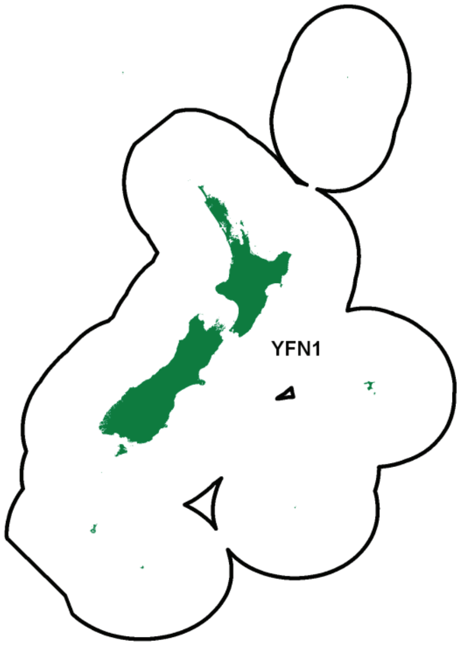
# YELLOWFIN TUNA (YFN)

*(Thunnus albacares)*




## 1. FISHERY SUMMARY

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

**Table 1: Recreational and Customary non-commercial allowances, TACCs and TACs for yellowfin tuna.**

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

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

Management of the yellowfin stock throughout the Western and Central Pacific Ocean (WCPO) is the responsibility of the Western and Central Pacific Fisheries Commission (WCPFC). Under this regional convention New Zealand is responsible for ensuring that the management measures applied within New Zealand fisheries waters are compatible with those of the Commission.

At its second annual meeting (2005) the WCPFC passed a Conservation and Management Measure (CMM) (this is a binding measure that all parties must abide by throughout the convention area including EEZ's) 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 an additional CMM relating to conservation and management if yellowfin tuna (http://www.wcpfc.int/). A further measure CMM2008-01 was agreed to in December 2009, the aim of which was to:

- "Ensure through the implementation of compatible measures for the high seas and EEZs that bigeye and yellowfin tuna stocks are maintained at levels capable of producing their maximum sustainable yield; as qualified by relevant environmental and economic factors including the special requirements of developing States in the Convention area as expressed by Article 5 of the Convention.

- Achieve, through the implementation of a package of measures, over a three-year period commencing in 2009, a minimum of 30% reduction in bigeye tuna fishing mortality from the annual average during the period 2001-2004 or 2004;
- Ensure that there is no increase in fishing mortality for yellowfin tuna beyond the annual average during the period 2001-2004 average or 2004; and
- Adopt a package of measures that shall be reviewed annually and adjusted as necessary by the Commission taking account of the scientific advice available at the time as well as the implementation of the measures. In addition, this review shall include any adjustments required by Commission decisions regarding management objectives and reference points."

This measure is large and detailed with numerous exemptions and provisions. Despite this effort reductions are being attempted through seasonal FAD closures, and high seas area closures (in high seas pockets) for the purse seine fleets, longline effort reductions as well as other methods. At the 2009 meeting the Scientific Committee recommended that this measure would need to be strengthened if it was to achieve its objectives.

## 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). Figure 1 shows historic landings and longline fishing effort for YFN stocks.

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

| | YFN 1 (all FMAs) | | | | | |
|---|---|---|---|---|---|---|
| Fish Yr | JPNFL | KORFL | NZ/MHR | Total | LFRR | NZ ET |
| 1979/80 | 10.1 | | | 10.1 | | |
| 1980/81 | 79.1 | 29.9 | | 109 | | |
| 1981/82 | 89.4 | 6.7 | | 96.1 | | |
| 1982/83 | 22.4 | 6.6 | | 29 | | |
| 1983/84 | 46.1 | 12.8 | | 58.9 | | |
| 1984/85 | 21.3 | 64.5 | | 85.8 | | |
| 1985/86 | 92.5 | 3.3 | | 95.8 | | |
| 1986/87 | 124.8 | 29 | | 153.8 | | |
| 1987/88 | 35.2 | 37.3 | | 72.5 | | |
| 1988/89 | 11.5 | 1.8 | | 13.3 | 19 | |
| 1989/90 | 29.1 | | 4.3 | 33.4 | 6.3 | |
| 1990/91 | 7.4 | | 10.7 | 18.1 | 19.9 | |
| 1991/92 | 0.2 | | 16.1 | 16.3 | 11.8 | |
| 1992/93 | | | 10.1 | 10.1 | 69.7 | 0.2 |
| 1993/94 | | | 50.5 | 50.5 | 114.4 | 1.5 |
| 1994/95 | | | 122.2 | 122.2 | 193.4 | 0.3 |
| 1995/96 | | | 251.6 | 251.6 | 156.7 | 7.4 |
| 1996/97 | | | 144.1 | 144.1 | 105.3 | 0.2 |
| 1997/98 | | | 93.6 | 93.6 | 174.7 | 2.3 |
| 1998/99 | | | 136.1 | 136.1 | 100.6 | 0.3 |
| 1999/00 | | | 77.8 | 77.8 | 168 | 2.1 |
| 2000/01 | | | 123.5 | 123.5 | 62.5 | 3.1 |
| 2001/02 | | | 64.5 | 56.7 | 61.9 | 1.9 |
| 2002/03 | | | 41.8 | 39.7 | 42.1 | 2.1 |
| 2003/04 | | | 57.7 | 21.1 | 21.4 | 36.6 |
| 2004/05 | | | 42.0 | 36.1 | 41.4 | 6.0 |
| 2005/06 | | | 9.3 | 9.2 | 8.8 | 0.1 |
| 2006/07 | | | 19.8 | 17.3 | 19.7 | 0.9 |
| 2007/08 | | | 22.4 | 22.4 | 22.3 | 0.1 |
| 2008/09 | | | 43.6 | 43.6 | 43.3 | 38.2 |

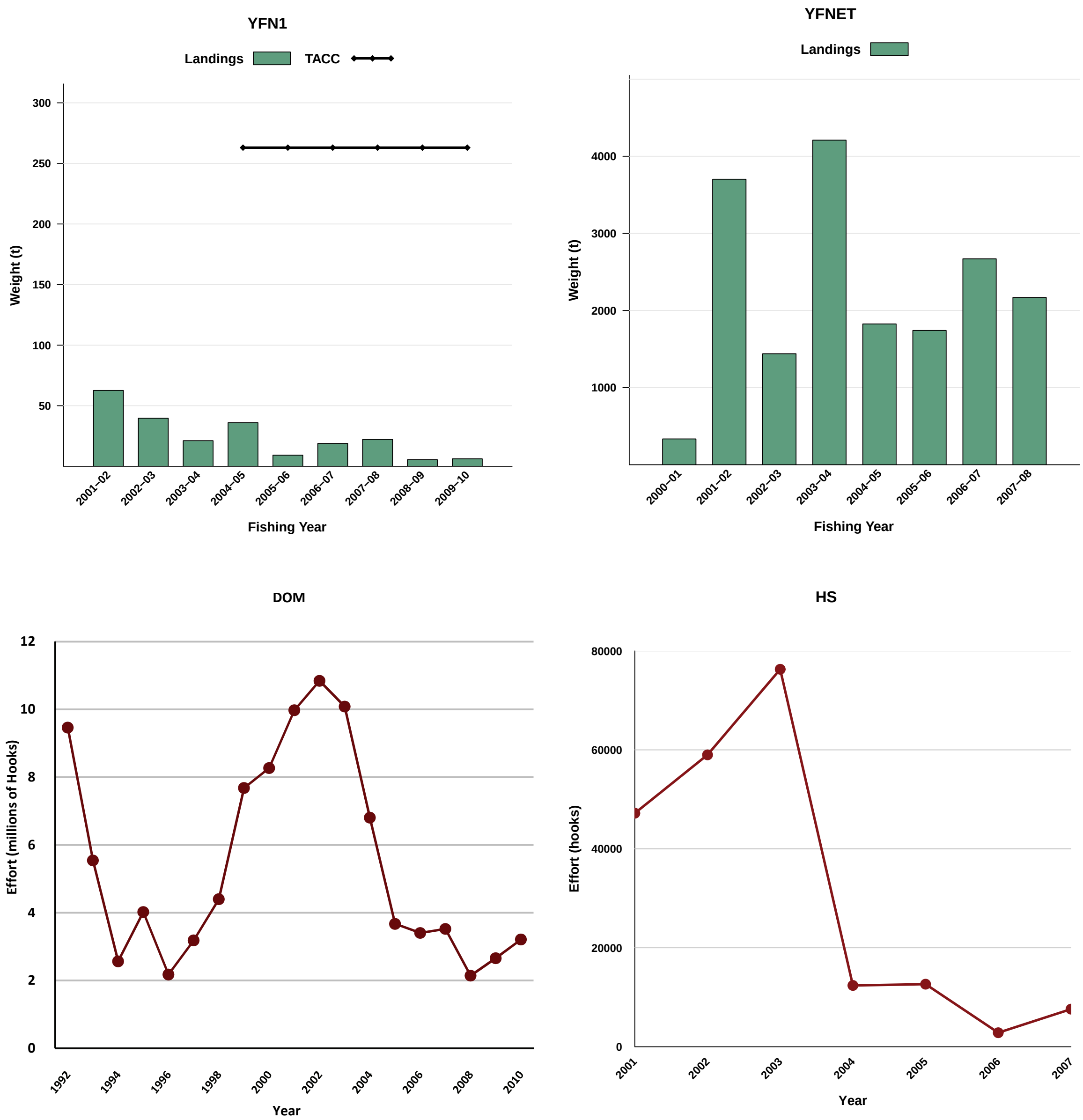



**Figure 1: [Top] Yellowfin catch from 2001-02 to 2009-10 within NZ waters (YFN1), and 2000-01 to 2007-08 on the high seas (YFNET). [Bottom] Fishing effort (number of hooks set) for all domestic (including effort by foreign vessels chartered by NZ fishing companies) and high seas New Zealand flagged surface longline vessels, from 1992 to 2010 and 2001 to 2007, respectively.**

**Table 3: Reported total New Zealand within EEZ landings* and WCPO landings (t) of yellowfin tuna from 1991 to 2008.**

| 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 | 2008 | 12 | 539 481 |

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.

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 Customary non-commercial fisheries
An estimate of the current customary catch is not available.

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

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

| $L_\infty$ (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, stock assessments of the WCPO stock of yellowfin tuna are 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 2009 assessment undertaken by OFP (Langley *et al.* 2009) and reviewed by the WCPFC Scientific Committee in August 2009 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 24 fisheries and quarterly time periods from 1952 through 2008.

The spatial and fishery structure is equivalent to that used in the 2007 assessment and the data sets have been updated to include the catch, effort, and size composition data from the last two years. However, there have been a number of significant changes to the model inputs, in particular the adoption of an alternative catch history for the purse-seine fleet that includes a substantially higher level of catch for the associated purse-seine fishery. There have also been refinements to the catch histories from the Philippines fisheries, the longline CPUE indices, and biological parameters (M-at age and spawning fraction). The current assessment also investigated a range of structural assumptions related to the relative weighting of the longline CPUE indices and longline size frequency data, the consideration of an increase in the catchability of the longline fisheries ("effort creep"), and assumptions regarding the parameterisation of the spawner-recruit relationship (SRR).

For comparative purposes, the current assessment model was also configured to be equivalent to the 2007 assessment (including purse-seine catches calculated using the previous approach). The model yielded results that were very similar to the results of the 2007 base case assessment model. In general, the results from the range of current model options were considerably more optimistic than the 2007 base case model with respect to the key MSY based indicators of stock status. This was principally due to the assumptions regarding the steepness of the SRR, although some of the other changes in model inputs and assumptions were also influential. The main conclusions of the current assessment are as follows.

1. For all analyses, there are strong temporal trends in the estimated recruitment series. Initial recruitment was relatively high but declined during the 1950s and 1960s. Recruitment remained relatively constant during the 1970s and 1980s and then declined steadily from the early 1990s. Recent recruitment is estimated to be considerably lower than the long-term average.

2. Trends in biomass are generally consistent with the underlying trends in recruitment. Biomass is estimated to have declined throughout the model period. Model options that incorporate an increase in longline efficiency (catchability) were characterised by a higher initial biomass level and a stronger overall decline.

3. The biomass trends in the model are principally driven by the time-series of catch and GLM standardised effort from the principal longline fisheries. The current assessment incorporated a revised set of longline CPUE indices and, for some model options, the indices were modified to account for an estimate increase in longline catchability. For some of the main longline fisheries (in particularly LL ALL 3), there is an apparent inconsistency between the trends in the size frequency data and the trends in longline catch and effort; i.e., the two types of data are providing somewhat

different information about the relative level of fishing mortality in the region. The current assessment includes a range of model sensitivities to examine the relative influence of these two data sources. Nonetheless, further research is required to explore the relationship between longline CPUE and yellowfin abundance and the methodology applied to standardise the longline CPUE data.
4. Fishing mortality for adult and juvenile yellowfin tuna is estimated to have increased continuously since the beginning of industrial tuna fishing. A significant component of the increase in juvenile fishing mortality is attributable to the Philippines and Indonesian surface fisheries, which have the weakest catch, effort and size data. There has been recent progress made in the acquisition of a large amount of historical length frequency data from the Philippines and these data were incorporated in the assessment. However, there is an ongoing need to improve estimates of recent and historical catch from these fisheries and maintain the current fishery monitoring programme within the Philippines. While the various analyses have shown that the current stock status is relatively insensitive to the assumed level of catch from the Indonesian fishery, yield estimates from the fishery vary in accordance with the level of assumed Indonesian catch. Therefore, improved estimates of historical and current catch from these fisheries are important in the determination of the underlying productivity of the stock.

5. The ratios $B_t$ / $B_{t,F=0}$ provide a time-series index of population depletion by the fisheries. Depletion has increased steadily over time, reaching a level of about 60% of unexploited biomass (a fishery impact of 40%) in 2004-2007. This represents a moderate level of stock-wide depletion although it is considerably higher than the equivalent equilibrium-based reference point ($B_{MSY}$/ $B_0$ of approximately 0.35-0.40). However, depletion is considerably higher in the equatorial region 3 where recent depletion levels are approximately 0.35 and 0.30 for total and adult biomass, respectively (65% and 70% reductions from the unexploited level). Impacts are moderate in region 4 (30%), low (about 15-20%) in regions 1, 2, and 5 and minimal (5%) in region 6. If stock-wide over-fishing criteria were applied at the level of our model regions, we would conclude that region 3 is fully exploited and the remaining regions are under-exploited.

6. The attribution of depletion to various fisheries or groups of fisheries indicates that the Philippines/Indonesian domestic fisheries and associated purse-seine fishery have the highest impact, particularly in region 3, while the unassociated purse seine fishery has a moderate impact. These fisheries are also contributing significantly to the fishery impact in all other regions. Historically, the coastal Japanese pole-and-line and purse-seine fisheries have had a significant impact on biomass levels in their home region (1). In all regions, the longline fishery has a relatively small impact, less than 5%.

7. The current assessment includes a number of changes to the model assumptions, particularly related to the biological parameters (natural mortality and reproductive capacity), the relative influence of the longline CPUE and size frequency data, and changes to the input data (most notably the purse-seine catch). However, the most influential change from the previous assessment relates to the assumptions regarding the steepness of the spawner-recruit relationship. Previous assessments have determined low values of steepness in the model estimation procedure, while the current assessment has assumed a range of fixed values for steepness (0.55-0.95). Assuming a moderate value of steepness (0.75) has resulted in a considerably more optimistic assessment of the stock status (compared to 2007 base case) due to the actual value of steepness and, to a lesser degree, the interaction between steepness and the other changes in model assumptions (especially the revised biological parameters, lower penalty on the longline effort deviations, and increasing longline catchability).

8. For a moderate value of steepness (0.75), $F_{current}$/ $F_{MSY}$ is estimated to be 0.54-0.68 indicating that under equilibrium conditions the stock would remain well above the level capable of producing MSY ( $B_{Fcurrent}$ / $B_{MSY}$ 1.39-1.59 and $SB_{Fcurrent}$/ $SB_{MSY}$ 1.50-1.79), while $B_{current}$ /$B_{MSY}$ and $SB_{current}$ /$SB_{MSY}$ are estimated to be well above 1.0 (1.41-1.67 and 1.46-1.88, respectively). For lower values of steepness (0.55 and 0.65), the estimates of $F_{current}$ /$F_{MSY}$ are below 1.0 and $B_{current}$ /$B_{MSY}$ and $SB_{current}$ / $SB_{MSY}$ are estimated to be above 1.0 for the entire range of sensitivities considered.

9. Sensitivity analyses were conducted to investigate the influence of a range of key model inputs, principally those relating to steepness of the SRR, the levels of catch from the Indonesian/Philippines

and purse-seine fisheries, M-at-age, and the region 6 CPUE index. The interaction between each of these factors and the other key model assumptions (relative weighting of longline CPUE and size frequency data and increase in longline catchability) was also examined. The uncertainty associated with the point estimates of the key MSY based reference points was also determined using a likelihood profile approach. Both analyses revealed that most of the uncertainty in estimates of $F_{current}/F_{MSY}$, $B_{current}/ B_{MSY}$ and $SB_{current}/SB_{MSY}$ was attributable to the value of steepness for the SRR. Model options with low values of steepness approached the MSY based reference points; however, none of the range of model options yielded estimates of fishing mortality exceeding FMSY or levels of current biomass below (or close to) $SB_{MSY}$. The probability distributions derived from the likelihood profiles were consistent with these observations.

10. The estimates of MSY for the four principal models are 552,000-637,000 mt and considerably higher than recent catches estimates for yellowfin (430,000 mt, source WCPFC Yearbook 2007). The large difference between the MSY and recent catches is partly attributable to the stock assessment model incorporating the higher (preliminary) purse-seine catch estimates (representing an additional catch of approximately 100,000 mt per annum in recent years). The more optimistic models suggest that the stock could potentially support long-term average yields above the recent levels of catch. However, it is important to note that recent (1998-2007) levels of estimated recruitment are considerably lower (80%) than the long-term average level of recruitment used to calculate the estimates of MSY. If recruitment remains at recent levels, then the overall yield from the fishery will be lower than the MSY estimates.

11. While estimates of current fishing mortality are generally well below FMSY, any increase in fishing mortality would most likely occur within region 3 - the region that accounts for most of the catch. This would exacerbate the already high levels of depletion that are occurring within the region. Further, the computation of MSY-based metrics assumes that the relationship between spawning biomass and recruitment occurs at the global level of the stock and, therefore, does not consider the differential levels of impact on spawning biomass between regions. The spawning biomass in region 3 is estimated to have been reduced to approximately 30% of the unexploited level; however, due to the lower overall depletion of the entire WCPO stock, the model assumes that there has been no significant reduction in the spawning capacity of the stock. A more conservative approach would be to consider the spawning capacity at the regional level and define reference points accordingly.

12. The current assessment has undertaken a more comprehensive analysis of model uncertainty than previous assessments. The analysis indicates that the assumptions regarding the spawner-recruit relationship represent the most significant source of uncertainty. For tuna species, there are no strong empirical data available to inform the model regarding the likely range of values of steepness of the SRR that underpin the MSY based stock indicators. On that basis, it may be more appropriate to adopt alternative fishing mortality and biomass based reference points that are not reliant on the MSY concept, although inevitably some assumption regarding the SRR is necessary, implicitly or explicitly, in the formulation of other alternative stock indicators.

13. The structural uncertainty analysis investigated the impact of a range of sources of uncertainty in the current model and the interaction between these assumptions. Nonetheless, there remains a range of other assumptions in the model that should be investigated either internally or through directed research. Further studies are required: to refine our estimates of growth, natural mortality and reproductive potential, incorporating consideration of spatio-temporal variation and sexual dimorphism; to examine in detail the time-series of size frequency data from the fisheries, which may lead to refinement in the structure of the fisheries included in the model; to consider size based selectivity processes in the assessment model; to collect age frequency data from the commercial catch in order to improve current estimates of the population age structure; to improve the accuracy of the catch estimates from a number of key fisheries, particularly those catching large quantities of small yellowfin; to refine the methodology and data sets used to derive CPUE abundance indices from the longline fishery; and to refine approaches to integrate the recent tag release/recapture data into the assessment model."

## 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 (Langley et al., 2009) (http://www.wcpfc.int/). The ratios $B_t / B_{t,F=0}$ provide a time-series index of population depletion by the fisheries. Depletion has increased steadily over time, reaching a level of about 60% of unexploited biomass (a fishery impact of 40%) in 2004–2007. This represents a moderate level of stock-wide depletion although it is considerably higher than the equivalent equilibrium-based reference point ( $\tilde{B}_{MSY} / \tilde{B}_0$ of approximately 0.35–0.40). However, depletion is considerably higher in the equatorial region 3 where recent depletion levels are approximately 0.35 and 0.30 for total and adult biomass, respectively (65% and 70% reductions from the unexploited level). Impacts are moderate in region 4 (30%), low (about 15–20%) in regions 1, 2, and 5 and minimal (5%) in region 6. If stock-wide over-fishing criteria were applied at the level of our model regions, we would conclude that region 3 is fully exploited and the remaining regions are under-exploited.

The attribution of depletion to various fisheries or groups of fisheries indicates that the Philippines/Indonesian domestic fisheries and associated purse-seine fishery have the highest impact, particularly in region 3, while the unassociated purse seine fishery has a moderate impact. These fisheries are also contributing significantly to the fishery impact in all other regions. Historically, the coastal Japanese pole-and-line and purse-seine fisheries have had a significant impact on biomass levels in their home region (1). In all regions, the longline fishery has a relatively small impact, less than 5%.

### 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. 2000-2005 for the 2009 assessment.

Key reference points are in Table 5.

**Table 5: Comparison of reference points from the 2009 yellowfin stock assessment considering four sensitivity analyses and the basecase from the 2007 assessment. $Y_{Fcurrent}$ = Equilibrium yield at $F_{current}$.**

| Management Quantity | 2009 Assessment | 2007 Assessment |
|---|---|---|
| Most Recent Catch | 539,481 mt (2008) | 426,726 mt (2006) |
| MSY | Range: 485,200 ~ 584,000 mt | Base case: 400,000 mt<br>Range: 344,520 ~ 549,200 mt |
| $F_{current}/F_{MSY}$ | Range: 0.41 ~ 0.85 | Base case: 0.95<br>Range: 0.56 ~ 1.0 |
| $B_{current}/B_{MSY}$ | Range: 1.38 ~ 1.88 | Base case: 1.17<br>Range: 1.13 ~ 1.42 |
| $SB_{current}/SB_{MSY}$ | Range: 1.44 ~ 2.43 | Base case: 1.25<br>Range: 1.12 ~ 1.74 |
| $Y_{Fcurrent}/MSY$ | Range: 0.76 ~ 0.98 | Base case: 1.0<br>Range: 0.88 ~ 1.0 |
| $B_{current}/B_{current, F=0}$ | Range: 0.53 ~ 0.63 | Base case: 0.51<br>Range: 0.51 ~ 0.58 |

The estimate of MSY is lower than recent catches in some model runs. This is due to high fishing mortality and fishing down the stock towards $B_{MSY}$-levels. The SB ratio larger than 1.0 indicates that the stock is not in an overfished state. The ratio of $F_{current}$ compared with $F_{MSY}$ (the fishing mortality level that would keep the stock at MSY) is less than 1.0 indicating that overfishing is not 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.

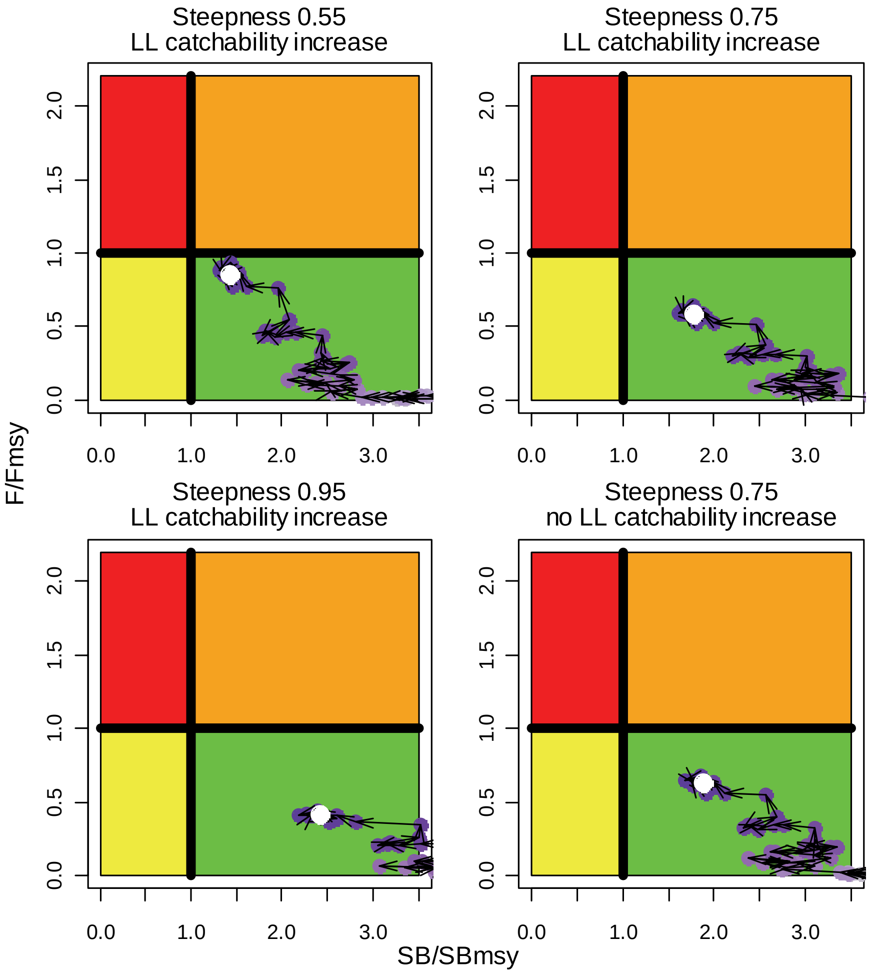
## 5. STATUS OF THE STOCKS

**Stock structure assumptions**

Western and Central Pacific Ocean

All biomass in this Table refer to spawning biomass (SB)

| **Stock Status** | |
|---|---|
| Year of Most Recent Assessment | 2009 |
| Reference Points | Target: $SB>SB_{MSY}$ and $F<F_{MSY}$<br>Soft Limit: Not established by WCPFC; but evaluated using HSS default of 20%$SB_0$.<br>Hard Limit: Not established by WCPFC; but evaluated using HSS default of 10%$SB_0$. |
| Status in relation to Target | Likely that $SB>SB_{MSY}$ and $F<F_{MSY}$ |
| Status in relation to Limits | Soft Limit: Unlikely to be below<br>Hard Limit: Unlikely to be below |

| Historical Stock Status Trajectory and Current Status |
|---|
|  |
| **Temporal trend in annual stock status, relative to spawning biomass (SBMSY x-axis) and FMSY (y-axis) reference points, for the model period (1952–2008) from four principal model options chosen by SC5. The colour of the points is graduated from mauve (1952) to dark purple (2008) and the points are labelled at 5-year intervals. LL = longline.** |

| **Fishery and Stock Trends** | |
|---|---|
| Recent trend in Biomass or Proxy | Biomass has been reduced steadily over time reaching a level of about 60% of unexploited biomass in 2004-2007. However, depletion is considerably higher in the equatorial region 3 where recent depletion levels are approximately 0.35 and 0.30 for total and adult biomass, respectively (65% and 70% reductions from the unexploited level). Impacts are moderate in region 4 (30%), low (about 15-20%) in regions 1, 2, and 5 and minimal (5%) in region 6. |
| Recent Trend in Fishing Mortality or Proxy | Fishing mortality has increased over time but is estimated to be lower than $F_{MSY}$ in all cases but for lower values of steepness is approaching $F_{MSY}$. |
| Other Abundance Indices | |
| Trends in Other Relevant Indicator or Variables | Recent (1998-2007) levels of estimated recruitment are considerably lower (80%) than the long-term average level of recruitment used to calculate the estimates of MSY. If recruitment remains at recent levels, then the overall yield from the fishery will be lower than the current MSY estimates. |

| **Projections and Prognosis** | | |
|---|---|---|
| Stock Projections or Prognosis | Region 3 (the tropical WPO) is fully exploited and the remaining regions are under-exploited. Future stock trends are uncertain due to exploitation patterns and recruitment autocorrelation. | |
| Probability of Current Catch causing decline below limits | Soft Limit: Unlikely<br>Hard Limit: Very 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 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 24 fisheries and quarterly time periods from 1952 through 2008. | |
| Period of Assessment | Latest assessment: 2009 | Next assessment: 2011 |
| Changes to Model Structure and Assumptions | The spatial and fishery structure is equivalent to that used in the 2007 assessment and the data sets have been updated to include the catch, effort, and size composition data from the last two years. However, there have been a number of significant changes to the model inputs, in particular the adoption of an alternative catch history for the purse-seine fleet that includes a substantially higher level of catch for the associated purse-seine fishery. There have also been refinements to the catch histories from the Philippines fisheries, the longline CPUE indices, and biological parameters (M-at age and spawning fraction). The current assessment also investigated a range of structural assumptions related to the relative weighting of the longline CPUE indices and longline size frequency data, the consideration of an increase in the catchability of the longline fisheries (“effort creep”), and assumptions regarding the parameterisation of the spawner-recruit relationship (SRR). However, the most influential change from the previous assessment relates to the assumptions regarding the steepness of the spawner-recruit relationship. Previous assessments have determined low values of steepness in the model estimation procedure, while the current assessment has assumed a range of fixed values for steepness (0.55-0.95). Assuming a moderate value of steepness (0.75) has resulted in a considerably more optimistic assessment of the stock status (compared to 2007 base case). | |
| Major Sources of Uncertainty | | |

| **Qualifying Comments** |
|---|
| The biomass trends in the model are principally driven by the time-series of catch and GLM standardised effort from the principal longline fisheries. The current assessment incorporated a revised set of longline CPUE indices and, for some model options, the indices were modified to account for an estimate increase in longline catchability. For some of the main longline fisheries (in particularly LL ALL 3), there is an apparent inconsistency between the trends in the size frequency data and the trends in longline catch and effort; i.e., the two types of data are providing somewhat different information about the relative level of fishing mortality in the region. The current assessment includes a range of model sensitivities to examine the relative influence of these two data sources. Nonetheless, further research is required to explore the relationship between longline CPUE and yellowfin abundance and the methodology applied to standardise the longline CPUE data.<br>The spawning biomass in region 3 is estimated to have been reduced to approximately 30% of the unexploited level; however, due to the lower overall depletion of the entire WCPO stock, the model assumes that there has been no significant reduction in the spawning capacity of the stock. |
| **Fishery Interactions** |

Interactions with protected species are known to occur in the longline fisheries of the South Pacific, particularly south of 30°S. Seabird bycatch mitigation measures are required in the New Zealand, Australian EEZ's and through the WCPFC Conservation and Management Measure (CMM2007-04). Sea turtles also get incidentally captured in longline gear; the WCPFC is attempting to reduce sea turtle interactions through Conservation and Management Measure (CMM2008-03). Shark bycatch is common in longline fisheries and largely unavoidable; this is being managed through New Zealand domestic legislation and to some extent through Conservation and Management Measure (CMM2008-06).

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