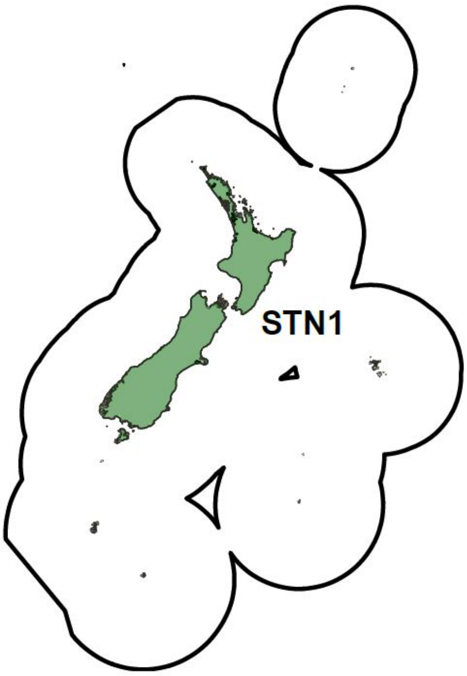
SOUTHERN BLUEFIN TUNA (STN)

(*Thunnus maccoyii)*



1. FISHERY SUMMARY

Southern bluefin tuna were introduced into the Quota Management System (QMS) on 1 October 2004 under a single Quota Management Area, STN 1, with allowances for customary and recreational fisheries and other sources of mortality within the Total Allowable Catch (TAC) and a Total Allowable Commercial Catch (TACC). The 2023–24 allowances and the TACC are outlined in Table 1.

Table 1: Recreational and customary non-commercial allowances, TACC, and TAC for southern bluefin tuna for the 2023 - 24 fishing year.

Fishstock	Recreational allowance (t)	Customary non-commercial allowance (t)	Other mortality (t)	TACC (t)	TAC (t)
STN 1	69	2	20	1 197	1 288

Southern bluefin tuna were added to the Third Schedule of the Fisheries Act 1996 with a TAC set under s14 because a national allocation of southern bluefin tuna for New Zealand has been determined as part of an international agreement. The TAC applies to all New Zealand fisheries waters, and all waters beyond the outer boundary of the exclusive economic zone.

Southern bluefin tuna were also added to the Sixth Schedule of the Fisheries Act 1996 with the provision that:

> "A person who is a New Zealand national fishing against New Zealand's national allocation of southern bluefin tuna may return any southern bluefin tuna to the waters from which it was taken from if –
> (a) that southern bluefin tuna is likely to survive on return; and
> (b) the return takes place as soon as practicable after the southern bluefin tuna is taken."

Management of southern bluefin tuna throughout its range is the responsibility of the Commission for Conservation of Southern Bluefin Tuna (CCSBT), of which New Zealand is a founding member.

Current members of the CCSBT also include Australia, Japan, the Republic of Korea, the Fishing Entity of Taiwan, Indonesia, the Republic of South Africa, and the European Community. The Philippines have Cooperating Non-member status. Determination of the global TAC and provision of a national allocation to New Zealand is carried out by the CCSBT.

1.1 Management procedure

In 2011, the Commission adopted a management procedure to set quotas for 3-year periods based on the latest fisheries indicators from the stock. The Management Procedure was designed to rebuild the spawning stock to 20% of the unfished level by 2035 (with 70% certainty). However, the Commission decided not to fully implement the first increase indicated by the operation of the Management Procedure in 2011 because there was concern that the TAC may have to be reduced again at the end of the 3 years. Instead, the Commission opted for a limited increase in the first 3-year period. Quotas set for the 3 years allowed a 1000 t increase in 2012 to 10 449 t, and a further increase in 2013 to 10 949 t.

At the 20th meeting of CCSBT in October 2013 the TAC was confirmed at 12 449 t for 2014–15 and on the basis of the operation of the management procedure the TAC for 2015 to 2017 was recommended to be set at 14 647 t. The TAC for 2015–16 was also confirmed at this higher figure. At the 21st meeting of CCSBT in October 2014 the TAC was confirmed at 14 647 t for 2016–17. In 2016 the Management Procedure was run again and recommended a TAC of 17 647 t for 2018–20 (Table 2) that was confirmed by CCSBT23 in October 2016. In 2019, the Management Procedure was modified to a target of 30% of the unfished level (with 50% certainty), with 20% of the unfished level now representing an interim target (the Cape Town Procedure or CTP). The corresponding result from the 2020 operation of the CTP resulted in no change to the TAC for 2021–23, while the 2022 operation of the Management Procedure resulted in a 3000 t increase for 2024–26 (to 20 647 t), which the 2023 Commission confirmed. Country allocations for 2024–26 are shown in Table 2.

Table 2: Allocated catches for members for 2024–26.

Member	Effective catch limit (t)
Japan	7 247
Australia	7 295
New Zealand	1 288
Republic of Korea	1 468
Fishing Entity of Taiwan	1 468
Indonesia	1 336
European Community	13
South Africa	527

1.2 Commercial fisheries

The Japanese distant water longline fleet began fishing for southern bluefin tuna in the New Zealand region in the late 1950s and continued after the declaration of New Zealand's EEZ in 1979 under a series of bilateral access agreements until 1995.

The domestic southern bluefin tuna fishery began with exploratory fishing by Watties in 1966 and Feron Seafoods in 1969. Most of the catch was used for crayfish bait (reported landings began in 1972). During the 1980s the fishery developed further when substantial quantities of southern bluefin tuna were air freighted to Japan. Throughout the 1980s, small vessels hand lining and trolling for southern bluefin tuna dominated the domestic fishery. Southern bluefin tuna were landed to a dedicated freezer vessel serving as a mother ship, or, ashore for the fresh chilled market in Japan.

Longlining for southern bluefin tuna was introduced to the domestic fishery in the late 1980s under government encouragement and began in 1988 with the establishment of the New Zealand Japan Tuna Company Ltd. The Japanese charter vessels ceased fishing as of 1 May 2016 due to changes in New Zealand government legislation.

New Zealand-owned and -operated longliners, mostly smaller than 50 GRT, began fishing in 1991 for southern bluefin tuna (1 vessel). The number of domestic vessels targeting STN expanded throughout the 1990s and early 2000s prior to the introduction of STN into the QMS. Table 3 summarises southern bluefin landings in New Zealand waters since 1972. Figure 1 shows historical landings and TACC values for domestic southern bluefin tuna.

Table 3: Reported domestic[1] and total[2] southern bluefin tuna landings (t) from 1972 to 2023 (calendar year).

Year	NZ landings (t)	Total stock (t)	Year	NZ landings (t)	Total stock (t)
1972	1	51 925	1998	337	17 777
1973	6	41 205	1999	461	19 529
1974	4	46 777	2000	380	15 475
1975	0	32 982	2001	358	16 031
1976	0	42 509	2002	450	15 258
1977	5	42 178	2003	390	14 077
1978	10	35 908	2004	393	13 505
1979	5	38 673	2005	264	16 156
1980	130	45 054	2006	238	11 747
1981	173	45 104	2007	379	10 599
1982	305	42 788	2008	319	11 395
1983	132	42 881	2009	419	10 954
1984	93	37 090	2010	501	9 743
1985	94	33 325	2011	547	9 459
1986	82	28 319	2012	776	10 292
1987	59	25 575	2013	756	11 770
1988	94	23 145	2014	825	11 909
1989	437	17 843	2015	923	14 361
1990	529	13 870	2016	950	14 445
1991	164	13 691	2017	913	13 946
1992	279	14 217	2018	1 008	17 148
1993	217	14 342	2019	959	17 102
1994	277	13 155	2020	853	15 666
1995	436	13 932	2021	788	16 824
1996	139	16 646	2022	875	17 139
1997	334	16 076	2023	1 103	

[1] Japanese vessels operating under charter agreement, i.e., all catch against the New Zealand allocation.
[2] These figures are likely to be underestimates because they do not incorporate the findings from the Market and Farming Reviews.
Source: New Zealand data from Annual Reports on Fisheries, Fisheries New Zealand data, New Zealand Fishing Industry Board Export data, and LFRR data; total stock from www.ccsbt.org.

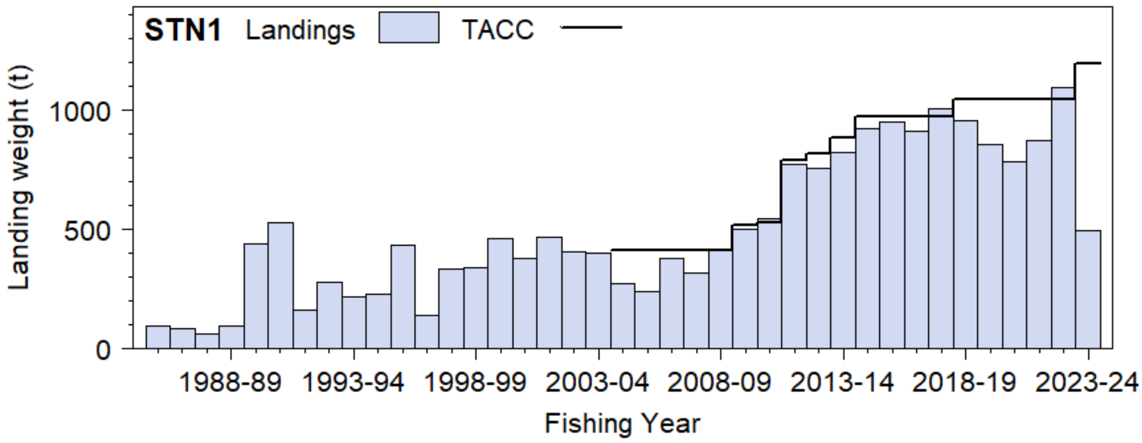


Figure 1: Commercial catch (t) and TACC (t) of southern bluefin tuna from 1985–86 to present within New Zealand fishing waters (STN 1).

Since 1991 surface longlines have been the predominant gear used to target southern bluefin tuna in the domestic fishery with 96% of all days fished using this method and only 4% using hand line (less than 1% used trolling). This represents a major change from the 1980s when most fishing was by hand line.

In the few instances when the New Zealand allocation has been exceeded, the domestic catch limit has been reduced in the following year by an equivalent amount. Table 3 contrasts New Zealand STN catches with those from the entire stock. The low catches relative to other participants in the global fishery are due to New Zealand's limited involvement historically rather than to local availability. Table 4 indicates that, throughout most of the 1980s, catches of STN up to 2000 t were taken within the New Zealand EEZ.

Table 4: Reported catches or landings (t) of southern bluefin tuna by fleet and fishing year. NZ, New Zealand domestic and charter fleet; ET, catches by New Zealand flagged vessels outside these areas; JPNFL, Japanese foreign licensed vessels; LFRR, estimated landings from Licensed Fish Receiver Returns; and MHR, Monthly Harvest Return Data.

Fishing year	JPNFL	NZ	Total	LFRR/MHR	NZ ET
1979–80	7 374.7		7 374.7		
1980–81	5 910.8		5 910.8		
1981–82	3 146.6		3 146.6		
1982–83	1 854.7		1 854.7		
1983–84	1 734.7		1 734.7		
1984–85	1 974.9		1 974.9		
1985–86	1 535.7		1 535.7		
1986–87	1 863.1		1 863.1	59.9	
1987–88	1 059.0		1 059.0	94.0	
1988–89	751.1	284.3	1 035.5	437.0	
1989–90	812.4	379.1	1 191.5	529.3	
1990–91	780.5	93.4	873.9	164.6	
1991–92	549.1	248.9	798.1	279.1	
1992–93	232.9	126.6	359.5	216.4	
1993–94	0.0	287.3	287.3	277.0	
1994–95	37.3	358.0	395.2	435.3	
1995–96		141.8	141.8	140.5	
1996–97		331.8	331.8	333.5	
1997–98		330.8	330.8	331.5	
1998–99		438.1	438.1	457.9	
1999–00		378.3	378.3	381.3	
2000–01		366.0	366.0	366.4	
2001–02		468.3	468.3	465.4	
2002–03		405.7	405.7	391.7	0.0
2003–04		399.6	399.6	394.6	0.0
2004–05		272.1	272.1	264.1	0.0
2005–06		237.7	237.7	238.0	0.1
2006–07*		379.1	379.1	379.1	–
2007–08*		318.2	318.2	318.2	–
2008–09*		417.3	417.3	417.5	–
2009–10*		499.5	499.5	499.5	–
2010–11*		547.3	547.3	547.3	–
2011–12*		775.2	775.2	775.2	–
2012–13*		758.2	758.2	758.2	–
2013–14*		824.6	824.6	824.6	–
2014–15*		923.1	923.1	923.1	–
2015–16*		949.4	949.4	949.4	–
2016–17*		913.5	913.5	913.5	–
2017–18*		1 009.7	1 009.7	1 009.7	–
2018–19*		906.4	906.4	906.4	–
2019–20*		962.1	962.1	962.1	–
2020–21*		782.5	782.5	782.5	–
2021–22*		875.3	875.3	875.3	–
2022–23		1 097.6	1 097.6	1 097.6	–
2023–24		497.5	497.5	497.5	–

* Southern bluefin tuna landings have not been separated into within zone and ET since 2006–07.

Data on reported catch of southern bluefin tuna are available from the early 1950s. By 1960, catches had peaked at nearly 80 000 t, most taken on longline by Japan. From the 1960s to the mid-1970s, when Australia was expanding their domestic surface fisheries for southern bluefin tuna, total catches were in the range 40 000 to 60 000 t. From the mid-1970s to the mid-1980s catches were in the range 35 000 to 45 000 t. Catches declined from 33 325 t in 1985 to 13 869 t in 1990 with the introduction of quotas that reduced the global catch to 9440 t in 2011 with the introduction of a Management Procedure that reduced quotas still further. Since 2011 the quota has been increased under the Management Procedure with a concomitant increase in catch, reaching 16 936 t in 2018.

From 1960 to the 1990s catches by longline declined whereas surface fishery catches in Australian waters increased to reach a maximum level of 21 512 t in 1982 (equal to the longline catches of Japan). During the 1980s catches by both surface and longline fisheries declined but, following dramatic TAC reductions in the late 1980s, catches stabilised. The main difference between gear types is that surface fisheries target juveniles (aged 1–3 years) whereas longline fisheries catch older juveniles and adults (aged 4–40+ years). The surface fishery has comprised purse seine and pole-and-line vessels supported by aerial spotter planes that search out surface schools. The Australian surface fisheries prior to 1990 were a mix of pole-and-line and purse seine vessels and, since the mid-1990s, have become almost exclusively a purse seine fishery. Prior to 1990, surface fishery catches supplied canneries, whereas since the mid-1990s these vessels have caught juveniles for southern bluefin tuna farms where they are 'on-grown' for the Japanese fresh fish market. The fisheries of all other members (including New Zealand) are based on longline.

Analysis of New Zealand catch data shows that most southern bluefin tuna are caught in Fishery Management Areas (FMAs) 1, 2, 5, and 7. The northern FMAs (FMAs 1 and 2), which accounted for a small proportion of southern bluefin tuna before 1998 have in recent years accounted for about the same amount of southern bluefin tuna as the southern FMAs (FMAs 5 and 7). This change in spatial distribution of catches can be attributed to the increase in domestic longline effort in the northern waters. Table 5 shows the longline effort targeted at southern bluefin in New Zealand waters by the charter and domestic fleets since 1989. Some of the charter fleet effort in Region 5 was directed at fish species other than southern bluefin, but most of the effort targeted STN.

Table 5: Effort (thousands of hooks) for the charter and domestic fleet by year and CCSBT Region. The Japanese charter vessels ceased fishing as of 1 May 2016 due to changes in New Zealand government legislation.

	Charter			Domestic†		
Calendar year	**Region 5**	**Region 6**	**Other***	**Region 5**	**Region 6**	**Other***
1989		1 596.0	3.5			
1990	259	1 490.6		41.7		
1991	306	1 056.5		31.5	49.2	
1992	47.6	1 386.8	3	71.7	12.1	
1993	174.1	1 125.7	101.4	644.0	108.1	7.7
1994		799.1		122.6	143.3	5.8
1995	27.1	1 198.7	13.5	221.5	760.4	26.7
1996				417.9	564.3	11.5
1997	135.2	1 098.7		736.4	8.9	17.3
1998	225	616.0		633.6	314.5	1.2
1999	57.2	955.1		1 221.4	382.9	5.5
2000	30.3	757.9		1 164.0	454.4	8.5
2001		639.4		1 027.6	751.5	1.9
2002		726.4		1 358.6	1 246.8	13.5
2003	3	866.6		1 868.7	1 569.1	4.3
2004		1 113.5		1 154.1	1 431.9	1.2
2005	137	498.9		1 133.0	153.6	2.4
2006	39.4	562.5		1 036.4	122.4	0.9
2007	271.6	1 136.1		681.2	19.0	
2008		568.3		527.8	94.0	
2009	66.8	731.0		733.9	165.4	1.3
2010		484.9		1 114.9	294.2	1.3
2011		495.9		965.0	196.5	
2012		548.4	3.4	858.1	629.8	
2013	13.2	450.8		910.8	563.0	1.2
2014		653.3		533.4	484.1	
2015		622.3		631.9	463.3	
2016				884.3	565.3	12.6
2017				867.1	589.6	7.9
2018				1 203.9	485.0	3.7
2019				1 356.5	1 499.9	0.0
2020				775.0	683.7	
2021				505.4	488.0	0.9
2022				365.7	557.3	0.5
2023				429.1	714.6	3.9

* Includes erroneous position data and data without position data.
† Effort for sets that either targeted or caught southern bluefin tuna.

In 2023–24, southern bluefin tuna constituted 78% of the target surface longline catch (Figure 2). Surface 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 (*Thunnus obesus*), swordfish (*Xiphias gladius*), and southern bluefin tuna.

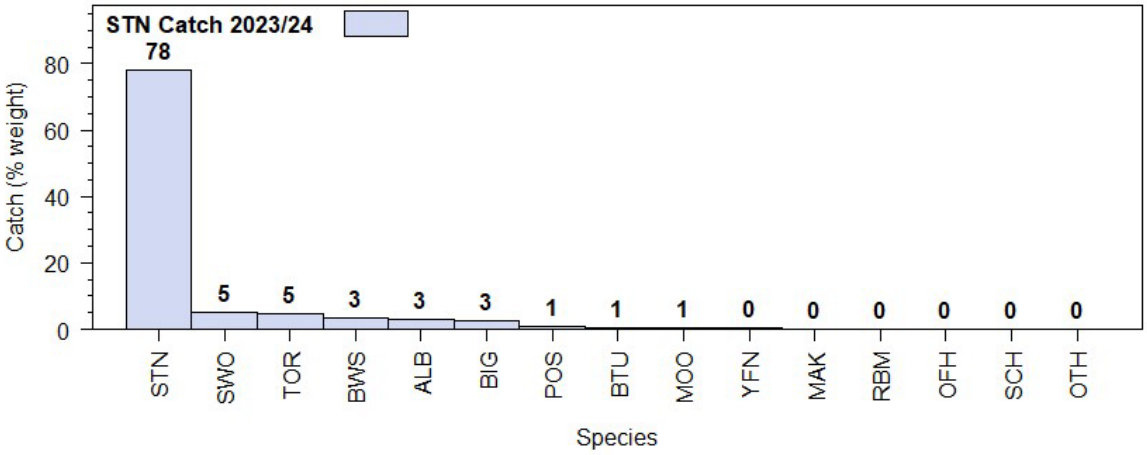


Figure 2: A summary of species composition of the reported southern bluefin tuna target surface longline estimated catch for the most recent fishing year. The percentage by weight of each species is calculated for all surface longline trips targeting southern bluefin tuna.

1.3 Recreational fisheries

Historically, a small summer recreational fishery has occurred off Fiordland on the west coast of the South Island since the 1970s. A recreational fishery for Pacific bluefin tuna (*Thunnus orientalis*) developed in 2005 from Greymouth or Westport, on the west coast of the South Island, in which STN are also occasionally taken as bycatch in August and September. At present, there are two distinct recreational fisheries; the west coast of the South Island from January to July and the east coast of the North Island in June to August, primarily in the eastern Bay of Plenty. The North Island recreational fishery emerged rapidly in 2017, when STN catches increased dramatically, and STN catches have remained high.

1.3.1 Estimates of recreational harvest

The recreational harvest estimate for STN in 2017–18 from all available data was 15 t and the estimated range using survey confidence intervals and the range in unaccounted catch was 13.4 to 17.0 t (Holdsworth 2019). In 2019–20 the recreational harvest estimate for STN for all fisheries combined was 48.9 t including an estimate for unaccounted recreational catch (Holdsworth 2021), increasing to 69.3 t in 2022–23 (Holdsworth 2024).

No estimates of recreational harvest of southern 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 using very similar methods to produce directly comparable results (Wynne-Jones et al. 2019, Heinemann & Gray 2024). The national panel survey results do not include estimates for southern bluefin tuna because the surveys did not reflect the number of fishers and fishing activity for the large gamefish species.

1.4 Customary non-commercial fisheries

An estimate of the current customary catch is not available**.** Given that Māori knew of several oceanic fish species and missionaries reported that Māori regularly fished several miles from shore, it is possible that southern bluefin tuna were part of the catch of Māori prior to European settlement. It is clear that Māori trolled lures (for kahawai) that are very similar to those still used by Tahitian fishermen for small tunas and also used large baited hooks capable of catching large southern bluefin tuna. However, there is no Māori name for southern bluefin tuna, therefore it is uncertain if Māori caught southern bluefin tuna.

1.5 Unreported catch

There is no known unreported catch of southern bluefin tuna by New Zealand vessels in the EEZ or from the high seas.

CCSBT has operated a catch documentation scheme since 1 January 2010, with documentation and tagging requirements for all STN, coupled with market-based controls and reporting obligations. Recent actions by individual CCSBT members to improve monitoring, control, and surveillance measures for southern bluefin tuna fisheries are also intended to halt the occurrence of unreported catch. The extent of unreported catch by non-cooperating non-members is not known.

1.6 Other sources of mortality

Incidental catches of southern bluefin tuna appear to be limited to occasional small catches in trawl and troll fisheries. Small catches of southern bluefin tuna have been reported as non-target catch (less than 0.5 t and 2 t, respectively), in trawl fisheries for hoki (*Macruronus novaezelandiae*) and arrow squid (*Nototodarus* spp.). In addition there have been occasional anecdotal reports of southern bluefin being caught in trawl fisheries for southern blue whiting (*Micromesistius australis*) and jack mackerel (*Trachurus* spp.) in sub-Antarctic waters.

In addition to the limited trawl bycatch, some discarding and loss (usually as a result of shark damage) occurs in the longline fishery before fish are landed. The overall incidental mortality rate from observed longline effort has been estimated as 0.54% of the catch. Discard rates are 0.86% on average from observer data, of which approximately 50% are discarded dead. Fish are also lost at the surface in the longline fishery during hauling, 1.47% on average from observer data, of which 95% are thought to escape alive. An allowance of 20 t has been made for other sources of mortality.

2. BIOLOGY

There is some uncertainty about the size and age when STN mature, but available data indicate that STN do not mature before 8 years (155 cm fork length, FL), and perhaps not until 15 years.

The growth rate has changed over the course of the fishery (see below), and the size-at-maturity depends on when the fish was alive (prior to the 1970s, during the 1970s, or in the period since 1980), as well as which maturity ogive is used. A simple linear interpolation is assumed for the 1970s. Table 6 shows the range of sizes (cm) for southern bluefin tuna aged 8 to 12 years for the two von Bertalanffy growth models used (see Table 8).

Radiocarbon dating of otoliths has been used to determine that southern bluefin tuna live beyond 30 years of age and that individuals reaching asymptotic length may be 20 years or older.

The sex ratio of southern bluefin caught by longline in the EEZ has been monitored since 1987. The ratio of males to females is 1.2:1.0 and is statistically significantly different than 1:1.

The parameters of length:weight relationships for southern bluefin tuna based on linear regressions of greenweight versus fork length are given in Table 7. The data used include all longline observer data for the period 1987 to 2000 from all vessels in the EEZ (n = 18 994).

Table 6: Differences in southern bluefin tuna size at ages 8–12 between the 1960s and 1980s.

	Length (cm FL)	
Age (y)	**1960s**	**1980s**
8	138.2	147.0
9	144.6	152.7
10	150.2	157.6
11	155.1	161.6
12	159.4	165.0

Table 7: Parameters of length:weight relationship for southern bluefin tuna. *l*n (weight) = B_1 *l*n (length) – b_0 (weight in kg, length in cm).

	b_0	B_1
Male	-10.94	3.02
Female	-10.91	3.01
All	-10.93	3.02

CCSBT scientists have used two stanza von Bertalanffy growth models since 1994 (Table 8):

$$l_t = L_\infty(1 - e^{-k2(t-t0)})(1 + e^{-\beta(t-t0-\alpha)}) / (1 + e^{\beta\alpha})^{-(k2-k1)}$$, where t is age in years.

Table 8: von Bertalanffy growth parameters for southern bluefin tuna.

	L_∞	k_1	k_2	α	β	t_0
1960 von Bertalanffy	187.6	0.47	0.14	0.75	30	0.243
1980 von Bertalanffy	182	0.23	0.18	2.9	30	-0.35

Although change in growth in the two periods (pre-1970 and post-1980) is significant, and the impact of the change in growth on the results of population models substantial, the differences between the growth curves seem slight. The change in growth rate for juveniles and young adults has been attributed to a density-dependent effect of overfishing.

No estimates of F and Z are presented because they are model dependent and because a range of models and modelling approaches are used. Prior to 1995 natural mortality rates were assumed to be constant and M = 0.2 was used. However, the results indicating that asymptotic size was reached at about 20 years and fish older than 30 years were still in the population suggested that values of $M \geq 0.2$ were likely to be too high. Tagging results of juveniles aged 1 to 3 years also suggests that M for these fish is high (possibly as high as M = 0.4), whereas M for fish of intermediate years is unknown. For these reasons M has been considered to be age-specific and represented by various M vectors. In the CCSBT stock assessments, a range of natural mortality vectors are now used.

A conversion factor of 1.15 is used for gilled and gutted southern bluefin tuna.

3. STOCKS AND AREAS

Southern bluefin tuna consist of a single stock, primarily distributed between 30º S and 45º S, which is only known to spawn in the Indian Ocean south of Java. Adults are broadly distributed in the South Atlantic, Indian, and western South Pacific oceans, especially in temperate latitudes, whereas juveniles occur along the continental shelf of Western and South Australia and in high seas areas of the Indian Ocean. Southern bluefin tuna caught in the New Zealand EEZ appear to represent the easternmost extent of a stock whose centre is in the Indian Ocean.

A large-scale electronic tagging programme, involving most members of the CCSBT, has been undertaken to provide better information on stock structure. The goal has been to tag smaller fish across the range of the stock. New Zealand has participated in this programme, with the deployment of 19 implantable tags in small fish in 2007. Fifteen larger STN were tagged with pop-off tags as well, with

12 tags having reported data. Of note, one of the tagged fish moved to the spawning ground south of Indonesia.

Electronic tagging of juvenile STN in the Great Australian Bight showed that for a number of years tagged juveniles were not moving into the Tasman Sea. It was not known whether this was due to unfavourable environmental conditions or range contraction following the decline in the stock. However, more of these tagged juveniles have now been reported in New Zealand catches.

Two sources of information suggest that there may be 'sub-structure' within the broader STN stock, in particular the Tasman Sea. Tagging of adult STN within the Australian east coast tuna and billfish fishery suggests that STN may spend most of the year within the broader Tasman Sea region. An analysis of the length and age composition of catches from the New Zealand joint-venture fleet showed that cohorts that were initially strong or weak did not change over time, e.g., if a particular year class was weak (or strong) when it initially recruited to the New Zealand fishery it remained so over time.

4. ENVIRONMENTAL AND ECOSYSTEM CONSIDERATIONS

The figures and tables in this section were updated and additional text included for the November 2024 Fishery Assessment Plenary. This summary is from the perspective of the southern bluefin tuna longline fishery; a more detailed summary from an issue-by-issue perspective is available in the Aquatic Environment & Biodiversity Annual Review where the consequences are also discussed (Aquatic environment and biodiversity annual review (AEBAR) | NZ Government (mpi.govt.nz)).

4.1 Role in the ecosystem

Southern bluefin tuna (*Thunnus maccoyii*) are apex predators, feeding opportunistically on a mixture of fish, crustaceans, and squid; and juveniles also feed on a variety of zooplankton and micronecton species (Young et al. 1997). Southern 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 Incidental catch

These capture estimates relate to the southern bluefin target longline fishery only, from the New Zealand EEZ. The capture estimates presented here include all animals recovered onto the deck (alive, injured, or dead) of fishing vessels but do not include any cryptic mortality (e.g., seabirds caught on a hook but not brought onboard the vessel).

4.2.1 Incidental catch of seabirds

Between 2002–03 and 2022–23, there were 1051 observed captures of birds in southern bluefin longline fisheries. Seabird capture rates since 2003 are presented in Figure 3. Observed capture rates peaked in 2021–22. Seabird captures were mostly concentrated off Fiordland and the west coast South Island (Table 9 and Figure 4). A recent decrease in observer coverage due to Health and Safety concerns has also increased uncertainty. Observed and estimated seabird captures in southern bluefin tuna longline fisheries are provided in Table 10.

Throughout the 1990s the minimum seabird mitigation requirement for surface longline vessels was the use of a bird scaring device (tori line) but common practice was that vessels set surface longlines primarily at night. In 2007 a notice was implemented under s11 of the Fisheries Act 1996 to formalise the requirement that surface longline vessels only set during the hours of darkness and use a tori line when setting. This notice was amended in 2008 to add the option of line weighting and tori line use if setting during the day. In 2011 the notices were combined and re-promulgated under a new regulation (Regulation 58A of the Fisheries (Commercial Fishing) Regulations 2001), which provides a more flexible regulatory environment under which to set seabird mitigation requirements. Late in 2019 work was commissioned to assess the operational functionality of an underwater bait setter during production fishing. The aim of this work was to assess the device without the use of other existing mitigation measures in the New Zealand surface longline fleet.

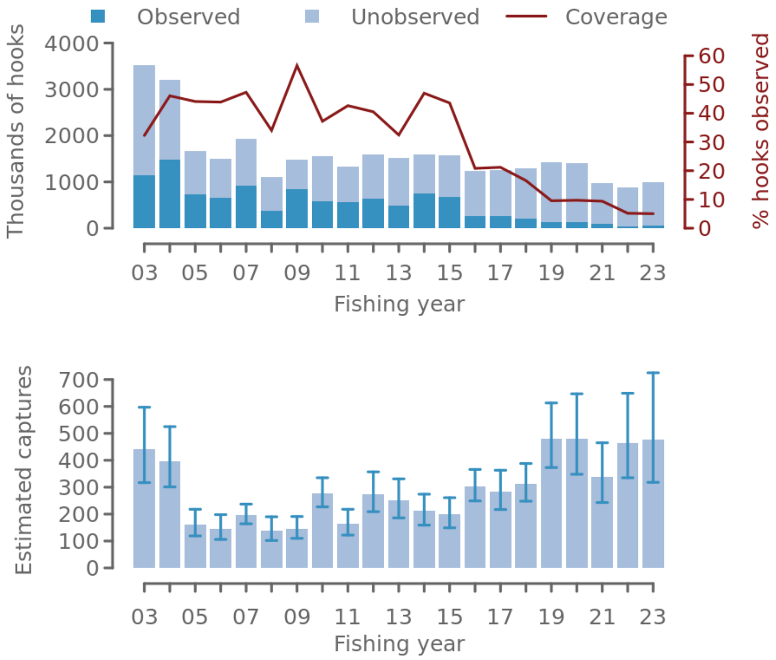


Figure 3: Fishing effort and observations (top) and estimated seabird captures (bottom) in the southern bluefin tuna longline fisheries from 2002–03 to 2022–23. https://protectedspeciescaptures.nz/PSCv9/released/.

Current results for the risk posed by commercial fishing to seabirds have been assessed via a spatially explicit fisheries risk assessment (SEFRA), supported under the NPOA-Seabirds 2020 risk assessment framework (Fisheries New Zealand & Department of Conservation 2020). The method used in the risk assessment arose initially from an expert workshop hosted by the Ministry of Fisheries in 2008. The overall framework is described in 3 - SEFRA - Aquatic Environment and Biodiversity Annual Review 2021 (mpi.govt.nz) and has been variously applied and improved in multiple iterations (most recently Edwards et al 2023). The method applies an 'exposure-effects' approach where exposure refers to the number of fatalities and is calculated from the overlap of seabirds with fishing effort compared with observed captures to estimate the species vulnerability (capture rates per encounter) to each fishery group. This is then compared with the population's productivity, based on population estimates and biological characteristics, to yield estimates of population-level risk.

The risk ratio is an estimate of potential deaths from interactions with trawl and bottom-longline and surface longline fisheries relative to the Population Sustainability Threshold (PST) for each species assessed. PST provides a reference point of anthropogonic deaths that can be sustained by the population relative to its size and reproductive rate and still meet long term recovery goals. A risk ratio above 1 indicates that domestic fishing related deaths alone exceed PST and the population is at risk of not obtaining long term recovery goals.

Edwards et al. (2023) assessed the domestic tuna and swordfish surface longline fishery contribution to the total risk posed by New Zealand commercial fishing to seabirds (Table 11). This fishery (which includes southern bluefin tuna targeting) contributes 0.313 of risk to Southern Buller's albatross (26.8% of the total risk posed by New Zealand commercial fishing included in the risk assessment), the only species categorised as Very high risk (Edwards et al. 2023), and 0.115, 0.089 and 0.042 of risk to Black petrel, Westland petrel and New Zealand white-capped albatross, respectively; these were assessed to be at high risk from New Zealand commercial fishing. The wider surface longline fishery contributes most of risk to species in the wandering albatross family: Gibson's albatross and Antipodean albatross, contributing 87% and 94% of their total risk respectively.

Table 9: Number of observed seabird interactions in southern bluefin tuna longline fisheries, 2002–03 to 2022–23, by species and area. The risk category is an estimate of aggregate potential fatalities across trawl and longline fisheries relative to the Population Sustainability Threshold, PST (an analogue of the PBR approach) (Edwards et al. 2023). The current version of the risk assessment does not include recovery factor. Other data via https://protectedspeciescaptures.nz/PSCv9/released/.

Species	Risk category	Fiordland	East coast North Island	West coast South Island	Stewart - Snares shelf	Bay of Plenty	Northland and Hauraki	East Coast South Island	Total
Southern Buller's albatross	Very high	331	11	131	2			7	**482**
New Zealand white-capped albatross	High	87	6	170	10	1		7	**281**
Campbell black-browed albatross	Low	3	15	4		2	3		**27**
Southern royal albatross	Low	6		8				1	**15**
Buller's albatross	NA		11	1		2			**14**
Gibson's albatross	Medium	4	4	3			1		**12**
Antipodean albatross	Medium		6				1		**7**
Black-browed albatross	NA		5						**5**
Wandering albatrosses	NA	1	4						**5**
Salvin's albatross	High		3			1			**4**
Smaller albatrosses	NA		1	1				1	**3**
Great albatrosses	NA			1				1	**2**
Northern Buller's albatross	Medium		2						**2**
Wandering albatross	NA	1	1						**2**
Albatrosses	NA	1							**1**
Black-browed albatrosses	NA		1						**1**
Grey-headed albatross	Low			1					**1**
Light-mantled sooty albatross	Low			1					**1**
Northern royal albatross	Low							1	**1**
Total albatrosses		**434**	**70**	**321**	**12**	**6**	**5**	**18**	**866**
White-chinned petrel	Low	21	2	2	2		1	40	**68**
Westland petrel	High	4		51				1	**56**
Grey petrel	Negligible		37			3	2	3	**45**
Sooty shearwater	Negligible				3			1	**4**
Grey-faced petrel	Negligible					1	1		**2**
Large seabirds	NA	2							**2**
Cape petrels	NA		2						**2**
Southern giant petrel	NA		2						**2**
Storm petrels	NA							2	**2**
Flesh-footed shearwater	Medium			1					**1**
Giant petrels	NA			1					**1**
Total other birds		**27**	**43**	**55**	**5**	**4**	**4**	**47**	**185**

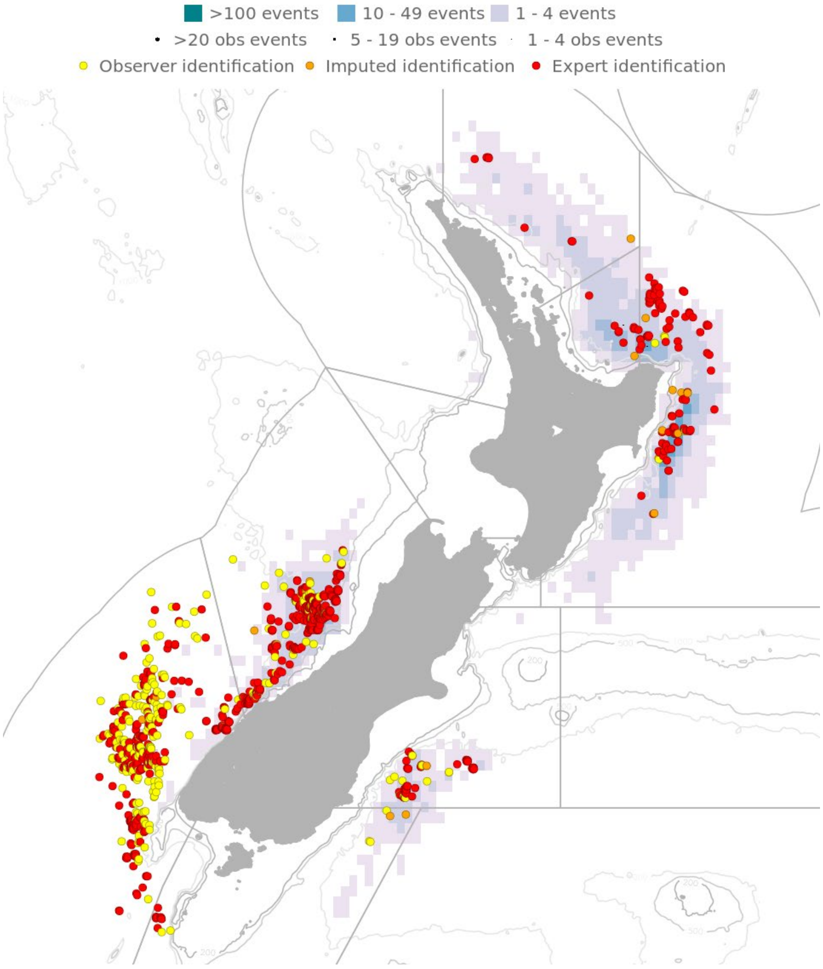


Figure 4: Distribution of fishing effort targeting southern bluefin tuna and observed seabird captures, 2002–03 to 2022–23. Fishing effort is mapped into 0.2-degree cells, with the colour of each cell being related to the amount of effort. Observed fishing events are indicated by black dots, and observed captures are indicated by red, orange, and yellow dots. Fishing is only shown if the effort could be assigned a latitude and longitude, and if there were three or more vessels fishing within a cell. Data grooming methods are described by Abraham & Berkenbusch (2019) and data are available via https://protectedspeciescaptures.nz/PSCv9/released/.

Table 10: Effort, observed, and estimated seabird captures in southern bluefin tuna fisheries by fishing year within the EEZ. For each fishing year, the table gives the total number of hooks; the number of observed hooks; observer coverage (the percentage of hooks that were observed); the number of observed captures (both dead and alive); the capture rate (captures per thousand hooks); and the mean number of estimated total captures (with 95% confidence interval). Estimates are based on methods described by Abraham & Berkenbusch (2019) and are available via https://protectedspeciescaptures.nz/PSCv9/released/. [Continued on next page]

	Fishing effort			Observed captures		Estimated captures	
Fishing year	All hooks	Observed hooks	% observed	Number	Rate	Mean	95% c.i.
2002–03	3 512 911	1 133 740	32.3	43	0.04	441	317–597
2003–04	3 195 171	1 471 964	46.1	70	0.05	398	301–525
2004–05	1 665 009	734 026	44.1	36	0.05	163	119–218
2005–06	1 493 868	655 475	43.9	29	0.04	146	106–198
2006–07	1 938 111	916 660	47.3	111	0.12	197	164–237
2007–08	1 104 825	375 975	34.0	30	0.08	140	102–190
2008–09	1 484 438	840 048	56.6	48	0.06	147	110–191
2009–10	1 559 858	580 395	37.2	112	0.19	276	227–335
2010–11	1 330 265	567 204	42.6	32	0.06	165	122–218
2011–12	1 593 754	645 530	40.5	50	0.08	275	209–357
2012–13	1 516 397	491 953	32.4	23	0.05	253	186–331
2013–14	1 590 670	747 220	47.0	34	0.05	211	159–274

Table 10: [Continued]

2014–15	1 567 969	683 250	43.6	32	0.05	200	149–261
2015–16	1 234 822	257 020	20.8	115	0.45	302	249–366
2014–15	1 567 969	683 250	43.6	32	0.05	200	149–261
2016–17	1 246 229	263 985	21.2	42	0.16	282	217–363
2017–18	1 300 941	215 418	16.6	79	0.37	312	248–388
2018–19	1 424 865	135 960	9.5	55	0.40	481	373–613
2019–20	1 399 829	135 969	9.7	5	0.04	479	348–647
2020–21	974 140	91 510	9.4	32	0.35	339	243–465
2021–22	875 642	45 420	5.2	55	1.21	464	335–649
2022–23	997 096	50 296	5.0	18	0.36	477	318–725

Table 11: Risk ratio of seabirds predicted by the SEFRA for the domestic tuna and swordfish surface longline fishery and all fisheries included in the SEFRA, 2006–07 to 2019–20, with a risk posed by the domestic tuna and swordfish SLL fishery. The risk ratio is an estimate of aggregate potential fatalities across trawl and longline fisheries relative to the Population Sustainability Threshold, PST (an analogue of the PBR approach) (Edwards et al. 2023). The current version of the risk assessment does not include a recovery factor. The New Zealand threat classifications are shown (Robertson et al. 2021).

			Risk ratio		
Species name	**Domestic SLL**	**Total risk from NZ commercial fishing**	**% of total risk from NZ commercial fishing**	**Risk category**	**NZ Threat Classification**
Southern Buller's albatross	0.313	1.19	26.8	Very high	At Risk: Declining
Antipodean albatross	0.141	0.16	94.4	Medium	Threatened: Nationally Critical
Gibson's albatross	0.137	0.16	89.7	Medium	Threatened: Nationally Critical
Black petrel	0.115	0.49	24.5	High	Threatened: Nationally Vulnerable
Westland petrel	0.089	0.38	25.9	High	At Risk: Naturally Uncommon
New Zealand white-capped albatross	0.042	0.5	8.7	High	At Risk: Declining
Northern Buller's albatross	0.038	0.19	20.6	Medium	At Risk: Naturally Uncommon
Southern royal albatross	0.018	0.08	24.4	Low	Threatened: Nationally Vulnerable
Campbell black-browed albatross	0.016	0.05	30.2	Low	At Risk: Naturally Uncommon
Flesh-footed shearwater	0.015	0.22	7.3	Medium	At Risk: Relict

4.2.2 Incidental catch of sea turtles

Between 2002–03 and 2022–23, there were six observed captures of sea turtles in southern bluefin longline fisheries (Table 12 and Table 13, Figure 5). Observer recordings documented all but one sea turtle as captured and released alive. Sea turtle captures for this fishery have only been observed off the east coast of the North Island.

Table 12: Number of observed sea turtle captures in southern bluefin tuna longline fisheries, 2002–03 to 2022–23, by species and area. Data grooming methods are described by Abraham & Berkenbusch (2019) and are available via https://protectedspeciescaptures.nz/PSCv9/released/.

Species	**Bay of Plenty**	**East coast North Island**	**Northland and Hauraki**	**Total**
Leatherback turtle	1	2	0	3
Green turtle	0	2	1	3
Total	1	4	1	6

Table 13: Fishing effort and sea turtle captures in southern bluefin tuna longline fisheries by fishing year within the EEZ. For each fishing year, the table gives the total number of hooks; the number of observed hooks; observer coverage (the percentage of hooks that were observed); the number of observed captures (both dead and alive); the capture rate (captures per thousand hooks); and the mean number of estimated total captures (with 95% confidence interval). Estimates are based on methods described by Abraham & Berkenbusch (2019) and are available via https://protectedspeciescaptures.nz/PSCv9/released/. **[Continued on next page]**

	Fishing effort			Observed captures		Estimated captures	
Fishing year	**All hooks**	**Observed hooks**	**% observed**	**Number**	**Rate**	**Mean**	**95% c.i.**
2002–03	3 512 911	1 133 740	32.3	0	0.000	25	9–49
2003–04	3 195 171	1 471 964	46.1	0	0.000	6	0–18
2004–05	1 665 009	734 026	44.1	0	0.000	4	0–10
2005–06	1 493 868	655 475	43.9	0	0.000	3	0–8
2006–07	1 938 111	916 660	47.3	0	0.000	2	0–7
2007–08	1 104 825	375 975	34.0	0	0.000	2	0–5

Table 13: [Continued]

			Fishing effort	Observed captures		Estimated captures	
Fishing year	**All hooks**	**Observed hooks**	**% observed**	**Number**	**Rate**	**Mean**	**95% c.i.**
2008–09	1 484 438	840 048	56.6	0	0.000	1	0–4
2009–10	1 559 858	580 395	37.2	0	0.000	5	1–11
2010–11	1 330 265	567 204	42.6	3	0.005	10	5–17
2011–12	1 593 754	645 530	40.5	0	0.000	2	0–7
2012–13	1 516 397	491 953	32.4	0	0.000	5	1–11
2013–14	1 590 670	747 220	47.0	0	0.000	3	0–8
2014–15	1 567 969	683 250	43.6	0	0.000	3	0–8
2015–16	1 234 822	257 020	20.8	1	0.004	6	2–12
2016–17	1 246 229	263 985	21.2	0	0.000	4	0–8
2017–18	1 300 941	215 418	16.6	0	0.000	4	0–10
2018–19	1 424 865	135 960	9.5	0	0.000	4	0–10
2019–20	1 399 829	135 969	9.7	1	0.007	5	1–12
2020–21	974 140	91 510	9.4	1	0.011	5	1–11
2021–22	875 642	45 420	5.2	0	0.000	4	0–9
2022–23	997 096	50 296	5.0	0	0.000	4	0–10

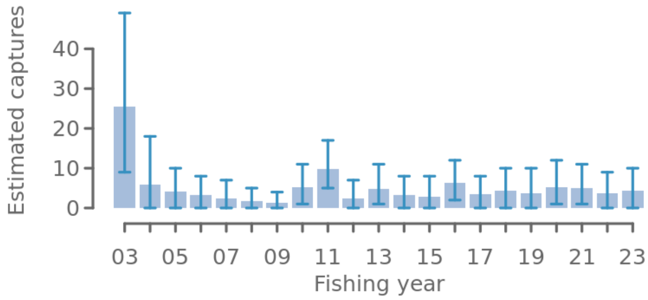


Figure 5: Estimated captures of sea turtles in southern bluefin tuna longline fisheries from 2002–03 to 2020–23. **https://protectedspeciescaptures.nz/PSCv9/released/.**

4.2.3 Incidental catch of marine mammals

4.2.3.1 Cetaceans

Cetaceans are dispersed throughout New Zealand waters (Perrin et al. 2008). The spatial and temporal overlap of commercial fishing grounds and cetacean foraging areas has resulted in cetacean captures in fishing gear (Abraham & Thompson 2009, 2011).

Between 2002–03 and 2022–23, there were 14 observed captures of whales and dolphins in southern bluefin longline fisheries (Table 14, Figure 6, and Table 15). Observed captures included four bottlenose dolphins, three beaked whales, three orca, two long-finned pilot whales, one common dolphin, and an unidentified cetacean. All but one of the captured animals recorded were documented as being caught and released alive, with catches occurring off the east coast of the North Island, west coast of the South Island, Fiordland, and Bay of Plenty.

Table 14: Number of observed cetacean captures in southern bluefin tuna longline fisheries, 2002–03 to 2022–23, by species and area. Data grooming methods are described by Abraham & Berkenbusch (2019) and data are available via https://protectedspeciescaptures.nz/PSCv9/released/.

Species	Bay of Plenty	East coast North Island	Fiordland	West coast South Island	East coast South Island	Total
Long-finned pilot whale		1		1		2
Beaked whales	2	1				3
Bottlenose dolphin	2	2				4
Orca	1				2	3
Common dolphin				1		1
Unidentified cetacean			1			1
Total	5	4	1	2	2	14

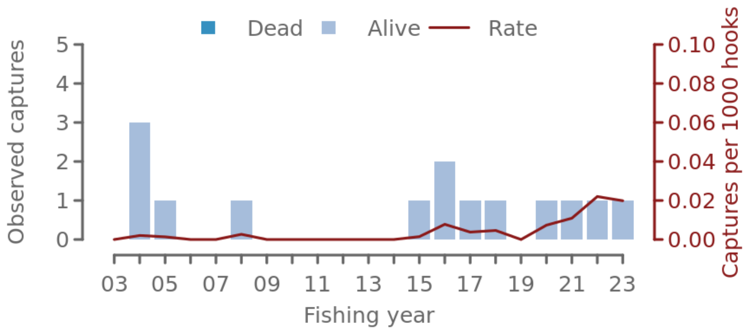


Figure 6: Observed captures of cetaceans in southern bluefin longline fisheries from 2002–03 to 2022–23. Data grooming methods are described by Abraham & Berkenbusch (2019) and data are available via https://protectedspeciescaptures.nz/PSCv9/released/.

Table 15: Effort and cetacean captures in southern bluefin tuna longline fisheries by fishing year. For each fishing year, the table gives the total number of hooks; the number of observed hooks; observer coverage (the percentage of hooks that were observed); the number of observed captures (both dead and alive); and the capture rate (captures per thousand hooks). For more information on the methods used to prepare the data, see Abraham & Berkenbusch (2019) and data are available via https://protectedspeciescaptures.nz/PSCv9/released/.

Fishing	Fishing effort			Observed captures	
year	All hooks	Observed hooks	% observed	Number	Rate
2002–03	3 512 911	1 133 740	32.3	0	0.000
2003–04	3 195 171	1 471 964	46.1	3	0.002
2004–05	1 665 009	734 026	44.1	1	0.001
2005–06	1 493 868	655 475	43.9	0	0.000
2006–07	1 938 111	916 660	47.3	0	0.000
2007–08	1 104 825	375 975	34.0	1	0.003
2008–09	1 484 438	840 048	56.6	0	0.000
2009–10	1 559 858	580 395	37.2	0	0.000
2010–11	1 330 265	567 204	42.6	0	0.000
2011–12	1 593 754	645 530	40.5	0	0.000
2012–13	1 516 397	491 953	32.4	0	0.000
2013–14	1 590 670	747 220	47.0	0	0.000
2014–15	1 567 969	683 250	43.6	1	0.001
2015–16	1 234 822	257 020	20.8	2	0.008
2016–17	1 246 229	263 985	21.2	1	0.004
2017–18	1 300 941	215 418	16.6	1	0.005
2018–19	1 424 865	135 960	9.5	0	0.000
2019–20	1 399 829	135 969	9.7	1	0.007
2020–21	974 140	91 510	9.4	1	0.011
2021–22	875 642	45 420	5.2	1	0.022
2022–23	997 096	50 296	5.0	1	0.020

4.2.3.2 New Zealand fur seals

Currently, New Zealand fur seals are dispersed throughout New Zealand waters but are more common in waters south of about 40° S to Macquarie Island. The spatial and temporal overlap of commercial fishing grounds and New Zealand fur seal foraging areas has resulted in New Zealand fur seal captures in fishing gear (Mattlin 1987, Rowe 2009). Most fisheries with observed captures occur in waters over or close to the continental shelf, which slopes steeply to deeper waters relatively close to shore, and thus rookeries and haulouts, around much of the South Island and offshore islands. Captures on longlines occur when the fur seals attempt to feed on the bait and fish catch during hauling. Most New Zealand fur seals are released alive, typically with a hook and short snood or trace still attached.

New Zealand fur seal captures in surface longline fisheries have been generally observed in waters off the west coast of the South Island, but also in the Bay of Plenty-East Cape area (Table 16 and Table 17). Observed captures consist primarily of fur seals that are released alive. Observed capture rates increased to 2019, then declined (Figure 7). Although fur seal captures have occurred throughout the range of this fishery, most occurred off the south-west coast of the South Island, Fiordland (Figure 8).

Table 16: Number of observed New Zealand fur seal captures in southern bluefin tuna longline fisheries, 2002–03 to 2022–23, by species and area. Data are from Abraham & Berkenbusch (2019), retrieved from https://protectedspeciescaptures.nz/PSCv9/released/.

	Bay of Plenty	East coast North Island	East coast South Island	Chatham Rise	Fiordland	Northland and Hauraki	Stewart-Snares Shelf	West coast South Island	Total
New Zealand fur seal	31	70	19	1	244	4	5	133	507

Table 17: Effort and captures of New Zealand fur seals by fishing year in southern bluefin tuna longline fisheries by fishing year within the EEZ. For each fishing year, the table gives the total number of hooks; the number of observed hooks; observer coverage (the percentage of hooks that were observed); the number of observed captures (both dead and alive); the capture rate (captures per thousand hooks); and the mean number of estimated total captures (with 95% confidence interval). Estimates are based on methods described by Abraham & Berkenbusch (2019) and are available via https://protectedspeciescaptures.nz/PSCv9/released/.

	Fishing effort			Observed captures			Estimated captures	
Fishing year	All hooks	Observed hooks	% observed	Number	Rate		Mean	95% c.i.
2002–03	3 512 911	1 133 740	32.3	56	0.05	56	144	94–218
2003–04	3 195 171	1 471 964	46.1	40	0.03	40	147	92–225
2004–05	1 665 009	734 026	44.1	18	0.02	18	71	42–111
2005–06	1 493 868	655 475	43.9	12	0.02	12	63	36–99
2006–07	1 938 111	916 660	47.3	10	0.01	10	54	33–80
2007–08	1 104 825	375 975	34.0	8	0.02	8	46	27–72
2008–09	1 484 438	840 048	56.6	22	0.03	22	67	44–98
2009–10	1 559 858	580 395	37.2	19	0.03	19	95	61–141
2010–11	1 330 265	567 204	42.6	17	0.03	17	71	46–106
2011–12	1 593 754	645 530	40.5	40	0.06	40	108	79–145
2012–13	1 516 397	491 953	32.4	21	0.04	21	103	70–146
2013–14	1 590 670	747 220	47.0	57	0.08	57	134	102–173
2014–15	1 567 969	683 250	43.6	37	0.05	37	114	84–153
2015–16	1 234 822	257 020	20.8	3	0.01	3	109	70–160
2016–17	1 246 229	263 985	21.2	31	0.12	31	143	100–193
2017–18	1 300 941	215 418	16.6	12	0.06	12	119	78–169
2018–19	1 424 865	135 960	9.5	47	0.35	47	193	142–257
2019–20	1 399 829	135 969	9.7	13	0.10	13	178	120–253
2020–21	974 140	91 510	9.4	22	0.24	22	129	84–185
2021–22	875 642	45 420	5.2	10	0.22	10	148	91–220
2022–23	997 096	50 296	5.0	12	0.24	12	138	81–214

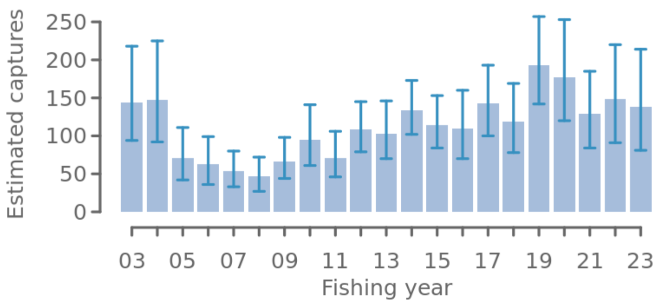


Figure 7: Estimated captures of New Zealand fur seals in southern bluefin longline fisheries from 2002–03 to 2022–23. Data grooming methods are described by Abraham & Berkenbusch (2019) and data are available via https://protectedspeciescaptures.nz/PSCv9/released/.

Figure 8: Distribution of fishing effort targeting southern bluefin tuna and observed New Zealand fur seal captures, 2002–03 to 2022–23. Fishing effort is mapped into 0.2-degree cells, with the colour of each cell being related to the amount of effort. Observed fishing events are indicated by black dots, and observed captures are indicated by yellow dots. Fishing is only shown if the effort could be assigned a latitude and longitude, and if there were three or more vessels fishing within a cell. Data grooming methods are described in Abraham & Berkenbusch (2019) and are available via https://protectedspeciescaptures.nz/PSCv9/released/.

4.3 Non-target fish catch

This section summarises fish catches taken in tuna longline sets that either targeted or caught southern bluefin tuna. Numbers of fish observed, estimated numbers scaled from observer to the commercial fishing effort, and CPUE during the 2010 calendar year are shown in Table 18. The scaled estimates provided for the domestic fleet can be considered less reliable than those of the charter fleet because they are based on lower observer coverage.

Bycatch composition from the charter fleet and the domestic fleet is different. This is likely to be due to differences in waters fished, with the charter fleet mostly operating in southern waters, and the domestic vessels fishing primarily in waters north of about 40° S. Charter vessels only fished off the west coast of the South Island in 2010. Blue shark (*Prionace glauca*), Ray's bream (*Brama brama*), and albacore (*Thunnus alalunga*) were predominant in the catches overall, with these three species making up nearly 70% of the catch. Charter vessels caught mostly blue sharks and Ray's bream. Blue sharks dominated the catches of the domestic vessels, followed by albacore.

Table 18: Numbers of fish caught reported on commercial catch effort returns (Observed), estimated from observer reports and total fishing effort (Scaled), and catch per unit effort (CPUE) for fish species caught on longline sets where southern bluefin tuna was either targeted or caught during the 2010 calendar year.

	Charter			New Zealand domestic		
	Observed	Scaled	CPUE	Observed	Scaled	CPUE
Blue shark	2 024	2 501	5.226	5 062	57 834	46.406
Ray's bream	3 295	4 072	8.508	362	4 136	3.319
Albacore tuna	90	111	0.232	1 219	13 927	11.175
Dealfish	882	1 090	2.277	7	80	0.064
Big scale pomfret	349	431	0.901	3	34	0.028
Porbeagle shark	72	89	0.186	279	3 188	2.558
Deepwater dogfish	305	377	0.788	0	0	0.000
Swordfish	3	4	0.008	269	3 073	2.466
Lancetfish	3	4	0.008	337	3 850	3.089
Mako shark	11	14	0.028	211	2 411	1.934
Moonfish	76	94	0.196	143	1 634	1.311
Butterfly tuna	15	19	0.039	103	1 177	0.944
Oilfish	2	2	0.005	44	503	0.403
School shark	34	42	0.088	2	23	0.018
Sunfish	7	9	0.018	65	743	0.596
Rudderfish	39	48	0.101	18	206	0.165
Flathead pomfret	56	69	0.145	0	0	0.000
Escolar	0	0	0.000	58	663	0.532
Pelagic stingray	0	0	0.000	8	91	0.073
Thresher shark	7	9	0.018	9	103	0.083
Hoki	0	0	0.000	1	11	0.009
Pacific bluefin tuna	0	0	0.000	2	23	0.018
Skipjack tuna	0	0	0.000	1	11	0.009
Striped marlin	0	0	0.000	1	11	0.009
Yellowfin tuna	0	0	0.000	0	0	0.000

4.4 Benthic interactions
There are no known benthic interactions for this fishery.

4.5 Key environmental and ecosystem information gaps
Cryptic mortality is unknown at present but developing a better understanding of this in future may be useful for reducing uncertainty of the seabird risk assessment and could be a useful input into risk assessments for other species groups. The survival rates of released target and bycatch species are currently unknown.

Observer coverage of the New Zealand fleet is not spatially and temporally representative of the fishing effort.

5. STOCK ASSESSMENT

Determination of the status of the southern bluefin tuna stock is undertaken by the CCSBT Scientific Committee (CCSBT-SC). The stock assessment was updated in 2023 (Hillary et al 2023) in accordance with the 3-yearly schedule of stock assessment updates agreed by CCSBT. The report describes the reconditioning of the southern bluefin tuna operating models and current estimates of stock status, following initial work for the Operating Model and Management Procedure (OMMP) technical meetings earlier in 2022 and 2023. The assessment results are based on the agreed base case and a range of sensitivity scenarios. This is the fourth stock assessment since the Management Procedure was implemented in 2011. The next stock assessment is scheduled for 2026.

5.1 Estimates of fishery parameters and abundance

5.1.1 Fisheries indicators

As part of the stock assessment, a range of fisheries indicators that were independent of any stock assessment model were considered to provide support and/or additional information important to aspects of current stock status. Indicators considered included those relating to recent recruitment, spawning biomass, and vulnerable biomass and were based on catch-at-age data, CPUE data, and information from various surveys (e.g., troll surveys).

Fisheries indicators were updated in 2023 and the summary is given below.

- Three indicators of juvenile (age 1–2) SBT abundance were provided in 2023; the trolling indices (grid-type index and piston-line index) with one increasing and one decreasing, and the gene-tagging abundance estimate increasing slightly compared with that for 2019.
- The Japanese longline CPUE indicators for the 4, 5, 6&7, 8–11, and 12+ age groups are well above the historically lowest levels observed in the late 1980s and the mid-2000s. In 2022, all but the 8–11 index increased over the previous year.
- The standardised CPUEs in Area 9 for Korea decreased in 2022 relative to 2021.
- For the Taiwanese CPUE standardisation, the CPUE for the area east of 60 degrees east increased slightly in 2022 relative to 2021 but declined in the western area.
- The standardised New Zealand CPUE has been substantially higher in recent years (especially 2021–22) after experiencing a sharp drop in 2019. The standardised index, calculated for the first time this year, changed from a historically high level in 2016 to slightly lower levels in 2017 and 2018, and declined sharply in 2019.

5.1.2 CPUE and length frequency data in New Zealand waters

Due to the exit of the foreign charter fleet in 2016 and substantial changes in the relative amount of fishing effort in Regions 5 and 6, New Zealand decided to conduct a standardised CPUE analysis for the first time in 2020 and subsequently updated in 2021, 2022, and 2023. The analysis conducted was a forward stepwise GLM assuming a negative binomial distribution using both the additional percent of deviance explained and AIC criteria to select or reject variables. Variables offered to the analysis were year (forced to be the first variable accepted), month, area, vessel, fleet, target, hooks set (as a polynomial distribution), and length of set (also polynomial). The variables accepted were year, vessel, month, and area.

Figure 9 shows both the standardised and unstandardised CPUE as well as a 3-year running average based on the standardised index. Both the standardised and unstandardised indices show a marked decline in CPUE in 2019, with subsequent increases, rising markedly especially from 2021 to 2022. Length frequency distributions for the five most recent years for both the foreign charter fleet and the domestic New Zealand fleet are shown in Figure 10.

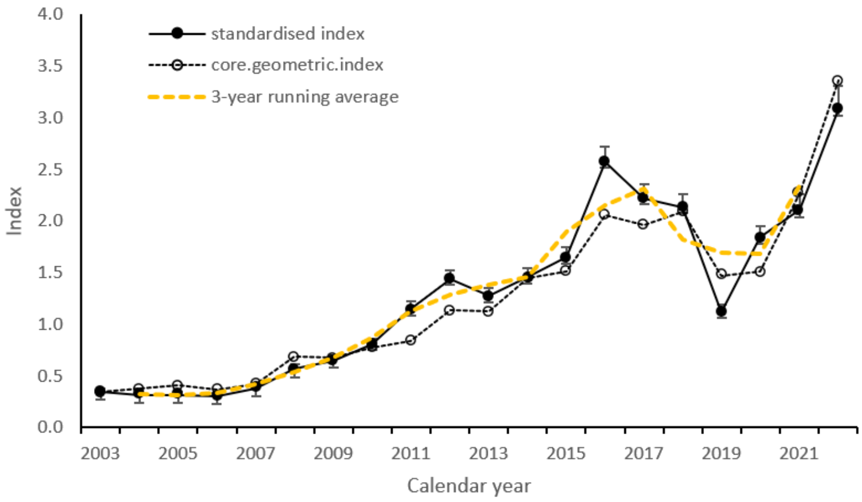


Figure 9: Standardised and unstandardised CPUE indices from unraised catch and effort reported on TLCERs for 2003 to 2022, and a 3-year moving average based on the standardised index. Catch per unit of effort for the period 2003 to 2022 was standardised for changes in the core fleet, month, and area of fishing, assuming a negative binomial error structure. The measurable was number of fish per longline set and number of hooks and length of longline were offered but not accepted into the model. The 3-year running average is plotted at the midpoint of the year range.

5.2 Assessment methods

Current and projected stock status reported in this section were estimated using a reference set of Operating Models that encapsulates key uncertainties defined by a grid specified at the 13th OMMP. The grid (Table 19) comprises 108 cells resulting from the crossing of four values of steepness (*h*), three values of natural mortality at age 0 (M_0), three values of natural mortality at age 10 (M_{10}), a single value of Ω (implying a linear relationship between CPUE and the exploitable biomass for the main longline fishery (LL1)), one choice of the age range used to standardise LL1 selectivity over time, one series of CPUE based on a General Additive Model GAM, and three values of ψ (power parameter for relative reproductive contribution by age). In addition, a number of sensitivities were run to evaluate the impact of changing some data inputs and assumptions.

Other assumptions made for the reference set of Operating Models include:

- Non-Member Unaccounted Mortality (UAM): estimated catches in Table 20 are added to the LL1 historical catches. These values were estimated applying the GLM method and assuming the catch rates estimated for targeted LL fisheries.
- An assumed 20% over-catch is added to the Australian surface fishery in conditioning (ramping up from 0 in 1992 to 20% in 1999) and in projections.
- Maintain the increased flexibility for Indonesian selectivity, commencing in 2012, to accommodate the sharp increase in abundance of younger fish (< age 7 year) in the catch.
- The recruitment deviate simulated for the first year of projections is uncorrelated to historical deviates from the conditioned model; future recruitment deviates are simulated using an empirical estimate of autocorrelation.
- The Cape Town Procedure (CTP) developed in 2019 is applied in projections to calculate TACs in 3-year blocks with the first TAC block being 2021–2023.
- Catches for 2021 and beyond are allocated to four fisheries using the fractions specified in Table 21.

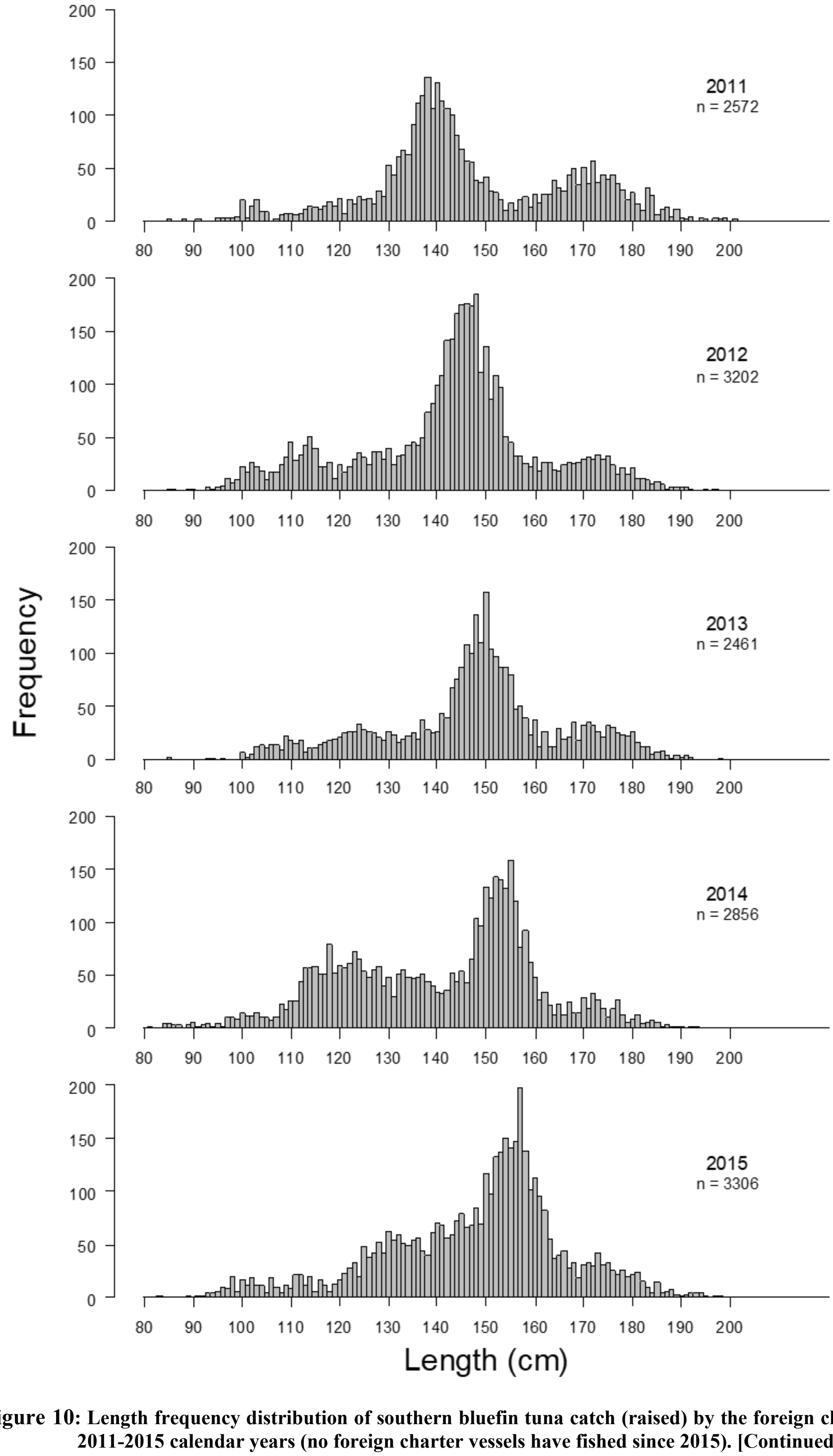


Figure 10: Length frequency distribution of southern bluefin tuna catch (raised) by the foreign charter fleet for the 2011-2015 calendar years (no foreign charter vessels have fished since 2015). [Continued on next 2 pages]

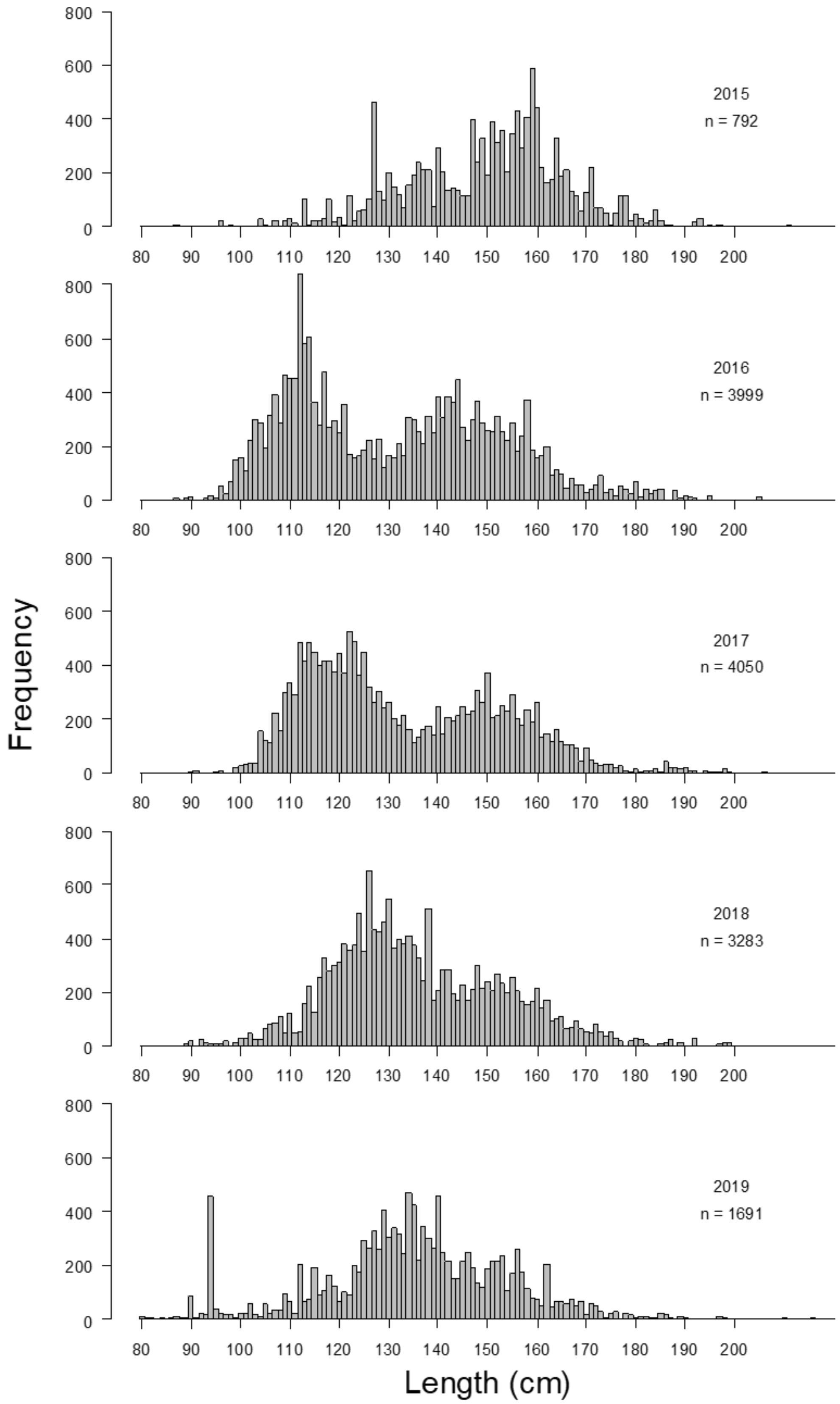


Figure 10 [Continued]: Length frequency distribution of southern bluefin tuna catch by the domestic commercial fleet for the 2015–19 calendar years.

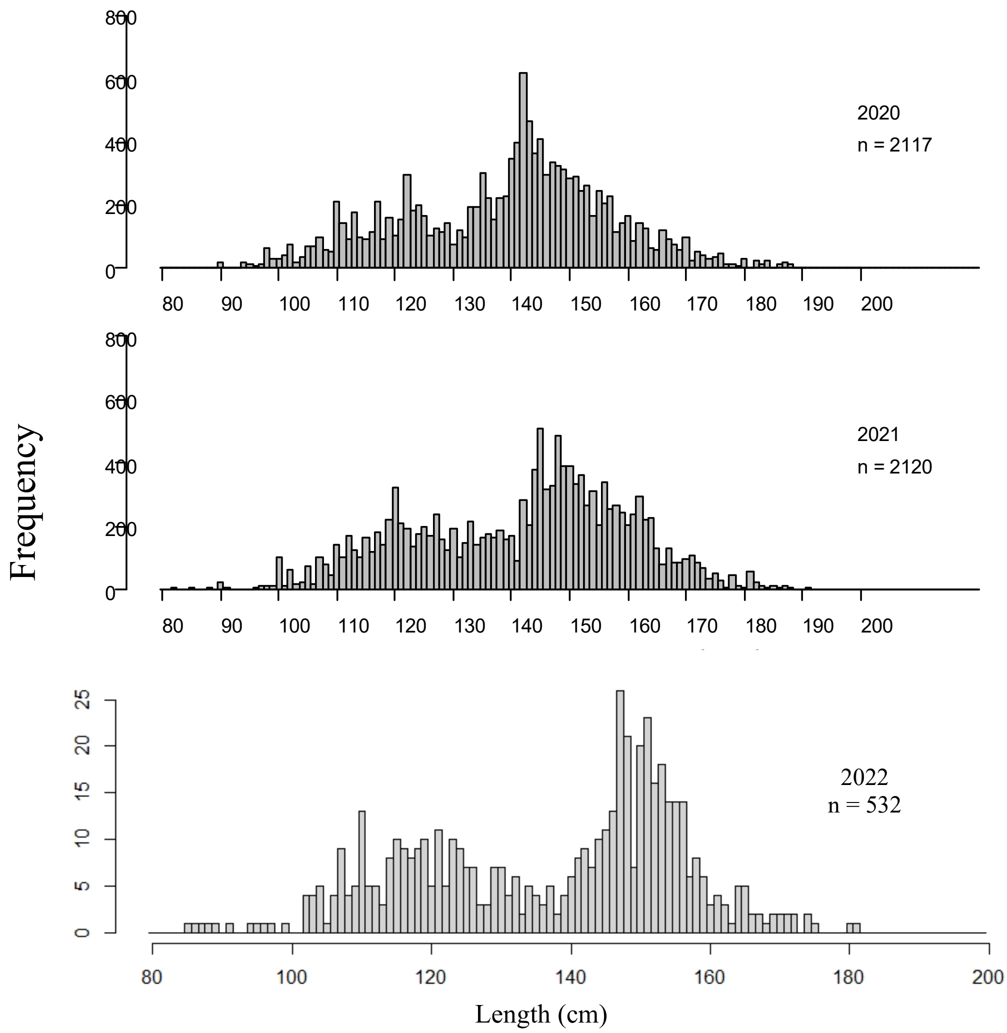


Figure 10 [Continued]: Length frequency distribution of southern bluefin tuna catch by the domestic commercial fleet for the 2020–22 calendar years.

Table 19: Reference set grid used for the 2023 stock assessment. Sampling weight refers to how the grid of models is sampled to generate a distribution from 2000 parameter draws.

Parameter	Value	Cumulative N	Prior	Sampling weight
h	0.55, 0.63, 0.72, 0.80	4	Uniform	Prior
M_0	0.4, 0.45, 0.5	12	Uniform	Posterior
M_{10}	0.065, 0.085, 0.105	36	Uniform	Posterior
Omega (Ω)	1	36	Uniform	Prior
CPUE	GAM	36	Uniform	Prior
CPUE age range	5-17	36	0.67, 0.33	Prior
Psi (ψ)	1.5, 1.75, 2.0	108	0.25, 0.5, 0.25	Prior

Table 20: Estimates of potential annual catches in tonnes by Non-Cooperating, Non-Members of CCSBT, provided by the GLM method assuming targeted effort (using LL1 catchability). UAM is unaccounted mortality.

Year	UAM added to LL1 (t)	Year	UAM added to LL1 (t)
2007	126	2014	121
2008	72	2015	326
2009	152	2016	756
2010	271	2017	984
2011	151	2018	1 155
2012	275	2019	1 160
2013	432	2020	1 155

Table 21: Catch allocation used in projections corresponding to CCSBT's resolution on the nominal Allocation of the Global Total Allowable Catch to countries (table 1 of report of CCSBT 26, nominal catch proportion) converted to the four Operating Model fisheries considered in the projections.

Fishery in Operating Model projections	LL1	LL2	Indonesia	Surface
Allocation	0.5752	0.0713	0.0607	0.3091

The CCSBT Operating Models for the 2023 stock assessment were reconditioned. This included updated data series, up to and including 2022, and was the second stock assessment to include the gene-tagging estimates of 2-year-old abundance. The reference set of Operating Models and sensitivity tests agreed at the 13th OMMP meeting were run along with projections (using the adopted CTP, as endorsed by the 2019 Extended Commission) for the priority sensitivity tests.

Revised CPUE series were fitted well. Fits to the conventional tagging data were good, and the value assumed for the over-dispersion factor for these data was still considered appropriate. The gene-tagging data were fitted well, with all estimates falling within the predictive intervals of the Operating Models. The fits to the CKMR data—both parent offspring pairs (POPs) and half-sibling pairs (HSPs)—were good with the overall number and age structure of POPs well explained so that no obvious adult capture year or juvenile cohort effects were apparent in the fits. The HSPs are also well explained with no obvious juvenile cohort effects and were consistent with the POP data as well. The fits to the size data for the main longline fleets, LL1 and LL2, were good, as were the fits to the age data for the Indonesian and surface fisheries. In summary, there were no obvious issues with the fits to any of the data sets used in conditioning the reference set of Operating Models.

5.3 Assessment results

5.3.1 Spawning biomass

For the 2023 (and 2020) stock assessment(s), spawning biomass was expressed as Total Reproductive Output (*TRO*) rather than B_{10+} (knife-edge maturity at age 10), as was the case for assessments in 2017 and previously. With the inclusion of the close-kin mark-recapture (CKMR) data, the 2023 stock assessment model required the definition of the actual *TRO* of the adult population (for which *SSB* is a proxy). *TRO* corresponds to the total relative reproductive output summed over all adults weighted by their relative individual contribution to reproduction. Specifically, it is the sum of abundance across all ages, where ages are weighted using a parametric relationship informed from the age distribution of parents in the POP genetic data. For these operating models, the following median (and 80% CI) estimates were obtained (Table 22): TRO_{2023}/TRO_0 is 0.23 (0.21–0.29); relative biomass aged 10+ (B_{10+}) is 0.22 (0.19–0.26); the ratio of current fishing mortality relative to F_{MSY} was 0.46 (0.34–0.65); and *TRO* relative to TRO_{MSY} was 0.85 (0.61–1.29); and estimates of *MSY* were 30 648 t (29 152–31 376). Here, TRO_0 means the same thing as $TRO_{unfished}$. For previous stock assessments in 2011, 2014, 2017, and 2020, B_{10+} relative to its initial value was estimated to be 5%, 7%, 11%, and 20%, respectively. The new estimate of 22% in 2023 indicates continued rebuilding. According to the 2023 assessment, the stock has been rebuilding at approximately 5% per year since the low point in TRO_0 in 2009 (Figure 11).

Table 22: Southern bluefin tuna stock status estimates for 2023 from the 2023 stock assessment and for 2020 from the 2020 stock assessment model. Uncertainty is presented inbrackets as 80% confidence intervals.

Variable	2023 status	2020 status
Reported catch in year preceding assessment (t)	17 139	17 102
Current status relative to initial *TRO*	0.23 (0.21–0.29)	0.20 (0.16–0.24)
Current status relative to initial B_{10+}	0.22 (0.19–0.26)	0.17 (0.14–0.21)
F relative to F_{MSY}	0.46 (0.34–0.65)	0.52 (0.37–0.73)
TRO relative to TRO_{MSY}	0.85 (0.61–1.29)	0.69 (0.49–1.03)
MSY	30 648 (29 152–31 376) t	33 207 (31 471–34 564) t

The 2023 stock assessment incorporates the half-sibling pair data from the close-kin mark-recapture work, and additional parent offspring pair data that extend the existing POP data, as was done in 2020.

The estimated trajectory of *TRO* for the reference set over the full time series for the fishery is shown in Figure 11. This shows a continuous decline from the late 1950s to the late 1970s, then a short period of stabilisation followed by a further decline from the early 1980s to about 2009, with a subsequent appreciable increase. The corresponding recruitment estimates are given in Figure 12. Although recent recruitment has not been as high as it was estimated to be during the 1950s to 1970s, it has increased appreciably since the early 2000s.

Based on the stock assessment results presented to the CCSBT Extended Scientific Committee (ESC) in 2023, and the 2022 reconditioning of the STN operating model, the stock status advice was compiled from the updated reference set of operating models. The estimated relative *TRO* (Figure 11) and recruitment trajectories (Figure 12) showed some differences with respect to results obtained in 2022 for the base set of operating models used for Management Procedure testing. In particular, the CPUE GLM series was replaced with a GAM series, which corrected downward the very high 2018 point obtained with the GLM standardisation and resulted in a downward revision of the size of the 2013 cohort. A high level estimated in 2022 did not appear to result from the same issue of increased contraction of fishing effort.

These stock assessment results, as reviewed by the ESC, indicate that the 2023 estimates of current stock status are very similar to the projected rebuilding estimates from the 2020 stock assessment and the updated operating models used for testing the Management Procedures in 2022. The stock has been rebuilding by approximately 5% per year since the low point in 2009, and the Management Procedure-based rebuilding plan for STN appears to be on track towards achieving the Extended Commission's objective. The ESC concluded that the 2023 reference set of operating models provided robust stock assessment advice. The recent upward trend in the adult population is a positive signal for rebuilding, recent recruitment is above the expected level, and current levels of fishing mortality suggest future rebuilding has been somewhat faster than initially envisaged in 2011.

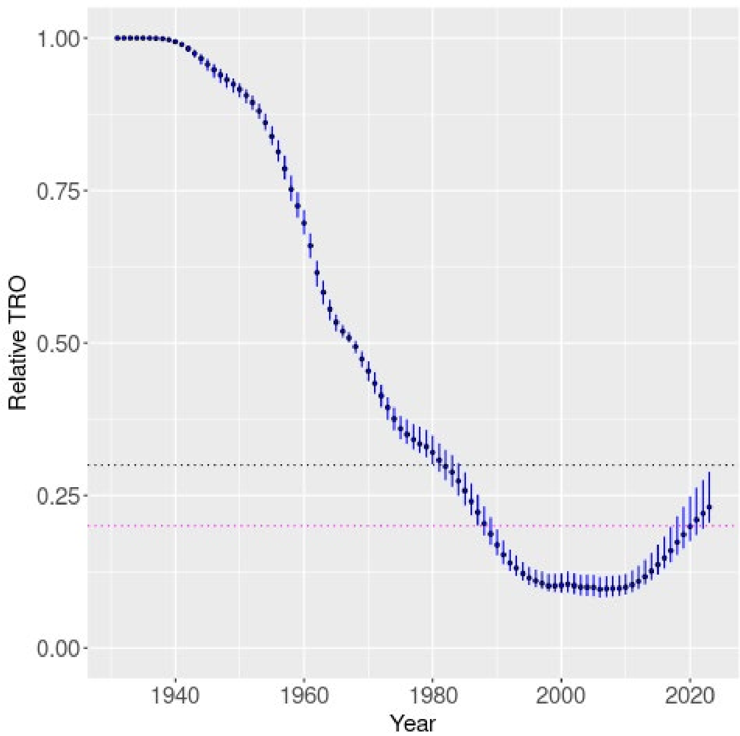


Figure 11: Relative *TRO* (median and 80% Probability Intervals (PI)) for the reference set of models for the 2023 stock assessment. The magenta horizontal line is at 20% TRO_0; the black horizontal line is at 30% TRO_0.

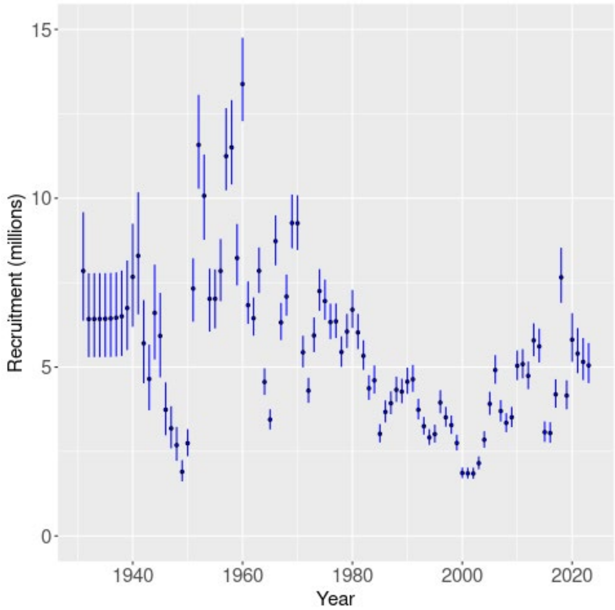


Figure 12: Absolute recruitment of age-0 fish (median and 80% PI). The last estimated recruitment is 2019; the final four recruitments shown are model predictions given the preceding recruitments and the autocorrelation in the historical year-class deviations.

5.3.2 Sensitivity tests

The sensitivity tests were specified to assess the impacts on stock status estimates from additional areas of uncertainty that are not covered in the reference set of 108 models. Most of the sensitivity tests results indicate consistent or slightly more optimistic stock status results compared with the reference set, with results from only 2 of 12 sensitivity tests being slightly more pessimistic.

5.3.3 Projections

Future catch levels will be set by the CCSBT based on the output from the management procedure, with the most recent iteration being the Cape Town Procedure. Management Procedures are currently designed to rebuild the spawning stock to 30% of the unfished level by 2035 (with 50% certainty).

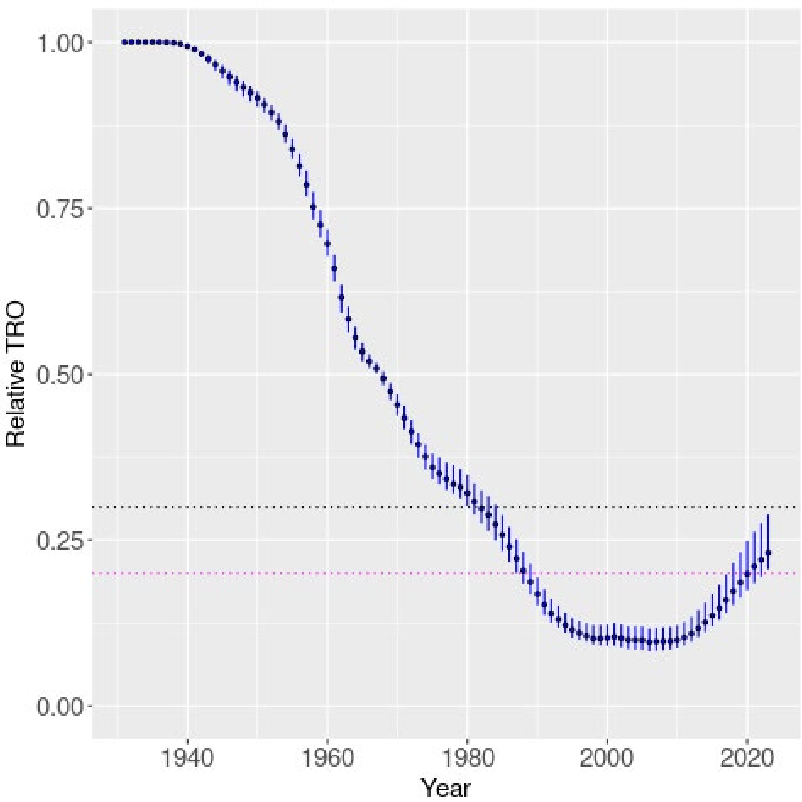
Projections calculated using the Cape Town Procedure (adopted in 2019 and reconditioned in 2022) and the reference set of operating models indicate that the target of 30% TRO_0 will be reached by 2035 with a probability of 0.51. The Scientific Committee noted that the reported catch has been less than the global TAC every year since 2017, the 2023 stock status represents an improvement over the 2020 status estimated in the last stock assessment conducted in 2020, and projections for the reference set of models indicate that the management procedure is on track to reach the new rebuilding target (50% probability of being greater than 30% TRO_0, by 2035) and maintain the stock at this level after the target year.

6. STATUS OF THE STOCK

Stock Status		
Most Recent Assessment Plenary Publication Year	2023	
Catch in most recent year of assessment	Year: 2022	Catch: 17 139 t
Assessment Runs Presented	Reference set model plus a range of sensitivity scenarios	
Reference Points	Target: 30% TRO_0 with 50% certainty by 2035 Soft Limit: Default 20% B_0 Hard Limit: Default 10% B_0 Overfishing threshold: F_{MSY}	

Status in relation to Target	Total Reproductive Output: TRO_{2023}/TRO_0 = 23% with 50% certainty is currently below the target for 2035. Very Unlikely (< 10%) to be at or above the target
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 Very Unlikely (< 10%) to be occurring

Historical Stock Status Trajectory and Current Status



Trends in relative Total Reproductive Output, *TRO* (*TRO_{2023}/TRO_0*) for 1931–2023 estimated for the current reference set. The magenta horizontal line is at 20% *TRO_0*; the black horizontal line is at 30% *TRO_0*.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Increasing trajectory of *TRO*
Recent Trend in Fishing Intensity or Proxy	Fishing mortality is below F_{MSY}.
Other Abundance Indices	CPUE has been increasing since 2009.
Trends in Other Relevant Indicators or Variables	Recent recruitments are estimated to be well below the historically high levels from 1950 to 1970 but have improved appreciably since the poor recruitment of 1999–2003.

Projections and Prognosis	
Stock Projections or Prognosis	The management procedure adopted by the CCSBT should rebuild the stock to 30% TRO_0 by 2035 with a 50% probability.

Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Unlikely (< 40%) for Soft Limit Very Unlikely (< 10%) for Hard Limit
Probability of Current Catch or TACC causing Overfishing to continue or commence	Very Unlikely (< 10%)

Assessment Methodology and Evaluation		
Assessment Type	Level 1 – Full Quantitative Stock Assessment	
Assessment Method	Reference set of reconditioned CCSBT Operating Model	
Assessment Dates	Latest assessment Plenary publication year: 2023	Next assessment: 2026
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	Revised CPUE, catch-at-age and length-frequency data, gene-tagging estimate, close-kin (C-K) biomass estimate	1 – High Quality
Data not used (rank)	N/A	Aerial survey estimates
Changes to Model Structure and Assumptions	- Fully revised CPUE - Gene tagging estimates for age 2	
Major Sources of Uncertainty	-	

Qualifying Comments
The Management Procedure evaluated in 2022 resulted in a 3000 t increase to the TAC for 2024–26.

7. FOR FURTHER INFORMATION

Abraham, E R; Berkenbusch, K (2019) Preparation of data for protected species capture estimation, updated to 2017–18. *New Zealand Aquatic Environment and Biodiversity Report No. 234*. 49 p.

Abraham, E R; Berkenbusch, K; Richard, Y; Thompson, F (2016) Summary of the capture of seabirds, mammals, and turtles in New Zealand commercial fisheries, 2002–03 to 2012–13. *New Zealand Aquatic Environment and Biodiversity Report No.* 169. 205 p.

Abraham, E R; Richard, Y (2019) Estimated capture of seabirds in New Zealand trawl and longline fisheries, to 2016–17. *New Zealand Aquatic Environment and Biodiversity Report No. 226*. 85p.

Abraham, E R; Thompson, F N (2009) Capture of protected species in New Zealand trawl and longline fisheries, 1998–99 to 2006–07. *New Zealand Aquatic Environment and Biodiversity Report No. 32*. 197 p.

Abraham, E R; Thompson, F N (2011) Summary of the capture of seabirds, marine mammals, and turtles in New Zealand commercial fisheries, 1998–99 to 2008–09. Final Research Report prepared for Ministry of Fisheries project PRO2007/01. 170 p. (Unpublished report held by Fisheries New Zealand, Wellington.)

Abraham, E R; Thompson, F N; Oliver, M D (2010) Summary of the capture of seabirds, marine mammals, and turtles in New Zealand commercial fisheries, 1998–99 to 2007–08. *New Zealand Aquatic Environment and Biodiversity Report No. 45*. 148 p.

Anon (2001) Report of the Sixth meeting of the Scientific Committee, Tokyo, Japan, 28–31 August 2001.

Anon (2004a) Report of the Fifth Meeting of the Stock Assessment Group, 6–11 September 2004, Jeju, Republic of Korea

Anon (2004b) Report of the Ninth Meeting of the Scientific Committee, 13–16 September 2004, Jeju, Republic of Korea.

Anon (2005a) Report of the Sixth Meeting of the Stock Assessment Group, 29 August–3 September 2005, Taipei, Taiwan.

Anon (2005b) Report of the Tenth Meeting of the Scientific Committee, 9 September 2005, Narita, Japan.

Anon (2006a) Report of the Seventh Meeting of the Stock Assessment Group, 4–11 September 2004, Tokyo, Japan.

Anon (2006b) Report of the Eleventh Meeting of the Scientific Committee, 12–15 September 2006, Tokyo, Japan.

Anon (2009a) Report of the Operating Model and Management Procedure Technical Meeting, 13–17 July 2009, Seattle, USA.

Anon (2009b) Report of the Fourteenth Meeting of the Scientific Committee, 5–11 September 2009, Busan, Republic of Korea.

Anon (2011) Report of the Sixteenth Meeting of the Scientific Committee, 19–29 July 2011, Bali, Indonesia.

Anon (2012a) Report of the Seventeenth Meeting of the Scientific Committee, 27–31 August 2012, Tokyo, Japan.

Anon (2012b) Review of National SBT Fisheries for the Scientific Committee - New Zealand. CCSBT-ESC/1208/SBT Fisheries New Zealand.

Anon (2017) Report of the Twenty-second Meeting of the Scientific Committee, 28 August–2 September 2017, Yogyakarta, Indonesia.

Anon (2019) Report of the Twenty-fourth Meeting of the Scientific Committee, 2–7 September 2019, Capetown, South Africa.

Baird, S J (2008) Incidental capture of New Zealand fur seals (*Arctocephalus forsteri*) in longline fisheries in New Zealand waters, 1994–95 to 2005–06. *New Zealand Aquatic Environment and Biodiversity Report No. 20.* 21 p.

Bentley, N; Langley, A D; Middleton, D A J; Lallemand, P (2013) Fisheries of New Zealand, 1989/90–2011/12. Retrieved from http://fonz.tridentsystems.co.nz. Accessed 11 October 2013.

Best, E (1929) Fishing methods and devices of the Maori. *Dominion Museum Bulletin No. 12*.

Bravington, M; Grewe, P; Davies, C (2012) Report of the Close-Kin Project: estimating the absolute spawning stock size of SBT using genetics. CCSBT-ESC/1208/19.

Edwards, C T T; Peatman, T; Goad D; Webber, D N (2023) Update to the risk assessment for New Zealand seabirds. *New Zealand Aquatic Environment and Biodiversity Report No. 314*. 66 p.

Fisheries New Zealand (2022) Aquatic Environment and Biodiversity Annual Review 2021. Compiled by the Aquatic Environment Team, Fisheries Science and Information, Fisheries New Zealand, Wellington New Zealand. 779 p.

Fisheries New Zealand & Department of Conservation (2020) National Plan of Action – Seabirds 2020 Reducing the incidental mortality of seabirds in fisheries. Fisheries New Zealand, Wellington New Zealand. 21 p.

Harley, S J; Kendrick, T (2006) Annual Review of National SBT Fisheries for the Scientific Committee. CCSBT-ESC/0609/SBT Fisheries New Zealand.

Hillary RM, Preece AL, Takahashi N, Davies CR and Itoh T. (2023) The southern bluefin tuna stock assessment in 2023. CCSBT-ESC/2308/16

Heinemann A; Gray, A. (2024) National Panel Survey of Recreational Marine Fishers 2022-23. *New Zealand Fisheries Assessment Report 2024/51*. 116 p.

Holdsworth, J C (2019) Recreational harvest of southern bluefin tuna in New Zealand, 2017–18. *New Zealand Fisheries Assessment Report 2019/08*. 17 p.

Holdsworth, J C (2021) Recreational harvest of southern bluefin tuna in New Zealand, 2019–20. *New Zealand Fisheries Assessment Report 2021/16*. 20 p.

Holdsworth, J C (2024) Recreational harvest of southern bluefin tuna in New Zealand, 2022–23. *New Zealand Fisheries Assessment Report 2024/21*. 18 p

Hufflett, C (2000) Southern bluefin tuna. (Unpublished report available from Solander Fisheries, Nelson.)

Leigh, G M; Hearn, W S (2000) Changes in growth of juvenile southern bluefin tuna (*Thunnus maccoyii*): an analysis of length–frequency data from the Australian fishery. *Marine and Freshwater Researc*h *51*: 143–154.

Mattlin, R H (1987) New Zealand fur seal, *Arctocephalus forsteri*, within the New Zealand region. *In*: Croxall, J P; Gentry, R L, Status, biology, and ecology of fur seals: Proceedings of an international symposium and workshop, Cambridge, England, 23–27 April 1984. *NOAA Technical Report NMFS-51*.

Ministry for Primary Industries (2013) National Plan of Action – 2013 to reduce the incidental catch of seabirds in New Zealand Fisheries. Ministry for Primary Industries, Wellington, New Zealand. 59 p.

Murray, T; Richardson, K M (2001) Trends in the New Zealand southern bluefin tuna fishery. CCSBT-SC/0108/SBT Fisheries New Zealand.

Murray, T; Richardson, K; Griggs, L (2004) New Zealand tuna fisheries, 1991–2000. *New Zealand Fisheries Assessment Report 2004/59*. 65 p.

Perrin, W F; Wursig, B; Thewissen, J G M (eds) (2008) *Encyclopedia of marine mammals*. Second Edition. Academic Press, San Diego.

Richard, Y; Abraham, E R (2013) Application of Potential Biological Removal methods to seabird populations. *New Zealand Aquatic Environment and Biodiversity Report No. 108*. 30 p.

Richard, Y; Abraham, E R (2015) Assessment of the risk of commercial fisheries to New Zealand seabirds, 2006–07 to 2012–13. *New Zealand Aquatic Environment and Biodiversity Report No. 162.* 85 p.

Richard, Y; Abraham, E R; Berkenbusch, K (2017) Assessment of the risk of commercial fisheries to New Zealand seabirds, 2006–07 to 2014–15. *New Zealand Aquatic Environment and Biodiversity Report 191.*104 p.

Richard, Y; Abraham, E R; Berkenbusch, K (2020) Assessment of the risk of commercial fisheries to New Zealand seabirds, 2006–07 to 2016–17. *New Zealand Aquatic Environment and Biodiversity Report 237*. 57 p.

Richard, Y; Abraham, E R; Filippi, D (2011) Assessment of the risk to seabird populations from New Zealand commercial fisheries. Final Research Report for projects IPA2009/19 and IPA2009/20. 137 p. (Unpublished report held by Fisheries New Zealand, Wellington.)

Richard, Y; Abraham, E R; Filippi, D (2013) Assessment of the risk of commercial fisheries to New Zealand seabirds, 2006–07 to 2010–11. *New Zealand Aquatic Environment and Biodiversity Report No. 109.* 58 + 70 p.

Robertson, H A; Baird, K; Dowding J E; Elliott, G P; Hitchmough, R A; Miskelly, C M; McArthur, N; O'Donnell, C F J; Sagar, P M; Scofield, R P; Taylor, G A (2017) Conservation status of New Zealand birds, 2016. *New Zealand Threat Classification Series* 19. Department of Conservation, Wellington. 23 p. Retrieved from http://www.doc.govt.nz/documents/science-and-technical/nztcs19entire.pdf.

Rowe, S J (2009) Conservation Services Programme observer report: 1 July 2004 to 30 June 2007. *DOC Marine Conservation Services Series 1*. 93 p.

Sharp, B; Waugh, S; Walker, N A (2011) A risk assessment framework for incidental seabird mortality associated with New Zealand fishing in the New Zealand EEZ. 39 p. (Unpublished report held by Fisheries New Zealand, Wellington.)

Thompson, F N; Abraham, E R (2010) Estimation of fur seal (*Arctocephalus forsteri*) bycatch in New Zealand trawl fisheries, 2002–03 to 2008–09. *New Zealand Aquatic Environment and Biodiversity Report No. 61*. 37 p.

Thompson, F N; Berkenbusch, K; Abraham, E R (2013) Marine mammal bycatch in New Zealand trawl fisheries, 1995–96 to 2010–11. *New Zealand Aquatic Environment and Biodiversity Report No. 105*. 73 p.

Waugh, S; Fillipi, D; Abraham, E (2009) Ecological Risk Assessment for Seabirds in New Zealand fisheries. Final Research Report for Ministry of Fisheries project PRO2008-01. 58 p. (Unpublished report held by Fisheries New Zealand, Wellington.)

Wynne-Jones, J; Gray, A; Heinemann, A; Hill, L; Walton, L (2019) National Panel Survey of Marine Recreational Fishers 2017–18. *New Zealand Fisheries Assessment Report 2019/24*. 104 p.

Wynne-Jones, J; Gray, A; Hill, L; Heinemann, A (2014) National Panel Survey of Marine Recreational Fishers 2011–12: Harvest Estimates. *New Zealand Fisheries Assessment Report 2014/67*. 139 p.

Young, J W; Lamb, T D; Le, D; Bradford, R W; Whitelaw, A W (1997) Feeding ecology and interannual variations in diet of southern bluefin tuna, *Thunnus maccoyii*, in relation to coastal and oceanic waters off eastern Tasmania, Australia. *Environmental Biology of Fishes 50*: 275–291