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ORIGINAL RESEARCH

A historical appraisal of fish assemblage and the artisanal fishery in San Antonio Bay, northern Patagonia, Argentina

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ABSTRACT. For nearly a century, the artisanal fishery in San Antonio Bay, northern Patagonia, has relied on habitats crucial for fish spawning, nursery, and feeding. This study characterizes the composition and temporal dynamics of the coastal fish assemblage and evaluates its relationship with the artisanal fishery by comparing current findings with historical records. Sampling was conducted bi-monthly over two annual cycles in traditional fishing grounds. The abundance and biomass of each captured species were quantified and standardized per haul based on the area swept by the net. Of the 17 fish species identified, *Odontesthes argentinensis* was the most abundant while *Eleginops maclovinus* was the most represented in terms of biomass. While biomass remained constant, a significant seasonal effect was observed in fish abundance, which increased during the warmer months. Compared to 1990s records, species composition and dominance shifted, particularly with the replacement of *O. platensis* by *O. argentinensis*. Additionally, current data revealed a higher prevalence of juvenile individuals, and a lower occurrence of large fish compared to historical observations. Target species have remained relatively consistent since the early years of fishery activity, and overall fishing capacity has increased in the past decade. Yet, catch volumes are at their lowest point. Changes in fish species dominance in the SAB assemblage may stem from population cycles, and climate change, while the decline of the fish landings relates to socioeconomic factors. Long-term monitoring of coastal fish assemblage dynamics is essential for effective management of this artisanal fishery.

Key words: Fish assemblage, fish stock shifts, artisanal fishery trends.

Una evaluación histórica del ensamble de peces y la pesca artesanal en la Bahía San Antonio, norte de la Patagonia, Argentina

RESUMEN. Durante casi un siglo, la pesca artesanal en la Bahía de San Antonio, al norte de la Patagonia, ha dependido de hábitats cruciales para el desove, la crianza y la alimentación de los peces. Este estudio caracteriza la composición y la dinámica temporal del ensamble íctico costero, y evalúa su relación con la pesca artesanal mediante la comparación de los hallazgos actuales con los registros históricos. El muestreo se realizó bimensualmente durante dos ciclos anuales en zonas de pesca tradicionales. La abundancia y biomasa de cada especie capturada se cuantificó y estandarizó por lance en función del área barrida por la red. De las 17 especies de peces identificadas, *Odontesthes argentinensis* fue la más abundante, mientras que *Eleginops maclovinus* fue la más representada en términos de biomasa. Si bien la biomasa se mantuvo constante, se observó un efecto estacional significativo en la abundancia de peces, que aumentó durante los meses más cálidos. En comparación con los registros de la década de 1990, la composición y la dominancia de las especies cambiaron, en particular con el reemplazo de *O. platensis* por *O. argentinensis*. Además, los datos actuales revelaron una mayor prevalencia de individuos juveniles y una menor ocurrencia de peces grandes en comparación con las observaciones históricas. Las especies objetivo se han mantenido relativamente constantes desde los primeros años de la actividad pesquera, y la capacidad pesquera general ha aumentado en la última década. Sin embargo, los volúmenes de captura se encuentran en su punto más bajo. Los cambios en la dominancia de las especies de peces en el conjunto SAB podrían deberse a los ciclos poblacionales y al cambio climático, mientras que la disminución de los desembarques pesqueros se relaciona con factores socioeconómicos. El monitoreo a largo plazo de la dinámica de los conjuntos de peces costeros es esencial para la gestión eficaz de esta pesquería artesanal.

Palabras clave: Ensamble pesquero, cambios en las poblaciones de peces, tendencias de la pesca artesanal.

INTRODUCTION

Coastal zones are highly dynamic and complex environments, where marine, terrestrial, and atmospheric processes interact to shape the structure and distribution of biological communities (Sheaves et al. 2014). The structural complexity of these areas supports diverse habitats that serve as spawning, nursery, shelter, and feeding grounds for many species, including commercially important fish and crustaceans (López-Ordaz et al. 2009). This habitat diversity enhances species richness and trophic web complexity, making these ecosystems ecologically significant (Sheaves et al. 2014).

San Antonio Bay (SAB), located in northern Patagonia (Figure 1), has long been recognized as a critical region for marine biodiversity and artisanal fisheries (González 1991; González et al. 1996; Perier 1994). This bay and its surrounding areas on San Matías Gulf were erected as a marine protected area (San Antonio Bay Natural Protected Area) in 1993 with the aim to protect critical sites and ecological process for birds, both local and migratory, and then also protecting marine mammals and fish. Three urban centers (San Antonio Oeste, Puerto San Antonio Este, and Las Grutas) are located into the protected area. These communities engage in various activities that rely heavily on the bay, including artisanal fishing, port services, industry, tourism, and recreation (Häder et al. 2020).

Artisanal fishing in the region prior to 1930s was primarily for household consumption. Since then, it has significantly contributed to the local economy and development, with fishermen reporting annual catches of ~ 15 t (González 1994). In the 1940s, shark liver was exported to wartime countries, but this trade collapsed by the decade's end (González 1994; Narvarte et al. 2022). By the 1950s, three species of silversides (genus *Odontesthes*) and *Eleginops maclovinus* dominated the catches. By 1956, total landings had reached 265 t, supplying regional and national markets, including major urban centers (Poder Ejecutivo de la Provincia de Río Negro 1962). However, despite its importance, the stock status, species composition, or fishery dynamics of the coastal fish assemblage, for which official fishery statistics have been available since the 1960's, have not been revisited since the Périer's (1994) foundational study. This gap is particularly concerning given the ongoing socio-cultural shifts and the potential effects of global change (GC).

Perier (1994) defined SAB as an important reproduction and nursery area for several fish species. Furthermore, that study described the modalities of artisanal fishing, as well as an examination of the importance of fish assemblages for the sustainability of this fishery. The fishing modality described, employs beach seines (60-100 m long) deployed from small wooden or fiberglass boats (4-6 m length), powered either by oars or small outboard motors (15-25 HP). Fishing operations are shored based, typically involving two fishermen: while one fisherman remains on land, the other drags the boat with a rope on foot or by rowing in a semicir-

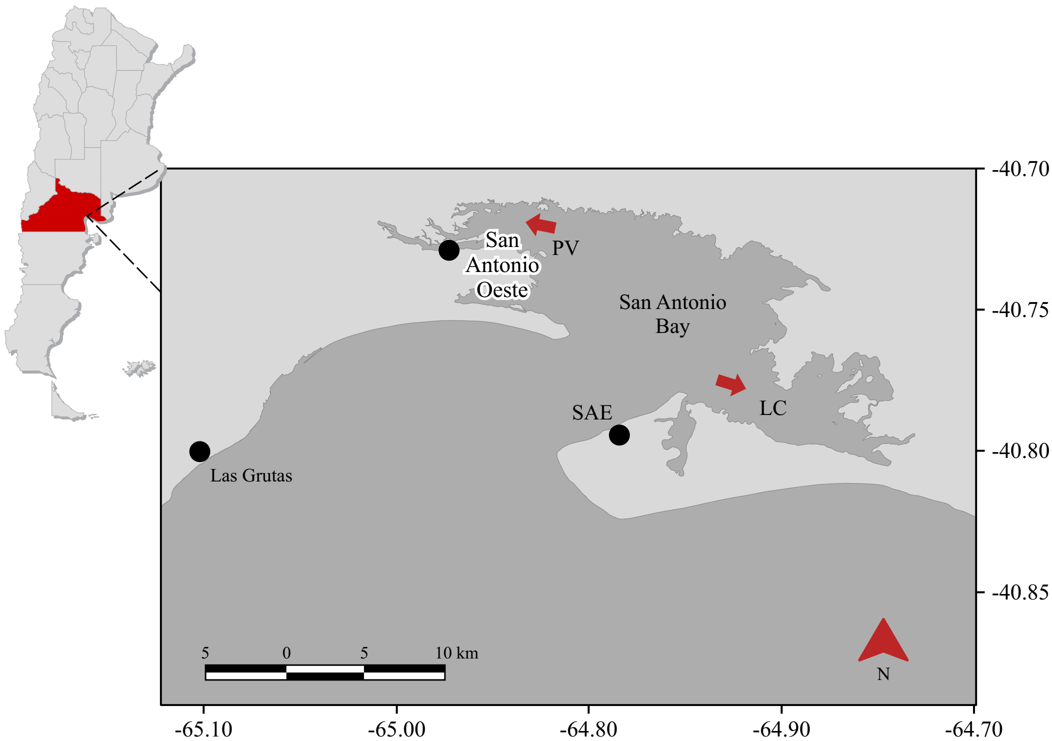

Figure 1. Study area and fishing grounds in San Antonio Bay (Río Negro, Argentina): Left arrow: Canal Encerrado; Punta Verde (PV). Right arrow: Canal Escondido; Puerto San Antonio Este (SAE); La Cuadra (LC).

cular path to encircle the fish's school. Both then haul the net synchronously, perpendicular to the coastline (supplementary material, Figure S1). Given that the understanding of marine fish assemblage structure and dynamics requires habitat knowledge, that study also described the main fishing grounds considering the mean temperature by month, mean salinity and type of biogenic coverage highlighting the presence of mussels (*Brachidonthes rodriguezii*, *Mytilus platensis*, *Aulacomya atra*), crustaceans (*Cyrtograpsus angulatus*, *Neohelice granulata*) and halophytic vegetation (*Sarcocornia* sp. and *Spartina alterniflora*). Since then, SAB experienced an increase in urbanization that triggered signs of eutrophication in the inner channels (Martinetto 2010; Saad 2019), and the inception of a sodium carbonate industry since 2003 (Häder et al. 2020). In addition, GC drivers projected for northern Patagonia, such as alterations in wind patterns and increased occurrence of torrential rain (Häder et al. 2020; Helbling et al. 2022; Narvarte et al. 2022; Burgueño et al. 2024), must also be considered. At the same time, SAB exhibits changes in the benthic assemblage, showing a drastic decrease in the mussel *B. rodriguezii* abundance (Müller 2024), the simultaneous introduction of two invasive species, the algae *Undaria pinnatifida* and the ascidia *Styela clava* (Pereyra et al. 2015; Arcángel et al. 2022; Rodríguez et al. 2025), and more recently, the green crab *Carcinus maenas* (Müller et al. 2025). These concurrent changes, along with shifts in exploitation patterns of the coastal fisheries, could alter the structure, distribution, and ecological interactions of species within the SAB ecosystem.

In the face of both natural and anthropogenic pressures, identifying the temporal trends in the dynamics of the fish community (including seasonal and interannual variations) is essential to assess its stability and ecological resilience. Additionally, the role of artisanal fisheries in this ecosystem provides valuable insight into the sustainability of local fishing practices and their potential impact on species composition and resource availability. In this context, the aim of this research was twofold: first, to characterize the composition and temporal dynamics of the coastal fish assemblage in SAB; and second, to evaluate the relationship between the coastal fish assemblage and the artisanal fishery in SAB by comparing current metrics with historical data. This research will contribute to the management of fishery resources in SAB, providing a basis for future research on the interplay between diversity indicators, the cultural and socio-economic trajectory of small-artisanal fisheries, and fishery productivity in coastal systems.

MATERIALS AND METHODS

Study area

Located in the northwest of San Matías Gulf, SAB (40° 46′ S, 64° 54′ W –Figure 1) is a sheltered inland basin characterized by a macrotidal regime reaching up to 9 meters (Aliotta et al. 2000). This bay has a variety of habitats, including intertidal flats with tidal channels and pools, vegetated and unvegetated crab flats, sandy beaches, vast sandbanks, rocky bottoms, and reef settings (González et al. 2003; Carbone et al. 2007). Its link to the oceanic dynamics of the gulf promotes significant water exchange twice daily, therefore providing nutrients and organic matter to the northern section of the gulf (Esteves et al. 1996; Williams 2011; Saad et al. 2019) and maintaining the region's high productivity (Narvarte et al. 2022). The bay has the seasonality of austral temperate habitats, with water temperature following air temperature and salinity peaking in summer (Saad et al. 2025). This strong temperature-salinity coupling is typical of inverse estuaries, where evaporation exceeds freshwater supply, resulting in high salinity levels (Piola and Scasso 1988). Furthermore, SAB is a microbial-dominated system with high bacterial and phagotrophic protist biomass but low phytoplankton biomass, which peaks during the warm season (Saad et al. 2025).

Sampling procedure

Bi-monthly samplings were conducted over two full annual cycles (2022-2024) at different sites of the SAB. The sampling stations were located in areas traditionally used as fishing grounds by artisanal fishermen (Perier 1994), specifically: (1) the sector known as Canal Escondido, between La Cuadra and Punta Perdices, and (2) Canal Encerrado, between Punta Verde and Puerto San Antonio Oeste (Figure 1). These channels are similar in shape and bottom granulometry owing to their exposure to uniform macrotidal dynamics and are considered the primary conduits of the numerous water flow branches of the bay. Nonetheless, they differ in terms of primary biogenic cover, due primarily to nutrient supplies from the city that flow into the Canal Encerrado. Each month, four fishing hauls were performed in the sampling stations, using a beach seine (80 me buoy-rope length, 2 m height) with mesh sizes from 40 to 20 mm in the wing panels and 10 mm in the bag. Each haul was conducted employing a motorboat (4 m length, 60 HP) for transit, emulating the manual local artisanal fishermen's strategies around low tide (supplementary material, Figure S1). The area swept by the net in each site was calculated from the buoy-rope width and the tow distance (measured with GPS).

Assemblage analysis and historical data

Abundance (number of individuals) and biomass (weight) of each haul were estimated to characterize the fish assemblage structure. Then, both abundance and biomass were standardized based on the area swept by the net in each haul (ind. m^{-2} and g m^{-2}, respectively). Additionally, percentages of abundance and biomass of each species were estimated, relative to the whole catch (throughout the two sampling years) in number and weight. The ecological status (relative importance) of each fish species within the assemblage was assessed through a graphical analysis, plotting species abundance (X-axis) against percentage frequency of occurrence (Y-axis), following the Olmstead-Tukey test (Sokal and Rohlf 1979). This plot allowed us to classify species into four ecological categories: dominant (high abundance or biomass and high frequency of occurrence), common (low abundance or biomass and high frequency of occurrence), occasional (high abundance or biomass and low frequency of occurrence) and, rare (low abundance or biomass and low frequency of occurrence (González-Acosta 1998). To assess sampling accuracy and estimate total species richness, a species rarefaction curve was constructed based on the number of hauls using the *specaccum* function from the *vegan* R package (Oksanen et al. 2020). In addition, the *Chao1* estimator of asymptotic richness was computed using the *estimate* R function, and its values was compared to the observed number of species. For dominant and commercially relevant species, individuals were measured to obtain body length data and compare the current size structure of catches with data reported from SAB in the early 1990's.

The variability observed in species abundance and biomass for all species collected across sampling years, seasons (warm: spring and summer months; cold: autumn and winter months), and channels, was assessed using a multivariate generalized linear model (manyglm function) with the mvabund R package (Wang et al. 2012) assuming a negative binomial distribution. To complement this analysis, a non-Metric Multidimensional Scaling (nMDS) ordination was performed using Bray-Curtis dissimilarity, with prior data transformation (square root) to visualize patterns of variability in species abundance and biomass across temporal and spatial scales, reducing the effects of hyperdominance.

Species composition and seasonal dynamics of fish assemblage were compared with historical available data gathered from technical reports (González 1991, 1994; González et al. 1996), other public and published sources (Poder Ejecutivo de la Provincia de Río Negro 1962; Perier 1994; Narvarte et al. 2022). Historical records of fish landings, effort and registered fisherman/boats were provided by the Maritime Fisheries Directorate of the Río Negro province and analysed to qualitatively assess the available fishery information over time.

RESULTS

Structure of the fish assemblage

A total of 9,154 individuals of 17 fish species belonging to 13 families were recorded along the study. Among them two species were chondrichthyans while the remaining 15 were teleosts (Table 1). *Odontesthes argentinensis* was the most abundant species (64.5% of total catch), followed by *Diplodus argenteus* (12.8% of total catch, Figure 2 A). In terms of the assemblage biomass, *E. maclovinus* was the most highly represented (33.5% of total catch weight) followed by *O. argentinensis* (29% of total catch weight Figure 2 B). According to the Olmstead-Tukey test, with respect to abundance, four species were classified as dominant, only one as common and, 12 as rare (Figure 3 A). No species were classified as occasional. In terms of biomass, three species were dominant, two were common, only one was occasional, and 11 were rare (Figure 3 B).

Multivariate generalized linear models detected a significant seasonal effect on fish abundance ($p = 0.001$), while year and channel showed no significant influence (Table 2). For biomass, no significant effects of any predictor were detected. Full model statistics for each predictor are presented in (Table 2). In fact, the nMDS results

Table 1. List of fish species recorded in the coastal fish assemblage of San Antonio Bay during the period 2022-2024 with reports of ecological status (OT status).

		OT status	
Family	Species	Biomass	Abundance
Serranidae	*Acanthistius patachonicus*	Rare	Rare
Clupeidae	*Brevoortia aurea*	Rare	Rare
Sparidae	*Diplodus argenteus*	Dominant	Dominant
Serranidae	*Dules auriga*	Rare	Rare
Eleginopsidae	*Eleginops maclovinus*	Dominant	Dominant
Engraulidae	*Engraulis anchoita*	Rare	Rare
Syngnathidae	*Hippocampus patagonicus*	Rare	Rare
Syngnathidae	*Leptonotus blainvillianus*	Rare	Rare
Sciaenidae	*Micropogonias furnieri*	Rare	Rare
Mugilidae	*Mugil liza*	Rare	Rare
Myliobatidae	*Myliobatis goodei*	Rare	Occasional
Atherinopsidae	*Odontesthes argentinensis*	Dominant	Dominant
Atherinopsidae	*Odontesthes smitti*	Dominant	Common
Atherinopsidae	*Odontesthes incisa*	Rare	Rare
Paralichthyidae	*Paralichthys orbignyanus*	Common	Common
Paralichthyidae	*Paralichthys patagonicus*	Rare	Rare
Rajidae	*Sympterygia bonapartii*	Rare	Rare

mirrored the intra-annual pattern observed in the multivariate analysis for abundance (Figure 4 A) and confirmed the lack of significant effects on biomass (Figure 4 B). Species specific contributions in the resulting nMDS also differed depending on whether abundance or biomass was considered. Abundances of *O. argentinensis*, and *E. maclovinus* were significantly associated ($p < 0.05$) to the warm season. For biomass *P. patagonicus*, *P. orbignyanus, E. maclovinus* and *Acanthistius patachonicus* significantly contributed to seasonal dissimilarities ($p < 0.05$), suggesting that although these species may be less abundant, they contribute disproportionately to total biomass. Notably, *E. maclovinus* consistently appeared as a key species in both abundance and biomass analyses, highlighting its structural importance in the assemblage.

The fish assemblage over time and fishery

The fish assemblage in the bay included 25 species in Perier's (1994) study, with *O. platensis*, *E. maclovinus*, *D. argenteus*, *P. orbignyanus*, and *Brevoortia aurea* as the dominant species (supplementary material, Table S1). That study also recorded other pelagic species, such as *Engraulis anchoita*, *Pomatomus saltatrix*, and *Scomber japonicus*, albeit with low frequency of occurrence (< 5%). In comparison, our results reveal a similar overall species composition but a lower total number of species. However, the species rarefaction curve and the *Chao1* estimator (supplementary material, Figure S2) suggested that approximately 81% of the estimated species was captured in our study, indicating that some rare species may have remained undetected. Additionally, the taxonomic identity of the dom-

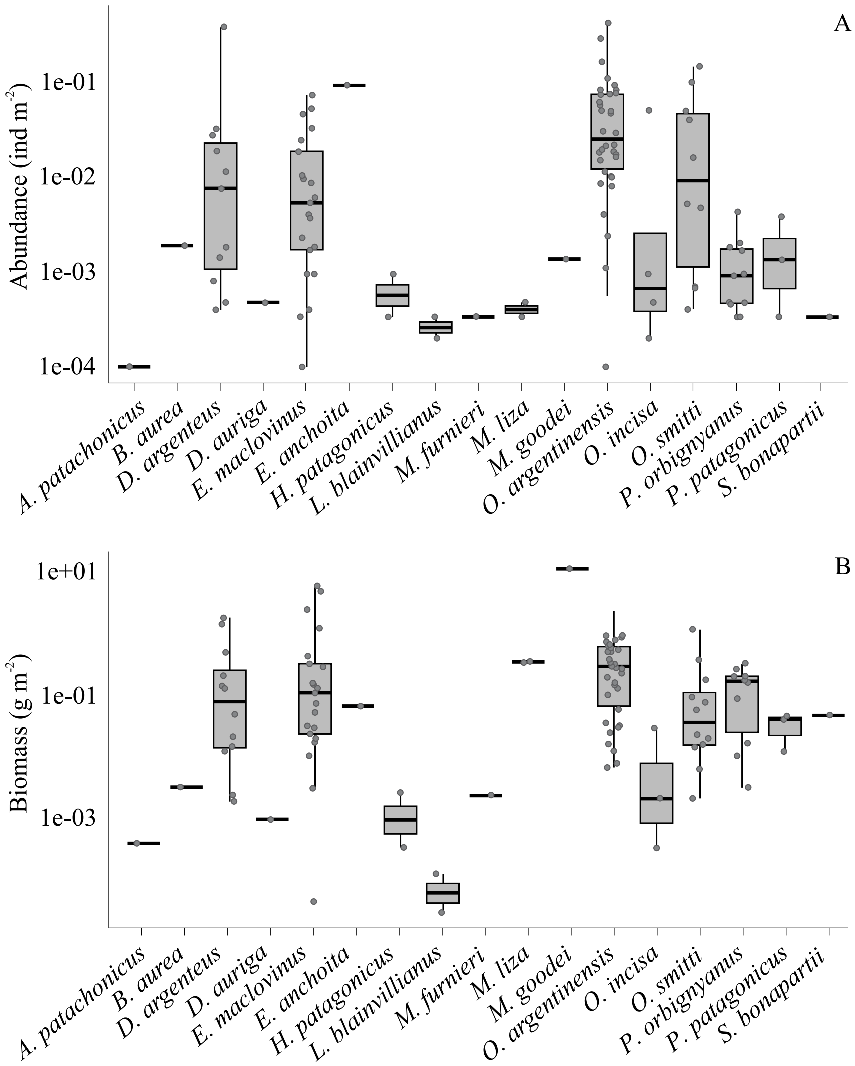

Figure 2. Log-scaled overall standardized abundance (A) and biomass (B) recorded for each species. Boxplots represent data variability, showing median quartiles and dispersion values recorded for each species (whiskers). Individual dots correspond to observed data in the overall sampling period.

inant fish species in the environment shifted from *O. platensis* to *O. argentinensis* (Figure 3). The *D. argenteus* abundance in catches increased, while the *E. maclovinus* declined. *Paralichthys patagonicus* was absent in the 1990s records, but appeared in this study, at low abundance, exclusively found in the warm season. Notably, *O. smitti*, previously recorded only in surrounding waters (Perier 1994), was now observed within the bay.

Length-frequency distributions of the dominant species show noticeable differences between the current dataset and that reported by Perier (1994) (Figure 5). For *D. argenteus*, two size groups were recorded in the present study, with juvenile and adult classes both well represented. In contrast, the 1994 data showed a predominance of intermediate-sized individuals, and no juveniles recorded within the bay. Both juvenile and adult size classes

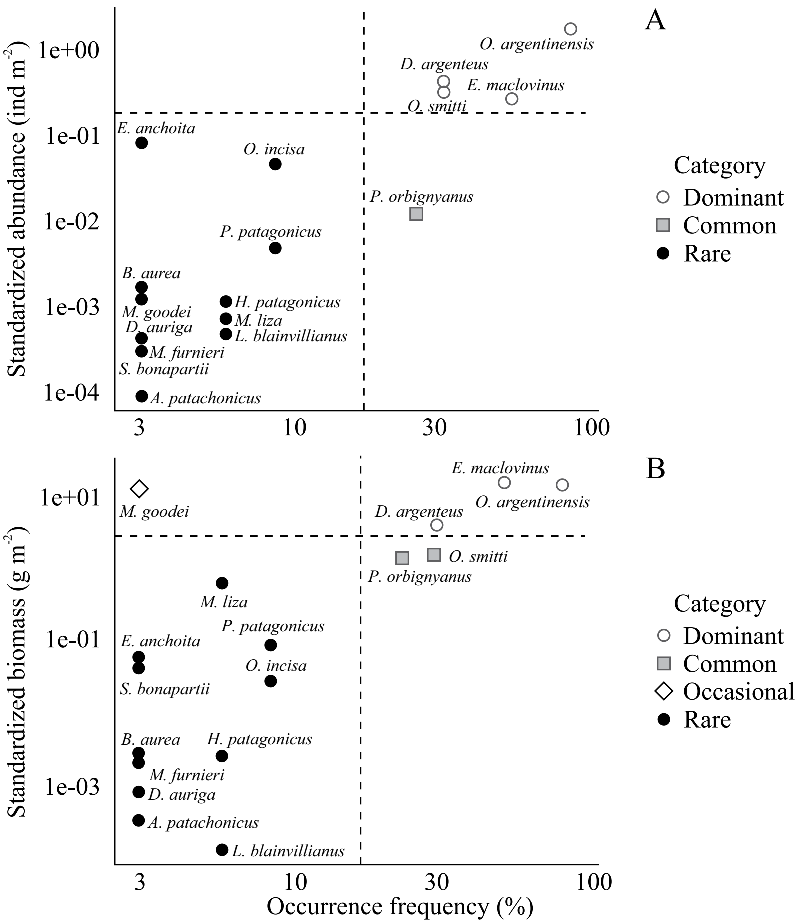

Figure 3. Hierarchical classification of the San Antonio Bay fish assemblage for standardized abundance (A) and standardized biomass (B). Dotted lines represent the respective mean value of frequency and abundance/biomass.

Table 2. Summary of multivariate tests from *manyglm* models for fish assemblage abundance and biomass. *P-values* are from likelihood ratio tests (999 resampling iterations, PIT-trap method).

Response	Predictor	*P-value*
Abundance	Season	**0.001**
	Year	0.493
	Channel	0.198
Biomass	Season	0.401
	Year	0.599
	Channel	0.253

were also seen for *E. maclovinus*, with a higher frequency of young in the present study. Current information reveals comparable frequencies in smaller sizes of individuals when compared to 1994, and a marked drop in the frequency of bigger fish. *Paralichthys orbignyanus* showed a less defined size structure distribution in both studies, though in the present study, smaller sizes appeared slightly more frequently. Individuals of intermediate size were notably scarce, in contrast to their predominance in 1994 data. Finally, the histogram for *Odontesthes* spp. shows the size structure of two species within the genus, *O. argentinensis* and *O. platensis*, which were dominating in the current

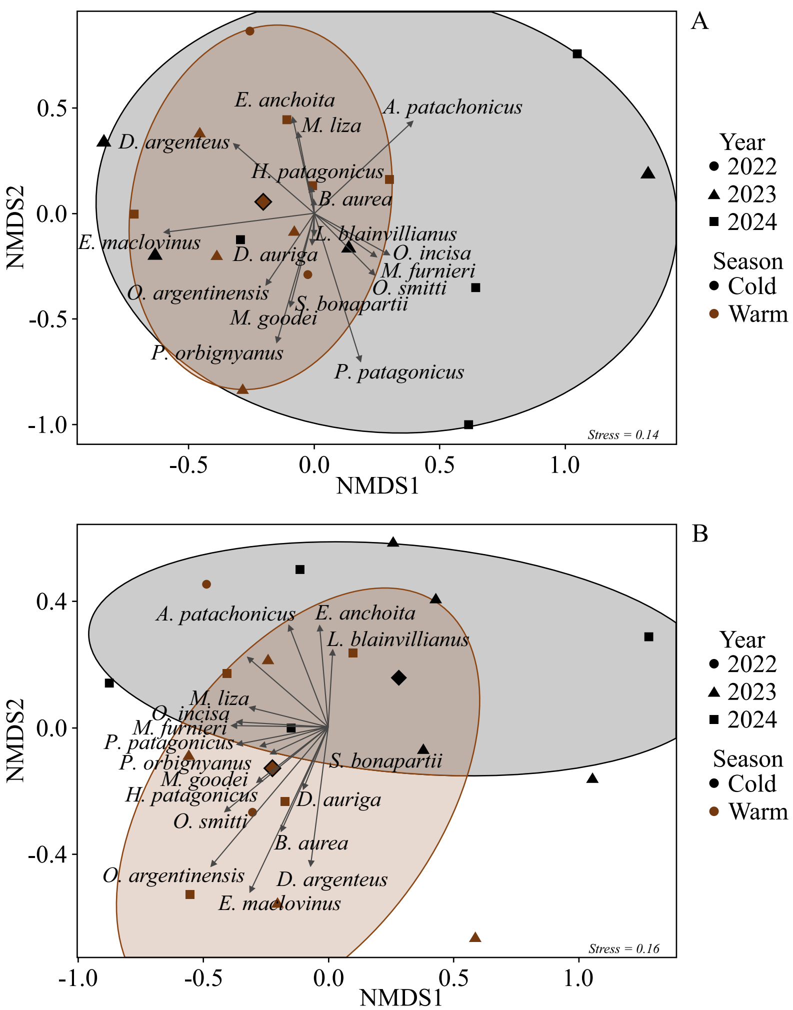

Figure 4. NMDS ordination plot of abundance (A) and biomass (B)according to the season, based on the composition of the SAB fish assemblage. The points represent the samples, grouped by season and year; the squares represent the centroids of each season, summarizing the average position of the samples in the ordination space; the arrows indicate the correlation of each species with the assemblage configuration in the ordination space, where the direction and length of each arrow reflect the contribution and gradient of association of each species with the nMDS axes.

and the 90's reported assemblage, respectively. In both cases, juvenile individuals showed the highest frequency, while larger sizes were less frequent.

Historical data from public fishery statistics indicate that the main target species of the artisanal coastal fishery around SAB have remained relatively consistent since its early development. Key species such as *Odontesthes* spp. and *E. maclovinus* have historically been the primary targets (Figure 6). However, fish catches have declined over the last two decades: since 2006 a significant reduction has been observed, which fell to 12% (average 2006-2024) of the historical average of previous years (average 1980-2005). This period of lower fish catches coincides with the start of artisanal octopus fishing within the SAB, and with an increase in the number of boats engaged in this activity (Figure 7).

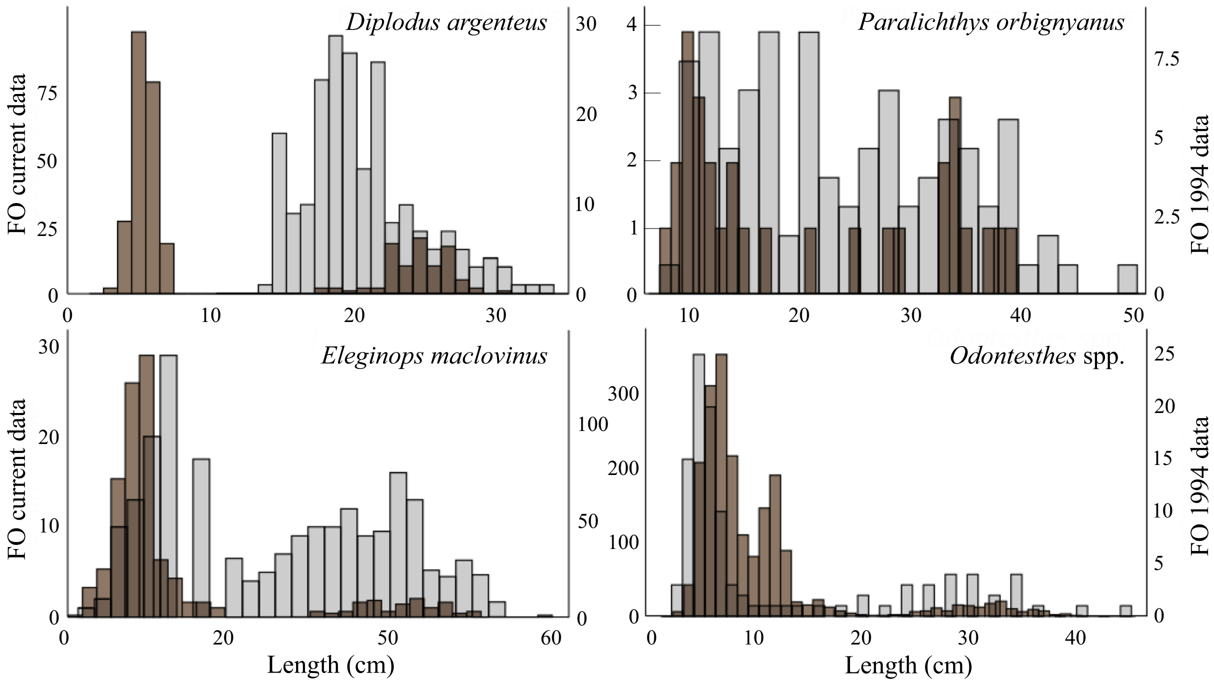

Figure 5. Length-occurrence frequency of dominant species in the SAB fish assemblage from Perier (1994) and current data.

DISCUSSION

This study examined intra- and inter- annual changes in the current coastal fish assemblage within traditional fishing grounds of the artisanal fishery in SAB. The analysis focused on species abundance, biomass, and size distribution of the dominant species. The core assemblage is composed of a few key species: *O. argentinensis* and *O. smitti*, *E. maclovinus*, and *D. argenteus*. Except for *O. smitti* which is absent during the warmer months, all these species inhabit the bay year-round. The assemblages reported here are consistent with previous studies (González 1993; Perier 1994; Jerés et al. 2018) which report a high diversity of both temperate-cold and temperate-warm water species in SAB and surrounding area in NW San Matías Gulf.

Species composition in both channels of the bay exhibited a clear seasonal pattern in abundance rather than an interannual pattern. In contrast, biomass showed no significant variation in response to any predictor variable. In temperate environments, generally the main factors influencing the distribution, abundance and biomass of fish assemblages fluctuate seasonally (Hauck 2018; Vilas et al. 2020). Thus, the observed seasonal patterns in the studied species are likely driven by their physiological responses to environmental changes (e.g. temperature, salinity, trophic resources) in accordance with their life-history strategies. This variability may also contribute to fluctuations in biomass within the assemblage, preventing the detection of a stable temporal trend over the study period. Moreover, seasonal movements to inshore areas driven by reproductive behavior during certain months may contribute to shaping the coastal fish assemblage, as previously documented for other coastal areas of the southwest Atlantic Ocean (Llompart et al. 2013a; Rodrigues and Vieira 2013). Here, the variation of species composition may be linked to

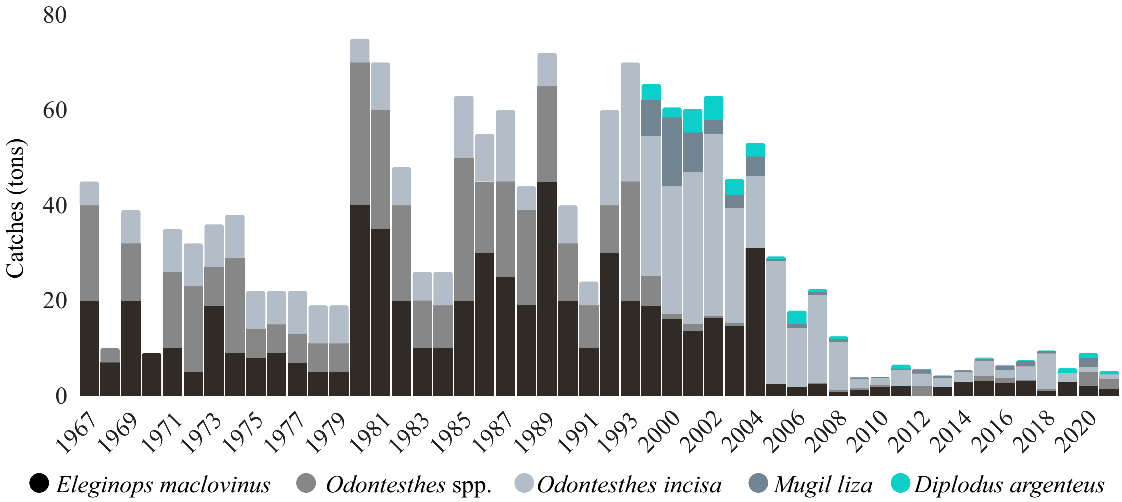

Figure 6. Historical landings (catches) of fish species in SAB for the period 1967-2019. Source: Maritime Fisheries Directorate, Río Negro.

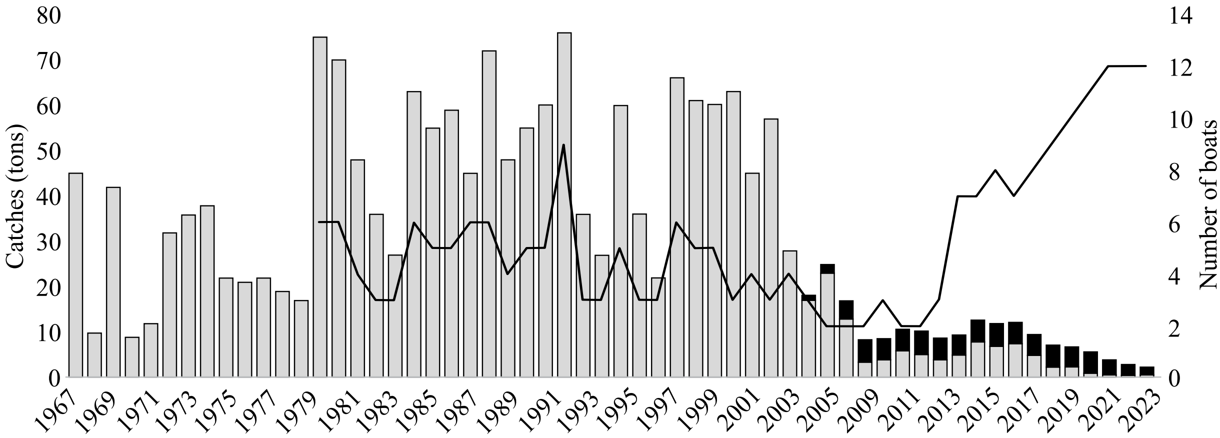

Figure 7. Annual landings (catches) for the artisanal fisheries of coastal fishes and the small Patagonian octopus in SAB (left Y-axis), and fishing capacity based on the number of registered artisanal boats (right Y-axis). Source: Maritime Fisheries Directorate, Río Negro.

the movement patterns of certain species moving entering and leaving SAB. For instance, during their reproductive season (May-August), adults of *E. maclovinus* migrate out of the bay, extending along the west coast of San Matías gulf and then returning to the bay during the remaining months (Gastaldi et al. 2009). Similarly, the rays M. *goodei* and *S. bonapartii* were observed exclusively during the warm season. These species migrate, approaching the coast during this period to spawn (oviposition) or give birth, seeking sheltered environments for their offspring (Rico 2000; Molina et al. 2015; Estalles et al. 2017).

These changes may be driven, in part, by shifts in the invertebrate assemblage (i.e. prey availability) due to coastal eutrophication, such as increased phytoplankton and microphytobenthos productivity, which can enhance fish abundance by boosting food resources (Santinelli 2008). In the Baltic Sea, Sandström and Karas (2002) reported that coastal eutrophication alters fish species dominance, based on juvenile tolerance. In SAB, eutrophication increased in recent years, likely due to local population growth and tourism (Martinetto et al. 2010; Teichberg et al. 2010), and the improper treatment of wastewater (Bonuccelli et al. 2021), though large tidal amplitudes in the system may buffer its effects (Saad et al. 2019, 2025).

Although the total number of species observed in this study was lower than that reported by Perier (1994) within the bay, the species rarefaction curve and *Chao1* estimator suggest that our sampling effort was sufficient to capture most of the expected richness (supplementary material, Figure S2). This reinforces the robustness of the observed differences, suggesting that undetected species likely represent rare species, with low occurrence frequencies-a pattern consistent with historical data (supplementary material, Table S1). Taken together, the observed changes in the fish assemblage, such as the replacement of *O. platensis* by *O. argentinensis* as the dominant fish species, may reflect both population fluctuations and broader ecological shifts. For instance, *O. argentinensis*, is commonly found in the coastal areas of Brazil, Uruguay, and Argentina, and its current dominance may be driven by migratory patterns, recruitment pulses, or long-term abundance shifts (de Buen 1953; Chao et al. 1985; Moresco and Bemvenuti 2006; Llompart et al. 2013b). These trends, at the same time, can be influenced by climate change, whose regional impacts have only recently been considered (Galván et al. 2022; Helbling et al. 2022; Narvarte et al. 2022; Saraceno et al. 2022). Temperature shifts and ocean acidification can directly and indirectly alter communities, leading to shifts in their composition, potentially affecting fisheries (Narvarte et al. 2022). Moreover, studies in Patagonia and Uruguay suggest that coastal and demersal fish assemblages are undergoing compositional and distributional shifts related to warming, and fishery-related factors (Gianelli et al. 2019; Galván et al. 2022; Cuesta Nuñez et al. 2023; Rincón-Díaz et al. 2024).

Our results also point to potential shifts in length-frequency distributions of the dominant species of the SAB coastal assemblage. Compared to Perier's 1994 study, we found a higher prevalence of immature individuals in species such as *D. argenteus* and both silversides species (*Odontesthes* spp.), while larger fish are notably less represented. These differences may indicate changes in recruitment success, growth rates, or survival, driven by coastal fish species' natural life-history strategies, which commonly include seasonal movements, ontogenetic habitat adaptations, and reproductive migrations (Blaber 2000; Biolé et al. 2020). Environmental variability (temperature fluctuations, eutrophication, or habitat destruction) can alter juvenile development and adult distribution (Arranz et al. 2023). For instance, it has been shown that increasing water temperature can affect fish metabolism, accelerate their growth and cause earlier maturation, which could alter the size structure of populations (Blanchard et al. 2005; Ayllón et al. 2021). Furthermore, selective fishing tactics, particularly those targeting larger individuals, have been demonstrated to limit the presence of older size classes, even driving evolutionary shifts toward lower body sizes and early maturity (Law 2000; Ikpewe et al. 2021).

From a historical perspective, fluctuations in fishing activity in SAB were followed by changes in the number of operating boats, which remained variable over time. As a small-scale, subsistence-oriented activity (González 1994; Perier 1994), artisanal fishing has continuously generated employment, especially during national socioeconomic crises. During these periods local populations relied on fishing for both income and subsistence, making it a supplemental source of revenue to cope with economic problems. (González 1994; Salas et al. 2007; Sylwan y González 2008). After nearly a century of operation, this fishery has markedly declined over the past two decades, likely due to anthropogenic causes, as cultural shifts driven by technological advancements, employment diversification, and changing consumer patterns in modern society.

The traditional target species of artisanal fishery of SAB have met local consumer demand for many years. However, they have been replaced in the last decades by other species of greater demand and value (e.g. hake *Merluccius hubbsi*, shrimp *Pleoticus muelleri*) from industrial and artisanal fishing. It was not until 2006 that other economically valuable species present in SAB, as the Patagonian small octopus *Octopus tehuelchus*, began to be exploited by artisanal fishermen with their capacity increasing from 2014 to a maximum of 12 registered vessels in 2024. This species, caught with longlines of artificial refuges made of PVC pipes (Osovnikar et al. 2004; González and Osovnikar 2012; Storero and Narvarte 2024) has become one of the most valuable resources for artisanal fishermen, despite its underrepresentation in official statistics due to the lack of declaration in fishing reports.

In summary, throughout the analysed period, fluctuations in catch volumes and fishing capacity were observed. Even though the overall trend from 2004 to 2024 indicates a continuous increase in number of boats registered, only a few remain focused on *O. tehuelchus* and certain fish species, leading to a decrease in total catches of resources. This decline in fish catches, coupled with the shifting focus towards alternative resources such as *O. tehuelchus* and other targets of industrial fisheries outside the bay, highlights the adaptation of artisanal fishers in response to changing fishery conditions and economic opportunities. These changes enabled fishers who had previously viewed fish capture as a secondary option, often relying on precarious or low-income jobs, to leave that instability behind and dedicate themselves exclusively to octopus fishing. Further evaluation is necessary to determine the extent of operational capacities and skills among artisanal fishers to sustain extractive activities, as well as the possible loss of traditional fishing expertise due to the migration of fishers to the industrial sector and other economic activities.

Finally, the shifts in the fish assemblage of SAB reflect a complex interplay of environmental changes, anthropogenic pressures, and ecological dynamics, highlighting the need for ongoing monitoring to assess species responses and ecosystem stability. While artisanal fishing of fish species has declined, the bay still holds untapped fishery potential based in traditional and emergent resources. Sustainable management strategies could help balance conservation with resource use. Future efforts should focus on identifying drivers of spatial-temporal dynamics, monitoring key indicators of change, and collaborating with local fishers to understand their adaptability, and the evolving trajectory of the fishery.

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Declaration of AI use

Artificial intelligence tools were used to enhance the clarity and language of the manuscript during the writing process. No scientific content, data analysis, or interpretation was generated by AI. The authors take full responsibility for the integrity and accuracy of all scientific content.

Author contributions

Maité A. Barrena: conceptualization; methodology; formal analysis; investigation; writing-original draft; visualization. Juan Francisco Saad: methodology; investigation; writing-review and editing. Marianela Gastaldi: methodology; investigation; writing-review and editing. Dennis N. Landete: investigation. Fausto N. Firstater: conceptualization; supervision; writing-review and editing; funding acquisition. Maite A. Narvarte: conceptualization; methodology; investigation; writing-review and editing; supervision; project administration; founding acquisition. Raúl A. González: conceptualization; methodology; investigation; writing-review and editing; supervision; project administration; founding acquisition.

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