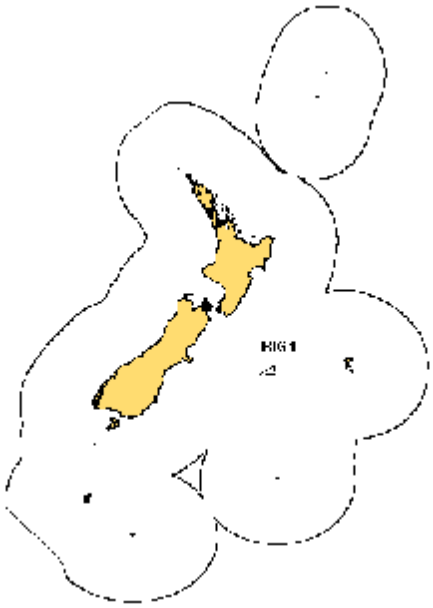
BIGEYE TUNA (BIG)
(Thunnus obesus)



1. FISHERY SUMMARY

Bigeye tuna were introduced into the QMS on 1 October 2004 under a single QMA, BIG 1, with allowances, TACC, and TAC as follows:

Fishstock	Recreational Allowance	Maori customary Allowance	Other mortality	TACC	TAC
BIG 1	8	4	14	714	740

Bigeye were added to the Third Schedule of the 1996 Fisheries Act with a TAC set under s14 because bigeye 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 bigeye stock 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.

At its second annual meeting the WCPFC passed a resolution relating to conservation and management measures for tunas. Key aspects of this resolution are repeated below.

For purse-seine fishing in the area of the Convention bounded by 20N and 20S:

- *CCMs[1] shall take necessary measures to ensure that purse seine effort levels do not exceed either 2004 levels, or the average of 2001 to 2004 levels, in waters under their national jurisdiction, beginning in 2006;*
- *The Commission shall implement compatible measures as required under Article 8 of the Convention, to ensure that purse seine effort levels do not exceed 2004 levels on the high seas in the Convention Area or the total fishing capacity will not increase in the Convention Area;*
- *CCMs shall develop management plans for the use of FADs (anchored and drifting) within waters under national jurisdiction which shall be submitted to the Commission.*

[1] CCMs refers to Members and Cooperating Non-Members of the WCPFC and includes New Zealand

For longline fishing in the Convention area:

- *The catch of bigeye for each CCM for the next 3 years shall not exceed the average annual bigeye catch for the years 2001-2004 or the year 2004 (for China and the USA);*
- *This does not apply to CCMs that caught less than 2,000 tonnes in 2004. Each CCM that caught less than 2,000 tonnes of bigeye in 2004 shall ensure that their catch does not exceed 2,000 tonnes in each of the next 3 years.*

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 BMSY in accordance with Article 5 in the Convention.

(a) Commercial fisheries

Commercial catches by distant water Asian longliners of bigeye tuna, in New Zealand fisheries waters, began in 1962 and continued under foreign license agreements until 1993. Bigeye were not a primary target species for these fleets and catches remained modest with the maximum catch in the 1980s reaching 680 t. Domestic tuna longline vessels began targeting bigeye tuna in 1990. There was an exponential increase in the number of hooks targeting bigeye before a plateau was reached at approximately 6.6 million hooks in 2000/01.

Catches from within New Zealand fisheries waters are very small (0.3% average for 1999-2003) compared to those from the greater stock in the WCPO. In contrast to New Zealand, where bigeye are taken almost exclusively by longline, 40% of the WCPO catches of bigeye are taken by purse-seine and other surface gears (e.g. ring nets).

Table 1: Reported total New Zealand within EEZ landings* (t) and landings from the Western and Central Pacific Ocean (t) of bigeye tuna by calendar year from 1991 to 2005.

Year	NZ landings (t)	Total landings (t)	Year	NZ landings (t)	Total landings (t)
1991	44	72 210	1999	421	118,477
1992	39	91 486	2000	422	109,794
1993	74	79 294	2001	480	107,121
1994	71	86 421	2002	200	124,285
1995	60	78 074	2003	205	114,735
1996	89	79 126	2004	185	119,472
1997	142	108 971	2005	174	Not available
1998	388	112 867			

Source: Ministry of Fisheries Licensed Fish Receiver Reports, Solander Fisheries Ltd, and the WCPFC Yearbook 2004.
*New Zealand purse seine vessel operating in tropical regions also catch small levels of bigeye when fishing around Fish Aggregating Devices (FAD. These catches are not included here at this time as the only estimates of catch are based on analysis of observer data across all fleets rather than specific data for NZ vessels. Bigeye catches are combined with yellowfin catches on most catch effort forms.

Table 2: Reported catches or landings (t) of bigeye 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.

	BIG 1 (all FMAs)					
Fish Yr	**JPNFL**	**KORFL**	**NZ**	**Total**	**LFRR**	**NZ ET**
1979/80	205.8			205.8		
1980/81	395.9	65.3		461.2		
1981/82	655.3	16.8		672.1		
1982/83	437.1	11.1		448.2		
1983/84	567.0	21.8		588.8		
1984/85	506.3	51.6		557.9		
1985/86	621.6	10.2		631.8		
1986/87	536.1	17.6		553.7		
1987/88	226.9	22.2		249.1		
1988/89	165.6	5.5		171.1	4.0	
1989/90	302.7		12.7	315.4	30.7	0.4
1990/91	145.6		12.6	158.2	36.0	0.0
1991/92	78.0		40.9	118.9	50.0	0.8
1992/93	3.4		43.8	47.2	48.8	2.2
1993/94			67.9	67.9	89.3	6.1
1994/95			47.2	47.2	49.8	0.5
1995/96			66.9	66.9	79.3	0.7
1996/97			89.8	89.8	104.9	0.2
1997/98			271.9	271.9	339.7	2.6
1998/99			306.5	306.5	391.2	1.4
1999/00			411.7	411.7	466.0	7.6
2000/01			425.4	425.4	578.1	13.6
2001/02			248.9	248.9	276.3	2.0
2002/03			196.1	196.1	195.6	0.6
2003/04			216.3	216.3	217.5	0.8
2004/05			162.3	162.3	159.8	0.7

(b) Recreational fisheries

Recreational fishers make occasional catches of bigeye tuna while trolling for other tunas and billfish, but the recreational fishery does not regularly target the species. There is no information on the size of catch.

(c) Maori customary fisheries

An estimate of the current customary catch is not available, but it is considered to be low.

(d) Illegal catch

There is no known illegal catch of bigeye tuna in the EEZ.

(e) Other sources of mortality

The estimated overall incidental mortality rate from observed longline effort is 0.23% of the catch. Discard rates are 0.34% on average from observer data, of which approximately 70% are discarded dead (usually because of shark damage). Fish are also lost at the surface in the longline fishery, 0.09% on average from observer data, of which 100% are thought to escape alive.

2. BIOLOGY

Bigeye tuna are epi-pelagic opportunistic predators of fish, crustaceans and cephalopods generally found within the upper few hundred meters of the surface. Tagged bigeye tuna have been shown to be capable of movements of over 4000 nautical miles over periods of one to several years. Juveniles and small adults school near the surface in tropical waters while adults tend to stay deeper. Individuals found in New Zealand waters are mostly adults. Adult bigeye tuna are distributed broadly across the Pacific Ocean, in both the northern and southern hemisphere and reach a maximum size of 210 kg and

maximum length of 250 cm. The maximum reported age is 11 years old and tag recapture data indicate significant numbers of bigeye reach at least 8 years old. Spawning takes place in the equatorial waters of the western Pacific Ocean in spring and early summer.

Natural mortality and growth rates are both estimated within the stock assessment. Natural mortality is assumed to vary with age with values about 0.5 for bigeye larger than 40 cm. A range of von Bertalanffy growth parameters has been estimated for bigeye in the Pacific Ocean depending on area. These are as follows:

L_∞ (cm)	K	t_0	Country
169.0	0.608		Mexico
187.0	0.380		French Polynesia
195.0	0.106	-1.13	Japan
196.0	0.167		Hawaii
222.0	0.114		Hawaii
220.0	0.183		Hawaii

3. STOCKS AND AREAS

There are insufficient data available to determine whether there are one or more stocks of bigeye tuna in the Pacific Ocean. The present information, based on tagging data, are summarized below. Up until the end of 2003 over 18,000 bigeye had been tagged in the Pacific Ocean, 8,074 in the WCPO and 10,336 in the eastern Pacific Ocean (EPO). A lower proportion of fish tagged in the WCPO (12.5% or about 1,000 fish) have been recovered compared to the EPO (39.3% or about 4060 fish). In each region approximately 95% of fish were recaptured within 1000 nm of the release point, which could be due to a combination of high fishing mortality and low movement rates. Of the over 5,000 recoveries, only four fish (<0.08%) have been reported recaptured after crossing the 150°W meridian. Thus, the best available data suggest minimal exchange of fish between the WCPO and EPO. Also, analysis of mtDNA and DNA microsatellites in nearly 800 bigeye tuna failed to reveal significant evidence of widespread population subdivision in the Pacific Ocean. For the purposes of stock assessment and management, it is assumed that there are two stocks, one in the EPO, east of 150°W, and the other in the western and central Pacific, and that there is no net movement between these areas. Notwithstanding this assumption, the Commissions responsible for tuna management in the Pacific, the Inter-American Tropical Tuna Commission (IATTC) and WCPFC, will collaborate closely on bigeye research and stock assessment. In the past few years, the IATTC, the Secretariat of the Pacific Community, and the National Research Institute of Far Seas Fisheries of Japan have been developing a Pacific-wide assessment of bigeye.

4. STOCK ASSESSMENT

With the establishment of the WCPFC in 2004, future stock assessments of the western and central Pacific Ocean stock of bigeye tuna will be undertaken by the Oceanic Fisheries Programme (OFP) of Secretariat of the Pacific Community under contract to WCPFC. As noted above, there is continuing work on a Pacific-wide bigeye assessment.

No assessment is possible for bigeye 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 2005 assessment undertaken by OFP and reviewed by the WCPFC Scientific Committee in August 2005 is provided below.

“The assessment used the stock assessment model and computer software known as MULTIFAN-CL. The bigeye tuna model is age (40 age-classes) and spatially structured (6 regions) and the catch, effort, size composition and tagging data used in the model are classified by 20 fisheries and quarterly time periods from 1952 through 2004. Six independent analyses are 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 assuming certain arbitrary increases in fishing power for the main longline and purse seine fleets.

The analyses conducted are:

SHBS-MEST	Statistical habitat-based standardised effort for main longline fisheries, M (assumed constant across age-class) estimated.
SHBS-MFIX	Statistical habitat-based standardised effort for main longline fisheries, M-at-age assumed at fixed levels.
GLM-MEST	General linear model standardised effort for main longline fisheries, M (assumed constant across age-class) estimated.
GLM-MFIX	General linear model standardised effort for main longline fisheries, M-at-age assumed at fixed levels.
FPOW-MEST	General linear model standardised effort for main longline fisheries, M (assumed constant across age-class) estimated. Fishing power expansions incorporated into longline (1% per year) and purse seine (4 % per year) effort. No other temporal trends in catchability for these fisheries.
FPOW-MFIX	General linear model standardised effort for main longline fisheries, M-at-age assumed at fixed levels. Fishing power expansions incorporated into longline (1% per year) and purse seine (4 % per year) effort. No other temporal trends in catchability for these fisheries.

The order (from best to worst) of the models in terms of their fit to the composite data and prior assumptions was: FPOW-MEST, GLM-MEST, FPOW-MFIX, GLM-MFIX, SHBS-MEST and SHBS-MFIX.

The catch, size and tagging data used in the assessment were the same as those used last year, with the exception that additional recent fishery data (2003 and 2004 for longline, 2003 for Philippines and Indonesia, 2004 for purse seine) was included. It should be noted that 2004 data are not complete for some fisheries. The estimation of standardised effort for the main longline fisheries using the GLM and SHBS approaches involved a new method of scaling indices of abundance among regions (see Langley et al. 2005 for details). Overall, the new procedure resulted in higher relative abundance in the tropical regions (3 and 4) and lower relative abundance in the northern (1 and 2) and southern (5 and 6) regions compared to the method used in previous years.

The SHBS- and GLM-based analyses produced results that were broadly comparable to those of recent assessments. Recruitment showed an increasing trend from the 1970s on, while biomass declined through the 1960s and 1970s after which it was relatively stable or declining slightly. The fisheries are estimated to have reduced overall biomass to 30-50% of unfished levels by 2004, with impacts more severe in the equatorial region of the WCPO, particularly in the west. Yield analyses suggest that recent average fishing mortality-at-age is near to or above the fishing mortality at Maximum Sustainable Yield (MSY). On the other hand, the current level of total biomass is estimated to be above equilibrium biomass expected at MSY, with the exception of those analyses assuming fishing power increases in the main longline and purse seine fisheries. In the latter analyses, total biomass is marginally above the MSY level and the current adult biomass is below the MSY level.

Current biomass is generally above equilibrium levels because of above-average recruitment since about 1990. On the basis of all of the results presented in the assessment, we conclude that maintenance of current levels of fishing mortality carries a high risk of overfishing. Should recruitment fall to average levels, current fishing mortality would result in stock reductions to near and possibly below MSY-based reference points."

(a) Estimates of fishery parameters and abundance

There are no fishery-independent indices of abundance for the bigeye 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 data and several methods are compared. Returns from a large scale tagging programme undertaken in the early 1990s provides information on rates of fishing mortality which in turn has improved estimates of abundance.

(b) Biomass estimates

Across the five sensitivity analyses considered as plausible, $B_{current}$ (average biomass for 2001-2003) was estimated to be 31 – 51 % (base case of 46%) of B_0 (average unfished biomass) and 106 – 148 % (base case of 125 %) B_{MSY}.. These estimates apply to the WCPO portion of the stock or an area that is approximately equivalent to the waters west of 150°W.

(c) Estimation of Maximum Constant Yield (MCY)

No estimates of MCY are available.

(d) Estimation of Current Annual Yield (CAY)

No estimates of CAY are available.

(e) 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.

Some key reference points are as follows:

CPUE series	MSY	$SSB_{current}/SSB_{MSY}$	Prob($SSB_{current}$ >SSB_{MSY})	$F_{current}/F_{MSY}$	Prob($F_{current}$>F_{MSY})
GLM-MFIX	66 040	1.10	Low (but not reported)	1.23	High (but not reported)

The estimate of MSY is lower than recent catches. This is due to high fishing mortality and above average recruitment. In contrast to the 2004 assessment, spawning biomass (SSB) was estimated (point estimate) to be only 1.10 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.

(f) Other factors

There are three areas of concern with the bigeye stock:

- juveniles occur in mixed schools with small yellowfin and also with skipjack tunas throughout the equatorial Pacific Ocean. As a result, they are vulnerable to large-scale purse seine fishing, particularly when floating objects are set on. Catches of juveniles can be very high proportion of total removal from the stock;
- the historic and continuing large catch of adults by the longline fishery that dramatically reduced the spawning stock over time. At present, there is uncertainty about some of the key data inputs to the assessment and as a result the true stock status could be better or worse than currently estimated; and
- several consecutive weak year classes have been observed in neighbouring 'stock' of bigeye tuna in the EPO leading to a dramatic decline in abundance. A similar decline in recruitment in the WCPO or a shift of effort from the EPO would increase the risk to the WCPO stock.

5. STATUS OF THE STOCKS

The 1st meeting of the Western and Central Pacific Fisheries Commission provided the following summary on the status of the stock:

> "The 2005 stock assessment is generally consistent with the result of the 2004 assessment, although the point estimates of the reference points are slightly more pessimistic. In particular, while the 2004 assessment indicated that over fishing was possibly occurring ($F_{current}$ /F_{MSY} ~ 1), the 2005 assessment indicates that over fishing is likely occurring ($F_{current}$ / F_{MSY} > 1 for the base case and three of five sensitivity analyses). Both assessments indicate that the stock is presently not in an over fished state (Bcurrent /BMSY > 1) because of high levels of estimated recruitment since 1990. The assessment indicates that the equatorial regions are the most highly impacted, while fishery impacts in the peripheral temperate regions are not large.
>
> The Scientific Committee recommends that fishing mortality for bigeye tuna is reduced from $Fc_{current}$. If future recruitment declines to levels closer to the long-term average, a further decrease in total catch and effort is likely to be necessary in order to maintain the stock at sustainable levels. Spatial patterns of fishing impacts remain uncertain, but some areas in the equatorial WCPO are more heavily impacted and in these areas more urgent management actions may be required."

The most recent assessment was undertaken in 2005 and covered the western and central Pacific stock. On a regional level there are concerns relating to the current status of this stock and the level of fishing effort. New Zealand domestic catches represent 0.3% of the total removals form the stock. The stock 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. 2004. Report of the 3rd meeting of the Scientific Coordinating Group. WCPFC/PrepCon/41. www.ocean-affairs.com.

Anon. 2004. Report of the 16th meeting of the Standing Committee on Tuna and Billfish. www.spc.int.

Hampton, J., Kleiber, P., Takeuchi, Y., Kurota, H. and Maunder, M. 2003. Stock assessment of bigeye tuna in the western and central Pacific Ocean, with comparisons to the entire Pacific Ocean. SCTB16 Working Paper BET–1. www.spc.int

Hampton, J., Kleiber, P., Langley, A., Hiramatsu, K. 2004. Stock assessment of bigeye tuna in the western and central Pacific Ocean, SCTB17 Working Paper SA–2. www.spc.int

Hampton, J., Kleiber, P., Langley, A., Takeuchi, Y., Ichinokawa, M. 2005. Stock assessment of bigeye tuna in the western and central Pacific Ocean. SC-1 SA-WP-2. 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.

Harley, S.J., Maunder, M.N., and Deriso, R. 2005. Assessment of bigeye tuna (*Thunnus* obsesus) in the eastern Pacific Ocean. Collective Volume of Scientific Papers, ICCAT, 57(2).