Indonesian marine fisheries statistics but unfortunately there is no estimate available for Wahoo. MMAF & OFP (2021) also presented an annual report to WCPFC about the availability of catch estimates from "other commercial fisheries" in Indonesia; Wahoo was not mentioned in the report.

Indonesian Centre of Data, Statistics and Information database

In 2020, 191.9 mt of Tenggiri was reported from various fisheries within the Indonesian EEZ. It is unclear if Tenggiri is reported as a single species from the mackerel family (Scombridae), and clarification from MMAF is required. Gear data is not available, although regional data suggests that Jawa Barat (West Java WPP 712; 573) produces the most Tenggiri, followed by Kepulauan Riau (Raui Islands: WPP 711) and Papua (WPP 717; 718).

FAO – FishStat J

In 2020, reported catch was 1,113 t and has averaged 967.7 t over the most recent four years (Table 3). FAO data suggests that only seven Nations caught Wahoo in 2017–2020, of these Fiji had the greatest catch. However, the FAO data is highly likely to be incomplete given that reported catches to the WCPFC (Table 4) and IOTC (Table 5) differ to those reported to FAO. Furthermore, it is unlikely that Fiji caught precisely 440 t each year. In 2015, the reported catch of wahoo by Fiji longliners was 237 mt (1.6% of the Fiji longline catch)[4] and the average over 2011–2015 was of approximately 196 mt (based on Fiji annual reports to WCPO).

Table 10. FAO reported catch of Wahoo between 2017 and 2020 in the Indo-Pacific [FAO 57 (Indian Ocean) and 71 (WCPO)].

Nation	Annual reported catch (t)			
	2017	2018	2019	2020
Australia	21.02	20.63	18.74	15.03
Belize	0	0	0	0
Fiji	440	440	440	440
Guam	6.79	6.85	5.64	5.64
India	126.38	0	519.01	118
Indonesia	0	150.76	0	285.47
New Zealand	0	0	0	0
Northern Mariana Is.	1.09	0.41	0.15	0.51
Other nei	0	0	0	0
Palau	0	0	0	0
Portugal	0	0	0	0
Spain	0	0	0	0
Sri Lanka	152	90	318.50	248.40
Taiwan	0	0	0	0
United Kingdom	0	0	0	0
Grand Total	**747.28**	**708.65**	**1302.04**	**1113.05**

Western Central Pacific Fisheries Commission (WCPFC)

In the WCPO, Wahoo is a retained bycatch species. Longline operations interact with Wahoo more often than purse seine operations. Catches of Wahoo from Longline vessels operating in the WCPO report their catch in number of fish (Peatman and Nicol, 2020). Between 2003 and 2018, an annual average of 420,481 individual fish were landed (Table 11).

Large purse seine vessels operating in equatorial waters took an average of 116.7 mt each year between 2003 and 2020.

Longline catches are reported by number of fish (Table 11). Whilst it is difficult to get an average size for Wahoo taken by all longline vessels, data from the MSC certified Philippines handline fishery suggests that 305 Wahoo weighed a total of 406 kg; this is 1.3 kg per fish. This 1.3 kg fish weight was used in Table 12 to estimate total longline catch in 2003–2018.

1. [4] *MSC certification report* Fiji Albacore, Yellowfin and Bigeye Tuna longline

Table 12. WCPFC reported catch of Wahoo from Longline and large scale equatorial Purse seine operations (Source: Peatman and Nicol, 2020; 2021)

Year	Longline catch (Number of fish)	Purse seine (t)
2003	47,7200	94
2004	40,2100	137
2005	41,3500	102
2006	46,9700	109
2007	45,7200	121
2008	36,1600	177
2009	35,7700	150
2010	35,8800	100
2011	34,3500	161
2012	39,0700	162
2013	39,5700	143
2014	48,7400	167
2015	51,8400	80
2016	41,1000	83
2017	42,9400	106
2018	45,3800	121
2019	NA	48
2020	NA	40
Grand Total	**6,727,70 fish Estimated 8,746 t**	**2101 tonnes**

The data within each Annual Report for each country is presented in Table 13; these data may be already accounted for in WCPFC catch data, and it is significantly less than longline and purse seine catch data (Table 12). However, it is interesting to note the nations reporting this bycatch data even though it is outside their obligation, and also to note that those nations taking the vast majority are not including Wahoo data in their annual reports.

Table 13. Wahoo catches as reported in Annual Reports presented to the WCPFC Scientific Committee SC-17 (2021) {Longline LL)

Country	Gear Type	Catch (t)		
		2018	2019	2020
Australia	LL		5.1	3
Tonga	all		9	5
PNG	Purse seine		0.1	0.1
Samoa	LL			8
Palau	undefined	1.76	0.29	
EU	purse seine			1.5
Fiji	LL			140
	TOTAL	**1.76**	**14.49**	**157.6**

Indian Ocean Tuna Commission database

In the three years of 2018–2020, a total of 3,366.6 tonnes of Wahoo was reported to the IOTC (Table 14); the average annual catch was 1,122 t. Indonesia's reported catch in 2018 (150.8 t) represented 18.8% of the total reported catch for the Indian Ocean (800.3 t), and purse seine operations took 94% of Indonesia's Wahoo catch. The Indian trawl and gillnet fishery took the largest share of the Wahoo catch (Table 14).

Table 14. Wahoo annual catch by Nation and gear type for 2018–2020 as reported to the IOTC

Nation (gear type)	Catch (t) 2018	2019	2020
AUSTRALIA	**1.40**	**0.97**	**0.73**
Hand line	0.50		
Longline targeting swordfish	0.79	0.47	0.23
Troll line	0.12	0.50	0.50
COMOROS	**220.64**	**281.25**	**301.63**
Gillnet	60.52	36.51	36.60
Hand line	23.45	55.57	99.50
Troll line	136.67	189.17	165.54
EU.FRANCE	**50.04**	**36.13**	**34.34**
Purse seine	50.04	36.13	34.34
EU.FRANCE.MAYOTTE	**2.38**	**0.97**	**1.70**
Coastal longline		0.01	0.01
Hand line	0.38	0.96	0.40
Troll line	2.00		1.28
EU.FRANCE.REUNION	**109.94**	**84.98**	**49.81**
Coastal longline	3.70	1.86	1.92
Hand line and Troll line	104.10	81.13	45.12
Longline targeting swordfish	2.14	1.99	2.78
EU.ITALY			**0.08**
Purse seine			0.08
EU.PORTUGAL	**0.20**	**0.26**	**0.04**
Longline targeting swordfish	0.20	0.26	0.04
EU.SPAIN	**2.75**	**0.94**	**0.40**
Longline targeting swordfish	2.75	0.94	0.40
INDIA		**618.01**	**377.00**
Coastal Longline and Troll line combination		95.00	262.00
Exploratory longline		0.01	
Gillnet		304.64	66.99
Hook and line		36.98	8.13
Small purse seine		19.37	4.26
Trawl		162.01	35.62
INDONESIA	**150.76**		**7.29**
Longline Fresh	9.49		7.29
Purse seine	141.28		
IRAN ISLAMIC REP.			
KENYA			
Longline targeting swordfish			
MALDIVES	**34.49**	**23.60**	**11.68**
Baitboat	21.38	16.07	1.94
Baitboat (OFFSHORE)	1.59	0.48	0.29
Coastal longline	1.53		
Hand line	2.89	1.62	0.95
Hand line (offshore)	0.31		0.01
Troll line	6.79		
Trolling mechanized		5.42	8.49
MAURITIUS	**5.93**	**5.20**	**5.18**
Hand line and Troll line	2.17	2.01	1.85

Nation (gear type)	Catch (t) 2018	2019	2020
Longline targeting swordfish	3.76	3.19	1.53
Purse seine			1.80
MOZAMBIQUE			
OMAN	**116.00**	**16.03**	**138.83**
PAKISTAN			
SEYCHELLES			
SOUTH AFRICA	**0.01**	**0.40**	**0.04**
Longline			0.04
Longline targeting swordfish	0.01	0.40	
SRI LANKA	**88.90**	**312.50**	**251.56**
Beach seine		132.50	146.69
Coastal longline	28.60	93.50	56.00
Gillnet	16.00	32.60	24.00
Hand line	4.30	9.60	13.10
Longline Fresh	9.70		3.10
Offshore gillnet	3.60	2.50	0.50
Ring net	22.00	37.20	8.17
Ring net (offshore)	4.60	4.60	
Trolling mechanized	0.10		
TANZANIA			
UK.TERRITORIES	**5.16**	**3.86**	
Hand line	5.16	3.86	
UN. ARAB EMIRATES			
UNITED KINGDOM	**11.72**	**0.85**	
Longline targeting swordfish	11.72	0.85	
Grand Total	**800.32**	**1385.96**	**1180.31**

MSC certified tuna fisheries in Indo-Pacific

During the MSC certification process, the client supplies catch data for all target, primary and secondary species. In nearly every case, Wahoo made up less than 2% of the total catch. The only exception was the *French Polynesia Albacore and Yellowfin longline fishery* which reported that Wahoo made up 3.7% of the 2015 catch. Wahoo was assessed as a secondary 'minor' species in each MSC assessment.

Table 15. Reported Wahoo catch by MSC certified tuna fisheries operating in the Indo-Pacific region.

MSC certified fishery	Year	Reported Wahoo catch (t)
American Samoa EEZ Albacore and Yellowfin Longline Fishery	2013	1.6
Australia Eastern Tuna and Billfish Fishery (albacore tuna, yellowfin tuna, bigeye tuna and swordfish)	2018	0.24
Echebastar Indian Ocean purse seine skipjack tuna		0.8
Fiji Albacore, Yellowfin and Bigeye Tuna longline	2016	11.3
French Polynesia albacore, yellowfin and swordfish longline fishery	2015	230

MSC certified fishery	Year	Reported Wahoo catch (t)
Indonesian pole and line and hand-line Skipjack, Yellowfin Tuna in WCP Archipelagic waters;		1
Kiribati albacore, bigeye and yellowfin tuna longline fishery	no volume data, in 2017 10 DOL kept.	
Maluku Indonesia Handline Yellowfin Tuna Fishery		
Micronesia Skipjack, Yellowfin and Bigeye Tuna Purse Seine Fishery	2019	2.04
MIFV RMI EEZ Longline Yellowfin and Bigeye Tuna	2017	37
Nauru skipjack, yellowfin, and bigeye tuna purse seine fishery	2019-20 season	0.904
Pan Pacific yellowfin, bigeye and albacore longline fishery	2016	7
Philippines Small Scale Yellowfin Tuna Handline Fishery	2019	0.03
PNA Western and Central Pacific skipjack, yellowfin and bigeye tuna purse seine fishery (FAD and non-FAD sets)	2015	
PNG Fishing Industry Association's purse seine Skipjack & Yellowfin Tuna Fishery	average annual 2013-17	
PT Citraraja Ampat Sorong Pole and Line Skipjack and Yellowfin Tuna Fishery	2017	0
Solomon Islands longline albacore and yellowfin tuna fishery	no catch data, only % of discards	
Solomon Islands skipjack and yellowfin tuna purse seine and pole and line	average annual 2015-19	1.008
SZLC CSFC & FZLC FSM EEZ Longline Yellowfin and Bigeye Tuna	2020	18.67
SZLC, CSFC & FZLC Cook Islands EEZ South Pacific albacore, yellowfin and bigeye longline	2018	58.1
Tri Marine Western and Central Pacific Skipjack and Yellowfin Tuna	average annual 2015-19	16.8
Tropical Pacific yellowfin and skipjack free-school purse seine fishery	2020	0.28
WPSTA Western and Central Pacific Skipjack and Yellowfin Purse Seine Fishery	average of 2014 & 2015	35
Estimated annual catch reported from MSC certified tuna fisheries in Indo-Pacific region		**421.772 t**

Although there is likely to be some duplication (i.e., catches reported to multiple databases for the same catch), Table 16 collates the annual catch of Wahoo from various tables above and the estimated fishing mortality is over 3,463 t. The UoA took 10.8 tonne of Wahoo in 2019–20 and 2021–22 using drifting longlines in the Indian Ocean.

Table 16. Summary of Wahoo catches in the Indian and western central Pacific Ocean

DATA SOURCE	Mean Wahoo Annual Catch (t)
Indonesian Fisheries	191.9 t
FAO catch from Statistical Areas 57, 71)	967.7 t
Western Central Pacific Ocean	
WCPFC longlines	420,481 fish Estimate 546.6 t
WCPO purse seine	116 t
Annual country reports to WCPFC	86 t
Indian Ocean (IO) - IOTC	1122 t
MSC certified fisheries	421.7 t
UoA Longline fishery (IO)	10.8
Estimated annual catch (tonnes)	3462.7 t

COBIA - *Rachycentron canadum*

Cobia is an important marine fish species for commercial aquaculture throughout their distribution range in tropical and subtropical regions around the world. Benetti et al. (2021)[5] provided a comprehensive overview of this species, albeit for the purpose of aquaculture. An overview of the Cobia ecology and life history is presented in Table 17 below using information from (Sajeevan, 2011) and Fishbase unless otherwise referenced.

Table 17. State of the Knowledge for Cobia biology and ecology

	Common names	Scientific name	Local names
Species	Cobia	*Rachycentron canadum*	
Distribution	Globally distributed in coastal sub-tropical waters. Absent from the eastern Pacific Ocean. Adults occur in a variety of habitats, over mud, sand and gravel bottoms; over coral reefs, off rocky shores and in mangrove sloughs; inshore around pilings and buoys, and offshore around drifting and stationary objects; occasionally in estuaries.		
Stock structure	Cobia are usually a solitary species; however, they do form large spawning aggregations (usually in open water) during the warmer months to spawn; spawning 15 – 20 times per season[6]. Joy et al. (2016), described pamixia of Cobia populations in Indian waters based on mt DNA markers. In contrast, Divya et al. (2019) used more powerful microsatellite and mitochondrial markers to indicate three separate populations or management units within Indian waters. Significant genetic differentiation of Cobia has also been detected on relatively small spatial scales. For example, Salari Aliabadi et al. (2008) reported three different populations of Cobia in the northern coasts of the Persian Gulf and Oman that were separated by short distances of 140– 310 kms. Additionally, Gold et al. (2013) reported population separation of Cobia from the Northern Gulf of Mexico, the US western Atlantic, and Taiwan waters using both nuclear encoded microsatellite and mt DNA analysis. The stock structure of Cobia across Indonesia, is not yet known. The determination of population subdivision in such large marine pelagic fish species is often challenging due to large effective population sizes, high dispersal capacities, and lack of apparent physical barriers to gene flow[7].		
Stock status	There is no stock assessment for the Indonesian fishery, although surrogate data is available. In India, Moosamikandy & Madhusoodana (2016) conducted a stock assessment of cobia *Rachycentron canadum* from the North West coast of India and found that In Australia, a preliminary assessment using Queensland (NE Australia) recreational, commercial and charter catch data applied to a modified catch-MSY model estimated that the 2019 biomass of Cobia was 76 per cent of unfished levels. The fishing mortality in 2019 was 0.06 which was well below the limit reference point indicating that the current level of fishing mortality is unlikely to cause the stock to become recruitment impaired[8].		

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[5] https://onlinelibrary.wiley.com/doi/epdf/10.1111/jwas.12810
[6] https://fishesofaustralia.net.au/home/species/4421#moreinfo
[7] https://fish.gov.au/report/345-Cobia-2020
[8] https://fish.gov.au/report/345-Cobia-2020

	An assessment using catch data from Western Australia, Northern Territory and Queensland commercial fisheries applied to a modified catch-MSY model. The model estimated that the 2019 biomass of Cobia was 57 per cent of unfished levels. There were high uncertainty in the estimates of biomass depletion, harvest rate and MSY using a catch-MSY model. The estimated fishing mortality level in 2019 was 0.12[9].
Growth and size	Attains 200 cm TL, more common < 110 cm TL
Longevity	12.5 years
Size of Maturity	50 – 70 cm TL NE Australia 78 cm FL[10]
Age of Maturity	3 years NE Australia 1.5 years[11] India: 1.4–1.7 years (Sajeevan, 2011),
Natural mortality	India: Natural mortality coefficient and total mortality value estimated were 0.416 and 0.76 respectively
Diet	Sajeevan (2011) examined the life history and ecology of this species from Indian waters. Cobia is carnivorous, and feed extensively on fishes, crustaceans, cephalopods, and benthic invertebrates. Crabs and puffer-fish make up a large proportion of their diet.
Fecundity	2 – 5.5 million eggs
Listings	Low Concern IUCN Redlist (2012)

Fishing mortality

Reported catches in the Indo-Pacific were investigated and collated, although stock structure remains unresolved. CEA (2018) aggregated the best available data and provide light analysis on Indonesian marine fisheries statistics but unfortunately there is no estimate available Cobia. MMAF & OFP (2021) also presented an annual report to WCPFC about the availability of catch estimates from "other commercial fisheries" in Indonesia; Cobia was not mentioned in the report.

Indonesian Centre of Data, Statistics and Information database

Cobia is not listed in the database.

FAO – FishStat J

In 2020, reported catch was 2,642 t and catch has averaged 2,917 t over the most recent four years (Table 18). FAO data suggests that only three Nations caught Cobia in 2017–2020. However, the FAO data is highly likely to be incomplete given that some catch data is available for other countries. For example, in Australia, 50.9 t was reported for 2019[12], of which 31.9 t was taken from northern Australia.

[9] https://fish.gov.au/report/345-Cobia-2020

[10] https://fish.gov.au/report/345-Cobia-2020

[11] https://fish.gov.au/report/345-Cobia-2020

[12] https://www.fish.gov.au/report/345-Cobia-2020

Table 18. FAO reported catch of Cobia between 2017 and 2020 in the Indo-Pacific [FAO 57 (Indian Ocean) and 71 (WCPO)].

Nation	Annual reported catch (t)			
	2017	2018	2019	2020
India	0	0	0	1,000
Malaysia	1,647	1502	1,203.43	800.52
Philippines	1,791	1493	1,390	842.45
Grand Total	**3,438**	**2,995**	**2,593.43**	**2,642.97**

Western Central Pacific Fisheries Commission (WCPFC)

In the WCPO, Cobia may be a retained bycatch species but there is no data on interactions with either the longline or purse seine fleet.

No data for Cobia was presented in any WCPFC Country Annual Reports

Indian Ocean Tuna Commission database

No data for cobia was reported to the IOTC .

MSC certified tuna fisheries in Indo-Pacific

During the MSC certification process, the client supplies catch data for all target, primary and secondary species. In nearly every case, Cobia is likely to make up much less than 2% of the total catch. The only exceptions were the *Solomon Islands Skipjack and Yellowfin purse seine and Pole and Line fishery* which reported that 15 kg of Cobia, and 2 kg landed by the *Eastern Tuna and Billfish Fishery* of Australia (Table 19). Cobia is either not assessed or assessed as a secondary 'minor' species during the MSC assessment process.

Table 19. Reported Cobia catch by MSC certified tuna fisheries operating in the Indo-Pacific region.

MSC certified fishery	Year	Reported Cobia catch (t)
Australia Eastern Tuna and Billfish Fishery (albacore tuna, yellowfin tuna, bigeye tuna and swordfish)	2018	0.002
Solomon Islands skipjack and yellowfin tuna purse seine and pole and line	average annual 2015-19	0.015
Estimated annual catch reported from MSC certified tuna fisheries in Indo-Pacific region		**0.017 t**

Other known mortality

In northern Australia (FAO 71), Cobia is not targeted by any fisheries; the majority of catch is landed as by-product in the Northern Territory Demersal Fishery trawl sector[13]. The catch in this jurisdiction (Northern Territory) has been steadily increasing over the past 20 years peaking at 18 t in 2016 before declining to 9 t in 2019. The catch of Cobia in Western Australia has been stable for the past 10 years (2010–19), ranging from 11.5–20.4 t, with a mean annual catch of 14.9 t (Gaughan and Santoro 2020). Historical catch trends in Queensland reached a maximum combined catch of 123 t in 2006 and then a subsequent decline to 45 t in 2019. The New South Wales commercial catch from 2012 to 2019 averaged approximately 2 t per annum, and Cobia is not a major component of recreational landings (West et al. 2015, Murphy et al. 2020). Only

[13] https://fish.gov.au/report/345-Cobia-2020

minor catches of Cobia (<0.05 t per annum) have been reported from the Commonwealth Eastern Tuna and Billfish Fishery.

Table 20 collates the annual catch of Cobia. The UoA has yet to list Cobia as a catch species in the data provided.

Table 20. Summary of Cobia catches in the Indian and western central Pacific Ocean

DATA SOURCE	Mean Cobia Annual Catch
FAO catch from Statistical Areas 57, 71)	2917. t
MSC certified fisheries	0.017 t
Australian fisheries	50.9 t
Estimated annual catch (tonnes	2967.9 t

3. CATCH TRENDS

There is no catch trend data available for Cobia from the WCPFC or IOTC.

When comparing annual reported catches in the WCPFC-CA (Figure 6), it is clear to see that Wahoo catches by both purse seine and longline fleets have not varied much in 14–16 years. Conversely, Mahi Mahi catches have been less stable with significant growth from 2007 to a peak in 2011 and lower catches each subsequent year for longline. The weight of longline caught Mahi Mahi and Wahoo is an estimate only, and using number of fish and average fish size (1.3 kg) has limitations when looking at trends as the size composition of catches may have changed significantly.

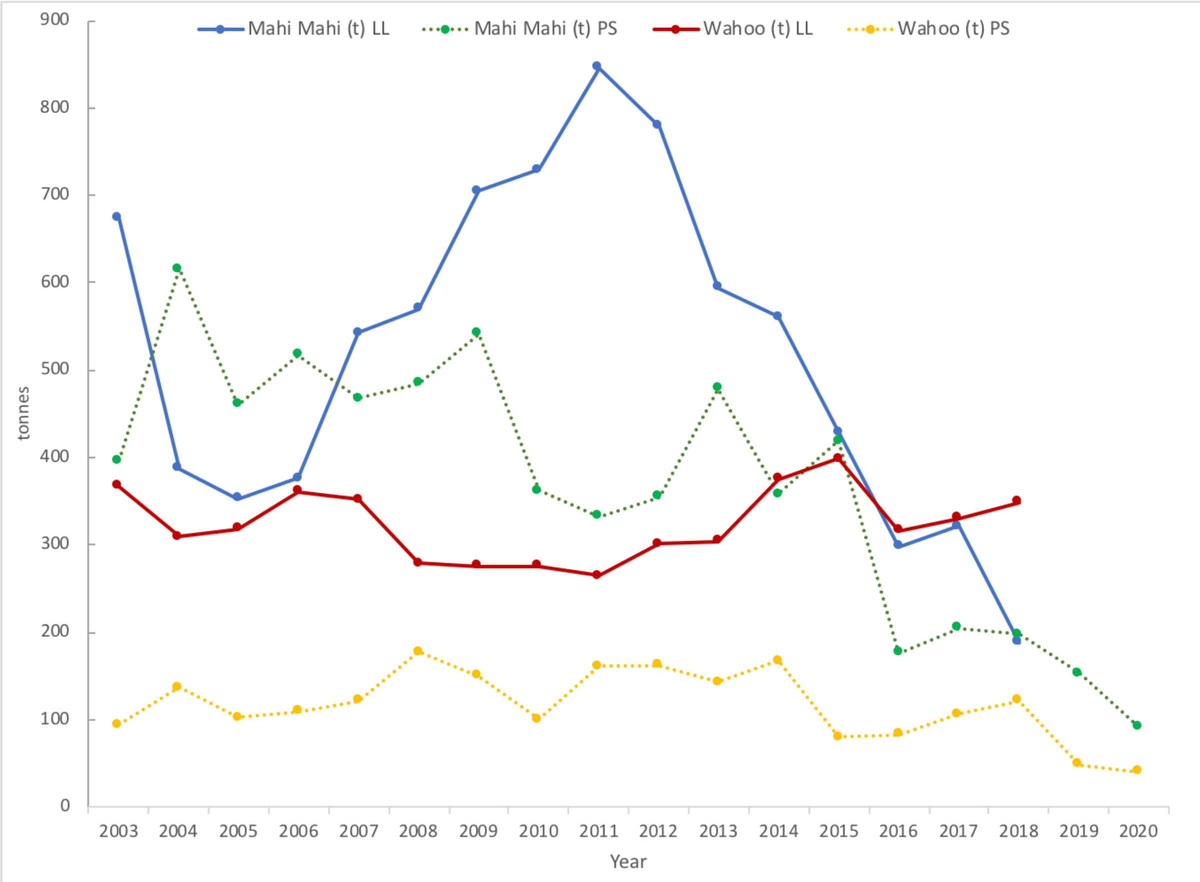

Figure 6. Reported Longline (LL) and Purse Seine (PS) catches of Mahi Mahi and Wahoo from the WCPFC-CA between 2003 and 2020 (produced using data from Peatman & Nicol).

In the Indian Ocean, reported catches of Mahi Mahi have been increasing since 2011, with a peak in 2019 (Figure 7). Gillnetters dominate the reported gear type, although more recently, there has been an increase in Mahi Mahi catches by the purse seine (specifically ring-net) fleet.

Reported Wahoo catches date back to 1954 in the Indian Ocean (Figure 8), and all catches were reportedly from line operations until the late 1970s. The Gillnet fleet made up more than 50% of the Wahoo catch in 1991, and there has been a steady increase in gillnet catches since. In 2012, Longline catches were dominant, and purse seine catches increased in proportion in 2015.

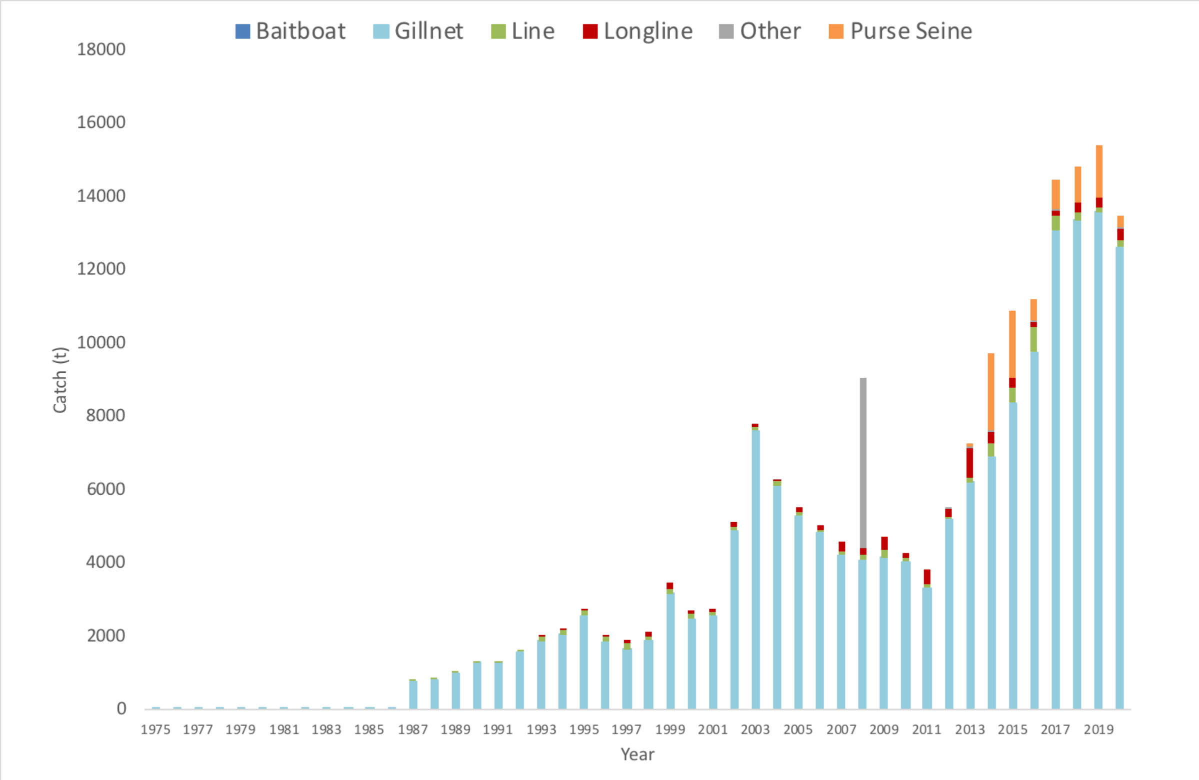

Figure 7. IOTC reported catches of Mahi Mahi by gear type from the Indian Ocean between 1975 and 2020 (Source: IOTC database)

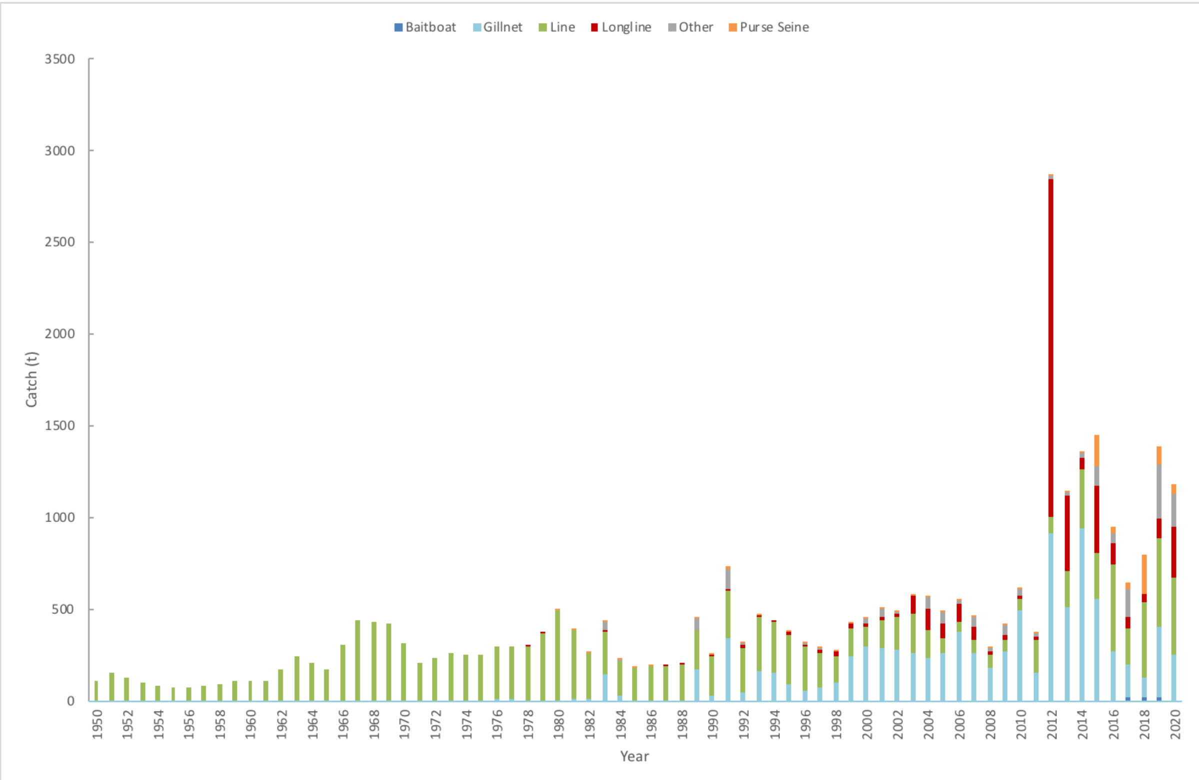

Figure 8. IOTC reported catches of Wahoo by gear type from the Indian Ocean between 1950 and 2020 (Source: IOTC database)

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