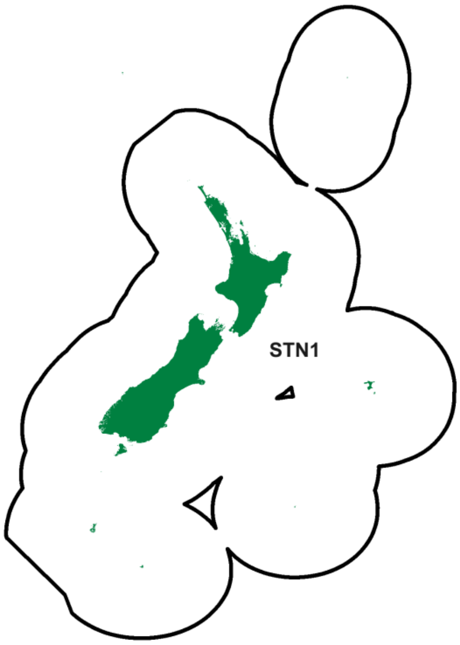
SOUTHERN BLUEFIN TUNA (STN)

(*Thunnus maccoyii*)



1. FISHERY SUMMARY

Southern bluefin tuna were introduced into the QMS on 1 October 2004 under a single QMA, STN 1, with allowances for customary and recreational fisheries and other sources of mortality within the TAC and a commercial TACC. The current allowances and the TACC are outlined in Table 1.

Table 1: Recreational and Customary non-commercial allowances, TACCS and TAC (all in tonnes) for southern bluefin tuna.

Fishstock	Recreational Allowance (t)	Customary non-commercial Allowance (t)	Other mortality (t)	TACC (t)	TAC (t)
STN 1	8	1	4	987	1000

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 and Indonesia. The Republic of South Africa, the European Community, and 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.

Management procedure

In 2011, the Commission adopted a management procedure (MP) to set quotas for three year periods based on the latest fisheries indicators from the stock. The MP is 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 MP in 2011 as 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 three year period. Quotas set for the three years allowed a 1000 t increase in 2012 to 10 449 t, a further increase in 2013 to 10 949 t and subject to the MP output an increase to 12 449 t in 2014.

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 tonnes. 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 MP was run again and recommended a TAC of 17 647 t for 2018–2020 that was confirmed by CCSBT23 in October 2016.

Table 2: Allocated catches for Members for 2018–2020.

Member	Effective catch limit (t)
Australia	6165
Fishing Entity of Taiwan	1240.5
Japan	6165
New Zealand	1088
Republic of Korea	1240.5
Indonesia	1002
European Community	11
South Africa	423

Market and farming reviews

In July 2006, the CCSBT Commission reviewed the results of two joint Australia / Japan reviews: the first was an assessment of the amount of southern bluefin tuna being sold through Japanese markets (referred to as the Market Review), and the second was an assessment of the potential for overcatch from the Australian surface fishery and associated farming operations (referred to as the Farming Review).

The Market Review reported that quantities of southern bluefin tuna sold through the Japanese markets (back to the mid-1980s) were well in excess of the amount reported by Japan as domestic catch or imported from other countries (measured through the Trade Documentation Scheme), i.e., there were large volumes of unreported catch. The Market Review could not determine where the catch came from.

The Farming Review reported that while the catch in numbers from the surface fishery were probably well reported there was scope for biases in reported catch in weight due to two factors: (1) changes in the weight of fish between the time of capture and when the weight sample is taken; and (2) the sample of fish taken to estimate the mean weight of fish in the catch may not be representative (causing either negative or positive biases in the mean weight estimate).
The Farming Review was inconclusive.

While Japan does not accept the findings of the Market review they have acknowledged some illegal catch during the 2005 fishing season and changed how they manage their fishery and in 2006 accepted a cut in their allocated catch to 3000 t down from 6065 t for a minimum of 5 years. Current allocations for all countries are provided in Table 2 above.

The findings of the two reviews have resulted in considerable uncertainty in the southern bluefin tuna science process as even the most fundamental data (e.g., catch history) are not reliable and may be very different from reported catches. Further, many of the indicators of stock status previously relied upon are now under question as they may be biased due to illegal activity.

1.1 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 Ferons 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 handlining 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. 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.

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 two thousand tonnes were taken within the New Zealand EEZ.

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 through 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 through 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 and fluctuated about 15 000 t per year until 2005. However, since 2006 catches have been generally less than 12 000 t (see Table 4). However, it should be noted that reported total catches are likely to be underestimates, at least after 1989, as they do not incorporate the findings from the Market and Farming Reviews. Despite this uncertainty the catches reported in 2009 (10 941 t) are the lowest estimated global catch for over 50 years.

From 1960 to the 1990s catches by longline declined while surface fishery catches in Australian waters increased to reach its 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 (age-1 to age-3 year olds) while longline fisheries catch older juveniles and adults (age-4 year old up to age-40+). The surface fishery has comprised purse seine and pole & line vessels supported by aerial spotter planes that search out surface schools. The Australian surface fisheries prior to 1990 were a mix of pole & line and purse seine vessels, and have since the mid-1990s become almost exclusively a purse seine fishery. Whereas prior to 1990, surface fishery catches supplied canneries, since the mid-1990s these vessels catch 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 FMA1, FMA2, FMA5 and FMA7. The northern FMAs (FMA1 and FMA2) 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 (FMA5 and FMA7). 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 other fish species than southern bluefin but most of the effort was targeting STN.

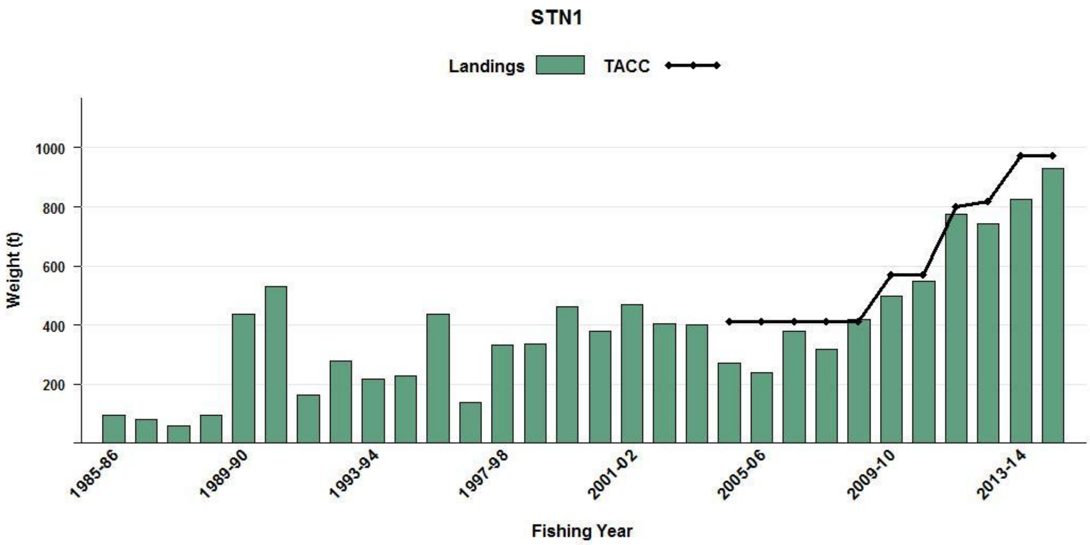


Figure 1: Commercial catch and TACC of southern bluefin tuna from 1985–86 to 2014–15 within New Zealand fishing waters (STN 1).

Table 3: Reported domestic[1] and total[2] southern bluefin tuna landings (t) from 1972 to 2015 (calendar year) [continued on next page].

Year	NZ Landings (t)	Total stock (t)	Year	NZ Landings (t)	Total stock (t)
1972	1	51 925	1994	277	13 154
1973	6	41 205	1995	436	13 637
1974	4	46 777	1996	139	16 356
1975	0	32 982	1997	334	16 076
1976	0	42 509	1998	337	17 776
1977	5	42 178	1999	461	19 529
1978	10	35 908	2000	380	15 475
1979	5	38 673	2001	358	16 032
1980	130	45 054	2002	450	15 258
1981	173	45 104	2003	390	14 077
1982	305	42 788	2004	393	13 504
1983	132	42 881	2005	264	16 150
1984	93	37 090	2006	238	11 741
1985	94	33 325	2007	379	10 583
1986	82	28 319	2008	319	11 396

Table 3 [Continued]

Year	NZ landings (t)	Total stock (t)	Year	NZ landings (t)	Total stock (t)
1987	59	25 575	2009	419	10 946
1988	94	23 145	2010	501	9 723
1989	437	17 843	2011	547	9 440
1990	529	13 870	2012	776	10 049
1991	164	13 691	2013	756	11 726
1992	279	14 217	2014	825	11 911
1993	217	14 344	2015	923	14 098

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

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.

Fish Yr	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*		825.6	825.6	825.6	-
2014/15*		928.8	928.8	928.8	-

* - Southern bluefin tuna landings are not separated into within zone and ET since 2006/07

Table 5: Effort (thousands of hooks) for the charter and domestic fleet by year and CCSBT Region.

	Charter			Domestic#		
Calendar Year	**Region 5**	**Region 6**	**Other***	**Region 5**	**Region 6**	**Other***
1989		1596	3.5			
1990	259	1490.6		41.7		
1991	306	1056.5		31.5	49.2	
1992	47.6	1386.8	3	71.7	12.1	
1993	174.1	1125.7	101.4	644.0	108.1	7.7
1994		799.1		122.6	143.3	5.8
1995	27.1	1198.7	13.5	221.5	760.4	26.7
1996				417.9	564.3	11.5
1997	135.2	1098.7		736.4	8.9	17.3
1998	225	616		633.6	314.5	1.2
1999	57.2	955.1		1221.4	382.9	5.5
2000	30.3	757.9		1164.0	454.4	8.5
2001		639.4		1027.6	751.5	1.9
2002		726.4		1358.6	1246.8	13.5
2003	3	866.6		1868.7	1569.1	4.3
2004		1113.5		1154.1	1431.9	1.2
2005	137	498.9		1133.0	153.6	2.4
2006	39.4	562.5		1036.4	122.4	0.9
2007	271.6	1136.1		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		1114.9	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	

* Includes erroneous position data and data without position data

\# Effort for sets that either targeted or caught southern bluefin tuna

The majority of southern bluefin tuna (88%) are caught in the southern bluefin tuna fishery (Figure 2). However, albacore comprise an equal proportion of the catch (29%) as southern bluefin tuna (Figure 3). Longline fishing effort is distributed along the east coast of the North Island and the south west coast of the South Island. The 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.

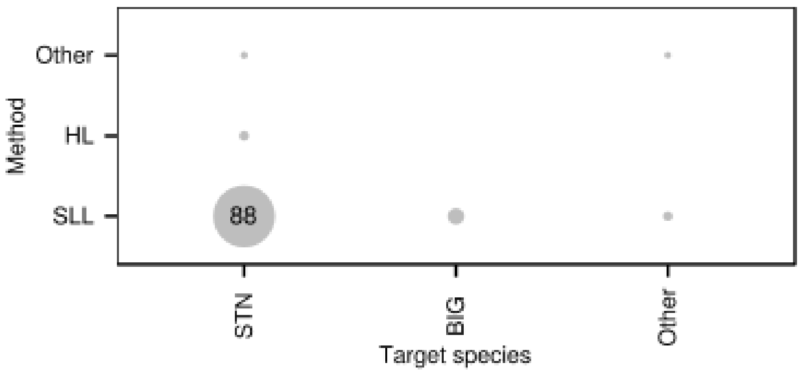


Figure 2: A summary of the proportion of landings of southern bluefin tuna taken by each target fishery and fishing method for 2012–13. The area of each circle is proportional to the percentage of landings taken using each combination of fishing method and target species. The number in the bobble is the percentage. SLL = surface longline, HL = hook and line (Bentley et al 2012).

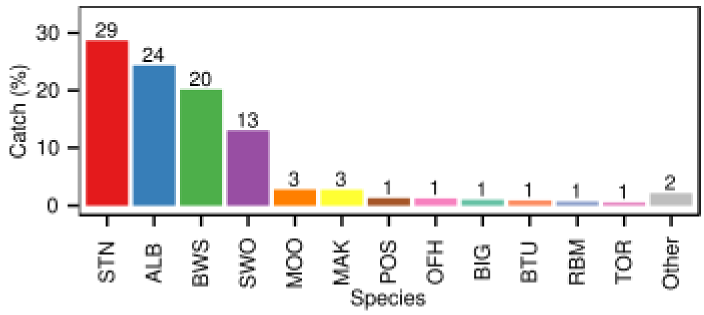


Figure 3: A summary of species composition of the reported southern bluefin tuna target surface longline catch for 2012–13. The percentage by weight of each species is calculated for all surface longline trips targeting southern bluefin tuna (Bentley et al 2012).

1.2 Recreational fisheries

Charter vessels based in Milford Sound have been known to have targeted southern bluefin tuna historically. Gamefish charter vessels occasionally take southern bluefin as bycatch when targeting Pacific bluefin tuna when fishing out of Greymouth or Westport. The highest estimates of recreational catch of southern bluefin are 4025 kg (35 fish) from 2007.

The estimate of non-commercial STN catch as bycatch from the Pacific bluefin tuna game fishery was less than one tonne in 2010. Six fish were reported as non-commercial STN catch from recreational charter vessels in 2012, and 2 were released alive. Since then mandatory reporting of bluefin tuna has been introduced for amateur charter vessels. The reported catch from amateur charter vessels is shown in the following text table:

	Sum of Number Caught	Sum of Number Retained	Sum of Estimated Weight
2013	12	12	550
2014	0	0	0
2015	1	0	15

1.3 Customary non-commercial fisheries

An estimate of the current customary catch is not available**.** Given that Maori knew of several oceanic fish species and missionaries reported that Maori regularly fished several miles from shore, it is possible that southern bluefin tuna were part of the catch of Maori prior to European settlement. It is clear that Maori 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 Maori name for southern bluefin tuna, therefore it is uncertain if Maori caught southern bluefin tuna.

1.4 Illegal catch

There is no known illegal catch of southern bluefin tuna by New Zealand vessels in the EEZ or from the high seas. The review of the Japanese Market suggests very large illegal catch from the broader stock historically.

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.

1.5 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 (*Notodarus* 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 there is some discarding and loss (usually as a result of shark damage) before fish are landed that occurs in the longline fishery. The estimated overall incidental mortality rate from observed longline effort is 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 4 t has been made for other sources of mortality.

2. BIOLOGY

The age at which 50% of southern bluefin are mature is uncertain because of limited sampling of fish on the spawning ground off Java. Recent sampling of the Indonesian catch suggests that 50% age-at-maturity may be as high as 12 years, while interpretations of available data since 1994 have used 8 years and older fish as representing the adult portion of the stock in the population models.

As the growth rate has changed over the course of the fishery (see following section and Table 7) 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.

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

Age	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

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 in Table 7.

Table 7: Parameters of length/ weight relationship for southern bluefin tuna. ln (Weight) = b_1 ln(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

The data used include all longline observer data for the period 1987 to 2000 from all vessels in the EEZ (n = 18 994).

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

While 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 over fishing.

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 juvenile's ages 1 to 3 years also suggests that M for these fish is high (possibly as high as M = 0.4), while 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 30ºS and 45ºS, 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 while 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 Commission, 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, having deployed 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 thus far. 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, in the last couple of years more of these tagged juveniles have 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 years within the broader Tasman Sea region. An analysis of the length and age composition of catches from the New Zealand JV 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 2016 Fishery Assessment Plenary following review of the text by the Aquatic Environment Working Group in 2015. 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 (www.mpi.govt.nz/document-vault/11521) (Ministry for Primary Industries 2016).

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 of seabirds, sea turtles and mammals

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 Seabird bycatch

Between 2002–03 and 2013–14, there were 651 observed captures of birds in southern bluefin longline fisheries. Seabird capture rates since 2003 are presented in Figure 4. Capture rates peaked in 2006–07 and 2009–10. Seabird captures were most concentrated off Fiordland and around East Cape (see Table 9 and Figure 5). Previously bayesian models of varying complexity dependent on data quality were used (Richard & Abraham 2014); more recently a single model structure has been developed to provide a standard basis for estimating seabird captures across a range of fisheries (Richard & Abraham in prep.). Observed and estimated seabird captures in southern bluefin tuna longline fisheries are provided in Table 10.

Through 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 s 11 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 repromulgated 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.

Risk posed by commercial fishing to seabirds has been assessed via a level 2 method which supports much of the NPOA-Seabirds 2013 risk assessment framework (MPI 2013b). The method used in the level 2 risk assessment arose initially from an expert workshop hosted by the Ministry of Fisheries in 2008. The overall framework is described in Sharp et al. (2011) and has been variously applied and improved in multiple iterations (Waugh et al 2009, Richard et al 2011, Richard & Abraham 2013, Richard et al 2013 and Richard & Abraham 2015). The method applies an “exposure-effects” approach where exposure refers to the number of fatalities 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 to the population’s productivity, based on population estimates and biological characteristics to yield estimates of population-level risk.

The 2016 iteration of the level 2 risk assessment has included significant modifications to the methodology; in order to include the full uncertainty around population size the total population size was included instead of N_{min} in the PST calculation; using the allometric survival rate and age at first reproduction for the calculation of R_{max}, applying a revised correction factor as the previous was found to be biologically implausible; applying a constraint on the fatalities calculated based on observed survival rates; including live release survival; allowing change in vulnerability over time where there is enough data; switch to assuming number of incidents is related to vulnerability. There were also changes made to the fisheries groups, seabird demographic data were updated and the Stewart Island shag was split into the Otago and Foveaux shags. The 2016 iteration derives a risk ratio, which is an estimate of aggregate potential fatalities across trawl and longline fisheries relative to the Population Sustainability Threshold, PST (an analogue of the Potential Biological Removals, PBR, approach) (Richard & Abraham in prep).

The 2016 iteration of the seabird risk assessment (Richard & Abraham in prep.) assessed the southern bluefin tuna surface longline target fisheries contribution to the total risk posed by New Zealand commercial fishing to seabirds (see Table 11). These target fisheries contribute 0.053 of PST to the risk to Southern Buller's albatross (over 13% of the total risk to this species from commercial fishing including in the risk assessment) and 0.077 of PST to Gibson's albatross (over 22% of the total risk assessed); both species were assessed to be at high risk from New Zealand commercial fishing. This fishery also contributed 0.047 of PST to Antipodean albatross (over 23% of the total risk assessed), which was assessed to be at medium risk from New Zealand commercial fishing (Richard & Abraham in prep.).

Table 9: Number of observed seabird captures in southern bluefin tuna longline fisheries, 2002–03 to 2014–15, 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 PBR approach) (Richard & Abraham in prep). The current version of the risk assessment does not include recovery factor. The New Zealand threat classifications are shown (Robertson et al 2013 at http://www.doc.govt.nz/documents/science-and-technical/nztcs4entire.pdf). Other data, version 2016001.

Species	Risk category	Fiord-land	East Coast North Island	West Coast South Island	Stewart Snares Shelf	Bay of Plenty	Northland and Hauraki	Total
Southern Buller's albatross	High	312	17	44		2		375
New Zealand white-capped albatross	High	67	5	43	10	1		126
Campbell black-browed albatross	Low	4	15	4		2	3	28
Gibson's albatross	High	3	5	3			1	12
Wandering albatrosses	NA	2	4					6
Antipodean albatross	Medium		4				1	5
Southern royal albatross	Negligible	4		1				5
Salvin's albatross	High		3			1		4
Black-browed albatrosses	NA		5					5
Light-mantled sooty albatross	Negligible		1				1	1
Smaller albatrosses	NA		1					1
Northern Buller's albatross	Medium		1					1
Great Albatross	NA			1				1
Total albatrosses		**392**	**62**	**97**	**10**	**6**	**5**	**572**
Grey petrel	Negligible	37			3	2	42	40
White-chinned petrel	Negligible	21	1		1		1	24
Westland petrel	High	2		6				8
Sooty shearwater	Negligible			3			3	4
Cape petrels	NA		2					2
Southern giant petrel	NA		2					2
Seabird - large	NA	2						2
Total other seabirds		**25**	**43**	**6**	**4**	**3**	**3**	**84**

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 in Richard and Abraham (in prep) and are available via https://data.dragonfly.co.nz/psc/. Estimates from 2002–03 to 2014–15 are based on data version 2016001.

Fishing year	Fishing effort			Observed captures		Estimated captures	
	All hooks	Observed hooks	% observed	Number	Rate	Mean	95% c.i.
2002–2003	3 513 361	1 133 740	32.3	43	0.038	532	360–807
2003–2004	3 195 171	1 471 964	46.1	70	0.048	504	341–752
2004–2005	1 661 979	734 026	44.2	36	0.049	196	132–297
2005–2006	1 493 418	655 445	43.9	29	0.044	173	112–270
2006–2007	1 938 111	916 660	47.3	111	0.121	231	182–303
2007–2008	1 104 825	375 975	34.0	30	0.080	155	96–251
2008–2009	1 484 438	840 048	56.6	48	0.057	176	117–276
2009–2010	1 559 858	580 395	37.2	112	0.193	305	231–415
2010–2011	1 330 265	567 204	42.6	32	0.056	201	130–304
2011–2012	1 593 754	645 530	40.5	51	0.079	376	231–621
2012–2013	1 516 397	491 903	32.4	23	0.047	315	191–517
2013–2014	1 589 620	747 220	47.0	34	0.046	288	177–469
2014–2015	1 564 319	683 250	43.7	32	0.047	268	167–436

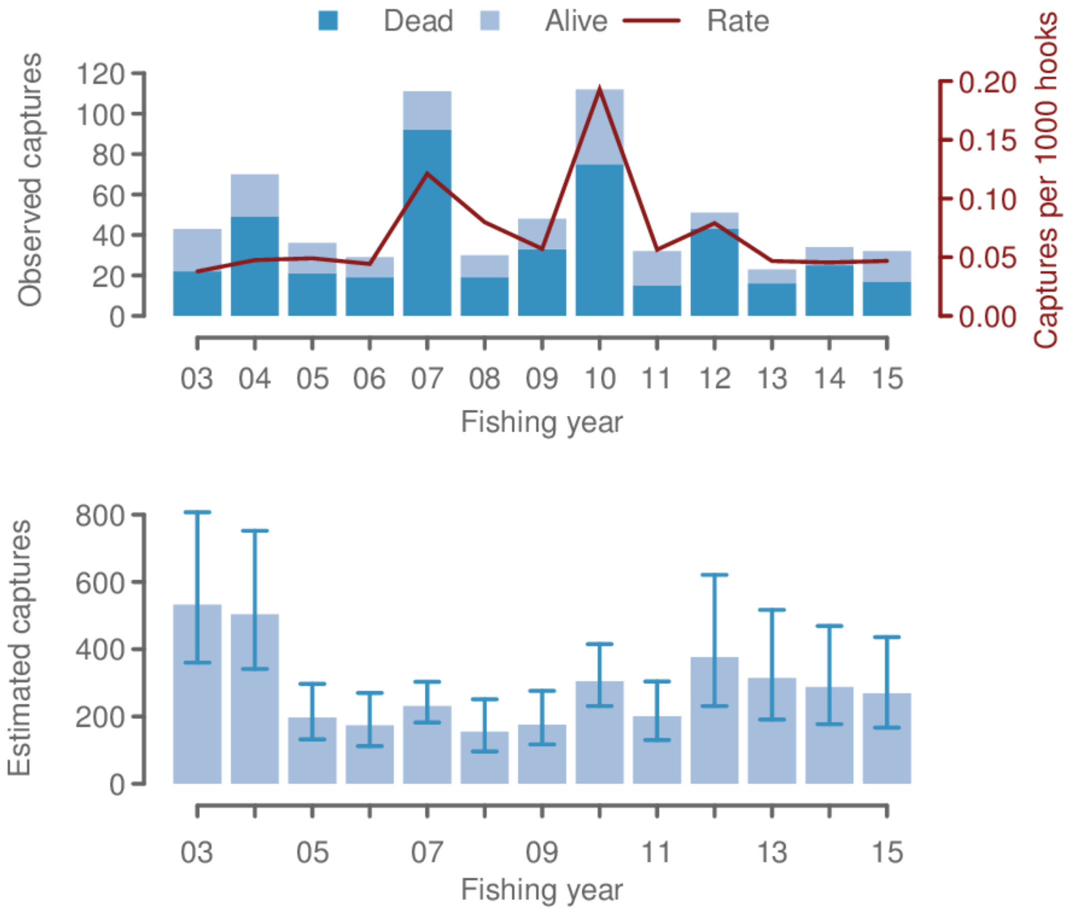


Figure 4: Observed and estimated captures of seabirds in southern bluefin tuna longline fisheries from 2002–03 to 2014–15. Data grooming and estimates are based on methods described in Richard and Abraham (in prep) and are available via https://data.dragonfly.co.nz/psc/. Estimates from 2002–03 to 2014–15 are based on data version 2016001.

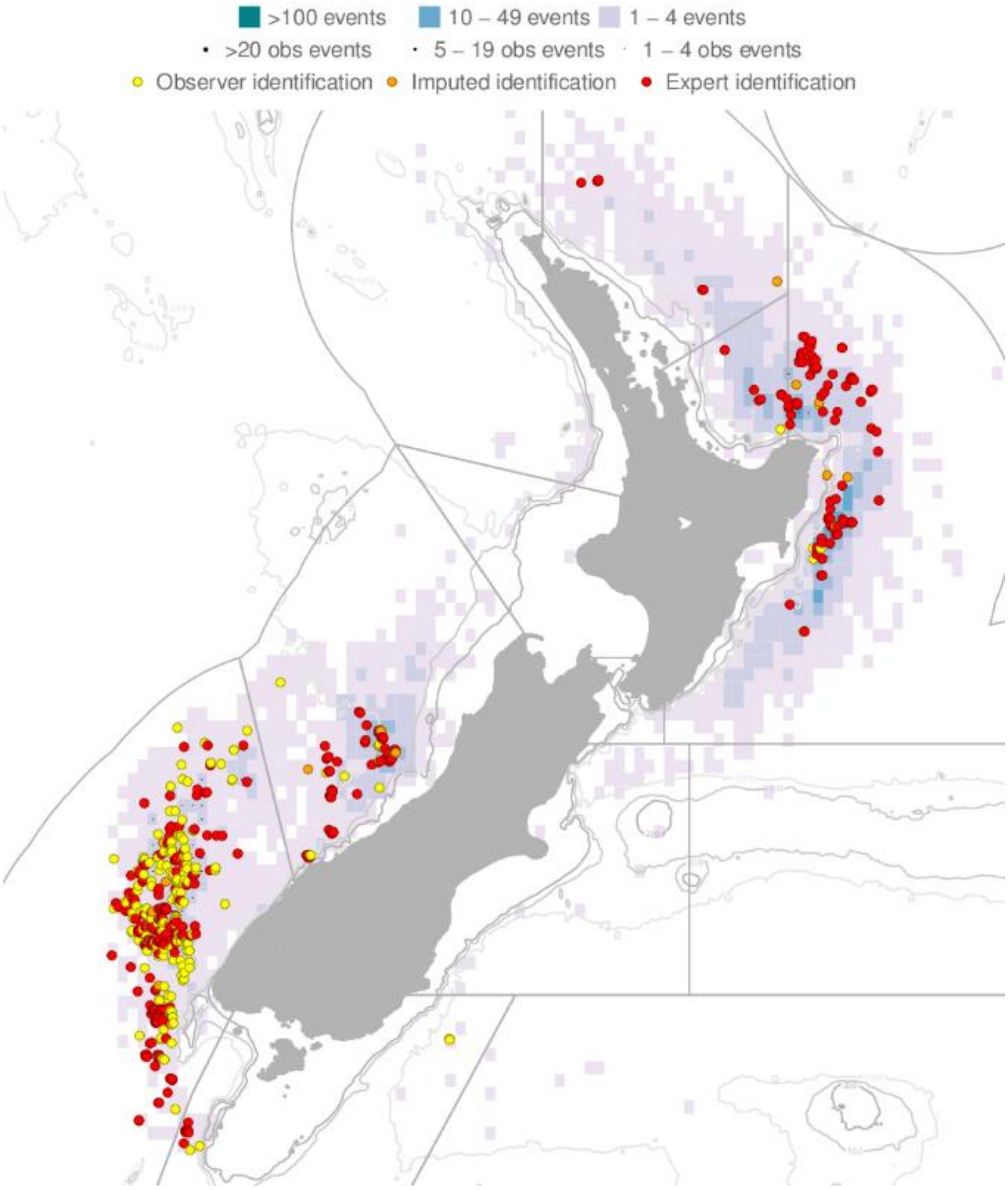


Figure 5: Distribution of fishing effort targeting southern bluefin tuna and observed seabird captures, 2002–03 to 2014–15. Fishing effort is mapped into 0.2-degree cells, with the colour of each cell being related to the amount of effort. Observed fishing events are indicated by black dots, and observed captures are indicated by red 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 Richard and Abraham (in prep) and are available via https://data.dragonfly.co.nz/psc/. Estimates from 2002–03 to 2014–15 are based on data version 2016001.

Table 11: Risk ratio of seabirds predicted by the level two risk assessment for the southern bluefin tuna target surface longline fisheries and all fisheries included in the level two risk assessment, 2006–07 to 2013–14, showing seabird species with risk category of very high or high, or a medium risk category and risk ratio of at least 1% of the total risk. 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 PBR approach) (from Richard & Abraham, in prep.). Other data, version 2016001. The current version of the risk assessment does not include a recovery factor. The New Zealand threat classifications are shown (Robertson et al 2013 at http://www.doc.govt.nz/documents/science-and-technical/nztcs4entire.pdf)

Species name	Risk ratio: STN target SLL	Risk ratio: Total risk from NZ commercial fishing	Risk ratio: % of total risk from NZ commercial fishing	Risk category	NZ Threat Classification
Black petrel	0.000	1.153	0.06	Very high	Threatened: Nationally Vulnerable
Salvin's albatross	0.001	0.78	0.21	High	Threatened: Nationally Critical
Flesh-footed shearwater	0.001	0.669	0.15	High	Threatened: Nationally Vulnerable
Westland petrel	0.042	0.476	10.28	High	At Risk: Naturally Uncommon
Southern Buller's albatross	0.053	0.392	13.83	High	At Risk: Naturally Uncommon
Chatham Island albatross	0.000	0.362	0.27	High	At Risk: Naturally Uncommon
New Zealand white-capped albatross	0.010	0.353	2.77	High	At Risk: Declining
Gibson's albatross	0.075	0.337	22.76	High	Threatened: Nationally Critical
Northern Buller's albatross	0.031	0.253	12.58	Medium	At Risk: Naturally Uncommon
Antipodean albatross	0.047	0.203	23.92	Medium	Threatened: Nationally Critical

4.2.2 Sea turtle bycatch

Between 2002–03 and 2014–15, there were three observed captures of sea turtles in southern bluefin longline fisheries (Tables 12 and 13, Figure 6). Observer recordings documented all sea turtles as captured and released alive. Sea turtle captures for this fishery have only been observed off the east coast of the North Island (Figure 7).

Table 12: Number of observed sea turtle captures in southern bluefin tuna longline fisheries, 2002–03 to 2014–15, by species and area. Data grooming methods are described in Thompson et al (2013) and are available via https://data.dragonfly.co.nz/psc/ data version 2016001.

Species	Bay of Plenty	East Coast North Island	Total
Leatherback turtle	1	1	2
Green turtle	0	1	1
Total	1	2	3

Table 13: Fishing effort and sea turtle 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). Data grooming methods are described in Thompson et al (2013) and are available via https://data.dragonfly.co.nz/psc/ data version 2016001.

Fishing year	Fishing effort			Observed captures	
	All hooks	Observed hooks	% observed	Number	Rate
2002–2003	3 513 361	1 133 740	32.3	0	0.000
2003–2004	3 195 171	1 471 964	46.1	0	0.000
2004–2005	1 661 979	734 026	44.2	0	0.000
2005–2006	1 493 418	655 445	43.9	0	0.000
2006–2007	1 938 111	916 660	47.3	0	0.000
2007–2008	1 104 825	375 975	34.0	0	0.000
2008–2009	1 484 438	840 048	56.6	0	0.000
2009–2010	1 559 858	580 395	37.2	0	0.000
2010–2011	1 330 265	567 204	42.6	3	0.005
2011–2012	1 593 754	645 530	40.5	0	0.000
2012–2013	1 516 397	491 903	32.4	0	0.000
2013–2014	1 589 620	747 220	47.0	0	0.000
2014–2015	1 564 319	683 250	43.7	0	0.000

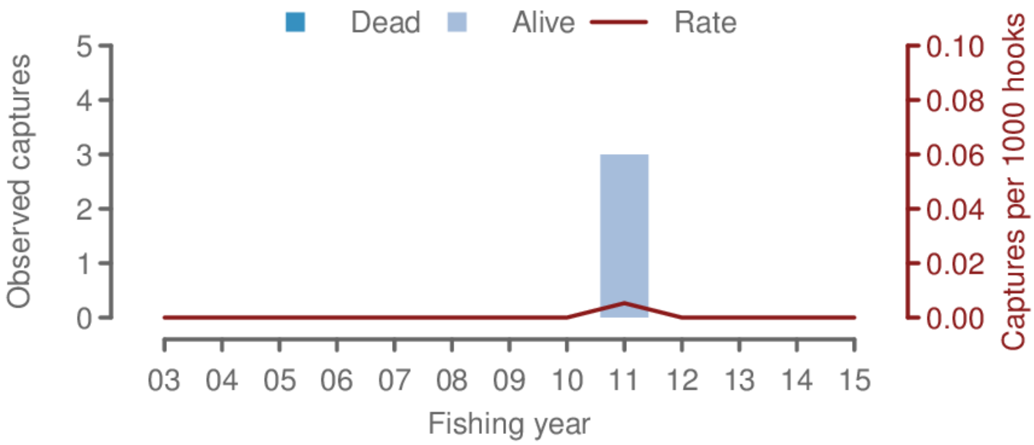


Figure 6: Observed captures of sea turtles in southern bluefin tuna longline fisheries from 2002–03 to 2014–15. Data grooming methods are described in Thompson et al (2013) and are available via https://data.dragonfly.co.nz/psc/ data version 2016001.

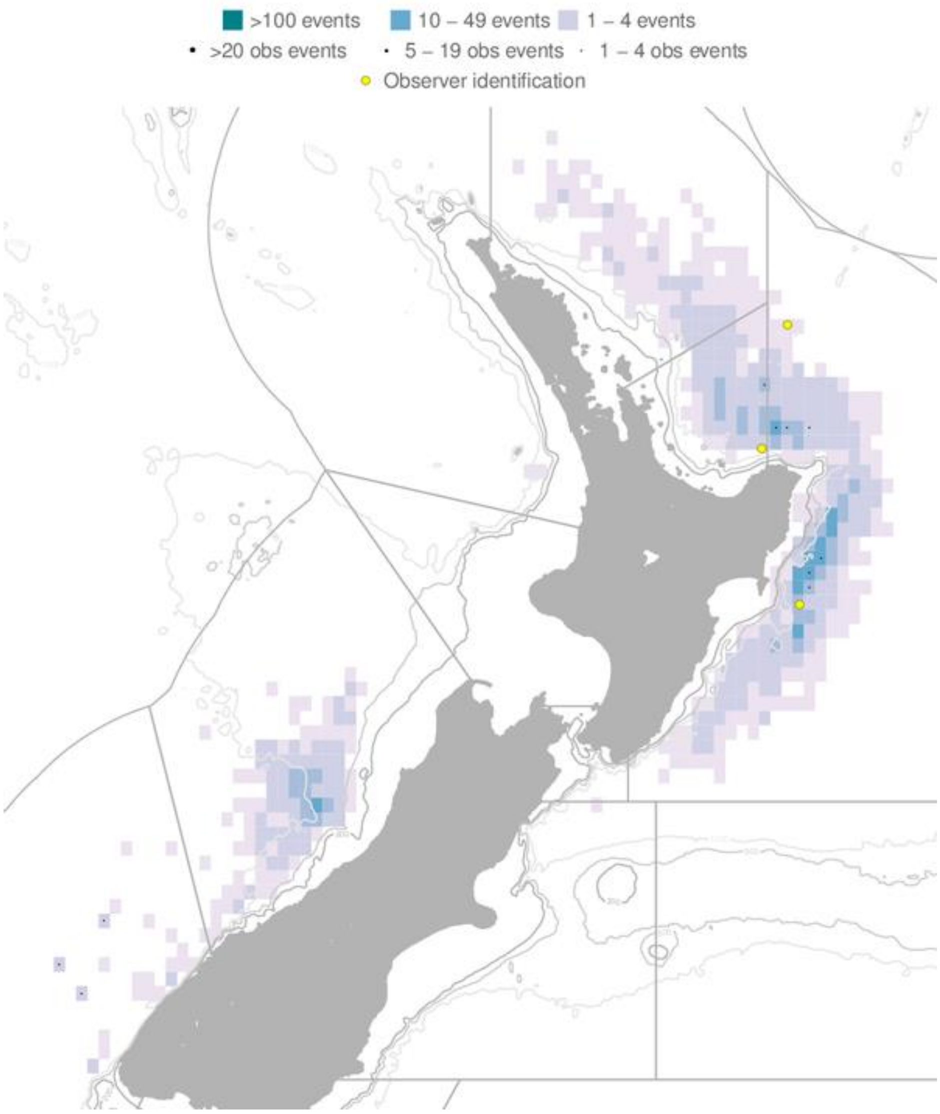


Figure 7: Distribution of fishing effort targeting southern bluefin tuna and observed sea turtle captures, 2002–03 to 2014–15. Fishing effort is mapped into 0.2-degree cells, with the colour of each cell being related to the amount of effort. Observed fishing events are indicated by black dots, and observed captures are indicated by red 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 Thompson et al (2013) and are available via https://data.dragonfly.co.nz/psc/ data version 2016001.

4.2.3 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 2014–15, there were six observed captures of whales and dolphins in southern bluefin longline fisheries (Tables 14 and 15, Figure 8). Observed captures included two long-finned pilot whales, two beaked whales, one bottlenose dolphin and an unidentified cetacean. All captured animals recorded were documented as being caught and released alive (https://data.dragonfly.co.nz/psc/ data version 2016001), with catches occurring in the east coast of the North Island, west coast of the South Island, Fiordland, and Bay of Plenty (Figure 9).

Table 14: Number of observed cetacean captures in southern bluefin tuna longline fisheries, 2002–03 to 2014–15, by species and area. Data grooming methods are described in Thompson et al (2013) and are available via https://data.dragonfly.co.nz/psc/ data version 2016001.

Species	Bay of Plenty	East Coast North Island	Fiordland	West Coast South Island	Total
Long-finned pilot whale	0	1	0	1	2
Beaked whales	1	1			2
Bottlenose dolphin	1				
Unidentified cetacean			1	0	1
Total	1	2	1	1	5

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 Thompson et al (2013) and are available via https://data.dragonfly.co.nz/psc/ data version 2016001.

Fishing year	Fishing effort			Observed captures	
	All hooks	Observed hooks	% observed	Number	Rate
2002–2003	3 512 911	1 133 740	32.3	0	0.000
2003–2004	3 195 171	1 471 964	46.1	3	0.002
2004–2005	1 661 979	734 026	44.2	1	0.001
2005–2006	1 493 868	655 445	43.9	0	0.000
2006–2007	1 938 111	916 660	47.3	0	0.000
2007–2008	1 104 825	375 975	34.0	1	0.003
2008–2009	1 484 438	840 048	56.6	0	0.000
2009–2010	1 559 858	580 395	37.2	0	0.000
2010–2011	1 330 265	567 204	42.6	0	0.000
2011–2012	1 593 754	645 530	40.5	0	0.000
2012–2013	1 516 397	491 903	32.4	0	0.000
2013–2014	1 589 620	747 220	47.0	0	0.000
2014–2015	1 564 319	683 250	43.7	1	0.001

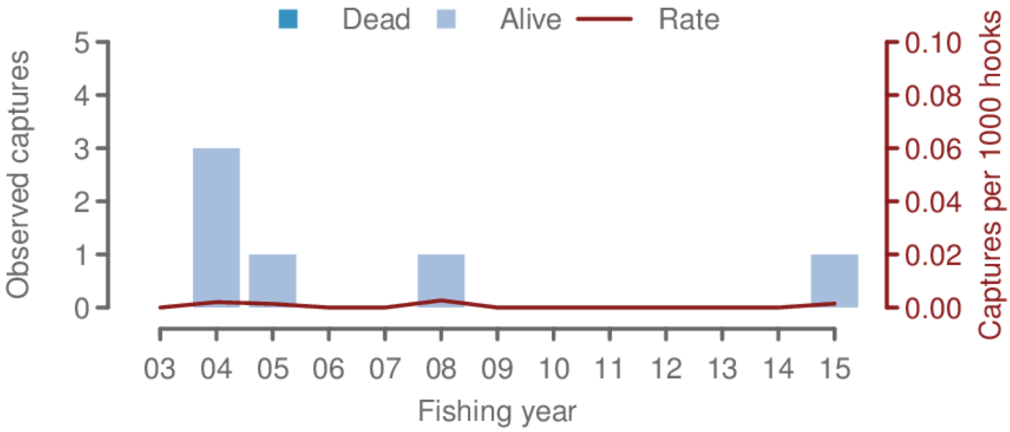


Figure 8: Observed captures of cetaceans in southern bluefin longline fisheries from 2002–03 to 2014–15. Data grooming methods are described in Thompson et al (2013) and are available via https://data.dragonfly.co.nz/psc/ data version 2016001.

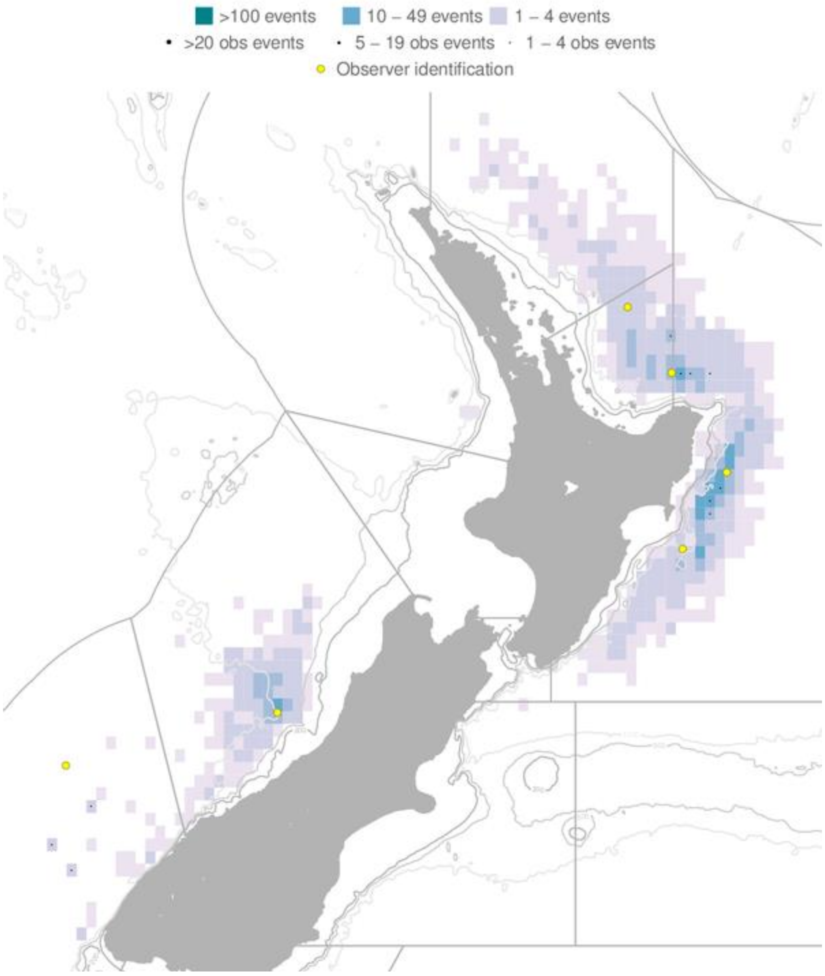


Figure 9: Distribution of fishing effort targeting southern bluefin tuna and observed cetacean captures, 2002–03 to 2014–15. Fishing effort is mapped into 0.2-degree cells, with the colour of each cell being related to the amount of effort. Observed fishing events are indicated by black dots, and observed captures are indicated by red 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 Thompson et al (2013) and are available via https://data.dragonfly.co.nz/psc/ data version 2016001.

4.2.3.2 New Zealand fur seal bycatch

Currently, New Zealand fur seals are dispersed throughout New Zealand waters, but are more common in waters south of about 40º 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 south and west of Fiordland, but also in the Bay of Plenty–East Cape area. Estimated numbers range from 127 (95% CI 121–133) in 1998–99 to 25 (14–39) in 2007–08 during southern bluefin tuna fishing by chartered and domestic vessels (Abraham et al 2010) (Tables 16 and 17). These capture rates include animals that are released alive (100% of observed surface longline capture in 2008–09; Thompson & Abraham 2010). Capture rates in 2011–12 and 2013–14 were higher than they were in the early 2000s (Figure 10). While fur seal captures have occurred throughout the range of this fishery, most have occurred off the Southwest coast of the South Island (Figure 12).

Table 16: Number of observed New Zealand fur seal captures in southern bluefin tuna longline fisheries, 2002–03 to 2014–15, by species and area. Data from Thompson et al (2013), retrieved from http://data.dragonfly.co.nz/psc/ data version 2016001.

	Bay of Plenty	East Coast North Island	Fiordland	Northland and Hauraki	Stewart Snares Shelf	West Coast South Island	Total
New Zealand fur seal	19	46	243	4	4	41	357

Table 17: Effort and captures of New Zealand fur seal by fishing year in southern bluefin tuna longline fisheries. 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). Data from Thompson et al (2013), retrieved from http://data.dragonfly.co.nz/psc/. Estimates from 2002–03 to 2014–15 are based on data version 2016001.

Fishing year	Fishing effort			Observed captures		Estimated captures	
	All hooks	Observed hooks	% observed	Number	Rate	Mean	95% c.i.
2002–2003	3 513 361	1 133 740	32.3	56	0.049	365	262–490
2003–2004	3 195 171	1 471 964	46.1	40	0.027	171	125–227
2004–2005	1 661 979	734 026	44.2	18	0.025	82	55–117
2005–2006	1 493 418	655 445	43.9	12	0.018	59	34–90
2006–2007	1 938 111	916 660	47.3	10	0.011	35	21–55
2007–2008	1 104 825	375 975	34.0	8	0.021	47	26–73
2008–2009	1 484 438	840 048	56.6	22	0.026	71	49–98
2009–2010	1 559 858	580 395	37.2	19	0.033	106	70–150
2010–2011	1 330 265	567 204	42.6	17	0.030	81	53–117
2011–2012	1 593 754	645 530	40.5	40	0.062	187	136–251
2012–2013	1 516 397	491 903	32.4	21	0.043	143	95–207
2013–2014	1 589 620	747 220	47.0	57	0.076	233	180–291
2014–2015	1 564 319	683 250	43.7	37	0.054	173	127–228

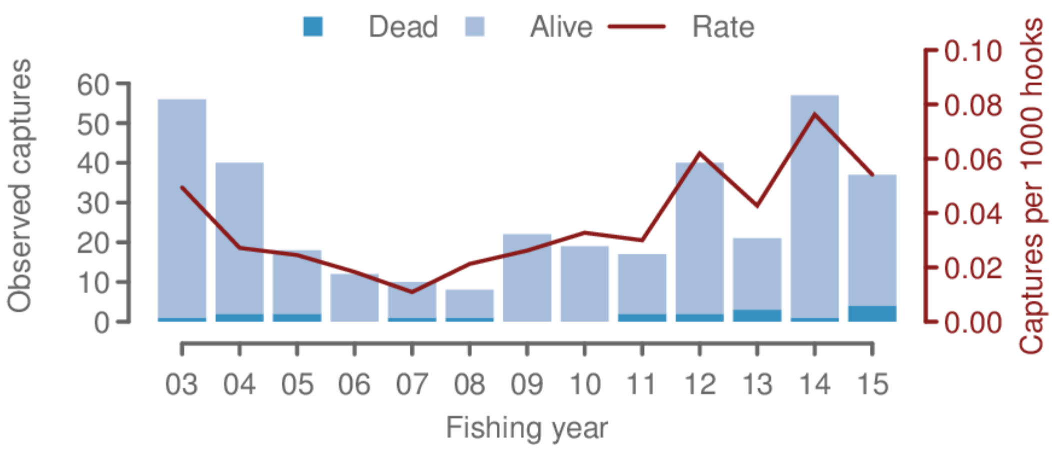


Figure 10: Observed captures of New Zealand fur seal in southern bluefin longline fisheries from 2002–03 to 2013–14. Data grooming methods are described in Thompson et al (2013) and are available via https://data.dragonfly.co.nz/psc/ data version 2016001.

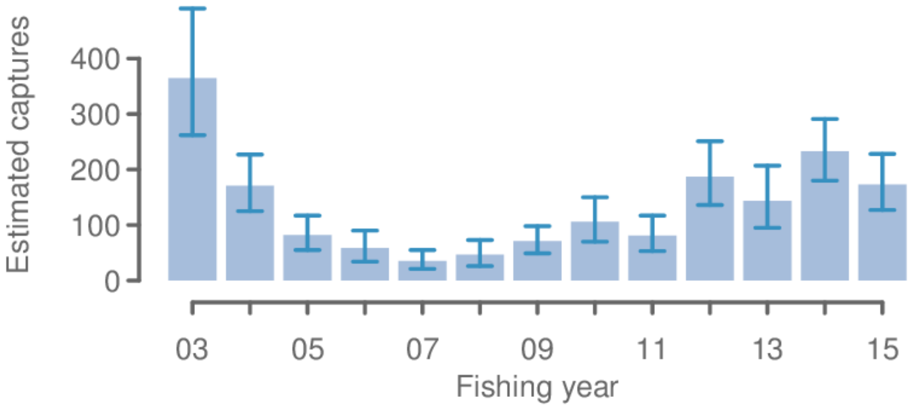


Figure 11: Estimated captures of New Zealand fur seal in southern bluefin longline fisheries from 2002–03 to 2014–15. Data grooming methods are described in Thompson et al (2013) and are available via https://data.dragonfly.co.nz/psc/ data version 2016001.

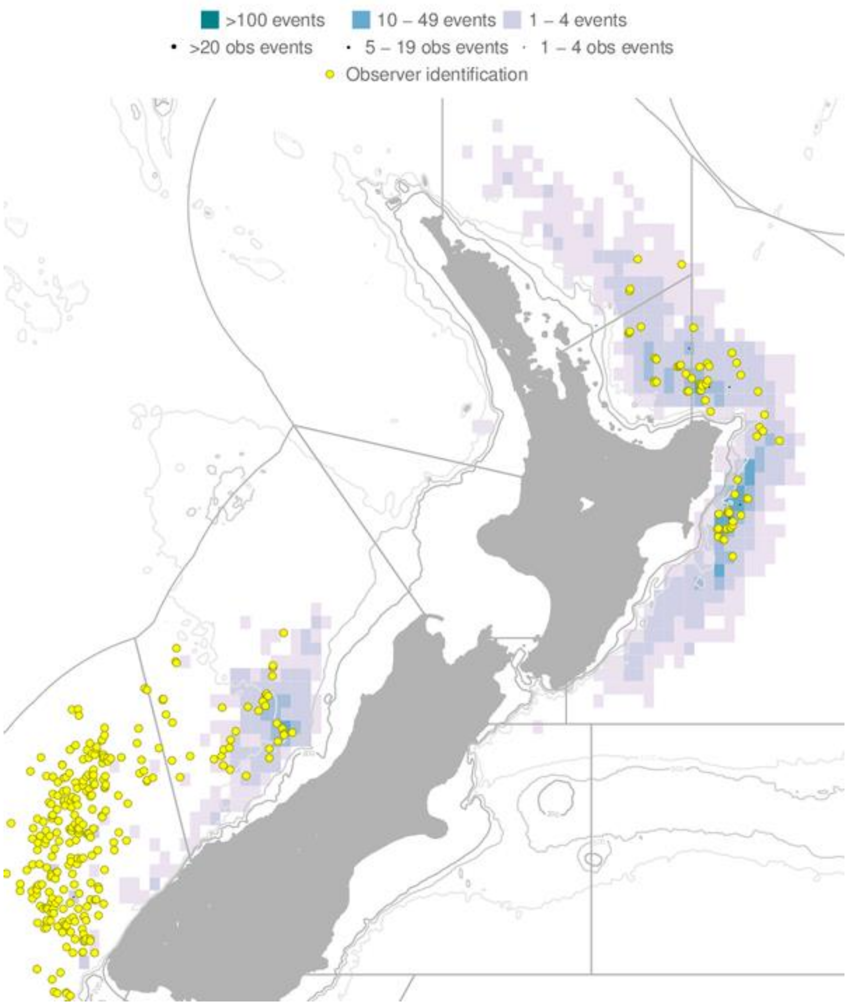


Figure 12: Distribution of fishing effort targeting southern bluefin tuna and observed New Zealand fur seal captures, 2002–03 to 2014–15. Fishing effort is mapped into 0.2-degree cells, with the colour of each cell being related to the amount of effort. Observed fishing events are indicated by black dots, and observed captures are indicated by red 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 Thompson et al (2013) and are available via https://data.dragonfly.co.nz/psc/ data version 2016001.

4.3 Incidental fish bycatch

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 years are shown in Table 18. The scaled estimates provided for the domestic fleet can be considered less reliable than those of the charter fleet as 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, Ray's bream, and albacore 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 (reported), 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
Rays 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	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	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

N/A

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 is currently unknown.

Observer coverage in 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 2014 for the first time since 2011. The report describes the reconditioning of the SBT operating models and the current estimates of stock status, following initial work for the OMMP meeting. The assessment results are based on the agreed base case and a range of sensitivity scenarios. This is the first stock assessment since the MP was implemented in 2011, and the first stock assessment with the close-kin data formally included. The stock assessment was not updated in 2016, but is scheduled to be updated in 2017.

5.1 Estimates of fishery parameters and abundance

Fishery indicators

As part of the stock assessment, a range of fishery 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., aerial sightings and troll surveys).

Fishery indicators were updated in 2016 and the summary was as follows:

- In terms of recruitment indicators, the fact that there was no information on recruitment collected in 2015 needs to be noted. The 2016 aerial survey (an index of age 2–4 relative abundance) was the highest on record, following the high 2014 index. A substantial increase in the patch size observed (about 2.6 times higher than the average from previous surveys) contributed to the higher value in 2016. The CV associated with the 2016 index was similar to previous years. The 2016 trolling survey index was higher than the 2014 index and slightly above the average value 2006–2016. Preliminary analysis of 2016 CDS data from New Zealand shows a very strong mode of fish around 20 kg (processed weight), which has not been seen in previous years, and possibly reflects strong recruitment consistent with the 2016 aerial survey.
- Recent longline CPUE index values for the Japanese fleet for ages 5 to 7 were well above the historically lowest levels observed in the mid-2000s. The index for these ages showed an increasing trend in recent years. The CPUE index for ages 8–11 has increased since 2011. The index for age 12+ has fluctuated around a low level. The Korean standardised CPUE series also showed an increasing trend over recent years. The time-series of direct ageing distribution data available from the New Zealand foreign charter fishery indicated relatively strong cohorts now about to enter the spawning component of the stock.
- The monitoring of length and age of Indonesian catches on the spawning ground indicate a substantial increase in the frequency of smaller and younger size and age classes since 2012. Information presented to the meeting indicates that the unusually small size classes may have been caught outside the spawning ground (in areas 2 and 8) and that, if this is the

case, these fish should be excluded from the monitoring series. Once this is resolved the spawning ground indicator related to mean estimated age of all fish can be re-considered.

Length frequencies and CPUE in New Zealand waters

CPUE in 2015 increased slightly for the charter fleet, which largely fishes the west coast of the South Island (CCSBT region 6), and also for the domestic fleet (Figure 14). Since 2007 catch rates (by number) have increased to much higher levels than in 2003–06. The length frequency data (Figure 13) show that this increase is mainly due to the recruitment of a strong length mode that has grown through the fishery and now dominates the catch at about 155 cm.

5.2 Biomass estimates

5.2.1 Spawning biomass

In 2014 the stock remains at a very low state estimated to be 9% of the initial SSB, and below the level to produce maximum sustainable yield (MSY), however there has been some improvement since the 2011 stock assessment and fishing mortality is below the level associated with MSY. B10+ relative to initial is estimated to be 7% which is up from the estimate of 5% in 2011.

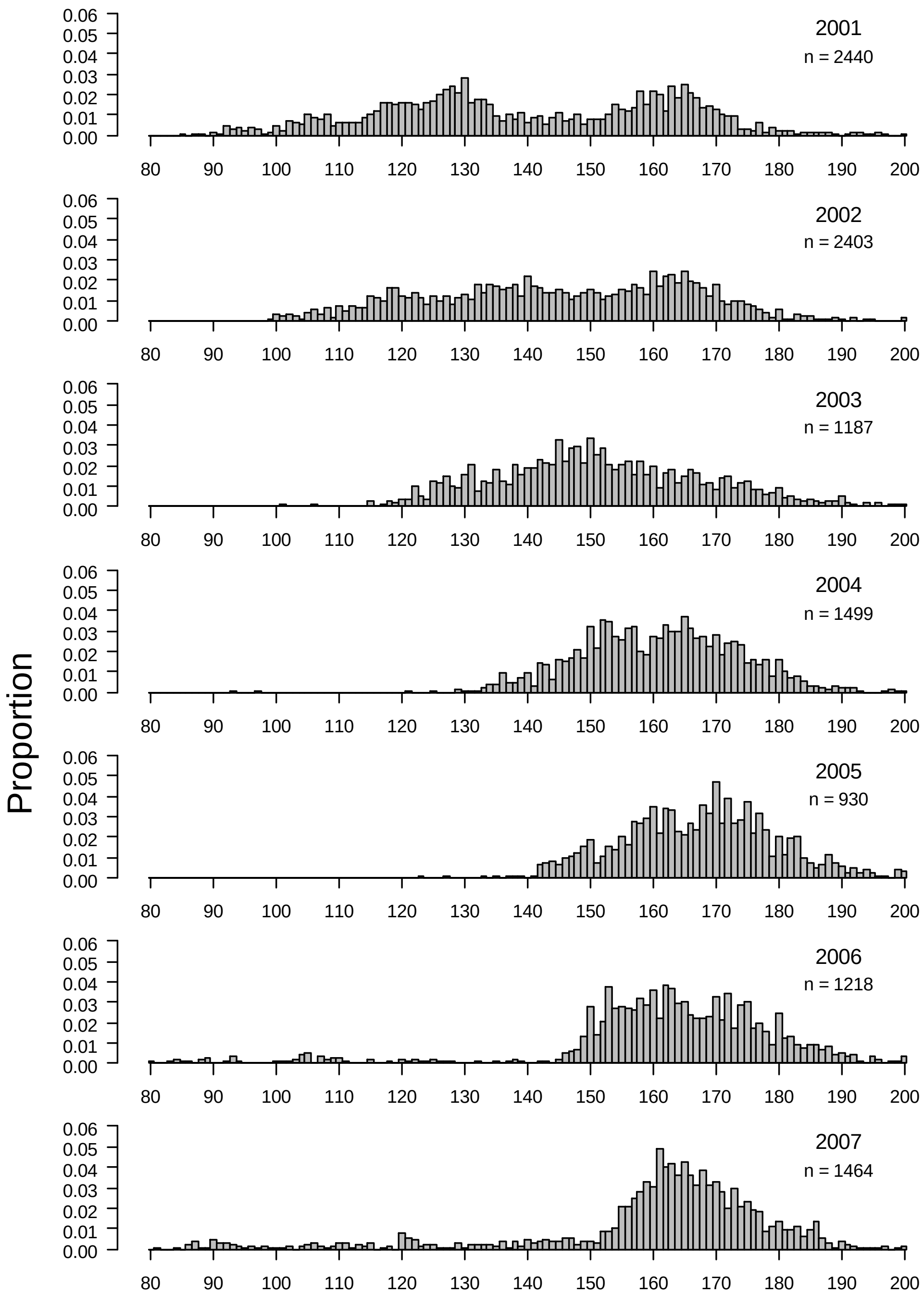


Figure 13: Proportion at length for the Japanese charter fleet operating in New Zealand Fishery waters for 2001 to 2015. Source: CCSBT-ESC/1409/SBT Fisheries New Zealand (2014) [Continued on next page].

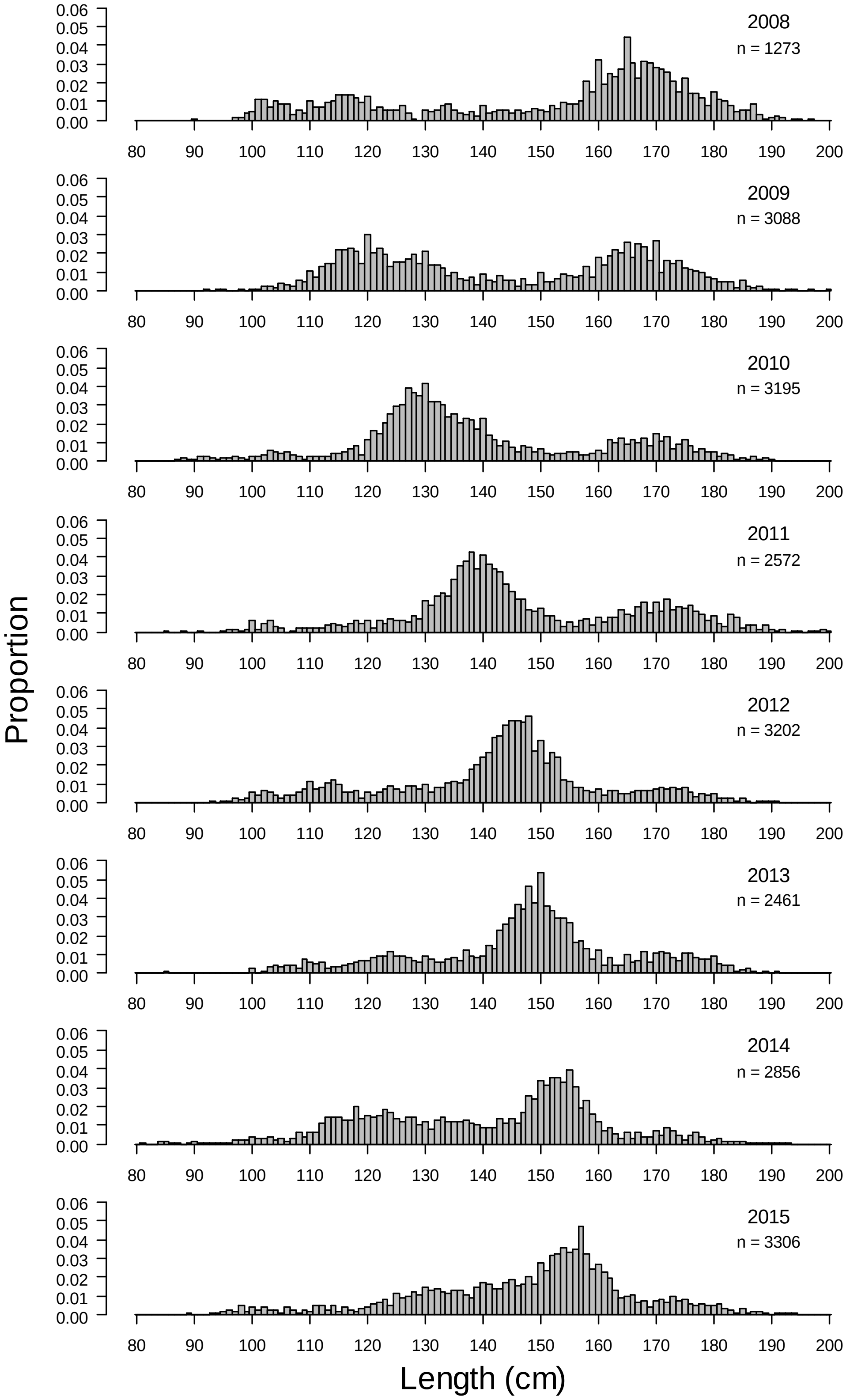


Figure 13 [Continued]: Proportion at length for the Japanese charter fleet operating in New Zealand Fishery waters for 2001 to 2015. Source: CCSBT-ESC/1509/SBT Fisheries New Zealand (2015).

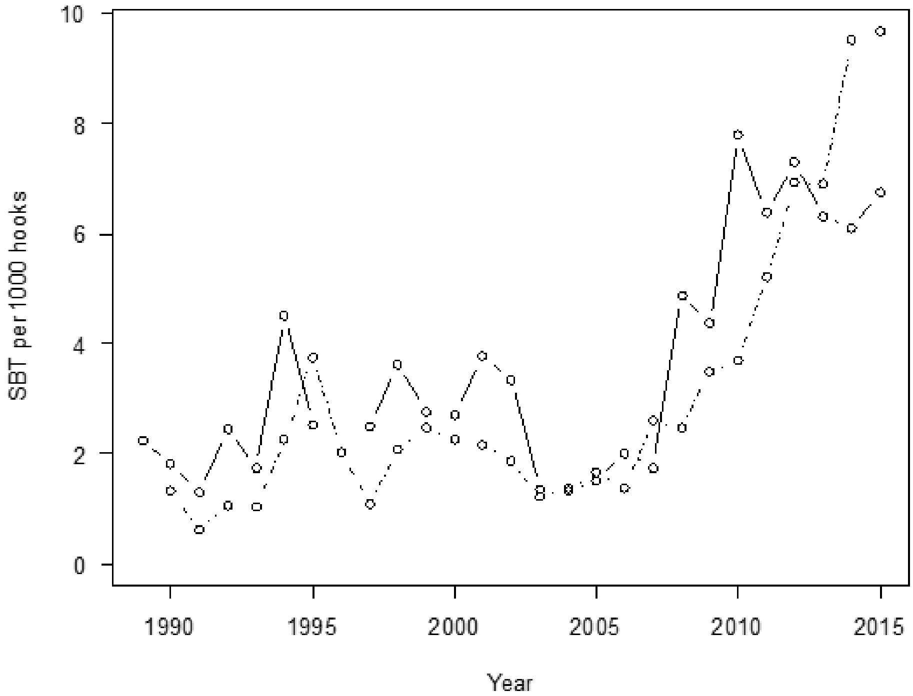


Figure 14: Nominal catch per unit effort (number of STN per thousand hooks) by calendar year for the New Zealand Charter (solid line) and domestic (dashed line) longline fleets operating in New Zealand based only on effort from sets that either targeted or caught southern bluefin tuna. Source: CCSBT-ESC/1509/SBT Fisheries - New Zealand (2015).

The estimated trajectory of spawning stock biomass integrated over the grid for the base case over the full time series for the fishery is given in Figure 15. 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 mid-1990s to a very low level. The spawning stock biomass is estimated to have remained at this low level with relatively small annual variation until the early 2000s. For the more recent period, a decline in the median spawning stock biomass is evident from 2002 through 2012. There is no current evidence of the spawning stock rebuilding, but it is projected to start rebuilding after 2013.

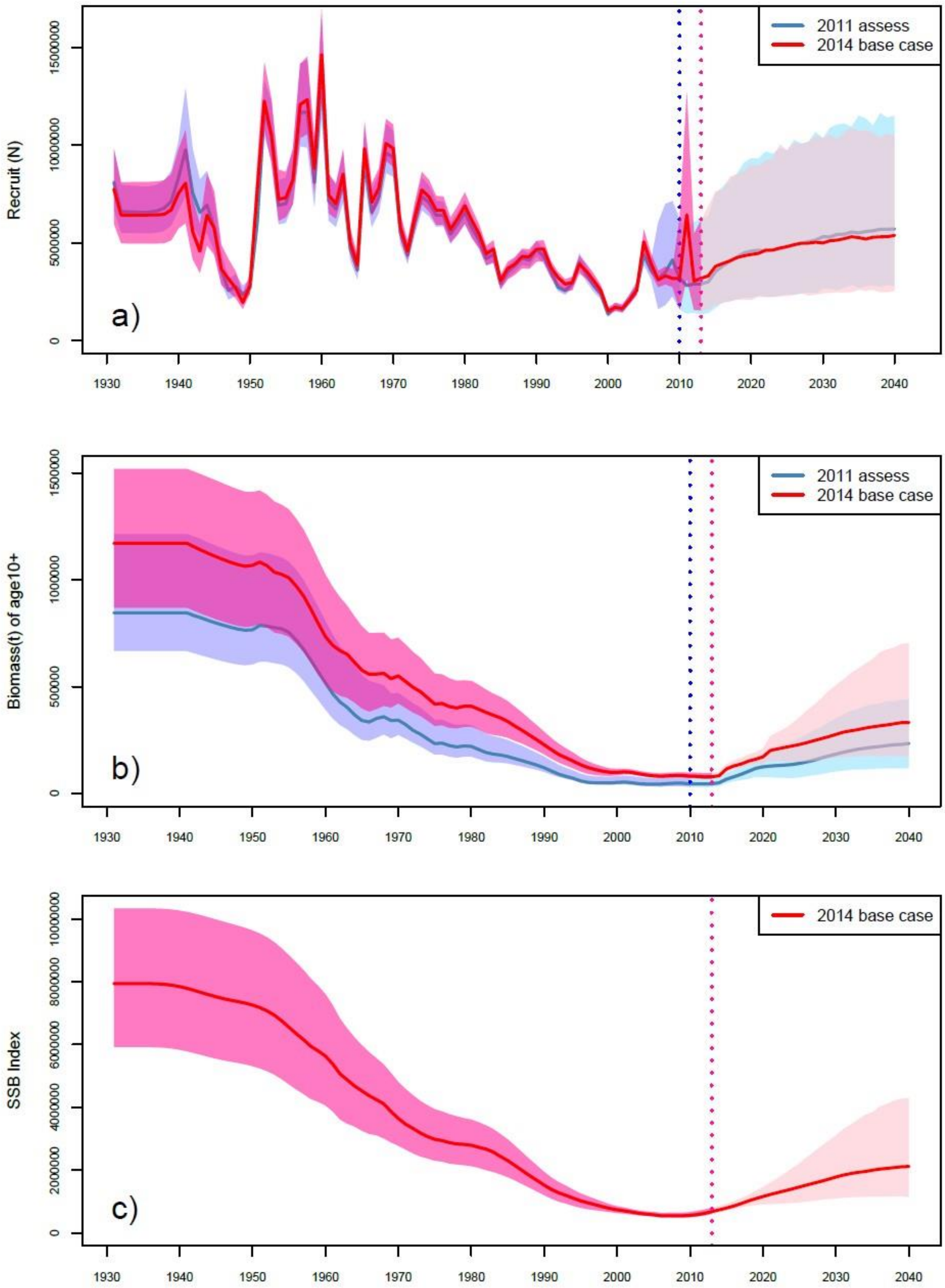


Figure 15: Recruitment and spawning stock biomass for the base case, showing the medians, quartiles and 90th percentiles, together with reference points of 20% of pre-exploitation spawning stock biomass and the spawning stock biomass in 2004 (B_{2004}). Source: Report of the Scientific Committee 2011.

The close-kin genetics project has now been completed, and the inclusion of the close-kin data within the operating model (OM) has been reviewed by the Extended Scientific Committee and approved for inclusion. Both the stand-alone abundance estimator from the close-kin project and the OM with the close-kin data included suggest that the current spawning biomass may be appreciably higher than was previously estimated. Indications in the OM incorporating the close-kin data are that biomass depletion (i.e. $B_{current}/B_0$) and also absolute biomass are not as low as previously estimated. However, associated estimates of the probable levels of sustainable yield are very similar. When these two aspects are considered in combination, the indications are that the estimated recent productivity of the resource (upon which TAC advice is based) differs only slightly from previous estimates.

5.2.2 Stock projections

Note that the future catch levels will be set by the Commission based on the output from the Management Procedure. The MP is designed to rebuild the spawning stock to 20% of the unfished level by 2035 (with 70% certainty). The base case achieved the rebuilding target with a slightly greater probability than 70%.

In 2013 the EC requested that the ESC conduct sensitivity analysis of the potential impacts of unaccounted mortalities (UAM) on the assessment of stock status and incorporate this in their advice on exceptional circumstances. In addition, the EC requested that the ESC provide preliminary advice on the impact of unaccounted mortalities on the rebuilding plan for SBT and recommendations beyond the current TAC block (2015–2017). The ESC tested a range of UAM scenarios with the most extreme being an extra catch of 1000 t of large fish plus 1000 t of small fish.

Current stock status estimates appear to be unaffected by the unaccounted mortality scenarios. There are impacts on the projections and rebuilding performance from the unaccounted mortality scenarios. From the analysis of the impacts of unaccounted mortality scenarios on projections the ESC notes that if total mortalities are as large as those considered in the added-catch scenario, then impacts on the rebuilding plan may be substantial. The probability of achieving the rebuilding target by 2035 is reduced to 49%. There is a differential impact from catches of large and small fish; unaccounted catch mortalities of large fish impact directly or early, and impacts from unaccounted small fish catches have a substantial lag-time before the impacts will be observed. The ESC noted that the added catch scenario was potentially plausible given the available data, information and anecdotal market reports. The probability of rebuilding for this scenario was similar to but not worse than the most pessimistic scenario tested in 2011 (upq sensitivity run).

The ESC noted that the current analysis is based on a different reference set, but the equivalent level of performance of the MP to sensitivities was accepted by the EC in 2011.

5.3 Other yield estimates and stock assessment results

In 2012 the preliminary results from the close-kin genetics study were reported at the Scientific Committee of CCSBT (CCSBT-ESC/1208/19). Over 13 000 bluefin caught in the GAB (juveniles) and off Indonesia (mature adults) from 2006 to 2010 were genotyped and 45 Parent-Offspring Pairs (POPs) were detected. When these data were analysed in an independent assessment model the result was that adult abundance was estimated to be higher than the current estimates from the Operating Model used by the Scientific Committee in 2011. The data from the close-kin study have been incorporated into the Operating Model in 2014.

6. STATUS OF THE STOCK

Based on the stock assessment results presented to the ESC in 2014, the following stock status advice for the reference set of operating models was compiled (Table 19). Two measures of the current spawning stock size are presented. The new method used in the operating model is presented as spawning stock biomass (SSB), and is based on a revised spawning potential estimate which has been introduced into the operating model along with incorporation of the close-kin data. The biomass aged 10 and older (B10+) is also presented, because this is the same measure used in previous stock assessments and therefore allows for comparisons.

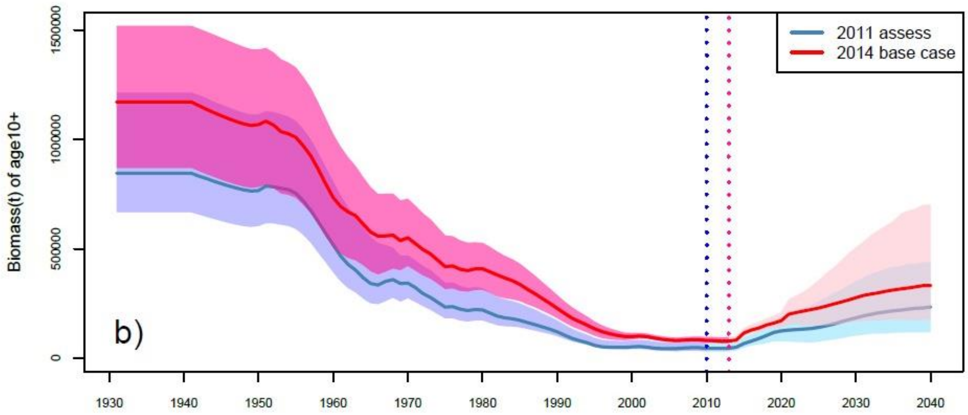
The stock remains at a very low state estimated to be 9% of the initial SSB, and below the level to produce maximum sustainable yield (MSY), however there has been some improvement since the 2011 stock assessment and the fishing mortality rate is below the level associated with MSY. B10+ relative to initial is estimated to be 7% which is up from the estimate of 5% in 2011. The current TAC has been set following the recommendation from the management procedure adopted in 2011.

Table 19: Assessment of southern bluefin tuna stock status in 2014

Maximum sustainable yield	33 000 t (30 000–36,000)
Reported 2013 catch	11 726 t
Current replacement yield	44 600 t (35 500–53 600)
Current (2014) spawner biomass (B10+)	83 000 (75 000–96 000)
Current depletion (Current relative to initial)	
SSB	0.09 (0.08–0.12)
B10+	0.07 (0.06–0.09)
Spawner biomass (2014) relative to SSB_{MSY}	0.38 (0.26–0.70)
Fishing mortality (2013) relative to F_{MSY}	0.66 (0.39–1.00)
Current management measures	Effective catch limit for Members and Cooperating Non-members: 12 449 t in 2014, and 14 647 t /yr for the years 2015–2017.

Stock Status	
Year of Most Recent Assessment	2014
Assessment Runs Presented	Base case model plus a range of sensitivity scenarios
Reference Points	Target: B_{MSY} Soft Limit: Default 20% B_0 Hard Limit: Default 10% B_0 Overfishing threshold: F_{MSY}
Status in relation to Target	Well below B_{MSY}. Spawning stock biomass estimated to be about 38% B_{MSY}. Very Unlikely (< 10%) to be at or above B_{MSY}.
Status in relation to Limits	Very Likely (> 90%) to be below the soft limit About as Likely as Not Likely (40–60%) to be below the hard limit
Status in relation to Overfishing	Overfishing is Unlikely (< 40%) to be occurring

Historical Stock Status Trajectory and Current Status



Spawning stock biomass for the base case, showing the medians, quartiles and 90th percentiles, together with reference points of 20% of pre-exploitation spawning stock biomass and the spawning stock biomass in 2004 (B_{2004}). Source: Report of the Scientific Committee 2011.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Flat trajectory of SSB
Recent Trend in Fishing Intensity or Proxy	Reduced in last 4 years. Current fishing mortality is below F_{MSY}.
Other Abundance Indices	CPUE has been increasing since 2007; juvenile abundance has improved in recent years.
Trends in Other Relevant Indicators or Variables	Recent recruitments are estimated to be well below the levels from 1950–1980, but have improved since the poor recruitments of 1999–2002.
Projections and Prognosis	
Stock Projections or Prognosis	The Management Procedure adopted by the Commission in 2011 should rebuild the SB to 20% SB_0 by 2035 with a 70% probability. The MP was evaluated in 2013 and the increased CPUE and the increased index for the aerial survey resulted in a recommended TAC increase for 2015–17.
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Likely (> 60%)
Probability of Current Catch or TACC causing Overfishing to continue or commence	Unlikely (< 40%)

Assessment Methodology and Evaluation		
Assessment Type	Level 1: Full Quantitative Stock Assessment	
Assessment Method	Base case grid of reconditioned CCSBT Operating Model	
Assessment Dates	Latest assessment: 2014	Next assessment: 2017
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	CPUE, catch at age and length frequency data, scientific aerial survey indices, close-kin (C-K) biomass estimate	1 – High Quality
Data not used (rank)	N/A	

Changes to Model Structure and Assumptions	Biomass estimate from the close-kin (C-K) analysis incorporated into the Operating Model
Major Sources of Uncertainty	CPUE indices: - Historical indices have an unknown bias from misreporting - Fisheries management and operational changes since 2006 mean that recent CPUE series may not be comparable with earlier years - The level of assumed unaccounted mortality may have compromised OM conditioning and achieving the rebuilding target with the agreed probability

Qualifying Comments
The MP was evaluated in 2013 and resulted in an increase in the TAC for 2015–17 of 2198 t to 14 647 t.

Fishery Interactions
The ERS working group noted interactions reported by observers on seabirds, turtles and sharks but total mortalities of these groups have not been estimated.

7. FOR FURTHER INFORMATION

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*.

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. (Unpublished report held by the Ministry for Primary Industries, Wellington.) 170 p.

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

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

Caton, A (ed.) (1991) Review of aspects of southern bluefin tuna biology, population and fisheries. I-ATTC Special Report 7: 181–350.

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

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

Kalish, J M; Johnston, J M; Gunn, J S; Clear, N P (1996) Use of bomb radiocarbon chronometer to determine age of southern bluefin tuna (*Thunnus maccoyii*). *Marine Ecology Progress Series* 143: 1–8.

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 (2016) Aquatic Environment and Biodiversity Annual Review 2015. Compiled by the Fisheries Management Science Team, Ministry for Primary Industries, Wellington, New Zealand. 682 p.

Ministry for Primary Industries (2013b) 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*.
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 (2014a) Estimated capture of seabirds in New Zealand trawl and longline fisheries, 2002–03 to 2011–12. Draft New Zealand Aquatic Environment and Biodiversity Report held by Ministry for Primary Industries, Wellington.
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.*
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. Unpublished report held by the Ministry for Primary Industries, Wellington. 137 p.
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 + 70p.
Robertson, H A; Dowding, J E; Elliot, G P; Hitchmough, R A; Miskelly, C M; O'Donnell, C F J; Powlesland, R G; Sagar, P M; Scofield, R P; Taylor, G A (2013) Conservation status of New Zealand Birds, 2012. *New Zealand Threat Classification Series 4*. 22 p.
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., Unpublished report held by the Ministry for Primary Industries, Wellington. 39 p.
Strickland, R R (1990) Nga tini a Tangaroa, a Maori-English, English-Maori dictionary of fish names. *New Zealand Fisheries Occasional Publication no. 5*.
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 Ministry for Primary Industries, Wellington.)
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.