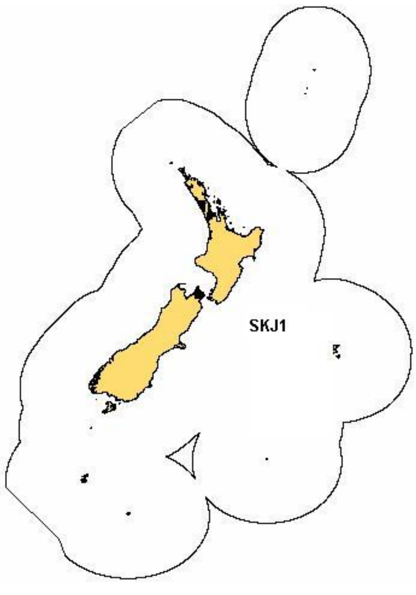
SKIPJACK TUNA (SKJ)

(Katsuwonus pelamis)
Aku



1. FISHERY SUMMARY

Management of skipjack tuna throughout the Western and Central Pacific Ocean (WCPO) will be the responsibility of the Western and Central Pacific Fisheries Commission (WCPFC). Under this regional convention New Zealand will be responsible for ensuring that the management measures applied within New Zealand fisheries waters are compatible with those of 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 always been predominantly a purse seine fishery although landings by other gear types (especially troll) are made. 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 in FMA 1, FMA 2 and occasionally FMA 9 during summer months. Since 2001, however, New Zealand companies have purchased 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 almost 7000 t annually since 2002. This increase is due, in part, to the fishing by these large capacity super seiners fish within the EEZ. Catches in the New Zealand EEZ are variable and even without the increased capacity of recent years can exceed 10 000 t in a good season (peak year was 1999/00 when 10 561 t were landed and landings in 2003/04 were 9 225 t).

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.

Table 1: Reported 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 2002 to 2007.

	NZ landings (t)			All WCPO Landings
Year	Within NZ fisheries waters	Outside NZ fisheries waters*	Total	Total landings (t)
2002	3321	13 591	16 912	1 312 532
2003	4035	14 520	18 555	1 314 787
2004	9424	10 865	20 288	1 403 856
2005	10 656	10 746	21 402	1 504 414
2006	7247	19 588	26 835	1 565 553
2007	13 944	15 678	29 622	1 696 803

*Includes some catches taken in the EEZs of other countries under access agreements.
Source: Ministry of Fisheries Licensed Fish Receiver Reports, MHR data, High Seas reporting system, Solander Fisheries Ltd, and the Lawson (2008).

Catches from within New Zealand fisheries waters are very small (0.4% average for 2005-2007) compared to those from the greater stock in the WCPO. Catches by New Zealand flagged vessels in the WCPO are larger (1.6% average for 2003-2005).

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	5769	
1989/90	6627	3972	
1990/91	7408	5371	
1991/92	1000	988	
1992/93	1189	946	
1993/94	3216	3136	
1994/95	1113	861	
1995/96	4214	4520	
1996/97	6303	6571	
1997/98	7325	7308	
1998/99	5690	5347	
1999/00	11 035	10 561	
2000/01	4697	4020	
2001/02	3726	3487	3581
2002/03	4581	2826	3868
2003/04	10 305	9225	9606
2004/05	10 201	7575	10 201
2005/06	7 713	7702	7702
2006/07	11 834	10 761	10 762

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 Maori customary fisheries

There is no information on the customary take, but it is considered to be low. Skipjack tuna are referred to as aku in Maori.

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 residence 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). In 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. 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. 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.

4. STOCK ASSESSMENT

With the establishment of WCPFC in 2004, future (beginning in 2005) stock assessments of the western and central Pacific Ocean stock of skipjack tuna will be 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 likely varies from year to year.

The most recent assessment was in 2008 for the WCPO stock of skipjack tuna that used the statistical, age-based, catch at length stock assessment model known as MULTIFAN-CL. A summary of the 2008 assessment undertaken by OFP and reviewed by the WCPFC Scientific Committee in August 2008 is provided below (from Langley and Hampton 2008).

““The assessment uses the stock assessment model and computer software known as MULTIFAN-CL. The skipjack tuna model is age (16 age-classes) 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 1952 through 2007.

The catch, size and tagging data used in the assessment were updated from the 2005 assessment. A large amount of tagging data was integrated in the assessment model, although the current assessment does not include tag releases and recoveries from the recent PNG and Solomon Islands tagging programmes. For each region, a standardised effort series was calculated from a GLM analysis of catch and effort data from the Japanese distant-water pole-and-line fishery. The standardized effort series were scaled among regions by the overall CPUE from the region and the size of the region (regional weighting factors).

The assessment was conducted at two spatial scales: the entire WCPO stratified into six regions and a model restricted to the two regions encompassing the equatorial WCPO. A number of sensitivity analyses were conducted using the WCPO model.

All WCPO model options estimated a large biomass in the regions north of the equatorial area (regions 1−4), at least relative to the level of catch from these regions. This is most pronounced for regions 3 and 4 which account for 12% and 24% of the total biomass, respectively, while catches from these regions are negligible. This is attributable to the assumption of pole-and-line catchability being equivalent between all regions and the relatively high regional weighting factors associated with these two regions – despite the low catch from these regions, the overall regional pole-and-line CPUE was high and the regions are relatively large. Consequently, these two regions carry significant weight in the overall assessment.

For these northern regions (1−4), there are insufficient data included in the model to reliably estimate levels of regional stock abundance. For each region, there is little or no contrast in the time-series of CPUE data, with the possible exception of a decline in CPUE for the JPDW PL 2 fishery. Further, while there is a considerable number of tag releases and, in some regions, tag recoveries, there is no information available regarding the reporting rates for the corresponding fisheries and, consequently, the tag data are uninformative regarding stock size. In the absence of informative data at the regional level, the assessment model is gaining information on the relative stock size for these northern regions largely from the estimate of (shared) catchability from the equatorial regions, mediated by the regional scaling factors.

For the WCPO models, the current estimates of total abundance and the corresponding estimates of yield and MSY-related management quantities are extremely uncertain and may be considerably inflated by the high levels of biomass in the northern regions. The *equatorial* model, which encompasses the domain of the main fisheries within the WCPO, represents a more robust assessment given that it is not sensitive to the assumptions applied to the northern regions of the WCPO model. The large tagging data set, and associated information on tag reporting rates, is relatively informative regarding stock size in the two constituent regions of the *equatorial* model. On that basis, the *equatorial* model was adopted as the principal assessment and, consequently, the scope of the key conclusions is limited to the equatorial region of the WCPO skipjack fishery. These conclusions are essentially unchanged from the last three assessments, as follows.

1. The growth estimates are in general agreement with perceived length-at-age estimates of skipjack from the Pacific and other regions. Moreover, the model seemed to be able to make a consistent interpretation of the size data, which is crucial to a length-based approach. Discrepancies between the estimated growth curve and age−length observations for tagged skipjack might be due to the tropical surface fisheries selecting mainly the smaller, slower growing skipjack from the older age-classes.

2. Similar to other tropical tunas, estimates of natural mortality are strongly age-specific, with higher rates estimated for younger skipjack.

3. The *equatorial* model estimates significant seasonal movements between the western and eastern equatorial regions. The performance of the fishery in the eastern region has been shown 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 dynamic is unlikely to be captured by the parameterisation of movement in the current model.

4. 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 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. Recent recruitment is estimated to be at an historically high level, but is poorly determined due to limited observations from the fishery.

5. The biomass trends are driven largely by recruitment. The highest biomass estimates for the model period occurred in 1998−2001 and in 2005−2007, immediately following periods of sustained high recruitment within the eastern equatorial region (region 6). The model results suggest that the skipjack population in the equatorial region of the WCPO in recent years has been considerably higher (about 40%) than the overall average level for the model period.

6. 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. For all the principal Japanese pole-and-line fisheries, there is a significant increase in standardized CPUE in the late 1980s and early 1990s and the increase is particularly pronounced in the equatorial regions. The increase in CPUE, and the high CPUE for the subsequent period, is influential regarding the general trend in both recruitment and total biomass over the model period. For some regions, most notably region 5, there is a relatively poor fit to the observed CPUE data, particularly during the period when the CPUE series increased rapidly. This indicates a degree of conflict between the CPUE series and the other sources of data, especially the size data, within the assessment model. It remains unclear whether the standardized CPUE indices represent a reliable index of stock abundance.

7. 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 recent data included 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. Consequently, there has been no direct information on the level of absolute biomass from the equatorial component of the stock for at least a decade. Further, the tagging programme occurred prior to the expansion of the fishery in region 6 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 6 is likely to be less well determined than for region 5. The data from recent tagging programmes within PNG and Solomon Islands waters should be integrated into the stock assessment as a matter of urgency.

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 biomass by about 40% in the western equatorial region and 20% in the eastern region.

9. The principal conclusions are that skipjack is currently exploited at a moderate level relative to its biological potential. Furthermore, the estimates of $F_{current}/\tilde{F}_{MSY}$ and $B_{current}/\tilde{B}_{MSY}$ reveals 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. Recruitment variability, influenced by environmental conditions, will continue to be the primary influence on stock size and fishery performance.

10. The range of sensitivity analyses undertaken were restricted to the WCPO wide model and, therefore, are not directly relevant to the *equatorial* model. Nonetheless, the main conclusions of the assessment appeared relatively insensitive to a number of the model assumptions investigated. However, a crucial assumption is the distribution of recruitment between model regions in the broader WCPO assessment. There are insufficient data to estimate this reliably within the assessment model and many of the key model outputs of the WCPO models are likely to be strongly influenced by the values assumed."

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. 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.

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. For the eastern component of the equatorial WCPO, fishing mortality rates for adult skipjack have steadily increased over the model period consistent with the increase in total catch. Since the early 1990s, there has also been a general increase in fishing mortality rates in west, although exploitation rates are much lower than the east due to the higher overall level of biomass in west.

4.2 Biomass estimates

The biomass trends are driven largely by recruitment. The highest biomass estimates for the model period occurred in 1983-88 and 1998-2000, immediately following periods of sustained high recruitment. The model results suggest that the skipjack population in the WCPO in recent years has been considerably higher (about 20%) than the overall average level for the model period.

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. 2001-2003 for the 2005 assessment. Some key reference points are presented in Table 4.

Table 4: Key reference points for skipjack tuna.

Model	MSY (t)	$SSB_{current}/SSB_{MSY}$	$F_{current}/F_{MSY}$
Four scenarios	1 304 000 – 2 656 000	3.20 – 5.00	0.08 – 0.34

The range of estimates of MSY are generally higher than recent catches. Spawning biomass (SSB) was estimated (point estimate) to be about three times the level necessary to produce MSY. The ratio larger than 1.0 indicates that the stock has not yet reached an over-fished state. The ratio of $F_{current}$ compared with F_{MSY} (the fishing mortality level that would keep the stock at MSY) is well below 1 (about 0.1) indicating that current fishing mortality levels are very low.

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 are set on. The fishery in New Zealand fisheries waters is conducted on non-mixed schools.

5. STATUS OF THE STOCKS

The 4th meeting of the WCPFC the Scientific Committee provided the following summary on the status of the stock (Anon 2008):

"The major conclusions of the skipjack assessment are essentially unchanged from the last three assessments (2002, 2003, and 2005) and Table 2 compares reference points between the 2008 and 2005 assessments. According to the key conclusions of the models presented, overfishing is not occurring and the stock is not in an overfished state. These conclusions are similar to the model runs from the 2005 base-case assessment. Depletion levels estimated in the 2005 WCPO assessment (0.86) were similar to the current equatorial model (0.66), $F_{current}/\tilde{F}_{MSY}$ was more optimistic (0.17 for 2005 compared to 0.26) and $B_{current}/\tilde{B}_{MSY}$ was essentially the same (3.01 for 2005 compared to 2.99, Table 2, Figure 9). There is a zero probability that $B_{current}/\tilde{B}_{MSY}$ is below to 1.0.

The SC acknowledged that skipjack catches in 2007 increased to a historical high of ~1.7 million t. The SC noted the increasing trend in estimated recruitment throughout the entire time series of the fishery. This trend may reflect skipjack's high productivity relative to other tuna species and its position in the ecosystem. These high recent catches are considered to be sustainable unless recruitment falls persistently below the long-term average. However, any increases in purse-seine catches of skipjack may result in a corresponding increase in fishing mortality for bigeye and yellowfin tunas.

The SC noted the increasing trend in recruitment throughout the fisheries' time series and the likely impact this trend has on the sustainability of current high catch levels. The SC discussed one potential ecological mechanism or theory to explain the increase in estimated biomass (and estimated recruitment) of skipjack tuna, despite the high catch levels. That theory suggests that the high productivity of the skipjack tuna stock might have allowed it to increase its component of the overall environment carrying capacity, during the period in which the biomass of top predators (e.g. shark, billfish, other tuna) has declined."

There are currently no concerns relating to the current status of this stock though there are concerns that any increases in fishing effort on this stock could adversely bigeye and yellowfin tuna. New

Zealand catches represent 1.5% of the total catch. The stock is presently above the level necessary to produce the maximum sustainable yield. Current catches from the stock are likely to be sustainable. Current catches will move the stock towards a size that will support the maximum sustainable yield.

6. FOR FURTHER INFORMATION

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

Anon. 2008. Commission or 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. 234pp.

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

Langley, A. and Hampton, J. 2008. Stock assessment of skipjack tuna in the Western and Central Pacific Ocean. Report to the Western and Central Pacific Fisheries Commission Scientific Committee WCPFC-SC4-2008/SA-WP-04. 74pp.

Langley, A., Hampton, J, and Ogura, M,. (2005). Stock assessment of skipjack tuna in the western and central Pacific Ocean. SC-1 SA-WP-4. First meeting of the WCPFC-Scientific Committee, 8-19 August 2005, Noumea, New Caledonia.

Langley, A., Ogura, M., and Hampton, J. (2003). Stock assessment of skipjack tuna in the western and central Pacific Ocean, SCTB16 Working Paper SKJ-1. www.spc.int.

Lawson, T.A. 2008. Western and Central Pacific Fisheries Commission Tuna Fishery Yearbook 2007. Western and Central Pacific Fisheries Commission, Pohnpei, Federated States of Micronesia. 203pp.