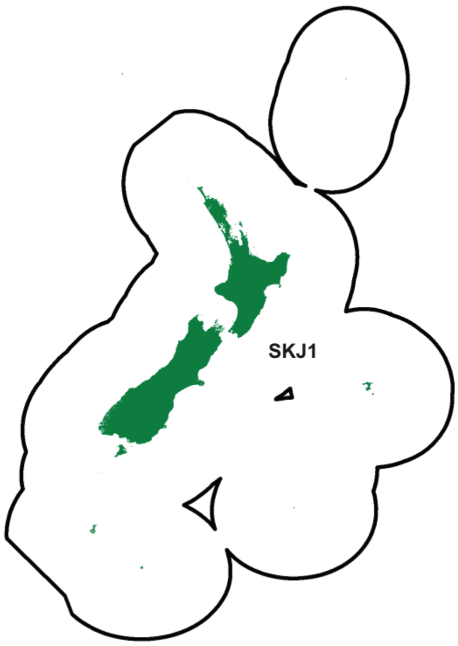
SKIPJACK TUNA (SKJ)

(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.

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 (<1%) are taken by other gear types (especially troll). The purse seine fishery for most of its history has been based on a few (4 to 5 medium sized vessels < 400 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 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 have averaged about 7400 t annually between 2001 and 2008. Catches in the New Zealand EEZ are variable and can approximate 10 000 t in a good season such as 1999/00, 2003/04, 2004/05, 2006/07 and 2007/08.

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 and longline fishing effort for SKJ fisheries.

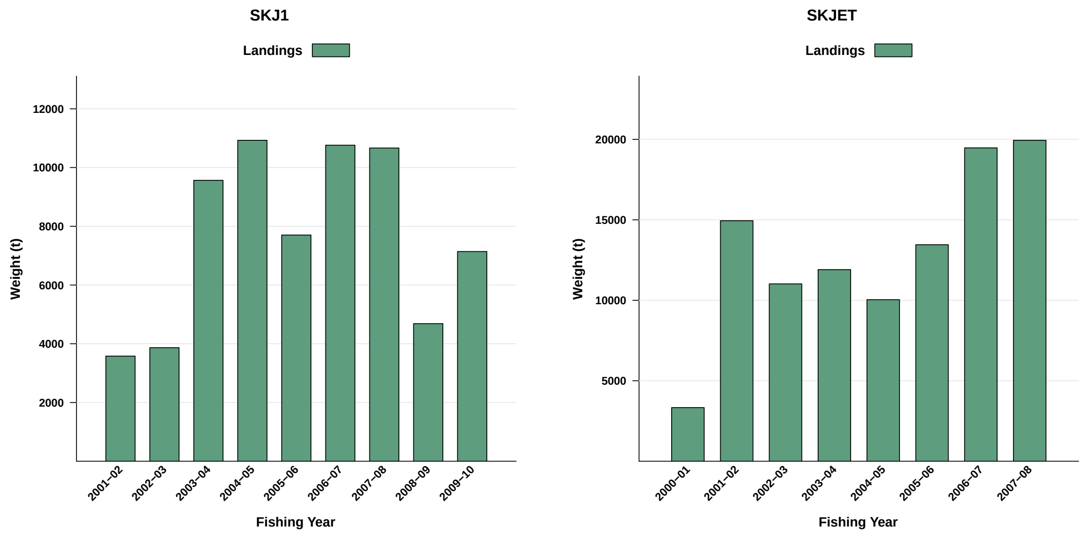


Figure 1: Skipjack purse seine catch from 2001-02 to 2009-10within NZ waters (SKJ1), and 2000-01 to 2007-08 in the equatorial Pacific by New Zealand vessels.

Catches from within New Zealand fisheries waters are very small (0.5% average for 2007-2009) compared to those from the greater stock in the WCPO. Catches by New Zealand flagged vessels in the WCPO are larger (1.2% average for 2007-2009).

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 2009.

	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	1,140,407
2002	3,555	15,827	19,382	1,316,865
2003	3,828	14,769	18,597	1,305,667
2004	9,704	10,932	20,636	1,402,583
2005	10,819	8,335	19,154	1,490,778
2006	6,671	18,178	24,849	1,563,079
2007	11,120	20,484	31,604	1,672,996
2008	9,057	17,324	26,381	1,622,008
2009	4,385	21,180	25,565	1,789,979

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

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	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	4 739
2009/10			8,020	8 020

The catch of skipjack within New Zealand fisheries waters comes predominantly from FMAs 1 and 9, with lesser amounts from FMAs 2, 7 and 8.

1.2 Recreational fisheries

Recreational fishers using rod and reel regularly catch skipjack tuna particularly in FMA 1, FMA 2 and FMA 9. They do not comprise part of the voluntary recreational tag and release programme and there is limited information on the size of the recreational catch. Much of the recreational skipjack catch is used as bait.

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.

2. BIOLOGY

Skipjack tuna are epi-pelagic opportunistic predators of fish, crustaceans and cephalopods found within the upper few hundred meters 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 that 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 maximum values for age 1 skipjack and M 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 area and size of skipjack studied (Table 3). 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.

Table 3: The range in L_∞ and k by country or area.

L_∞ (cm)	k	Country/Area
84.6 to 102.0	1.16 to 0.55	Hawaii
79.0 to 80.0	1.10 to 0.95	Indonesia

144.0	0.185	Japan
65.0 to 74.8	0.92 to 0.52	Papua New Guinea
72.0 to 84.5	0.70 to 0.51	Philippines
104.0	0.30 to 0.43	Taiwan
62.0	1.10	Vanuatu
61.3	1.25	Western Pacific
65.1	1.30	Western tropical Pacific

3. STOCKS AND AREAS

Surface-schooling, adult skipjack tuna (>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.

4. STOCK ASSESSMENT

Recent stock assessments of the western and central Pacific Ocean stock of skipjack tuna have been undertaken by the Oceanic Fisheries Programme of Secretariat of the Pacific Community (OFP) under contract to WCPFC.

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

The most recent stock assessment of the WCPO stock of skipjack tuna was conducted in 2010 and reviewed by the WCPFC Scientific Committee in August 2010. The executive summary of the stock assessment report is provided below (from Hoyle et al. 2010).

"The assessment uses the stock assessment model and computer software known as MULTIFAN-CL. The skipjack tuna model is age (16 quarterly age-classes) and spatially structured. The catch, effort, size composition, and tagging data used in the model are grouped into 17 fisheries (a change from the 24 fisheries used in the 2008 assessment) and quarterly time periods from 1972 through 2009.
The current assessment incorporates a number of changes from the 2008 assessment, including:

1. Updated catch and size data;
2. Updated Japanese tagging data which now includes Japanese tags released in the southern regions. The final runs of the current assessment did not include tag releases and recoveries from the recent SPC-PTTP tagging programmes, but these data were considered during the assessment development.
3. A revised (and considerably different) standardised effort series for each region was included based on a new GLM analysis of catch and effort data from the Japanese distant-water pole-and-line fishery.
4. A new 3 region spatial structure which effectively condensed the previous multiple northern regions into a single northern region and imposed two equatorial regions that cover similar areas to the equatorial regions in the bigeye and yellowfin stock assessments (although they extend further south to 20S).

In addition to these changes, a large suite of additional models were run to aid the development of the final base model, which is considered the most plausible model and therefore the model upon which management advice should be based. The sensitivity of the base model to key assumptions (i.e. regarding the stock recruitment relationship, natural mortality, cpue time series, and purse seine catch data) were explored via sensitivity analyses. The results of these analyses should also be considered when developing management advice.

A number of trends in key data inputs were noted as particularly influential for the assessment results. For the northern region, there was little contrast in the Japanese pole and line CPUE time-series. However, both the southern region Japanese pole and line CPUE time series showed declines, with greater decline in region 2. This contrasts strongly with the trends apparent in the previous assessment, and is the main reason for the somewhat different results.

The large tagging data set, and associated information on tag reporting rates, is relatively informative regarding stock size. The relative sizes of fish caught in different regions are also indicative of trends in stock size, mediated though growth, total mortality, and movement rates.

Overall, the main assessment results and conclusions are as follows.

1. As with other tropical tunas, estimates of natural mortality are strongly age-specific, with higher rates estimated for younger skipjack.
2. The model estimates significant seasonal movements between all three regions. The performance of the fishery in the eastern region has been shown by other studies to be strongly influenced by the prevailing environmental conditions with higher stock abundance and/or availability associated with El Niño conditions (Lehodey et al. 1997). This is likely to be at least partly attributable to an eastward displacement of the skipjack biomass due to the prevailing oceanographic conditions, although this interaction is not explicitly parameterised in the current model.
3. Recruitment showed an upward shift in the mid-1980s and is estimated to have remained at a higher level since that time. Recruitment in the eastern equatorial region is variable, with recent peaks in recruitment occurring in 1998 and 2004‒2005 following strong El Niño events around that time. Conversely, the lower recruitment in 2001‒2003 followed a period of sustained La Nina conditions. Recruitment since 2005 is estimated to have dipped and then recovered, but the most recent years are poorly determined due to limited observations from the fishery.
4. The biomass trends are driven by both fishing mortality and recruitment. The highest biomass estimates for the model period occurred in 1988-1990 and in 1998‒2001, immediately following periods of high recruitment. Very high recruitment is estimated to have occurred in 2004-2006, but biomass has been constrained by higher catches. The model results suggest that recent skipjack population biomass has been lower than previously observed.
5. The biomass trajectory is influenced by the underlying assumptions regarding the treatment of the various fishery-specific catch and effort data sets within the model. The Japanese pole-and-line fisheries are all assumed to have constant catchability, with any temporal trend in efficiency assumed to have been accounted for by the standardization of the effort series. The estimated CPUE trends are influential regarding the general trend in both recruitment and total biomass over the model period. For all regions, there is a good fit to the observed CPUE data. This indicates reasonable consistency between the CPUE series and the other sources of data within the assessment model.
6. The model also incorporates a considerable amount of tagging data that provides information concerning absolute stock size during the main tag recovery period. For the equatorial regions, the most informative data in the model are from an intensive tagging programme that ceased in the early 1990s with most tag recoveries occurring over the following 18 months. This tagging programme occurred prior to the expansion of the fishery in region 3 in the mid–late 1990s and, consequently, given the low exploitation rates, fewer tags were recovered from this region. On this basis, the level of absolute biomass in region 3 is likely to be less well determined than for region 2.
7. Data from the recent SPC-PTTP tagging program were included in preliminary runs of the current assessment model, but the data need further preparation before they can be fully integrated. Analyses of the SPC-PTTP data outside the assessment model were consistent with the conclusions of this assessment.

8. Within the equatorial region, fishing mortality increased throughout the model period and is estimated to be highest in the western region in the most recent years. The impact of fishing is predicted to have reduced recent (2005-2008) biomass by about 50% in the western equatorial region and 25% in the northern and eastern regions. For the entire stock, the depletion is estimated to be approximately 40%.

9. A range of sensitivity analyses undertaken indicate that the main conclusions of the assessment are relatively insensitive to most of the model assumptions investigated.

10. ***Based on estimates of*** $F_{current}/\widetilde{F}_{MSY}$ ***and*** $B_{current}/\widetilde{B}_{MSY}$ ***from the base model and associated sensitivity grid, it is concluded that overfishing of skipjack is not occurring in the WCPO, nor is the stock in an overfished state.*** These conclusions appear relatively robust, at least within the statistical uncertainty of the current assessment. Although the current (2005-2008) level of exploitation is well below that which would provide the maximum sustainable yield, recent catches have increased strongly and the mean catch for 2005-2008 of 1.4 million tonnes is equivalent to the estimated MSY at the assumed steepness of 0.75. The maximum yield at the somewhat higher recruitment levels of the past ten years (1999-2008), and assuming steepness of 1, is 1.8 million tonnes. Fishing mortality and recruitment variability, influenced by environmental conditions, will both continue to affect stock size and fishery performance."

4.1 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 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. Data from the recent Pacific Tuna Tagging Programme will be incorporated in the next stock assessment (scheduled for 2011).

Fishing mortality for the juvenile skipjack is very low in all regions, although it has tended to increase slightly over time within the western component of the equatorial WCPO. This is mainly due to the steady increase in catch from the Philippines fishery. For adult skipjack, fishing mortality rates vary considerably between regions. Fishing mortality rates are highest in the western equatorial region and are estimated to have increased considerably over the last five years. For the eastern component of the equatorial WCPO, fishing mortality rates for adult skipjack remained relatively low until recent years. Since 2007, fishing mortality rates in the eastern region are estimated to have increased in line with the higher catches taken from the area.

4.2 Biomass estimates

The biomass trajectories are largely driven by the trends in the pole-and-line CPUE indices. The indices have remained relatively stable and to account for the increasing total catch the stock assessment model estimated an upward shift in recruitment during the mid-1980s. Recruitment is estimated to have remained at a higher level since that time..

4.3 Estimation of Maximum Constant Yield (MCY)

No estimates of MCY are available.

4.4 Estimation of Current Annual Yield (CAY)

No estimates of CAY are available.

4.5 Other yield estimates and stock assessment results

Though no reference points have yet been agreed by the WCPFC, stock status conclusions are generally presented in relation to two criteria. The first relates to "overfished" which compares the current biomass level to that necessary to produce the maximum sustainable yield. The second relates to "over-fishing" which compares the current fishing mortality rate to that which would move the stock towards a biomass level necessary to produce the maximum sustainable yield. The first criteria is similar to that required under our own Fisheries Act while the second has no equivalent in our legislation and relates to how hard a stock can be fished.

Because recent catch data are often unavailable, these measures are calculated based on the average fishing mortality/biomass levels in the 'recent past', e.g. 2005-2008 for the 2010 assessment. The assessment included a wide range of sensitivities to key assumptions. Some key reference points for the range of model sensitivities are presented in Table 4.

Table 4: Key reference points for skipjack tuna.

MSY (t)	$SSB_{current}/SSB_{MSY}$	$F_{current}/F_{MSY}$
1 200 800 – 1 767 600	2.16 – 3.37	0.11 – 0.61

Recent catches were comparable to the upper limit of the range of estimates of MSY and were considerably higher than the lower range of plausible MSY estimates. The estimates of MSY are sensitive to the assumptions regarding the steepness of the stock-recruitment relationship and current yields are consistent with recent (above average) levels of recruitment.. Spawning biomass (SSB) was estimated to be about 2-3 times the level necessary to produce MSY and, by definition, well above the overfished threshold. The ratio of $F_{current}$ compared with F_{MSY} (the fishing mortality level that would produce the MSY under equilibrium conditions) is below 1 indicating that recent fishing mortality rates were at a sustainable level.Fishing mortality rates were estimated to have increased considerably in the last two years but still remain well below the F_{MSY} level.

4.6 Other factors

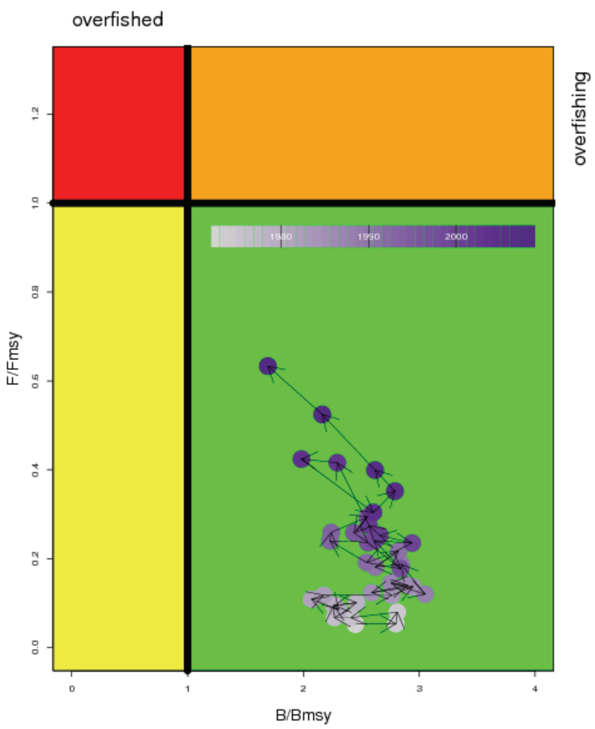
One area of concern with fisheries for skipjack tuna relates to the potential for significant bycatch of juvenile bigeye and yellowfin tunas in the purse seine fishery in equatorial waters. Juveniles of these species occur in mixed schools with skipjack tuna broadly through the equatorial Pacific Ocean,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

5. STATUS OF THE STOCKS

Stock structure assumptions
Skipjack tuna are considered to be a single stock in the WCPO but the assessment presented below is limited to the area north of 20°S and, hence, does not include the component of the fishery within New Zealand waters.

Stock Status	
Year of Most Recent Assessment	A full stock assessment was conducted in 2010.
Reference Points	Target: $B>B_{MSY}$ and $F<F_{MSY}$ Soft Limit: Not established by WCPFC; but evaluated using HSS default of 20%B_0. Hard Limit: Not established by WCPFC; but evaluated using HSS default of 10%B_0.
Status in relation to Target	Very Likely to be above B_{MSY} and Very Likely that $F<F_{MSY}$
Status in relation to Limits	Soft Limit: Very Unlikely to be below Hard Limit: Very Unlikely to be below
Historical Stock Status Trajectory and Current Status	



Temporal trend in annual stock status for skipjack tuna, relative to BMSY (x-axis) and FMSY (y-axis) reference points, for the model period (1972–2009) from the equatorial model. The colour of the points is graduated from mauve (1972) to dark purple (2009).

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Biomass increased in the mid 1980's and fluctuated about the higher level over the subsequent period, before declining in the two most recent years (2008, 2009). Recent depletion levels are estimated at 0.40 (i.e. 0.6 of the unfished level).
Recent Trend in Fishing Mortality or Proxy	F is estimated to have remained well below F_{MSY} over the history of the fishery, although the level of fishing mortality has increased considerably over the last 5 years.
Other Abundance Indices	
Trends in Other Relevant	Recruitment showed an upward shift in the mid-1980s and is

Indicator or Variables	estimated to have fluctuated about the higher level since that time. Recruitment in the eastern equatorial region is considerably more variable with recent peaks in recruitment occurring in 1998 and 2004−2005 following strong *El Niño* events around that time. Conversely, the lower recruitment in 2001−2003 followed a period of sustained *La Nina* conditions.

Projections and Prognosis	
Stock Projections or Prognosis	Recent catches are above the MSY level but have been supported by above average recruitment. If recruitment returned to long-term average levels then the current level of catches would reduce the biomass to below B_{MSY}. Conversely, current catches are likely to be sustainable if recruitment remains at the recent average level.
Probability of Current Catch or TACC causing decline below Limits	Soft Limit: Unknown Hard Limit: Unlikely

Assessment Methodology		
Assessment Type	Level 1: Quantitative Stock assessment	
Assessment Method	The assessment uses the stock assessment model and computer software known as MULTIFAN-CL.	
Main data inputs	The skipjack tuna model is age (16 quarterly age-classes, i.e. 4 years) and spatially structured, and the catch, effort, size composition and tagging data used in the model are classified by 24 fisheries and quarterly time periods from 1972–2009.	
Period of Assessment	Latest assessment: 2010	Next assessment: 2011
Changes to Model Structure and Assumptions	The 2010 assessment represented a considerable revision of the previous (2008) assessment with changes to the spatial structure of the model and key data sets, in particular the standardised CPUE indices from the Japanese pole-and-line fishery.	
Major Sources of Uncertainty	A range of sensitivity analyses were undertaken to investigate key sources of uncertainty in the model, including steepness, natural mortality, and catch history. The key conclusions of the stock assessment, in particularly the current stock status, are robust to the range of assumptions investigated. However, there remains considerable uncertainty regarding the utility of the Japanese pole-and-line CPUE indices as an index of stock abundance.	

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 substantially increased the catch of bigeye and yellowfin and has contributed to the biomass decline of these two species. Sea turtles also get incidentally captured in purse seine nets and FAD's; the WCPFC is attempting to reduce sea turtle interactions through Conservation and Management Measure (CMM2008-03). Mortality of whale sharks, basking sharks and whales, that act as FADs and are caught in purse seine nets, is known to occur, but the extent of this is currently unknown.

6. FOR FURTHER INFORMATION

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