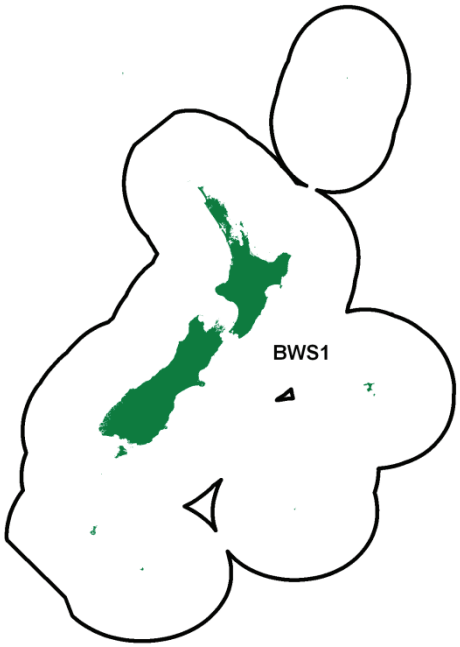
BLUE SHARK (BWS)

(*Prionace glauca*)



1. FISHERY SUMMARY

Blue shark was introduced into the QMS on 1 October 2004 under a single QMA, BWS 1, with allowances, TACC, and TAC in Table 1.

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

Fishstock	Recreational Allowance	Customary non-commercial Allowance	Other mortality	TACC	TAC
BWS 1	20	10	190	1 860	2 080

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

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

"A commercial fisher may return any blue shark to the waters from which it was taken from if –

(a) that blue shark is likely to survive on return; and

(b) the return takes place as soon as practicable after the blue shark is taken."

Management of blue sharks 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.

1.1 Commercial fisheries

Most of the blue shark catch in the New Zealand EEZ is caught in the tuna surface longline fishery. Relatively little blue shark is caught by other methods. Data collected by the Ministry of Fisheries Observer Services from the tuna longline fishery suggest that most of the blue shark catch is processed (72% of the observed catch), although usually only the fins are retained and the rest of the carcass is dumped (> 99% of the processed, observed catch). Greenweight (total weight) is obtained by applying species specific conversion factors to the weight of the fins landed. Figure 1 shows historical landings and fishing effort for BWS1 and BWSET.

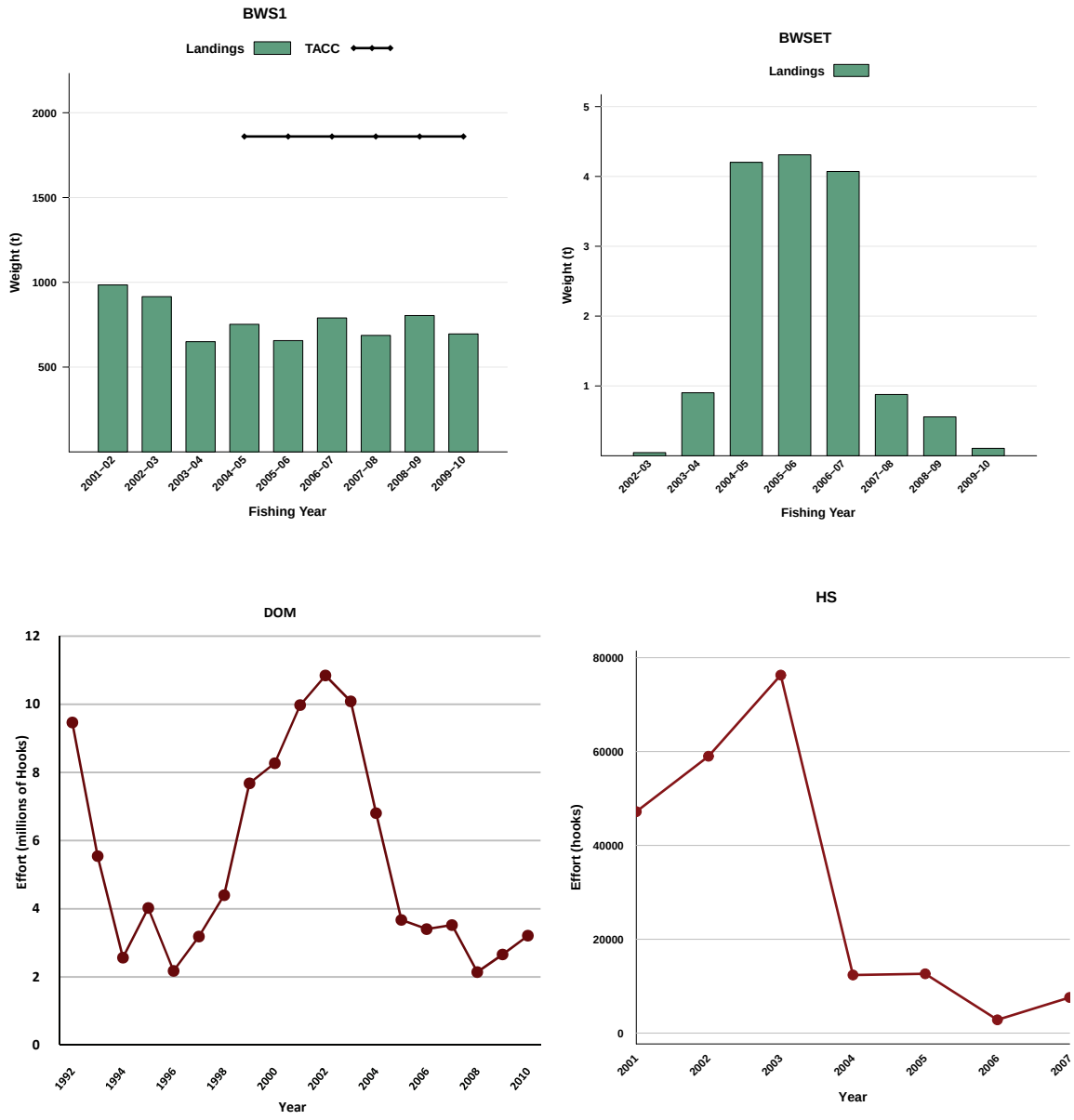


Figure 1: [Top] Blue Shark catch from 2001-02 to 2009-10 within NZ waters (BWS1), and 2002-03 to 2008-09 on the high seas (BWSET). [Bottom] Fishing effort (number of hooks set) for all domestic (including effort by foreign vessels chartered by NZ fishing companies) and high seas New Zealand flagged surface longline vessels, from 1992 to 2010and 2001 to 2007, respectively.

Landings of blue sharks reported on Catch Effort Landing Returns (CELRs), Catch Landing Returns (CLRs), and Licensed Fish Receiver Returns (LFRRs) are given in Table 2. Total weights reported by fishers (CELR and CLRs) were 551–1167 t per annum during 1997–98 to 2008–09. Processors (LFRRs) reported 525–1415 t per annum during the same period. As with mako (*Isurus oxyrinchus*) and porbeagle (*Lamna nasus*) sharks, there has been a decline in reported landings of blue sharks since 2000-01 to below 700 t. This is thought to have been a result of a decrease in domestic tuna longline fishing effort. Estimated catches in the tuna longline fishery calculated by scaling-up observed catches to the entire fleet are considerably higher than reported landings in all fishing years for which these estimates are available. However, these estimates are imprecise and probably biased, as MFish observer coverage of the domestic fleet (which accounts for most of the fishing effort) has been low (just below 10% in the last years 2007-2009).

In addition to catches within New Zealand fisheries waters, small catches are taken by New Zealand vessels operating on the high seas (Figure 1).

Table 2: New Zealand estimated commercial landings (t) reported by fishers (CELRs and CLRs) and processors (LFRRs) by fishing year. Also shown for some years are the estimated numbers of blue sharks caught by tuna longliners, as reported to WCPFC (2008).

Year	Total reported	LFRR/MHR	Estimated catch by tuna longliners
1989–90	12	5	
1990–91	2	3	
1991–92	18	13	
1992–93	39	33	
1993–94	371	118	
1994–95	254	140	
1995–96	152	166	
1996–97	161	303	
1997–98	551	537	
1998–99	576	525	
1999–00	641	1 031	
2000–01	1 167	1 415	
2001–02	1 076	1 105	
2002-03*	968	914	
2003-04*	649	649	
2004-05*	734	734	
2005-06*	656	656	98 912
2006-07*	790	794	53 297
2007-08*	681	687	
2008-09*		804	
2009-10*		696	

[1] Note that there may be some misreporting of blue shark catches (MFish species code "BWS") as bluenose (*Hyperoglyphe antarctica*; MFish species code "BNS") and vice versa.
*MHR rather than LFRR data.

Catches of blue sharks observed by the MFish Observer Services aboard tuna longline vessels are concentrated off the west and south-west coasts of the South Island, and the north-east coast of the North Island, extending northwards to the Kermadec Islands. However, these apparent distributions are biased by the spatial distribution of MFish Observer Services coverage; blue sharks are probably caught by tuna longline vessels throughout most of the New Zealand EEZ. Most of the blue shark landings reported by fishers (CELR and CLR forms) are concentrated in FMAs 1 & 2.

1.2 Recreational fisheries

Blue sharks are caught in relatively large numbers by recreational fishers in the NZ EEZ. Although not as highly regarded as other large, pelagic sharks such as mako in northern New Zealand, blue sharks are the primary target gamefish in southern New Zealand. Several hundred blue sharks are routinely tagged and released each year by the New Zealand Cooperative Gamefish Tagging Programme, an ongoing tag and release programme that operates in New Zealand's recreational gamefish fisheries. The total recreational catch is unknown.

1.3 Customary non-commercial fisheries

Prior to European settlement, Maori caught large numbers of cartilaginous fishes, including blue sharks. However, there are no estimates of current Maori customary catch.

1.4 Illegal catch

There is no known illegal catch of blue sharks.

1.5 Other sources of mortality

About 90% of all observed blue sharks caught in the tuna longline fishery are retrieved alive. About 28% of all observed blue sharks are discarded. The proportion of sharks discarded dead is unknown. Mortality rates of blue sharks tagged and released by the New Zealand Cooperative Gamefish Tagging Programme are also unknown.

2. BIOLOGY

Blue sharks (*Prionace glauca*) are large, highly migratory, pelagic carcharhinids found throughout the world's oceans in all tropical and temperate waters from about 50° N to 50° S. They are slender in build, rarely exceeding 3 m in total length and 200 kg in weight. They feed opportunistically on a range of living and dead prey, including bony fishes, smaller sharks, squids, and carrion.

In New Zealand waters, male blue sharks are sexually mature at about 190–195 cm fork length (FL), and female blue sharks at about 170–190 cm FL. Internationally, gestation in female blue sharks lasts between 9–12 months and between 4–135 pups (averaging 26–56) are born alive, probably during the spring. Pups are probably born at about 50 cm FL. The few embryos from New Zealand fisheries waters examined to date consisted of mid-term pups 21–37 cm FL collected in July and a full-term pup 54 cm FL collected in February. Blue sharks 50–70 cm FL are caught year-round in New Zealand fisheries waters but only in small numbers.

Age and growth estimates are available for blue sharks in New Zealand waters. These estimates were derived from counts of opaque growth zones in X-radiographs of sectioned vertebrae with the assumption that one opaque zone is formed per year. This assumption is untested. Female blue sharks appear to approach a lower mean asymptotic maximum length and grow at a faster rate than males. This differs from the age and growth analyses of blue shark from other oceans, where females typically approach a larger mean asymptotic maximum length than males.

This is thought to result from the presence of relatively few large (> 250 cm FL), old female blue sharks in length-at-age dataset analysed. The MFish observer data suggest that large (> 250 cm FL) female blue sharks are missing from the catch, despite reliable personal observations to the contrary from commercial and recreational fishers. There is evidence of size and sex segregation in the distributions of blue sharks in the North Pacific, with large, pregnant females tending to be found nearer the equator than males or smaller females. Given It is possible that large female blue sharks occur in New Zealand but have not been adequately sampled by observers.

Growth rates estimated for New Zealand blue sharks are broadly comparable with overseas studies. Males and females appear to grow at similar rates until about seven years of age, when their growth appears to diverge. Age-at-maturity is estimated at 8 years for males and 7-9 years for females. The maximum recorded ages of male and female blue sharks in New Zealand waters are 22 and 19 years, respectively. Blue sharks appear to be fully recruited to the commercial longline fishery by the end of their second year. The commercial catch sampled by the MFish observers consists of both immature and mature fish.

Estimates of biological parameters for blue sharks in New Zealand waters are given in Table 3.

Table 3: Estimates of biological parameters.

Fishstock	Estimate					Source
1. Natural mortality (M)						
BWS 1	0.19–0.21					Manning & Francis (2005)
2. Weight = a (length)^b (Weight in kg, length in cm fork length)						
	a	b				
BWS 1 males	1.578×10^{-6}	3.282				Ayers et al. (2004)
BWS 1 females	6.368×10^{-7}	3.485				
3. Von Bertalanffy model parameter estimates						
	k	t_0	L_∞			
BWS 1 males	0.0668	-1.7185	390.92			Manning & Francis (2005)
BWS 1 females	0.1106	-1.2427	282.76			
4. Schnute model (case 1) parameter estimates (are provided for comparison with the von Bertalanffy estimates above)						
	L_1	L_2	κ	γ	L_∞	
BWS 1 males	65.21	217.48	0.1650	0.1632	297.18	Manning & Francis (2005)
BWS 1 females	63.50	200.60	0.2297	0.0775	235.05	

3. STOCKS AND AREAS

The New Zealand Cooperative Gamefish Tagging Programme has tagged and released 3961 blue sharks between 1993/94 and 2007/08 in the New Zealand EEZ. Most tagged sharks were captured and released off the east coast of the South Island in recent years. A total of 66 tagged sharks have been recaptured since the start of the tagging programme. The recapture data show dispersal of tagged sharks away from their release point, although the relationship between time at liberty and dispersal is unclear. While some tagged sharks have been recaptured with little apparent movement away from their release point, others have been recaptured off Australia, Fiji, and French Polynesia. The most distant blue shark recapture to date was caught off Chile.

Although the data are relatively sparse, an overview of tagging data from Australia, New Zealand, the Central Pacific, and California suggest population exchange between not only the eastern and western South Pacific, but also between the South Pacific, south Indian, and even South Atlantic oceans. This suggests that blue sharks in the South Pacific constitute a single biological stock, although whether this is part of a single, larger Southern Hemisphere stock is unclear.

No other data are available on blue shark stock structure in the South Pacific.

4. STOCK ASSESSMENT

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

Quantitative stock assessments of blue sharks outside the New Zealand EEZ have been mostly limited to standardised CPUE analyses, although quantitative assessment models have been developed using conventional age-structured and MULTIFAN-CL methods. There have been no quantitative stock assessments of blue sharks in New Zealand waters and no quantitative stock assessments are possible with the current data.

Unstandardised CPUE indices computed from tuna longline catches recorded by the MFish observers in the NZ EEZ are highly variable (Figure 2). These indices are not thought to reflect stock abundance as they do not consider confounding factors such as inward and outward migration of blue sharks through the New Zealand EEZ, vessel gear parameters other than the number of hooks set, and the location and time and date the gear was set.

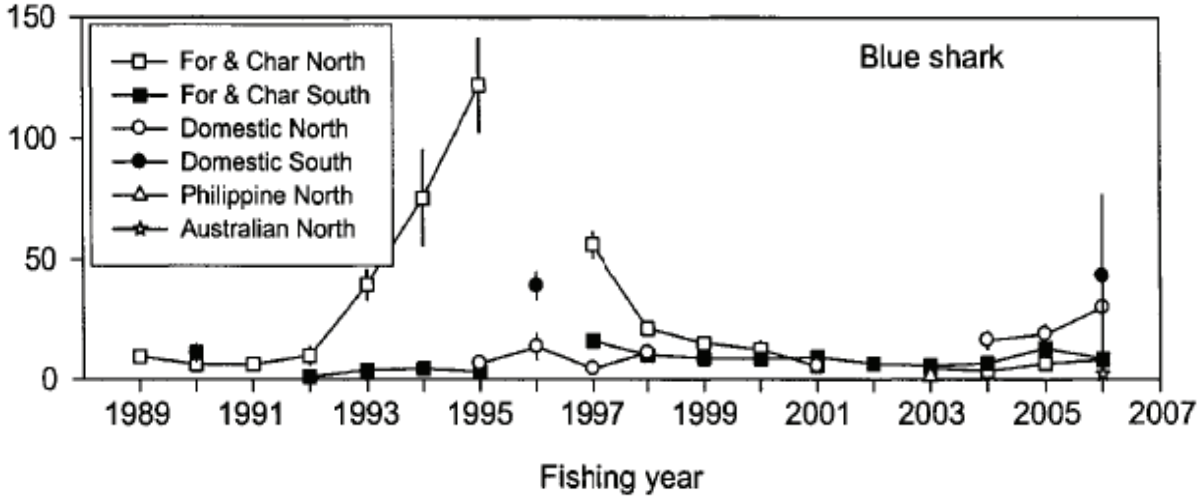


Figure 2: Unstandardised CPUE indices for the New Zealand domestic tuna longline fishery based on observer reports. Years are fishing years (1994 = October 1993 to September 1994). Confidence intervals are from bootstrapped data. Source: Griggs et al. (2008).

Blue sharks are the most heavily fished of the three large pelagic shark species (blue, mako, and porbeagle sharks) commonly caught in the tuna longline fishery. Compared to mako and porbeagle

sharks, however, blue sharks are relatively fecund, fast growing, and widely distributed. Nevertheless, there is some concern about the impact of a rapid increase in domestic fishing effort in the late 1990s and the early 2000s. This has now been ameliorated in New Zealand by a substantial decline in tuna longline fishing effort since 2002-03. The status of the stock is uncertain.

5. STATUS OF THE STOCK

Stock structure assumptions
BWS1 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 by WCPFC; but evaluated using HSS default of 20%SB_0. Hard Limit: Not established by WCPFC; but evaluated using HSS default of 10%SB_0.
Status in relation to Target	Unknown
Status in relation to Limits	Unknown
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 1990s to a peak in the early 2000s but have declined slightly since that time.

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: 2011 (SPC)
Changes to Model Structure and Assumptions		
Major Sources of Uncertainty	Historical catch recording may not be accurate.	

Qualifying Comments
The Western and Central Pacific Fisheries Commission will be attempting a WCPO assessment in 2011.

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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