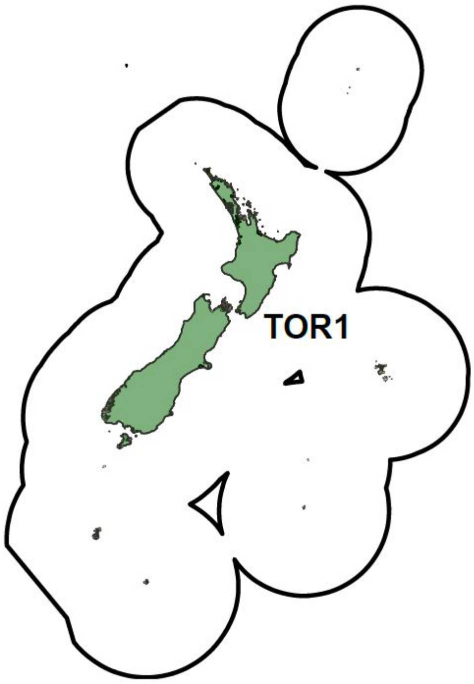
PACIFIC BLUEFIN TUNA (TOR)

(Thunnus orientalis)



1. FISHERY SUMMARY

Pacific bluefin tuna was introduced into the Quota Management System (QMS) on 1 October 2004 under a single Quota Management Area, TOR 1, with New Zealand allowances, Total Allowable Commercial Catch (TACC), and Total Allowable Catch (TAC) given in Table 1.

Table 1: Recreational and customary non-commercial allowances, TACC, and TAC (all in t) for Pacific bluefin tuna.

Fishstock	Recreational allowance	Customary non-commercial allowance	Other mortality	TACC	TAC
TOR 1	25	0.50	3.5	116	145

Pacific bluefin tuna were added to the Third Schedule of the 1996 Fisheries Act with a TAC set under s14 because Pacific bluefin tuna is a highly migratory species and it is not possible to estimate MSY for the part of the stock that is found within New Zealand fisheries waters.

Pacific bluefin tuna is believed to be a single Pacific-wide stock and is covered by two regional fisheries management organisations, the Western and Central Pacific Fisheries Commission (WCPFC), and the Inter-American Tropical Tuna Commission (IATTC). They cooperate in the management of the Pacific bluefin tuna stock throughout the Pacific Ocean.

Currently, the TACC is set above New Zealand's national catch limit set by the WCPFC. New Zealand's catch of Pacific bluefin tuna has historically been significantly below the WCPFC limit. During the 2022–23 fishing year, however, catch significantly increased to 103 tonnes, exceeding the WCPFC catch limit (63 tonnes). Because fishing effort decreased over this period, the increase in catch may be due to increased abundance of the stock, as well as changing oceanic conditions.

In light of the recent increase in catch, and following a recent analysis estimating that bluefin tunas typically have high post-release survival (>80%) following capture by surface longline and troll (Moore & Finucci, 2024), the Minister for Oceans and Fisheries approved a new commercial exception for the return of Pacific bluefin tuna to the sea, when caught in these gears and likely to survive. This exception came into effect on 1 March 2024. Despite the new provision allowing live release, in 2023 fishers continued to report increased catch of Pacific bluefin tuna which cannot be released alive and must be landed, often in excess of their Annual Catch Entitlement (ACE).

1.1 Commercial fisheries

Pacific bluefin tuna was not widely recognised as a distinct species until the late 1990s. It was previously regarded as a sub-species of *Thunnus thynnus* (northern bluefin tuna, NTU). Prior to June 2001, catches of this species were either recorded as NTU or misidentified as southern bluefin tuna. Fishers have since become increasingly able to accurately identify TOR and, from June 2001, catch reports have rapidly increased. Catches of TOR may still be under-reported to some degree because there is still some reporting against the NTU code. Recent genetic work suggests that true NTU (*Thunnus thynnus*) are not taken in the New Zealand fishery (see Biology section below for further details). Figure 1 shows the historical landings and domestic longline fishing effort for TOR 1.

Pacific bluefin has been fished in the New Zealand EEZ since at least 1960, with some catch likely but undocumented prior to that time. New Zealand catches are small compared with total stock removals (Table 2). In contrast to New Zealand, where Pacific bluefin tuna are taken almost exclusively by longline, the majority of catches are taken in purse seine fisheries in the western and central Pacific Ocean (by Japan and Korea) and Eastern Pacific Ocean (by Mexico). Much of the fish taken by the Mexican fleet are on-grown in sea pens.

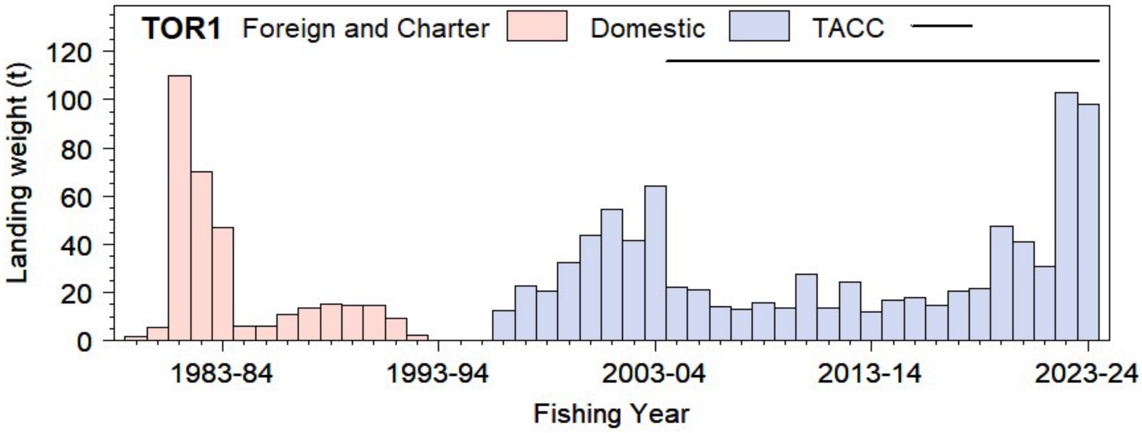


Figure 1: Commercial catch of Pacific bluefin tuna by foreign licensed and New Zealand vessels from 1979–80 to present within New Zealand waters (TOR 1).

Table 2: Reported total New Zealand landings (t) of Pacific bluefin tuna (includes landings attributed to NTU) and total Pacific Ocean catches, 1991 to 2023 (calendar years).

Year	NZ landings (t)	Total stock (t)	Year	NZ landings (t)	Total stock (t)	Year	NZ landings (t)	Total stock (t)
1991	1.5	15 759	2002	56.86	19 026	2013	23.9	11 324
1992	0.3	13 977	2003	40.8	18 528	2014	12.1	17 099
1993	5.6	10 781	2004	67.3	25 536	2015	16.5	11 221
1994	1.9	16 891	2005	29.2	29 174	2016	17.6	13 275
1995	1.8	29 200	2006	21.1	26 234	2017	14.4	14 744
1996	4.2	23 505	2007	14	20 720	2018	20.7	10 565
1997	14.3	24 579	2008	14.0	24 523	2019	23.1	11 589
1998	20.4	15 754	2009	16.0	19 440	2020	46.1	14 025
1999	21.2	29 136	2010	13.6	17 852	2021	41.7	15 142
2000	20.9	33 946	2011	27.4	17 068	2022	34.3	17 633
2001	49.8	18 781	2012	13.3	14 841	2023	105.0	18 058

Source: New Zealand landings, for 1991–2001 Licensed Fish Receiver Returns data and Solander Fisheries Ltd.; 2003–present MHR data. Total Pacific landings available from the International Scientific Committee (ISC). This covers most catches from this stock but does not include South Pacific catches by coastal states in the South Pacific.

Prior to the introduction into the QMS, the highest catches were made in Fishery Management Area (FMA) 1 and FMA 2. Although it is possible to catch Pacific bluefin as far south as 48º S, few catches are made in the colder southern FMAs. Although recent catches have occurred in FMA 7, fish have been in poor condition with little commercial value. Catches are almost exclusively by tuna longlines, typically as a bycatch of sets targeting bigeye (*Thunnus obesus*) tuna; there is no targeted commercial fishery for Pacific bluefin tuna in New Zealand.

In New Zealand longline fisheries, Pacific bluefin tuna made up around 7% of the commercial catch in 2023–24 (Figure 2). Longline fishing effort is distributed along the east coast of the North Island and the south-west coast of the South Island. The south-west coast South Island fishery predominantly targets southern bluefin tuna, whereas the east coast of the North Island targets a range of species including bigeye, swordfish, and southern bluefin tuna.

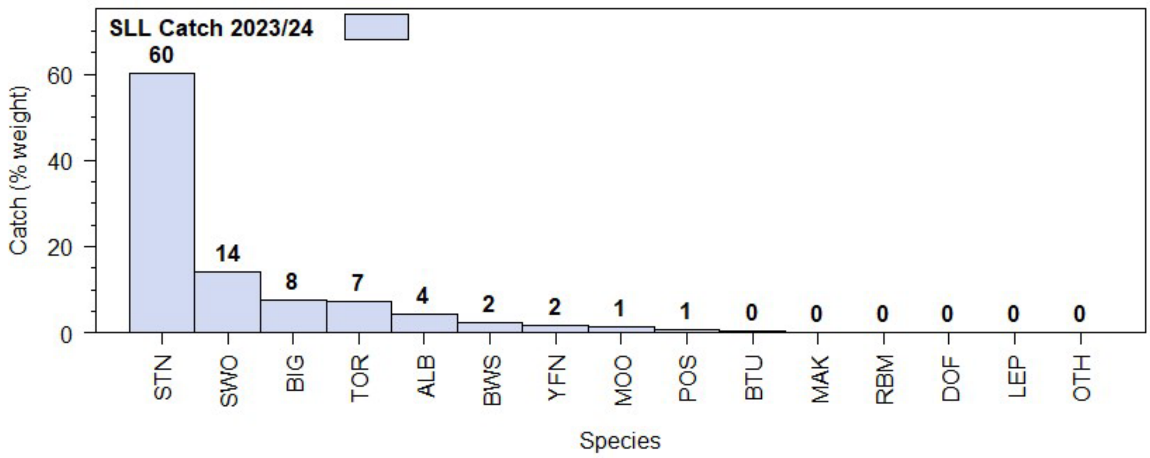


Figure 2: A summary of species composition of all surface longline estimated catch. The percentage by weight of each species is calculated for all surface longline trips.

1.2 Recreational fisheries

Recreational fishers make occasional catches of Pacific bluefin tuna. In 2004 a target recreational fishery developed off the west coast of the South Island targeting large Pacific bluefin tuna that feed on spawning aggregations of hoki (*Macruronus novaezealandiae*), and a recreational allowance of 1 tonne was set. Fish taken in this fishery were submitted for various world records for this species. Some information on charter vessel catch was collected through voluntary reporting and from 2011 recreational charter boats have been required to register and report catch and effort in this fishery. A small number of private boats are also active in the fishery. The recreational allowance for Pacific bluefin was increased from 1 t to 25 t per year from 1 October 2011 to recognise the growth in this fishery. There has been a decline in catch rates and recreational fishing effort since 2015, although this may change as the abundance of Pacific bluefin tuna in New Zealand waters increases.

1.2.2 Estimates of recreational harvest

No estimates of recreational harvest of Pacific Bluefin tuna were generated from the telephone diary surveys conducted in 1994, 1996, and 2000 because so few were reported. A national panel survey was conducted for the first time throughout the 2011–12 fishing year (Wynne-Jones et al. 2014) and was repeated during the 2017–18 and 2022–23 fishing years (Wynne-Jones et al. 2019, Heinemann & Gray 2024). The national panel survey results do not include estimates for Pacific bluefin tuna because the surveys do not reflect the number of fishers and fishing activity for the large gamefish species.

1.3 Customary non-commercial fisheries

There is no quantitative information available to allow the estimation of the harvest of Pacific bluefin tuna by customary fishers; however, the Māori customary catch of Pacific bluefin is probably negligible because of its seasonal and offshore distribution.

1.4 Unreported catch

There is no known unreported catch of Pacific bluefin tuna in New Zealand fisheries waters.

1.5 Other sources of mortality

There is likely to be a low level of shark damage and discard mortality of Pacific bluefin caught on tuna longlines that may be on the order of 1–2% assuming that all tuna species are subject to equivalent levels of incidental mortality. There have been reports that some fish hooked in the target recreational fishery have been lost due to entanglement of the fishing line with trawl warps. The survival of these lost fish is not known. An allowance of 3.5 t has been made for other sources of mortality.

2. BIOLOGY

Pacific bluefin tuna are epipelagic opportunistic predators of fish, crustaceans, and cephalopods found within the upper few hundred metres of the water column. Individuals found in New Zealand fisheries waters are mostly adults. Adult Pacific bluefin occur broadly across the Pacific Ocean, especially the waters of the North Pacific Ocean, occupying a broad thermal niche, occurring in waters from less than 10 °C to 30 °C (Fujioka et al. 2021).

Like all *Thunnus* species, Pacific bluefin tuna are obligate ram ventilators, requiring a constant supply of water over their gills to breath. The species has a complex system of heat exchangers (retia mirabilia) in their muscle, eyes, brain, and viscera, that, coupled with their elevated metabolic rates, enable bluefins to conserve heat (Shiels et al. 2011).

There has been some uncertainty among fishers regarding bluefin tuna taken in New Zealand waters. Some fishers believe that three species of bluefin tuna are taken in New Zealand waters with some small catches of true ‘Northern’ Atlantic tuna (*Thunnus thynnus*, NTU) in addition to Pacific and southern bluefin tuna. This belief is based on several factors including differences in morphology and the prices obtained for certain fish on the Japanese market.

To address this issue, muscle tissue samples were taken from 20 fish for which there was uncertainty as to whether the fish was a Pacific bluefin tuna (*Thunnus orientalis*) or an Atlantic bluefin tuna. A further sample from a fish thought to be a southern bluefin tuna was also included. The tissue samples were sequenced for the COI region of DNA, and the sequences compared with COI sequences for the three species of tuna held in GenBank. All DNA sequences, except one, matched with sequences for

Pacific bluefin tuna. The final sample was confirmed as a southern bluefin tuna. Therefore, based on DNA analysis, there is presently no evidence that Atlantic bluefin tuna are taken in New Zealand waters (Smith et al 2001, Smith & McVeagh 2006). Further tissue samples from fish thought by fishers to be NTU will be collected by scientific observers.

Adult Pacific bluefin reach a maximum size of 550 kg and length of 300 cm. Maturity is reached at 3 to 5 years of age and individuals live to 15+ years old. Spawning takes place between the Philippine Sea and the Japanese Ryuku Islands in April, May, June, spreading to the waters off southern Honshu in July and to the Sea of Japan in August. Some Pacific bluefin may spawn in the Kuroshio-Oyashio transition area off northeastern Japan from May to July (Shiao et al. 2021 and references therein).

Pacific bluefin of 270 to 300 kg produce about 10 million eggs but there is no information on the frequency of spawning. Juveniles make extensive migrations north and eastwards across the Pacific Ocean as 1–2 year old fish. Pacific bluefin caught in the southern hemisphere, including those caught in New Zealand waters, are mainly adults.

Natural mortality is assumed to vary from about 0.1 to 0.4 and to be age specific in assessments undertaken by the IATTC. A range of von Bertalanffy growth parameters have been estimated for Pacific bluefin based on length-frequency analysis, tagging, and reading of hard parts (Table 3).

Table 3: von Bertalanffy growth parameters for Pacific bluefin tuna.

Method	*L* infinity	*k*	t_0
Length frequencies	300.0		
Scales	320.5	0.1035	- 0.7034
Scales	295.4		
Tagging	219.0	0.211	

The length:weight relationship of Pacific bluefin based on observer data from New Zealand caught fish yields the following:

whole weight = $8.058\, e^{0.015\, \text{length}}$ $R^2 = 0.895$, n = 49 (weight is in kg and length is in cm).

Although the sample size of genetically confirmed Pacific bluefin that have been sexed by observers is small (50 fish), the sex ratio in New Zealand waters is not significantly different from 1:1.

3. STOCKS AND AREAS

Pacific bluefin tuna constitutes a single Pacific-wide stock that is primarily distributed in the northern hemisphere.

Between 2006 and 2008, 42 Pacific bluefin were tagged from recreational charter vessels in New Zealand waters using Pop-off Satellite Archival Tags (PSATs), and all tags that have ‘reported’ indicate that these fish survived catch and release and spent several months within the New Zealand or Australian EEZs and adjacent waters over spring and summer. In addition, 138 Pacific bluefin have been released with conventional tags. There have been four recaptures all from the West Coast recreational fishery. One fish was recaptured after two years, 22 nautical miles from the release point, and another after four years at liberty just 60 miles from where it was released. Both of these fish had carried PSAT tags.

4. ENVIRONMENTAL AND ECOSYSTEM CONSIDERATIONS

This summary is from the perspective of Pacific bluefin tuna but there is no directed fishery for this species. Pacific bluefin tuna is largely caught as bycatch in the target Southern bluefin tuna and Swordfish surface longline fisheries, and a more details description of bycatch for these fisheries is provided in their respective chapters. The incidental catch sections below reflect the New Zealand longline fishery as a whole and are not specific to this species; a more detailed summary from an issue-by-issue perspective is available in the Aquatic Environment and Biodiversity Annual Review where the consequences are also discussed (Fisheries New Zealand 2021).

4.1 Role in the ecosystem

Pacific bluefin tuna (*Thunnus orientalis*) is one of the largest teleost fish species (Kitagawa et al. 2004), comprising a single population that spawns only to the south of Japan and in the Sea of Japan (Sund et al. 1981). Pacific bluefin tuna are large pelagic predators, so they are likely to have a 'top down' effect on the fish, crustaceans, and squid they feed on.

4.2 Non-target fish catch

Observer records indicate that a wide range of species are landed by the longline fleets in New Zealand fishery waters. Blue sharks are the most commonly caught species (by number), followed by lancetfish and porbeagle shark (Table 4).

Table 4: Total estimated catch (numbers of fish) of common bycatch species in the New Zealand surface longline fishery as estimated from observer data from 2017 to 2022. Observer data too limited to raise to the fleet for 2023. Also provided is the percentage of these species retained (2022 data only) and the percentage of fish that were alive when discarded, N/A (none discarded). (New Zealand 2024)

Species	2017	2018	2019	2020	2021	2022	% retained (2022)	discards % alive (2022)
Blue shark	49 924	63 618	89 377	37 093	39 524	65 277	0	91.9
Porbeagle shark	3 101	2 594	2 883	1 320	2 248	2 810	0	29.2
Lancetfish	13 274	13 163	18 747	11 457	4 211	2 212	0	2.1
Butterfly tuna	406	419	348	120	388	663	96.0	0
Moonfish	2 022	2 698	1 975	1 834	1 033	526	100.0	N/A
Oilfish	227	602	417	1 149	504	510	0	74.3
Pelagic stingray	1 798	2 949	526	1721	3 182	508	0	97.1
Ray's bream	2 421	1 579	1 949	3 211	2 514	494	90.0	10.0
Mako shark	1 391	2 721	1 138	859	933	310	0	72.2
Striped marlin	290	247	157	279	426	175	0	66.7
Escolar	300	594	488	808	388	146	0	30.0
Skipjack tuna	57	184	8	134	110	117	100.0	N/A
Rudderfish	680	253	186	164	221	80	66.7	33.3
Dealfish	72	25	23	69	18	80	0	33.3
Sunfish	1 648	3 648	1 982	1 618	1 537	56	0	100.0
Big scale pomfret	17	34	0	52	17	53	0	50.0
School shark	59	187	116	29	64	27	100.0	N/A
Deepwater dogfish	32	6	90	29	42	27	0	100.0
Thresher shark	260	253	193	269	161	15	0	0

4.3 Benthic interactions

There are no known interactions with benthic habitats for this fishery.

5. STOCK ASSESSMENT

The ISC[1] has conducted benchmark stock assessments every four years since 2012. Between the consecutive benchmark assessments, ISC conducts an updated assessment to track the current stock status using additional data observations. In 2024, the Pacific Bluefin Working Group (PBFWG) conducted a benchmark stock assessment (Anon, 2024).

The PBFWG critically reviewed all aspects of the model, and some modifications were made. A total of 26 fleets were defined for use in the stock assessment model based on country/gear/season/region stratification until the end of the fishing year 2022 (June 2023). Quarterly observations of catch and size compositions, when available, were used as inputs to the model to describe the removal processes. Annual estimates of standardized CPUE from the Japanese distant water, offshore, and coastal longline, the Chinese Taipei longline, and the Japanese troll fleets were used as measures of the relative

[1] International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean.

abundance of the population. The CPUE of Japanese longline (adult index) after 2020 and Japanese troll (recruitment index) after 2010 were not included in the model, as these observations were considered potentially biased due to additional management measures in Japan. The assessment model was fitted to the input data in a likelihood-based statistical framework. Maximum likelihood estimates of model parameters, derived outputs, and their variances were used to characterize stock status and to develop stock projections.

One of the major changes made in this assessment is that the PBFWG decided to shorten the stock assessment model by starting in 1983 instead of 1952. This adjustment was implemented because more reliable data are available after 1983. Additionally, the adoption of a shorter model period enhances flexibility and can accommodate diverse productivity assumptions. This flexibility is an important feature as this model will be used in the upcoming PBF management strategy evaluation (MSE). The PBFWG confirmed that the results and management quantities of the longer period model and the shorter period model are consistent and that the change in the duration of the assessment model does not affect the management advice. Other changes include refined parameterization of selectivity to reduce model residuals and shortening of the recruitment index from 1983–2016 to 1983–2010. The truncation of the recruitment index was supported by various analyses and was considered appropriate to reduce the SSB retrospective bias (Mohn's ρ for 10 years-retrospective analysis in the base case is -0.06), which was observed in several previous assessment models.

Stock status and trends

While there are few Pacific bluefin tuna (PBF) catch records prior to 1952, PBF landing records are available dating back to 1804 from coastal Japan and to the early 1900s for U.S. fisheries operating in the Eastern Pacific Ocean (EPO). Based on these landing records, PBF catch is estimated to be high from 1929 to 1940, with a peak catch of approximately 47 635 t (36 217 t in the Western Pacific Ocean (WPO) and 11 418 t in the EPO) in 1935; thereafter catches of PBF dropped precipitously due to World War II. PBF catches increased significantly in 1949 as Japanese fishing activities expanded across the North Pacific Ocean. By 1952, a more consistent catch reporting process was adopted by most fishing nations and estimated annual catches of PBF fluctuated widely from 1952–2022 (Figure 3). During this period reported catches peaked at 40 383 t in 1956 and reached a low of 8 653 t in 1990. The reported catch in 2021 and 2022 was 15 107 t and 17 458 t, respectively, including non-member countries of the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC). Management measures were implemented by Regional Fisheries Management Organizations (RFMOs) beginning in 2011 (WCPFC in 2011 and IATTC in 2012) and became stricter in 2015. While a suite of fishing gears has been used to catch PBF, the majority of the catch is currently made by purse seine fisheries (Figure 4). Catches during 1952–2022 were predominantly composed of juvenile PBF; the catch of age 0 PBF has increased significantly since the early 1990s but declined as the total catch in weight declined since the mid-2000s and due to stricter control of juvenile catch (Figures 3 and 5).

The base-case model results show that: (1) spawning stock biomass (SSB) fluctuated throughout the assessment period (fishing years 1983–2022); (2) the SSB steadily declined from 1996 to 2010; (3) the SSB has rapidly increased since 2011; (4) fishing mortality (F%SPR) decreased from a level producing about 1% of SPR[2] in 2004–2009 to a level producing 23.6% of SPR in 2020–2022; and (5) SSB in 2022 increased to 23.2% of $SSB_{F=0}$[3], achieving the second rebuilding target by WCPFC and IATTC in 2021. Based on the model diagnostics, the estimated biomass trend throughout the assessment period is considered robust. The SSB in 2022 was estimated to be 144 483 t (Table 5, Figure 6), more than 10 times its historical low in 2010. An increase in immature fish (0–3 years old) is observed in 2016–2019 (Figure 7), likely resulting from reduced fishing mortality on this age group. This led to a substantial increase in SSB after 2019. The method to estimate the confidence interval was changed from bootstrapping in the previous assessments to normal approximation of the Hessian matrix.

[2] SPR (spawning potential ratio) is the ratio of the cumulative spawning biomass that an average recruit is expected to produce over its lifetime when the stock is fished at the current fishing level to the cumulative spawning biomass that could be produced by an average recruit over its lifetime if the stock was unfished. F%SPR: F that produces % of the spawning potential ratio (i.e., 1-%SPR).

[3] $SSB_{F=0}$ is the expected spawning stock biomass under average recruitment conditions without fishing.

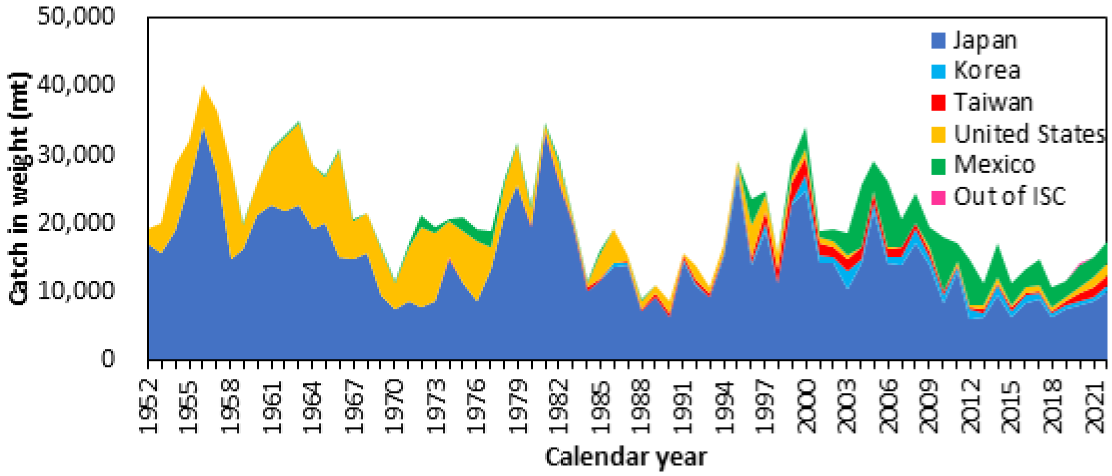


Figure 3. Annual catch (tonnes) of Pacific bluefin tuna (*Thunnus orientalis*) by ISC members from 1952 through to 2022 (calendar year) based on ISC official statistics.

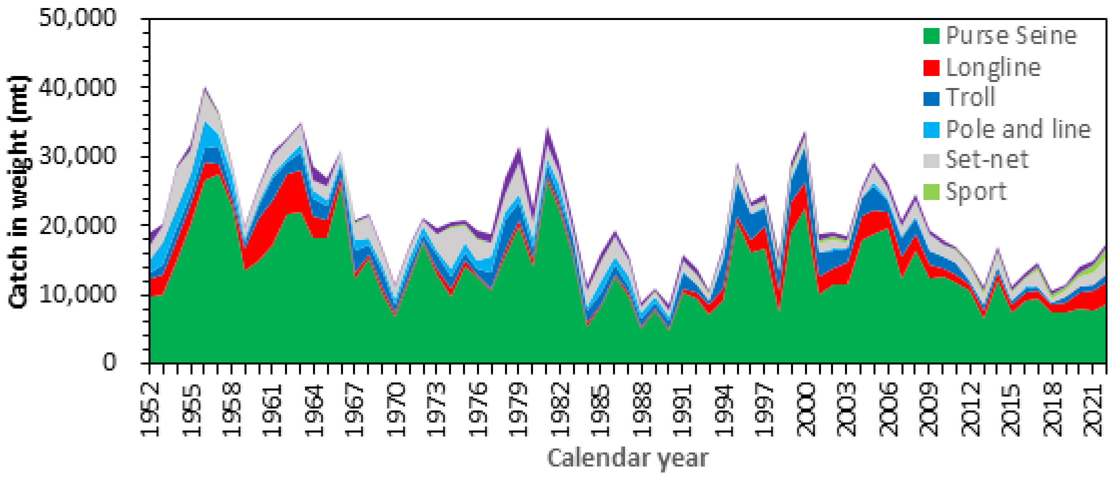


Figure 4. Annual catch (tonnes) of Pacific bluefin tuna (*Thunnus orientalis*) by gear type by ISC member countries from 1952 through 2022 (calendar year) based on ISC official statistics.

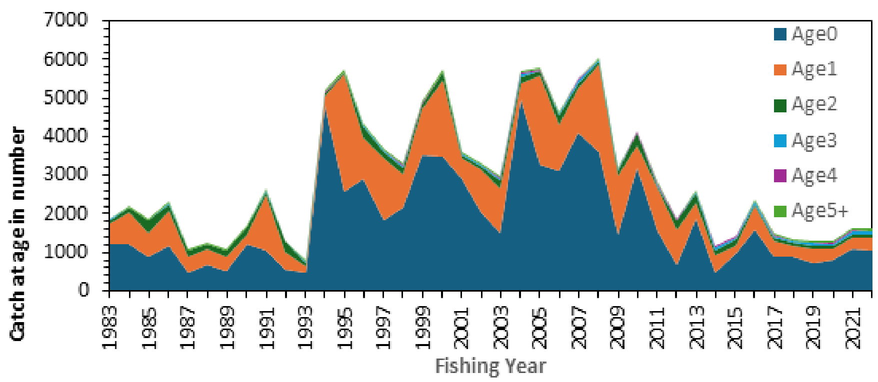


Figure 5. Estimated annual catch-at-age (number of fish) of Pacific bluefin tuna (*Thunnus orientalis*) by fishing year estimated by the base-case model (1983–2022)

Historical recruitment estimates have fluctuated since 1983 without an apparent trend (Figure 6). Currently, stock projections assume that future recruitment will fluctuate around the historical (1983–

2020 FY) average recruitment level. Previously, no significant autocorrelation was found in recruitment estimates, supporting the use in the projections of recruitment sampled at random from the historical time series. In addition, now that SSB has recovered to 23.2%$SSB_{F=0}$, the PBFWG considers the assumption that the future recruitment will fluctuate within the historical range to be reasonable. The PBFWG also confirmed that the distributions of historical recruitment from the updated long-term model (1952–2022) and the present base-case model (1983–2022) are comparable.

Table 5. Total biomass, spawning stock biomass, recruitment, spawning potential ratio, and depletion ratio of Pacific bluefin tuna (*Thunnus orientalis*) estimated by the base-case model, for the fishing years 1983-2022.

Year	Total Biomass (mt)	Spawning Stock Biomass (mt)	Recruiment (x1000 fish)	Spawning Potential Ratio	Relative biomass over $SSB_{F=0}$
1983	31,993	15,429	11,827	3.7%	2.5%
1984	34,852	13,898	8,176	7.1%	2.2%
1985	38,514	14,280	9,207	4.6%	2.3%
1986	38,713	15,925	8,094	1.8%	2.6%
1987	36,385	16,934	6,956	10.4%	2.7%
1988	40,630	19,967	8,977	16.4%	3.2%
1989	47,141	20,590	4,187	18.1%	3.3%
1990	57,723	26,079	21,138	22.1%	4.2%
1991	75,302	34,208	7,400	13.2%	5.5%
1992	84,406	43,037	4,375	16.8%	6.9%
1993	93,667	55,854	3,985	19.0%	9.0%
1994	103,163	64,267	30,951	12.0%	10.3%
1995	116,349	79,269	15,247	7.3%	12.7%
1996	109,419	75,121	17,967	9.2%	12.1%
1997	108,955	68,311	11,344	7.5%	11.0%
1998	104,534	66,696	15,469	5.2%	10.7%
1999	100,748	60,915	21,993	5.6%	9.8%
2000	94,830	57,366	13,910	1.9%	9.2%
2001	82,675	54,907	16,944	9.6%	8.8%
2002	83,931	51,822	13,375	6.3%	8.3%
2003	79,217	49,650	6,748	2.3%	8.0%
2004	70,699	41,296	27,619	1.3%	6.6%
2005	65,488	33,668	15,323	0.6%	5.4%
2006	51,886	26,737	13,854	1.1%	4.3%
2007	45,705	20,791	23,619	0.5%	3.3%
2008	44,337	16,082	21,038	1.0%	2.6%
2009	39,232	12,526	7,983	1.7%	2.0%
2010	37,537	12,275	17,593	2.8%	2.0%
2011	39,632	14,236	13,822	5.8%	2.3%
2012	43,506	17,447	7,663	9.6%	2.8%
2013	48,901	19,711	14,239	7.6%	3.2%
2014	54,166	22,690	4,882	15.9%	3.6%
2015	62,945	28,019	13,367	20.9%	4.5%
2016	77,523	37,762	16,040	21.5%	6.1%
2017	94,213	44,541	11,417	31.4%	7.2%
2018	118,007	56,986	9,991	37.1%	9.2%
2019	146,407	74,734	7,485	29.5%	12.0%
2020	168,571	104,243	6,828	28.4%	16.8%
2021	182,567	131,729	8,275	20.5%	21.2%
2022	186,632	144,483	11,467	21.9%	23.2%
Median (1983-2022)	73,000	35,985	11,647	8.4%	5.8%
Average (1983-2022)	78,528	44,112	12,769	11.5%	7.1%
Unfished (Equilibrium)	785,281	622,254	13,261	100%	100%

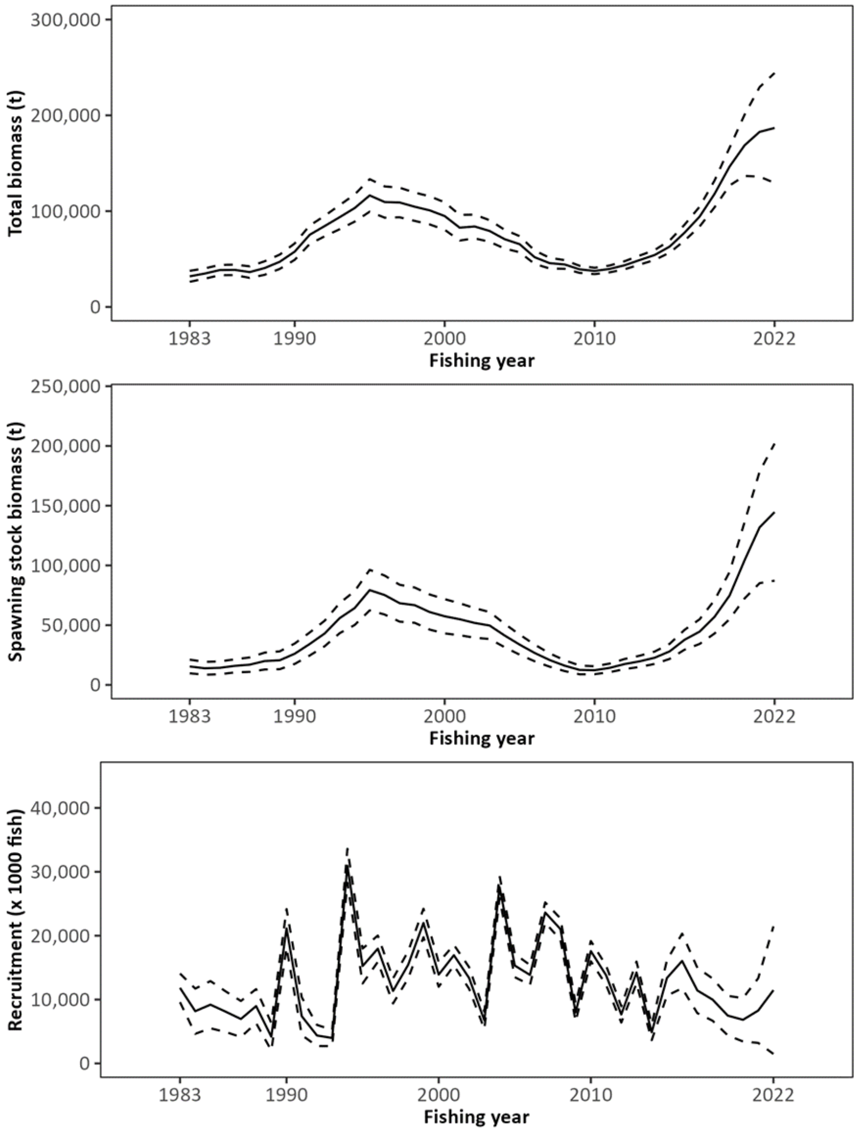


Figure 6. Trajectory of total stock biomass (top), spawning stock biomass (middle), and recruitment (bottom) of Pacific bluefin tuna (*Thunnus orientalis*) (1983–2022) estimated from the base-case model. The solid line is the point estimate, and dashed lines delineate the 90% confidence interval. The method used to estimate the confidence interval was changed from bootstrapping in the previous assessments to the normal approximation of the Hessian matrix.

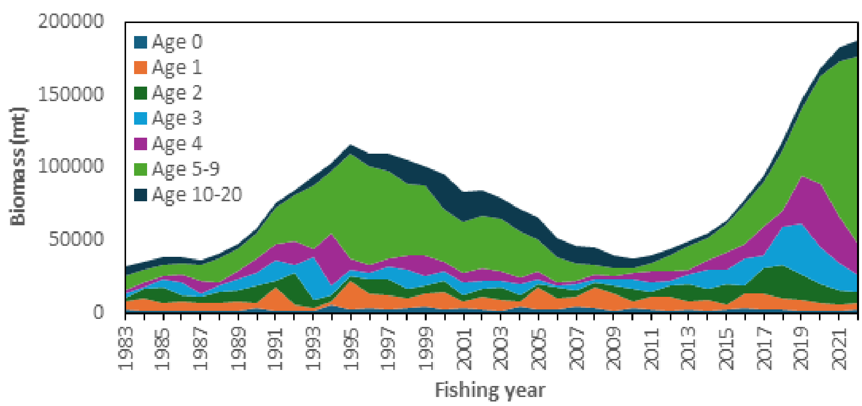


Figure 7. Total biomass (tonnes) by age of Pacific bluefin tuna (*Thunnus orientalis*) estimated from the base-case model (1983–2022). Note that the recruitment estimates for 2019–2022 are more uncertain than for other years.

The 20th WCPFC Scientific Committee (SC20) noted that PBF spawning stock biomass (SSB) has increased substantially in the last 12 years. These biomass increases coincide with a decline in fishing mortality, particularly for fish aged 0 to 3, over the last decade. The latest (2022) SSB is estimated to be 23.2% of $SSB_{F=0}$ and the probability that it is above 20%$SSB_{F=0}$ is 75.9%.

No biomass-based limit or target reference points have been adopted for PBF, but the PBF stock is not overfished relative to 20%$SSB_{F=0}$, which has been adopted as a biomass-based reference point for some other tuna species by the IATTC and WCPFC. SSB of PBF reached its initial rebuilding target (SSBMED = 6.3%$SSB_{F=0}$) in 2017, 7 years earlier than originally anticipated by the RFMOs, and its second rebuilding target (20%$SSB_{F=0}$) in 2021.

No fishing mortality-based reference points have been adopted for PBF by the IATTC and WCPFC either. The recent (2020–2022) F%SPR is estimated to be 23.6% and thus the PBF stock is not subject to overfishing relative to some of the F-based reference points proposed for tuna species (Table 6), including F20%SPR. It should be noted that the default overfishing threshold for the New Zealand Harvest Strategy Standard is F40%SPR (MPI 2008).

Table 6. Ratios of the estimated fishing mortalities (Fs and 1-SPRs for 2002–04, 2012–14, 2020–2022) relative to potential fishing mortality-based reference points, and terminal year SSB (t) for each reference period, and depletion ratios for the terminal year of the reference period for Pacific bluefin tuna (*Thunnus orientalis*) from the base-case model. F_{max}: Fishing mortality (F) that maximizes equilibrium yield per recruit (Y/R). Fxx%SPR: F that produces a given % of the unfished spawning potential (biomass) under equilibrium conditions.

Reference Period	Fmax	(1-SPR)/(1-$SPR_{xx\%}$)				Estimated SSB for terminal year of each period (ton)	Depletion rate for terminal year of each period (%)
		$SPR_{20\%}$	$SPR_{25\%}$	$SPR_{30\%}$	$SPR_{40\%}$		
2002-2004	1.88	1.21	1.29	1.38	1.61	41,296	6.6%
2012-2014	1.24	1.11	1.19	1.27	1.48	22,690	3.6%
2020-2022	0.84	0.95	1.02	1.09	1.27	144,483	23.2%

Management advice and implications

The Kobe plot shows that the point estimate of the SSB2022 was 23.2%$SSB_{F=0}$ and that the recent (2020–2022) fishing mortality corresponds to F23.6%SPR (Table 5 and Figure 8). The apparent increase in F in the terminal period compared to the historical low in 2018 (F37.1%SPR) is a result of low recruitment in this period. As noted, the recruitment estimates in recent years are more uncertain and this result needs to be interpreted with caution.

SC20 provided the following information on the conservation of the Pacific bluefin tuna stock based on the ISC24 findings (ISC 2024):

- The PBF stock is recovering from the historically low biomass in 2010 and has exceeded the second rebuilding target (20%$SSB_{F=0}$). The risk of SSB falling below 7.7%$SSB_{F=0}$ (interim Limited Reference Point (LRP) for tropical tunas in IATTC) at least once in 10 years is negligible;
- Projection results (Table 7 and Figure 9) show that increases in catches are possible. However, the risk of falling below the second rebuilding target will increase with larger increases in catch;
- The projection results assume that the CMMs (Conservation and Management Measures) are fully implemented and are based on certain biological and other assumptions. For example, these future projection results do not contain assumptions about discard mortality. Discard mortality may need to be considered as part of future increases in catch; and
- Given the uncertainty in future recruitment and the influence of recruitment on stock biomass as well as the impact of changes in fishing operations due to the management, monitoring recruitment and SSB should continue. Research on a recruitment index for the stock assessment should be pursued, and maintenance of a reliable adult abundance index should be ensured. In addition, accurate catch information is the foundation of good stock assessment.

Table 7. Future projection scenarios for Pacific bluefin tuna (*Thunnus orientalis*). The numbering of Scenarios is different from those given by the IATTC-WCPFC NC Joint WG meeting. Fishing mortality in scenario 3 was kept at zero. The catch limit for scenario 12 is calculated to achieve SPR 30% and allocated to fleets proportionately. The Japanese unilateral measure (transferring 250 mt of the catch upper limit from that for small PBF to that for large PBF during 2022–2034) is reflected in the projections.

Harvesting scenarios											
Reference No	Scenarios				Catch limit in the projection				Specified fishery impact at 2034		Note
	WCPO		EPO		WCPO		EPO				
	Small	Large	Small	Large	Small	Large	Small	Large	WCPO	EPO	
1	Status quo (WCPFC CMM2023-02, IATTC Resolution 21-05)				4,475	7,859	3,995		-	-	JWG's request 1(NC19 Summary Report, Attachment E; Maintaining the current CMM)
2	Maintaining the current CMM assuming maximum transfer utilizing the conversion factor				3,236	9,799	3,995		-	-	JWG's request 02 (Maximum utilization of transfer from small fish catch limit to large fish catch limit using the conversion factor).
3	No fishing allowed				0	0	0		-	-	JWG's request 03 (No fishing)
4	Status quo +60%	Status quo +60%	Status quo +60%		7,310	12,424	6,392		-	-	JWG's request 04-1 (scenario achieving 20%SSB0 with 60%probability by pro-rata change in catch).
5	Status quo	Status quo +180%	Status quo +180%		4,475	21,555	11,186		-	-	JWG's request 04-2 (scenario achieving 20%SSB0 with 60%probability by proportional change in catch among the WCPO large fish catch limit and EPO total catch limit).
6	Status quo +20%	Status quo +163%	Status quo +108%		5,420	20,235	8,310		-	-	JWG's request 04-3 (scenario achieving 20%SSB0 with 60% probability by maintaining the total catch proportion between WCPO and EPO as status quo while limiting the catch limit increase for WCPO small fish as 20% of its original catch limit).
7	Status quo +30%	Status quo +131%	Status quo +92%		5,893	17,789	7,670		-	-	JWG's request 04-4 (scenario achieving 20%SSB0 with 60% probability by maintaining the total catch proportion between WCPO and EPO as status quo while limiting the catch limit increase for WCPO small fish as 30% of its original catch limit).
8	Status quo +30%	Status quo +30%	Status quo +190%		5,893	10,142	11,586		70	30	JWG's request 05-1 (explored constant catch scenario achieving 20%SSB0 with 60% probability and fishery impact ratio between WCPO and EPO as 70% and 30% while maintaining the catch proportion of small and large fish in WCPO as status quo).
9	Status quo +55%	Status quo +55%	Status quo +80%		7,074	12,044	7,191		80	20	JWG's request 05-1 (explored constant catch scenario achieving 20%SSB0 with 60% probability and fishery impact ratio between WCPO and EPO as 80% and 20% while maintaining the catch proportion of small and large fish in WCPO as status quo).
10	Status quo +10%	Status quo +130%	Status quo +190%		4,948	17,751	11,586		70	30	JWG's request 05-2 (explored constant catch scenario achieving 20%SSB0 with 60% probability and fishery impact ratio between WCPO and EPO as 70% and 30% while maintaining the catch proportion of small fish in WCPO lower than that of status quo).
11	Status quo +40%	Status quo +120%	Status quo +80%		6,015	17,540	7,191		80	20	JWG's request 05-3 (explored constant catch scenario achieving 20%SSB0 with 60% probability and fishery impact ratio between WCPO and EPO as 80% and 20% while maintaining the catch proportion of small fish in WCPO lower than that of status quo).
12	SPR30%				-				-	-	SPR30% Scenario F1719 multiplied 1.4

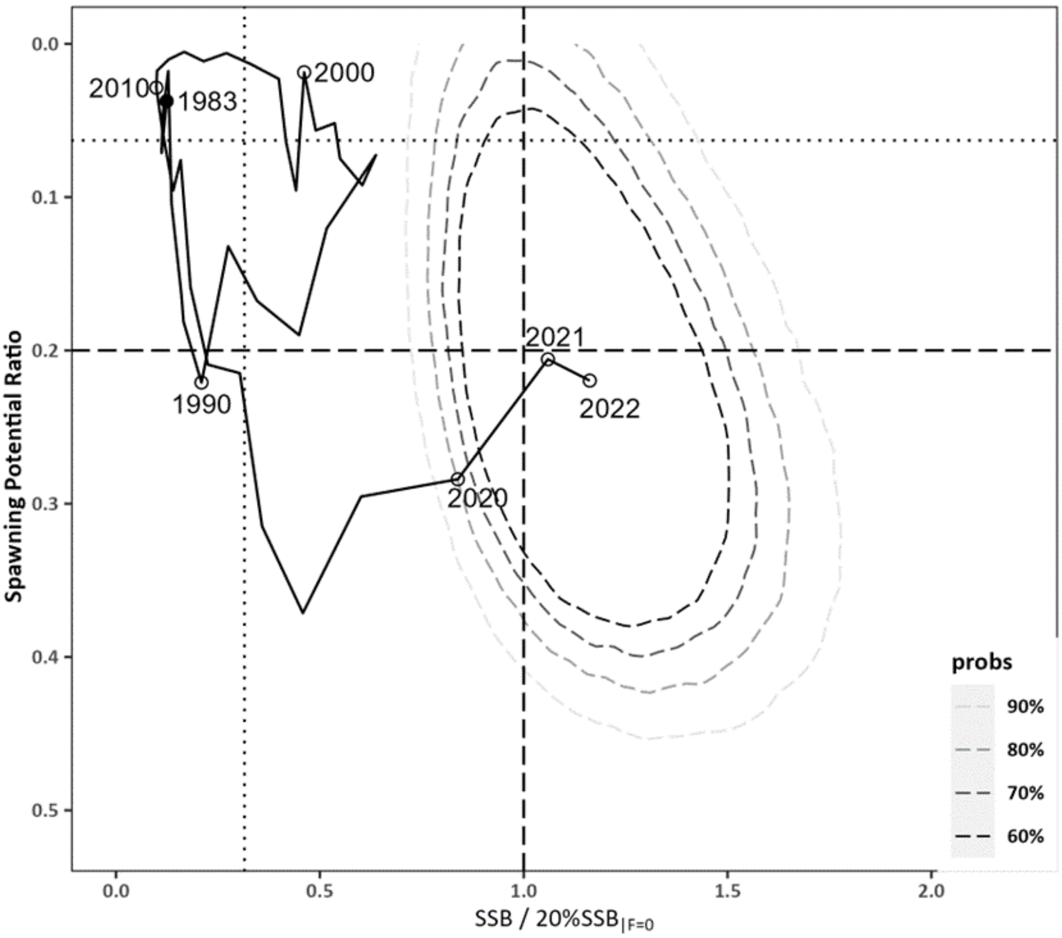
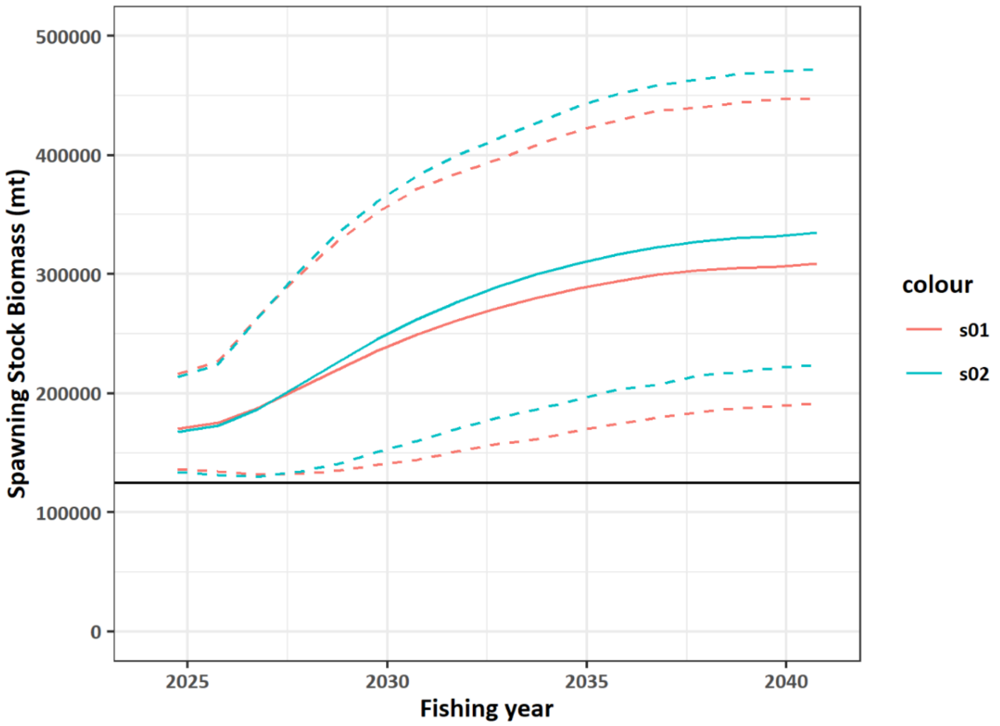


Figure 8. Kobe plot for Pacific bluefin tuna (*Thunnus orientalis*) estimated from the base-case model from 1983 to 2022. The X-axis shows the annual SSB relative to 20%$SSB_{F=0}$ and the Y-axis shows the spawning potential ratio (SPR) as a measure of fishing mortality. Vertical and horizontal dashed lines show 20%$SSB_{F=0}$ (which corresponds to the second biomass rebuilding target) and the corresponding fishing mortality that produces SPR, respectively. Vertical and horizontal dotted lines show the initial biomass rebuilding target (SSB_{MED} = 6.3%$SSB_{F=0}$) and the corresponding fishing mortality that produces SPR, respectively. SSB_{MED} is calculated as the median of estimated SSB over 1952–2014 from the 2022 assessment. Contour plots represent 60% to 90% of two probability density distributions in SSB and SPR for 2022.



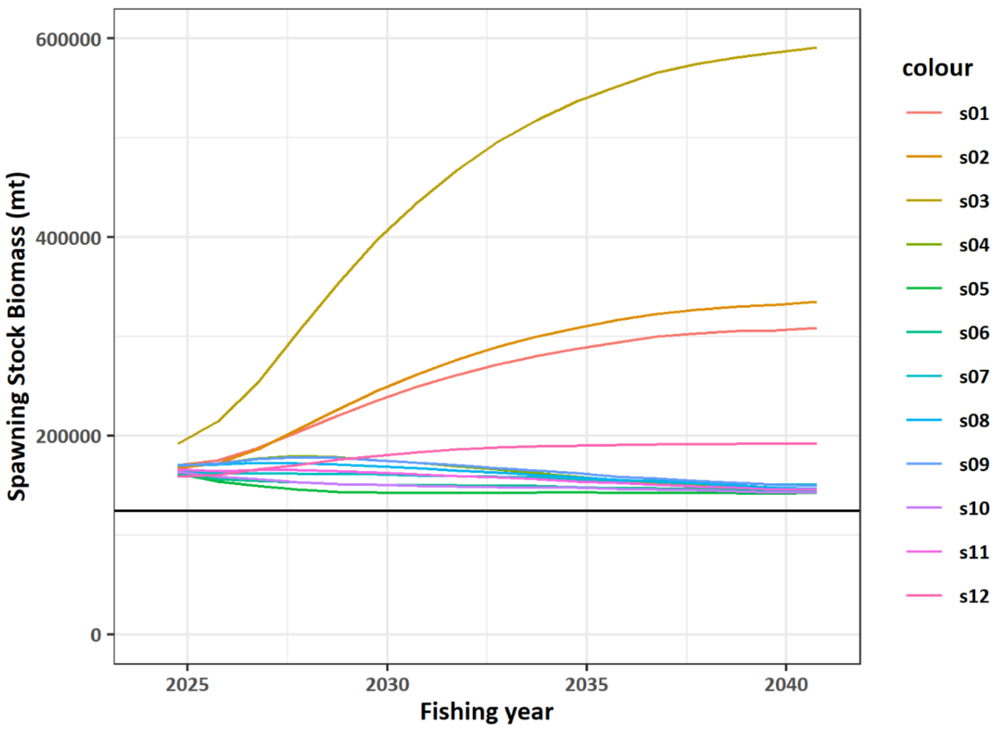


Figure 9. Comparisons of various projection results for Pacific bluefin tuna (*Thunnus orientalis*) obtained from projection results. (Top) Median of scenarios 1 and 2 (solid lines) and their 90% confidence intervals (dotted lines). (Bottom) Median of all harvest scenarios examined from Table 7. The horizontal line represents the second rebuilding target.

5.1 Estimates of fishery parameters and abundance

There are no fishery independent indices of abundance for the Pacific bluefin tuna stock. Relative abundance information is available from standardised indices of longline catch per unit effort data.

5.2 Biomass estimates

After the steady decline in SSB from 1996 to the historically low level in 2010, the PBF stock has started recovering, and recovery has been more rapid in recent years, coinciding with the implementation of stringent management measures.

The 2022 SSB was 10 times higher than the historical low and is above the second rebuilding target adopted by the WCPFC and IATTC, which was achieved in 2021. The stock has recovered at a faster rate than anticipated when the Harvest Strategy to foster rebuilding (WCPFC HS 2017-02) was implemented in 2014. The fishing mortality (F%SPR) in 2020–2022 is at a level producing 23.6%SPR.

6. STATUS OF THE STOCKS

Stock structure assumptions

Western and central Pacific Ocean. All references to biomass in these tables refer to spawning biomass (*SB*).

Stock Status		
Most Recent Assessment Plenary Publication Year	2024	
Catch in most recent year of assessment	Year: 2022	Catch: 17 458 t
Assessment Runs Presented	Updated base case model	
Reference Points	Target: Not established; B_{MSY} evaluated using HSS default of 40% SB_0 Soft Limit: Not established by WCPFC or IATTC; but evaluated using HSS default of 20% SB_0 Hard Limit: Not established by WCPFC or IATTC; but evaluated using HSS default of 10% SB_0 Overfishing threshold: F_{MSY} evaluated using HSS default of $F_{40\%SPR}$	
Status in relation to Target	Unlikely (< 40%) to be at or above 40% SB_0	
Status in relation to Limits	About as Likely as Not (40–60%) to be below the Soft Limit Very Unlikely (< 10%) to be below the Hard Limit	
Status in relation to Overfishing	Overfishing is Likely (> 60%) to be occurring	

Historical Stock Status Trajectory and Current Status
-

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Biomass has been increasing since 2011
Recent Trend in Fishing Intensity or Proxy	Fishing intensity has declined since 2010
Other Abundance Indices	-
Trends in Other Relevant Indicator or Variables	Recruitment estimates in the 2024 assessment fluctuated widely without an apparent trend. Recent strong cohorts were observed in 2007 (23.6 million) and 2008 (21.0 million), while moderate cohorts occurred in 2010 (17.6 million) and 2016 (16.0 million). The average estimated recruitment was approximately 12.8 million fish for the entire stock

	assessment period (1983–2022). However, the 2009, 2012, 2014, 2019, and 2020 recruitments were relatively low (8.0, 7.6, 4.9, 7.5, and 6.8 million fish, respectively). Recruitment estimates were relatively more uncertain at the start of the assessment period until 1993 (average CV = 22%). Precision improved (average CV = 7.3%) during 1994–2010 but the estimates for the past nine years (2012–2022) were more uncertain due to the lack of a recruitment index (average CV = 25.5%).

Projections and Prognosis	
Stock Projections or Prognosis	The scenario approximating current management measures indicated that the stock would achieve the relative biomass associated with all the candidate target reference points (20%, 25%, 30%, and 40% of $SSB_{F=0}$) by the 2041 fishing year. This scenario showed a gradual increase in SSB, reaching a level where the 2034 SSB is higher than 40% $SSB_{F=0}$.
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Soft Limit: Very Unlikely (< 10%) Hard Limit: Very Unlikely (< 10%)
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unknown

Assessment Methodology and Evaluation		
Assessment Type	Level 1 – Full Quantitative Stock Assessment	
Assessment Method	Stock Synthesis v.3.30	
Assessment Dates	Latest assessment Plenary publication year: 2022	Next assessment: 2024
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- catch (retained and discarded) - size composition - catch per unit of effort (CPUE) from 1983 to 2023 - a length-at-age relationship from otolith-derived ages - natural mortality estimates from a tag-recapture study and empirical-life history methods	1 – High Quality (all)
Data not used (rank)	- model by started in 1983 instead of the previous 1952 - CPUE of Japanese longline (adult index) after 2020 - Japanese troll (recruitment index) after 2010	N/A
Changes to Model Structure and Assumptions	- refined parameterization of selectivity to reduce model residuals	
Major Sources of Uncertainty	- recruitment estimates in the terminal period (2019–2022) - steepness (fixed at 0.999)	

	- the assumed natural mortality rate, in particular for fish aged 2+

Qualifying Comments
- SC20 noted that some CCMs expressed concerns about the limited treatment of uncertainty of a single model run for providing management advice, especially with regards to steepness and the stock recruitment relationship (it was noted that the 2nd rebuilding target would not have been met if, for example, a steepness value below 0.98 had been used).

7. FOR FURTHER INFORMATION

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