

Demographic structure of broadnose seven-gill shark, *Notorynchus cepedianus*, caught by anglers in southern Patagonia, Argentina

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Between 2004 and 2007, tournament editions and the recreational fishery for the broadnose seven-gill shark, Notorynchus cepedianus, were monitored in Natural Reserves of Ría Deseado (RD, a breeding area for the Patagonian smooth hound) and Península de San Julián (SJ), southern Patagonia, Argentina. Sharks' catch composition by sex; total length (TL) and weight (W) were recorded. Reproductive status was assessed from the literature. Juvenile females dominated the catches in both areas during the 4-year period.

Keywords: seven-gill shark, breeding areas, recreational fishing, south-western Atlantic, Argentina

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INTRODUCTION

The broadnose seven-gill shark *Notorynchus cepedianus* inhabits exclusively coastal and shelf waters worldwide (Last & Stevens, 1994; Compagno *et al.*, 2006). Off California (USA) and southern Africa (Ebert, 1989, 1991a, b, 2002) females mature at larger total lengths (TL) than males with biennial reproductive cycle and one of the highest fecundity among elasmobranchs (Ebert, 1989). Due to its restricted limited inshore depth-range distribution in temperate waters, *N. cepedianus* is exposed to intensive inshore fisheries over most of its range and could be impelled to local extinction. But lack of fisheries data elsewhere makes it impossible to determine whether this pattern of depletion occurs throughout its range and the IUCN Sharks Specialist Group Red List Assessments set its conservation status as Data Deficient (IUCN, 2007).

In Argentina several studies about the taxonomy and distribution of the species have been carried out by Lahille (1928), Guzman & Campodónico (1976), Menni *et al.* (1984), and Menni & García (1985). Recently, Lucifora *et al.* (2005) studied the reproductive biology, abundance and feeding habits of the broadnose seven-gill shark in Bahía Anegada (40°36'S 62°08'W), in Buenos Aires province, Argentina. Monthly variation in abundance was found and the presence of neonates and juveniles was common in the study area. Male and female sizes at maturity were 170 and 224 cm total length (TL) respectively, featuring a similar size

at maturity of other studied regions. These authors pointed out that Bahía Anegada could be an important area for conservation of the seven-gill shark in the south-west Atlantic given the high abundance of juveniles and sub-adults.

Notorynchus cepedianus also has commercial value as a non-target catch in bottom trawling and gill-net fisheries in Buenos Aires province (Chiaromonte, 1998). In Patagonia, the species is mainly caught by anglers and recreational fishermen (Cochia *et al.*, 2006; Cedrola *et al.*, 2007), but in the coastal trawl fisheries it was recorded as a low frequency by-catch (Van der Molen *et al.*, 1998).

Protected areas of Ría Deseado (47°47'S 65°49'W) and Península de San Julián (49°17'S, 67°42'W) are placed in the north coast of Santa Cruz province, in southern Patagonia (Figure 1). Both areas concentrate a high diversity of seabird and migratory shorebirds together with several species of cartilaginous fish and marine mammals. Ría Deseado and Bahía de San Julián act as nursery and breeding areas for several species (Gandini & Frere, 1998; Chiaromonte & Pettovello, 2000; Bastida & Rodríguez, 2003; Wilson *et al.*, 2005).

The aim of this research is to investigate the population structure of *N. cepedianus* in southern Patagonia, Argentina. Moreover, we discuss the possibility that Ría Deseado and Bahía de San Julián operate as secondary nursery areas for *N. cepedianus*.

MATERIALS AND METHODS

Shark recreational fisheries occur in Ría Deseado (RD) and Bahía and Península de San Julián (SJ) every year between

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Fig. 1. Natural Reserves of Patagonia where *Notorynchus cepedianus* are caught by anglers: BA, Bahía Anegada; PD, Puerto Deseado; SJ, Península de San Julián.

early November and late March. Sharks are caught from the coast (in both locations) and small boats < 7 m long (only in Ría Deseado), with rod and reel. For 40 years now, broadnose seven-gill shark fishing competitions have taken place in both locations. Samples for this study were taken from tournament editions as well as from the recreational fishery during the fishing seasons 2004–2005, 2005–2006 and 2006–2007. Sex, size and weight of sharks caught were registered. Total length (TL) was recorded to the nearest millimetre, from the tip of the snout to the tip of the upper lobe of the caudal peduncle at natural position, and weight (W) to the nearest gram. Differences in mean TL between areas were tested by *t*-test (Zar, 1996). Total length–weight (TL–W) curves were calculated for males and females. Differences in the slopes of the TL–W relationship between the sampled areas (RD and SJ) for each sex were tested with a two-tailed Student's *t*-test for the slopes of log transformed data (Zar, 1996). To test for sexual differences in this relationship, the same test was carried out pooling the data from both localities for each sex. Sex ratios for each locality were tested by χ^2 -test. In each parametric test, normality was tested by a Kolmogorov–Smirnov test and the homogeneity of variance by Levene test (Zar, 1996).

RESULTS

A total of 111 broadnose seven-gill shark specimens (75 females and 36 males) were caught, 63 in RD and 48 in SJ. Juvenile females dominated the catches in both areas during the 4-year period (96.73% of the total female catch). In RD the females of the broadnose seven-gill sharks were larger than in SJ ($t = 5.389$, $df = 73$, $P < 0.01$; Figure 2A). Mean TL in RD was 1781 mm ($SD = 245.08$; range 1150–2320 mm TL) and the heaviest female weighed 70 kg. In SJ the mean TL was 1484 mm ($SD = 196.10$; range 1210–2000 mm TL) and the heaviest female weighed 36.9 kg. Juvenile males also dominated the catches of males in both areas during the 4-year period (86.11% of the total male catch). No differences between localities were detected in the case of males for the TL ($t = 1.520$, $df = 34$, $P > 0.05$; Figure 2B). The mean TL in RD was 1616 mm ($SD = 245.83$;

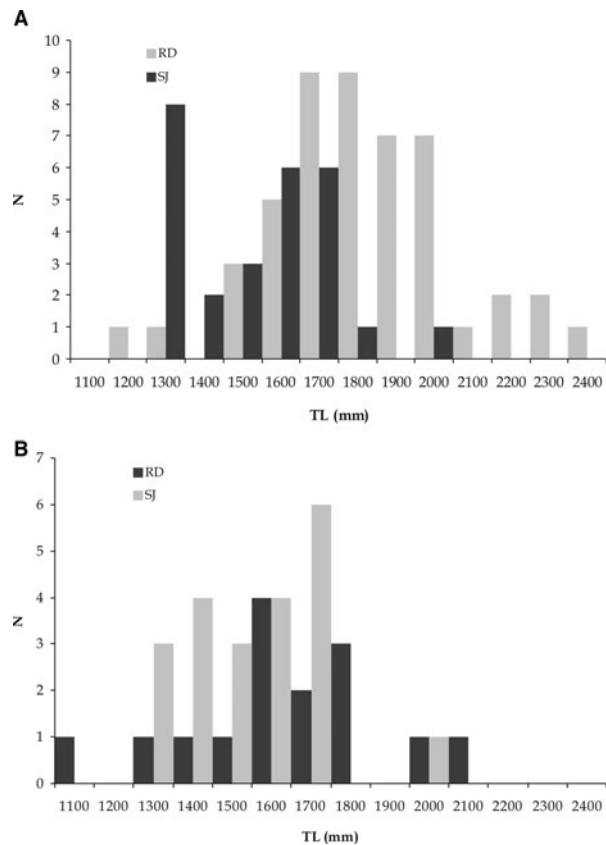


Fig. 2. Size–frequency distribution of *Notorynchus cepedianus* in Ría Deseado (RD) and Península de San Julián (SJ). A, females; B, males.

range 1100–2050 mm TL) and the heaviest male weighed 40 kg. In SJ the mean TL was 1508 mm ($SD = 184.26$; range 1250–2000 mm TL) and the heaviest male weighed 32.5 kg.

No significant differences were detected between the slopes of the $\log TL$ – $\log W$ relationship for TL–W relationship between localities for males ($t = -0.265$, $df = 32$, $P > 0.05$) and females ($t = 0.214$, $df = 71$, $P > 0.05$). Thus, for the comparison between sexes we pooled the data from both localities. The TL–W relationships are shown in Figure 3. The TL–W relationships are W (g) = $2.77E-06$ TL (mm) $^{3.0634}$ for females and W (g) = $1.05E-05$ TL (mm) $^{2.8858}$ for males. No significant differences were found between the slopes of the $\log TL$ – $\log W$ relationship of males and females ($t = 1.058$, $df = 107$, $P > 0.05$).

In RD the sex ratio (female:male) was 3.2:1, which results significantly different from 1:1 ($\chi^2 = 8.64$; $P > 0.05$). However, in SJ the sex ratio was 1.3:1 but these differences were not statistically significant to 1:1 ($\chi^2 = 0.5$; $P > 0.05$). Catches by number of *Notorynchus cepedianus* exhibit its maximum in December and January in both locations.

DISCUSSION

Seasonal abundance of *Notorynchus cepedianus* in southern Patagonia shows a peak during early summer (December to January). In Bahía Anegada (40°32'S), Lucifora *et al.* (2005) found the highest abundance during late summer and early autumn, which could reflect a south to north migratory movement. This peak corresponds with the arrival of the

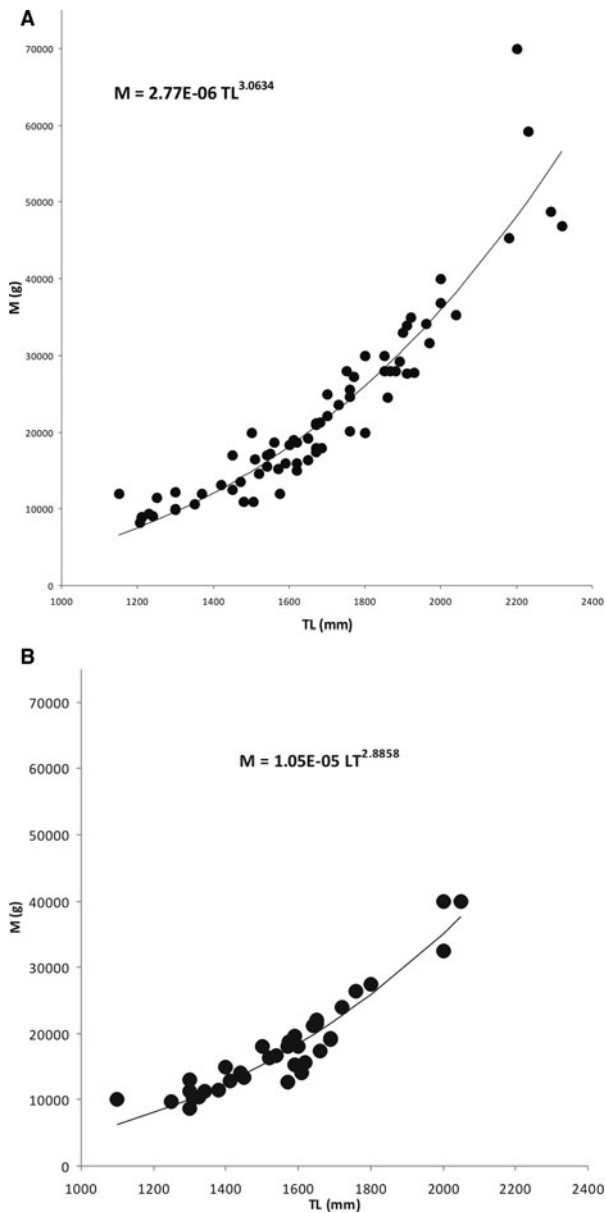


Fig. 3. TL–W relationship for *Notorynchus cepedianus* in southern Patagonia. A, females; B, males.

narrownose smooth hound shark, *Mustelus schmitti*, to RD. This shark is one of the preys of *N. cepedianus* in the area (Chiaramonte & Pettovello, 2000). Lucifora *et al.* (2005) obtained a similar result and observed that *M. schmitti* is the main dietary item in the size-class 100–170 cm of TL for *N. cepedianus* in northern Patagonia, which is the dominant size-class in our study samples (Figures 2 & 3). The RD and SJ bays are also feeding and nursery areas for Comerson's dolphin, *Cephalorhynchus commersonii*, and the South American sea lion, *Otaria flavescens*, both *N. cepedianus* preys (Bastida & Rodríguez, 2003; Crespi *et al.*, 2003; Lucifora *et al.*, 2005).

The size–frequency distribution for *N. cepedianus* in RD and SJ showed a bias on behalf of juveniles, with a dominance of females. Ebert (2002) found segregation by sex and life history stages in the populations of California and South Africa. Adolescent males are rare in nursery areas, whereas juvenile females of comparable size tend to remain there.

Dietary changes associated with the size of *N. cepedianus* may, in part, explain how food resources within a given area are partitioned to minimize competition between conspecifics at different life history stages. Within the species, reduced competition between adults and sub-adults would increase survivorship for the latter during the critical early stages of life (Ebert, 2002). According to our findings and Ebert's (2002) conclusions, the dominance of juvenile females of *N. cepedianus* in RD and SJ indicate that these protected areas operate as secondary nursery areas for the species as defined by Bass (1978), and become the southernmost nursery areas known for the species in the south-western Atlantic.

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