ISC/21/SHARKWG-1/ 02

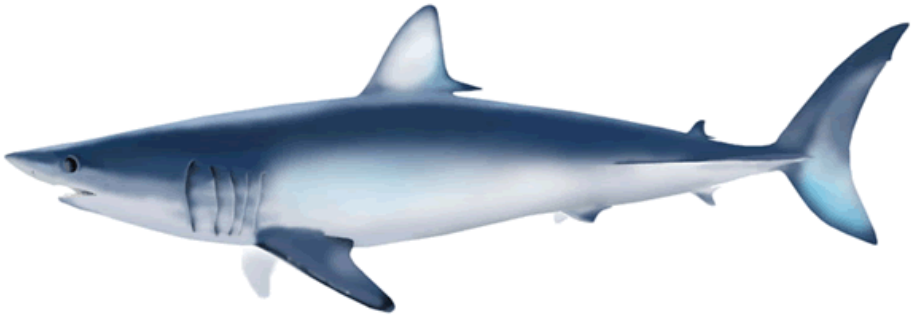
Updated size composition of shortfin mako shark caught by the Taiwanese tuna longline fishery in the North Pacific Ocean

Kwang-Ming Liu [A, B], Wen-Pei Tsai [C], and Kuan-Yu Su [A B]

[A] Institute of Marine Affairs and Resource Management, National Taiwan Ocean University, Keelung 20224, Taiwan

[B] George Chen Shark Research Center, National Taiwan Ocean University, Keelung 20224, Taiwan

[C] Department of Fisheries Production and Management, National Kaohsiung Marine University, Kaohsiung 808, Taiwan



---

[1] Working document submitted to the ISC Shark Working Group Workshop, 22-26 February, 2021

ABSTRACT

There are two types of Taiwanese tuna longline vessels, namely the large-scale tuna longline vessels (LTLL, ≧100 GRT) and the small-scale tuna longline vessels (STLL, ＜100 GRT). In the present study, the size data of the shortfin mako shark caught by these two fisheries are presented. All size data recorded in other measurements were converted to pre-caudal length (PCL) by using the converting equations available. The size of shortfin mako caught by the Taiwanese STLL from 1989-2019 in the North Pacific ranged from 61 to 338 cm PCL for females (n = 116,281), and 60–262 cm PCL for males (n = 108,505). The sizes of 11,173 individuals (sexes combined) recorded in the logbook of LTLL from 2005-2019 ranged from 61 to 303 cm PCL. Two modes (mostly 100 and 150 cm PCL) were observed in the size distribution of shortfin mako shark caught by the STLL in the North Pacific Ocean. This also implied that the catches comprised mostly immature fish (female < 228, male < 172 cm PCL). The capture of high proportion of immature sharks may have serious impact on the sustainability of the fishery.

1. Introduction

The shortfin mako shark (SMA), *Isurus oxyrinchus*, is one of the most commonly caught shark species in the Taiwanese commercial offshore longline fishery and one of the major by-catch shark species of tuna longline fisheries in the far seas. Shortfin mako shark is a large apex predator that exhibits slow growth, low fecundity and late maturity, and is particularly susceptible to exploitation owing to its life-history characteristics. Clarke *et al*. (2006) mentioned that about half a million shortfin mako sharks were utilized in the global shark fin trade in 2000. Given the high fishing pressure on this species and declining population trends, the shortfin mako was listed as "Endangered" on the IUCN Red List of Threatened Species (Rigby *et al*., 2019) and was listed on the CITES Appendix II (CITES, 2019). Despite of the stock assessment by the ISC Shark Working Group in 2018, the stock status of this species in the North Pacific Ocean is concerned by environmental groups. Size-frequency data are important for stock assessment modelling especially for length-based models such as Stock Synthesis. For example, temporal change in the size frequency distribution of population can provide valuable information concerning recruitment, growth and mortality. Size frequency could be used in support of fishery research and management in a number of way. Hence, the present study was to update the size distributions of the shortfin mako shark caught by the Taiwanese tuna longline fishery, with a view to providing baseline information on some biological characteristics of the fishery.

2. Material and methods

2.1. Analysis of size frequency

Two types of fisheries data were used in this study: the commercial landing data for the small-scale tuna longline fishery (STLL), and the logbook data for the large-scale tuna longline fishery (LTLL). Sharks caught by the Taiwanese STLL in the Northwest Pacific are mainly landed at the Nanfangao fish market, eastern Taiwan. All shark species were weighed before being auctioned and processed, so we were able to obtain catch numbers and whole weights (*W*) of individuals from sale records, but individual sex and length information was lacking in these records. The measurements of total length (TL), fork length (FL), and pre-caudal length (PCL) were taken on an opportunistic basis. On the other hand, the logbook data of the

[1] Working document submitted to the ISC Shark Working Group Workshop, 22-26 February, 2021

Taiwanese LTLL from 2005 to 2019, provided by the Overseas Fisheries Development Council, Taiwan were used in this study. Logbooks were recorded by the captain of the vessels after each operation. These logbook data contain basic information on daily position, number of hooks used, catches in number, and weight by species (14 species before 2005), as well as the length measurement (fork length) of the first 30 fishes caught each operation.

As no sex information of shortfin mako shark in sale records, the sex of each individual shark caught by STLL was derived using the weight-specific sex ratio, which was estimated from a total of 1,944 sub-sampled fish (1137 females, 807 males) collected between 1995 and 2005 at Nanfangao fish market. The fork length (FL) measurements of these specimens were taken and their sexes were identified. The sex ratios (the proportion of females) of sharks smaller than 130 kg and greater than 230 kg were set as 0.5 and 1.0, respectively, based on our observations. For fish between 130 and 230 kg, the sex ratio of weight (S_W) was obtained from W through the equation $S_W = 8.35 \times 10^{-3} W^{0.876}$ (Tsai *et al.*, 2011). The whole weights were then converted to pre-caudal length (PCL) using the sex-specific W-PCL relationships: $W = 3.4 \times 10^{-5} PCL^{2.84}$ for female and $W = 4.62 \times 10^{-5} PCL^{2.77}$ for male, respectively (Su *et al.*, 2017).

3. Results and discussion

Using the weight-specific sex ratio, a total of 224,786 shortfin mako sharks landed at Nanfangao fish market between January 1989 and December 2019 were separated into 116,281 females and 108,505 males. The size ranges obtained from STLL vessels were 61–338 cm PCL for females (**Fig. 1**), 60–262 cm PCL for males (**Fig. 2**), respectively. The mode concentration of the SMA size distribution obtained from STLL was 148 cm and 149 cm PCL for female and male, respectively. Generally, the modes in the size distributions were similar for both sexes. However, the length frequency of SMA after 1995 revealed two modes at 100 cm, and 150 cm PCL, which showed the increase of smaller sized fish < 150 cm PCL. The STLL less than 50 GRT operated within the EEZ, while those of 50 -99 GRT mainly operate outside the EEZ. Whether the two modes in size distribution were due to the difference in fishing grounds (offshore vs open sea for different size STLL) need further investigation. Similar patter (bimodal size distributions) can also be found in that of LTLL. The length frequency of SMA caught by LTLL in the North Pacific between 2005 and 2019 were shown in **Fig. 3** which were obtained from commercial logbooks. The sizes of the 11,173 individuals (sexes combined) derived from LTLL ranged from 61 to 303 cm PCL and the mode was about 140 cm PCL. To compare this two type longline fishery, it seems likely that LTLL caught smaller SMA than STLL. This discrepancy may be due to different fishing ground and number of hook used. Overall, two modes (mostly 100 and 150 cm PCL) were observed in the size distribution of shortfin mako shark from the North Pacific Ocean, which also implied that the catches comprised mostly immature fish (female < 228 cm, male < 172 cm PCL). Furthermore, information on the size at birth and size at maturity (Joung and Hsu, 2005) indicates that the species was vulnerable to capture immediately after birth, and that immature sharks formed a large component of the landings, particularly in the case of females (Tsai et al., 2014). Sharks are vulnerable to overexploitation due to their *K*-selected life strategy (Stevens *et al.*, 2000), so the capture of a high proportion of immature sharks may have serious impacts on the population.

Therefore, a precautionary management measure for North Pacific shortfin mako should be considered to ensure the sustainability of this stock.

References

Clarke, S. C., McAllister, M. K., Milner-Gulland, E. J., Kirkwood, G. P., Michielsens, C. G. J., Agnew, D. J., Pikitch, E. K., Nakano, H., and Shivji, M. S. 2006. Global estimates of shark catches using trade records from commercial markets. Ecology Letters, 9: 1115–1126.

Dulvy, N. K., Baum, J. K., Clarke, S., Compagno, L. J. V., Cortés, E., Domingo, A., Fordham, S., Fowler, S., Francis, M. P., Gibson, C., Martínez, J., Musick, J. A., Soldo, A., Stevens, J. D., and Valenti, S. 2008. You can swim but you can't hide: the global status and conservation of oceanic pelagic sharks and rays. Aquatic Conserv: Mar. Freshw. Ecosyst., 18: 459–482.

Joung, S. J., and Hsu, H. H. 2005. Reproduction and embryonic development of the shortfin mako, *Isurus oxyrinchus* Rafinesque, 1810, in the northwestern Pacific. Zoological Studies, 44: 487-496.

Stevens J. D., Bonfil R., Dulvy N.K., Walker P. A. 2000. The effects of fishing on sharks, rays, and chimaeras (chondrichthyans), and the implications for marine ecosystems. ICES Journal of Marine Science 57: 476–494

Su, S. H., Kohin, S., Taylor, J., Semba, Y., Tsai, W. P., and Liu, K. M. 2017. The relation between weight and length of the shortfin mako shark in the North Pacific Ocean. ISC/17/SHARKWG-??

Tsai, W. P., Sun, C. L., Wang, S. P., and K. M. Liu. 2011. Evaluating the impacts of uncertainty on the estimation of biological reference points for shortfin mako shark, *Isurus oxyrinchus* in the Northwest Pacific Ocean. Marine and Freshwater Research, 62: 1383-1394.

Tsai, W. P., Sun, C. L., Punt, A. E., and Liu, K. M. 2014. Demographic analysis of the shortfin mako shark, *Isurus oxyrinchus*, in the Northwest Pacific using a two-sex stage-based matrix model. ICES Journal of Marine Science, 71: 1604-1618.

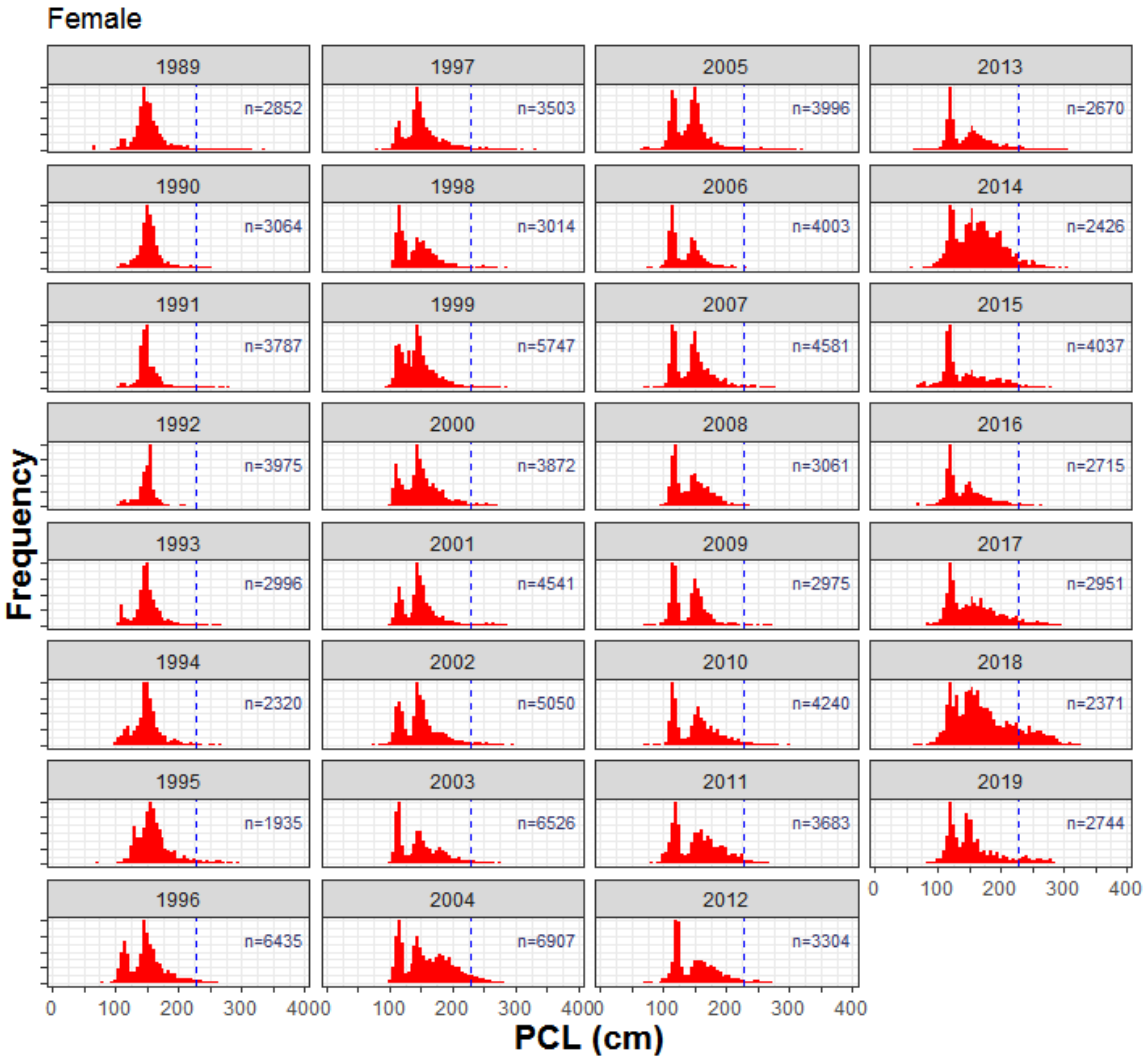


Fig. 1. Length frequency of female shortfin mako shark caught by STLL vessels.

[1] Working document submitted to the ISC Shark Working Group Workshop, 22-26 February, 2021

Document not to be cited without author's permission.

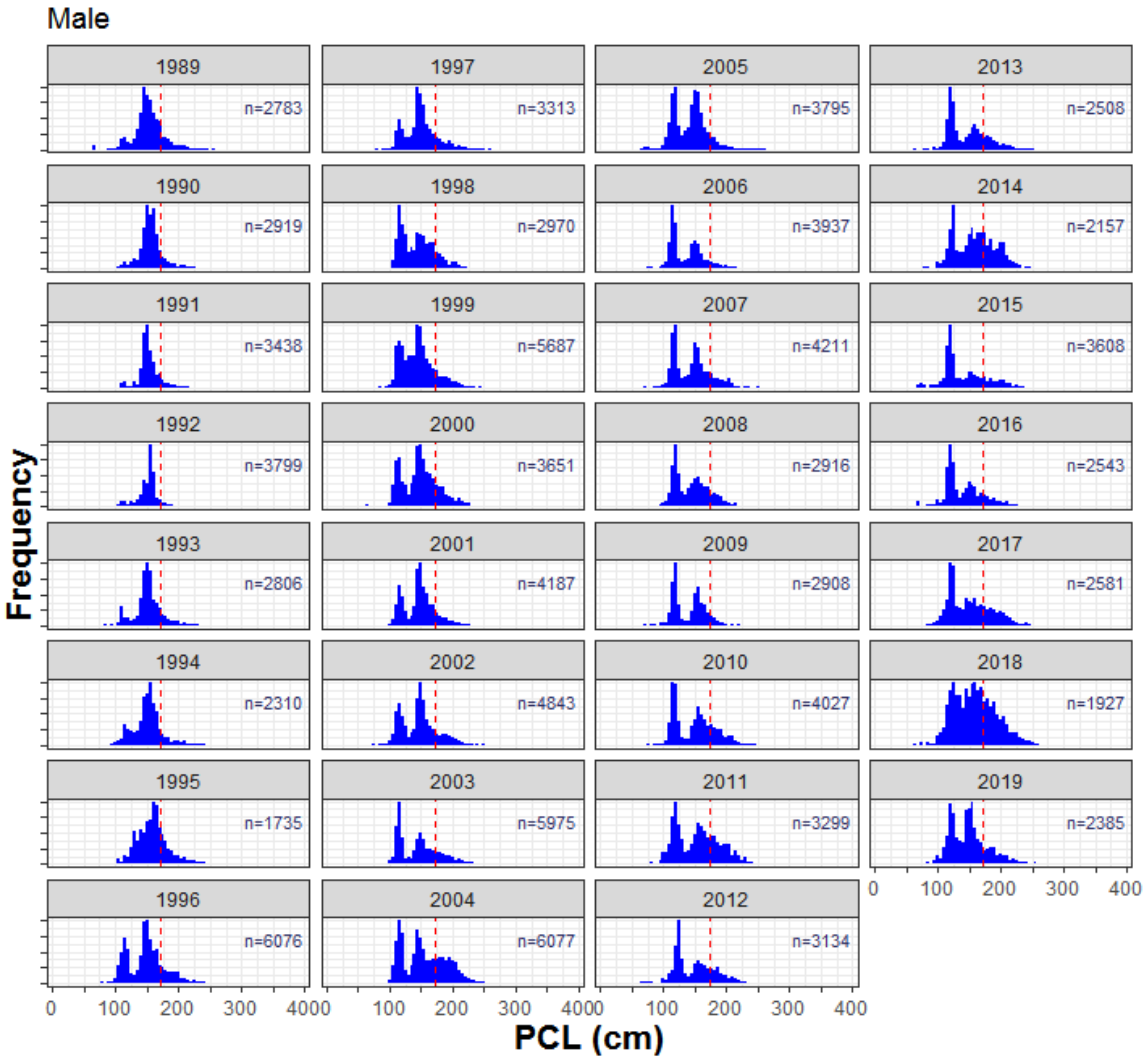


Fig. 2. Length frequency of male shortfin mako shark caught by STLL vessels.

[1] Working document submitted to the ISC Shark Working Group Workshop, 22-26 February, 2021

Document not to be cited without author's permission.

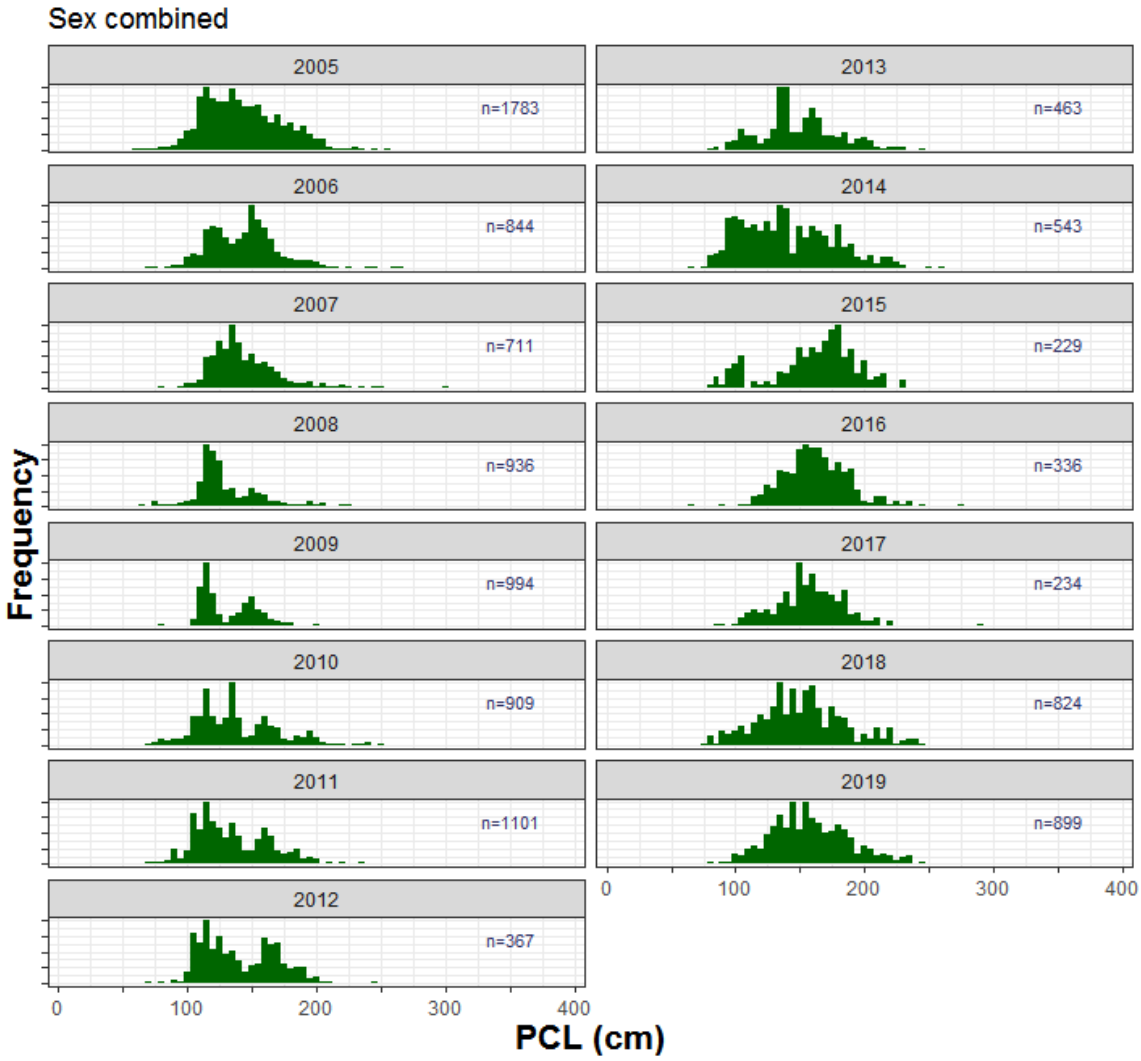


Fig. 3. Length frequency (sexes combined) of shortfin mako shark caught by LTLL vessels.