FLOUNDERS – Paralichthyidae Family [link 1]

The Pleuronectiformes are characterized by their considerable metamorphosis where from a bilateral symmetry at the larval level ends in juveniles and adults laterally compressed with both eyes on one side of the head. The monophyly of the order is supported by three morphological synapomorphs, the ocular migration during ontogeny, the anterior position of the dorsal fin origin and the presence of an organ that allows the eyes to protrude above the surface of the body. Most species are grouped mainly in the Paralichthyidae family and to a lesser extent in the Pleuronectidae, Achiropsettidae and Cynoglossidae families (Fabré and Díaz de Astarloa, 1996). The family Paralichthyidae, composed of species of high commercial value, is one of the most important fisheries resources exploited in artisanal and demersal fisheries in Argentine and Uruguayan waters (Fabré and Díaz de Astarloa, 1996; Díaz de Astarloa and Munroe, 1998).

In the southwest Atlantic Ocean species of Paralichthys occur from northern Brazil 1º N (Carvalho-Filho, 1999; Walsh et al., 2015) to central Patagonia, Argentina at ca. 47ºS (Díaz de Astarloa and Munroe, 1998). Throughout the southwest Atlantic region, species of Paralichthys occur in diverse habitats including coastal shallow-waters in areas containing muddy and silty substrata such as turbid estuaries, and also on sandy substrata in moderate depths on the continental shelf. In addition, some species of Paralichthys like P. *isosceles* also found on deep-water substrata located on the outer continental shelf.

The difficulty in identifying Pleuronectiform species and in particular Paralichthys species has led to different studies on traditional taxonomy (Cousseau and Díaz de Astarloa, 1991; Díaz de Astarloa, 1995a, 1995b, 1996; Díaz de Astarloa and Munroe, 1998; Díaz de Astarloa et al, 2006), external morphology (Díaz de Astarloa 1994) and partial aspects of cranial osteology (Díaz de Astarloa, 1991, 2005, Díaz de Astarloa et.al., 2018). At first, preliminary studies were carried out on those species that presented less complexity in their identification as Paralichthys isosceles and Xystreurys rasile (Fabré 1988, 1992; Fabré and Cousseau 1988, 1990; García 1987a and b; García and Menni 1990), and later the studies were extended to other species once the taxonomic problems were clarified (Macchi and Díaz de Astarloa 1996; Díaz de Astarloa and Munroe 1998; Incorvaia and Díaz de Astarloa 1998; Díaz de Astarloa 2005).

Among the diverse aspects studied focused on the correct identification of these species, Volpedo and Echeverría (1997) described the morphology of the internal and external faces of the right and left *sagitta* otoliths of soles obtained from commercial trawling in the ports of Mar del Plata and Puerto Madryn. They found that there are morphological differences between both *sagitta* for *Paralichthys orbignyanus*, *P. isosceles*, *P. patagonicus* and *X. rasile*. The common characteristics of the internal face of the otoliths were: the left *sagitta* has an areal depression, the sulcus is not divided while the right *sagitta* presents a horseshoe shaped depression and the fissure is present in both *sagittas*. The authors conclude that the study of the otoliths of the flatfish should include the internal and external faces of both *sagittas* to ensure the identity of these asymmetric fish. In [link 2] these differences in otoliths for the main species distributed in the Common Fisheries Area are included in detail.

The body shape and pigmentation pattern of each developmental stage as well as the morphometric and meristic characteristics of the early stages of the different flounder species were analyzed by Derisio (2004). The material examined included different stages of larval development of the species *Etropus longimanus* (Paralichthyidae) and *Symphurus trewavasae* (Cynoglossidae), and six species of juveniles belonging to the Families Paralichthyidae (*Paralichthys isosceles*, *P. orbignyanus*, *Xystreury rasile*, *E. longimanus*) and Cynoglossidae (S. *Trewavasae* and *S. jenunsi*). Juveniles of all species studied in the Family Paralichthyidae showed a characteristic pigmentation pattern similar to that of the adult form according to García and Menni (1990), Díaz de Astarloa (1994) and Figueiredo and Menezes (2000), highlighting small ocellated spots regularly arranged in *P. orbignyanus*, three or four ocellated spots in *P. isosceles* and two ocellated spots in *X. rasile*. The characteristics of the juveniles of the main sole species distributed within the Common Fishing Zone are presented in detail in [link 3].

Taking into account that the skeletal characteristics are important diagnostic elements in the taxonomic of species, recently Diaz de Astarloa *et.al.* (2018) [link 4] carried out a comparative osteological analysis of the axial, postcranial and appendicular skeletons of three species of the genus Paralichthys present in the waters of the southwestern Atlantic: *P. isosceles*, P. *orbignyanus* and *P. patagonicus*. The differences found were given in the number of vertebrae and intermuscular bones, and in the morphology and morphometry of vertebrae, caudal skeleton, pectoral girdle bones and basipterygium of the pelvic girdle. These results not only provide knowledge in the anatomical description of the skeleton of species of the genus Paralichthys, but also provide information that can be applied in studies of trophic ecology and phylogenetic relationships between congenital species and within the family to which they belong.

Knowledge of the biology and fisheries of the species of the family Paralichthyidae has included age and growth (Fabré and Cousseau, 1990; López-Cazorla, 2005), distribution and abundance (Fabré and Díaz de Astarloa, 2001; Díaz de Astarloa and Fabré, 2002, Norbis et. al. 2005), general aspects on its ecology (Díaz de Astarloa y Munroe, 1998), population dynamics (Fabré, 1992), food and nutrition habits (García, 1987; López-Cazorla y Forte, 2005), anomalies (Díaz de Astarloa, 1995b, 1998, Díaz de Astarloa *et al.* , 2006) and reproduction (Macchi anf Díaz de Astarloa, 1996; Radonic *et al*, 2007; Militelli, 2011) of some species of the genus.

Within the Common Fisheries Zone (ZCP) the Paralichthyidae Family is represented by the Genera Paralichthys and Xystreurys, which comprise the most abundant and/or frequent flounder. Species of high commercial value are considered *P. isoceles, P. patagonicus*, *P. orbignyanus* and *X. rasile*. These species are exploited in artisanal and demersal fisheries in Argentine and Uruguayan waters (Fabre and Díaz de Astarloa, 1996; Diaz de Astarloa and Munroe, 1998, Rico 2010). Rico and Lagos (2009) made a morphological description and geographical distribution of each species [link 5].

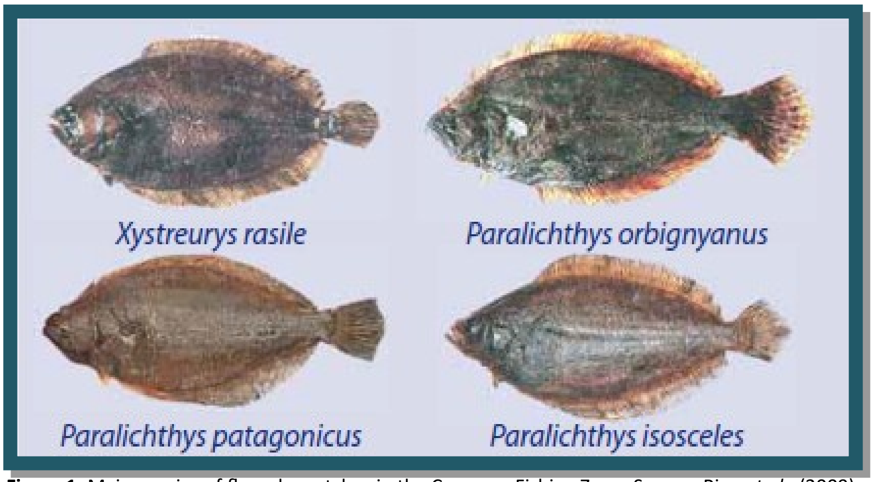


Figure 1. Main species of flounder catches in the Common Fishing Zone. Source: Rico *et al*., (2009).

In the Common Fishing Zone, distribution patterns in relation to environmental characteristics indicated that depth is important in determining the distribution of flounder (Díaz de Astarloa and Fabré 2003 [link 6]. *P. patagonicus* and *P. isosceles* are the most abundant mainly between 41 and 70 m depth while *X. rasile* is between 71 and 100 m although they have been recorded at lower depths. *P. patagonicus* is found at higher temperatures and lower salinity, while *P. isosceles* and *X. rasile* are present in colder and saltier waters. The type of substrate does not determine the differential distribution of these species or the biotic factors of interspecific competition for food. Figure 2 shows the distribution of these species within the ZCP as a diagram.

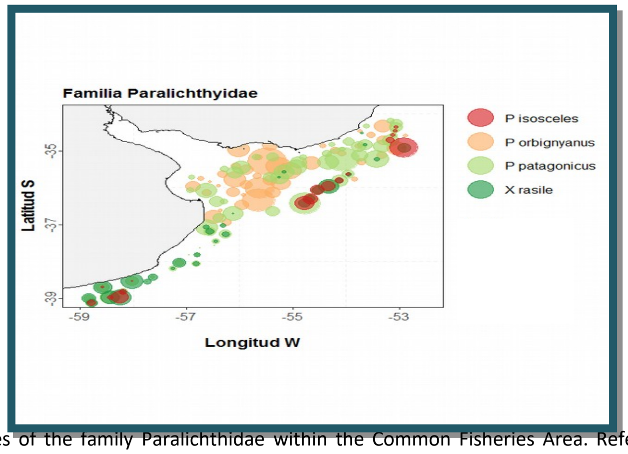


Figure 2. Distribution of some species of the family Paralichthidae within the Common Fisheries Area. Reference information: coastal research campaigns carried out within the CTMFM.

The comparison between the results of research cruises and the length samples in the Argentinean landing in 2001 identified the species *P. patagonicus* as the one with the highest presence in the landed catches. On the other hand, it is worth noting the important proportion of individuals identified as Paralichthys sp. This group would correspond to those soles not identified at the species level, such as *P. orbignyanus* or *X. rasile* that is identified in the length sampling of the landing. In more recent coastal research cruises carried out in the ZCP, it was observed that *P. patagonicus* continues to be the most abundant species. In this sense, as a reference to the fleet's area of operation, the distribution of these species by statistical fishing quadrant is presented (Figure 4).

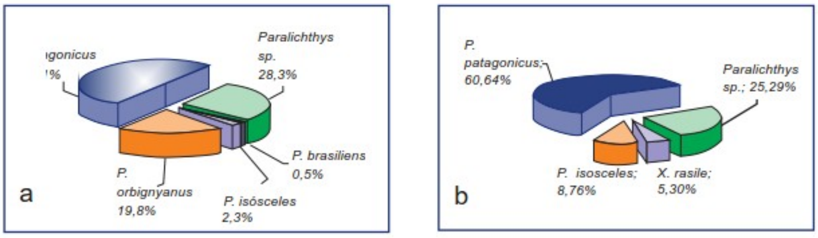


Figure 3. Percentage composition of total flounder catches. A) Research cruises (average 1981-2005), B) Argentine landings sampling (2001).

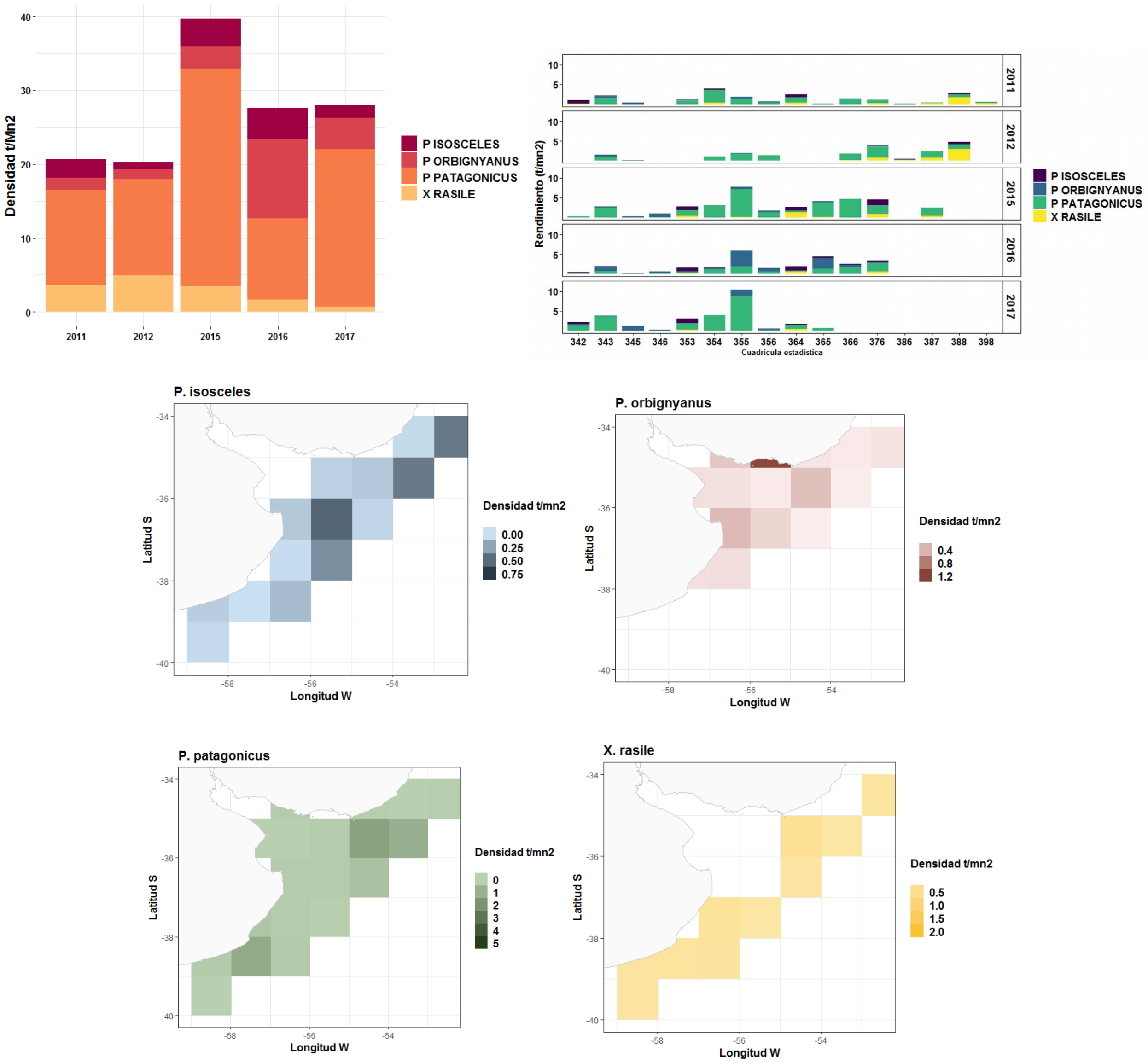


Figure 4. Density of flounder species in coastal research cruises within the ZCP and their corresponding distribution by statistical grid.

Paralichthys orbignyanus

Resource identification

Taxonomy
Class: Actinopterygii
Order: Pleuronectiformes
Family: Paralichthyidae
Specie: *Paralichthys orbignyanus (Valenciennes, 1839)*

Common name
Argentine: lenguado
Uruguay: lenguado
Brazil: linguado
English name: flounder

External distinguishing characteristics

Oblong body very compressed, with a small concavity in the dorsal profile at the height of the head, the eyes on the left side. Short and medium high caudal peduncle. Small scales, cycloid on both sides of the body, with accessory scales covering the body except the jaws, muzzle and anterior half of the interorbital space. The radii of the dorsal, anal and caudal fins are also half-scaled and only at the base are the radii of the pectoral and pelvic fins. Lateral line with a marked curvature over the pectoral fin. Small head, comprising about four times the total length. Large mouth in oblique position, the rear end exceeds the vertical passing through the rear edge of the lower eye. It presents notorious teeth arranged in a single row. Small eyes (fit six times the length of the head), separated from each other by a flat space between 1.2 and 2 times the orbital diameter. Nares on the ocular side located in front of the interorbital space and those on the blind side near the base of the first radius of the dorsal fin. A single dorsal fin, starts in front of the eyes, its height rises to the front two thirds of the body and then decreases. Caudal lanceolate fin. Anal fin similar to the dorsal fin but with a shorter base, it starts at the level of the vertical that passes through the base of the pectorals. Short pelvises are inserted in front of the base of the pectorals. The coloration on the ocular side is greenish brown to dark brown uniform or with irregular or rounded spots, light and dark. The light and dark spots are concentrated forming more or less large ocelli, some with white fringes. Pectoral and pelvic fins with 4 to 5 dark transversal bands. White blind side (Diaz de Astarloa *et.al*., 2006; Cousseau and Perrota, 2013)

Distinction of similar species in the area

It can be distinguished from the species of the Genus *Mancopsetta* because they lack pectorals and the concavity of the upper edge of the head is much more pronounced. Of the other species of the Genus *Paralichthys* (*P. patagonicus* and *P. isosceles*) because the first has ctenoid and cycloid scales and the second has large scales ctenoid on both sides. While it differs from *Xystreurys rasile* because the curve of the lateral line is much less pronounced and the teeth are viliform.

Geographical distribution

The species is present from Rio de Janeiro in Brazil to the San Matías Gulf (40°50'S) in Argentina. It inhabits waters no deeper than 20 m (Figure 5). It prefers low-salinity environments, such as the Patos Lagoon in Brazil, Rocha Lagoon in Uruguay, and Samborombón Bay and Mar Chiquita in Argentina (Díaz de Astarloa and Munroe 1998). In the Rio de la Plata they concentrate in waters with salinity above 21 ups but penetrate to salinities between 10 and 15 ups (Rico 2000). *P. orbignyanus* can be characterized as a marine/estuarine euryhaline teleoste that occurs mainly in estuarine and coastal waters. This species has been considered for cultivation because of its high tolerance to environmental factors such as salinity and pH.

Figura 5. Distribution of *Paralichthys orbignyanus* in Southwestern Atlantic. Fishbase.

Biology and Ecology

Feeding

The feeding habits of *P. orbignyanus* have been evaluated through stomach content in Bahía Blanca, Argentina (Lopez-Cazorla and Forte, 2005) and in the Laguna de Mar Chiquita (Rivera-Prisco *et al.,* 2001) and in Uruguay in la Laguna de Rocha (Norbis and Galli,

2004) Rivera-Prisco *et al*., (2001) worked with juvenile individuals, finding that they mainly consume polychaetes and crustaceans. López-Cazorla and Forte (2005) working with greater width of sizes (7 to 87.5 cm) found differences in diet between seasons and sizes. These authors propose that in general terms *P. orbignyanus* has a piscivorous-carcinophagous diet, which in early stages has a dominance of crustaceans in its diet, while in larger sizes there is a predominance of fish. They also find that during the summer and autumn the most consumed prey are fish, while in spring crustaceans (misidiaceans, shrimp and prawns) dominate in soles smaller than 45 cm, with fish being the predominant prey in larger sizes.

Norbis and Galli (2004) in Laguna de Rocha and working with sizes from 25 to 64 cm, found that *Odonthestes argentinensis* was the majority item in the diet of this flounder, only finding some individuals of *Micropogonias furnieri*, Brevoortia *aurea*, *P. orbignyanus* (cannibalism) and other unidentified teleost fishes in the diet of this flounder. They propose that the little variation in the diet was not related to the availability of prey in the lagoon, since *B. aurea* and *M. furnieri* are abundant resources of this body of water and the adults of *P. orbignyanus* have a specialized and selective diet. Carnikian (2006), working in the estuarine area of the Pando stream, observed that the sole go from a carcinophagous to a piscivorous habit as of 23 cm, consuming crustaceans, fish and molluscs, highlighting *Neomisis americana* -misidiaceans- (approx. 50%) and *M. furnieri* (approx. 36%), Summer was the most diverse season in terms of food items.

Reproduction

P. orbignyanus is a partial spawning whose reproductive season extends from October to April (Mellito da Silveira et al., 1995). Like other South Atlantic flounders, it spawns in marine waters, but its juveniles migrate to coastal lagoons. Outside of the spawning season, this flounder is mainly found in coastal lagoons and stream mouths, which suggests that these places would not only be breeding areas for the juveniles, but also feeding areas for the adults (Radonic, 2011). When studying the gonadal maturation of this species in the lagoons and in the sea, through the balance of fatty acids between the gonad (female) and the muscle throughout a reproductive cycle, it was observed that although the coastal lagoons constitute feeding areas for adults, these would cover the quantitative and not qualitative nutritional needs (Magnone *et al*., 2015).

Feeding

The feeding habits of *P. orbignyanus* have been evaluated through stomach content in Bahía Blanca, Argentina (Lopez-Cazorla and Forte, 2005) and in the Laguna de Mar Chiquita (Rivera-Prisco *et al*., 2001) and in Uruguay in the Laguna de Rocha (Norbis and Galli, 2004). Rivera-Prisco et al., (2001) worked with juvenile individuals finding that they consume mainly polychaetes and crustaceans. López-Cazorla and Forte (2005) working with larger size ranges (7 to 87.5 cm) found differences in diet between seasons and sizes. These authors propose that in general terms *P. orbignyanus* presents a piscivore-carcinophagous diet, which in early stages has a dominance of crustaceans in its diet, while in larger sizes there is predominance of fish. They also find that during the summer and autumn the prey mostly consumed are fish, while in spring crustaceans (misidiaea, shrimp and prawns) dominate in soles smaller than 45 cm, with fish being the prey predominant in larger sizes.

Norbis and Galli (2004) in Laguna de Rocha and working with sizes from 25 to 64 cm, found that *Odonthestes argentinensis* (silverside) was the majority item in the diet of this sole, only finding some individuals of *Micropogonias furnieri*, *Brevoortia aurea*, *P. orbignyanus* (cannibalism) and other unidentified teleosteal fishes in the diet of this flounder. The authors propose that the little variation in diet was not related to the availability of prey in the lagoon, since *B. aurea* and *M. furnieri* are abundant resources of this water body and the adults of *P. orbignyanus* have a specialized and selective diet. Carnikian (2006) working in the estuary zone of Pando stream observed that the soles go from a carcinophagic habit to a piscivorous one from 23 cm, consuming crustaceans, fish and mollusks, highlighting *American Neomisis* -mysiaceous (approx. 50%) and *Micropogonias furnieri* (approx. 36%). Summer was the most diverse season in terms of food items.

Recently, Magnone *et al.* (2015), [link 7] estimated the diet of *P. orbignyanus* in Laguna de Rocha through the quantitative analysis of the fatty acid profile. They determined that, in its adult phase, this species behaved like a piscivore feeding on three fish species *O. argentinensis* , *J. multidentata* and *M. furnieri* and a species of *N. americana* crustacean.

Distribution of the species in the area of the Treaty

Based on the analysis of coastal research cruises carried out in the area of the CTMFM by the B/I Aldebarán, it was observed that the density varied between 1.36 and 10.69 tonnes/mn^2 directly related to the area covered by the surveys (Figure 6). The species was more frequent in sets between 10 and 20 m deep (Figures 7 and 8).

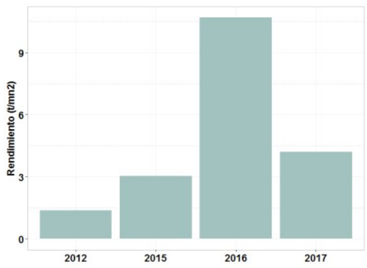


Figure 6. Density (tons/mn^2) of *P. orbignyanus* in coastal survey conducted in spring within the Common Fisheries Area

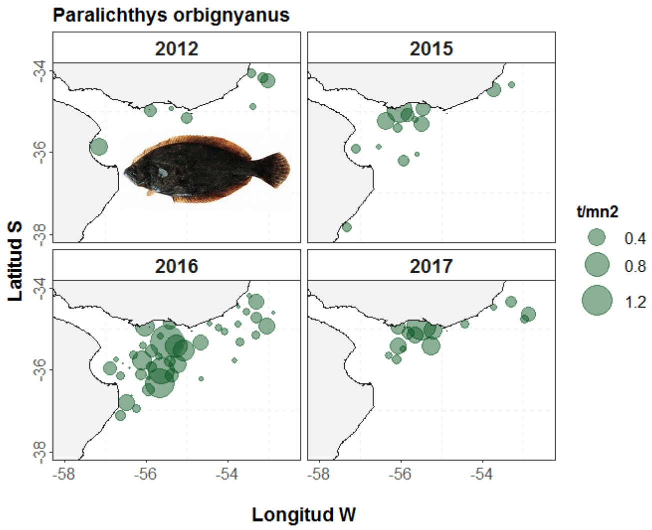


Figure 7. Yield (tons/mn$_2$) per fishing haul in coastal research cruises campaigns conducted in spring.

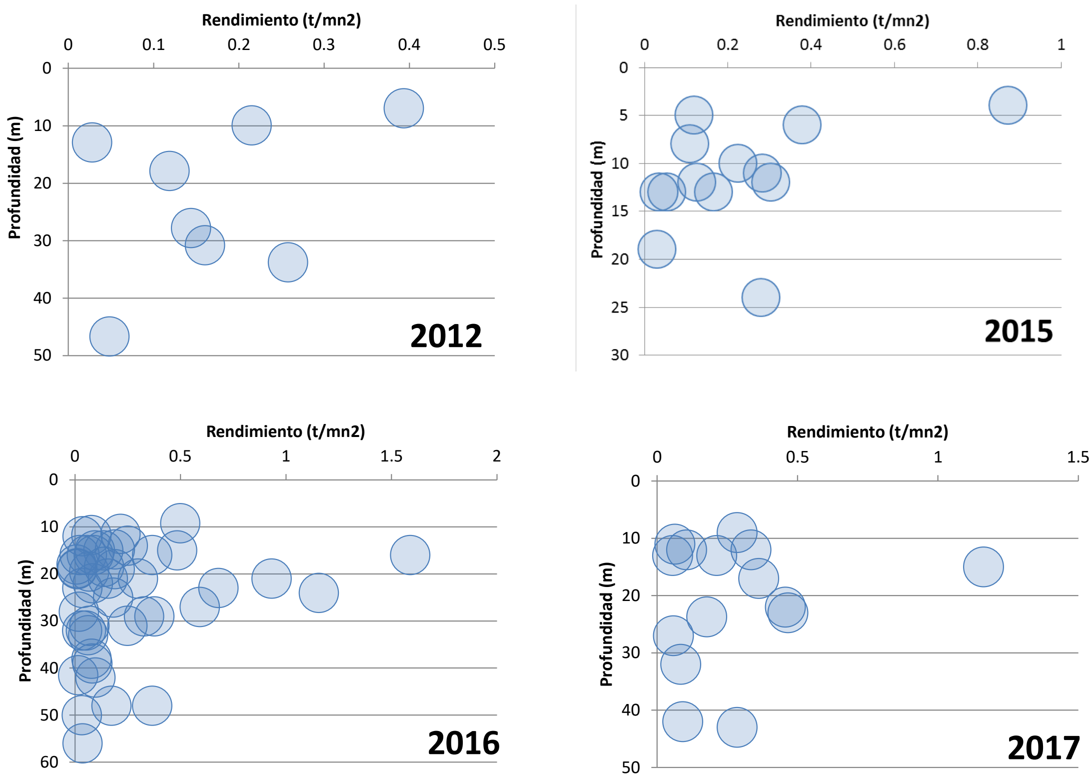


Figure 8. Yield by depth of *P. orbignyanus* in coastal surveys.

Paralichthys patagonicus

Resource identification [link 1]

Taxonomy
Class: Actinopterygii
Order: Pleuronectiformes
Family: Paralichthyidae
Specie: *Paralichthys patagonicus (*Jordan, 1889*)*

Common name
Argentina: lenguado
Uruguay: lenguado
Brazil: linguado
English name: flounder

External distinguishing characteristics

Oblong body, with a small concavity in the dorsal profile at the height of the head. Eyes located on the left side. Maximum height in the middle, comprising almost three times the total length. Caudal peduncle medium high. Ctenoid scales on the ocular side, cycloid scales on the cecum and in both presents small accessory scales interposed between the others. Lateral line well developed on both sides of the body strongly arched above the pectoral fin. Small head, fits about four times in total length. Mouth in oblique position, large on the ocular side. It is provided with strong teeth arranged in a single row. Eyes of medium size, separated from each other by a space equivalent to one third of the orbital diameter. Even nostrils, on the ocular side located in front of the interorbital space and those on the blind side near the starting point of the dorsal fin. Single dorsal fin that starts slightly in front of the front edge of the upper eye. The height rises to the front two-thirds of the body and then decreases. Caudal lanceolate fin. Anal fin similar in shape to the dorsal fin, but with a shorter base, it starts in front of the base of the pectorals. They are well developed on both sides, the one on the ocular side is 25% longer than the one on the blind side. The pelvic fins are located in front of the pectorals. Dark brown ocular flank. Sometimes with small light ocelli, distributed irregularly over body or fins. With two large dark brown ocelli fringed with white, one below the beginning of the straight part of the lateral line and the other on it, at a short distance from the base of the caudal. Blind side white.

Distinction of similar species in the area:
It can be distinguished from the species of the Genus *Mancopsetta* because they lack pectorals and the concavity of the upper edge of the head is much more pronounced. Of the other species of the Genus Paralichthys (*P. patagonicus* and *P. isosceles*) because the first has ctenoid and cycloid scales and the second has large scales ctenoid on both sides. While it differs from *Xystreurys rasile* because the curve of the lateral line is much less pronounced and the teeth are viliform.

Geographical distribution

P. patagonicus is widely distributed from Rio de Janeiro to at least as far south as northern Patagonia (43ºS). Although it occurs in shallow waters up to 200-m depth, is commonly captured between 70 and 100 m. It is the most economically important paralichthyid flounder in the southwest Atlantic since the high abundance and the big sizes that the flatfish attains, compared to other flatfishes occurring in the area (Díaz de Astarloa 1994). It is also the main species of flounder landed from commercial bottom trawl fisheries on the continental shelf and coastal shallow-waters in southern Brazil. Although flatfish species are not distinguished in commercial landings throughout the region and only one category of flatfishes instead of by species appears in the statistics, it was demonstrated that *P. patagonicus* is the most abundant landed species representing 96.3% of the total flatfish species landed in Rio Grande do Sul and 70% of the whole flounder landed in Argentina (Cousseau and Fabré 1990, Fabré and Díaz de Astarloa 1996). *Paralichthys patagonicus* is a benthic, soft bottom-feeding, carnivorous and opportunistic species. The decrease in abundance at depths greater than 50 m during spring coincides with the reproductive season (September-December) and the location on the external saline front of the Río de la Plata, and Bahía Blanca area, suggests a possible reproductive migration and may determine habitat use throughout life history (Macchi and Díaz de Astarloa, 1996; Fabré and Díaz de Astarloa, 2001; Díaz de Astarloa and Fabré, 2003).

Figura 9. Distribution of *Paralichthys patagonicus* in Southwestern Atlantic. Fishbase.

Biology and Ecology

Reproduction

The reproductive characteristics of the flounder (*Paralichthys patagonicus*) reaches maximum lengths of 60 and 67 cm LT and maximum ages of 18 and 19 years for males and females, respectively (Riestra, 2010). Macchi and Díaz de Astarloa (1996) [link 8] analyzed the reproductive characteristics of flounder (*P. patagonicus*) from the macro-microscopic study of the ovaries from samples coming from the commercial landing made in the Mar del Plata port during an annual cycle and from INIDEP research cruises surveys. The authors determined that this species is a multiple spawning, with a low partial fecundity and a variable reproductive frequency. The number of hydrated oocytes ranged from 20,000 to 160,000 for a size range of females between 42 and 53 cm LT. They also identified that the spawning period of this species extends between the months of September and February, with a peak of maximum reproductive activity in November.

The reproductive biology of *P. patagonicus* was studied by Militelli (2011) [link 9] between 34º and 42ºS with material from samples taken during December 2003 and 2005. The estimate of the first maturity length in 2003 for both sexes was 31.57 cm LT for the northern zone (34-38ºS), decreasing in 2005 to a value of 27.82 cm LT. In December 2003 the highest reproductive activity took place in El Rincón, however, in December 2005 the highest proportions of hydrated females were located in the northern sector. This could be due to the fact that colder temperatures were recorded for this area compared to 2003 (Figure 10). The values of partial fertility and relative fertility showed differences between years and between population groups. Partial fertility presented a potential adjustment with height and linear with weight and varied between 14,685 (30 cm TL) and 15,371 (50 cm TL) hydrated oocytes. Relative fertility ranged from 24 to 170 hydrated oocytes per gram. The author indicates that these differences could be attributed in part to the difference in water temperature between the two years, especially the high temperatures observed in 2005.

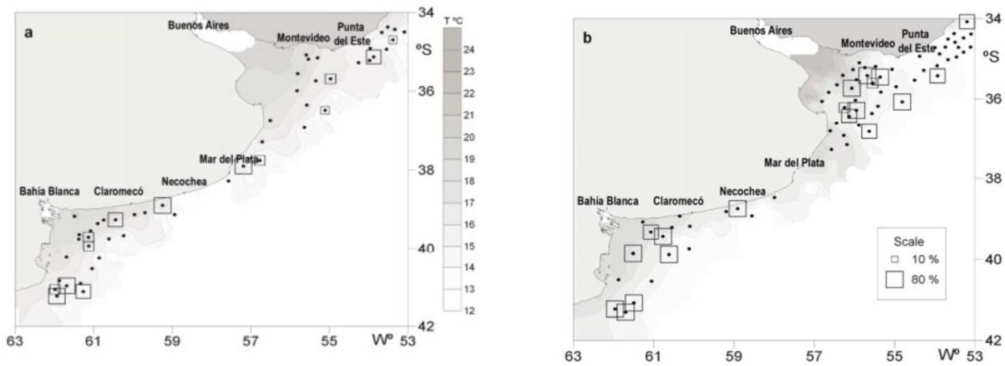


Figura 10. Presence of activity females (dots) (stage 2 and 3) and percentages of P. patagonicus in spawning stage (squares) during a) December 2003 and b) December 2005. The size of the squares is proportional to the percentage of gravid females (with hydrated oocytes). The isotherms, (ºC), represent the bottom temperature field. Taken from Militelli (2011).

Feeding

The feeding habits and diet composition of this species were analyzed from qualitative and quantitative analyses of stomach contents of specimens from landing samples of the commercial fleet in the port of Mar del Plata by Troccoli (2011). *Paralichthys patagonicus* is an ichthyophagous predator with a wide trophic spectrum and a varied diet with 20 prey items, preferably ichthyophagous and specialized in pelagic fish. The most consumed prey was *Engraulis anchoita*, followed in importance by *Trachurus lathami* and *Raneya brasiliensis*. Mollusks and crustaceans were also preyed on by this sole, but in lower proportions (Figure 11). The Patagonian sole showed a specialization in the diet towards *E. anchoita* and *T. lathami*. This preference increased with size and age, and coincided with a decrease in the trophic niche width. Likewise, a significant positive correlation was found between the size of the sole and the size of the prey consumed. The estimated trophic level placed *P. patagonicus* as a tertiary ichthyophageal consumer. In comparison with previous studies (Sánchez and Díaz de Astarloa 1999), the author observed a modification in the diet in the medium term, with a current predominance of small pelagic fish over demersal-bentonic fish, with a subsequent decrease in diversity and in the amplitude of the trophic spectrum.

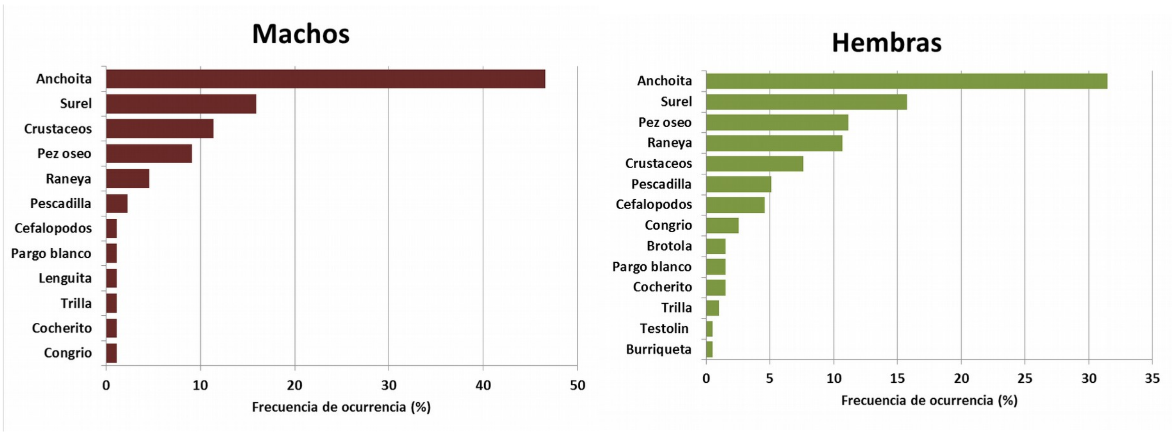


Figure 11. Composition of the diet of *Paralichthys patagonicus* years 2009-2010 for males and females Prey descriptors: FO (%) frequency of occurrence. Source of information Trocolli (2011).

Growth

The von Bertalanffy model described the growth of *P. patagonicus*, having a differential growth between sexes (Table 1). Females had greater growth than males (L_∞). The growth rate is higher in the winter period than in the summer period and higher in males than in females (Riestra, 2010).

Tabla 1. Growth parameters of *P.patagonicus* derived from the von Bertalanffy model.
Taken from Riestra (2010).

Von Bertalanffy	Female			Males		
Parameter	Prim-Ver	Oto-Inv	Total	Prim-Ver	Oto-Inv	Total
L_∞ (cm)	63,37	59,12	57,59	46,26	45,69	45,06
K (year $^{-1}$)	0,17	0,19	0,23	0,25	0,30	0,27
t_0 (year)	-1,2	-1,36	-0,81	-1,57	-0,68	-1,26

With information from research cruises in the Common Fishing Zone, Riestra (2010) determined that salinity in spring and temperature, in winter, (northern area 34°- 38°S) were the variables that influenced the spatial segregation of the different age classes of *P. patagonicus*. Four main age class groups were observed: young (2-3 years), intermediate (4-6 years), older (7-12 years) and old (13-16/18/19 years). *P. patagonicus* presented changes in its spatial distribution of the age classes being salinity determinant in spring and temperature in winter. Older adults migrate in spring to waters with higher temperature, high salinity and low depth, while intermediate and young adults prefer higher temperature, low salinity and deeper waters.

Distribution of the species in the area of the Treaty

Figure 12 shows the distribution by set of the densities of *P. patagonicus* present in the coastal research cruises within the ZCP between 2011 and 2017. The species covered the external area of the Rio de la Plata, the Buenos Aires coast and the Uruguayan coast. The highest density was observed in the spring of 2015 and although the 2017 survey did not cover the entire area, the total density was mainly given by a set located in the Rio de la Plata. This flounder was more frequent in sets near the 50 m isobath and was not recorded at depths greater than 90 m (Figure 13).

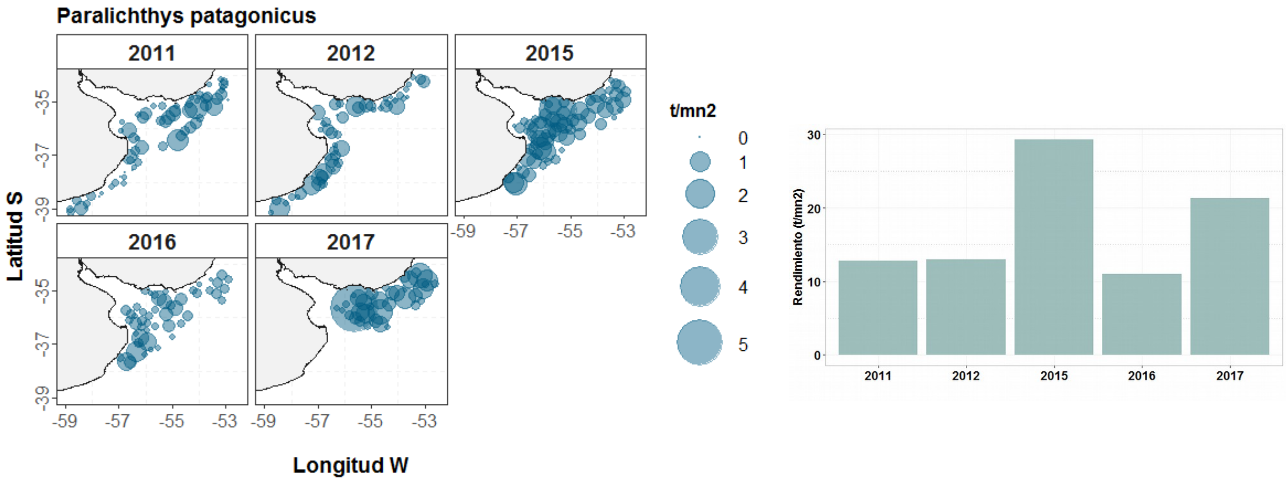
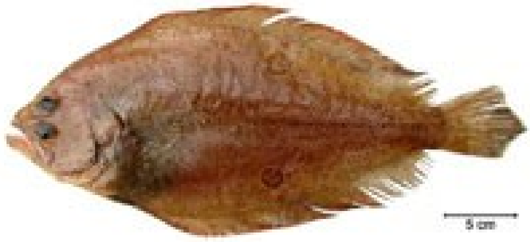


Figure 12. Spatial distribution of density of *P. patagonicus* in tons/mn² and total yield by coastal research cruises vessels. Springs.

Figure 13. Density by depth of *P. patagonicus* in coastal surveys.

Paralichthys isosceles

Taxonomy
Class: Actinopterygii
Order Pleuronectiformes
Family Paralichthyidae
Specie *Paralichthys isosceles* (Jordan, 1891)



Nombres comunes
Argentina: lenguado
Uruguay: lenguado
Brasil: linguado
Nombre común en inglés: Flounder

Distinctive external characters

Oblong body, compressed, with the eyes on the left side. Maximum body height 45% LS. Short caudal peduncle. Small head, 25 to 28% LS. Pre-orbital distance or muzzle approximately equal to or slightly shorter than the horizontal diameter of the eye, 18 to 20% LS. Large eyes separated by a narrow interorbital space. Medium size mouth in oblique position with small, tapered and sharp teeth, arranged in the premaxillary and dental in a single row. The first 4 or 5 pairs of premaxillary teeth are large, decreasing the size backwards. Relatively large scales, ctenoids on both sides of the body. No accessory scales. The dorsal fin starts on the blind side in front of the eyes. Light brown ocular side with three very evident ocelli, one in front of the caudal peduncle and the other two located in the middle of the body, short distance from the bases of the dorsal and anal fins respectively. Unpigmented blind side (Díaz de Astarloa 1998 [link 10] [link 11].

Distributions

P. isosceles is a species with a wide geographical distribution from latitude 34° 30'S to the Golfo San Jorge (47°S) (Figure 14). It is located up to the 100 m isobath, with a tendency for this species to inhabit more coastal waters to the south. The highest concentrations of the species are found in Rio Grande do Sul and Uruguay Fabré (1992).

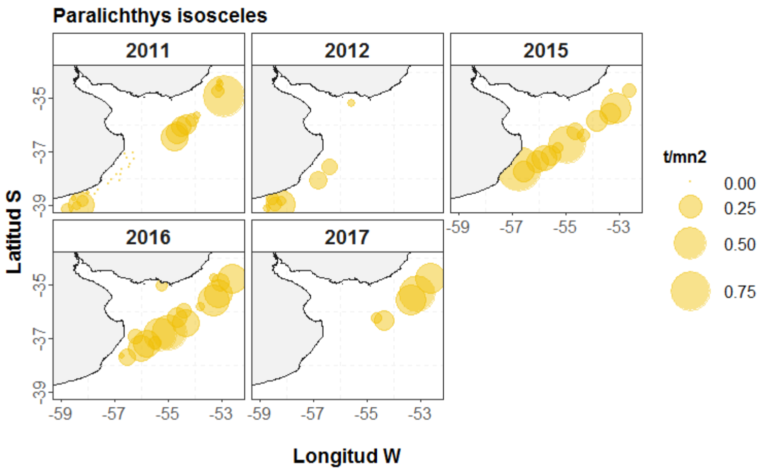
Figure 14. Distribution of *Paralichthys isosceles* in the southwestern Atlantic Source: Fishbase

Growth

This species forms an annual hyaline ring in winter and is detected in spring. The growth rate of the species decreases in winter and early spring, there is no spawning activity and feeding is reduced. During spring it prepares for spawning, the k factor increases, the growth rate accelerates, there is a slight increase in food intake (Fabré and Cousseau 1990).

Distribution of the species in the area of the Treaty

As a result of the analysis of the coastal sourvey carried out in the ZCP by the B/I Aldebarán it was observed that the highest densities occur at depths greater than 50 m, suggesting that the low salinities is a limitation in their distribution. No catches were recorded in any of the fishing hauls carried out within the waters of the Río de la Plata (Figures 15 and 16).



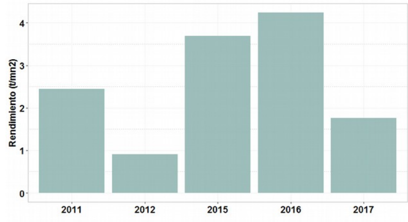


Figure 15. Density (tons/mn²) per fishing set in coastal research cruises conducted in spring.

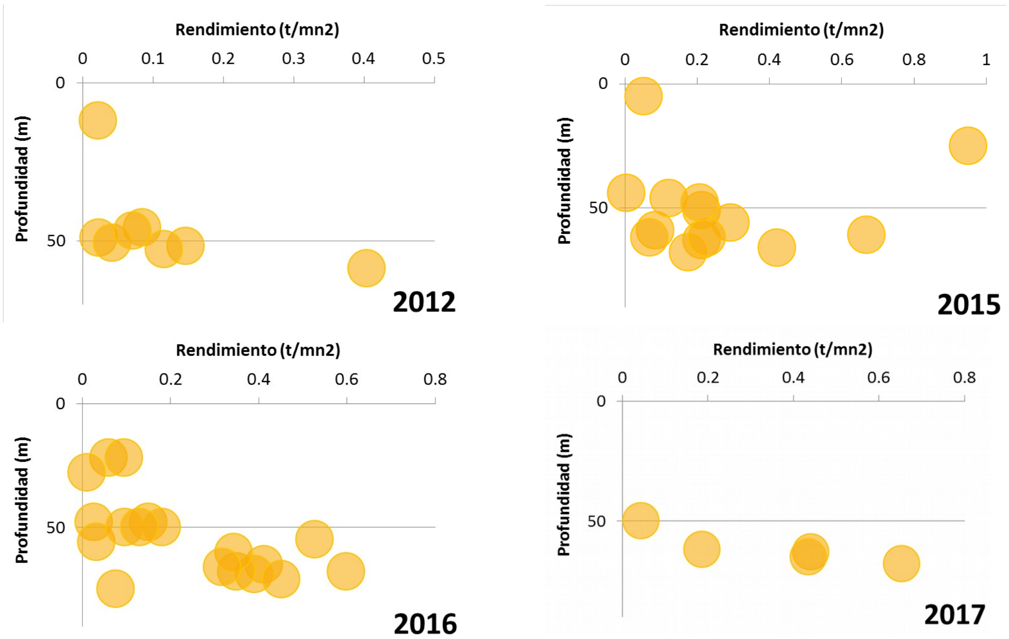


Figure 16. Density by depth of *P. isosceles* in coastal research cruises carried out in the Common Fisheries Area.

Xystreurys rasile

Taxonomía
Clase: Actinopterygii
Orden Pleuronectiformes
Familia Paralichthyidae
Especie *Xystreurys rasile* (Jordan, 1890)

Nombres comunes
Argentina: lenguado
Uruguay: lenguado
Brasil: linguado
Nombre común en inglés: flounder

Distinctive external characters

Elongated body, elliptical and equal dorsal and ventral profiles, with a slightly pronounced concavity in the profile above head height. Eyes located on the left side. Small scales, cycloid on both sides of the body, not present in the upper eyes, jaws, muzzle and interorbital space. Small scales over the radius of all fins. The lateral line on the ocular side begins behind the upper eye, describes a first curve slightly pronounced at the base of the pectoral fin and then another, also slightly pronounced, at the level of the same fin, then follow the midline of the flank. Small head understood almost five times in the total length. Medium mouth in oblique position on the ocular side. The rear end reaches the level of the center of the lower eye. Conical teeth very small and viliform, arranged in a single row. Large eyes, fit about three and a half times the length of the head, separated from each other by a space so narrow that it is more like a bone crest. The height rises to the front 2/3 of the body and then decreases. Lance-shaped caudal fin and anal fin similar to the dorsal one, but with a shorter base that starts below the base of the pectorals. They are well developed on both sides, the one on the ocular side is longer than the one on the blind side. Small pelvic fins are inserted somewhat in front of the base of the pectorals. Light brown coloring, with darker spots of different size and arrangement. Two dark, elliptical ocelli, on the lateral line, one anterior, at the junction of the curved section with the straight one, and another posterior, near the base of the caudal.

Distinction of similar species in the area

It is distinguished from other flounders in the region by the lateral line, the presence of two ocelli on it and by the viliform teeth.

Distribution

Xystreurys rasile is widely distributed from the northeastern Brazil to at least as far south as the continental shelf off San Jorge Gulf (47ºS). Here, it is more abundant on the continental shelf outside the gulf especially at 50-100-m depth. It is scarcely captured in Brazilian waters and represents together with O. darwinii 0.3% of the total flatfish captures in southern Brazil. In Argentina, throughout its range the species is very abundant in Buenos Aires Province, and in the southern portions of its range between 43 and 45ºS. Southerly it is either absent or occurs only rarely. It is traded as a small-sized or moderate-sized flounder category in Mar del Plata harbour, and with P. isosceles the two species represents between 2.4 and 2.6% of the total fish species sold (Fabré 1992, Fabré & Díaz de Astarloa 1996) (Figure 17). This species would be associated with lower granulometry bottoms, mainly sandy substrates. The type of bottom is only inversely correlated with the density of X. *rasile* in the spring, when this species is more abundant.

Figura 17. Distribution of *Xystreurys rasile* in the Southwest Atlantic. Source: Fishbase.

Biology and Ecology

Feeding

Garcia (1987) [link 12] cites *X. rasile* as a primary carnivore that feeds mainly on *Brachyura*, *Amphipoda* and *Isopoda* and, to a lesser proportion, on other crustaceans and polychaetes (Figure 18). Crustaceans represented 68.75% of the ingested food present in the four seasons of the year. The author did not register differences in the diet with respect to lengths and sexes. The highest food intensity was observed in spring and autumn with stomach contents between 87.88 and 88% respectively.

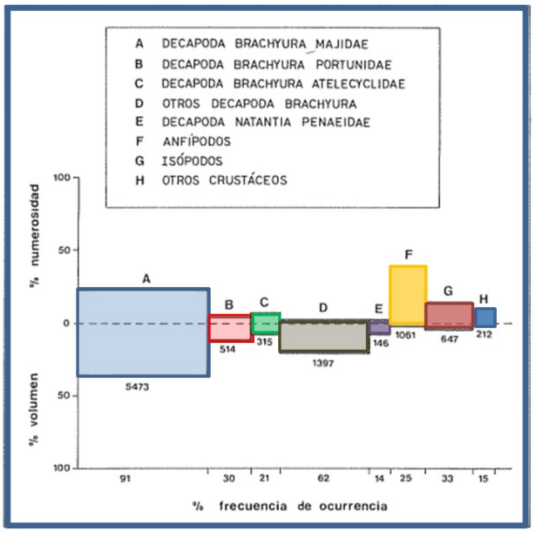


Figure 18. Index of relative importance of the groups that make up the *X. rasile* diet Modified from Garcia (1987).

Reproduction

The species is sexually inactive during the winter and begins to mature at the end of the winter. In the late spring, most of the population is in pre-spawning or advanced maturation and laying would occur at the end of the year. The frequency of the gonadal maturation stages indicates that in spring the pre-breeding specimens are more abundant towards the southern sector of the ZCP, in shallow waters, while in the extreme north immature specimens are abundant (Fabré 1992). Garcia and Menni (1990) studied the reproductive cycle of *X. rasile* from landing samples from the Port of Mar del Plata. These authors analyzed the monthly variation of the gonadosomatic index, in both sexes. The highest values occurred between September and December, reaching the maximum average in November. From these results, added to the percentage variation of maturity stages, the mentioned authors concluded that this species begins to mature at the beginning of spring, completing this process in the second half of it.

The length of the first sexual maturity was estimated at 20 cm for males and 21 cm for females, at 1.29 and 1.94 years respectively.

Growth

X. rasile is a fast growing species, doubling its size in the second year. It presents differential growth between sexes; the females grow more than the males. The rate of growth intensifies during the summer season and the opposite occurs during the winter. The period of slow growth coincides with the period of reproductive inactivity (Fabré and Cousseau, 1988 [link 13].

Given the lack of smaller flounder specimens corresponding to the coastal area near the port of Mar del Plata, growth parameters were estimated from the retrocalculated data. For all methods the estimates obtained were coincidental (Table 2).

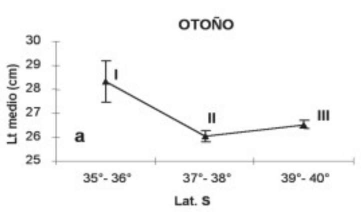
Table 2. Growth parameters estimated by different methods for *X. rasile*. Taken from Fabré and Cousseau (1988).

	Ford-Walford	Gulland	Beverton	Pauly	Allen	
					Tallas medias	Distribución completa
Linf	38,84	36,88	36,88	37,64	36,76 (0,106)	37,27 (1,34)
K	0,4621	0,4307	0,4337	0,415	0,431 (0,004)	0,430 (0,053)
t_0			0,2389	0,142	0,201 (0,008)	0,169 (0,109)

Distribution of the species in the area of the Treaty

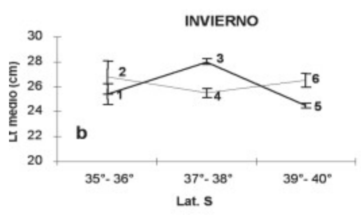
In the analysis of the population dynamics of *X. rasile* flounder between 34º-40ºS, Fabré *et.al*., (2001) found marked seasonal changes, related in turn to latitude and to the reproductive cycle. The authors verified a high variability in size distributions, sex ratios, maturity stages and age distributions. In the deepest areas, the size structure remained more stable, while between 50-75 m deep, marked seasonal changes occurred.

AUTUMN



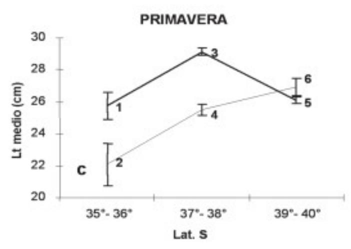
In autumn, the largest specimens were found in the northern end of the area (35°-36°S), while the smaller ones were located in intermediate latitudes (37°-38°S). Females always reach a larger size than males, regardless of latitude and depth. The average size increases as the depth decreases, due to the greater abundance of females in more coastal waters. In addition, in stratum I of depth (10 and 50 m), the few males present were the largest recorded. Conversely, the proportion of males in the deepest stratum (III 76-100) m is higher, while the average size of the females is smaller.

WINTER



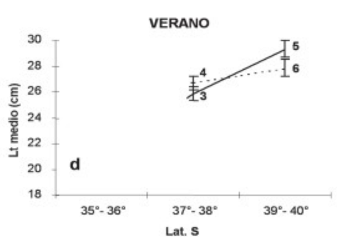
In winter the smaller individuals are found in shallower waters, both to the north (35°-36°S) and to the south (39°-40°S). Between 37°- 38°S, the relationship between average sizes observed to the north and south are reversed, i.e., in this case, the larger individuals are located at a shallower depth. At this time of year, females also exceed the size of males.

SPRING



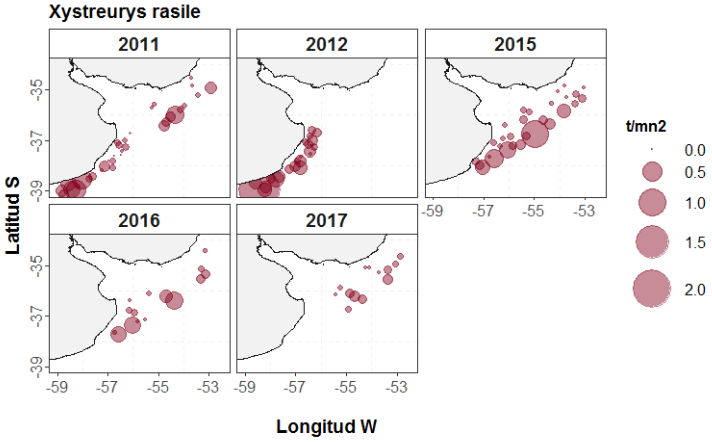
In spring the length structure is completely modified with respect to what was observed in winter. Between 35°-38°S the largest specimens are located at a shallower depth while at latitudes greater than 39°S the opposite is observed, the highest average size corresponds to the deepest stratum (76-100 m). With respect to latitude, the tendency between 76-100 m, is to increase the average length towards the south. At lower depths, larger individuals are concentrated in intermediate latitudes, between 37°-38°S.

SUMMER



In summer, between 35°-36°S, there were practically no catches. South of this latitude, the lower average corresponds to the shallower stratum.

In coincidence with Fabré *et.al*., (2001), with information from coastal survey in the spring, the highest concentrations of this species were identified on the 50 m isobath and south of the ZCP (Figure 19 and 20).



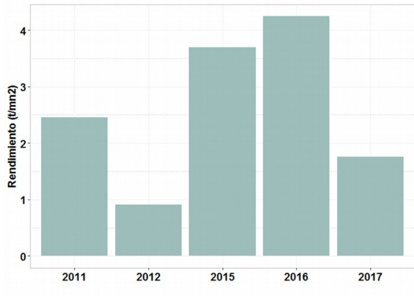


Figure 19. Density (tons/mn^2) per fishing set in coastal research cruises carried out in spring.

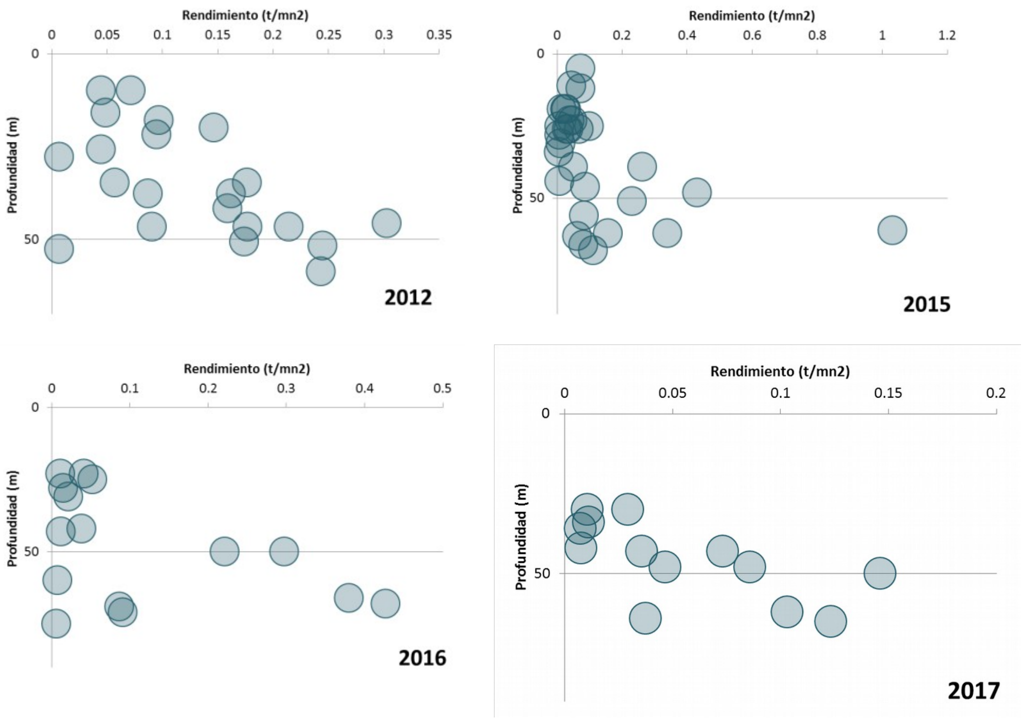


Figure 20. Density by depth of *X. rasile* in coastal surveys.

Fisheries

Catches of flounder landed by both the Argentine and Uruguayan fleets do not discriminate at the species level. In Argentina, on the basis of information provided by the Subsecretaria de Pesca y Acuicultura Argentina in 2019 this group of species constituted 6% of the total declared catch of the varied coastal. Flounder landings are mainly composed of *Paralichthys patagonicus*, *P. orbignyanus*, *P. isosceles* and *Xystreurys rasile*. These species arrive at the ports of Mar del Plata and Necochea and are classified into three size categories: small, medium and large (Rico and Lagos, 2009; Rico and Perrota, 2009). In Uruguay they are landed mainly by the coastal industrial fleet that operates with the bottom trawling.

Figure 21 shows the trend in landings from the ZCP for both countries. While between 2010 and 2012 the catches of the Argentine fleet exceeded 5,000 t in subsequent years decreased to the minimum recorded in 2017 (2,882 t). In 2019 an increase of 18% was observed with respect to 2017. As it happens with *P.brasiliensis* and *P.pagrus*, the percentage of flounders catch by the Uruguayan fleet is insignificant, reaching in 2019 a 2% of the total catch declared in the area. Uruguay's landing values in this period did not exceed 240 t.

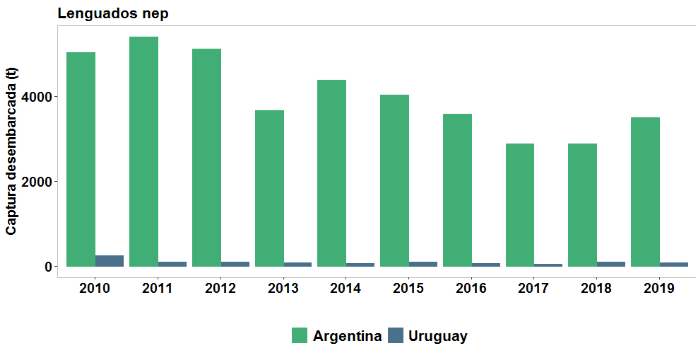


Figure 21. Trend of the landed catches (tons) of flounder Argentine and Uruguay in the ZCP.

A seasonality of the landings of this group of species was observed, with the maximum values corresponding to the spring-summer period. No trend was observed for the Uruguayan fleet (Figure 22).

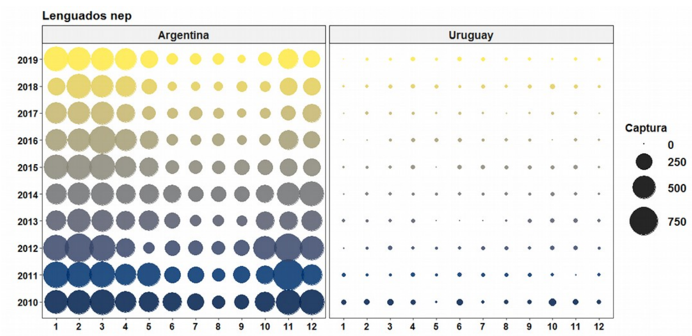


Figure 22. Monthly distribution of flounder catches in the ZCP by the Argentine and Uruguayan fleets.

The Argentine fleet that catches flounder operated mainly in the coastal area from Punta Rasa to the south, mainly in the statistical grids: 3655, 3756, 3857, 3858 and 3859 (Figure 23 and 24).

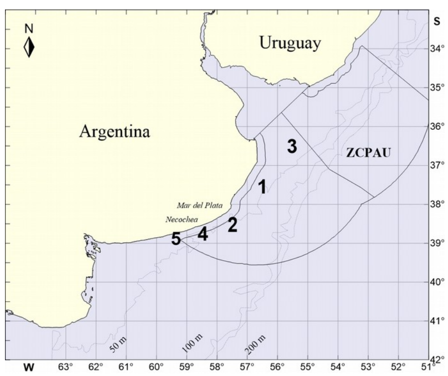


Figure 23. Location of the grids with the highest catches of flounder in

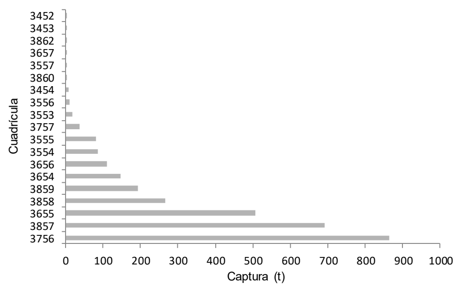


Figure 24. Landed catches (t) of flounder by the Argentine fleet

the year 2018. (The numbers correspond to the catch in decreasing order). operating north of 39° S by grid, year 2018.

For the 2010-2019 periods, the area where the greatest catch was recorded by the Uruguayan coastal fleet was in the external sector of the Rio de la Plata (Figure 25). It should be noted that this area is where the greatest effort is made by the fleet, given that the species targeted is *Micropogonias furnieri*.

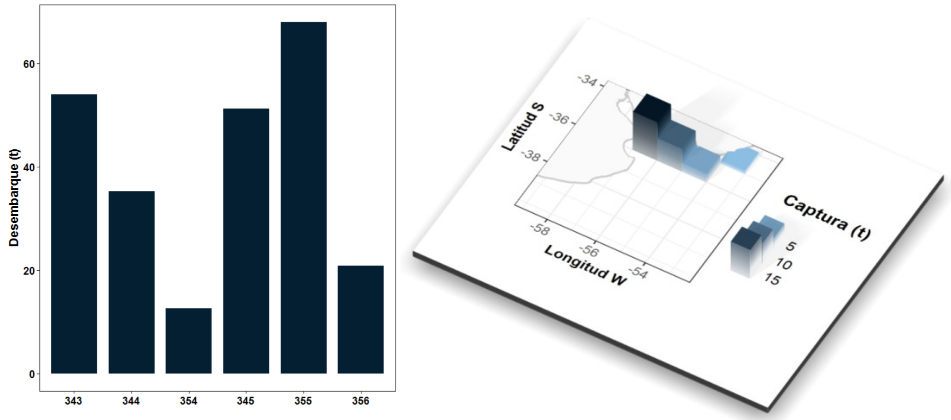


Figure 25. Catch distribution by statistical grid of the flounder group by the Uruguayan coastal fleet for the total period 2010-2019.

Only in 2010, a high concentration of catches was observed in the northern zone of the ZCP, statistical grid 343, followed by 354, 355 and 356 which showed the highest volume of landings by the Uruguayan fleet (Figure 26).

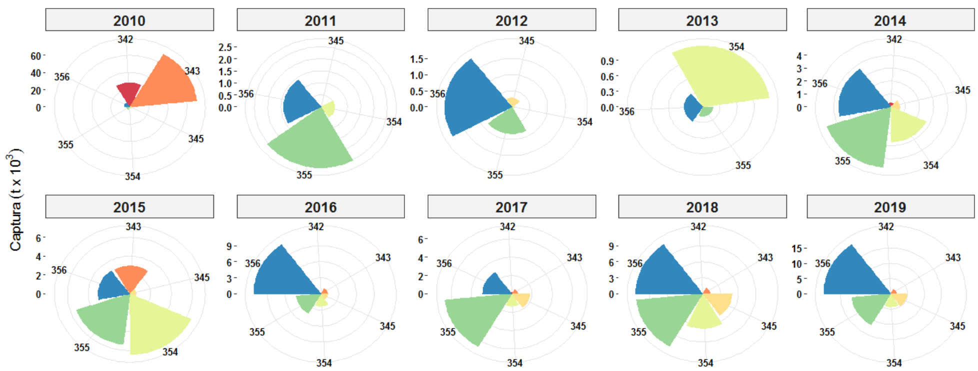


Figure 26. Catch Proportion of flounder group by statistical grid where the Uruguayan fleet operates. Note the change of scale on the y-axis.

The distribution of catches by the coastal fleet increased from 2017 towards the end of the period (Figure 27).

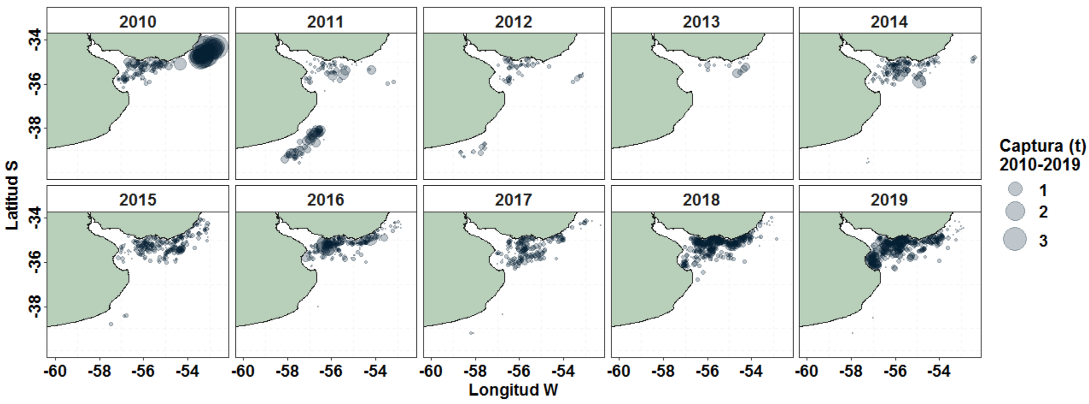


Figure 27. Distribution of flounder catches by the Uruguayan fleet.

Of the Argentine fleet, 90 vessels operated during 2018, ranging from artisanal to 40 meters in length. The 58.91% of the captures were carried out by the fleet stratum called Ic (from 18.24 to 24.99 m of length), composed by 33 vessels and 32.46% the stratum Ib (from 15 to 18.23 m of length) by 22 (Table 3), these two fleet strata were the most representative of this fishery. The port that registered greater landing of this group of species was Mar del Plata and to a lesser extent Necochea. Bottom trawling with gates was the main fishing gear used.

Table 3. Catch landed (t), percentage and number of vessels operating in the flounder fishery during 2018.

Estrato	Captura (t)	%	Nº embarcaciones
Artesanal	0,26	0,01	1
Ia	125	4,13	10
Ib	981	32,46	22
Ic	1.780	58,91	33
IIa	134	4,45	11
IIb	0,49	0,02	3
S.D.	0,76	0,03	10
Total	3.022	100	90

On the other hand, the Uruguayan fleet with a catch record for the flounder group reached a maximum of 17 vessels in 2019, corresponding to a total of 127 vessels in that year. It is worth mentioning that the low registrations in 2013 are due to an activity stoppage of the Uruguayan coastal fleet that lasted from May to the first half of August (Figure 28).

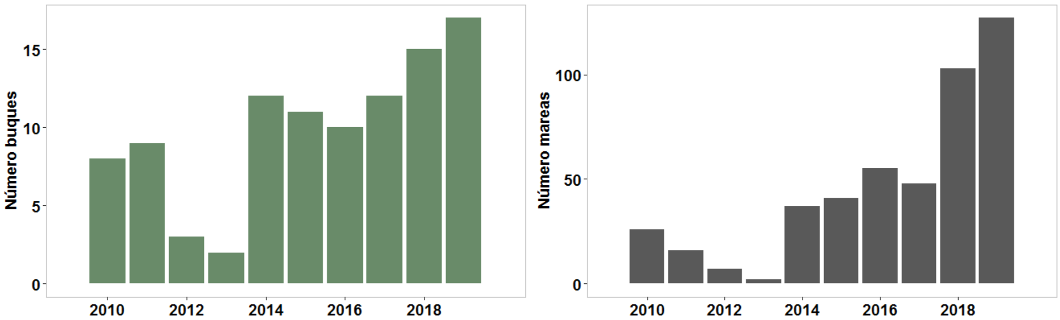


Figure 28. Number of vessels and number of annual tides of the Uruguayan fleet with flounder registry.

The quarterly distribution of the flounder catch by the Uruguayan fleet is shown in Figure 29.

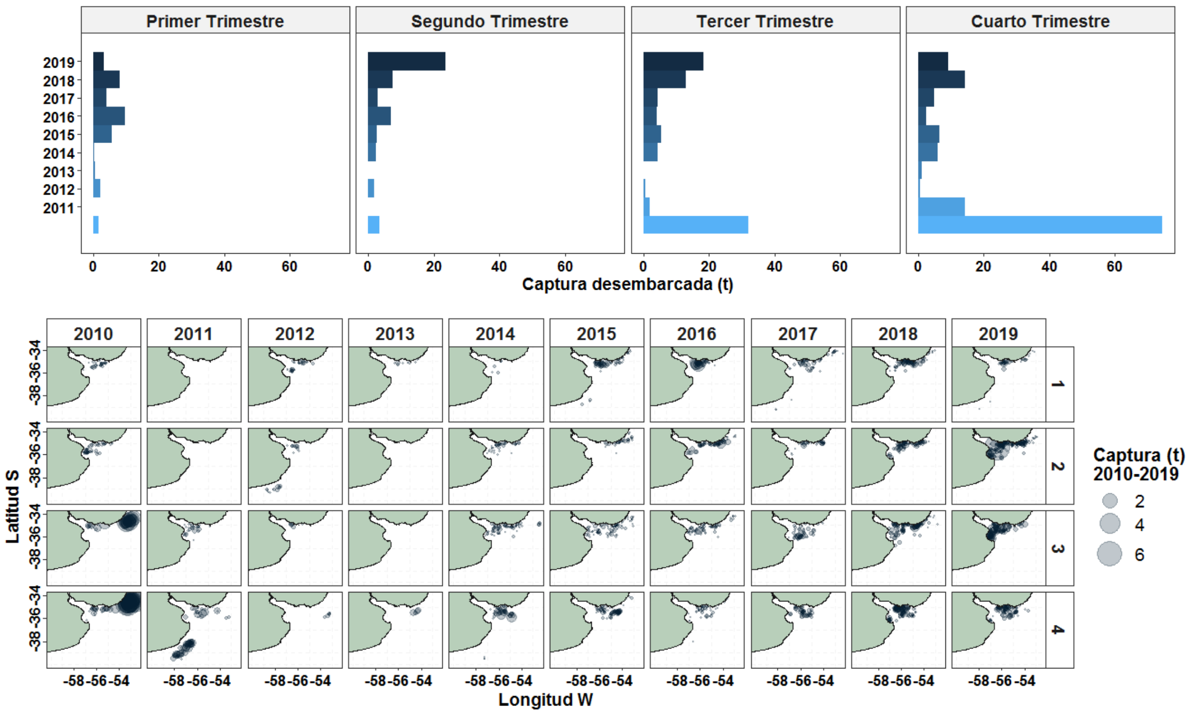


Figure 29. Total quarterly catch of the flounder group registered by the Uruguayan coastal fleet. Distribution set by set per quarter.

Status of fishery resource

A Surplus Production Model, fitted by Bayesian inference, was used to estimate flounder abundance. This model incorporates uncertainty in annual biomass transitions (process error) and uncertainty in observed indices of abundance associated with measurement and/or sampling (observation error). A reparametrization that expresses biomass values as a function of K (Pt=Bt / K) was used to facilitate the convergence of the Markov Monte Carlo chains towards the a posteriori distribution. Process and observation errors are assumed to be log-normal.

Standardized abundance indices

For the stocks assessment models, standardized annual CPUE series were used by means of General Linear Models (GLM) expressed in kg/day, considering the most important fleet strata in the fishery: Ib: 15 to 18.23 m and Ic: 18.24 to 24.99 m.

Sources of information

1) Satellite monitoring information (VMS): Satellite emissions of the Argentine commercial fleet with a frequency of one hour, in which the position, vessel identification, date, time, speed and course are recorded.
2) Fishing reports of the commercial fleet with satellite monitoring: Information from the landing declarations made in the national and provincial fishing reports sent by por la Dirección Nacional de Coordinación Pesquera, de la Secretaria de Agricultura Ganadería y Pesca and received at the INIDEP by the Oceanographic and Fishing Information System. Each record contains, in addition to the effort (hours), information about the area, the date and structural characteristics of the vessel as well as the catch by species (kg).

Model 1: two fleet (Ib and Ic) *ln (CPUE Ib,Ic) = μ + Year + Month+ (Year * Month) + ϵ*

Model 2: a fleet stratum (Ic) *ln (CPUEIc) = μ + Year + vessel + Month + (Year * Month) + ϵ*

VMS ln (CPUEijk) = μ + *Year* i + *vessel* j + *Month* k + (Año * Month)ik + ϵijk

CPUE: Catch per unit of effort expressed in kilograms per day of fishing, corresponding to the Year, Month, Stratum and/or Vessel.
μ: model constant.
Year: categorical variable corresponding to the date of arrival of the vessel.
Month: Categorical variable corresponding to the month of landed catch. 12 levels.
Vessel registration: numerical identification code of each vessel.
Statistical Square (CE) categorical variable corresponding to the fishing position.
ϵ: model error term.
In the case of the multi-species group of flounder, similar results were observed between the model without the EC factor and with the EC factor (Figure 30).

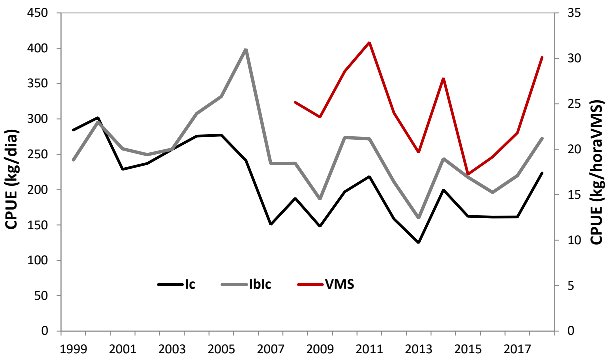


Figure 30. Relative abundance indices. CPUE kg/day (estrato Ib -Ic), CPUE kg/ day (estrato Ic), CPUE kg/hsVMS (trawl).

Surplus production model

Surplus production models provide simple descriptions of harvested populations, in terms of annual biomass levels (Bt), the intrinsic growth rate (r), the carrying capacity of the environment (K) and the efficiency of fishing gear (q).

The surplus production model (Schaefer, 1954) was used to determine indicators of stock productivity. The parameters of the model, its uncertainty and the performance indicators of the management strategy were estimated with Bayesian methods. This model was applied using the index of the Argentine fleet (Kg/day).

The Schaefer (1954) form of the surplus production function is

$$B_{t+1} = \left[B_t + rB_t\left(1 - \frac{B_t}{k}\right) - C_t \right]$$

Where Bt, Ct , and g(Bt) denote biomass at the start of year t, catch during year t, and the surplus production function, respectively.

The annual catch is treated as a fixed constant. A common, although simplifying assumption is that the relative abundance index is directly proportional to the biomass.

$$I_t = qB_t \exp(\varepsilon_t)$$

where catchability parameter *q*.

If it is assumed that the annual biomass is a percentage of the load capacity (K) the following re-parameterization can be proposed: Pt = Bt/K. The reason for using this re-parameterization is to accelerate the sampling process.

Under the state-space approach, we will have a process equation and an observation equation given by:

$$P_1 = e^{\varepsilon_{1proc}}$$

$$P_t = \left[P_{t-1} + P_{t-1} r (1 - P_{t-1}) - \frac{C_{t-1}}{K} \right] e^{\varepsilon_{t,proc}}, t = 2, \ldots, n$$

Where n is the number of years in the time period considered, q is the coefficient of catchability, ε_t^{proc} and ε_t^{obs} are random variables i.i.d representing the processing and observation errors respectively with $\varepsilon_t^{proc} \sim N(0, \sigma^2_{proc})$ and $\varepsilon_t^{obs} \sim N(0, \sigma^2_{obs})$ at each time. Note that it was considered the simplest case, that is, it was assumed that, processing and observation errors have normal distribution with mean 0 and constant variance.

The estimation of parameters was carried out under the Bayesian approach, this approach is usually used in the evaluation of resources because it is more intuitive and because the results obtained automatically include the uncertainty in the estimations.

Likelihood function

From equation (1) you have

$$\varepsilon_{t_{obs}} = \ln(CPUE_t) - \ln(qK) - \ln(P_t)$$

and under the assumption made with respect to the distribution of ε_t^{obs} the likelihood function is given by

$$L(Y/\theta) = \frac{1}{(\sqrt{2\pi})^n} \frac{1}{\sigma_{obs^n}} e^{-\frac{1}{2\sigma_{obs^2}} \sum_{t=1}^{n} [\ln(CPUE_t) - \ln(qK) - \ln(P_t)]^2}$$

where $Y = (\ln(CPUE_1), \ln(CPUE_2), \ldots, \ln(CPUE_n))^t$ the vector of observations and the vector of parameters

A priori uninformative distributions for the parameters, uniform in an interval, and all independent, were considered:

Parámetro	**Prior**
K	$\ln(K) \;\; U(\ln(40000); \ln(100000))$
r	$\ln(r) \sim U[\ln(0,2), \ln(0,5))$
Coeficientes de capturabilidad	*q~ U (ln(0,00001);ln(0.001)*
Error de proceso y observación	*τ_{proc} ~ U[0,02,400]* *τ_{obs} ~ U[(0,02,400)*

Projection and risk analysis

Projections were made at constant annual catches of the long-term (15 years) trend in abundance. The maximum biologically acceptable catch was estimated with a 10% risk that the biomass in the last year of the projection will be lower than the BMSY (Target Biological Reference Point - PBRO) and half of this amount, considered as the Biological Reference Point Limit (PBRL). A minimum risk (of 10%) was assumed due to the high levels of uncertainty estimated for this group of species. In addition, the projections were made at constant catch, because the effort did not remain stable, and declined sharply in recent years.

The exercises carried out were the following:

- M1: CPUE (kg/day) fleet stratum Ic
- M2: CPUE (kg/day) fleet stratum Ib-Ic
- M3: CPUE (Kg/hVMS) fleet stratum Ic

Results

The results of the application of the models presented, in general, an acceptable fit to the indices of abundance considered, as well as similar trends and biomass levels. However, it is important to note that the level of uncertainty associated with the estimation of the parameters was very high (Figure 30).

The average biomass estimate at the beginning of 2019 for Model 1 was 50,861 t and for Model 2, 54,109 t. As for the main parameters of the models, the mean load capacity was estimated at 74,887 t and 72,935 t and the intrinsic rate of population growth at 0.34 and 0.37 respectively.

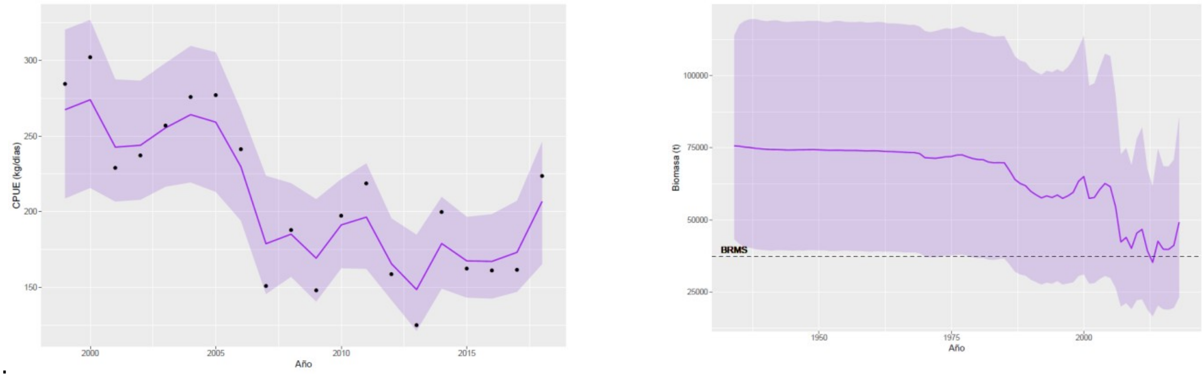
The total biomass presented, in both cases (Table 4), a slightly decreasing trend until 1984 and then is more marked until 1997. Subsequently, a recovery was observed until 2003 and fluctuations in average terms of a decreasing trend until 2016. A recovery was observed in the last two years of the period.

Table 4. Parameter estimated Surplus Model: MSY: Maximum sustainable yield, RY_{2019}: replacement yield, stock biomass giving MSY (B_{MSY}), B_{2018}, biomass estimated to 2018, B_{2018}/B_{RMS}: ratio of final-year biomass to biomass at MSY, B_{2018}/K: ratio of final-year biomass to carrying capacity, F_{RMS} fishing mortality rate at MSY.

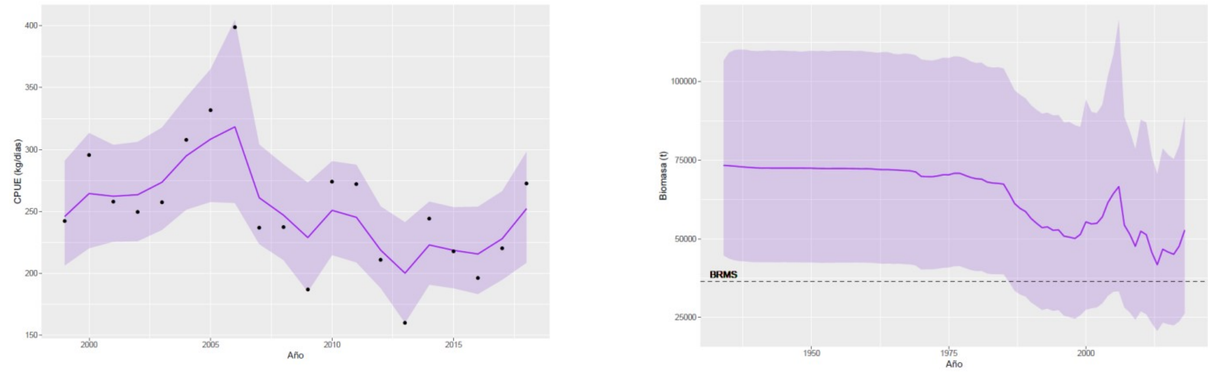
	Modelo 1		Modelo 2		Modelo3
	Media	IC (95%)	Media	IC (95%)	Media
Parámetros del modelo					
r	0,34	(0,21 - 0,49)	0,37	(0,21 - 0,49)	0,344
$K=B_0$	74.887	(46.931 - 98.580)	72.935	(46.881 - 98.254)	75.116
q	0,0047	(0,0025 - 0,0086)	0,0053	(0,0029 - 0,0092)	0,005
σ^2_{proc}	0,0208	(0,0031 - 0,0583)	0,0115	(0,0026 - 0,0415)	0,021
σ^2_{obs}	0,0156	(0,0027 - 0,0458)	0,0187	(0,0029 - 0,0450)	0,015
Parámetros de manejo					
RMS	6.275	(4.026 - 10.199)	6.519	(4.184 - 10.545)	6.326
CR_{2019}	4.647	(1.354 - 7.133)	4.310	(1.253 - 6.333)	4.660
B_{2018}	49.149	(23.214 - 85.648)	52.781	(26.350 - 88.969)	49.794
B_{2019}	50.861	(24.697 - 85.110)	54.109	(27.907 - 87.644)	51.467
B_{RMS}	37.443	(23.688 - 49.306)	36.467	(23.440 -, 49.127)	37.558
B_{2019}/B_{RMS}	1,36	(0,73 - 1,91)	1,47	(0,87 - 1,92)	1,36
B_{2019}/K	0,68	(0,36 - 0,95)	0,74	(0,44 - 0,96)	0,68
F_{2018}	0,072	(0,036 - 0,134)	0,066	(0,035 - 0,118)	0,071
F_{RMS}	0,171	(0,103 - 0,245)	0,183	(0,11 - 0,247)	0,172

The comparative biomass trends estimated for the models considered are presented in Figure 31. It was observed that the mean biomass trajectories and associated uncertainty levels were similar, although the IbIc Model estimate was higher mainly in the last 12 years of the assessment period.

ME1: CPUE (kg/día) estrato de flota Ic



ME2: CPUE (kg/día) estrato de flota Ib-Ic



ME3: CPUE (Kg/h$_{VMS}$) estrato de flota Ic

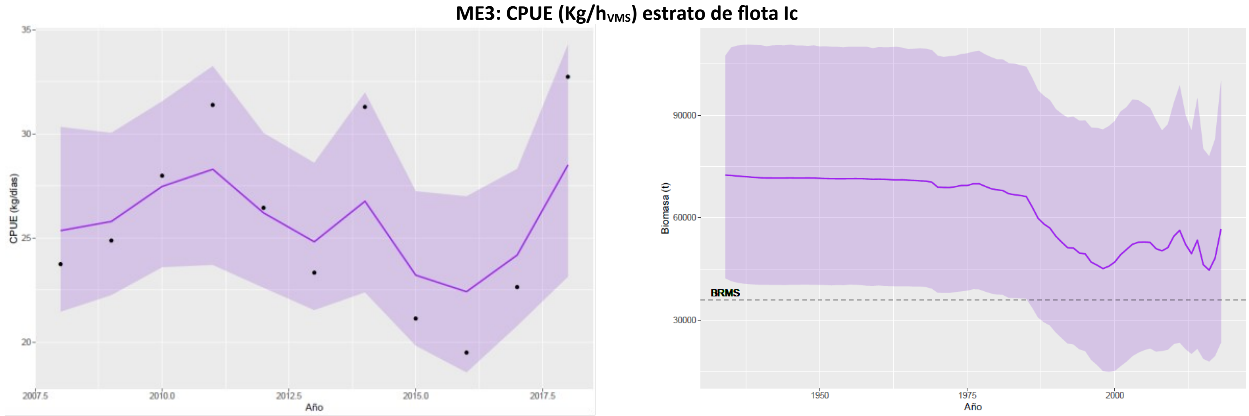


Figure 31. Fitting to the index of abundance and trend of total biomass. The band indicates the associated uncertainty

To visualize the trends and the current status of the group of flounder, the Kobe plot was made, which is subdivided into different zones, based on the consideration of the PBRO, the PBRL and an area adjacent to the PBRO - delimited by 90 and 100% of the latter on the horizontal axis and 100 and 110% of the same on the vertical axis - established in order to define a threshold from which recovery actions are generated to avoid reaching the PBRL. In addition, contour lines corresponding to the uncertainty and probability of the current situation were incorporated in each of the areas resulting from the Kobe diagram (Figures 32 to 34).

'In the Kobe ploy it was observed throughout the assessment period, in average terms, that the flounder was not subject to overfishing or overexploitation. The current situation indicate, the probability that the biomass is at a higher than optimal level and that the fishing mortality rate is less than optimal was 81% for the Ic Model and 90% for the IbIc Model. In addition, there is no risk that biomass will be below the PBRL for both models; while there is a low probability that biomass will be below the PBRO -12% and 5% for the Ic and IbIc Models respectively.

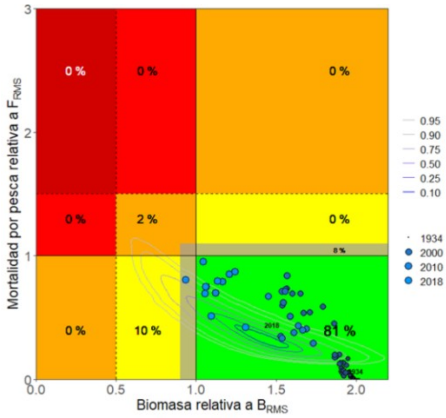


Figura 32. Kobe diagram of Model ME1: CPUE (kg/día) estrato de flota Ic. The points correspond to the state in each of the years of the period and the contour lines to the uncertainty associated with the state in the year 2018. The percentages correspond to the probability of being in each of the areas.

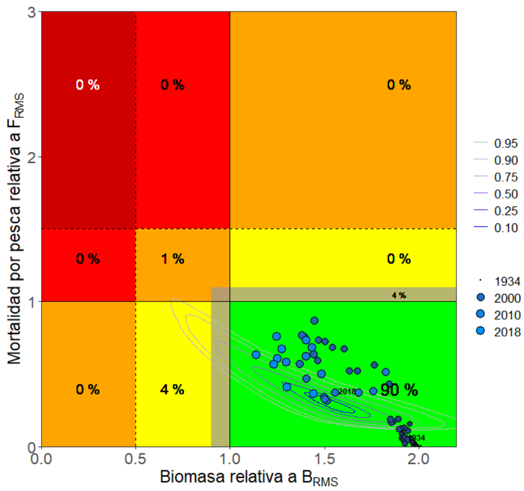


Figura 33. Kobe diagram of Model ME2: CPUE (kg/día) estrato de flota Ib-Ic. The points correspond to the state in each of the years of the period and the contour lines to the uncertainty associated with the state in the year 2018. The percentages correspond to the probability of being in each of the areas.

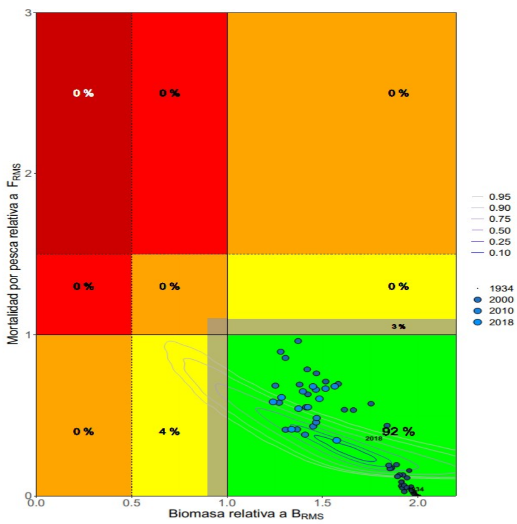


Figura 34. Kobe diagram of Model ME3: CPUE (Kg/hVMS) fleet stratum Ic. The points correspond to the state in each of the years of the period and the contour lines to the uncertainty associated with the state in the year 2018. The percentages correspond to the probability of being in each of the areas.

Synthesis of the results and management recommendations for 2020

From the joint work developed in the meeting of the current year, the *Grupo de Trabajo de Recursos Costeros* agreed to formulate the following recommendations for the catch of flounder group for 2019 and 2020 in the area of the Treaty.

CBA 2019-2020	**Modelo global***				
Modelo**	**M1**		**M2**	**M3**	
Riesgo	10%	**50%**	10%	10%	**50%**
2019	4.112	6.724	4.566	4.542	7.195
2020	4.112	6.724	4.566	4.542	7.195

	M1	**M2**	**M3**
RMS	6.275	6.519	6.326
CR_{2019}	4.647	4.310	4.660
B_{2019}	50.861	54.109	51.467
B_{RMS}	37.443	36.467	37.558
B_{2019}/B_{RMS}	1,36	1,47	1,36
B_{2019}/K	0,68	0,74	0,68
F_{2018}	0,072	0,066	0,071
F_{RMS}	0,171	0,183	0,172

* Surplus model: Maximum Sustainable Yield (MSY), Fishing mortality at MSY (F_{MSY}), Biomass at MSY (B_{MSY}),
** M1 índice flota argentina CPUE (kg/día) estrato de flota Ic. M2 índice flota argentina CPUE (kg/día) estrato de flota Ib-Ic. M3 Indice flota argentina CPUE (Kg/h $_{VMS}$) estrato de flota Ic

Current management measures

- Resolución CTMFM Nº 10/00 (Modifica Art. 1 Resol. 7/97). Corvina, pescadilla y otras especies demersales. Norma modificando eslora máxima/total de buques autorizados a operar en un sector de la Zona Común de Pesca.
- Resolución CTMFM Nº 7/20. Fíjese para el año 2020, en la Zona Común de Pesca, una captura total permisible (CTP) de lenguados en 5.300 toneladas.

Trade[1]

In the landings of Argentina these species are part of the so-called "fine fishing", due to the high quality of its meat and its low volumes of catch. As a consequence, the price it reaches in the market is very high. Uruguay, on the other hand, does not register market values for this group of species.

In terms of physical volume, Argentine flounder exports in the period 2011-2019 have averaged 1,562 t with a maximum in 2011 of 2,633 t and a minimum in 2017 of 951 t. The share of this group of species in total exports of fishery products did not exceed 0.28% in 2019, equivalent to a volume of 1,347 t (Figure 35).

1 La información para el desarrollo de este capítulo proviene de los informes anuales sobre comercialización de productos pesqueros elaborados por la Dirección de Economía Pesquera de la Subsecretaría de Pesca y Acuicultura [Exportaciones e Importaciones pesqueras – Informes anuales]. Los volúmenes exportados por Argentina incluyen no sólo las capturas correspondientes al área del Tratado, sino también aquéllas realizadas en las aguas propias adyacentes y pueden incorporar desembarques correspondientes a otras unidades de manejo, como por ejemplo el pez palo capturado en El Rincón.

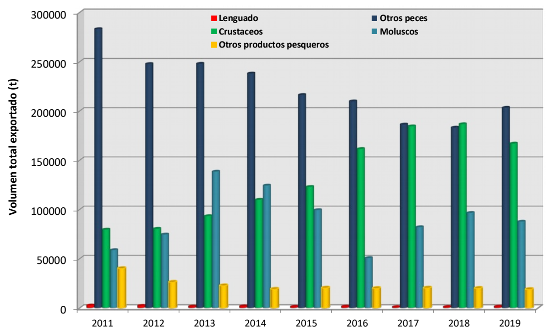


Figura 35. Flounder contribution to the total volume (t) of fishery products exported by Argentina between 2011and 2019.

The average price per ton of Argentine sole exports increased between 2011 and 2019, reaching in those years values, expressed in US dollars (USD) FOB, of 5,517 and 7,406, respectively, with the maximum value recorded in 2018 (8,047). In 2011, exports of this group of species reached a value of USD 14,526,000, equivalent to 0.97% of total exports of fish products, while in 2019 the value of flounder exports (USD 9,975,000) contributed 0.53% to the total exported (Figure 36).

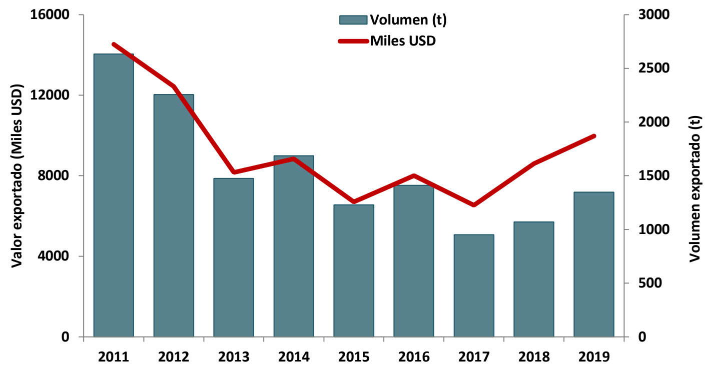


Figure 36. Volume exported (tons) and value (thousands of USD) of flounder by Argentina in the period 2011-2019.

The main destinations of Argentine sole exports in 2019 have been the United States and Italy, which together account for 99% of total exports (Figure 37). The volumes exported and the price and destination of each of these products vary according to the report prepared by the Dirección de Economía Pesquera de la SSPyA of Argentina. In 2019 sole was exported in frozen fillets in a total of 1,341 tons at an average price of USD 7,411.

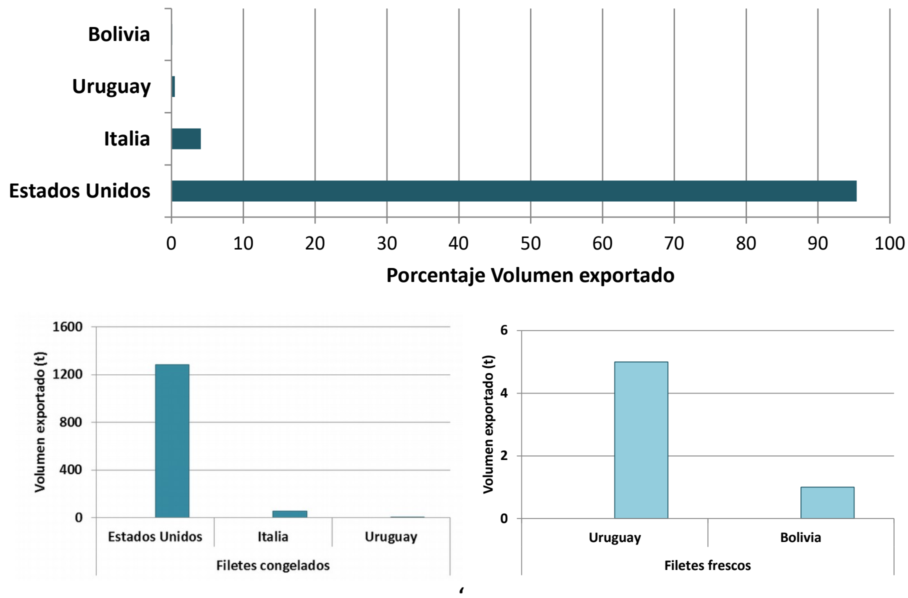


Figure 37. Flounder. Main export destinations in 2019.

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