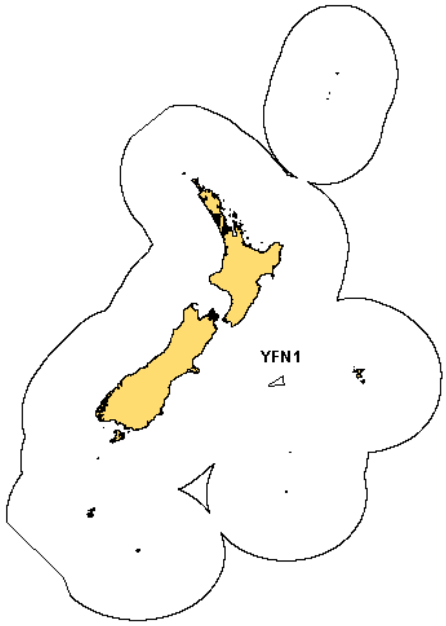
YELLOWFIN TUNA (YFN)

(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 Maori allowances, TACCs and TACs for yellowfin tuna.

Fishstock	Recreational Allowance	Maori customary 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) relating to conservation and management of tunas. Key aspects of this resolution were presented in the 2006 Plenary document. That measure was reviewed by the Scientific Committee (SC) and further recommendations were made such that at its third annual meeting (2006) the WCPFC passed a new CMM relating to conservation and management if yellowfin tuna (http://www.wcpfc.org/). Key aspects of this CMM are summarised as follows:

For hand-line, pole and line, purse seine fisheries north of 20ºN or south of 20ºS, ring-net, troll and unclassified fisheries Commercial Tuna Fisheries: beginning in 2007, CCMs (Cooperating Non-members, and Participating Territories) shall take necessary measures to ensure that the total capacity of their respective other commercial tuna fisheries for bigeye and yellowfin tuna, including purse-seining, but excluding artisanal fisheries and those fisheries taking less than 2000 t of bigeye and yellowfin, do not exceed the average level for the period 2001-2004 or 2004.

For purse seine (between 20°N and 20°S) fishing effort by their vessels in areas of the high seas does not exceed 2004 levels or the average of 2001-2004.

These measures will be reviewed annually and may be adjusted, considering the advice of the Scientific Committee concerning fishing mortality levels associated with maintaining the bigeye and yellowfin stocks at or above B_{MSY} in accordance with Article 5 in the Convention.

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 highly variable between years. 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).

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, and LFRR: Estimated landings from Licensed Fish Receiver Returns.

		YFN 1 (all FMAs)				
Fish Yr	JPNFL	KORFL	NZ	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			56.7	56.7	42.1	1.9
2002/03			39.7	39.7	-	2.1
2003/04			21.1	21.1	21.7	36.6
2004/05			36.1	36.1	35.4	6.0
2005/06			9.2	9.2	8.8	0.1
2006/07			17.3	17.3	19.7	0.5

Table 3: Reported total New Zealand within EEZ landings* and WCPO landings (t) of yellowfin tuna from 1991 to 2007.

Year	NZ landings (t)	WCPO landings (t)	Year	NZ landings (t)	WCPO landings (t)
1991	6	394 567	2000	107	424 097
1992	20	400 879	2001	137	420 955
1993	34	386 565	2002	25	403 923
1994	53	395 543	2003	41	437 147
1995	141	380 555	2004	57	370 349
1996	198	317 180	2005	40	433 914
1997	143	436 882	2006	14	437 197
1998	127	456 651	2007**	25	433 591
1999	154	398 646			

Source: Ministry of Fisheries Licensed Fish Receiver Reports, Solander Fisheries Ltd, Anon. 2006 and the WCPFC Yearbook 2004.
*New Zealand purse seine vessels operating in tropical regions also catch moderate levels of yellowfin tuna when fishing around Fish Aggregating Devices (FADs) and on free schools. These catches are not included here at this time as there are only estimates of catch based on analysis of observer data across all fleets rather than specific data for NZ vessels. Further, bigeye catches are combined with yellowfin catches on most catch effort forms.
**At the time of printing, NZ landings for 2007 were preliminary

Catches from within New Zealand fisheries waters are very small (0.02% average for 1999-2005) 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).

1.2 Recreational fisheries
Recreational fishers make regular catches of yellowfin tuna particularly during summer months and especially in FMA 1 and FMA 2 where the recreational fishery regularly targets yellowfin as far south as the Wairarapa coast.

While the magnitude of the recreational catch is unknown, yellowfin tuna rank as the fifth most commonly tagged and released species in the recreational fishery.

1.3 Maori customary 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 thought to escape 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 lengths 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 24-25ºC. Spawning takes place throughout the year but the main spawning season is November to April. Yellowfin are multiple 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 4).

Table 4: von Bertalanffy growth parameters for yellowfin tuna by country or area.

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

Females predominate in the longline catch of yellowfin tuna in the in the 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. STOCK ASSESSMENT

With the establishment of WCPFC in 2004, future (beginning in 2005) stock assessments of the WCPO stock of yellowfin 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 yellowfin 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.

A summary of the 2006 assessment undertaken by OFP and reviewed by the WCPFC Scientific Committee in August 2006 is provided below.

“The assessment uses the stock assessment model and computer software known as MULTIFAN-CL. The yellowfin tuna model is age (28 age-classes) and spatially structured (6 regions) and the catch, effort, size composition and tagging data used in the model are classified by 19 fisheries and quarterly time periods from 1952 through 2005.

Three independent analyses were conducted to test the impact of using different methods of standardising fishing effort in the main longline fisheries, using estimated or assumed values of natural mortality-at-age, and examining the effect of applying an incremental increase in effective fishing effort to mimic increased fishing efficiency.

The analyses conducted were (Hampton et al., 2006):

LOWSAMP Six-region spatial stratification, general linear model standardised effort for “main” longline fisheries, *M*-at-age assumed at fixed levels, lower effective sample size applied to the length and weight frequency samples.

HIGHSAMP Six-region spatial stratification, general linear model standardised effort for “main” longline fisheries, *M*-at-age assumed at fixed levels, higher effective sample size applied to the length and weight frequency samples. This analysis approximates the base-case model run (GLM-MFIX) from the 2005 assessment. The only significant difference is the parameterisation of the selectivity functions for the principal longline fisheries — allowing a decline in the selectivity for the oldest age classes.

7REGION Seven-region spatial stratification, general linear model standardised effort for “main” longline fisheries, *M*-at-age assumed at fixed levels, lower effective sample size applied to the length and weight frequency samples.

The LOWSAMP model was adopted as the base case because it was considered that the catch and effort data are more informative than the size-frequency data in the estimation of trends in fishing mortality."

Other sensitivities included in the 2005 assessment are not reported here (but see the 2006 Plenary document for details).

4.1 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 longline catch per unit effort data, though there is no agreement on the best method to standardise these. 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.

4.2 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 trend in biomass for the WCPO is largely driven by the biomass trend from the tropics i.e. region 3 (Hampton et al., 2006) (http://www.wcpfc.org/). "Biomass declines steadily during the early model period, remains relatively stable from the mid 1970s to mid 1990s, and then declines sharply (by about 40%) during the last decade. Depletion has increased steadily over time, reaching a level of 50% of unexploited biomass (a fishery impact of 50%) in 2004. This represents a moderate level of stock-wide depletion that is approaching the equivalent equilibrium-based limit reference point ($B_{MSY}/B_0 = 0.42$). If stock-wide over-fishing criteria were applied at the level of the model regions, it would be concluded that region 3 is over-exploited, region 4 is fully exploited, and the remaining regions are under-exploited.

The reference points that predict the status of the stock under equilibrium conditions are $B_{F\ current}/B_{MSY}$ (0.91) and $SB_{Fcurrent}/SB_{MSY}$ (0.87), which indicate that the long-term average biomass would approximate or fall below that capable of producing *MSY* at 2001−2004 average fishing mortality. Overall, current biomass exceeds the biomass yielding *MSY* ($B_{current}/B_{MSY} > 1.0$); i.e. **the yellowfin stock in the WCPO is not in an overfished state**. However, biomass levels in recent years have been declining under increasing levels of fishing mortality, and the probability of the stock becoming overfished is increasing over time. The estimate of $F_{current}/F_{MSY}$ reveals that **overfishing of yellowfin is likely to be occurring in the WCPO**. While the stock is not yet in an overfished state ($B_{current}/B_{MSY} > 1$), further biomass decline is likely to occur at 2001−2004 levels of fishing mortality.

Stock projections for 2006–2010 that attempt to simulate the conservation and management measures adopted at WCPFC2 indicate that the point estimate of B_t / B_{MSY} remains above 1.0 throughout the projection period. However, the increasing uncertainty in the future projections results in a greater probability of the biomass declining below B_{MSY} by the end of the projection period. The projections indicate a strong shift in the spatial distribution of biomass with continued depletion occurring in the equatorial regions."

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 reference point relates to "overfished" which compares the current biomass level to that necessary to produce the maximum sustainable yield (MSY). 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 MSY. The first criteria is similar to that required under the New Zealand 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.

Key reference points are in Table 5.

Table 5: Key reference points for yellowfin tuna.

Model	MSY	$SSB_{current}/SSB_{MSY}$	Prob($SSB_{current} < SSB_{MSY}$)	$F_{current}/F_{MSY}$	Prob($F_{current} > F_{MSY}$)
LOWSAMP	329 600	1.32	Low (but not reported)	1.11	High (but not reported)

The estimate of MSY is lower than recent catches. This is due to high fishing mortality and fishing down the stock to MSY-levels. In contrast to the 2004 assessment, spawning biomass (SSB) was estimated (point estimate) to be only 1.32 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 greater than 1.0 indicating that current fishing mortality levels are high and there very high chance that $F_{current}$ is actually greater than F_{MSY} and that over-fishing is occurring.

4.6 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.

5. STATUS OF THE STOCKS

The 3rd meeting of the WCPFC Scientific Committee provided the following summary on the status of the stock (Anon 2007):

> "The 2007 stock assessment conclusions differ slightly from the 2006 assessment, particularly in relation to the ratio of the current estimate of fishing mortality compared with the fishing mortality at maximum sustainable yield (F/F_{MSY}), with the threshold in the 2007 assessment being slightly more optimistic than that in the 2006 assessment. While the point estimate of F/F_{MSY} remains slightly less than 1.0 (0.95), the probability distribution associated with the fishing mortality-based reference point indicates that there is almost an equal probability that the value of F/F_{MSY} is less than or greater than the reference point. Therefore, the possibility of overfishing is still relatively high (47%). The reference points that predict the status of the stock under equilibrium conditions are B/B_{MSY} (1.10) and SB/SB_{MSY} (1.12), which indicate that the long-term average biomass would remain slightly above the level capable of producing MSY at 2002−2005 average fishing mortality. Overall, current biomass exceeds the estimated biomass at MSY ($B/B_{MSY} > 1.0$) indicating that the yellowfin stock in the WCPO is not in an overfished state, although there is a small probability (6.2%) that it is in an overfished state (Figs. 3−4). The change in the estimated MSY in 2007 from that in 2006 may reflect changes in the data structure, fishery designations and levels of uncertainty in the assessment, especially in estimating absolute values, and the change in the scenarios modeled between years.
>
> The attribution of depletion to various fisheries or groups of fisheries indicates that the Indonesian and Philippines domestic fisheries have the greatest impact, particularly in their home Region (3) and are contributing significantly to the impact in adjacent assessment Regions 1, 4 and 5 through fish movement. The purse-seine fishery also has a high impact in Regions 3 and 4 and accounts for a significant component (~40%) of the recent (2002−2005) impacts in all other Regions, except Region 6. It is notable that the composite longline fishery

is responsible for biomass depletion of about 10% in the WCPO during recent years and generally catches larger, older size classes, while purse-seine fisheries are responsible for a larger percentage of the impacts and generally the catch is smaller and younger fish.

The point estimate of the $F_{current}/F_{MSY}$ ratio (0.95) in the 2007 assessment was lower than the point estimate (1.11) in the 2006 assessment, where the "current" period is 2002–2005 for yellowfin stock assessment. This change is largely due to the new configuration of the fisheries, their updated size data, and the modeling improvements. However, the possibility of overfishing is still relatively high (47%).

The WCPO yellowfin tuna fishery can be considered to be fully exploited. Both the 2006 and 2007 assessments indicate that there is a high probability that overfishing is occurring (73% for the base case 2006 assessment and 47% for the base case 2007 assessment). In order to reduce the likelihood of overfishing, and if the Commission wishes to maintain average biomass at levels greater than 5% above B_{MSY}, reductions in the fishing mortality rate would be required (Fig. 5). The various levels of fishing mortality reduction required to maintain the biomass at specified levels above B_{MSY} (relative to the average levels for 2002–2005) are given in Figure 5.

Stock projections for 2007–2011, which attempt to simulate the conservation and management measures adopted at WCPFC2 and WCPFC3, indicate that the point estimate of B/B_{MSY} remains above 1.0 throughout the projection period. However, the increasing uncertainty in future projections is likely to result in an increased probability of the biomass declining below B_{MSY} by the end of the projection period."

New Zealand domestic catches represent 0.02% of the total WCPO catch (average 1999-2005). The stock size is presently above the level necessary to produce the maximum sustainable yield. Current catches from the stock are not sustainable. Current catches will move the stock towards and then below a size that will support the maximum sustainable yield.

6. FOR FURTHER INFORMATION

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

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 pp.

Anon. 2007. 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. 244pp.

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

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 and 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/).

Holdsworth, J.; Saul, P. (2003). New Zealand billfish and gamefish tagging 2001–02. *New Zealand FAR* 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.