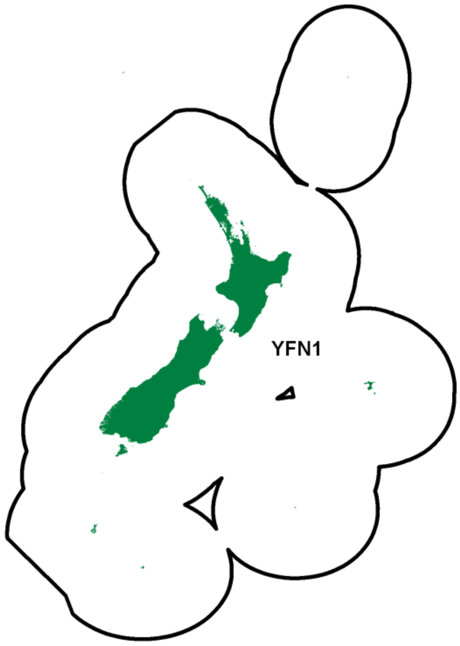
YELLOWFIN TUNA (YFN)

(Thunnus albacares)



1. FISHERY SUMMARY

Yellowfin tuna were introduced into the QMS on 1 October 2004 under a single QMA, YFN 1, with allowances, TACC, and TAC in Table 1.

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

Fishstock	Recreational Allowance	Customary non-commercial Allowance	Other mortality	TACC	TAC
YFN 1	60	30	5	263	358

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

Management of the yellowfin stock 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 of the Commission.

At its second annual meeting (2005) the WCPFC passed a Conservation and Management Measure (CMM) (this is a binding measure that all parties must abide by throughout the convention area including EEZs) relating to conservation and management of tunas. Key aspects of this resolution were presented in the 2006 Plenary document. A number of subsequent CMMs that impact on the catches of yellowfin have since been approved by the WCPFC.

At its annual meeting in 2014 the WCPFC approved CMM 2014-01. The aim of this CMM for yellowfin is to maintain the fishing mortality rate for yellowfin at a level no greater than Fmsy. 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, yellowfin purse seine catch limits, high seas purse seine effort limits, yellowfin longline catch limits, as well as other methods. This measure was amended and updated in 2015 through CMM2015-01.

1.1 Commercial fisheries

Most of the commercial catch of yellowfin takes place in the equatorial Western Pacific Ocean (WPO) where they are taken primarily by purse seine and longline. Commercial catches by distant water Asian longliners of yellowfin tuna, in New Zealand waters, began in 1962. Catches through the 1960s averaged 283 t. Yellowfin were not a target species for these fleets and catches remained small and seasonal. Domestic tuna longline vessels began targeting bigeye tuna in 1990–91 in northern waters of FMA 1, FMA 2 and FMA 9 (Table 2). Catches of yellowfin have increased with increasing longline effort, but as yellowfin availability fluctuates dramatically between years, catches have been variable. In addition, small catches of yellowfin are made by pole-and-line fishing (about 4 t per year) and also by trolling (about 14 t per year). Figure 1 shows historic landings and longline fishing effort for YFN stocks.

Catches from within New Zealand fisheries waters are very small (0.07% average for 2000–2011) compared to those from the greater stock in the WCPO (Table 3). In contrast to New Zealand, where yellowfin are taken almost exclusively by longline, 50% of the WCPO catches of yellowfin tuna are taken by purse seine and other surface gears (e.g., ring-nets and pole-and-line).

Table 2: Reported catches or landings (t) of yellowfin tuna by fleet and Fishing Year. NZ: New Zealand domestic and charter fleet, ET: catches outside these areas from New Zealand flagged longline vessels, JPNFL: Japanese foreign licensed vessels, KORFL: foreign licensed vessels from the Republic of Korea. LFRR: Estimated landings from Licensed Fish Receiver Returns and MHR: Monthly Harvest Return Data from 2001–02 onwards [Continued on next page].

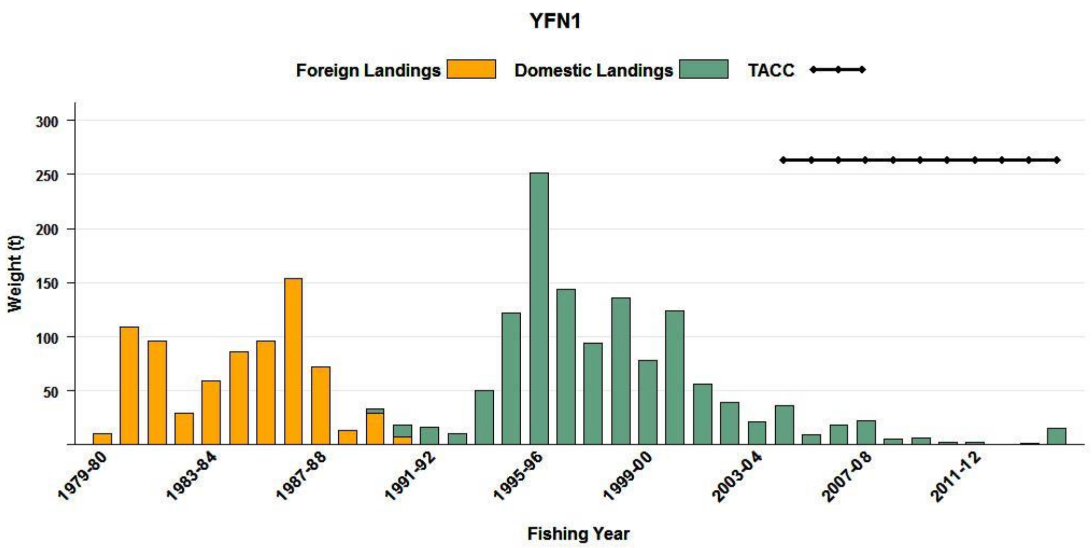
				YFN 1 (all FMAs)		
Fishing Year	JPNFL	KORFL	NZ/MHR	Total	LFRR	NZ ET
1979–80	10.1			10.1		
1980–81	79.1	29.9		109		
1981–82	89.4	6.7		96.1		
1982–83	22.4	6.6		29		
1983–84	46.1	12.8		58.9		
1984–85	21.3	64.5		85.8		
1985–86	92.5	3.3		95.8		
1986–87	124.8	29		153.8		
1987–88	35.2	37.3		72.5		
1988–89	11.5	1.8		13.3	19	
1989–90	29.1		4.3	33.4	6.3	
1990–91	7.4		10.7	18.1	19.9	
1991–92	0.2		16.1	16.3	11.8	
1992–93			10.1	10.1	69.7	0.2
1993–94			50.5	50.5	114.4	1.5
1994–95			122.2	122.2	193.4	0.3
1995–96			251.6	251.6	156.7	7.4
1996–97			144.1	144.1	105.3	0.2
1997–98			93.6	93.6	174.7	2.3
1998–99			136.1	136.1	100.6	0.3
1999–00			77.8	77.8	168	2.1
2000–01			123.5	123.5	62.5	3.1
2001–02			64.5	56.7	61.9	1.9
2002–03			41.8	39.7	42.1	2.1
2003–04			57.7	21.1	21.4	36.6
2004–05			42.0	36.1	41.4	6.0
2005–06			9.3	9.2	8.8	0.1
2006–07			18.8	17.3	19.7	1.0
2007–08			22.2	22.4	22.3	0.2
2008–09			5.4	43.6	43.3	3 200
2009–10			6.2	6.2	48.2	1 264
2010–11			2.8	2.8	234.8	818
2011–12			2.2	2.3	742.6	966
2012–13			0.6	0.6	249.1	1 042
2013–14			1.3	1.3	200.7	199.4
2014–15			15.1	15.1	129.3	115.6

Table 3: Reported total New Zealand within EEZ landings, catch made by New Zealand vessels outside New Zealand fishery waters (NZ ET)* and WCPO landings (t) of yellowfin tuna from 1991 to 2015.

Year	NZ landings (t)	WCPO landings (t)	Year	NZ landings (t)	NZ ET landings (t)	WCPO landings (t)
1991	6	403 152	2001	138	955	492 971
1992	20	413 882	2002	25	3 531	463 860
1993	34	351 556	2003	38	3 646	517 362
1994	53	391 108	2004	20	2 658	513 200
1995	141	381 423	2005	36	2 486	545 391
1996	198	351 762	2006	14	2 679	493 261
1997	143	457 984	2007	25	2 329	500 120
1998	127	550 299	2008	12	3 200	580 241
1999	154	479 090	2009	3	1 264	529 426
2000	107	523 956	2010	6	818	542 438
			2011	3	966	518 611
			2012	2	1 042	639 912
			2013	1	837	529 437
			2014	1	199	607,222
			2015	15	116	601,221

Source: Ministry of Fisheries Licensed Fish Receiver Reports, Solander Fisheries Ltd, Anon. 2006, Williams & Terawasi 2011; WCPO landings sourced from WCPFC Yearbook 2012 (Anon 2014.

*New Zealand purse seine vessels operating in tropical regions catch moderate levels of yellowfin tuna when fishing around Fish Aggregating Devices (FADs) and on free schools. These catches are only estimates of catch based on analysis of observer data across all fleets rather than specific data for New Zealand vessels. In addition, catches of juvenile bigeye and yellowfin tuna are often combined on catch effort returns due to difficulties in differentiating the catch.



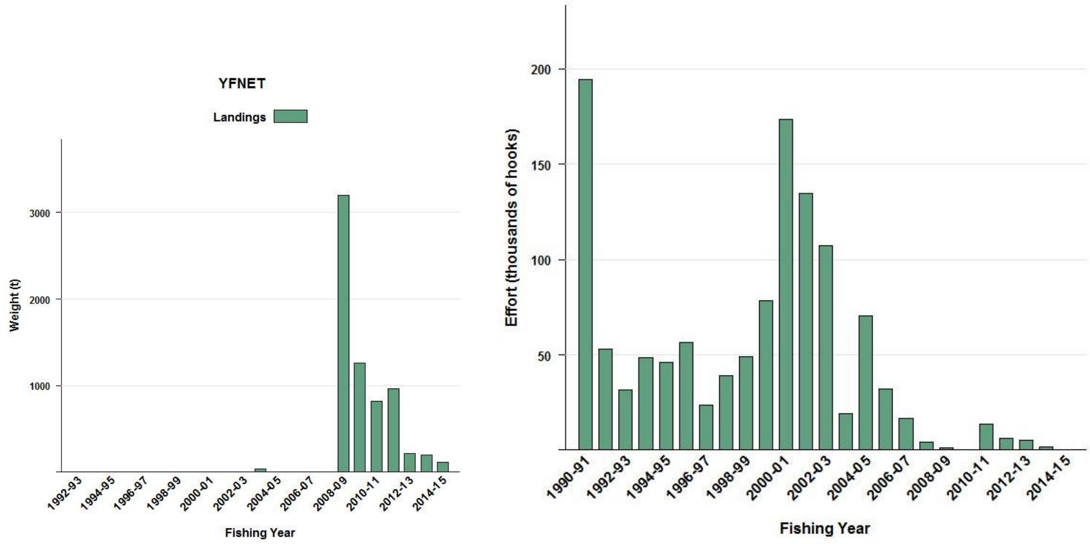


Figure 1: [Top] Yellowfin catch by foreign licensed and New Zealand vessels from 1979–80 to 2013–14 within New Zealand waters (YFN 1), and [middle] 1992–93 to 2014–15 on the high seas (YFN ET). [Middle] Fishing effort (number of hooks set) for all high seas New Zealand flagged surface longline vessels from 1990–91 to 2014–15.

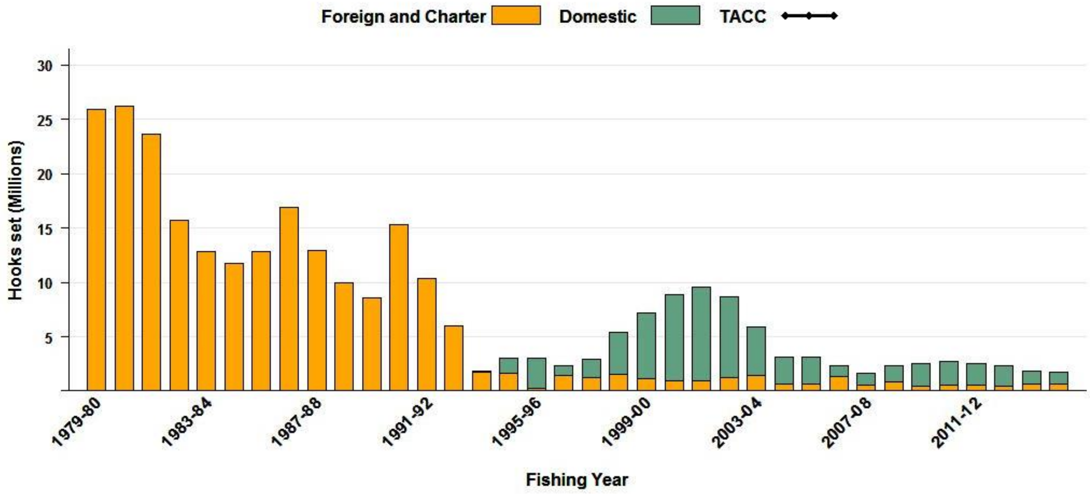


Figure 1 [Continued] Yellowfin effort by domestic vessels (including effort by foreign vessels chartered by New Zealand fishing companies) from 1979–80 to 2014–15

The majority of yellowfin tuna are caught in the bigeye tuna surface longline fishery (68%) (Figure 2), however, across all longline fisheries albacore make up the bulk of the catch (31%) and yellowfin tuna make up only 2% of the catch (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 4).

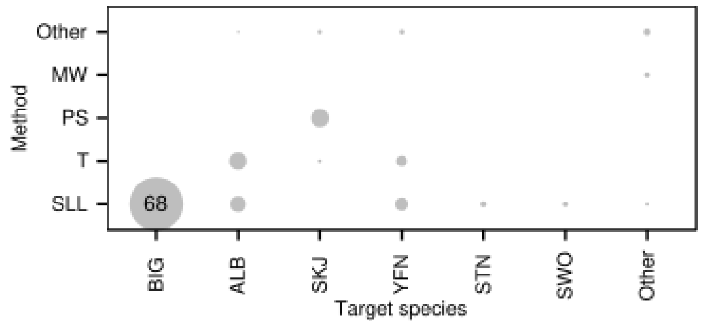


Figure 2: A summary of the proportion of landings of yellowfin tuna taken by each target fishery and fishing method for 2012-13. The area of each circle is proportional to the percentage of landings taken using each combination of fishing method and target species. The number in the circle is the percentage. SLL = surface longline, T = trawl, PS = purse seine, MW = mid-water trawl (Bentley et al 2013).

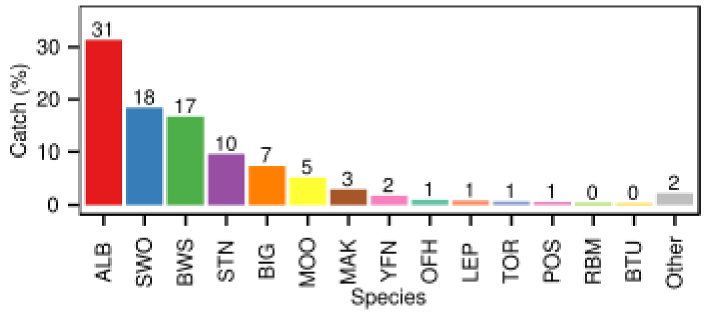


Figure 3: A summary of species composition of the reported surface longline catch for 2012-13. The percentage by weight of each species is calculated for all surface longline trips (Bentley et al. 2013).

Across all fleets in the longline fishery 79.4% of the yellowfin tuna were alive when brought to the side of the vessel (Table 4). The domestic fleets retain between 78 and 100% of their yellowfin tuna catch (Table 5).

Table 4: Percentage of yellowfin tuna (including discards) that were alive or dead when arriving at the longline vessel and observed during 2006–07 to 2009–10, by fishing year, fleet and region. Small sample sizes (number observed < 20) were omitted Griggs & Baird (2013).

Year	Fleet	Area	% alive	% dead	Number
2006–07	Domestic	North	75.0	25.0	28
	Total		**78.3**	**21.7**	**46**
2007–08	Domestic	North	75.8	24.2	33
	Total		**75.8**	**24.2**	**33**
2008–09	**Total**		**88.9**	**11.1**	**9**
2009–10	**Total**		**88.9**	**11.1**	**9**
Total all strata			**79.4**	**20.6**	**97**

Table 5: Percentage yellowfin that were retained, or discarded or lost, when observed on a longline vessel during 2006–07 to 2009–10, by fishing year and fleet. Small sample sizes (number observed < 20) omitted Griggs & Baird (2013).

Year	Fleet	% retained	% discarded or lost	Number
Total all strata		**71.0**	**29.0**	**617**
2006–07	Domestic	78.6	21.4	28
	Total	**80.4**	**19.6**	**46**
2007–08	Domestic	90.9	9.1	33
	Total	**90.9**	**9.1**	**33**
2008–09	**Total**	**100.0**	**0.0**	**9**
2009–10	**Total**	**100.0**	**0.0**	**9**
Total all strata		**87.6**	**12.4**	**97**

1.2 Recreational fisheries

Recreational fishers used to make regular catches of yellowfin tuna particularly during summer months and especially in FMA 1 and FMA 2 where the recreational fishery targeted yellowfin as far south as the Wairarapa coast. It is taken by fishers targeting it predominantly as a gamefish and is prized for food. Yellowfin comprise part of the voluntary recreational gamefish tag and release programme.

1.2.1 Management controls

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

1.2.2 Estimates of recreational harvest

No yellowfin tuna were reported as part of the 2011-12 National Panel Survey (Wynne-Jones et al. 2014). While the magnitude of the recreational catch is unknown, catches weighed at sport fishing clubs dropped from over 1000 fish per year in the 1990s to an average of 30 fish per year in the period 2011-2014.

1.3 Customary non-commercial fisheries

An estimate of the current customary catch is not available.

1.4 Illegal catch

There is no known illegal catch of yellowfin tuna in the EEZ. Estimates of illegal catch are not available, but are probably insignificant.

1.5 Other sources of mortality

The estimated overall incidental mortality rate from observed longline effort is 0.22% of the catch. Discard rates are 0.92% on average from observer data of which approximately 25% are discarded dead (usually because of shark damage). Fish are also lost at the surface in the longline fishery, 0.16% on average from observer data, of which 95% are reported as escaping alive.

2. BIOLOGY

Yellowfin tuna are epi-pelagic opportunistic predators of fish, crustaceans and cephalopods. Yellowfin tuna are found from the surface to depths where low oxygen levels are limiting (about 250 m in the tropics but probably deeper in temperate waters). Individuals found in New Zealand waters are mostly adults that are distributed in the tropical and temperate waters of the western and central Pacific Ocean. Adults reach a maximum size of 200 kg and length of 239 cm. First maturity is reached at 60 to 80 cm (1 to 2 years old), and the size at 50% maturity is estimated to be 105 cm. The maximum reported age is 8 years. Spawning takes place at the surface at night mostly within 10º of the equator when temperatures exceed 24ºC. Spawning takes place throughout the year but the main spawning season is November to April. Yellowfin are serial spawners, spawning every few days throughout the peak of the season.

Natural mortality is assumed to vary with age. A range of von Bertalanffy growth parameters has been estimated for yellowfin in the Pacific Ocean depending on area (Table 6).

Table 6: von Bertalanffy growth parameters for yellowfin tuna by country or area.

Country/Area	L_∞ (cm)	K	t_0
Philippines	148.0	0.420	
Mexico	162.0	0.660	
Western tropical Pacific	166.0	0.250	
Japan	169.0	0.564	
Mexico	173.0	0.660	
Hawaii	190.0	0.454	
Japan	191.0	0.327	-1.02

Females predominate in the longline catch of yellowfin tuna in the New Zealand EEZ (0.75 males:females).

3. STOCKS AND AREAS

Yellowfin tuna in New Zealand waters are part of the western and central Pacific Ocean stock that is distributed throughout the North and South Pacific Ocean west of about 150ºW.

4. ENVIRONMENTAL AND ECOSYSTEM CONSIDERATIONS

This summary is from the perspective of yellowfin tuna but there is no directed fishery for them.

4.1 Role in the ecosystem

Yellowfin tuna (*Thunnus albacares*) are epi-pelagic opportunistic predators of fish, crustaceans and cephalopods generally found within the upper few hundred meters of the ocean. Yellowfin 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 fish bycatch

Observer records indicate that a wide range of species are landed by the longline fleets in New Zealand fishery waters. Blue sharks are the most commonly landed species (by number), followed by Ray's bream (Table 7).

Table 7: Total estimated catch (numbers of fish) of common bycatch species in the New Zealand longline fishery as estimated from observer data from 2011 to 2015. Also provided is the percentage of these species retained (2015 data only) and the percentage of fish that were alive when discarded, N/A (none discarded).

Species	2012	2013	2014	2015	% retained (2015)	discards % alive (2015)
Blue shark	132 925	158 736	80 118	72 480	0.3	87.0
Rays bream	19 918	13 568	4 591	17 555	95.3	13.7
Lancetfish	7 866	19 172	21 002	12 962	0.2	44.6

Table 7 (Continued)

Species	**2012**	**2013**	**2014**	**2015**	**% retained (2015)**	**discards % alive (2015)**
Porbeagle shark	7 019	9 805	5 061	4 058	5.1	64.0
Moonfish	2 363	2 470	1 655	3 060	95.6	45.5
Mako shark	3 902	3 981	4 506	2 667	16.1	72.2
Butterfly tuna	713	1 030	699	1 309	86.9	11.1
Pelagic stingray	712	1 199	684	979	0.0	97.2
Dealfish	372	237	910	842	0.4	22.9
Sunfish	3 265	1 937	1 981	770	0.0	100.0
Escolar	2 181	2 088	656	653	82.5	71.4
Oilfish	509	386	518	584	46.7	83.3
Deepwater dogfish	647	743	600	545	2.3	88.3
Rudderfish	491	362	327	373	26.9	78.9
Thresher shark	246	256	261	177	0.0	53.3
Skipjack tuna	123	240	90	150	10.0	n/a
Striped marlin	124	182	151	120	10.0	55.6
School shark	477	21	119	88	43.5	76.9
Big scale pomfret	108	67	164	59	32.5	96.3

4.3 Benthic interactions
N/A

4.4 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

With the establishment of WCPFC in 2004, stock assessments of the WCPO stock of yellowfin tuna are undertaken by the Oceanic Fisheries Programme (OFP) of Secretariat of the Pacific Community (SPC) under contract to WCPFC.

No assessment is possible for yellowfin within the New Zealand EEZ as the proportion of the stock found within New Zealand fisheries waters is unknown and likely varies from year to year.

The yellowfin stock assessment was updated by the SPC in 2014 in SC10-SA-WP-04 (Davies et. al. 2014) and reviewed by the WCPFC Scientific Committee (SC10) in August 2014. In addition SC10-SA-IP-01 (Harley et. al. 2014) summarized the major changes to the tropical tuna stock assessments resulting from the recommendations provided in SC8-SA-WP-01 (Independent Review of the 2011 bigeye tuna stock assessment). Also, status quo stochastic projections were provided for yellowfin tuna in SC10-SA-WP-06 (Pilling 2014).

The following is a summary of the 2014 yellowfin stock assessment as agreed by the WCPFC Scientific Committee (SC10) in August 2014.

Some of the main improvements in the 2014 assessment are:

- Increases in the number of spatial regions to better model the tagging and size data;
- Inclusion of catch estimates from Vietnam and some Japanese coastal longline data previously not included;
- The use of operational longline data for multiple fleets to better address the contraction of the Japanese fleet and general changes over time in targeting practices;
- 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

The large number of changes since the 2011 assessment (some of which are described above), and the nature of some of these changes, means that full consideration of the impacts of individual changes is not possible. Nevertheless, the report details some of the steps from the 2011 reference case (LLcpueOP_TWcpueR6_PTTP) to the 2014 reference case (run37 – Ref.Case). Distinguishing features of the 2014 reference case model include:

- The steepness parameter of the stock recruitment relationship is fixed at 0.8.
- Long-term average recruitment is defined for the period 1965-2011.
- Natural mortality at age is fixed according to an external analysis in which it is assumed that the natural mortality rate of females increases with the onset of reproductive maturity.
- The likelihood function weighting of the size data is determined using an effective sample size for each fishing observation of one-twentieth of the actual sample size, with a maximum effective sample size of 50.
- For modelling the tagging data, a mixing period of 2 quarters (including the quarter of release) is applied.
- The last four quarterly recruitments aggregated over regions are assumed to lie on the stock-recruitment curve.

The rationale for these choices, which comprise the key areas of uncertainty for the assessment, is described in detail in the report. We report the results of "one-off" sensitivity models to explore the impact of these choices for the reference case model on the stock assessment results. A sub-set of key, plausible model runs was taken from these sensitivities to include in a structural uncertainty analysis (grid) for consideration in developing management advice.

The main conclusions of the current assessment are consistent with recent assessments presented in 2009 and 2011. The main conclusions are as follows

1. The new regional structure appears to work well for yellowfin, and in combination with other modelling and data improvements, provides a more informative assessment than in the past.

2. Spatially-aggregated recruitment is estimated to decline in the early part of the assessment, but there is no persistent trend post-1965.

3. There appears to be confounding between the estimates of regional recruitment distribution and movement such that certain regions have very low recruitments. While adding complexity to the recruitment process of age 1 fish, this did not add to the uncertainty over the range of runs considered in this assessment.

4. Latest catches marginally exceed the maximum sustainable yield (MSY).

5. Recent levels of fishing mortality are most likely below the level that will support the MSY.

6. Recent levels of spawning potential are most likely above (based on 2008-11 average and based on 2012) the level which will support the MSY.

7. Recent levels of spawning potential are most likely above (based on 2008-11 average and based on 2012) the LRP of 20%$SB_{F=0}$ agreed by WCPFC.

8. Recent levels of spawning potential are most likely higher (by 1%, based on 2008-11 average) and lower than (by 2% based on 2012) the candidate biomass-related TRPs currently under consideration for skipjack tuna, i.e., 40-60%$SB_{F=0}$.

9. Stock status conclusions were most sensitive to alternative assumptions regarding the modelling of tagging data, assumed steepness and natural mortality. However the main conclusions of the assessment are robust to the range of uncertainty that was explored.

Paper SC10-SA-WP-06 (Pilling 2014) contained status quo stochastic projections for bigeye, skipjack, and yellowfin tunas. The paper outlined an assessment of the potential consequences of recent (2012) fishing conditions on the future biological status of the three tropical tuna stocks, based on the 2014 tropical tuna stock assessments. Projected status in 2032 was reported relative to spawning biomass and fishing mortality reference levels in absolute terms (as a median of the projection outcomes) and in probabilistic terms.

A single assessment model run (the reference case model for each tropical tuna stock) was used as the basis for projecting future stock status. Only uncertainty arising from future recruitment conditions was therefore captured in the results, using two alternative hypotheses: where recruitment was assumed to follow the estimated stock recruitment relationship on average with randomly selected deviates from the period used to estimate the relationship in each stock assessment; or was assumed to be consistent with actual recruitments estimated over the period 2002-2011.

Under 2012 conditions, stochastic projection results indicated that for yellowfin tuna it was exceptionally unlikely (<1%) that the yellowfin stock would fall below the LRP level or that fishing mortality would increase above the F_{MSY} level by 2032, and dependent upon the future recruitment assumption, it was exceptionally unlikely (<1%; long-term recruitment deviate assumption) or very unlikely (<10%; recent recruitment assumption) to fall below SB_{MSY}.

Stock status and trends

There have been significant improvements to the 2014 stock assessment resulting from the implementation of the 2012 bigeye review recommendations which apply equally to yellowfin tuna. Improvements were made to regional and fisheries structures, catch estimates, CPUE, and tagging data inputs, and the MULTIFAN-CL modelling framework. This assessment is also the first since the adoption of a LRP based on the spawning biomass in the absence of fishing ($0.2SB_{F=0}$).

SC10 selected the reference case which had an assumed steepness of 0.8 to represent the stock status of yellowfin. To characterize uncertainty in the assessment, SC10 chose 3 additional models based on alternate values of steepness and tagging mixing period. Fuller details of the base case and other models are provided in Table 8.

Table 8: Description of the base case and key model chosen for the provision of management advice.

Name	Description
Base Case	JP longline CPUE for regions 1 and 2, all flags longline for regions 3 to 7, and all flags longline nominal for regions 8 and 9; with purse-seine CPUE for PH-ID in region 7 and all flags in region 8. Size data weighted as the number of samples divided by 20, steepness fixed at 0.8, M fixed, tag mixing period of 2 quarters, and fixed natural mortality.
h_0.65	Steepness=0.65.
h_0.95	Steepness=0.95.
Mix_1qtr	Tag mixing period=1 quarter

Time trends in estimated recruitment, biomass, fishing mortality and depletion are shown in Figures 14-18.

High levels of fishing mortality on juveniles have been recorded in region 7 (Figure 9). Stock depletion levels are higher in the equatorial regions than elsewhere, refer Figure 7.

The estimated MSY of 586,400 mt (Table 9) is within the range of previous assessments and model quantities are generally similar with these earlier assessments (Table 10). This is due largely to the consistent information on declining relative abundance provided by the longline CPUE indices and the large amount of tagging data input to the model.

The dramatic decline in the MSY in the 1970's follows the increased development of those fisheries that catch younger yellowfin, principally the small-fish fisheries in the west equatorial region (Figure 10).

Fishing mortality has generally been increasing through time, and for the reference case $F_{current}$ (2008-11 average) is estimated to be 0.72 times the fishing mortality that will support the MSY. Across the four models (base case and three sensitivity models) $F_{current}/F_{MSY}$ ranged from 0.58 to 0.90. This indicates that overfishing is not occurring for the WCPO yellowfin tuna stock, however latest catches are close to or exceed the MSY by up to 13% (Table 9 and Figure 8).

The latest (2012) estimates of spawning biomass are above both the level that will support the *MSY* (SB_{latest}/SB_{MSY} = 1.24 for the base case and range 1.05-1.51 across the four models) and the newly adopted LRP of $0.2SB_{F=0}$ ($SB_{latest}/SB_{F=0}$ = 0.38 for the base case and range 0.35-0.40.

Table 9: Estimates of management quantities for selected stock assessment models (see Table 17 for details). For the purpose of this assessment, "current" is the average over the period 2008–2011 and "latest" is 2012.

	Ref.Case	Mix_1	h_0.65	h_0.95
MSY (mt)	586400	526400	527200	642800
C_{latest}/MSY	1.02	1.12	1.13	0.93
$F_{current}/F_{MSY}$	0.72	0.87	0.9	0.58

Table 9 [Continued]

	Ref.Case	Mix_1	h_0.65	h_0.95
B_0	4319000	3862000	4475000	4221000
$B_{current}$	1994655	1597536	1996179	1995224
SB_0	2467000	2202000	2557000	2411000
SB_{MSY}	728300	648000	859600	594500
$SB_{F=0}$	2368557	2206510	2556733	2255523
$SB_{current}$	998622	746743	999474	998914
SB_{latest}	899496	770210	899362	898389
$SB_{current}/SB_{F=0}$	0.42	0.34	0.39	0.44
$SB_{latest}/SB_{F=0}$	0.38	0.35	0.35	0.4
$SB_{current}/SB_{MSY}$	1.37	1.15	1.16	1.68
SB_{latest}/SB_{MSY}	1.24	1.19	1.05	1.51

Table 10: Comparison of selected WCPO yellowfin tuna reference points from the 2009, 2011, and 2014 base case models.

Management quantity	Ref.case-2009	Ref.case-2011	Ref.case-2014
MSY	636,800	538,800	586,400
$F_{current}/F_{MSY}$	0.58	0.77	0.72
$SB_{latest}/SB_{F=0}$	0.50	0.44	0.38

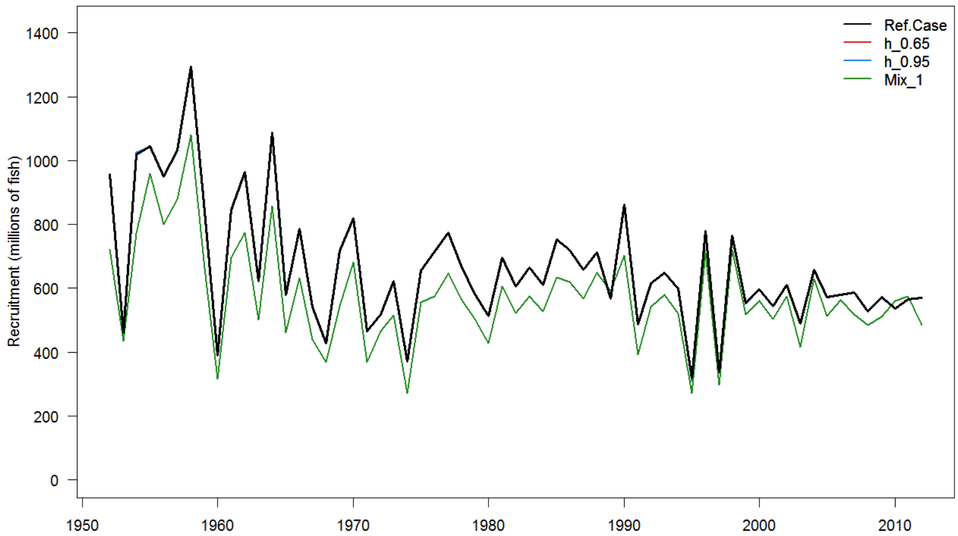


Figure 4: Estimated annual average recruitment for the WCPO obtained from the base case model and three additional runs described in Table 17. The model runs with alternative steepness values give the same recruitment estimates.

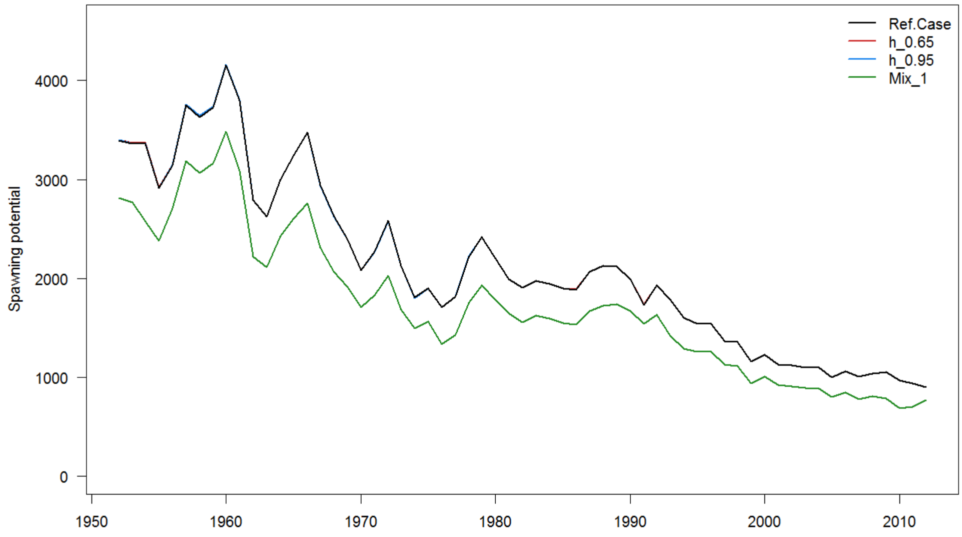


Figure 5: Estimated annual average spawning potential for the WCPO obtained from the base case model and three additional runs described in Table 17. The model runs with alternative steepness values give the same recruitment estimates.

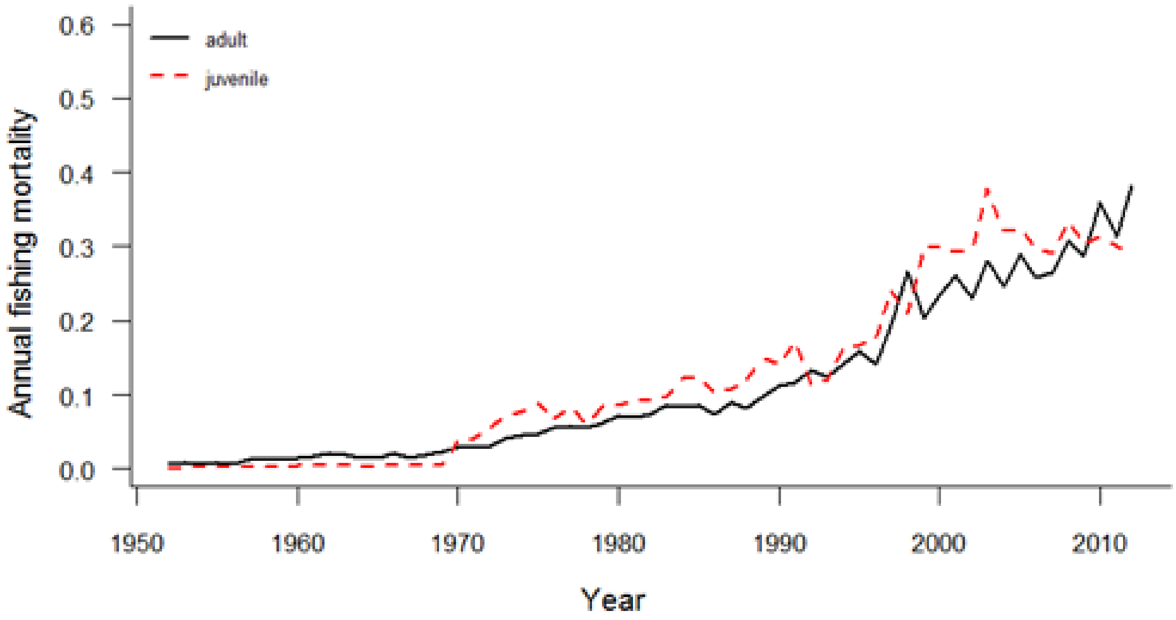


Figure 6: Estimated annual average juvenile and adult fishing mortality for the WCPO obtained from the base case model.

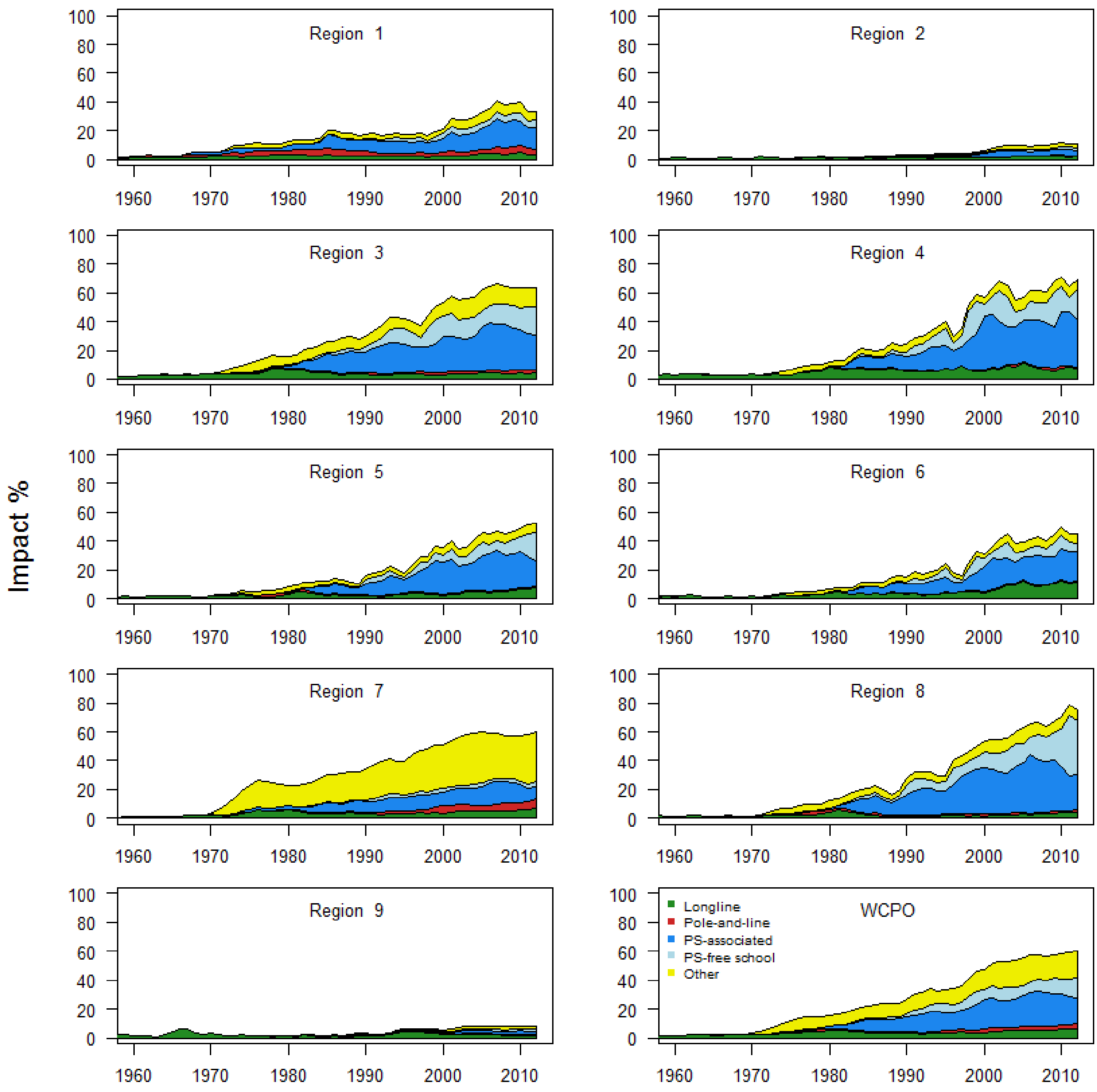


Figure 7: Estimates of reduction in spawning potential due to fishing (fishery impact = 1-$SB_t/SB_{t,F=0}$) by region and for the WCPO attributed to various fishery groups for the base case model.

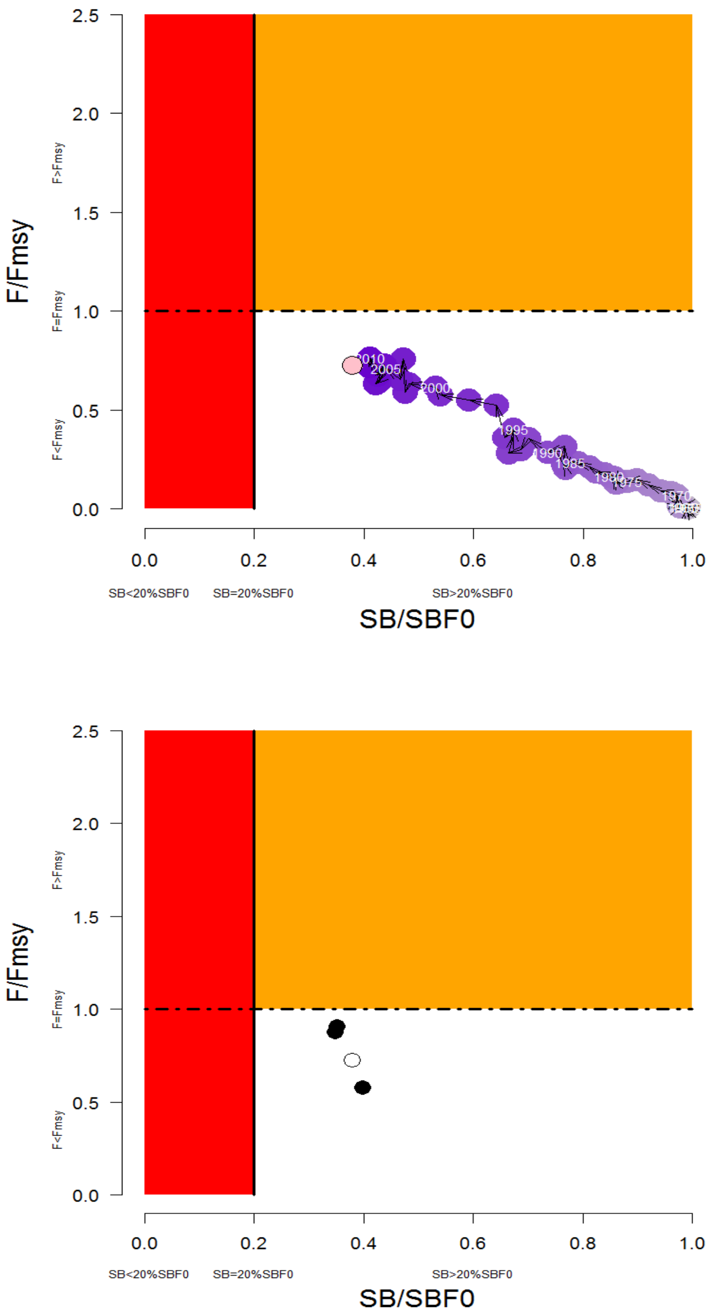


Figure 8: Temporal trend for the base case model (top) and terminal condition for the base case and other sensitivity runs (bottom) in stock status relative to $SB_{F=0}$ (x-axis) and F_{MSY} (y-axis). The red zone represents spawning potential levels lower than the agreed LRP which is marked with the 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 pink circle (top panel) is $SB_{2012}/SB_{F=0}$ (where $SB_{F=0}$ was the average over the period 2002-2011). The bottom panel includes the base case (white dot) and sensitivity analyses described Table 17.

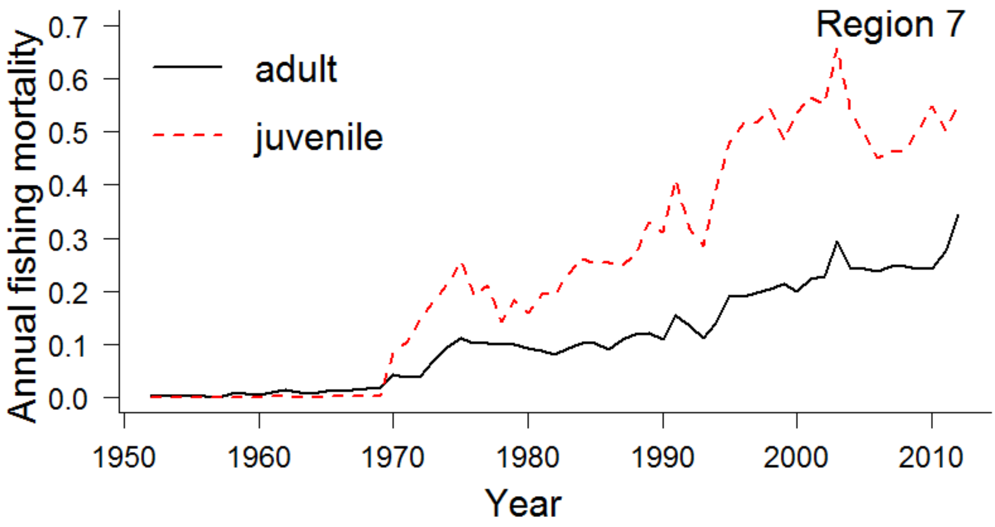


Figure 9: Estimated annual average juvenile and adult fishing mortality for the region 7 of the assessment obtained from the base case model.

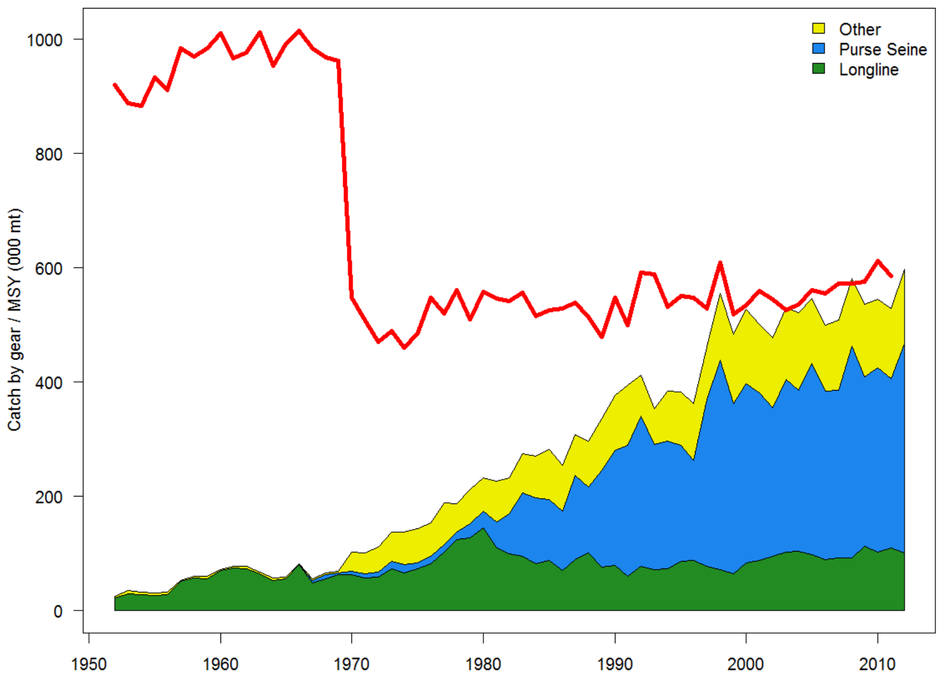


Figure 10: History of annual estimates of MSY compared with catches of three major fisheries for the base case model.

SC12 noted that no stock assessment was conducted for WCPO yellowfin tuna in 2016. Therefore, the stock status description from SC10 is still current. For further information on the stock status and trends from SC10, please see http://www.wcpfc.int/node/19472

SC12 noted that the total yellowfin catch in 2015 was 605,963 mt, a 2% increase over 2014 and a 7% increase over the average for 2010-14.

Purse seine yellowfin catch in 2015 was 15% lower than that in 2014 and effort was 21% lower. Longline catch in 2015 was 2% lower than that in 2014, and tropical longline effort (20N-10S) was 4% lower. Catches of other gears increased by 47% from 2014 to 2015.

SC12 noted that the results of the updated short-term projections using actual catch and effort levels in 2013¬¬-2015 indicated that the projected median spawning biomass depletion (SB/SBF=0) of yellowfin showed an increasing trend since 2012. SC12 also noted that the projected median spawning biomass depletion of yellowfin in 2016 was SB2015/SBF=0 = 0.49.

Management Advice and Implications

The WCPO yellowfin spawning biomass is above the biomass-based LRP WCPFC adopted, $0.2SB_{F=0}$, and overall fishing mortality appears to be below F_{MSY}. It is highly likely that stock is not experiencing overfishing and is not in an overfished state.

Latest (2012) catches (612,797mt (SC10-GW-WP-01)) of WCPO yellowfin tuna marginally exceed the MSY (586,400mt).

Future status under status quo projections (assuming 2012 conditions) depends upon assumptions on future recruitment. When spawner-recruitment relationship conditions are assumed, spawning biomass is predicted to increase and the stock is exceptionally unlikely (0%) to become overfished (SB_{2032}<$0.2SB_{F=0}$) or to fall below SB_{MSY}, nor to become subject to overfishing ($F>F_{MSY}$). If recent (2002-2011) actual recruitments are assumed, spawning biomass will remain relatively constant, and the stock is exceptionally unlikely (0%) to become overfished or to become subject to overfishing, and it was very unlikely (2%) that the spawning biomass would fall below SB_{MSY}.

The SC also noted that levels of fishing mortality and depletion differ between regions, and that fishery impact was highest in the tropical region (regions 3, 4, 7, 8 in the stock assessment model). The WCPFC could consider measures to reduce fishing mortality from fisheries that take juveniles, with the goal to increase to maximum fishery yields and reduce any further impacts on the spawning potential for this stock in the tropical regions.

WCPFC could consider a spatial management approach in reducing fishing mortality for yellowfin.

The SC recommend that the catch of WCPO yellowfin should not be increased from 2012 levels which exceeded MSY and measures should be implemented to maintain current spawning biomass levels until the Commission can agree an appropriate TRP.

SC12 noted that no management advice has been provided since SC10. Therefore, the advice from SC10 should be maintained, pending a new assessment or other new information. For further information on the management advice and implications from SC10, please see http://www.wcpfc.int/node/19472

5.1 Estimates of fishery parameters and abundance

There are no fishery-independent indices of abundance for the yellowfin tuna stock. Relative abundance information is available from standardized indices of longline catch per unit effort data. Returns from large scale tagging programmes undertaken in the early 1990s and 2000s also provide information on rates of fishing mortality which in turn leads to improved estimates of abundance.

5.2 Biomass estimates

These estimates apply to the WCPO portion of the stock or an area that is approximately equivalent to the waters west of 150°W. The stock assessment results and conclusions of the 2014 assessment show $SB_{current}$ / SB_{MSY} estimated at 1.37 over the period 2008-2011. Spawning biomass for the WCPO is estimated to have declined to about 38% of its initial level by 2012.

5.3 Yield estimates and projections

No estimates of MCY and CAY are available.

5.4 Other yield estimates and stock assessment results

SC10 achieved consensus to accept and endorse the reference case proposed in the assessment document, and that $SB_{20\%,F=0}$ be used as the LRP for stock status purposes as agreed by WCPFC. There was further discussion about whether to use SB_{latest} or $SB_{current}$ as the terminal spawning biomass for management purposes. The SC agreed to use the most recent information on spawning biomass, SB_{latest} corresponding to 2012. At 0.38 $SB_{F=0}$ SB_{latest} is above the limit reference point.

SC10 also endorsed the use of the candidate biomass-related target reference point (TRP) currently under consideration for skipjack tuna, i.e., 40-60% $SB_{F=0}$. At 0.38 $SB_{F=0}$ SB_{latest} is slightly below the target reference point.

5.5 Other factors

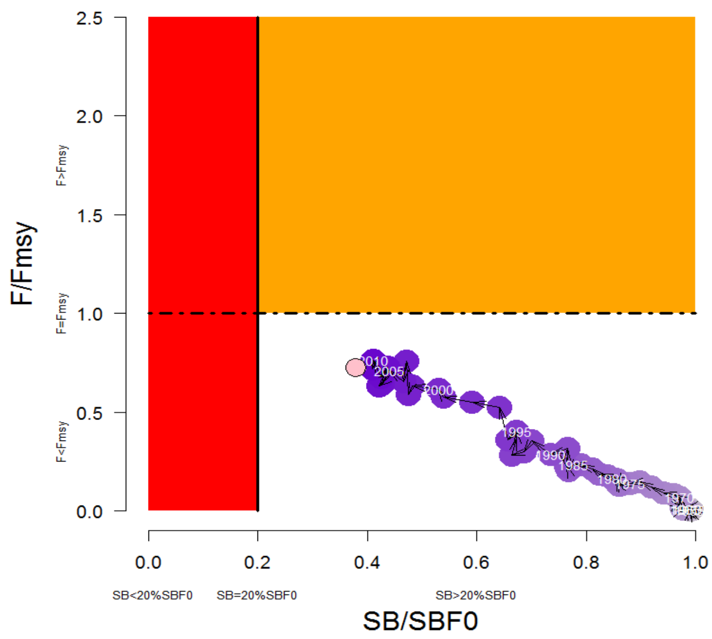
It is thought that large numbers of small yellowfin tuna are taken in surface fisheries in Indonesia and the Philippines. There are considerable uncertainties in the exact catches and these lead to uncertainties in the assessment. Programmes are in place to improve the collection of catch statistics in these fisheries.

6. STATUS OF THE STOCKS

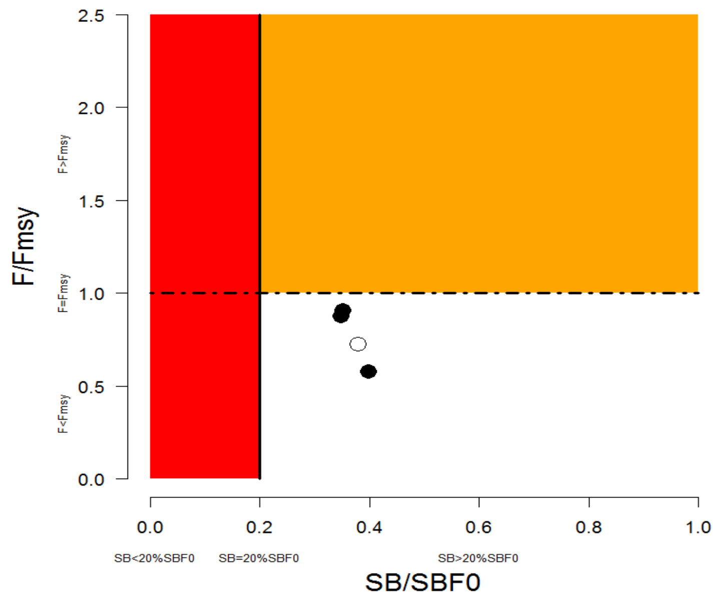
Stock structure assumptions

Western and Central Pacific Ocean

Stock Status	
Year of Most Recent Assessment	2014
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 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	Recent levels of spawning biomass are About as Likely as Not (40-60%) to be at or above the lower end of the range of 40-60% SB_0 (based on both the 2008-11 average and the 2012 estimate). Likely (> 60%) that $F < F_{MSY}$
Status in relation to Limits	Soft Limit: Very Unlikely (< 10%) to be below Hard Limit: Exceptionally Unlikely (< 1%) to be below
Status in relation to Overfishing	Overfishing is Unlikely (< 40%) to be occurring
Historical Stock Status Trajectory and Current Status	



Temporal trend for the base case model (top) The red zone represents spawning potential levels lower than the agreed LRP which is marked with the solid black line (0.2$SB_{F=0}$). The orange region is for fishing mortality greater than F_{MSY} ($F=F_{MSY}$; marked with the black dashed line). The pink circle is $SB_{2012}/SB_{F=0}$ (where $SB_{F=0}$ was the average over the period 2002-2011).



Terminal condition for the base case and other sensitivity runs (bottom) 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 (0.2$SB_{F=0}$). The orange region is for fishing mortality greater than F_{MSY} ($F=F_{MSY}$; marked with the black dashed line). The pink circle (top panel) is $SB_{2012}/SB_{F=0}$ (where $SB_{F=0}$ was the average over the period 2002-2011). This graph includes the base case (white dot) and sensitivity analyses described Table 17.

Fishery and Stock Trends	
Recent trend in Biomass or Proxy	Biomass has been reduced steadily over time reaching a level of about 38% of unexploited biomass in 2012. However, depletion is higher in the equatorial region 4 where recent depletion levels are approximately 0.31 for spawning biomass (a 69% reduction from the unexploited level) and 0.24 in region 8.

Recent Trend in Fishing Intensity or Proxy	Fishing mortality has increased over time but is estimated to be lower than F_{MSY} in all cases.
Other Abundance Indices	-
Trends in Other Relevant Indicator or Variables	Spatially-aggregated recruitment is estimated to have declined in the early part of the assessment, but there is no persistent trend post-1965. The analysis suggests that the substantial declines in spawning potential are being driven primarily by the fishing impacts rather than long-term declines in recruitment. However, recent recruitment is estimated to be slightly lower than the long-term average (by approximately 6%).

Projections and Prognosis	
Stock Projections or Prognosis	Stochastic projection results indicated that for yellowfin tuna it was Exceptionally Unlikely (< 1%) that the yellowfin stock would fall below the LRP level or that fishing mortality would increase above the F_{MSY} level by 2032.
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Soft Limit: Very Unlikely (< 10%) Hard Limit: Exceptionally Unlikely (< 1%)
Probability of Current Catch or TACC causing Overfishing to continue or commence	Exceptionally Unlikely (< 1%)

Assessment Methodology and Evaluation		
Assessment Type	Level 1: Quantitative Stock assessment	
Assessment Method	The assessment uses the stock assessment model and computer software known as MULTIFAN-CL.	
Assessment Dates	Latest assessment: 2014	Next assessment: Unknown
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	This assessment includes improved purse seine catch estimates; reviews of the catch statistics of the component fisheries; standardised CPUE analyses of operational level catch and effort data; size data inputs from the purse seine and longline fisheries; revised regional structures and fisheries definitions; preparation of tagging data and reporting rate information	1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	Changes to the data from the 2011 assessment included: - Increases in the number of spatial regions to better model the tagging and size data; - Inclusion of catch estimates from Vietnam and some Japanese coastal longline data previously not included;	

	- The use of operational longline data for multiple fleets to better address the contraction of the Japanese fleet and general changes over time in targeting practices; - 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	Estimated recruitments appear to be uncertain for the terminal time period (2012) as was indicated by the retrospective analyses, with the final recruitment estimate in each retrospective model altering as more data were added. The values of absolute abundance differ among the assessments due to a number of factors including changes in model structure, assumptions, input data and the MULTIFAN-CL software.

Qualifying Comments
-

Fishery Interactions
Interactions with protected species are known to occur in the longline fisheries of the South Pacific, particularly south of 25°S. Seabird bycatch mitigation measures are required in the New Zealand, Australian EEZ's and through the WCPFC Conservation and Management Measure (CMM2007-04). Sea turtles also get incidentally captured in longline gear; the WCPFC is attempting to reduce sea turtle interactions through Conservation and Management Measure (CMM2008-03). Shark bycatch is common in longline fisheries and largely unavoidable; this is being managed through New Zealand domestic legislation and to a limited extent through Conservation and Management Measure (CMM2010-07).

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. (2002) Annual Report of the Inter-American Tropical Tuna Commission. IATTC, La Jolla, California. 148 p.

Anon (2003) Report of the 16th meeting of the Standing Committee on Tuna and Billfish. www.spc.int.

Anon. (2006) The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean. Scientific Committee Second regular session, 7–18 August 2006, Manila, Philippines. Kolonia Pohnpei. 252 p.

Anon. (2007) Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean: Scientific Committee Summary report. Western and Central Pacific Fisheries Commission, Pohnpei, Federated States of Micronesia. 244 p.

Anon (2013) Tuna fishery yearbook 2012. Western and Central Pacific Fisheries Commission, 154 p.

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, *12 November 2013*.

CMM2010-07 (2010) Conservation and Management measure for sharks, for the Western and Central Pacific Ocean. CMM2010-07 of the Western and Central Pacific Fisheries Commission.

Davies, N; Harley, S; Hampton, J; McKechnie, S (2014) Stock assessment of yellowfin tuna in the western and central Pacific Ocean Rev 1. WCPFC-SC10-2014/SA-WP-4.

Griggs, L H; Baird, S J (2013) Fish bycatch in New Zealand tuna longline fisheries 2006–07 to 2009–10. *New Zealand Fisheries Assessment Report 2013/13*. 71 p.

Hampton, J; Kleiber, P; Langley, A; Hiramatsu, K (2004) Stock assessment of yellowfin tuna in the western and central Pacific Ocean, SCTB17 Working Paper SA–1. www.spc.int.

Hampton, J; Kleiber, P; Langley, A; Takeuchi, Y; Ichinokawa, M (2005) Stock assessment of yellowfin tuna in the western and central Pacific Ocean. SC-1 SA-WP-1. First meeting of the WCPFC-Scientific Committee, 8–19 August 2005, Noumea, New Caledonia.

Hampton, J; Langley, A; Harley, S; Kleiber, P; Takeuchi, Y; Ichinokawa, M (2005) Estimates of sustainable catch and effort levels for target species and the impacts on stocks of potential management measures. SC-1 SA-WP-10. First meeting of the WCPFC-Scientific Committee, 8–19 August 2005, Noumea, New Caledonia.

Hampton, J; Langley, A; Kleiber, P (2006) Stock assessment of yellowfin tuna in the western and central Pacific Ocean, including an assessment of management options. WCPFC-SC2-2006/SA WP-1 . Second meeting of the WCPFC-Scientific Committee, 7-18 August 2006, Manila, Philippines. (www.wcpfc.org/).

Harley, S; Davies, N; Rice, J; McKechnie, S; Hampton, J (2014) Summary of major changes in the 2014 tropical tuna stock assessments. WCPFC-SC10-2014/SA-IP-01.

Holdsworth, J; Saul, P (2003) New Zealand billfish and gamefish tagging 2001–02. *New Zealand Fisheries Assessment Report 2003/15*, 39 p.

Itano, D G (2000) The reproductive biology of yellowfin tuna (*Thunnus albacares*) in Hawaiian waters and the western tropical Pacific Ocean. SOEST Publication 00-01, University of Hawaii, 69 p.

Koido, T; Suzuki, Z (1989) Main spawning season of yellowfin tuna, *Thunnus albacares*, in the western tropical Pacific Ocean based on gonad index. *Bulletin of the Far Seas Fisheries Research Laboratory* 26: 153–163.

Langley, A; Harley, S; Hoyle, S; Davies, N; Hampton, J; Kleiber, P (2009) Stock assessment of yellowfin tuna in the western and central Pacific Ocean. Report to the Western and Central Pacific Fisheries Commission Scientific Committee WCPFC-SC5-2009/SA-WP-03. 120 p.

Langley, A; Hoyle, S; Hampton, J (2011) Stock assessment of yellowfin tuna in the western and central Pacific Ocean. Report to the Western and Central Pacific Fisheries Commission Scientific Committee WCPFC-SC7-2011/SA-WP-03. 134 p.

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 (2014) Aquatic Environment and Biodiversity Annual Review 2014. Compiled by the Fisheries Management Science Team, Ministry for Primary Industries, Wellington, New Zealand. 560 p.

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

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

Pilling, G M; Harley, S J; Davies, N; Rice, J; Hampton, J (2014) Status quo projections for bigeye, skipjack, and yellowfin tunas. WCPFC-SC10/SA-WP-06.

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 (2014) 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.

Richard, Y; Abraham, E R (2015). Assessment of the risk of commercial fisheries to New Zealand seabird, 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.

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.)

Williams, P; Terawasi, P (2011) Overview of the tuna fisheries in the western and central Pacific Ocean, including economic conditions – 2010. Report to the Western and Central Pacific Fisheries Commission Scientific Committee WCPFC-SC7-2011/GN-WP-01. 51 p.

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