



Analysis of large-scale spatio-temporal trends of *Ostrea puelchana* beds in Northern Patagonian gulfs, Argentina



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ABSTRACT

Wild oyster populations have declined severely worldwide, however fluctuations of South Atlantic populations are poorly documented. We explored the changes in the abundance of *Ostrea puelchana* population of Northern Patagonia, Argentina, by linking data from paleontological, archaeological and informal sources, with time series data from fishing, ecological and studies of oyster pathology.

The present work is the first study which includes a South Atlantic time series concerning oyster beds. The focal area for this study is the San Matías Gulf (SMG, 40° 50′–42° 15′ S, 63° 5′–65° 10′ W). Populations of *O. puelchana* were inferred from sub-fossil deposits (>700 years ago) throughout the gulf, but were documented in surveys a century ago only in the NW coast.

The population has declined in the last decades. However, new populations have established recently in the NE and southern regions of the gulf.

A *Bonamia exitiosa* epizootic was coincident with the declining trend of the abundance provided by the time series, suggesting that beds declined as a consequence of parasite infections.

Dredging fisheries for scallops took place in the 1970s and 1980s on the NE coast of the gulf, in areas adjacent to the NE oyster beds. We proposed that fishing activities might have had a low impact on oyster beds, since NE beds expanded and increased during that period.

The southward expansion of oyster population at latitudes beyond the historical distribution range might reflect long-term adequate environmental conditions for larval survival on the NE and S of the SMG.

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1. Introduction

Wild oyster populations have declined severely worldwide because of overfishing, habitat destruction, or diseases (Beck et al., 2011). For instance, since 1884, commercial harvesting of *Crassostrea virginica* in Chesapeake Bay has declined (Rothschild et al., 1994) due to overfishing (Gouletquer et al., 1994). Overfishing has also caused the collapse of Sydney rock (*Saccostrea glomerata*) and flat oyster (*Ostrea angasi*) in Australia (Nell, 2001), *Ostrea edulis* in Wadden Sea (Wolff, 2005), and *Ostrea lurida* in Western North America (Kirby, 2004). Habitat degradation through fishing disturbance may exacerbate the impact of additional stresses from

anoxia, the outbreaks of parasitic diseases, and of other symptoms of environmental deterioration (Beck et al., 2011). In Foveaux Strait, New Zealand, dredge fishery for *Ostrea* (= *Tiostrea*) *chilensis* was maintained over 130 years (Cranfield et al., 1999). The continued exploitation of these oyster beds subsequently reduced oyster densities to low levels. An infection caused by the Haplosporidian parasite, *Bonamia exitiosa*, between 1986 and 1992, resulted in the closure of the fishery, until the population rebuilt in 1995 (Cranfield et al., 2005).

Fluctuations of native oyster populations from South Atlantic are poorly documented (Beck et al., 2011); however, there is a significant concern about this, since oysters along South American coasts are also showing signs of decline. Carranza et al. (2009) ranked 10 oyster species within 10 distinct ecoregions from the Caribbean Sea and the Atlantic Ocean according to their biological, ecological and socio-economic value to determine the conservation status of their populations. Among them, the native puelche oyster, *Ostrea puelchana* D'Orbigny 1842, in the North Patagonian Gulfs

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ecoregion, received the highest priority for immediate conservation actions due to evidence of decline of the main beds. Scallop dredging operations, illegal fishing (vessels that operate in violation of the fishery laws, not declaring the catch) and diseases have been suggested as the main causes for bed contraction. However, recently *O. puelchana* was found outside the historic range, at the South coast of the San Matías Gulf (SMG) (Ciocco et al., 2001) and inside the San José Gulf (SJG; Cremonte et al., 2005).

In 1996, the oyster beds in the NW coast of the SMG were affected by *B. exitiosa*. Mortality in culture site inside the San Antonio Bay, SMG, was 95% (Kroeck and Montes, 2005), and the prevalence in wild beds reached a maximum of 57% (Kroeck et al., 2008). Its long-term effects on population density have not yet been evaluated.

The aims of this work were to explore the hypotheses that the *O. puelchana* populations of the NW of the SMG have declined as a consequence of epizootic infections by *B. exitiosa* while populations of the NE of the SMG have expanded and increased despite the impact of dredge activities. The possible underlying causes for the contraction-expansion population pattern were analyzed to recognize the temporal and spatial scales at which it occurred. These fluctuations of the oyster populations of the SMG were explored developing a timeline of distribution (and abundance since 1986) by linking the archival data collected from paleontological, archaeological and informal sources, with time series data collected during surveys and studies of oyster pathology.

2. Materials and methods

2.1. Biological background of the puelche oyster, *O. puelchana*

The native puelche oyster inhabits subtidal soft-bottoms (1–20 m depth) along the Atlantic coast of South America from Brazil to northern Patagonia, Argentina (Castellanos, 1957; Scarabino, 1977, Fig. 1). Relatively dense natural beds have been

reported only in its southernmost geographical distribution, at the NW and NE of the SMG (41°–42° S, 63°30′–65°W, Fig. 1) (Pascual and Bocca, 1988), apparently isolated from populations outside the gulf. The puelche oyster lives isolated or in clusters. A cluster is formed when larvae settle and grow on the shells of a “founder” oyster (Pascual et al., 2001), generating a tridimensional architectural structure.

O. puelchana is a protandric hermaphrodite, with consecutive sexuality. This species shows a unique breeding system: large oysters often carry small individuals attached to a flat platform originated from the anterior edge of the concave shell. “Carrier” oysters have a strong influence in the growth rate of small epibionts which are able to live in this “dwarf” condition for long periods (Pascual, 2000). Epibiotic individuals mature as males at about 3 mm of shell diameter (Morriconi and Calvo, 1989).

During the reproductive season oyster smaller than 55 mm in height are predominantly males. Spawning takes place from mid November to mid March (mid spring to late summer) (Morriconi and Calvo, 1979). Mean fertility ranges from 900,000 to 2,700,000 larvae. Brood size ranges from 447,500 to 3,790,000 larvae (mean = 1,868,212; $s = 813,808$; $n = 121$) (Castaños et al., 2005). Embryos are small (60–90 μm) and are incubated during a short breeding period (5–6 days; Zampatti and Pascual, 1989). Larvae have a long planktonic life (more than 10 days at 22 °C, Morriconi and Calvo, 1989). During the settlement season (December to March, Pascual and Bocca, 1988), oyster larvae settle on all available hard surfaces but preferentially on the shells of living oyster, probably mediated by chemical attraction (Pascual and Zampatti, 1995).

2.2. Study area

The San Matías Gulf (SMG) (40° 50′–42° 15′S, 63° 5′–65° 10′W, Fig. 1) is a semi-enclosed basin, partially communicated with the open sea through a shallow sill (60 m depth) (Rivas and Beier, 1990). Water circulation is driven by two eddies, one with cyclonic sense

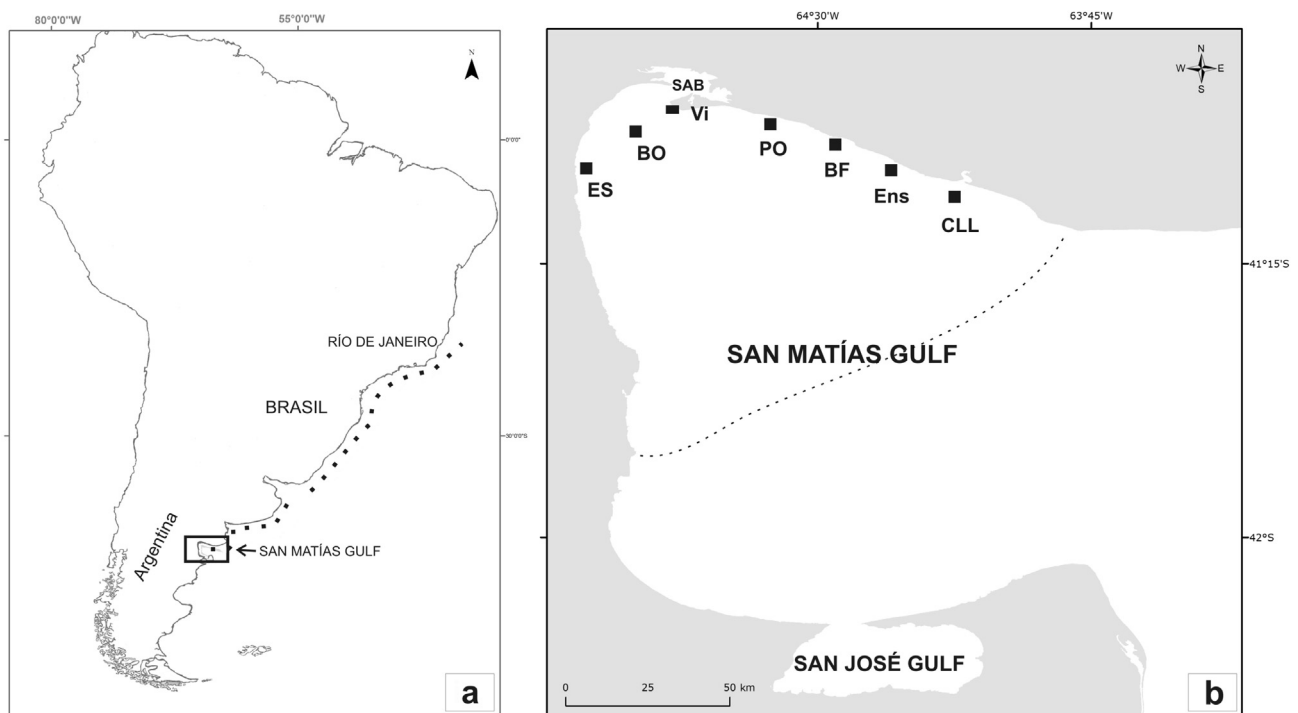


Fig. 1. a: *Ostrea puelchana* geographic distribution. b. Natural beds of *O. puelchana* at North Patagonian Gulfs (ES: El Sótano; BO: Bajo Oliveira; Vi: Punta Villarino; PO: Playa Orengo; BF: Barranca Final; Ens: Ensenada; CLL: Caleta de los Loros). SAB: San Antonio Bay. San Matías Gulf showing thermohaline front.

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