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Fisheries Research 76 (2005) 14–21

FISHERIES RESEARCH

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Age and growth of the shortfin mako shark, *Isurus oxyrinchus*, from the western coast of Baja California Sur, Mexico

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Received 16 November 2004; received in revised form 10 May 2005; accepted 17 May 2005

Abstract

Age and growth of the shortfin mako shark, *Isurus oxyrinchus*, were estimated using the number of growth marks on whole vertebrae from 109 individuals caught during 2000–2003 off the western coast of Baja California Sur, Mexico. A further 110 individuals were measured to obtain data on the age distribution of the population being fished. Sharks ranged from 77 to 290 cm in total length (TL). A significant linear relationship ($r^2 = 0.91$) was found between the vertebrae radius and total length, suggesting isometric growth of vertebrae with total length. Distinct bands of heavier calcification were visualized with silver nitrate staining. The periodicity of these growth marks was determined by the frequency of clear and dark margins of the vertebrae in each month of the year. We found that one growth mark is deposited annually. Estimated ages ranged from 0 to 18 years, with the majority of fish being 1–5 years old. Age and TL were used to describe the shortfin mako growth. Estimates of the von Bertalanffy curve parameters for the combined sexes were: $L_\infty = 411$ cm TL, $k = 0.05$ year^{-1}, $t_0 = -4.7$ years. Our results suggest that shortfin makos are relatively slow growing sharks, which combined with other life-history traits such as a low fecundity and delayed reproduction, makes this species highly susceptible to overfishing.

Keywords: Age; *Isurus oxyrinchus*; Growth; Mako shark; Baja California Sur

1. Introduction

There is considerable concern about shark fisheries around the world as declining catches are attributed to overfishing (Baum et al., 2003). Mexico is a major shark fishing nation in the America (Bonfil, 1994) and is seventh worldwide in landings with 4.6% of the global production (Mendizábal y Oriza et al., 2000). Shark fishing has traditionally been a very important activity in communities along Mexico's Pacific and Gulf of Mexico coasts. Mexican shark fisheries have been gaining importance and are one of the five most important fishery resources in the country (Castillo-Geniz, 1992). In Mexico the shark catches represent 2.4% of the fisheries (Villavicencio, 1996) with an average of 33 000 metric tons (mt) per year (Mendizábal y Oriza et al., 2000). Baja California Sur

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0165-7836/$ – see front matter
doi:10.1016/j.fishres.2005.05.004

is the most important state in shark catch in the Mexican Pacific contributing with 24.5% of the coast production (Mendizábal y Oriza et al., 2000). Reported landings of sharks for this state average 4450 mt per year (SEMARNAP, 1996–2000). However there is little information on the size of the catch by species and status of the affected stocks (Holts et al., 1998).

Shark fishery in Mexico is basically an artisanal multi-species fishery which operates with small boats ranging as far as 40 km from shore. This small boat fleet uses both gill nets and longlines (Holts et al., 1998). However in the northern states many sharks are caught by sport fishing (Castillo-Geniz, 1992). Moreover there are at least two commercial fisheries where shark bycatch occurs, the drift net fishery directed at swordfish, *Xiphias gladius*, and the purse-seine fishery of yellow fin tuna, *Thunnus albacares* (Mendizábal y Oriza et al., 2000). Sharks are caught in all coastal artisanal fisheries and there are no fishery regulations in place other than the limit on new permits (Márquez-Farias and Castillo-Geniz, 1998).

The shortfin mako shark is an important species in the commercial and recreational fisheries (Holts et al., 1998), and is also caught as bycatch mainly in the swordfish fishery (Mendizábal y Oriza et al., 2000). In spite of the fact that shortfin mako shark is important for the fisheries industry little is known about the basic biology of this species or the specific life history parameters of the animals caught in the Baja California Peninsula.

Shark management and conservation is hindered by our lack of knowledge at the population level (Baum et al., 2003), as well as the lack of basic biological information (Hoff and Musick, 1990). Biological information has been used to better understand the effects of excessive anthropogenic mortalities on specific groups and to predict population recovery trajectories (Musick, 1999). Understanding the age structure of a population forms the basis for calculations of growth rate, mortality rate and productivity, ranking it among the most influential of biological variables (Campana, 2001).

There are few age and growth studies for the shortfin mako. Pratt and Casey (1983) studied Atlantic mako shark and suggested that two pairs of bands are deposited annually in the vertebra. They estimated 4.5 years to the older male at 225 cm fork length (FL) and 11.5 years to the older female at 328 cm FL. Whereas, in the same year, Cailliet et al. (1983), worked with Pacific mako shark and proposed that only one pair of bands is deposited in the structure per year. The oldest fish was a female estimated to have 17 years and was the largest individual (321 cm TL) of their sample. Recently, Campana et al. (2002) estimated 21 years to a 328 cm FL Atlantic mako female and confirmed that only one pair of bands is deposited annually. The objective of this study was to gather information about the age and growth of that portion of the shortfin mako shark being landed in the waters of Baja California Sur, Mexico. These data will be useful in designing an effective management strategy for the fishery.

2. Materials and methods

Samples of mako shark vertebrae were collected from the cervical region of 109 fish from August 2000 to March 2003 at three localities, Punta Lobos, Punta Belcher and Las Barrancas, on the western coast of Baja California Sur, Mexico (Fig. 1). The fleets at these localities use longlines to catch sharks. Once fishermen landed the sharks on the beach, total length (TL), sex and maturity information were recorded and cervical vertebrae extracted. TL was always measured as a straight line distance from the tip of the rostrum to the end of the caudal fin.

In the laboratory, all connective tissue was removed from the vertebrae using a stereoscope. Occasionally

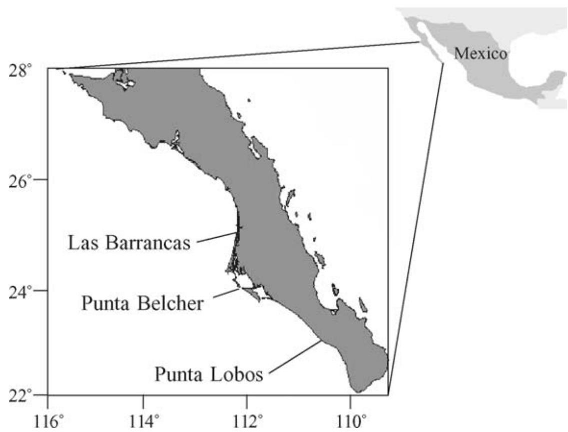

Fig. 1. Study area showing sampling locations.