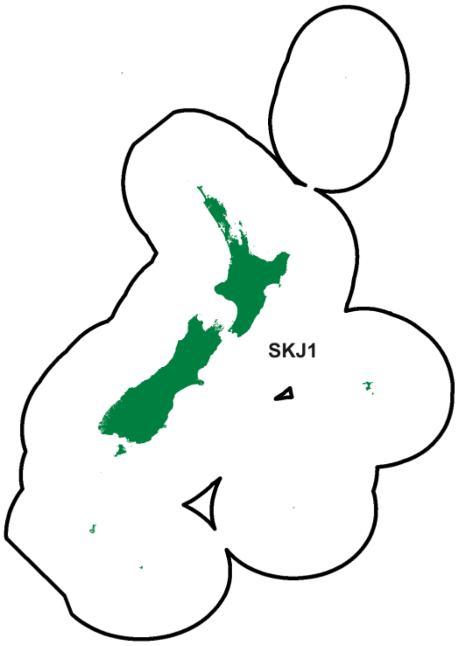
SKIPJACK TUNA (SKJ)

(Katsuwonus pelamis)
Aku



1. FISHERY SUMMARY

Management of skipjack tuna throughout the Western and Central Pacific Ocean (WCPO) is the responsibility of the Western and Central Pacific Fisheries Commission (WCPFC). Under this regional convention New Zealand is responsible for ensuring that the management measures applied within New Zealand fisheries waters are compatible with those adopted by the Commission.

At its annual meeting in 2014 the WCPFC approved CMM 2014-01. The aim of this CMM for skipjack is to maintain the fishing mortality rate for skipjack at a level no greater than F_{MSY}. This measure is large and detailed with numerous exemptions and provisions. Controls on fishing mortality are being attempted through seasonal fish aggregating device (FAD) closures, effort limits or equivalent catch limits for purse seine fisheries within EEZs, high seas purse seine effort limits, as well as other methods.

1.1 Commercial fisheries

Skipjack was the first commercially exploited tuna in New Zealand waters, with landings beginning in the 1960s in the Taranaki Bight and quickly extending to the Bay of Plenty. The fishery in New Zealand waters has been almost exclusively a purse seine fishery, although minor catches (less than 1%) are taken by other gear types (especially troll). The purse seine fishery through to 2000–01 was based on a few (5–7) medium sized vessels under 500 GRT operating on short fishing trips assisted by fixed wing aircraft, acting as spotter planes, in FMA 1, FMA 2 and occasionally FMA 9 during summer months. In addition, during the late 1970s and early 1980s a fleet of US purse seiners seasonally operated in New Zealand waters. During this period total annual catches were about 9000 t. Since 2001, however, New Zealand companies have also operated four large ex-US super seiners which fish for skipjack in the EEZ, on the high seas, and in the EEZs of various Pacific Island countries in equatorial waters.

Domestic landings within the EEZ between 2001 and 2015 ranged between 3555t and 13 312 t (Table 1). Catches in the New Zealand EEZ are variable and can approximate 10 000 t in good seasons.

Table 1 compares New Zealand landings with total catches from the WCPO stock, while Table 2 shows the catches reported on commercial logsheets and Monthly Harvest Returns. Figure 1 shows historical landings for SKJ fisheries.

Catches from within New Zealand fisheries waters are very small (0.6% average for 2007–2015) compared to those from the greater stock in the WCPO. Catches by New Zealand flagged vessels in the WCPO are larger (0.8% average for 2007–2015).

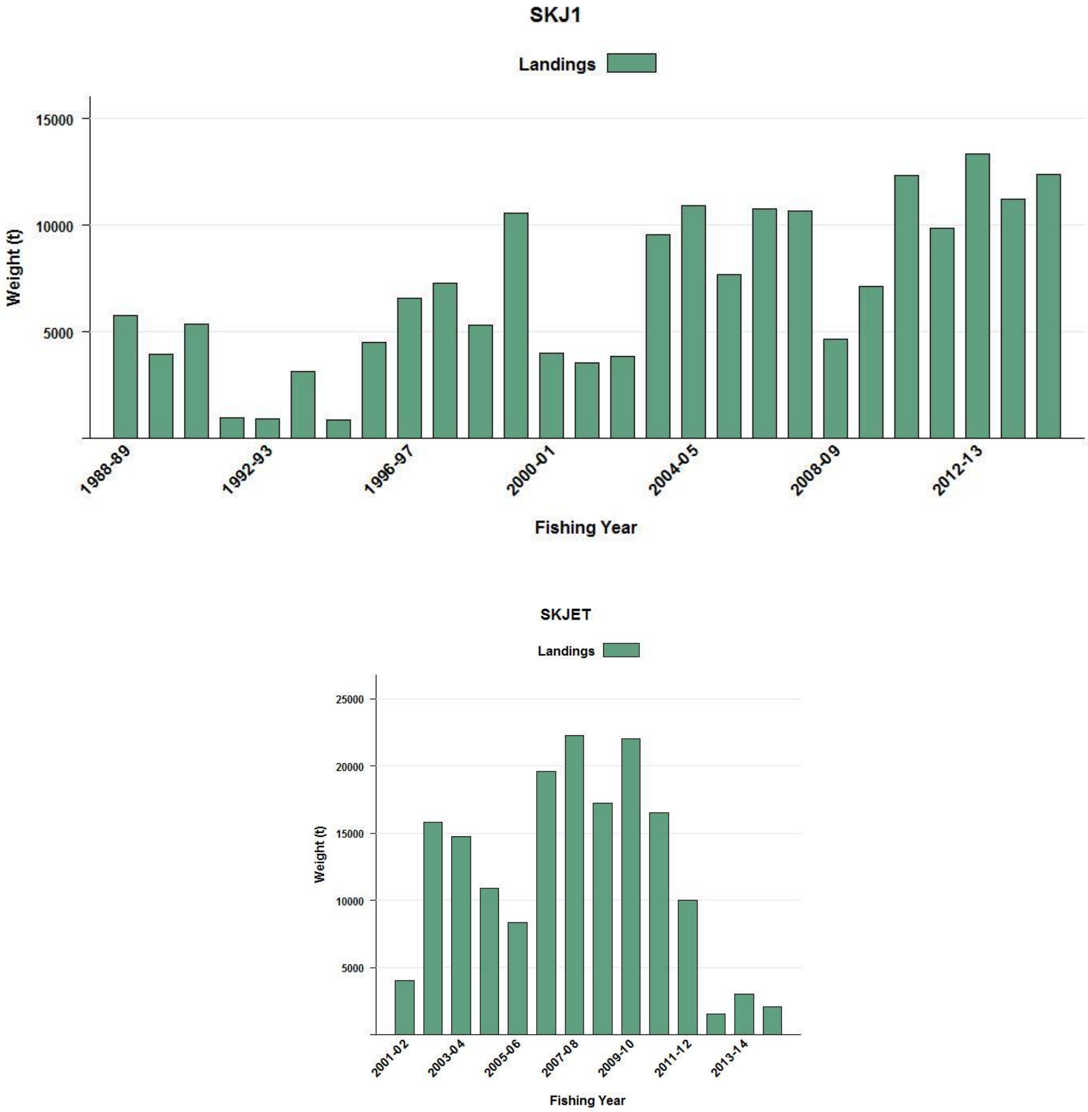


Figure 1: Skipjack purse seine catch from 1988–89 to 2014–15 within New Zealand waters (SKJ 1), and 2001–02 to 2014–15 in the equatorial Pacific by New Zealand vessels.

Table 1: Total New Zealand landings (t) both within and outside the New Zealand EEZ, and total landings from the Western and Central Pacific Ocean (t) of skipjack tuna by calendar year from 2001 to 2015.

	NZ landings (t)			All WCPO Landings
Year	Within NZ fisheries waters	Outside NZ fisheries waters*	Total	Total landings (t)
2001	4 261	4 069	8 330	1 106 302
2002	3 555	15 827	19 382	1 276 919
2003	3 828	14 769	18 597	1 278 420
2004	9 704	10 932	20 636	1 399 138
2005	10 819	8 335	19 154	1 395 737
2006	7 247	19 588	26 835	1 477 438
2007	11 392	22 266	33 659	1 659 557
2008	10 033	17 204	27 237	1 639 651
2009	4 685	21 991	26 676	1 777 598
2010	8 629	16 530	25 153	1 690 145
2011	10 840	9 999	20 839	1 524 599
2012	9 881	8 016	17 897	1 727 773
2013	13 312	10 207	23 520	1 771 822
2014	10 195	9 141	19 336	2 003 024
2015	12 223	6 362	18 585	1 819 798

*Includes some catches taken in the EEZs of other countries under access agreements.
Source: Ministry for Primary Industries Catch, Effort, Landing Returns, High Seas reporting system; OFP (2010); and Anon (2013).

Table 2: Reported commercial catches (t) within New Zealand fishing waters of skipjack by fishing year from catch effort data (mainly purse seine fisheries), and estimated landings from LFRRs (processor records) and Monthly Harvest Returns (MHRs).

Year	Total catches from catch/effort	LFRR	MHR
1988–89	0	5 769	
1989–90	6 627	3 972	
1990–91	7 408	5 371	
1991–92	1 000	988	
1992–93	1 189	946	
1993–94	3 216	3136	
1994–95	1 113	861	
1995–96	4 214	4 520	
1996–97	6 303	6 571	
1997–98	7 325	7 308	
1998–99	5 690	5 347	
1999–00	10 306	10 561	
2000–01	4 342	4 020	
2001–02	3 840	3 487	3 581
2002–03	3 664	2 826	3 868
2003–04	9 892	9 225	9 606
2004–05	10 311	8 301	10 928
2005–06	7 220	7 702	7702
2006–07	10 115	10 761	10 762
2007–08	10 116	10 665	10 665
2008–09	4 384	4 737	4 685
2009–10		8 020	7 141
2010–11		17 764	12 326
2011–12		11 814	9 866
2012–13		14 895	13 334
2013–14		14 275	11 206
2014–15		14 492	12 411

Skipjack tuna account for the largest proportion of purse seine target sets in New Zealand fishery waters (Figure 2). However, jack mackerel make up the bulk of the catch and skipjack tuna account for only 29% of the landed mass of the domestic purse seine fleet (Figure 3). The skipjack tuna catch occurs on both the east and west coasts of the North Island (Figure 4).

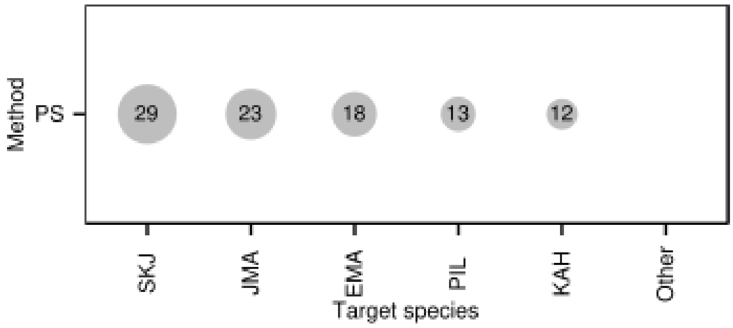


Figure 2: A summary of the proportion of target sets in the domestic purse seine fishery for 2012–13. The area of each circle represents the percentage of the vessel days targeting each species PS = purse seine (Bentley et al 2013).

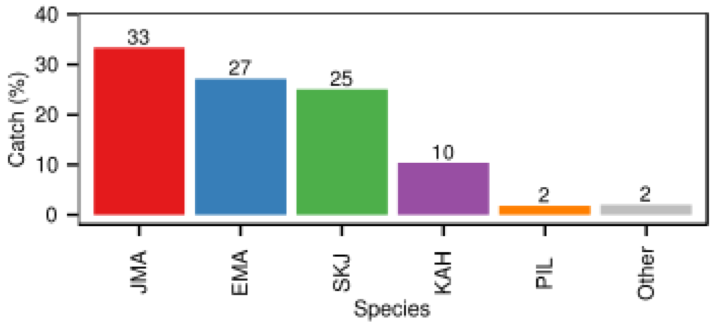


Figure 3: A summary of species composition for all reported domestic purse seine catches for 2012–13. The percentage by weight of each species is calculated for all domestic trips (Bentley et al 2013).

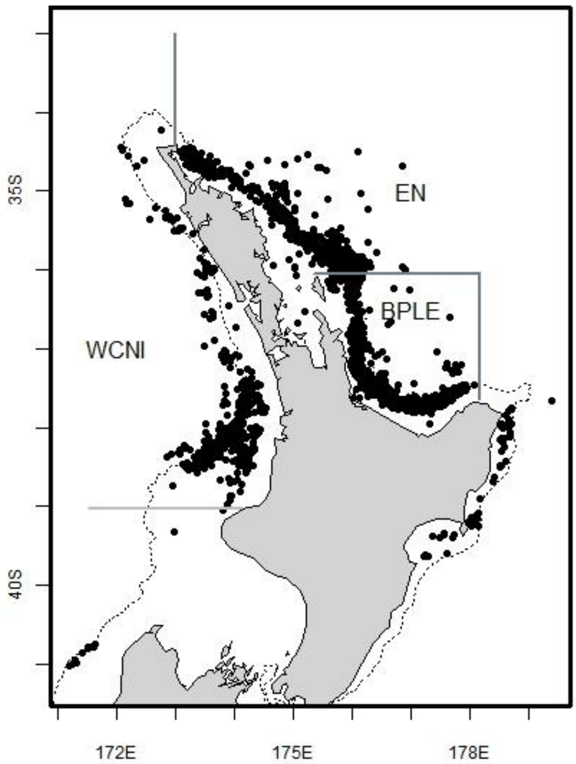


Figure 4: Location of purse-seine sets targeting skipjack tuna from 1999–2000 to 2008–09. The solid grey lines denote the boundaries of the main fishery areas (EN, east Northland, BPLE, Bay of Plenty; WCNI, west coast North Island). The dashed line represents the 200 m depth contour (Langley 2011).

Fishing activity for skipjack tuna by New Zealand flagged vessels outside of New Zealand fishery waters is generally limited to within the 10° S to 5° N latitudinal range (Figure 5). The distribution of fishing activity is largely constrained to areas of international waters (“high seas”) and the national waters of those countries for which the fleet has established access arrangements, most notably the EEZs of Tuvalu and Kiribati (Table 3). A limited amount of fishing has also occurred in the waters of Nauru, Solomon Islands, Tokelau, Federal States of Micronesia (FSM) and Marshall Islands although the activity in these areas has either been intermittent or maintained at a low level. Fishing access to a country’s national waters is generally negotiated collectively under the auspices of the New Zealand Far Seas Tuna Fishers Association. However, the individual members of the association may decide not to purchase a licence in a specific year (Langley 2011).

There are four main areas of international waters within the western equatorial Pacific. Of these areas, most of the fishing by the New Zealand fleet has been within the area of international waters surrounded by the national waters of Nauru, Kiribati (Gilbert Islands), Tuvalu, Solomon Islands, Papua New Guinea and FSM (the so called “high seas pockets”, denoted A2 in Figure 5. The fleet also operates in the narrow strip of international waters between Tuvalu and the Phoenix Islands (Kiribati) (area A3) and intermittently in the eastern area of international waters between the Phoenix Islands and Line Islands (Kiribati) (area A4). Limited fishing has occurred in the international waters between Papua New Guinea and FSM (area A1). Overall, the areas of international waters account for about 30% of the annual level of fishing activity and skipjack tuna catch of the New Zealand fleet operating in the equatorial fishery (Table 3) (Langley 2011).

Total fishing effort (number of sets) was highest in 2002 and was dominated by fishing within Kiribati waters. In the subsequent years, the fishing effort tended to fluctuate about the average level, with higher levels of effort in 2006 and 2009 and lower effort in 2005 and 2007 (Table 3) (Langley 2011).

In the initial years (2002–2005), there was considerable variability in the distribution of fishing effort among the main fishing areas. Fishing effort in Kiribati waters was high in 2002 and 2005 and fishing effort in Tuvalu waters was low in 2003 when a considerable amount of fishing occurred in the waters of FSM. During 2006–2009, the distribution of fishing effort was relatively stable with international waters and the EEZs of Tuvalu and Kiribati each accounting for about 25–35% of the annual fishing effort and 5–15% of the total effort occurring in other areas (Table 3) (Langley 2011).

1.2 Recreational fisheries

Skipjack by virtue of its wide distribution in coastal waters over summer is a seasonally important recreational species (the fourteenth most frequently caught finfish species by number in 2011–12). It is taken by fishers targeting it predominantly for use as bait, but it is also targeted as a food species. Skipjack are also frequently taken as bycatch when targeting other gamefish. Skipjack do not comprise part of the voluntary recreational gamefish tag and release programme. Skipjack are taken almost exclusively using rod and reel (over 99% of the 2011–12 harvest), and from trailer boats (over 59% of the 2011–12 harvest) and launches (over 37% of the 2011–12 harvest). They are caught predominantly around the upper North Island in FMAs 1 and 9 (over 92% of the 2011–12 harvest) with some catch in FMAs 2 and 8. Bag frequencies ranged from 1–21 fish, with 81% of bags in 2011–12 being 1–4 fish.

1.2.1 Management controls

There are no specific controls in place to manage recreational harvests of skipjack.

1.2.2 Estimates of recreational harvest

Recreational catch estimates are available from a national panel survey conducted in the 2011–12 fishing year (Wynne-Jones et al 2014). The panel survey used face-to-face interviews of a random sample of New Zealand households to recruit a panel of fishers and non-fishers for a full year. The panel members were contacted regularly about their fishing activities and catch information collected in standardised phone interviews. Note that the national panel survey estimate includes harvest taken on recreational charter vessels, but for skipjack is unlikely to estimate this proportion of the catch well. The national panel survey estimate does not include recreational harvest taken under s111 general approvals. The harvest estimate from this survey was 41 182 fish, with a mean weight of 2.24 kg, giving a total harvest of 92.08 tonnes (CV 0.23).

1.3 Customary non-commercial fisheries

There is no information on the customary take, but it is considered to be low.

1.4 Illegal catch

There is no known illegal catch of skipjack tuna.

1.5 Other sources of mortality

Skipjack tuna are occasionally caught as bycatch in the tuna longline fishery in small quantities; because of their low commercial value this bycatch are often discarded.

Table 3: Number of sets conducted by New Zealand flagged purse-seine vessels operating within areas of international waters (IW) and countries EEZ's in the western equatorial Pacific fishery by calendar year. KI denotes Kiribati. Areas of international waters (A1–4) are defined in Figure 5 (Langley 2011).

Area									Year
	2001	2002	2003	2004	2005	2006	2007	2008	2009
IW A1	0	0	50	0	0	0	0	0	0
IW A2	7	58	114	73	52	189	125	163	110
IW A3	7	15	74	37	16	39	43	19	30
IW A4	0	126	3	5	39	29	1	0	48
FSM	0	1	143	0	0	0	0	0	0
Gilbert Is (KI)	43	92	130	122	111	133	90	112	37
Line Is (KI)	0	149	0	0	3	0	27	0	0
Pheonix Is (KI)	12	126	31	44	144	49	62	9	164
Marshall Islands	0	0	4	6	10	0	0	0	0
Nauru	0	0	0	44	30	17	17	21	0
Solomon Islands	0	0	65	77	4	71	2	89	25
Tokelau	0	12	1	0	1	0	0	0	32
Tuvalu	94	187	29	136	81	138	141	169	211
Other	0	5	14	3	1	6	3	1	1
Total	163	771	658	547	492	671	511	583	658
% IW	9	26	37	21	22	38	33	31	29

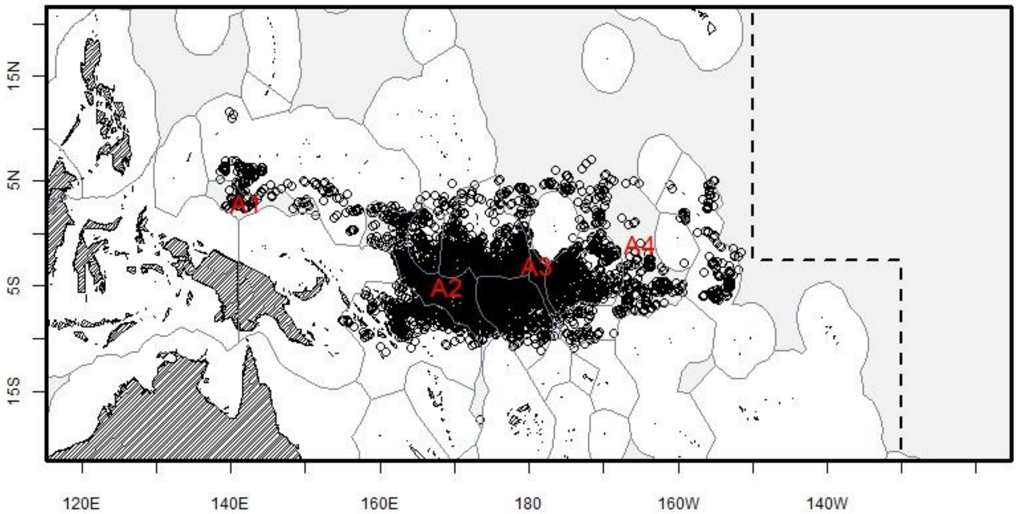


Figure 5: Distribution of purse-seine set locations for New Zealand flagged vessels operating in the equatorial region of the western Pacific Ocean from 2001 to 2009. The red labels (A 1–4) denote the four areas of international waters referred to in the text.

2. BIOLOGY

Skipjack tuna are epi-pelagic opportunistic predators of fish, crustaceans and cephalopods found within the upper few hundred metres of the surface. Individual tagged skipjack tuna are capable of movements of over several thousand nautical miles but also exhibit periods of residency around islands in the central and western Pacific, resulting in some degree of regional fidelity. Skipjack are typically a schooling species with juveniles and adults forming large schools at or near the surface in tropical and warm-temperate waters to at least 40ºS in New Zealand waters. Individuals found in New Zealand waters are mostly juveniles, which also occur more broadly across the Pacific Ocean, in both the northern and southern hemisphere. Adult skipjack reach a maximum size of 34.5 kg and lengths of 108 cm. The maximum reported age is 12 years old although the maximum time at liberty for a tagged skipjack of 4.5 years indicates that skipjack grow rapidly (reach 80 cm by age 4) and probably few fish live beyond 5 years old. Spawning takes place in equatorial waters across the entire Pacific Ocean throughout the year, in tropical waters spawning is almost daily. Recruitment shows a strong positive correlation with periods of El Niño.

Natural mortality is estimated to vary with age, with a maximum at age 1 and declining for older fish. A range of von Bertalanffy growth parameters has been estimated for skipjack in the western and central Pacific Ocean, depending on the area and the size of skipjack studied (Table 4). For skipjack tuna in the Pacific Ocean, the intrinsic rate of increase (k) is inversely related to asymptotic length (L_∞) by a power relationship; both parameters are also weakly correlated with sea surface temperature over the range 12º to 29º C.

Length frequency data were available from the MPI observer programme. In most years, the sampled component of the skipjack tuna purse-seine catch from the main fishery area was dominated by fish in the 40–50 cm (FL) length range (Figure 6). Considerably larger fish were caught in the Bay of Plenty and East Northland fisheries in 2004–05 and in the North Taranaki Bight fishery in 2005–06 and 2006–07. The modal structure in the length composition data indicates that the fishery is principally catching fish of 1–2 years of age (Tanabe et al 2003 estimated that skipjack tuna in the western Pacific reach 45 cm at 1 year and 65 cm at 2 years old) (Langley 2011).

Table 4: The range in L_∞ and k by country or area.

Country/Area	L_∞ (cm)	k
Hawaii	84.6 to 102.0	1.16 to 0.55
Indonesia	79.0 to 80.0	1.10 to 0.95
Japan	144.0	0.185
Papua New Guinea	65.0 to 74.8	0.92 to 0.52
Philippines	72.0 to 84.5	0.70 to 0.51
Taiwan	104.0	0.30 to 0.43
Vanuatu	62.0	1.10
Western Pacific	61.3	1.25
Western tropical Pacific	65.1	1.30

3. STOCKS AND AREAS

Surface-schooling, adult skipjack tuna (over 40 cm fork length, FL) are commonly found in tropical and subtropical waters of the Pacific Ocean.

Skipjack in the western and central Pacific Ocean (WCPO) are considered a single stock for assessment purposes. A substantial amount of information on skipjack movement is available from tagging programmes. In general, skipjack movement is highly variable but is thought to be influenced by large-scale oceanographic variability. In the western Pacific, warm, poleward-flowing currents near northern Japan and southern Australia extend their distribution to 40°N and 40°S. These limits roughly correspond to the 20°C surface isotherm.

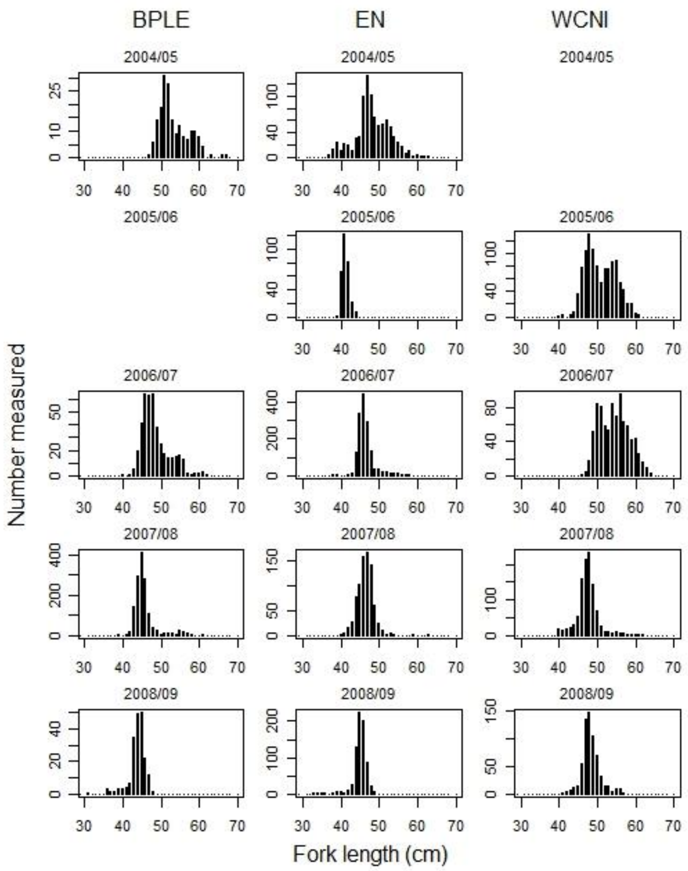


Figure 6: Length (FL) composition of the skipjack tuna catch sampled by MPI observers in the domestic target purse-seine fishery by fishery area (columns) and fishing year (rows) (fishery areas: BPLE, Bay of Plenty; EN, east Northland; WCNI, west coast North Island) (Langley 2011).

4. ENVIRONMENTAL AND ECOSYSTEM CONSIDERATIONS

This section was updated for the November 2015 Fishery Assessment Plenary after review by the Aquatic Environment Working Group. This summary is from the perspective of the skipjack tuna fishery; a more detailed summary from an issue-by-issue perspective is, or will shortly be, 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

Skipjack tuna (*Katsuwonus pelamis*) average 45–60 cm length in New Zealand, reaching an upper maximum of around 70 cm (Paul 2000). Skipjack are prey of larger tuna, HMS sharks and billfish.

4.2 Incidental bycatch

4.2.1 Purse seine fishery

4.2.1.1 Protected species bycatch

In the domestic skipjack purse seine fishery observer rates are relatively high. Relative to the skipjack catch (Table 5), observed bycatch is minor and consists mostly of teleosts. Spinetail devil rays (*Mobula japanica*) are the only protected species that have been observed captured by purse seine vessels in New Zealand. Work is underway to develop safe release methods for protected species, including sharks and rays. Overall Jack mackerel and blue mackerel are the most common teleost bycatch by weight but small numbers of large individuals such as striped marlin and mako sharks are also caught (Table 6).

Table 5: Domestic purse seine sets targeting skipjack tuna observed as a percentage of sets made for 2005–2015.

Calendar year	No. sets observed	% sets observed	% SKJ catch
2005	37	4.7	4.5
2006	104	17.6	35.5
2007	77	14.8	25.2
2008	118	27.6	57.3
2009	83	10.4	33.1
2010	109	8.8	15.3
2011	125	11.9	23.8
2012	113	9.5	19.7
2013	112	9.2	19.8
2014	95	10.1	15.3
2015	102	19.6	17.5

Table 6: Catch composition from six observed purse seine trips targeting skipjack tuna operating within New Zealand fisheries waters in 2011 and 2013 [continued on next page].

Common name	**Scientific name**	**Observed catch weight (kg)**	**% Catch**
Skipjack tuna	*Katsuwonus pelamis*	4 416 546	98.90
Jack mackerel	*Trachurus* spp.	22 057	0.49
Blue mackerel	*Scomber australasicus*	14 310	0.32
Sunfish	*Mola mola*	4 555	0.10
Spine-tailed devil ray	*Mobula japonica*	2 700	0.06
Striped marlin	*Tetrapturus audax*	1 520	0.03
Frigate tuna	*Auxis thazard*	1 010	0.02
Albacore tuna	*Thunnus alalunga*	679	0.02
Thresher shark	*Alopias vulpinus*	520	0.01
Jellyfish	Scyphozoa	309	0.01
Hammerhead shark	*Sphyrna zygaena*	245	0.01
Stingray	Dasyatididae	185	<0.01
Mako shark	*Isurus oxyrinchus*	158	<0.01
Swordfish	*Xiphias gladius*	150	<0.01
Frostfish	*Lepidopus caudatus*	102	<0.01
Flying fish	Exocoetidae	84	<0.01
Ray's bream	*Brama brama*	81	<0.01
Bronze whaler shark	*Carcharhinus brachyurus*	80	<0.01
Blue shark	*Prionace glauca*	70	<0.01
Slender tuna	*Allothunnus fallai*	50	<0.01
Snapper	*Pagrus auratus*	23	<0.01
Kahawai	*Arripis trutta*	20	<0.01
Porcupine fish	*Allomycterus jaculiferus*	15	<0.01
Tarakihi	*Nemadactylus macropterus*	15	<0.01
Electric ray	*Torpedo fairchildi*	12	<0.01
Pufferfish	*Sphoeroides pachygaster*	9	<0.01
Octopus	Octopoda	7	<0.01
Squid	Teuthoidea	7	<0.01
Kingfish	*Seriola lalandi*	6	<0.01
Rough skate	*Dipturus nasutus*	4	<0.01
Dolphinfish	*Coryphaena hippurus*	3	<0.01
Paper nautilus	*Argonauta nodosa*	2	<0.01
Pelagic ray	*Pteroplatytrygon violacea*	2	<0.01
John dory	*Zeus faber*	2	<0.01
Leatherjacket	*Parika scaber*	2	<0.01

Table 6 continued.

Common name	Scientific name	Observed catch weight (kg)	% Catch
Porae	*Nemadactylus douglasi*	2	<0.01
Rudderfish	*Centrolophus niger*	2	<0.01
Smooth skate	*Dipturus innominatus*	2	<0.01
Jack mackerel	*Trachurus murphyi*	1	<0.01
Pipefish	Syngnathidae	1	<0.01

5. STOCK ASSESSMENT

The most recent stock assessment was carried out in 2016 and assessed the stock of skipjack tuna in the WCPO up to the end of 2015. New developments to the assessment include addressing the recommendations of the previous assessment (2014), exploration of uncertainties in the assessment model, particularly in response to the inclusion of additional years of data, and to improve diagnostic weakness of previous assessments. Other key papers were presented to document: 1) methods of estimating standardized catch per unit effort indices, 2) construction of the tagging data input file, 3) revisions and summaries of fisheries definitions, and the guidance of the Pre-assessment workshop.

Stock status and trends

SC12 noted that the skipjack catch in 2015 was 1 827 750 t, was a 9% decrease over 2014 and a 3% increase over the average for 2010–14.

Purse seine skipjack catch in 2015 was 13% lower than that in 2014 and effort 21% lower.

The SC12 was unable to reach consensus on the description of stock status based on the 2016 stock assessment.

SC12 notes that the majority of members agreed on the following description of WCPO skipjack tuna status and trends.

Majority view of stock status and trends

A majority of SC12 CCMs selected the reference case model as the base case to represent the stock status of skipjack tuna. To characterize uncertainty, those CCMs chose the structural uncertainty grid. Summaries of important model quantities for these models are shown in Table 7.

Table 7: Description of the structural sensitivity grid used to characterise uncertainty in the assessment. The reference case option is denoted in bold face.

Axis	Levels	Option
Steepness	3	0.65, **0.80**, or 0.95
Mixing period	2	**1 quarter mixing**, 2 quarters mixing
Length composition weighting	3	sample sizes divided by 10, **20** or 50
Tagging overdispersion	3	**Default level**, Estimated, or Fixed (moderate) level

Table 8: Estimates of management quantities for the selected stock assessment models. For the purpose of this assessment, "recent" is the average over the period 2011–2014 and "latest" is 2015.

Quantity	RefCase	h0.65	h0.95	mix2qtr	Lgth10	Lgth50	EstVB	EstVBSD	EstOD	ODmiddle	InvMov	SRRqtrly	TermRec4
C_{latest}	1,679,528	1,679,517	1,679,522	1,679,609	1,679,535	1,679,467	1,679,194	1,679,283	1,679,169	1,679,313	1,679,538	1,679,520	1,679,698
MSY	1,891,600	2,026,400	1,832,800	2,076,800	1,84,8000	1,934,400	1,902,800	1,760,800	1,641,200	1,762,000	1,856,400	1,591,600	1,874,000
$Y_{F_{recent}}$	1,594,800	1,766,000	1,504,000	1,659,200	1,585,200	1,603,200	1,591,600	1,531,600	1,545,600	1,589,200	1,580,000	1,445,200	1,595,200
f_{mult}	2.23	1.96	2.48	2.47	2.14	2.31	2.23	2.04	1.61	1.88	2.17	1.69	2.17
F_{MSY}	0.24	0.22	0.27	0.24	0.26	0.23	0.25	0.27	0.24	0.25	0.24	0.19	0.24
$F_{recent}/F_{\mathrm{MSY}}$	0.45	0.51	0.40	0.41	0.47	0.43	0.45	0.49	0.62	0.53	0.46	0.59	0.46
SB_{MSY}	1,626,000	1,972,000	1,423,000	1,858,000	1,496,000	1,761,000	1,560,000	1,346,000	1,470,000	1,509,000	1,597,000	1,813,000	1,622,000
SB_0	6,764,000	7,637,000	6,284,000	7,463,000	6,256,000	7,420,000	6,996,000	5,453,000	5,858,000	6,055,000	6,618,000	6,469,000	6,767,000
$SB_{F=0}$	7,221,135	7,802,299	6,877,143	7,751,452	6,744,980	7,825,861	7,449,414	5,981,232	6,436,206	6,539,112	7,086,859	7,205,705	7,212,830
SB_{latest}/SB_0	0.62	0.55	0.66	0.68	0.64	0.59	0.59	0.59	0.45	0.51	0.63	0.65	0.66
$SB_{latest}/SB_{F=0}$	0.58	0.53	0.61	0.65	0.60	0.56	0.56	0.54	0.41	0.47	0.59	0.58	0.62
$SB_{latest}/SB_{\mathrm{MSY}}$	2.56	2.11	2.93	2.73	2.69	2.49	2.66	2.38	1.81	2.03	2.60	2.30	2.76
$SB_{recent}/SB_{F=0}$	0.52	0.48	0.54	0.56	0.52	0.51	0.50	0.50	0.41	0.46	0.52	0.52	0.51
$SB_{recent}/SB_{\mathrm{MSY}}$	2.31	1.90	2.63	2.32	2.36	2.28	2.41	2.21	1.80	1.98	2.29	2.07	2.28

Trends in estimated recruitment, spawning biomass, fishing mortality, MSY and depletion are shown in Figures 7–13.

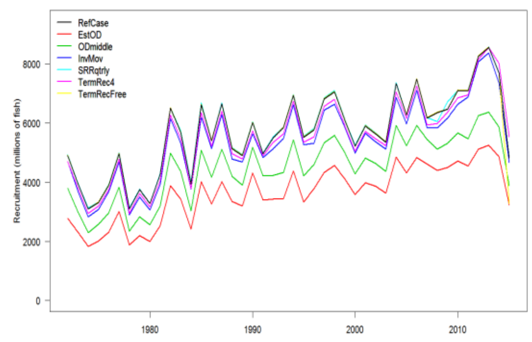


Figure 7: Estimated annual recruitment (millions of fish) for the WCPO obtained from the reference case model and six additional runs.

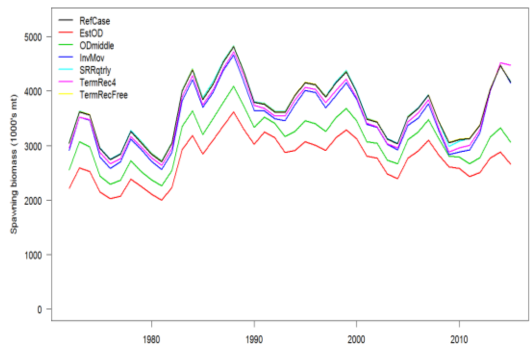


Figure 8: Estimated annual average spawning potential for the WCPO obtained from the reference case model and six additional runs.

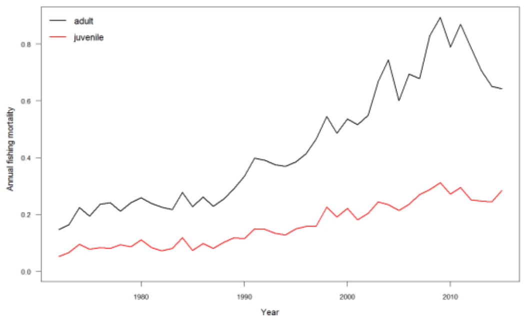


Figure 9: Estimated annual average juvenile and adult fishing mortality for the WCPO obtained from the reference case model.

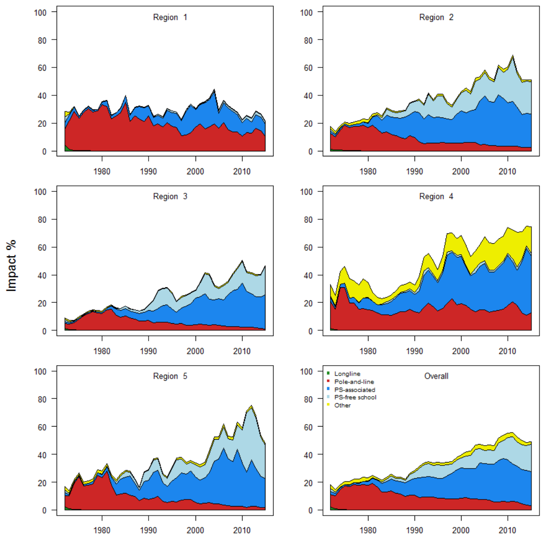


Figure 10: Estimates of reduction in spawning potential due to fishing (fishery impact = *1-SB$_t$/SB$_{t,F=0}$*) by region and for the WCPO attributed to various fishery groups for the reference case model.

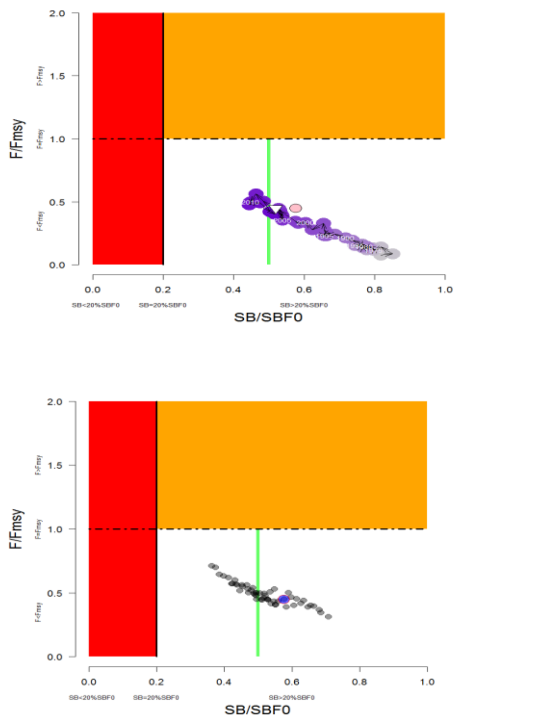


Figure 11: Temporal trend for the reference case model (top) and the structural uncertainty grid (bottom panel) in stock status relative to $SB_{F=0}$ (x-axis) and F_{MSY} (y-axis). The red zone represents spawning potential levels lower than the agreed LRP, which is marked with the solid black line ($0.2SB_{F=0}$). The orange region is for fishing mortality greater than F_{MSY} ($F=F_{MSY}$; marked with the black dashed line). The green line indicates the interim target reference point 50% $SB_{F=0}$.

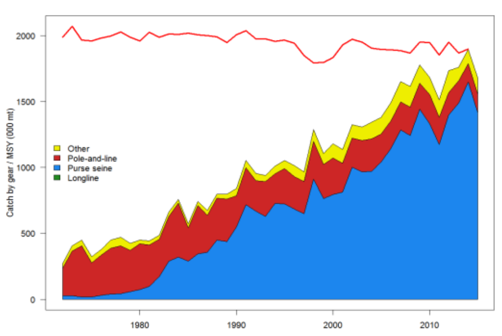


Figure 12: History of annual estimates of MSY compared with catches of three major fisheries for the reference case model.

Dynamics of most model quantities are relatively consistent with the results of the 2014 stock assessment, although there has been a period of several subsequent years with high recruitments and increased spawning biomass.

Fishing mortality of all age-classes is estimated to have increased significantly since the beginning of industrial tuna fishing, but fishing mortality still remains below the level that would result in the MSY (F_{recent}/ F_{MSY} = 0.45 for the reference case), and is estimated to have decreased moderately in the last several years. Across the reference case and the structural uncertainty grid F_{recent} / F_{MSY} varied between 0.38 (5% quantile) to 0.64 (95% quantile). This indicates that overfishing is not occurring for the WCPO skipjack tuna stock (Figure 11).

The estimated MSY of 1 891 600 t is moderately higher than the 2014 estimate due to the adoption of an annual, rather than quarterly, stock-recruitment relationship. Recent catches are lower than, but approaching, this MSY value (Figure 12).

The latest (2015) estimate of spawning biomass is well above both the level that will support MSY (SB_{latest}/SB_{MSY} = 2.56, for the reference case model) and the adopted LRP of 0.2 $SB_{F=0}$ (SB_{latest} /$SB_{F=0}$ = 0.58, for the reference case model), and SB_{latest} / $SB_{F=0}$ was relatively close to the adopted interim target reference point (0.5 $SB_{F=0}$) for all models explored in the assessment (structural uncertainty grid: median = 0.51, 95% quantiles = 0.39 and 0.67).

Alternative view of stock status and trends

China, Japan and Chinese Taipei considered it is not possible to select a base-case model from various sensitivity models in the 2016 assessment, given the advice from the Scientific Service Provider that a suite of the sensitivity models were plausible. Therefore, these members considered that it would be more appropriate to provide advice to WCPFC13 on skipjack stock status based on the range of uncertainty expressed by the alternative model runs in the sensitivity analysis rather than based on the single base case model.

The estimated MSY of WCPO skipjack stock ranges from 1 641 200 to 2 076 800 t across the alternative skipjack stock assessment models represented in the sensitivity grid. These CCMs also noted that some alternative models indicate that the 2015 biomass is below the adopted TRP of 0.5 $SB_{F=0}$.

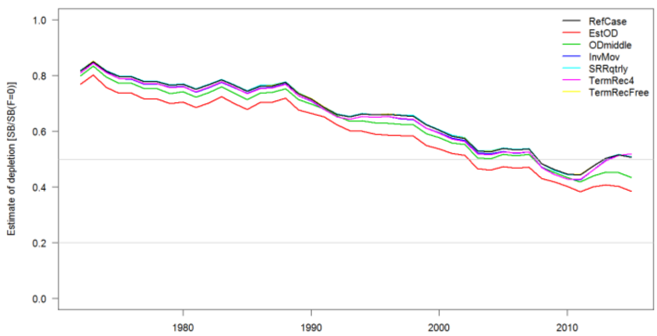


Figure 13: Estimated fisheries depletion $SB/SB_{F=0}$**, for each of the sensitivity models.**

Management advice and implications

SC12 noted that the skipjack assessment continues to show that the stock is currently moderately exploited and fishing mortality level is sustainable. The recent catches are fluctuating around and some models also indicate that the stock is currently under the TRP.

SC12 noted that fishing is having a significant impact on stock size and can be expected to affect catch rates. The stock distribution is also influenced by changes in oceanographic conditions associated with El Niño and La Niña events, which impact on catch rates and stock size. Additional purse-seine effort will yield only modest gains in long-term skipjack tuna catches and may result in a corresponding increase in fishing mortality for bigeye and yellowfin tunas. The management of total effort in the WCPO should recognize this.

SC12 noted that skipjack spawning biomass is now around the adopted TRP and SC12 recommends that the Commission take action to keep the spawning biomass near the TRP and also advocates for the adoption of harvest control rules based on the information provided.

In order to maintain the quality of stock assessments for this important stock, SC12 recommends 1) continued work on developing an index of abundance based on purse seine data; 2) regular large scale tagging cruises and complementary tagging work continue to be undertaken in a way that provides the best possible data for stock assessment purposes.

SC12 also notes that the current method of calculating the TRP is based on the most recent 10 years of recruitment information. However, the information on spawning potential, SB_{2015}, which is used to evaluate current stock status relative to the TRP can change very rapidly for skipjack which mature at age 1; this rapid maturation may provide an optimistic status evaluation when recruitment is estimated to have an increasing trend but is estimated with substantial uncertainty, as is currently observed in the case of skipjack which does not have a fishery-independent index of recruitment strength.

There is ongoing concern by at least one CCM that high catches in the equatorial region may be causing a range contraction of WCPO skipjack tuna, thus reducing skipjack tuna availability to fisheries conducted at higher latitudes than the Pacific equatorial region. SC12 reiterates the advice of SC11 whereby there is no demonstrated statistical evidence for SKJ range contraction. As a result, SC12 recommends that ongoing research on range contraction of skipjack tuna be continued in the framework of Project 67.

5.1 Estimates of fishery parameters and abundance

There are no fishery-independent indices of abundance for the skipjack tuna. Unlike other pelagic tunas, the low selectivity of skipjack tuna to longline gear means that no relative abundance information is available from longline catch per unit effort data. Regional CPUE indices derived from Japanese pole-and-line logsheet data and purse seine associated CPUE for the Philippines and Papua New Guinea fleets are the principal indices of stock abundance incorporated in the WCPO stock assessment. However, the pole-and-line fleet has declined considerably over the last 20 years and there has been a contraction of the spatial distribution of the fishery in the equatorial region. Purse seine catch per unit effort data is difficult to interpret. Returns from a large scale tagging programme undertaken in the early 1990s also provides information on rates of fishing mortality which in turn leads to improved estimates of abundance.

Average fishing mortality rates for juvenile and adult age-classes increased throughout the time series. Since the 1980s, the increase of fishing mortality to the current levels is due to the increase of catches of both juvenile and adult fish beginning at that time from both associated purse seine sets and the mixed gear fisheries in the Philippines and Indonesia. Fishing mortality on intermediate ages (5–8 quarters) is also increasing through time consistent with the increased fishing mortality from the purse seine fishery.

5.2 Biomass estimates

WCPO spawning potential is estimated to have been relatively stable during the 1970s, before increasing in the early 1980s due to higher recruitment, before declining over the past decade due to fishing. The eastern equatorial region (region 3) remains the region with the greatest spawning potential and the central equatorial region (region 2) is the second largest with the single northern region the third largest. The spawning potential in the western equatorial regions 4 and 5 are similar.

5.3 Yield estimates and projections

No estimates of MCY and CAY are available.

5.4 Other yield estimates and stock assessment results

SC12 did not achieve consensus to accept and endorse the reference case proposed in the assessment document. The majority view was that the latest (2015) estimate of spawning biomass is well above both the level that will support MSY (SB_{latest} /SB_{MSY} = 2.56, for the reference case model) and the adopted LRP of 0.2 $SB_{F=0}$ (SB_{latest} / $SB_{F=0}$ = 0.58, for the reference case model), and SB_{latest} / $SB_{F=0}$ was relatively close to the adopted interim target reference point (0.5 $SB_{F=0}$) for all models explored in the assessment (structural uncertainty grid: median = 0.51, 95% quantiles = 0.39 and 0.67).

As an alternative, China, Japan and Chinese Taipei considered it is not possible to select a base-case model from various sensitivity models in the 2016 assessment, given the advice from the Scientific Service Provider that a suite of the sensitivity models were plausible. Therefore, these members considered that it would be more appropriate to provide advice to WCPFC13 on skipjack stock status based on the range of uncertainty expressed by the alternative model runs in the sensitivity analysis rather than based on the single base case model.

5.5 Other factors

One area of concern with fisheries for skipjack tuna relates to the potential for significant bycatch of juvenile bigeye and yellowfin tunas in the purse seine fishery in equatorial waters. Juveniles of these species occur in mixed schools with skipjack tuna broadly through the equatorial Pacific Ocean, and are vulnerable to large-scale purse seine fishing when sets are made on floating objects (FADs). The fishery in New Zealand fisheries waters is on single species free schools.

While the skipjack resource within New Zealand waters is considered to represent a component of the wider WCPO stock, the extent of the interaction between the domestic fishery and the fisheries in the equatorial region is unclear. Catches within New Zealand waters vary inter-annually due to prevailing oceanographic conditions. Nonetheless, recent domestic catches have been at or about the highest level recorded from the fishery while the recent total catches from the WCPO have also been the highest on record. A review of domestic purse-seine catch and effort data and associated aerial sightings data from the skipjack tuna fishery did not reveal any temporal trend in the availability of skipjack to the domestic fishery (Langley 2011).

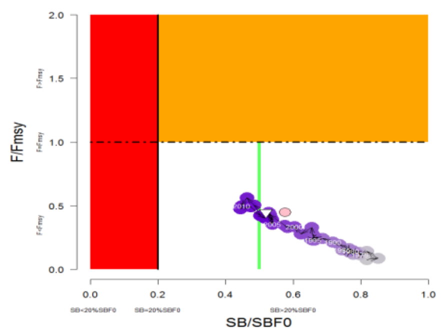
6. STATUS OF THE STOCKS

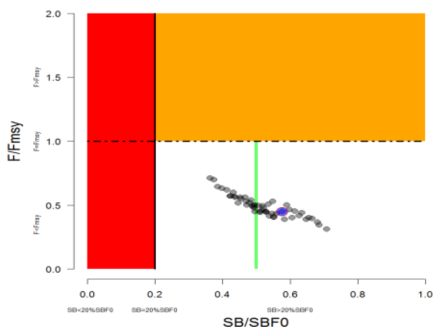
Stock structure assumptions

Skipjack tuna are considered to be a single stock in the WCPO.

Stock Status	
Year of Most Recent Assessment	A full stock assessment was completed in 2016
Assessment Runs Presented	Base case model and a range of sensitivities
Reference Points	Candidate biomass-related target reference point (TRP) currently under consideration for key tuna species is 40–60% SB_0 Limit reference point of 20% SB_0 established by WCPFC equivalent to the HSS default soft limit of 20% SB_0 Hard Limit: Not established by WCPFC; but evaluated using HSS default of 10% SB_0 Overfishing threshold: F_{MSY}
Status in relation to Target	Very Likely (> 90%) to be in the range 40–60% SB_0 and Very Likely (> 90%) that $F < F_{MSY}$
Status in relation to Limits	Soft Limit: Exceptionally Unlikely (< 10%) to be below Hard Limit: Exceptionally Unlikely (< 10%) to be below
Status in relation to Overfishing	Overfishing is Very Unlikely (< 10%) to be occurring

Historical Stock Status Trajectory and Current Status





Temporal trend for the reference case model (top) and the structural uncertainty grid (bottom panel) in stock status relative to $SB_{F=0}$ (x-axis) and F_{MSY} (y-axis). The red zone represents spawning potential levels lower than the agreed LRP, which is marked with the solid black line ($0.2SB_{F=0}$). The orange region is for fishing mortality greater than F_{MSY} ($F=F_{MSY}$; marked with the black dashed line). The green line indicates the interim target reference point 50% $SB_{F=0}$.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Biomass increased in the mid-1980s and fluctuated about the higher level over the subsequent period, before increasing again since 2008. Recent depletion level is estimated at 0.42 (i.e. biomass is estimated to be 0.58 of the unfished level).
Recent Trend in Fishing Intensity or Proxy	*F* is estimated to have remained well below F_{MSY} over the history of the fishery, and the level of fishing mortality has decreased moderately over the last several years
Other Abundance Indices	-
Trends in Other Relevant Indicator or Variables	Recruitment showed an upward trend since the mid-1980s before declining in the most recent few years. The estimated distribution of recruitment across regions should be interpreted with caution as MULTIFAN-CL can use a combination of movement and regional recruitment to distribute fish.

Projections and Prognosis	
Stock Projections or Prognosis	Projections not conducted
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Soft Limit: Exceptionally Unlikely (< 1%) Hard Limit: Exceptionally Unlikely (< 1%)
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Exceptionally Unlikely (< 1%)

Assessment Methodology and Evaluation		
Assessment Type	Level 1 – Full Quantitative Stock Assessment	
Assessment Method	The assessment uses the stock assessment model and computer software known as MULTIFAN-CL.	
Assessment Dates	Latest assessment: 2016	Next assessment: 2019

Overall assessment quality rank	1 – High Quality	
Main data inputs	Inputs include improved purse seine catch estimates; reviews of the catch statistics of the component fisheries; standardised CPUE analyses of Japanese pole-and-line operational level catch and effort data; CPUE data for two purse seine fisheries; size data inputs from the purse seine fishery; revised regional structures and fisheries definitions; and preparation of tagging data and reporting rate information.	1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	- Increases in the number of spatial regions to better model the tagging and size data; - Improved modelling of recruitment to ensure that uncertain estimates do not influence key stock status outcomes; and - A large amount of new tagging data corrected for differential post-release mortality and other tag losses	
Major Sources of Uncertainty	- Pole-and-line CPUE data are one of the most important drivers of the skipjack stock assessment; however with the continuing decline of the Japanese pole-and-line fleet particularly in the tropical regions, the ongoing reliance on this fleet to provide a suitable index of skipjack abundance will become increasingly problematic. - The current assessment had the greatest update of tagging data in many years and the limited sensitivity analyses demonstrated that key model outputs are lightly sensitive to tagging data assumptions such as the assumed mixing period. - One area of reduced uncertainty in the current assessment has been impact of steepness on the spawning potential reference point.	

Qualifying Comments
-

Fishery Interactions
There is a high level of bycatch of small bigeye and yellowfin tuna in the tropical skipjack purse seine fishery when using Fish Aggregating Devices (FADs). This has increased the catch of bigeye and yellowfin and has contributed to biomass declines of these two species. Sea turtles also get incidentally captured in purse seine nets and FADs; the WCPFC is attempting to reduce sea turtle interactions through Conservation and Management Measure (CMM2008-03). Mortality of whale sharks, basking sharks and whales, which act as FADs and are caught in purse seine nets, is known to occur, but the extent of this is currently unknown.

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