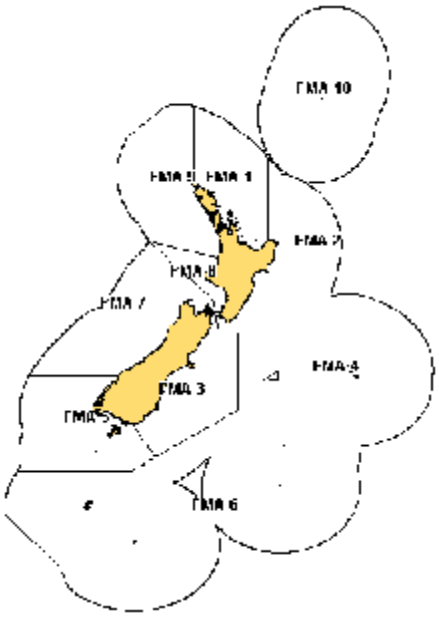
STRIPED MARLIN (STM)

(*Tetrapturus audax*)



1. FISHERY SUMMARY

Management of the striped marlin and other highly migratory pelagic species throughout the western and central Pacific Ocean (WCPO) will be the responsibility of the Western and Central Pacific Fisheries Commission (WCPFC). Under this new regional convention New Zealand will be responsible for ensuring that the fisheries management measures applied within New Zealand fisheries waters are compatible with those of the Commission.

(a) Commercial fisheries

Most of the commercial striped marlin catch in the southwest Pacific is caught in the tuna surface longline fishery, which started in 1952 and in the New Zealand region in 1956. Since 1980 foreign fishing vessels had to obtain a license to fish in New Zealand's EEZ and were required to provide records of catch and effort. New Zealand domestic vessels commenced fishing with surface longlines in 1989 and the number of vessels and fishing effort expanded rapidly during the 1990s. Also in 1989, licences were issued to charter up to five surface longline vessels (Japanese) to fish on behalf of New Zealand companies. Very few striped marlin are caught by other commercial methods, although there are occasional reports of striped marlin caught in purse seine nets, however these fish are seldom seen in catch records.

A three-year billfish moratorium was introduced in October 1987 in response to concerns over the decline in availability of striped marlin to recreational fishers. The moratorium prohibited access to the Auckland Fisheries Management Area (AFMA) by foreign licensed and chartered tuna longline vessels in, between 1 October and 31 May each year. Licence restrictions required that all billfish, including broadbill swordfish, caught in the AFMA be released. In 1990 the moratorium was renewed for a further 3 years with some amended conditions and it was renewed again in 1993 for a further year.

Regulations prohibited domestic commercial vessels from retaining billfish caught within the AFMA since 1988. In 1991 these regulations were amended to allow the retention of broadbill swordfish and prohibited the retention of marlin species (striped, blue and black marlin) by commercial fishermen in the entire EEZ of New Zealand. These regulations and government policy changes on the access rights of foreign licensed surface longline vessels have replaced the billfish moratorium. A billfish memorandum of understanding between representatives of commercial fishers and recreational interests provided a

framework for discussions on billfish management. This MOU was reviewed annually between 1990 and 1997, and was last signed in 1996.

Estimates of total landings (commercial and recreational) for New Zealand compared to the commercial removals from the wider stock are given in Table 1. Commercial catch of striped marlin reported on Catch Effort Landing Returns (CELRs) and Tuna Catch Effort Landing Returns (TCELRs) and recreational catches from New Zealand Big Game Fishing Council records are given in Table 1.

Table1: Commercial landings and discards (number of fish) of striped marlin in the New Zealand EEZ reported by fishing nation (CELRs and TLCERs), and recreational landings and number of fish tagged, by fishing year.

Fishing	Japan	Japan	Korea	Domestic	Philippine	NZ Recreational		Total
Year	Landed	Discarded	Landed	Discarded	Discarded	Landed	Tagged	
1979-80	592					692	17	1 301
1980-81	1 677		46			792	2	2 517
1981-82	2 799		44			704	11	3 558
1982-83	980		32			702	6	1 720
1983-84	1 176		199			543	9	1 927
1984-85	552		160			262		974
1985-86	1 711		19			395	2	2 127
1986-87	1 755		26			226	2	2 009
1987-88	167		100			281	136	684
1988-89	31		30			647	408	1 116
1989-90	123			6		463	367	959
1990-91		1		10		532	232	775
1991-92		13		1		519	242	775
1992-93		1		11		608	386	1 006
1993-94				59		663	929	1 651
1994-95				196		910	1 206	2 312
1995-96				471		705	1 104	2 280
1996-97		12		414		619	1 302	2 347
1997-98				451		543	898	1 892
1998-99				1 613		823	1 541	3 977
1999-00		2		801		398	791	1 992
2000-01				528		422	851	1 801
2001-02				225		430	765	1 420
2002-03				205	7	495	671	1 378
2003-04				423		592	1 047	2 062
2004-05				271		834	1 311	2 416

Total recorded commercial catch was highest in 1981–82 at 2843 fish and 198 t. Following the introduction of the billfish regulations striped marlin caught on commercial vessels were required to be returned to the sea and very of these fish were recorded on catch/effort returns. In 1995 the Ministry of Fisheries instructed that commercially caught marlin be recorded on TLCERs. However, compliance with this requirement was inconsistent and estimated catches in the tuna longline fishery (calculated by scaling-up observed catches to the entire fleet) are considerably higher in all fishing years for which these estimates are available (since 1994–95). However, these estimates are imprecise and probably biased, as the MFish Observer Programme coverage of the domestic fleet has been low until recent years and has not adequately covered the spatial and temporal distribution of the fishery.

Very few striped marlin in the TLCER database were reported south of 42°S and most striped marlin reported on TLCERs were caught north of latitude 38°S. Japanese and Korean vessels caught most striped marlin between 31°S and 35°S with a peak at 33°S. The New Zealand domestic fleet caught the majority of their striped marlin in the Bay of Plenty, East Cape area, between 36°S and 37°S.

A significant number of records from domestic commercial vessels provide the number of fish caught but not estimated catch weight. The total weight of striped marlin caught per season was calculated using fisher estimates from TLCER and CELR records plus an estimate for the records where weight was not recorded. The latter estimate was derived from the number of fish with blank weights multiplied by the mean striped marlin weight from recreational club records for that season. However, these fish were not landed but released. The total reported landings (or fishing mortality) by season is derived from the likely proportion of the commercial striped marlin hauled to the boat dead (estimated from observer records at 18%) plus the weight of fish landed by recreational fishers from New Zealand Big Game Fishing Council and club records (Table 2).

Table 2: Reported total New Zealand landings (commercial and recreational) (t) and commercial landings from the southwest Pacific Ocean (t) of striped marlin from 1991 to 2003.

Year	NZ landings (t)	SWPO landings (t)	Year	NZ landings (t)	SWPO (t)
1991	52	1 026	1999	98	1 817
1992	58	788	2000	54	1 545
1993	63	972	2001	54	1 421
1994	67	1 606	2002	50	1 649
1995	98	1 450	2003	59	2 150
1996	79	1 231	2004	70	Not available
1997	72	1 356	2005	93	Not available
1998	64	1 860			

Source: Blue Water Marine Research and SCTB Working paper SWG-3 and SPC longline data.

Combined landings from within New Zealand fisheries waters are relatively small compared to commercial landings from the greater stock in the southwest Pacific Ocean (3% average for 1998-2001). In New Zealand, striped marlin are landed almost exclusively by the recreational sector, but there are no current estimates of recreational catch from elsewhere in the southwest Pacific.

(b) Recreational fisheries

The striped marlin fishery is an important component of the recreational fishery and tourist industry from late December to May in northern New Zealand. There are approximately 100 recreational charter boats that derive part of their income from marlin fishing and a growing number of private vessels participating in the fishery. Many of the largest fishing clubs in New Zealand target gamefish and are affiliated to the national body, the NZ Big Game Fishing Council (NZBGFC). Clubs provide facilities to weigh fish and keep catch records.

In 1988 the NZBGFC proposed a voluntary minimum size of 90 kg for striped marlin in order to encourage tag and release. Fish under this size do not count for national contests or trophies but most are included in the catch records each season (1 July to 30 June). In 2004–05 the 60 recreational fishing clubs affiliated to NZBGFC reported landing 3989 billfish, sharks, kingfish and tuna and tagging and releasing a further 2228 gamefish. Of these, 834 striped marlin were landed and weighed in 2004–05 (21% of landed fish in NZBGFC records) and the number tagged was 1327 (60% of tagged fish in NZBGFC records). There is a fairly complete historical database of recreational catch records for each striped marlin caught by the Bay of Islands Swordfish Club and the Whangaroa Big Game Fishing Club going back to the 1920s, when this fishery started.

(c) Maori customary fisheries

Maori traditionally ate a wide variety of seafood however no record of specific marlin fishing methods has been found to date. An estimate of the current customary catch is not available.

(d) Illegal catch

There is no known illegal catch of striped marlin.

(e) Other sources of mortality

Some fish that break free from commercial or recreational fishing gear may die due to hook damage or entanglement in trailing line. A high proportion of fish that are caught are released alive at the boat by both commercial and recreational fishers. Data collected by the Ministry of Fisheries Observer Programme from the tuna longline fishery suggest that most striped marlin are alive on retrieval (72% of the observed catch). The proportion of striped marlin brought to the boat alive was similar on domestic longliners and foreign and charter vessels. However, post release survival rates are unknown. Recreational anglers tag and release 65% of their striped marlin catch (mean of the last ten years). Most of these fish are caught on lures. Preliminary results from 40 pop-up satellite archival tags (PSATs) deployed on lure caught striped marlin in New Zealand showed a high survival rate following catch and release. The pop-up archival tags are programmed to release from the fish following death. No fish died and sank to the seafloor. One fish was eaten (tag and all) by a Lamnid shark about 15 hours after it was tagged and released. A small proportion of other PSAT tags failed to report so the fate of these fish is unknown.

Striped marlin caught on baits in Mexico showed a 26% mortality rate within 5 days of release. Injury was a clear predictor of mortality; 100% of fish that were bleeding from the gill cavity died, 63% of fish hooked deep died, and 9% of those released in good condition died.

2. BIOLOGY

Striped marlin is one of eight species of billfish in the family Istiophoridae. They are epi-pelagic predators in the tropical, subtropical and temperate pelagic ecosystem of the Pacific and Indian Oceans. Juveniles generally stay in warmer waters of the range, while adults move into higher latitudes and temperate water feeding grounds in summer (southern hemisphere 1st quarter of the calendar year; 3rd quarter in the northern hemisphere). The latitudinal range estimated from longline data extends from 45^{o}N to 40^{o}S in the Pacific and from continental Asia to 45^{o}S in the Indian Ocean. Striped marlin are not uniformly distributed, having a number of areas of high abundance and tagged individuals have undergone extensive seasonal migrations.

Samples from recreationally caught striped marlin in New Zealand indicate the most frequent prey items are saury and arrow squid followed by jack mackerel. However, 28 fish and 4 cephalopod species have been identified from stomach contents indicating opportunistic feeding also occurs.

The highest striped marlin catch for the surface longline method is recorded in January-February but striped marlin have been caught in New Zealand fisheries waters in every month, with lowest catches in November and December.

Striped marlin are oviparous and are known to spawn in the Coral Sea between Australia and New Caledonia. Their ovaries start to mature in this region during late September or early October. Spawning peaks in November and December and 60-70% of fish captured at this time are in spawning condition. The minimum size of mature fish in the Coral Sea is recorded at approximately 170 cm lower jaw-fork length (LJFL) and 36 kg. Striped marlin captured in New Zealand are rarely less than 200 cm (LJFL) suggesting that these fish are all mature. Female striped marlin, on average, are lager than males but sexual dimorphism is not as marked as that seem in blue and black marlin. The sex ratio of striped marlin sampled from the recreational fishery in Northland (n = 61) was 1:1 prior to the introduction of the voluntary minimum size (90 kg). There is no clear evidence of striped marlin reproductive activity in New Zealand waters. The northern edge of the EEZ around the Kermadec Islands extends into subtropical waters. In some years there are moderate numbers of striped marlin in this area from October to December according to historical longline records. Striped marlin spawning could occur in this area in some years.

Unvalidated age and growth estimates are available for striped marlin in New Zealand waters. These estimates were derived from counts of opaque growth zones in thin sections of the third dorsal spine and assume that one opaque zone is formed per year. This assumption is untested. Growth bands for New Zealand striped marlin of between 2 and 8 bands are broadly comparable with overseas studies.

Melo-Barrera et al. (2003) identified between 2 and 11 bands in Mexico and Skillman and Yong (1976) classified up to 12 age groups from length frequency analysis of striped marlin in Hawaii. Recreational catch records kept by the International Game Fish Association (IGFA) list the heaviest striped marlin as 224.1 kg caught in New Zealand in 1975.

Estimates of biological parameters for striped marlin in New Zealand waters are given in Table 3.

Table 3: Estimates of biological parameters.

Fishstock	Estimate			Source
1. Natural mortality (M)				
STM	0.49–1.33			Boggs (1989)
STM	0.389–0.818			Hinton and Bayliff (2002)
2. Weight = a (length)^b (Weight in kg, length in mm lower jaw fork length)				
	a	b		
STM males	2.0×10^{-8}	2.88	New Zealand	Kopf et al. (in prep)
STM females	2.0×10^{-8}	2.90		
3. Von Bertalanffy model parameter estimates				
	k	t_0	L_∞	
STM	0.22	-0.04	3010	New Zealand	Kopf et al. (in prep)
STM	0.23	-1.6	2210	Mexico	Melo-Barrera et al (2003)
STM male	0.315–0.417	-0.521	2774-3144	Hawaii	Skillman and Yong (1976)
STM female	0.686–0.709	0.136	2887-3262	Hawaii	Skillman and Yong (1976)

3. STOCKS AND AREAS

Striped marlin are a highly migratory species and fish caught in the New Zealand fisheries waters are part of a wider stock. The stock structure of striped marlin in the Pacific Ocean is not well known, but the focus of current research activities. The two most frequently considered hypotheses are: (1) a single-unit stock in the Pacific, which is supported by the continuous "horseshoe-shaped" distribution of striped marlin; and (2) a two-stock structure, with the stocks separated roughly at the Equator, albeit with some intermixing in the eastern Pacific.

Spawning occurs in water warmer than 24°C mainly in November and December in the southern hemisphere. Known spawning areas in the southwest Pacific are in the Coral Sea in the west and French Polynesia in the east of the region. The southern hemisphere spawning season is out of phase with the north Pacific. Very warm equatorial water in the western Pacific, where striped marlin are seldom caught, may be acting as a natural barrier to stock mixing. However, in the eastern Pacific striped marlin may be found in equatorial waters and 3 fish tagged in the Northern hemisphere have been recaptured in the southern hemisphere. The results of mitochondrial DNA analysis are consistent with shallow population structuring within striped marlin in the Pacific.

The New Zealand Cooperative Gamefish Tagging Programme has tagged and released 14 504 striped marlin between 1 July 1975 and 30 June 2005. Of the 72 recaptures reported 28 have been made outside the EEZ spread across the region from French Polynesia (142°W) to eastern Australia (154°E) and from 2°S to 38°S latitude. There have been no reports of striped marlin tagged in the southwestern Pacific being recaptured elsewhere in the Pacific Ocean. Projects currently underway using electronic tags will reveal new information on the movement of Pacific striped marlin.

Striped marlin are believed to have a preference for sea surface temperatures of 20 to 25 °C. Generally striped marlin arrive in New Zealand fisheries waters in January and February and tag recaptures indicate that they leave the New Zealand EEZ between March and June, although they have been caught by surface longliners in the EEZ in every month. Within the EEZ most striped are caught in FMA1, FMA9, and FMA10.

4. STOCK ASSESSMENT

With the establishment of WCPFC in 2004, the Scientific Committee of the Western and Central Pacific Fisheries Commission (WCPFC) will review stock assessments of striped marlin in the western and central Pacific Ocean stock. Unlike the assessment for the main tuna stocks, billfish assessments will not be undertaken by the Oceanic Fisheries Programme of Secretariat of the Pacific Community (SPC) under contract to WCPFC, at least in the early years of the Commission. As the status of billfish stocks was recognised as important to the Commission, it was recommended that members of the WCPFC collaborate on billfish assessments.

Currently there is no stock assessment for striped marlin that includes the part of the stock that spends time in New Zealand waters. A stock assessment for striped marlin in the eastern Pacific Ocean assumes a single stock in the eastern Pacific in northern and southern hemispheres. The current biomass in the eastern Pacific Ocean was predicted to be larger than that which would support MSY (Hinton and Maunder 2003).

An earlier striped marlin stock assessment divided Pacific striped marlin into northern hemisphere and southern hemisphere stocks and calculated effective fishing effort, which factored in the difference in the depth of setting hooks and the effect this would have on catchability of striped marlin. For the southern stock a MSY range of between 5700 and 9100 t was estimated and it was inferred from this that the fishery was exploiting the stock at close to the optimum level (Suzuki 1989). Commercial catch in the southwest Pacific (10 – 50^{o}S, 140^{o}E to 130^{o}W from SPC data) ranges between 800 and 2400 t per year, while estimates of annual commercial catch in the western and central pacific range between 3000 and 6000 t over the last two decades.

Australia is currently collaborating with SPC on a striped marlin assessment for the southwest Pacific Ocean. It is unclear when the results of this assessment will be available, but New Zealand is providing data for the fisheries that catch striped marlin in New Zealand waters.

(a) Biomass and yield estimates

No estimates of biomass or yield are available.

(b) Other factors

Given that New Zealand fishers encounter some of the largest and likely oldest striped marlin in the Pacific, the abundance of fish found within New Zealand fisheries waters will be very sensitive to the status of the stock in addition to environmental factors that may also influence availability.

5. STATUS OF THE STOCK

Currently there is no stock assessment for striped marlin in the southwestern Pacific Ocean. An unknown proportion of that stock spends part of the year in New Zealand fisheries waters. Future assessments will be complicated by uncertain growth rate, catch statistics and by un-quantified changes in fishing practice that may confound signals in CPUE.

It is not known if the stock is presently above the level necessary to produce the maximum sustainable yield or if current catches from the stock are sustainable or will move the stock towards a level necessary to produce the maximum sustainable yield. A large proportion of striped marlin caught in New Zealand are released alive because of the regulations that prohibit landing of striped marlin on commercial vessels and the practice of tag and release by recreational fishers. A regional stock assessment has been proposed and New Zealand will be contributing where possible to this process.

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