



Catch and life history parameters of pelagic sharks in the Northwestern Pacific¹

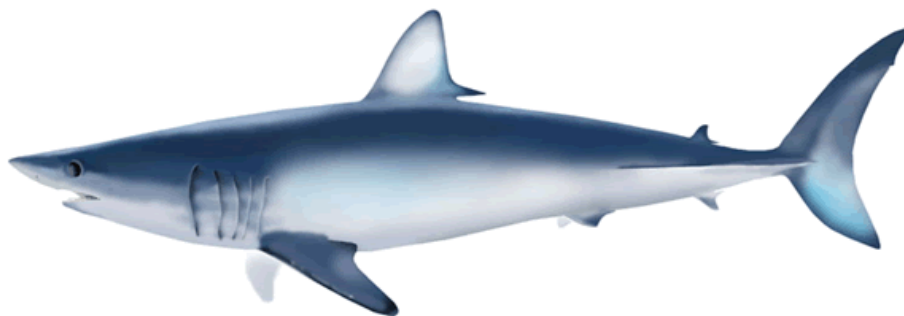
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Catch and life history parameters of pelagic sharks in the Northwest Pacific

Abstract - Annual landings (whole weight) of sharks at Nanfangao and Chengkung fish markets, eastern Taiwan fluctuated from 4,762 MT in 2001 to 4,794 MT in 2010 with a mean of 5,669 MT during this period. Blue shark was the dominant shark species and it consisted of 44.54% in weight of shark landing. The scalloped hammerhead and shortfin mako sharks were the other major species which comprised 9.87% and 9.42% in weight of shark landings, respectively. The life history parameters including age, growth and reproductive biology of 11 species of pelagic sharks in the Northwest Pacific were presented. Most age determinations were solely based on vertebral band counting only few were coupled with length-frequency analysis. Of these, 8 species are viviparous, and 3 species are ovoviviparous; the litter size ranges from 2 for pelagic and bigeye thresher shark to 30 for smooth hammerhead shark. The stock assessments of the pelagic thresher and shortfin mako suggested these stocks are overexploited.

Introduction

Sharks are important components in Taiwanese offshore fisheries and are the major bycatch species of the far sea tuna longline fisheries. Despite of the large quantities of shark catch, the low economical value of shark meat makes it continue to be a bycatch species of other fisheries. A lack of detailed data on shark catch, effort, and fishing grounds for individual species in Northwest Pacific hinders the implementation of shark resources management.

The stock assessment of key shark species (blue, oceanic whitetip, short- and longfin mako, silky, and bigeye, common, and pelagic thresher sharks) in the north Pacific will be conducted in this working group. However, very little is known on the catch, life history parameters, and stock status of these species although they are the apex predators in the marine ecosystems. Thus, the objective of this study is to provide the catch and life history parameters information of pelagic sharks caught by Taiwanese offshore longline fishery in the northwest Pacific. It is hoped that these information can be used as input parameters for future stock assessment of these species.

Annual landings of pelagic sharks

There are two kinds of Taiwanese tuna fleets operating in the North Pacific Ocean: the large-scale tuna longline and the small-scale tuna longline vessels. Sharks are the major bycatch of these fleets. However, the bycatch data for Taiwanese tuna longline fleets has never been reported until 1981 because their low economic value compared with tunas. In addition, species-specific data for sharks are not available before 2003 because all shark catches were recorded as single species “sharks”. Since 2003, the category of “sharks” on the logbook has been further separated into four sub-categories namely the blue shark, mako shark (*Isurus* spp.), silky shark, and other sharks.

The pelagic sharks caught in the Northwest Pacific Ocean by Taiwanese offshore longliners were landed at Nanfangao and Chengkung fish markets, eastern Taiwan. Annual landings (whole weight) of sharks at Nanfangao and Chengkung fish markets in eastern Taiwan fluctuated from 4,762 MT in 2001 to 4,794 MT in 2010 with a mean of 5,669 MT during this period (Fig.1).

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All shark species except blue shark were weighed before being auctioned and gutted, so we were able to obtain accurate catches (numbers) and individual whole weights (W) from sales records. The blue sharks were sold in different channel and other than total catch data were not available.

There are 11 species of pelagic sharks commonly caught by Taiwanese offshore longliners namely, shortfin mako (*Isurus oxyrinchus*), blue (*Prionace glauca*), pelagic thresher (*Alopias pelagicus*), bigeye thresher (*Alopias superciliosus*), silky (*Carcharhinus falciformis*), Oceanic whitetip (*Carcharhinus longimanus*), sandbar (*Carcharhinus plumbeus*), spinner (*Carcharhinus brevippina*), dusky (*Carcharhinus obscurus*), smooth hammerhead (*Sphyrna zygaena*), and scalloped hammerhead (*Sphyrna lewina*). Average percentage of shark landings by species at Nanfangao and Chengkung fish market was showed in Fig. 2. Blue shark was the dominant shark species and it consisted of 44.54% shark catch in weight. Followings are the scalloped hammerhead and shortfin mako and they comprised 9.87% and 9.42% of shark catch in weight, respectively.

The life history parameters of pelagic sharks

Age and growth and reproductive biology of 11 species in the Northwest Pacific have been examined. Chen et al. (1988, 1990) described age and growth, and reproduction biology of the scalloped hammerhead shark. Fishery biology including age and growth and reproductive biology of the bigeye thresher shark has been reported (Chen et al. 1997, Liu et al. 1998). Joung and Chen (1995), Chen et al. (1996), and Liu (2002) described the reproductive biology of the sandbar shark, and the smooth hammerhead, respectively. Fishery biology of the pelagic thresher shark, the spinner shark, and the silky shark have been described by Liu et al. (1999), Leu (1997), and Lee (2002), respectively.

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A summary of biological information including growth parameters and weight-length relationship for these species in Northwest Pacific was given in Tables 1 and 2. Eight of 11 species fall in viviparity including requirium sharks such as silky, sandbard, spinner, oceanic whitetip, dusky sharks, blue shark, smooth hammerhead, and scalloped hammerhead. Other sharks fall in ovoviviparity such as pelagic, bigeye threshers, and shortfin mako (Table 3).

Reproductive cycle is important information in stock assessment. Liu et al. (1999) documented that pelagic thresher from northeastern Taiwan breeds throughout the year. The requirium sharks show a distinct biennial cycle such as sandbar (Joung and Chen 1995), spinner (Joung et al. 2005), silky (Joung et al. 2008). A 3-year reproductive cycle was found for shortfin mako (Joung and Hsu 2005) (Table 3).

Stock assessment

Based on the sale records of Nanfangao and Chengkung fish markets, the percentage of shortfin mako shark landings increased but the median weight of individuals decreased from 82 kg in 1990 to 70 kg in 2007. Chang and Liu (2009) applied per recruit and virtual population analysis on this species in the Northwest Pacific and concluded that this stock is overexploited. Similar situation was also found on the pelagic thresher in the Northwest Pacific by Liu et al. (2006) and Tsai et al. (2010). The above studies were solely based on Taiwanese data. More data on the catch, effort, and life history parameters of pelagic sharks in the North Pacific are needed to facilitate the stock assessment of these species.

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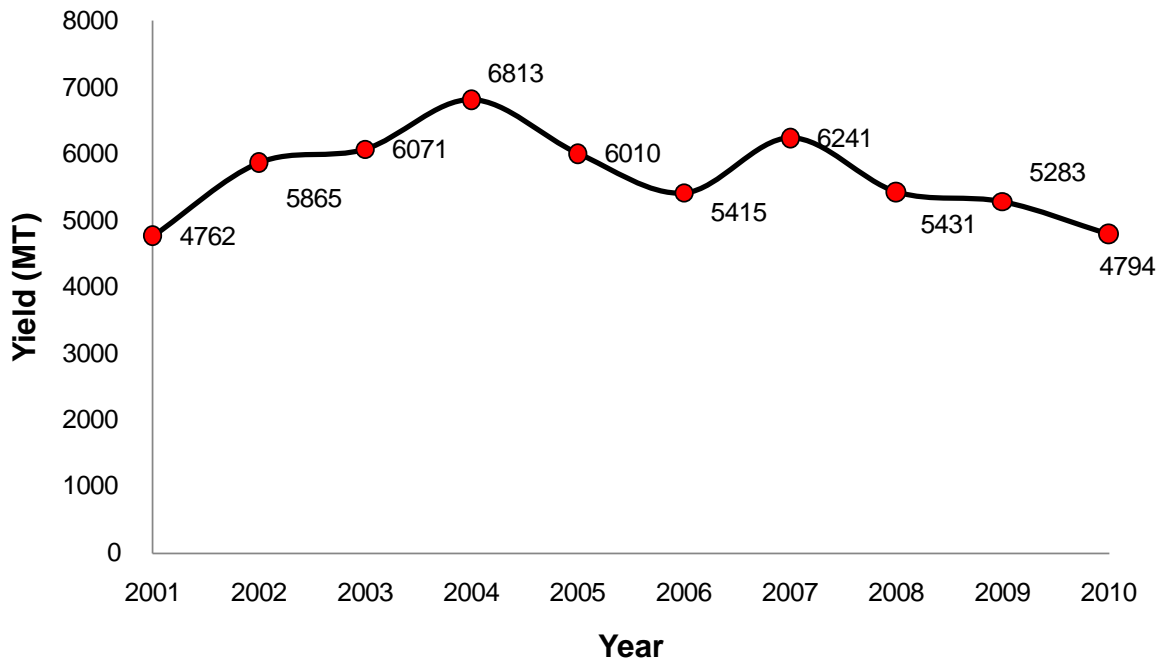


Fig. 1. Annual landing of sharks at Nanfangao and Chengkung fish markets from 2001 to 2010.

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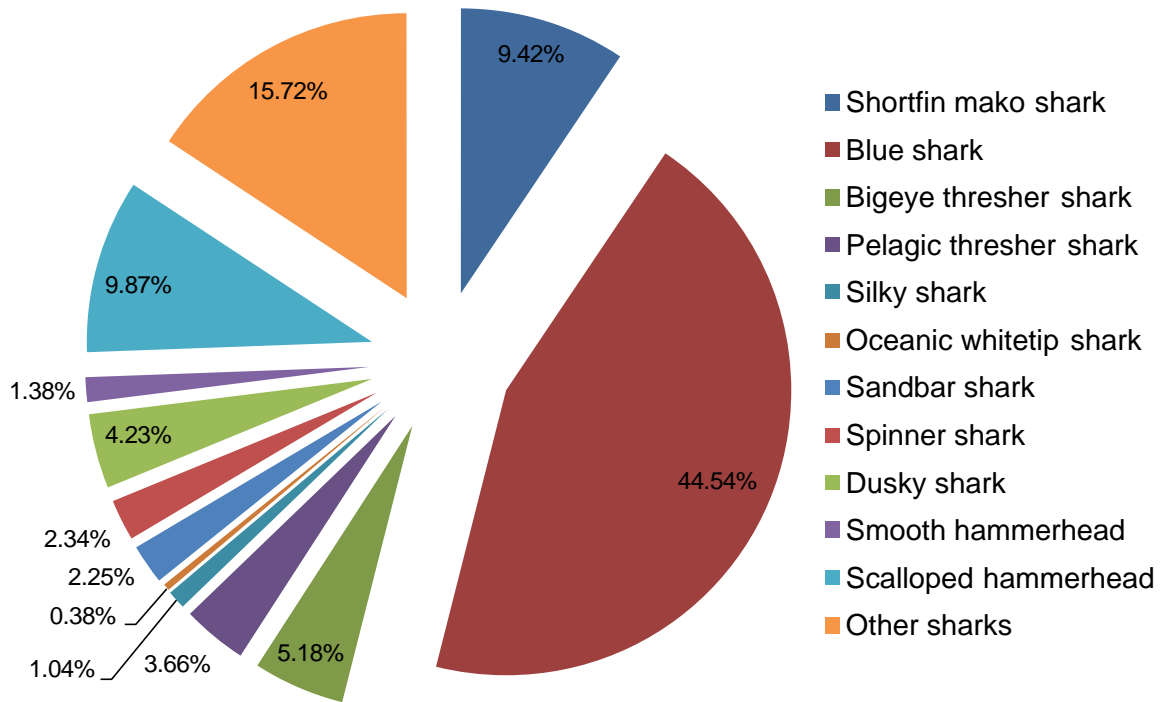


Fig. 2. Average percentage of shark landings by species at Nanfangao and Chengkung fish markets from 2001 to 2010.

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Table 1. Age and growth parameters of the pelagic sharks in the Northwest Pacific.

Scientific name	Common name	Sex	Sample size (n)	TL _∞	k	t ₀	L ₀	Ref.
<i>Isurus oxyrinchus</i>	Shortfin mako shark	M	133	332.1	0.056	-6.08	-	Joung and Hsu, 2005 ; Chang,2006
		F	213	413.8	0.050	-	80	
<i>Prionace glauca</i>	Blue shark	M	181	375.8	0.121	-1.55	-	Huang, 2006
		F	250	322.7	0.161	-1.32	-	
<i>Alopias superciliosus</i>	Bigeye thresher shark	M	107	400.1	0.088	-4.24	-	Liu et al., 1998
		F	214	422.0	0.092	-4.21	-	
<i>Alopias pelagicus</i>	Pelagic thresher shark	M	114	346.7	0.118	-5.48	-	Liu et al., 1999
		F	155	382.9	0.085	-7.67	-	
<i>Carcharhinus falciformis</i>	Silky shark	M	132	314.5	0.097	-2.32	-	Joung et al., 2008
		F	118	341.1	0.077	-3.03	-	
<i>Carcharhinus longimanus</i>	Oceanic whitetip shark	M	112	334.9	0.090	-1.36	-	Chen, 2006
		F		323.8	0.109	-0.37	-	
<i>Carcharhinus plumbeus</i>	Sandbar shark	M	185	200.0	0.140	-4.00	-	Joung et al., 2004
		F	176	223.0	0.100	-4.50	-	
<i>Carcharhinus brevipinna</i>	Spinner shark	M	104	257.4	0.203	-1.71	-	Joung et al., 2005
		F	102	288.2	0.151	-1.99	-	
<i>Carcharhinus obscurus</i>	Dusky shark	M	220	473.3	0.043	-4.45	-	Chen, 2004
		F	167	414.6	0.055	-3.50	-	
<i>Sphyrna zygaena</i>	Smooth hammerhead	M	96	358.8	0.128	-0.72	-	Chou, 2004
		F	70	375.2	0.111	-1.31	-	
<i>Sphyrna lewini</i>	Scalloped hammerhead	M	42	320.6	0.222	-0.75	-	Chen et al., 1990
		F	226	319.7	0.249	-0.41	-	

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Table 2. The parameters of weight-length relationships for the pelagic sharks in the Northwest Pacific.

Scientific name	Common name	Sex	Sample size (n)	a	b	Ref.
<i>Isurus oxyrinchus</i>	Shortfin mako shark	M	807	2.8×10^{-5}	2.771	Joung and Hsu, 2005 ; Chang,2006
		F	1137	1.9×10^{-5}	2.847	
<i>Prionace glauca</i>	Blue shark	Combined	44	1.00×10^{-6}	3.23	Wu, 2003
<i>Alopias superciliosus</i>	Bigeye thresher shark	Combined	1905	9.80×10^{-6}	2.686	Liu et al., 1998
<i>Alopias pelagicus</i>	Pelagic thresher shark	M	865	2.66×10^{-4}	2.493	Liu et al., 1999
		F	1300	2.56×10^{-4}	2.511	
<i>Carcharhinus falciformis</i>	Silky sharks	Combined	469	2.92×10^{-6}	3.150	Joung et al., 2008
<i>Carcharhinus longimanus</i>	Oceanic whitetip shark	Combined	188	1.66×10^{-5}	2.819	Chen, 2006
<i>Carcharhinus plumbeus</i>	Sandbar shark	Combined	400	1.89×10^{-6}	3.230	Joung et al., 2004
<i>Carcharhinus brevipinna</i>	Spinner Shark	M	111	3×10^{-6}	3.144	Joung et al., 2005
		F	82	8×10^{-6}	2.943	
<i>Carcharhinus obscurus</i>	Dusky shark	M	294	8.01×10^{-6}	2.957	Chen, 2004
		F	209	2.03×10^{-6}	3.216	
<i>Sphyrna lewini</i>	Scalloped hammerhead	Combined	2165	1.29×10^{-6}	3.271	Chen et al. 1990
<i>Sphyrna zygaena</i>	Smooth hammerhead	Combined	435	2.4×10^{-6}	3.150	Chou, 2004

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Table 3. Reproductive parameters of the pelagic sharks in the Northwest Pacific.

Scientific name	Common name	R	L _b (cm)	L _m (cm)	T _m (yr)	f	G _p (month)	R _c (yr)	Source of data
<i>Alopias pelagicus</i>	Pelagic thresher shark	ov	174.00	287.00	8.6	2.0	12.0	1	Liu et al.1999
<i>Alopias superciliosus</i>	Bigeye thresher shark	ov	148.70	336.58	12.85	2.0	12.0	1	Chen et al.1997
<i>Carcharhinus brevipinna</i>	Spinner shark	v	67.50	222.50	7.8	8.5	11.0	2	Joung et al. 2005
<i>Carcharhinus falciformis</i>	Silky shark	v	69.50	215.00	9.70	9.0	12.0	2	Joung et al. 2008
<i>Carcharhinus longimanus</i>	Oceanic whitetip shark	v	64.00	194.70	8.23	10.0	12.0	1	Chen 2006
<i>Carcharhinus obscurus</i>	Dusky shark	v	101.00	281.00	16.40	11.0	13.0	2	Chen 2004
<i>Carcharhinus plumbeus</i>	Sandbar shark	v	62.50	172.50	7.85	7.5	11.0	2	Joung & Chen 1995
<i>Isurus oxyrinchus</i>	Shortfin mako	ov	74.00	278.00	20.00	11.1	24.0	3	Joung & Hsu 2005; Chang 2006
<i>Prionace glauca</i>	Blue shark	v	45.00	189.00	4.20	29.0	10.0	2	Wu 2003
<i>Sphyrna lewini</i>	Scalloped hammerhead	v	48.50	230.00	4.70	25.8	10.0	2	Chen et al. 1988
<i>Sphyrna zygaena</i>	Smooth hammerhead	v	55.00	259.40	11.00	30.0	10.0	2	Liu 2002

R: reproduction type, L_b: size at birth, L_m: size at maturity, T_m: age at maturity, f: litter size, G_p: gestation period, R_c: reproduction cycle

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