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Population biology and fishery characteristics of the smooth-hound *Mustelus schmitti* in Anegada Bay, Argentina

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ABSTRACT

The smooth-hound *Mustelus schmitti* is a commercially important and common target shark inhabiting the southwestern Atlantic coastal system and is usually found in shallow waters. Using experimental and artisanal fishing records, we assessed seasonal biological and demographic characteristics related to fishing of the smooth-hound and its potential impact on this species. We found that after birth, juveniles remain in Anegada Bay until sexual maturity. The young adults mate in spring and then leave the bay in summer. The older adults come back to the bay in early spring to give birth, and mate and finally return to the open sea in late spring. This pattern suggests that the bay acts as a seasonal nursery and reproductive area. This species represents 95% of the fishery captures in this bay, although the fishery is highly seasonal. The average harvest during the years 2003–2008 was 164 tons, which represented only 2% of the total Argentinean smooth-hound landings. Fishing effort in the bay can be considered moderate due to the narrow time window and the use of selective gear that prevents the capture of juveniles. Future research should be directed at developing management plans at a broader regional scale to allow the recovery of *M. schmitti* stocks under heavy fishing pressure in other fishing areas.

1. Introduction

The smooth-hound *Mustelus schmitti* is a common shark inhabiting the southwestern Atlantic coastal system from Brazil to southern Patagonia (Menni, 1985; Chiaramonte and Pettovello, 2000) and is usually found in shallow waters (Cousseau and Perrotta, 2004; Oddone et al., 2007). *M. schmitti* is extensively exploited by commercial and artisanal fisheries along this coastline (Chiaramonte, 1998; Miranda and Vooren, 2003; Paesch and Domingo, 2003) and especially within latitudes from 36° to 41°S (Massa et al., 2004a), where the species represents the most highly targeted shark by artisanal gill net fishermen (Chiaramonte, 1998). *M. schmitti* is also captured during bottom trawling for other species through multifleet fishing and, as such, comprises up to 20% of that fishery's coastal harvest (Massa et al., 2004a,b; Fernández Aráoz et al., 2009). In recent years, the overall yield of this species within the southwestern Atlantic region has greatly decreased primarily because of an increase in fishing effort (Massa and Hozbor, 2003). The El Rincón area in the southwest Buenos Aires province is of particular significance because extensive coastal commercial fishing has developed there (Massa et al., 2004a) and because this region has also been identified as a main nursery site for this species (Cousseau, 1986; Cousseau et al., 1998).

Biological and demographic studies of *M. schmitti* have received considerable attention in recent years (*e.g.*, Chiaramonte and Pettovello, 2000; Oddone et al., 2005, 2007; Sidders et al., 2005). Most of these earlier studies, however, were based on samplings from moderate to deep waters during restricted sampling periods (Menni, 1985) and from net-trawling fishing vessels (Vooren, 1997; Miranda and Vooren, 2003; Pereyra et al., 2008). Such information may be skewed with respect to body size and may not consider seasonal demographic variation and size ranges, thus ignoring the possibility of differences in these parameters among the various shoreline zones. Because of the particular biological features of sharks, fishing could exert a large negative impact on these animals if their biological parameters and population structure were not properly considered as a basis for their sustainable management. More information based on the life-history patterns of this species is thus required to assess the influence of the fishery on

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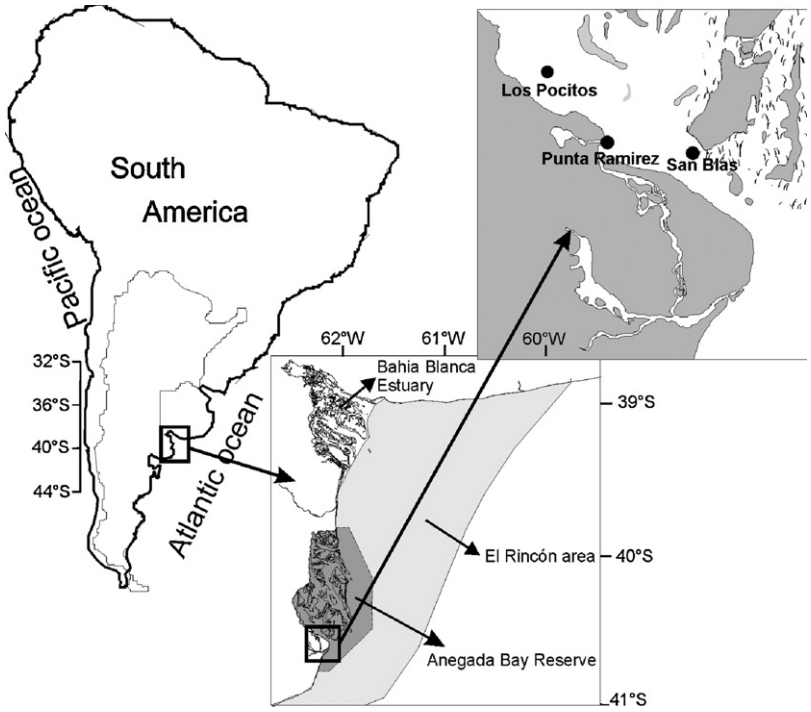

Fig. 1. Geographic location of the study area and the sampling sites.

fishing areas such, such as in Anegada Bay. Although artisanal fishing activity in this bay has a long history, unsound management guidelines were in place up until 2002, when a co-management framework was proposed to organize smooth-hound fishing. Since 2008, however, this fishery has been closed as a result of protective measures in this reserve area.

The present study investigates the seasonal biological and demographic characteristics of the *M. schmitti* populations in the shallow waters of Anegada Bay. Previous studies have focused only on deeper and more outlying regions and have not addressed the importance of coastal areas for this species or how these shark populations could be impacted by inshore fishing. Accordingly, we compared the fishery in this area with that throughout the El Rincón region in general to obtain a broader perspective on the conservation status of this species in the face of the current extent of fishing pressure. At the same time, we suggest future directions to achieve sustainable management of this resource in Anegada Bay and the El Rincón area.

2. Materials and methods

2.1. Study area

Anegada Bay (from 39.96°S to 40.60°S and from 62.10°W to 62.46°W) comprises a reserve designated in 2001 as a multiple-use zone and encompasses the southern part of the Buenos Aires province (Argentina), with its southernmost area considered as part of north Patagonia (Fig. 1).

The bay consists of three main coastal ecosystems characterized by marshes, tidal plains, and psammitic beaches and contains small islands and banks connected by a diffuse network of channels, with depths ranging from 10 to 24 m. The complete El Rincón coastal area has a low level of salinity (30–33 ups), partly as a result of the influence discharge from the Colorado and Negro river (Lucas et al., 2005). The water temperatures ranges from 5 °C in winter to 21.7 °C in summer, whereas the salinity ranges from 32.5 to 35.0 ups (Borges, 2006).

There are sandbars in the southern part of Anegada Bay that can become exposed during low tides. The coastal sediments are heterogeneous and are composed of sand, gravel, wave-cut platforms, and marshes. A distinctive characteristic of the area is the presence of a tidal-inlet system that connects Anegada Bay with the outer sea, the San Blas Channel. This channel is 2.5 km wide and 12 km long and has a maximum depth of 28 m. The current velocities there reach 2 m/s during flood tides and 1.8 m/s during ebb tides. The channel bottom is covered by unconsolidated sediments in its central regions and cohesive sediments toward its mouth (Cuadrado and Gómez, in press).

2.2. Sampling and data collection

2.2.1. Experimental fishing

The study area comprised the Southern part of Anegada Bay, where three main sites were chosen for the sampling of the fish community: (a) San Blas (40.5307°S, 62.2249°W), located in the north flank of the San Blas Channel, a high-current environment near the channel's opening to the outer sea where the sampling depth ranged from 3 to 4.5 m; (b) Punta Ramírez (40.5211°S, 62.3182°W), located at the mouth of a secondary tidal channel (3-m deep), a tributary of San Blas Channel, where the sampling depth ranged from 0.8 to 3 m; and (c) Los Pocitos (40.466°S, 62.366°W), located in the south flank of the San Blas Channel in a shallower (12 m depth) and lower-current environment situated within Anegada Bay, where the sampling depth ranged between 2.8 and 6.4 m.

Each area was seasonally sampled from October 2007 through February 2009 using seven bottom gill nets with a length of 25 m and a height of 2 m with different mesh sizes (distance between opposite knots: 64, 70, 80, 105, 135, 150, and 170 mm). Sampling was always carried out during a nocturnal tidal cycle. After each haul, all of the captured smooth-hounds were sexed, measured (total length: TL), and grouped into size classes differing by 10 mm. A subsample composed of ten randomly selected individuals within each length interval was measured (TL, in mm) and weighed (total weight, W, in g). The stage of maturity was determined macroscopi-