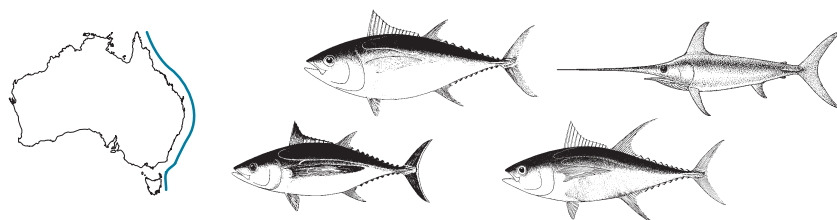


Eastern Tuna and Billfish Fishery



Main features

STATUS

- Bigeye tuna and yellowfin tuna: not overfished, but subject to overfishing in the western and central Pacific Ocean (WCPO).
- Striped marlin and broadbill swordfish: uncertain stock status in the south-western Pacific.
- Albacore tuna: not overfished and not subject to overfishing in the South Pacific.

RELIABILITY OF THE ASSESSMENT

- Reasonable for bigeye, yellowfin and albacore tuna in the WCPO.
- Uncertain for striped marlin and swordfish in the south-western Pacific.
- Otherwise unknown.

The relevance of these regional assessments to the Australian Fishing Zone (AFZ) is unclear because mixing and interactions between stock components in the WCPO and AFZ are not well understood.

CURRENT CATCH (DOMESTIC, 2007)

- Total retained catch 5758 t (valued at \$40.9 million in 2006–07); yellowfin

tuna 1380 t (\$11.3 million); bigeye tuna 998 t (\$4.9 million); swordfish 1349 t; striped marlin 358 t (combined billfish \$9 million); albacore tuna 1916 t (\$5.9 million); and byproduct 635 t (\$1.4 million).

- Swordfish and striped marlin values based on reported unit price for all billfish combined.

LONG-TERM POTENTIAL YIELD

- Uncertain.
- Historical catches of yellowfin tuna by Japanese longliners exceeded 3000 t in the eastern AFZ.
- Albacore offers scope for expansion.

MAIN MANAGEMENT OBJECTIVES

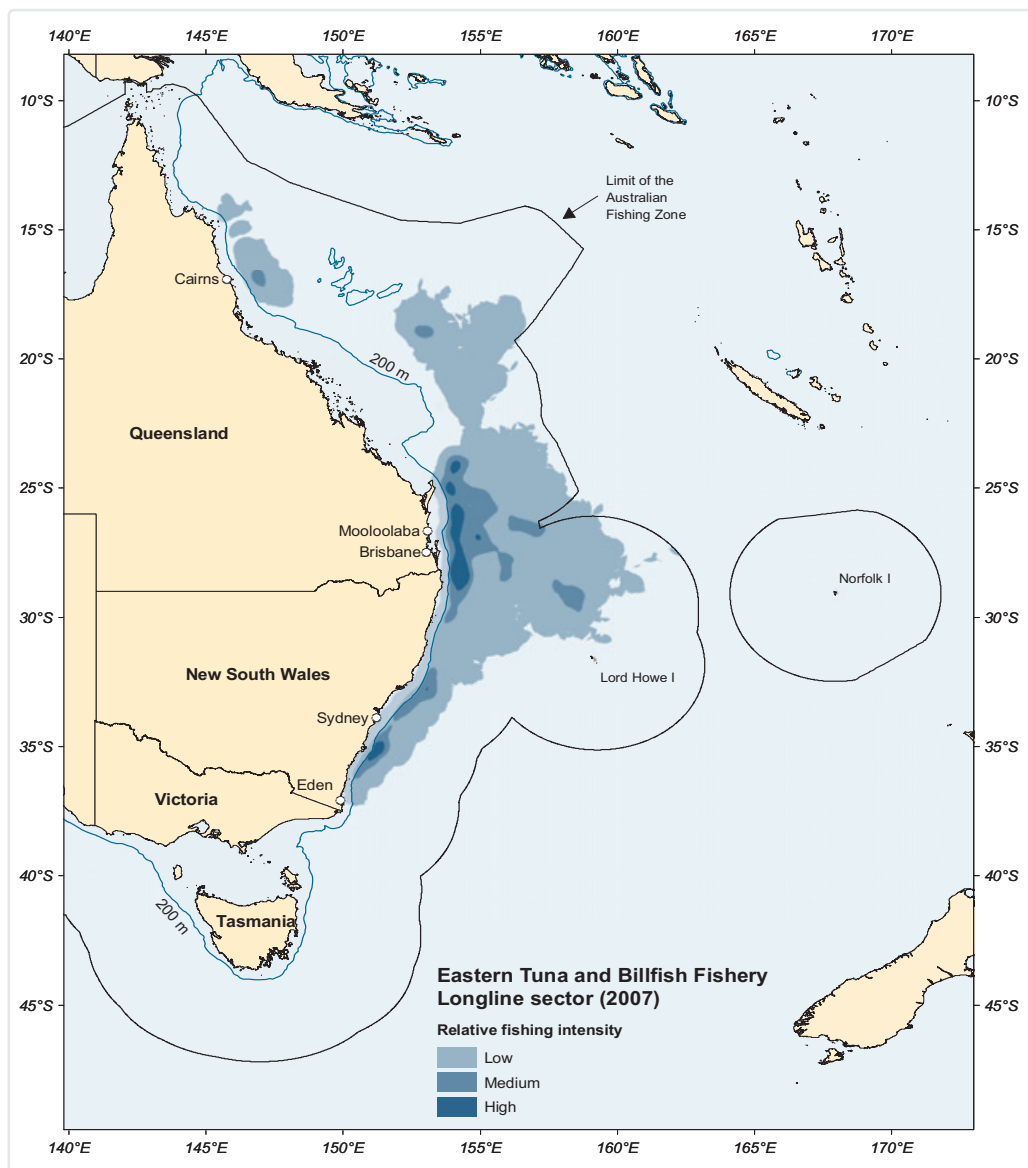
- Control Australian pelagic longline effort at a level that ensures that impacts on target, byproduct and bycatch species (including threatened, endangered and protected species) are sustainable in the area of the WCPO in which the fleet operates.

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Main features *continued*

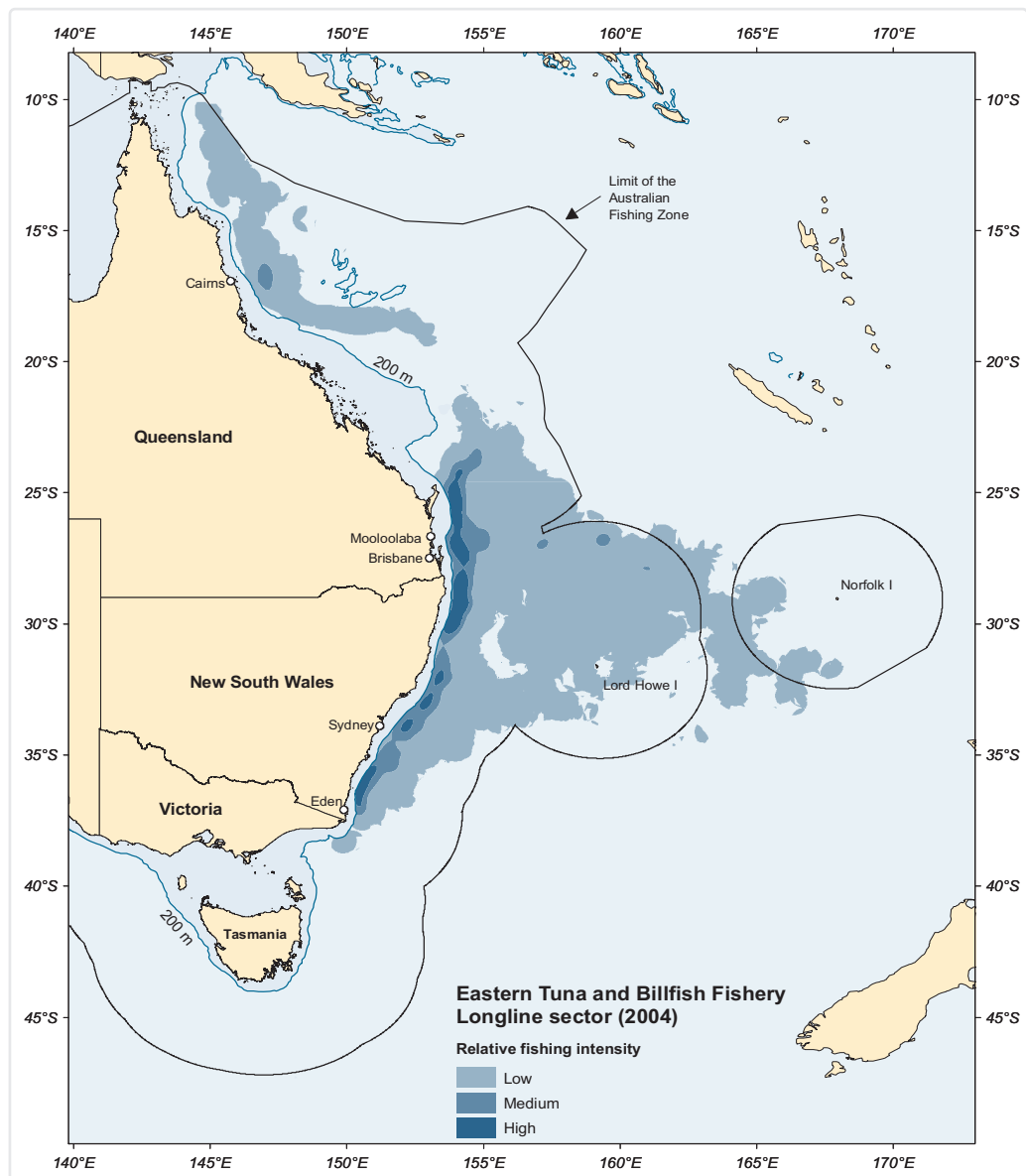
MANAGEMENT METHODS

- Input controls (such as limited entry, gear and area restrictions) and restrictions on byproduct and bycatch.
- Statutory management plan with transferable effort rights and a total allowable effort is being implemented.
- A maximum catch limit, bycatch limits and a series of trigger catch levels introduced to limit swordfish and albacore catches.
- Mitigation measures in place to reduce the take of seabirds.
- Harvest strategy being developed for the fishery.



Highlights

- Tuna and billfish are highly migratory fish that support significant purse-seine and longline fisheries throughout the Pacific Ocean. Many of these species are also prized by recreational and charter fishers.
- There is overfishing of bigeye and yellowfin in the WCPO, particularly in equatorial waters, and both stocks are considered to be close to overfished, based on the default definitions of 'overfishing' ($F_{\text{CURRENT}} > F_{\text{MSY}}$) and 'overfished' ($B_{\text{CURRENT}} < B_{\text{MSY}}$) used by the Western and Central Pacific Fisheries Commission (WCPFC).



- Annual longline effort in the domestic fishery has fallen from over 12 million hooks in 2003 to 8–9 million hooks in recent years as a result of increased operating costs, declining catch rates and the surrender of permits under the 2006 restructure package. The gross value of production has fallen by 50% since the early 2000s.
- Of concern are declines over the past decade in catch rates of bigeye, swordfish and striped marlin. Declines in swordfish catch rates (especially in inshore areas) combined with increasing operating costs and fluctuating market returns resulted in many longliners targeting low-value albacore during 2006. Declines in albacore catch rates and the strengthening of the Australian dollar subsequently saw targeting redirected to other species in 2007.
- The management plan for the domestic longline fishery is to implement a hook-based management system incorporating transferable effort rights.
- The bycatch of sharks, marlins, seabirds and sea turtles is a major issue in the management of longline fisheries throughout the world.

Background

History of the fishery

Domestic commercial

The Eastern Tuna and Billfish Fishery (ETBF) extends from Cape York to the South Australia–Victoria border and includes waters around Tasmania. Broadbill swordfish (*Xiphias gladius*), bigeye tuna (*Thunnus obesus*) and yellowfin tuna (*Thunnus albacares*) are the most valuable commercial species. They are caught by pelagic longline and either airfreighted fresh-chilled to Japan and the United States or sold on the domestic market, which now takes the greater share. Longliners also take significant amounts of striped marlin (*Tetrapturus audax*) and albacore tuna (*Thunnus alalunga*). Some

of these species are also caught by other fishing methods, such as rod-and-reel, handlining and trolling, but almost no bigeye or swordfish, and probably less than 5% of the annual yellowfin catch, are taken by methods other than longlining. Several other species make up a significant component of the retained catch, including black oilfish or escolar (*Lepidocybium flavobrunneum*), rudderfish (*Centrolophus niger*), moonfish (*Lampris guttatus*) and mahi mahi (*Coryphaena hippurus*).

Sporadic troll catches of pelagic species have been reported off New South Wales since first European settlement. With the introduction of live-bait-and-pole techniques for southern bluefin tuna (*Thunnus maccoyii*), the fishery expanded rapidly in the 1950s. The introduction of purse seining in the 1970s boosted catches further. Those activities also led to the development of a purse seine and pole-and-line fishery for skipjack tuna (*Katsuwonus pelamis*) off southern New South Wales. In 2004, the Australian Fisheries Management Authority (AFMA) established separate management arrangements for skipjack tuna (see the *Skipjack fisheries* chapter).

Domestic longlining for yellowfin commenced off New South Wales in the early 1960s, with the catch sold to canneries and local fish markets. Longlining increased markedly after successful airfreighting of fresh-chilled tuna to Japan in the early 1980s. There was a second wave of expansion in the 1990s in northern Queensland waters, where catch rates for yellowfin and bigeye were high. In the mid-1990s, better access to swordfish markets in the United States prompted many fishers to move to southern Queensland ports, such as Mooloolaba, to target swordfish. Total effort in the ETBF trebled during this period, but then declined after 2003. Longline catches of striped marlin increased markedly in the late 1990s. Many swordfish longliners used deep-setting techniques to target albacore in 2006 in response to reduced swordfish availability, high operating costs and market demand for albacore.

Domestic longliner boats are mostly 15–25 m long, but many of the larger boats left the fishery as a result of the 2006 structural adjustment initiative. Domestic longliners use monofilament gear, but fishing practices vary with target species, location and season. On average, each operation sets over 1200 hooks per day and fishes for around 107 days per year. Trip length ranges up to 30 days, but most trips are between 2 and 15 days. The catch is stored on ice, in ice slurry or in refrigerated brine. Some vessels range up to 1000 nm or further from port to fish, but 40–300 nm is more typical.

Domestic recreational

Gamefishing has grown in popularity in Australia since the formation of the Game Fishing Association of Australia in 1938. By 2000, the association had more than 10 000 members, most of whom fished along the south-eastern coast of Australia. Many gamefishers tag and release their catch, especially marlins.

As well as organised recreational fishing, many other recreational anglers target tunas and billfish in the area of the ETBF. Apart from data gathered at tournaments, few data are available on recreational participation levels, catches and fishing effort directed at tuna and billfish.

Foreign commercial

Japanese longliners began fishing off Australia's east coast in the late 1950s. Large (40–55 m) freezer longliners remained at sea for several months, setting 2500–3500 hooks per day from a 60-nm mainline. Japan's annual catch in the area of the ETBF ranged up to 3300 t for yellowfin, 750 t for bigeye and 1000 t for swordfish. With the declaration of the AFZ in 1979, Japanese longliners were licensed under bilateral agreements. Australia progressively restricted areas of access as domestic commercial and recreational fisheries for tuna and billfish grew. Japanese access lapsed in November 1997 after agreement could not be reached on the global total allowable catch for southern bluefin tuna.

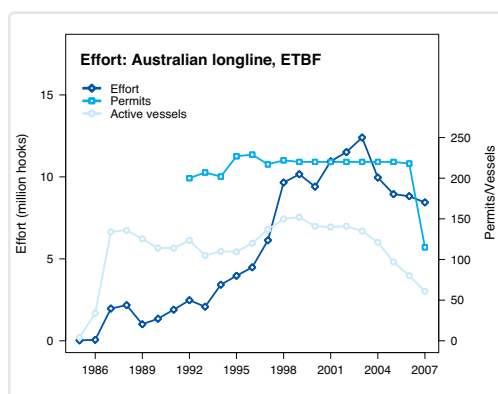
Many other nations fish for tuna and billfish in the WCPO. Longliners from Japan, South Korea and Taiwan target bigeye, yellowfin and albacore near the eastern AFZ. In the late 1980s, many small longliners from Taiwan, Japan and China established bases in equatorial areas such as Guam and Palau to airfreight fresh tuna, such as bigeye, to sashimi markets in Japan. Other nations, such as Fiji, New Caledonia and New Zealand, have also established domestic longline fleets. Since 2004, Spanish longliners have fished for swordfish in international waters of the south-western Pacific. Since 1995, locally based longline fleets have increasingly targeted albacore in the subtropical south Pacific for canning markets.

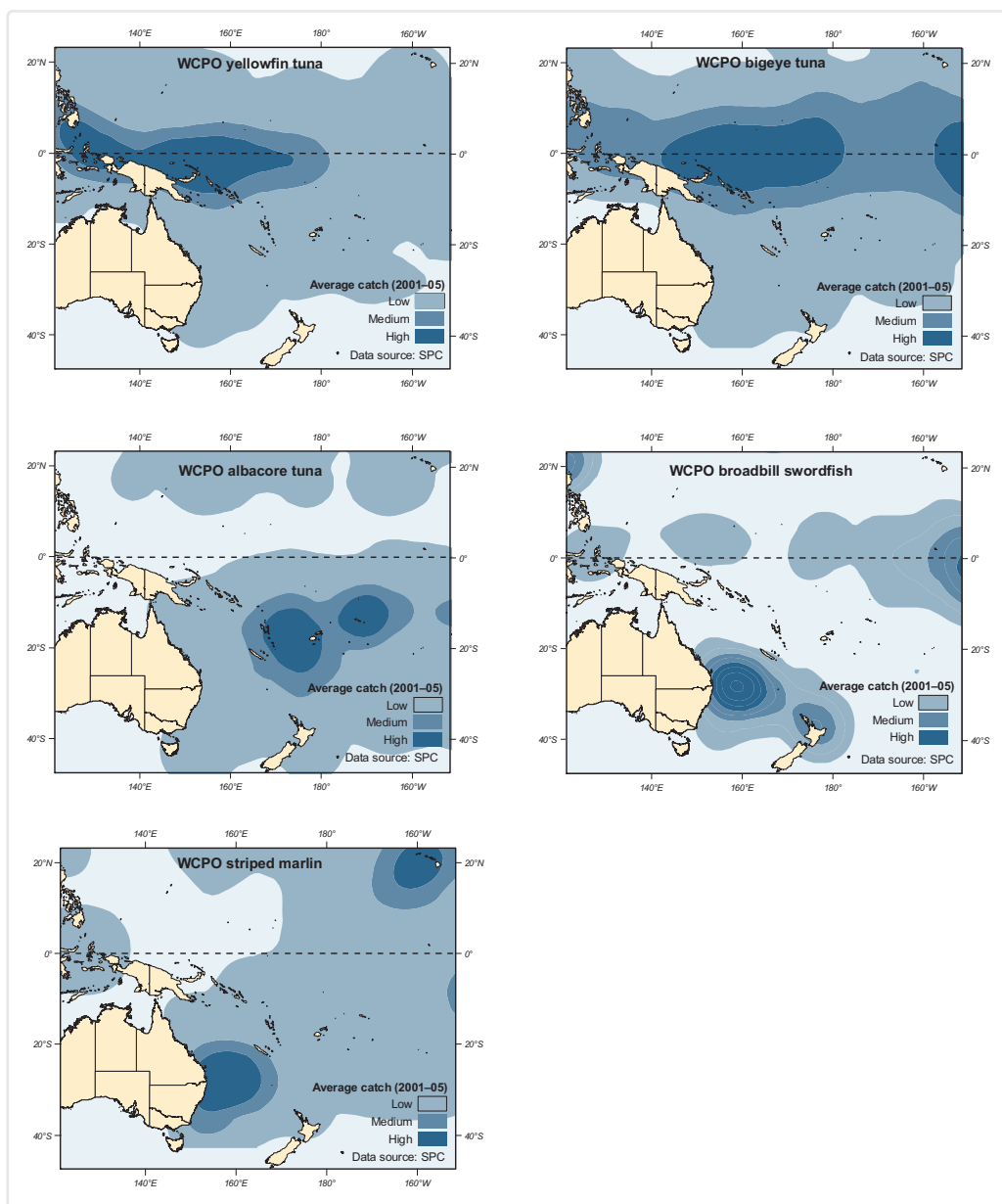
In addition to longliners, large fleets of foreign purse-seine, pole-and-line and trolling vessels fish for tuna in the WCPO for canning markets. The bulk of the WCPO tuna catch is purse-seined skipjack, with yellowfin (more caught by purse seine than by longline), bigeye and albacore (both mostly caught by longline) making up most of the remainder.

The 2006 and 2007 fisheries

Western and Central Pacific Ocean Fishery

Tuna and billfish fished in the ETBF are likely to be components of broader WCPO stocks. The catches of skipjack, yellowfin, bigeye and albacore in 2006 totalled 2.190 million t in the WCPO, which was





slightly below the 2005 record catch. The skipjack catch (1.538 million t) was the highest on record, and accounted for 70% of the WCPO total in 2006.

Bigeye tuna accounts for a small proportion (6%) of the total catch, but its annual value in the WCPO exceeds \$720 million. Around 60% of the WCPO bigeye catch is taken by longline. Since 1980, the total catch of bigeye over the entire Pacific Ocean has

ranged between 120 000 t and 255 000 t. The 2006 bigeye catch for the Pacific Ocean was the lowest for the past 7 years, owing to reduced catches in the eastern Pacific. The WCPO catch of bigeye for 2006 (75 000 t) was also lower than catches in recent years. Note that Indonesian and Filipino landings data are being revised, and estimates of past catches are likely to be increased.

Annual WCPO catches of yellowfin have exceeded 400 000 t in most years since the late 1990s. They fell to 378 000 t in 2004, then rose to 427 000 t in 2006.

After 1970, annual catches of albacore in the South Pacific ranged between 25 000 t and 35 000 t, but with the introduction of driftnet fishing rose to 49 000 t in 1989. With the cessation of driftnet fishing, annual catches generally ranged between 30 000 t and 40 000 t per year throughout the 1990s, before increasing to over 60 000 t in 2002, mainly as a result of growth in several Pacific island domestic longline fisheries. The 2006 catch (68 000 t) was the highest on record.

Eastern Tuna and Billfish Fishery

ETBF longline fishing effort declined from a peak of 12.7 million hooks in 2003 to 8.4 million hooks in 2007. The 2006 structural adjustment resulted in the surrender of almost 100 of the more than 200 longlining permits originally available in the fishery. About 60 vessels reported longlining during 2007. In addition to restructuring, the decreased activity is attributed to high operating costs (driven mainly by oil prices and the cost of squid bait), the strength of the Australian dollar and reduced catch rates of swordfish in inshore areas and around seamounts.

Nominal catch per unit effort (CPUE) for domestic-longlined yellowfin peaked at around 27 fish per 1000 hooks in 1987 (when 2 million hooks were set). During the years

from 1992 to 1996, catch rates varied between 12 and 18 yellowfin per 1000 hooks, decreasing to less than 8 during 1997 when a significant part of the fleet switched to targeting swordfish. Since 1998, catch rates have varied between 4 (in 1999) and 9 (in 2002) yellowfin per 1000 hooks.

Nominal CPUE for swordfish and bigeye peaked in 1997 (when 6 million hooks were set) and then fell quickly. Since 2000, catch rates of both species have remained well below their peak, declining to record lows in 2006. Catch rates of swordfish in inshore regions declined significantly, and localised depletion became apparent on the inshore 'Brisbane Grounds'. Large vessels had maintained higher catch rates by operating progressively further offshore. Several longliners in the ETBF began to use deep, daytime sets to catch albacore in 2005. They were joined by over 20 ETBF longliners in 2006. The proportion of swordfish taken from outside the AFZ subsequently declined from almost 40% of the total weight in 2004 to less than 10%. Following the brief lapse in swordfish targeting during 2006, catch rates of swordfish increased in 2007. Nominal CPUE is a crude method for assessing fish stocks, particularly in the case of a multispecies fishery like the ETBF, where variations in catch rate may simply reflect altered targeting practices. Nonetheless, increases in total effort have not been matched by increases in total catch over the fishery's history.

Catches and catch rates of striped marlin increased in the late 1990s. In 1999, recreational anglers reported their best striped marlin season on record, but recreational catches then declined. Commercial longliners also reported high catch rates of large (~80 kg whole weight) striped marlin from 1998 to 2001, followed by declines. The reasons for these apparent fluctuations in availability in the ETBF are unknown, but may be related to fluctuations in recruitment; migrations; exploitation rates in the ETBF and adjacent waters; targeting; or broadscale variations in oceanographic or migration patterns.



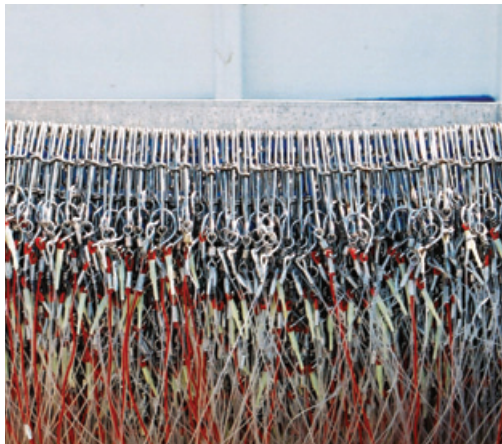
Longline catch of tuna

Recreational catches of other billfish continue to be patchy. The heavy tackle fishery for large black marlin (*Makaira indica*) off Cairns reported a very poor season in 2007, with few smaller black marlin hooked southwards along the Queensland coast. A few large black marlin (120–150 kg) were hooked off New South Wales.

Current monitoring and research

An Australian Government logbook for domestic longliners was introduced in 1986. Return rates were poor until 1995, when AFMA enforced returns as a condition of fishing permits, maintained a monthly audit and supported the program with regular field liaison.

In 1997, the collection of individual processed-weight data from the major ETBF processors became routine for swordfish, yellowfin and bigeye. It has since been extended to striped marlin and albacore, as well as several other species. In 2003, AFMA implemented an at-sea observer program in the longline sector of the ETBF. With the decline in fishing activity, coverage rates have increased to over 6% of the total fishing effort reported in logbooks. In the past, the program has had difficulty obtaining a



Longline branch lines with line clips and circle hooks

representative sample of the full spatial and temporal extent of the fishery. AFMA has increased the target for observer coverage to 8.5% of hooks deployed in the fishery. In 2006, AFMA introduced catch disposal records for the domestic fishery, which collects verified numbers and total weights of all fish landed after each trip.

Current research in the ETBF includes:

- defining regional connections in south-west Pacific swordfish
- investigating the size composition, age composition and spawning activity of albacore tuna in the ETBF
- studying the population biology and habitat preferences of striped marlin in the south-western Pacific
- developing harvest strategies for the ETBF
- developing robust stock-status indicators
- determining the ecological impacts of longline fishing in the ETBF
- determining the depths fished and the effective longline effort targeted at various species in the ETBF
- developing and assessing bycatch mitigation devices to reduce interactions of marine mammals with longline and gillnet gear, and using technology to reduce mammal predation on the catch
- conducting integrated assessment, and developing and evaluating an assessment framework for the ETBF
- updating the stock assessment of swordfish in the south Pacific Ocean.

Recent research in the ETBF has included:

- studying the effects of bycatch mitigation measures, such as circle hooks and wire leaders, on target and non-target catches
- stock assessment of striped marlin in the south-western Pacific Ocean
- an analysis of the interactions of domestic longline and recreational gamefish fisheries taking or targeting striped marlin off New South Wales
- a review of byproduct interactions and economics in Australia's tuna and billfish fisheries

- studies of migration and habitat preferences of bigeye on the east coast of Australia
- studies of the age and growth of swordfish from Australian waters
- studies of the age and growth of bigeye from the eastern and western AFZ
- development of an operating model and evaluation of harvest strategies for the ETBF
- studies of the dynamics of the interactions of the fishery and swordfish on seamounts off eastern Australia
- studies of the biology of, and fisheries for, striped marlin
- investigation of the origin of yellowfin recruits to the eastern AFZ
- research into the reproductive dynamics of swordfish in the domestic longline fishery off eastern Australia.

Harvest strategy

A harvest strategy framework, scheduled for implementation in early 2009, has been developed for the ETBF. Computer-based evaluations are being used to test the likely performance of the harvest strategies for each of the five target species (yellowfin, bigeye, striped marlin, broadbill swordfish, albacore). The framework includes a ‘decision tree’ that defines rules and subsequent adjustments to the recommended biological catch (or level of fishing effort) for each target species.

Empirical indicators of stock status are used because robust, region-specific assessments are not available for stocks within the ETBF. For each target species, the decision tree uses information on the relative values and trends in the standardised catch rates of three size-classes of fish (small, prime, large) and the proportion of ‘large’ fish in the catch. The values of these indicators are compared with target reference levels. The target reference levels are based on the expected catch rates and size proportion when the mean spawners per recruit is at 40% of the pre-fished level of spawners-per-recruit (SPR_{40}). SPR_{40} was



Tuna longliner, Ulladulla

used as a proxy for the default target reference points required by the Commonwealth Fisheries Harvest Strategy Policy. The framework does not currently contain an explicit limit reference level. Management strategy evaluations are being used to tune the harvest strategy for each species to ensure that they comply with the specifications of the policy. Those evaluations will also take into account the multi-species nature of the fishery, so that the harvest strategies maintain the breeding potential of each species above an implicit limit reference point of SPR_{20} .

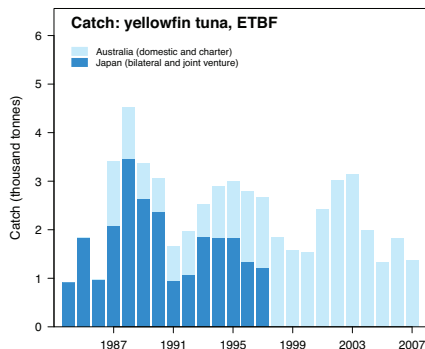
By considering size data, the harvest strategy should be more robust to potential biases in the reliability of longline catch rates as indices of stock abundance. The impact of uncertainty over the extent of linkages between the ETBF and wider Pacific stocks will be investigated as part of the evaluations conducted during 2008. The harvest strategy is cost-effective in using data from existing programs that monitor commercial fishing activities. This will necessitate rigorous data verification and the collection of auxiliary data—for example, variations in fishing power and discarding.

Status of stocks

YELLOWFIN TUNA

→ STATUS

Overfishing in the western and central Pacific Ocean, but stocks not overfished.



Yellowfin tuna inhabit tropical and subtropical waters and are considered to consist of a single stock in the WCPO. They are fast-growing and mature at about 2 years of age. They spawn where sea-surface temperatures are at least 26°C. In equatorial waters, mature females are capable of releasing millions of eggs at a time, and can spawn every 1 or 2 days during the spawning season. Yellowfin can grow to 180 cm long and weigh over 100 kg when they are 6 years or older, but the average weight of those caught by Australian longliners is about 34 kg.

Tagging studies show that yellowfin move between the ETBF and WCPO. On the other hand, many tagged fish are recaptured close to where they were tagged, even after long periods at liberty. Yellowfin-recapture rates from WCPO tagging programs of the early 1980s and 1990s showed a high population turnover and low to moderate exploitation rates in the equatorial region.

About half of the WCPO yellowfin catch is taken by purse seine. Nominal catch rates are characterised by strong inter-year variability, but they do not show any clear

trend. The same pattern appeared in the standardised catch rates of the main longline fleets after initial, rapid declines when longlining commenced. The Secretariat of the Pacific Community (SPC) developed an integrated, spatial and age-structured model (MULTIFAN-CL) that estimates population parameters at regional and subregional levels. The WCPFC's 2007 assessment of yellowfin stock status was consistent with the 2005 and 2006 assessments. Current levels of catch and fishing effort are not sustainable, with the most recent estimate indicating a 48% probability that fishing mortality is exceeding the level that would produce the maximum sustainable yield (MSY). SPC assessments use the WCPFC's default definitions of 'overfishing' ($F_{\text{CURRENT}} > F_{\text{MSY}}$) and 'overfished' ($B_{\text{CURRENT}} < B_{\text{MSY}}$), which tend to be more conservative than those defined in the Australian Government's Commonwealth Fisheries Harvest Strategy Policy.

Yellowfin from different areas of the ETBF appear to have a common recruitment source—probably the Coral Sea—but in some years recruits may come from other WCPO regions, perhaps in response to variations in regional circulation. Analyses of tag-recapture data on yellowfin released in the north-western Coral Sea in the early 1990s indicated that their exploitation rate in the ETBF was lower than in the WCPO. Before the large expansion in domestic fishing effort in the mid-to-late 1990s, the status of the yellowfin tuna resource off eastern Australia was based on the analysis of in-zone Japanese longline catch-and-effort data. Those data were standardised for changes in the spatial distribution of fishing effort, changes in longline depth, monthly variations in sea-surface temperature and the El Niño – Southern Oscillation (ENSO) in order to obtain an annual index of relative abundance (or availability). While the analyses indicated large inter-year variations in abundance in the ETBF, they did not indicate a long-term decline between 1970 and the mid-1990s.

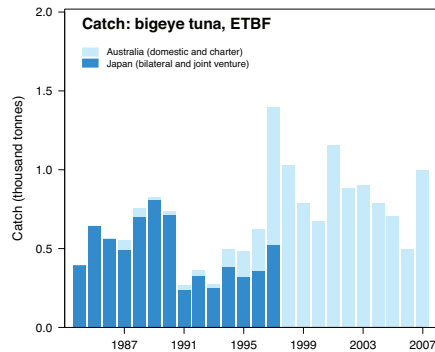
Since the cessation of Japanese longline effort in the AFZ in 1997, standardised catch rates from the domestic longline fleet have been used to assess the status of yellowfin tuna in the ETBF. Yellowfin catch rates display no long-term trend but considerably more inter-year variation than those of the other principal target species in the ETBF. The catch rates of prime-sized yellowfin (25–50 kg) showed threefold variations during the years from 1997 to 2007. The catch rate of small yellowfin (<25 kg) was low between 1998 and 2000, indicating that poor recruitment may have resulted in low catch rates of prime-sized fish in 1999 and of large-sized fish in 2000. However, depletion in local areas cannot be ruled out as a possible cause. Recreational fishers have reported very poor seasons for yellowfin in inshore waters since the mid-1990s.

The regional stock assessment shows that the greatest impact from fishing is in the equatorial western Pacific, while exploitation rates in the temperate regions are estimated to be low to moderate. There is uncertainty about whether purse seining in the WCPO has any effect on ETBF longline catch rates. Management decisions have been predominantly influenced by the tagging-based assessments of exploitation rates in the wider WCPO. However, those assessments might not accurately reflect the ETBF status because the amount of mixing between WCPO and ETBF stocks is unknown. Optimisation of economic benefits may warrant restraint of yellowfin fishing activity in the ETBF because of the possibility of local depletion if there is little or sporadic recruitment from the WCPO to the ETBF.

BIGEYE TUNA

→ STATUS

Overfishing in the western and central Pacific Ocean, but stocks not overfished.



Bigeye are slower growing than yellowfin, maturing at about 3 years of age and reaching 200 cm and over 180 kg when 8 years or older. Those caught by Australian longliners average about 30 kg. Bigeye spawn in equatorial waters throughout the year. They have a wide distribution both latitudinally and vertically because of their tolerance of low oxygen levels and low temperatures. Catch rates and information on habitat preferences of bigeye suggest that ENSO events increase bigeye catchability in the WCPO by raising the lower limit of vertical distribution. They are capable of long-range movements, perhaps across the entire Pacific. While genetic studies indicate a single stock across the Pacific, recaptures of tagged bigeye also show that many remain in the area of release.

The annual bigeye catch in the WCPO convention area usually ranged between 80 000 t and 100 000 t during the decade to 1997 but since then has usually been above 120 000 t, mainly due to the expansion of purse seining with fish-aggregating devices, which takes large numbers of juvenile bigeye along with skipjack and yellowfin tuna. The eastern Pacific Ocean purse-seine catch has

been increasing, but the longline catch there has declined steadily from its mid-1980s peak.

For several years, age-structured assessment models have consistently indicated that overfishing of bigeye is occurring in both the WCPO and the eastern Pacific Ocean. Current levels of catch and fishing effort in the WCPO are not considered to be sustainable. The most recent (2004) estimate of fishing mortality is 25% above the level that would produce the MSY. This means that, according to the WCPFC's default definitions, the stock will soon warrant classification as overfished ($B_{\text{CURRENT}} < B_{\text{MSY}}$) if fishing continues at 2001–04 levels and recruitment remains at the long-term average level. The eastern Pacific Ocean stock is now assessed as overfished. For both yellowfin and bigeye, the greatest impact from fishing is in equatorial waters; bigeye at higher latitudes, such as in the ETBF, are estimated to be moderately exploited.

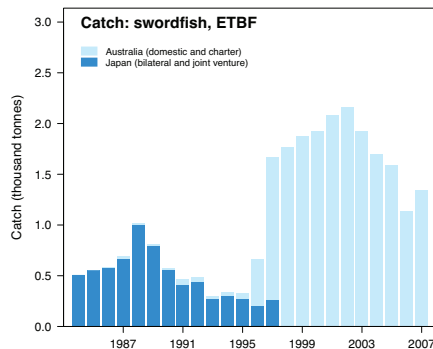
There is no specific bigeye assessment for the ETBF. It is unlikely that ETBF bigeye are a separate stock, but there could be some isolation from the broader WCPO. Scientists from the SPC and CSIRO analysed exploitation rates and movement patterns of recaptured bigeye that had been tagged and released in the Coral Sea during the early 1990s. Australian longliners based in Cairns reported most of the recaptures, and exploitation rates in the Coral Sea may be high.

Standardised catch rates of bigeye in the ETBF show a decline in rates for large bigeye between 1997 and 2004, recent rates being less than half those achieved in the late 1990s. The catch rates of prime-sized bigeye also remain at around half those of the late 1990s—although the catch rates of small bigeye are around double their earlier values.

BROADBILL SWORDFISH

→ STATUS

Overfished status uncertain and overfishing status uncertain in the south-western Pacific.



Swordfish, like bigeye and yellowfin, have a Pacific-wide distribution. During the day, swordfish live in deep waters (down to 600 m, although they may dive to 1000 m). At night, they tend to move to surface waters to feed. Reported distributions of larvae and longline catches show three or four Pacific areas where swordfish are most abundant, and genetic studies suggest that there may be several semi-independent stocks (a northern stock, a south-western stock and two or three eastern Pacific stocks). The amount of mixing among them is unknown.

In the north Pacific, swordfish grow rapidly during their first 2 years of life, after which females grow faster than males. Females also reach much larger sizes than males: most swordfish larger than about 200 kg are female. In the central Pacific, females are sexually mature at about 4 years of age or 50–60 kg, whereas males mature by about 2 years or 20 kg. By contrast, a study of swordfish in the ETBF suggests that female swordfish may mature later in other areas. Like yellowfin and bigeye, swordfish have a high reproductive capacity, and they spawn broadly across the oceans—including tropical waters of the ETBF—when sea-surface temperature exceeds 24°C.

The average size of swordfish in longline catches tends to increase with latitude. Presumably, the juvenile swordfish commonly found in tropical and subtropical waters migrate to higher latitudes as they mature. Large, solitary, adult swordfish are most abundant at 15–35° north and south of the equator. Swordfish distribution also varies with sex: larger females are more common at higher latitudes, and males more common in tropical and subtropical waters.

The complex migration patterns of swordfish and sexual differences in growth rates mean that size-composition monitoring should also record catch location and swordfish sex. This would require monitoring at sea because swordfish are landed gilled and gutted.

The expansion of longline fisheries in Australia and New Zealand resulted in significant increases in swordfish catches after the mid-1990s. The total annual catch in the south-western Pacific is currently 4000–5000 t with an additional 1000–3000 t taken further to the east. Distant-water longliners that fish for tuna in international waters account for as much as half of the south-western Pacific catches of swordfish. There are concerns about the sustainability of uncontrolled expansion in catches, particularly by the Spanish longline fleet.

In 2006 the first stock assessment of swordfish in the south-western Pacific, undertaken by CSIRO in collaboration with New Zealand, explored a variety of plausible scenarios and assumptions, but there were no definitive conclusions on stock status. Nevertheless, the assessment showed consistent declines in stock abundance in recent years, and most model projections predicted further declines at current levels of fishing mortality. The WCPFC Scientific Committee suggested that any further increases in fishing mortality would likely move south-western Pacific swordfish to an overfished state.

Nominal longline catch rates indicated that, as the catch rates have progressively declined nearer the coast, ETBF longliners have fished progressively further offshore.

Longline catch rates also declined around seamounts off southern Queensland and northern New South Wales. Possible causes are increasing competition among longliners, a concentration of less-experienced fishers in more-inshore regions or depletion of localised aggregations of swordfish in the ETBF (management arrangements have been introduced to address this issue—see ‘Management performance’). Standardised catch rates of both prime and large swordfish during 2003–04 were one-third of the rates observed in 1997, although catch rates increased in 2007.

The impact of the rapid increase and subsequent decline in ETBF swordfish catches over the past decade will depend on swordfish stock structure and mixing rates between the ETBF and wider Pacific. If the swordfish harvested in the ETBF are a local stock, the drop in catch rates is likely to be due to localised depletion, and replenishment will depend on localised recruitment. A tagging study is underway to help determine the mixing of swordfish throughout the south-western Pacific.

Swordfish catch rates in the north Pacific are closely correlated with changes in the strength of oceanic fronts. Consequently, studies of broadscale oceanographic events, such as ENSO, and decade-scale changes in ocean productivity may have implications for management of the ETBF swordfish fishery.

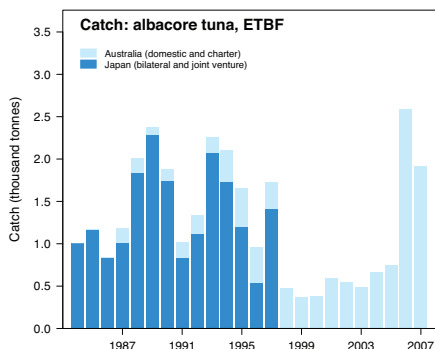


Longliner putting to sea, Ulladulla

ALBACORE TUNA

→ STATUS

Not overfished and not subject to overfishing in the south Pacific.



Albacore are believed to consist of a single stock in the south Pacific. The juveniles live in the cooler, temperate waters of the subtropical-convergence zone, while the adults mostly live to its north and spawn in tropical and subtropical waters. The waters off south-eastern Tasmania are at the southern limit of albacore distribution.

Albacore are slower growing than skipjack and yellowfin. They mature at about 85 cm when 5–6 years old, and grow to about 120 cm when over 10 years old. Albacore often make long-range seasonal movements.

Traditionally, longliners landed albacore as a byproduct when targeting sashimi tuna. Japanese longliners took 1000–2000 t of albacore per year in the ETBF during the 1980s and 1990s before their AFZ access ended in 1997. Domestic catches were much lower, ranging up to about 600 t per year. Attempts to develop a domestic albacore troll fishery off south-eastern Australia in the late 1980s were unsuccessful because the total catch was too small to make domestic canning viable.

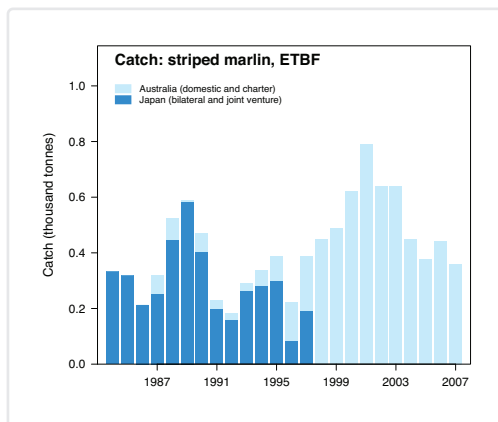
Using deep-setting techniques from Samoa, several domestic longliners began targeting albacore in 2005. Most of the albacore catch was exported for canning, but industry actively developed new markets for fresh product to increase returns. The deep longline sets also produced valuable catches of bigeye. Catch rates and profits were high, while the cost of fuel and bait were lower than for swordfish longlining. Over 25 Mooloolaba-based longliners were fishing for albacore by mid-2006, resulting in the albacore catch taken in the ETBF during 2006 reaching around 2600 t. By the end of that year, canning prices for albacore had fallen by about 25%. Combined with unfavourable currency exchange rates, the price reduction resulted in most longliners switching back to sashimi tuna and swordfish, while others developed new markets for their albacore.

There is no stock assessment of ETBF albacore. The SPC has developed a MULTIFAN-CL model for the south Pacific stock. They estimated that, with above average recruitment, the biomass increased to a peak in the late 1980s, before declining in subsequent years. However, the biomass remains well above the level required to produce MSY. Nevertheless, several domestic fleets in the south Pacific (such as those of French Polynesia and Samoa) have reported declines in their albacore catch rates in recent years. The declines may be a consequence of broadscale oceanographic conditions or localised depletion, but remain a concern in the absence of a clear understanding of mechanisms determining the local abundance and availability of albacore.

MARLINS

→ STATUS

Overfished status and overfishing status of striped marlin uncertain in the south-western Pacific.



Marlins are large, highly migratory pelagic species that do not tend to form large schools. Loose aggregations occur during spawning periods, at which time mature females release millions of eggs. Young marlins grow quickly to become peak predators on a variety of prey, including fish, squid and crustaceans.

The three species caught off the east coast of Australia—black, blue and striped marlin—are distributed throughout tropical and subtropical waters of the Pacific Ocean. Black marlin seem most abundant near landmasses, whereas the others have broader, oceanic distributions, with blue marlin most abundant in equatorial and tropical waters, and striped marlin in subtropical waters.

The stock structure of the three marlin species is uncertain. However, there is evidence to suggest that black marlin constitute a single stock across the Pacific. Tag-recapture data show evidence of significant transoceanic movements, while recent genetic studies concluded that enough gene flow occurs across the species' range to prevent marked substructuring of populations.

Molecular analyses of blue marlin samples from various Pacific sites have been unable to detect structuring, which implies a single

Pacific stock. Gene flow among fish from geographically separated locations seems sufficient to prevent the accumulation of significant genetic differences. Tag-recapture data also show that blue marlin are capable of long-distance movements.

Preliminary studies suggest significant genetic differences between striped marlin in the south-western Pacific and those in the north-central and eastern Pacific. Widely separated spawning grounds, a lack of confirmed tag-recapture evidence for east-west transoceanic movements and low catch rates in the equatorial band of the WCPO also support the notion of a semi-independent south-western Pacific stock.

Large numbers of marlin have been taken by longline throughout the Pacific Ocean. In eastern Australia the landing and sale of striped marlin are permitted, but the commercial retention of black and blue marlin by domestic longliners has been banned since 1998 and operators are required to release them—despite indications that at least 30% of hooked marlin die.

In the 1970s, the development of a charter-vessel gamefish industry for black marlin off Cairns (an important black marlin spawning ground) raised concern over the bycatch of marlins by Japanese longliners. Charter catch rates did not increase significantly after Japanese longliners were excluded from the AFZ, even though the subsequent levels of domestic longlining off Cairns have been less than half the historical Japanese levels. Subtle variations in the distribution of marlin on a regional scale may be responsible for much of the year-to-year variation.

Despite increased longline fishing in the ETBF during the 1990s and early 2000s, longline effort and marlin catch remain much lower than in the wider Pacific. The peak Australian catch of black marlin, in 1987, was only 1.1% (for blue marlin, 4%) of the estimated total western Pacific catch of the species. Reported catches since then represent even smaller percentages.

Blue marlin have a broader oceanic distribution and support larger catches (about

25 000 t annually in the western Pacific in recent years) than do black marlin (about 2700 t annually). Consequently, they are less likely to be affected by longlining in the ETBF than are black marlin. Catches by other nations might reduce ETBF catches of blue marlin, depending on the amount caught, the proximity of activities to Australia, marlin movement patterns and the species' biology (for example, its growth and natural mortality rates).

Longliners fishing for tuna and swordfish take significant catches of striped marlin in the Pacific. Most are caught incidentally, but some fleets target them in certain high-abundance regions and seasons. Other longline fleets, such as those of New Zealand and Fiji, also catch striped marlin. At sashimi markets in Japan, striped marlin fetches high prices—at times comparable with bigeye prices—and it has a growing domestic market in Australia. The annual ETBF striped marlin

catch trebled after 1997, peaking at 782 t in 2001, and then declined to about 500 t.

Recreational catches of striped marlin also increased in the ETBF during the 1990s. More than 15 000 striped marlin have been tagged and released off the east coast since 1995, compared with fewer than 1500 in the previous decade. Striped marlin have surpassed black marlin as the billfish species most frequently caught, tagged and released by anglers.

Production models fitted to Japan's 1952–80 longline data suggest that the MSY for Pacific striped marlin had not been reached by 1980, and that fishing pressure on the stock during the late 1970s may have been less than that in the 1960s. A recent assessment of striped marlin in the north Pacific suggests that the stock is overfished and that spawning biomass and landings will continue to decline if the fishing mortality continues at current rates.

Within the ETBF, standardised catch rates of striped marlin have declined over the past decade, with catch rates in recent years being around half those of the late 1990s. In 2006, the Bureau of Rural Sciences (BRS) and the SPC completed the first stock assessment of striped marlin in the south-western Pacific. The assessment highlighted significant declines in abundance, particularly in the late 1950s when Japanese longliners targeted the species in the Coral Sea. It was uncertain whether overfishing was occurring or whether the stock was overfished. However, several of the plausible scenarios indicated that current fishing mortality equalled or exceeded F_{MSY} , and current spawning biomass levels equalled or were below the spawning biomass that would support MSY. The WCPFC Scientific Committee subsequently recommended that there be no increase in striped marlin fishing mortality in the south-western Pacific.

No reliable stock assessment is available for black or blue marlin in the ETBF or the wider Pacific. Commercial catch data can be unrepresentative because longliners often release or discard marlin, and recreational



Striped marlin

data are difficult to collect and analyse. A preliminary assessment of blue marlin in the Pacific indicated a significant reduction in catch rates after the 1970s. Current catches are close to the estimated sustainable level for the current biomass. Reductions in catch rates and catches might result largely from the introduction of deep-longline fishing techniques. Black marlin catch rates have also declined substantially in the western Pacific, at least partly because of access restrictions and changes in fishing practices.

Environmental issues

More than 100 marine species have been recorded from the ETBF longline sector, including tuna and tuna-like fish, billfish, sharks, rays, various other fish, seabirds and occasionally sea turtles and marine mammals. When Japanese longliners were operating in the fishery, they retained about 30 species (mainly tuna, billfish and some sharks) for commercial sale. The remaining species (most commonly blue shark, *Prionace glauca*) were released or discarded at sea. Commercial markets have since developed in Australia and overseas for several other species, such as mahi mahi and wahoo (*Acanthocybium solandri*). Trip limits are in place for several byproduct species.

AFMA has a bycatch action plan for the two Commonwealth-managed tuna longline fisheries (the ETBF and the Western Tuna and Billfish Fishery). AFMA and CSIRO recently completed an ecological risk assessment of the ETBF. The assessment combines various productivity and susceptibility attributes to assess the ecological risk that longlining poses to all species that are encountered. AFMA will use the results of the assessment to develop management strategies for at-risk species and ecological groups.

In 2000, a BRS report highlighted high levels of shark bycatch and the widespread practice of 'shark finning' in Australia's tuna fisheries, particularly in the ETBF and the Western Tuna and Billfish Fishery. AFMA banned the practice of finning sharks at sea,

prohibiting the possession or landing of fins separate from carcasses. It also enforces a landing limit of 20 sharks per vessel per fishing trip. In 2005, AFMA banned the use of wire leaders or 'traces' on longline branchlines in the ETBF. The measure is intended to reduce shark mortality: sharks are more likely to bite through synthetic fibre leaders and escape. A BRS study confirmed that banning wire leaders reduced shark catches and may increase catch rates of target species, such as bigeye tuna. However, the study also highlighted the possibility of unseen or 'cryptic' mortality among the many animals that are able to escape by biting through the leader.

Sharks, and also pilot, killer and false killer whales, sometimes remove or damage hooked fish before the longline is hauled. This is a growing problem for the ETBF longline fishery. The hooking or entanglement of cetaceans in longlines is extremely rare.

Public concern over incidental catches of sea turtles resulted in fishery closures for United States longliners in the north Pacific and north Atlantic. In the ETBF, the introduction of shallow longline sets to target swordfish increased the likelihood of catching sea turtles. A BRS project concluded that sea turtle interaction rates in the ETBF are low compared with rates in other longline fisheries and that almost all sea turtles are released alive. The United States is moving to ban imports of seafood from longline fisheries that do not use the sea turtle bycatch mitigation measures that are required under US domestic legislation, such as large circle hooks and fish baits. An Australian study of the effects of circle hooks on catch rates of target and non-target species in the ETBF will be completed in 2008.

Seabirds, such as albatrosses and shearwaters, are attracted to longline baits when vessels are setting their gear, and some birds become hooked and drown. In the ETBF, industry and government have investigated ways of reducing interactions between seabirds and longlines. In August 1998, a threat abatement plan was introduced

to reduce the incidental catch of seabirds by longliners fishing in the ETBF and other Commonwealth-managed fisheries. Longliners are required to carry an approved bird-scaring 'tori' line, which must be used when setting south of 25° S. In those areas, they are also required to manage offal discharge, use thawed baits when setting at night, and use weighted swivels on longlines set during the day. Nominal catch rates of seabirds have fallen below 0.05 birds per 1000 hooks in recent years. However, at times, observer data have not been representative of the fishery. Analyses that adjust estimates for this bias in observer coverage confirm that fishery-wide catch rates are currently below the 0.05 target, but also indicate a significant probability of seabird catch rates exceeding the target level in some areas and seasons.

Longliners often catch live bait in inshore waters of New South Wales. The ecological risk assessment suggests that the removal of the baitfish poses a moderate risk to those species and the ecology of inshore waters.

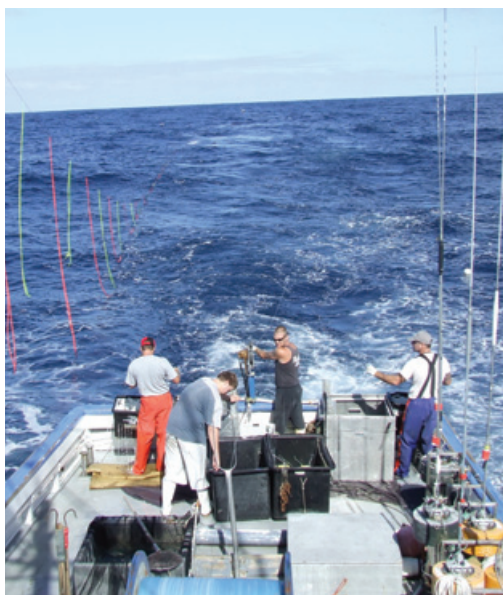
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Management performance

Australia, along with other Pacific and distant-water fishing nations, has been closely involved in negotiating arrangements for managing the WCPO tuna fishery. A convention for establishing formal regional management arrangements for tuna and billfish fisheries in the WCPO came into force in 2004, establishing the WCPFC. The ETBF should benefit from mechanisms that will allow control of the region's fishing activities and from a regional approach to monitoring and data collection, research and assessment. However, progress so far has been slow. For example, the conservation and management measures intended to reduce fishing mortality for swordfish and for striped marlin in the south-western Pacific are unlikely to be completely effective because they are based on limits on the total number of vessels targeting those species.

A management plan for the ETBF was introduced in 2005 and implementation has begun, but the allocation of statutory fishing



Bird-scaring tori line

rights is unlikely to commence until after 2008. The new management arrangements are based on gear units (longline clips). The likelihood of localised depletion of swordfish in some regions of the ETBF indicates that further management action may be required if declines in the economic efficiency of the fishery and possible impacts on shelf and seamount ecosystems are to be avoided. It is unlikely that a single management measure, such as limiting the total number of hook-days allocated to each operator, will be effective in limiting fishing mortality of a single species, such as swordfish, in this multispecies fishery. The management plan has a broad scope with which to introduce further input controls, and the AFMA board has approved trigger total allowable catches. Vessels are currently monitored through logbooks, verified landing records, observers and vessel-monitoring systems (VMSs).

In response to declining catch rates since the late 1990s, AFMA has set annual trigger catch levels of 1400 t for swordfish. To achieve the target, trigger catch limits were

set for the catch of swordfish in each quarter of the year. If the trigger catch levels are breached, operators are limited to 10 swordfish per trip (with some exemptions based on catch history). The trip limit continues until catches meet the next quarterly trigger level. To date, catch levels have remained below their associated trigger levels.

Following the rapid expansion of albacore longlining in 2006, AFMA closed the main fishing ground (the 'albacore area') to new entrants. As an interim arrangement until the management plan is fully implemented, AFMA introduced a 3200 t catch limit for the species in the albacore area for 2007. With reduced targeting of albacore, arrangements associated with the albacore area have been removed.

Some ETBF longliners target southern bluefin tuna off New South Wales during winter, after fishing for tropical tuna and billfish in earlier seasons. Other longliners take southern bluefin tuna incidentally when targeting other tunas. All southern bluefin tuna taken must be covered by quota. Since 2000, AFMA has placed specific operational-area and quota-holding requirements on ETBF longliners to reduce the likelihood of southern bluefin tuna being captured without quota. Observers are regularly placed on longliners in those areas during winter, and all ETBF operators are required to operate a VMS.

For monitoring other impacts of fishing, including the status of target species, AFMA relies on data collected through logbooks. However, logbook data require independent verification. The program that placed observers on Japanese longliners in the AFZ was effective in verifying logbooks. An observer program was established in 2003 for the domestic fishery. Since 2006, AFMA has checked logbook records against the verified weights recorded in catch disposal records after each trip.

