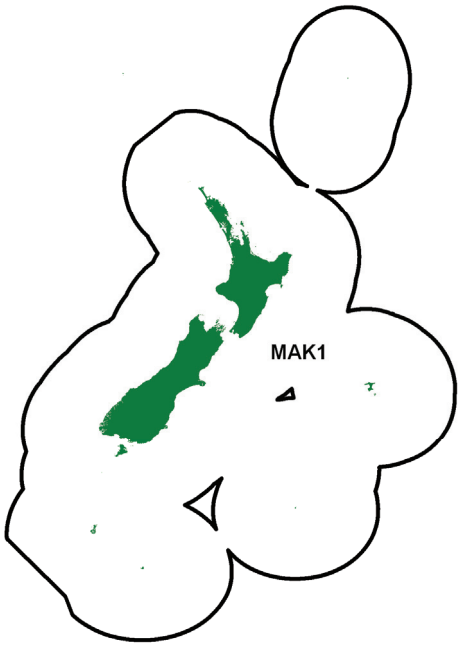
MAKO SHARK (MAK)

(*Isurus oxyrinchus)*
Mako



1. FISHERY SUMMARY

Mako shark were introduced into the QMS on 1 October 2004 under a single QMA, MAK 1, with allowances, TACC, and TAC in Table 1.

Table 1: Recreational and Customary non-commercial allowances, TACCS and TACs for mako shark.

Fishstock	Recreational Allowance	Customary non-commercial Allowance	Other mortality	TACC	TAC
MAK 1	50	10	46	406	512

Mako shark was added to the Third Schedule of the 1996 Fisheries Act with a TAC set under s14 because mako shark 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.

Mako shark was also added to the Sixth Schedule of the 1996 Fisheries Act with the provision that:

> "A commercial fisher may return any mako shark to the waters from which it was taken from if –
> (a) that mako shark is likely to survive on return; and
> (b) the return takes place as soon as practicable after the mako shark is taken."

Management of the mako shark throughout the western and central Pacific Ocean (WCPO) will be the responsibility of the Western and Central Pacific Fisheries Commission (WCPFC). Under this regional convention New Zealand will be responsible for ensuring that the management measures applied within New Zealand fisheries waters are compatible with those of the Commission. However, it is not expected that WCPFC will attempt to actively manage mako shark in the first years of the Commission.

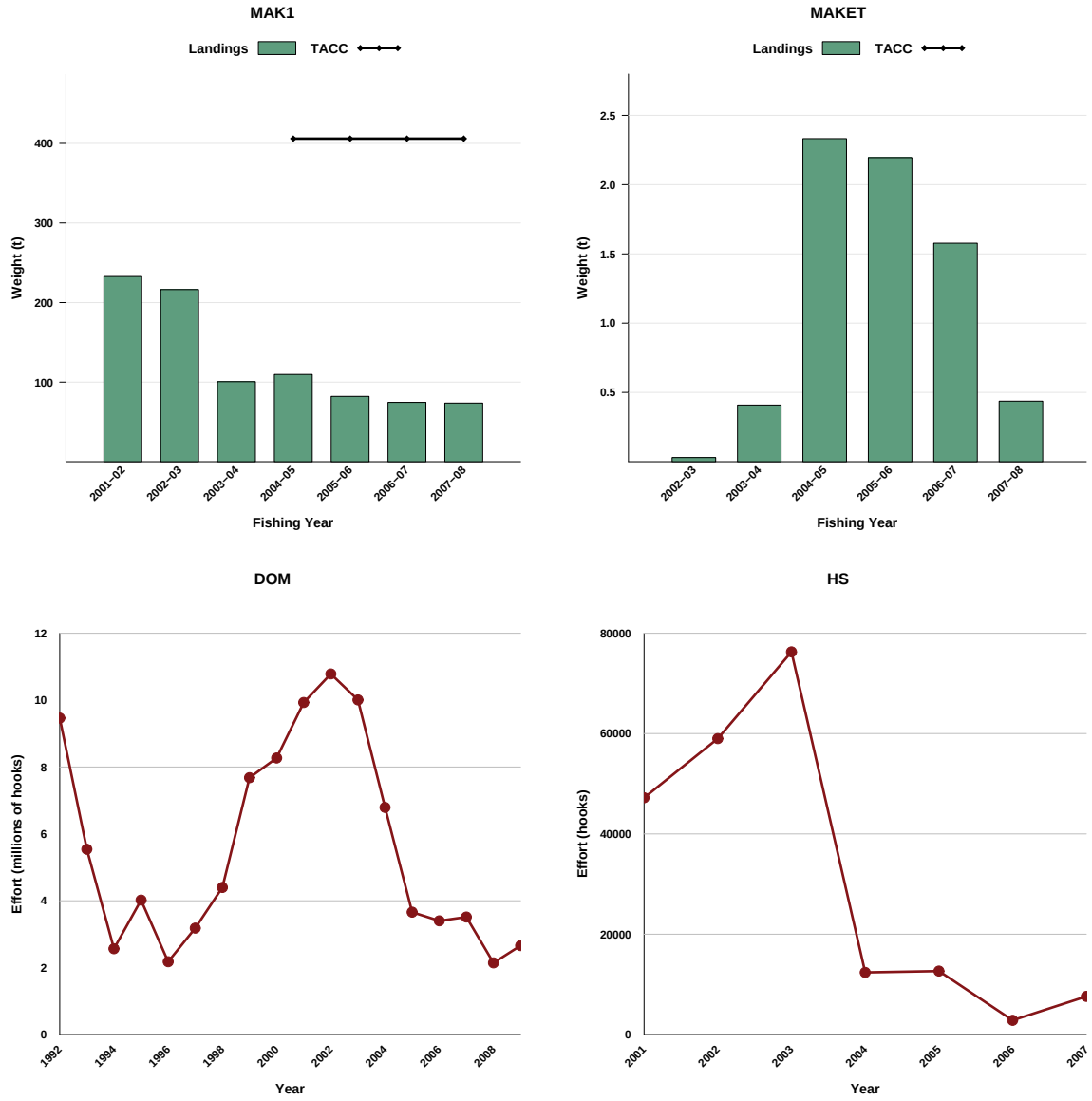


Figure 1: [Top] Mako Shark catch from 2001-02 to 2008-09 within NZ waters (MAK1) and on the high seas (MAKET). [Bottom] Fishing effort (number of hooks set) for all domestic and high seas surface longline vessels, from 1992 to 2009 and 2001 to 2007, respectively.

1.1 Commercial fisheries

Most of the commercial catch of mako sharks is taken by tuna longliners, but bottom longliners and bottom and mid-water trawlers also take some. About three-quarters of mako sharks caught by tuna longliners are processed, and the rest are discarded.

Landings of mako sharks reported on CELR (landed), CLR, LFRR, and MHR forms are shown in Table 2. The total weights reported by fishers were 86–295 t during 1997–98 to 2002–03. Processors reported 76–319 t on LFRRs during the same period. There was a steady increase in the weight of mako shark landed between 1997–98 and 2000–01, resulting from a large increase in domestic fishing effort in the tuna longline fishery, and probably also improved reporting. Landings have since declined to one-third of the peak landings. Estimates of the catch of mako sharks aboard tuna longliners, based on scaled up scientific observer records, are imprecise, and possibly biased, because the observer coverage of the domestic fleet (which accounts for most of the fishing effort) has been low (less than 5% in the years 1996-97 to 2004-05) and has not adequately covered the spatial and temporal distribution of the fishery.

In addition to catch taken within New Zealand fisheries waters, a small amount (about 1 t) is taken by longline vessels fishing on the high seas.

Table 2: New Zealand commercial landings (t) of mako sharks reported by fishers (CELRs and CLRs) and processors (LFRRs) by fishing year. Also shown for some years are the estimated numbers of makos caught by tuna longliners, as reported to the WCPFC

Year	Total reported	LFRR/MHR	Estimated catch by tuna longliners
1989/90	11	15	
1990/91	15	21	
1991/92	17	16	
1992/93	24	29	
1993/94	44	50	
1994/95	63	69	
1995/96	67	66	
1996/97	51	55	
1997/98	86	76	
1998/99	93	98	
1999/00	148	196	
2000/01	295	319	
2001/02	242	245	
2002/03*	233	216	
2003/04*	100	100	
2004/05*	107	112	
2005/06*	82	84	6 560
2006/07*	75	75	3 859
2007/08*	74	74	
2008/09*		78	

*MHR rather than LFRR data.

Catches of mako sharks reported by Ministry of Fisheries Observer Services aboard tuna longliners are concentrated off the west and southwest coast of South Island, and the northeast coast of North Island. However, these apparent distributions are biased by the spatial distribution of observer coverage. Mako sharks are probably taken by tuna longliners throughout New Zealand fishery waters. The target species for this fishery are mainly southern bluefin, bigeye, and albacore tuna. Most of the mako landings reported on CELR and CLR forms were taken in FMAs 1 and 2.

1.2 Recreational fisheries

There is a significant recreational catch of mako sharks and they are highly prizes as a sport fish. Reported catch has declined since the mid 1990s. Fishing clubs affiliated to the New Zealand Big Game Fishing Council have reported landing about 40 makos per year over the last four seasons. In addition recreational fishers tag and release 200 to 300 makos per season.

1.3 Customary non-commercial fisheries

There are no estimates of Maori customary catch of mako sharks. Traditionally, makos were highly regarded by Maori for their teeth, which were used for jewellery. Target fishing trips were made, with sharks being caught by flax rope nooses to avoid damaging the precious teeth.

1.4 Illegal catch

There is no known illegal catch of mako sharks.

1.5 Other sources of mortality

Many of the mako sharks caught by tuna longliners (about 75%) are alive when the vessel retrieves the line. It is not known how many of the sharks that are returned to the sea alive under the provisions of Schedule 6 of the Fisheries Act survive.

2. BIOLOGY

Makos occur worldwide in tropical and warm temperate waters, mainly between latitudes 50°N and 50°S. In the South Pacific, makos are rarely caught south of 40°S in winter–spring (August–November) but in summer–autumn (December–April) they penetrate at least as far as 55°S. Makos

occur throughout the New Zealand EEZ (to at least 49°S), but are most abundant in the north, especially during the colder months.

Mako sharks produce live young around 57–69 cm fork length (FL). In New Zealand, female makos mature at about 275–285 cm FL and males at about 180–185 cm FL. The length of the gestation period is uncertain, but is thought to be 18 months with a resting period between pregnancies leading to a two- or three-year cycle. Only one pregnant female has been recorded from New Zealand, but newborn young are relatively common. Litter size is 4–18 embryos. If the reproductive cycle lasts three years, and mean litter size is 12, mean annual fecundity would be 4 pups per year.

Estimates of mako shark age and growth in New Zealand were derived by counting vertebral growth bands, and assuming that one band is formed each year. This assumption has recently been validated for North Atlantic mako sharks. Males and females grow at similar rates until age 7–9 years, after which the relative growth of males declines. In New Zealand, males mature at about 7–9 years and females at 19–21 years. The maximum ages recorded are 29 and 28 years for males and females respectively.

The longest reliably measured mako appears to be a 351 cm FL female from the Indian Ocean, but it is likely that they reach or exceed 366 cm FL. In New Zealand, makos recruit to commercial fisheries during their first year at about 70 cm FL, and much of the commercial catch is immature. Sharks less than 150 cm FL are rarely caught south of Cook Strait, where most of the catch by tuna longliners consists of subadult and adult males.

Makos are active pelagic predators of other sharks and bony fishes, and to a lesser extent squids. As top predators, makos probably associate with their main prey, but little is known of their relationships with other species.

Estimates of biological parameters are given in Table 3.

Table 3: Estimates of biological parameters.

Fishstock	Estimate				Source
1. Natural mortality (M)					
MAK 1	0.10-0.15				Bishop et al. (2006)
2. Weight = a(length)^b (Weight in kg, length in cm fork length)					
Both sexes combined	a		b		
MAK 1	2.388×10^{-5}		2.847		Ayers et al. (2004)
3. Schnute growth parameters	L_1	L_{10}	κ	γ	
MAK 1 males	100.0	192.1	-	3.40	Bishop et al. (2006)
MAK 1 females	99.9	202.9	-0.07	3.67	Bishop et al. (2006)

3. STOCKS AND AREAS

Up to the 2007-08 fishing year, 11 471 makos had been tagged in New Zealand waters and 316 recaptured. Most of the tagged makos in 2006-07 were small to medium sharks with estimated total weights at 90 kg or less, with a mode at 10 kg, and they were mainly tagged off east Northland. Most movements were less than 500 km, with sharks remaining around east Northland or travelling to the Bay of Plenty and the west coast of North Island. However, long distance movements out of the New Zealand EEZ were frequent, with makos travelling to Australia or the western Tasman Sea (1500–2000 km), the tropical islands north of New Zealand (New Caledonia, Fiji, Tonga, Solomon Islands; 1500–2400 km) and to the Marquesas Islands in French Polynesia (4600 km).

DNA analysis of mako sharks collected in the North-east Pacific, South-west Pacific (Australia), North Atlantic and South-west Atlantic oceans showed that North Atlantic makos were genetically isolated from those found elsewhere, but there was no significant difference among the remaining sites.

The stock structure of mako sharks in the Southern Hemisphere is unknown. However, given the scale of movements of tagged sharks, it seems likely that sharks in the South-west Pacific comprise a single stock. There is no evidence to indicate whether this stock also extends to the eastern South Pacific or the North Pacific.

4. STOCK ASSESSMENT

With the establishment of WCPFC in 2004, future stock assessments of the western and central Pacific Ocean stock of mako shark will be reviewed by the WCPFC. Unlike the major tuna stocks, in the short term, development of a regional assessment for mako shark is likely to be done by collaboration among interested members.

There have been no stock assessments of mako sharks in New Zealand, or elsewhere in the world. No estimates of yield are possible with the currently available data.

Unstandardised CPUE analysis of tuna longline catches recorded by observers show no long-term trends over the period 1992–93 to 2004–05. These indices may not reflect stock abundance because they do not take into account variation in the numbers of mako sharks migrating into the New Zealand EEZ each year, and variation in many other influencing factors (e.g., vessel, gear, location and time of year).

Compared with a wide range of shark species, the productivity of mako sharks is low. Females have a high age at maturity, moderately high longevity (and therefore low natural mortality rate), and low annual fecundity. The low fecundity is cause for strong concern, as the ability of the population to replace sharks removed by fishing is very limited.

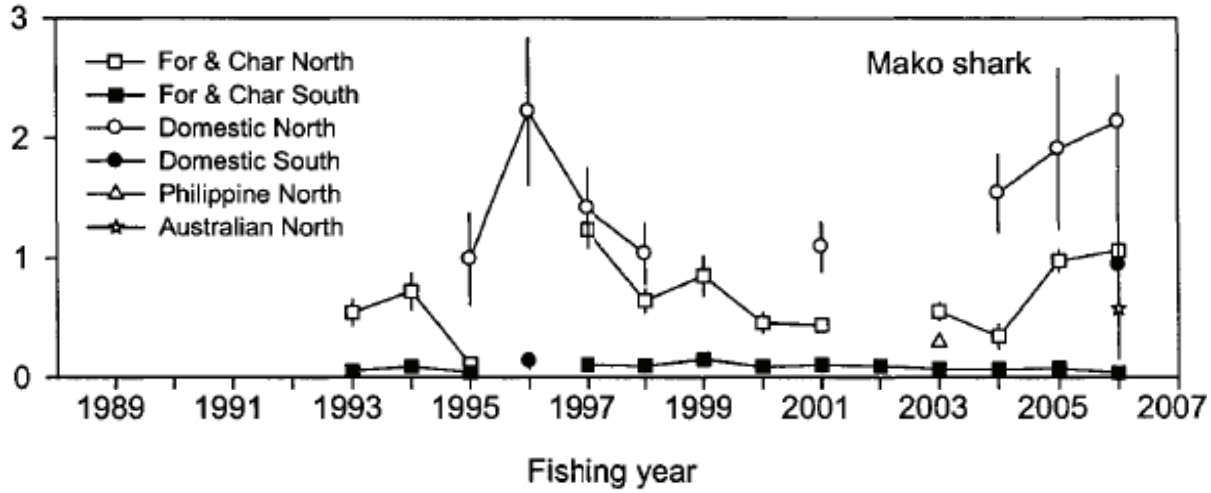


Figure 2: Unstandardised CPUE indices for the tuna longline fishery based on observer reports. Years are fishing years (1993 = October 1992 to September 1993). Confidence intervals are from bootstrapped data. Source: Griggs et al. (2008).

5. STATUS OF THE STOCK

Stock structure assumptions

MAK1 is assumed to be part of the wider South Western Pacific Ocean stock but the assessment below relates only to the New Zealand component of that stock.

Stock Status	
Year of Most Recent Assessment	2008
Reference Points	Target: Not established Soft Limit: Not established Hard Limit: Not established
Status in relation to Target	Unknown
Status in relation to Limits	Unknown
Historical Stock Status Trajectory and Current Status	

Fishery and Stock Trends	
Trend in Biomass or Proxy	Unknown
Trend in Fishing Mortality or Proxy	Unknown
Other Abundance Indices	CPUE analyses have been undertaken in New Zealand but are not considered to have generated reliable estimates of abundance.
Trends in Other Relevant Indicator or Variables	Catches in New Zealand increased from the early 1980's to a peak in the early 2000's but have declined form highs of 295t to 83t in 2006-07.

Projections and Prognosis	
Stock Projections or Prognosis	Unknown
Probability of Current Catch causing decline below limits	Soft Limit: Unknown Hard Limit: Unknown

Assessment Methodology		
Assessment Type	Level 3: Qualitative Evaluation: Fishery characterization with evaluation of fishery trends (e.g. catch, effort and nominal CPUE) - there is no agreed index of abundance.	
Assessment Method	CPUE analysis	
Main data inputs	Catch and effort	
Period of Assessment	Latest assessment: 2008	Next assessment: ?
Changes to Model Structure and Assumptions		
Major Sources of Uncertainty	Historical catch recording may not be accurate.	

Qualifying Comments

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).

6. FOR FURTHER INFORMATION

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