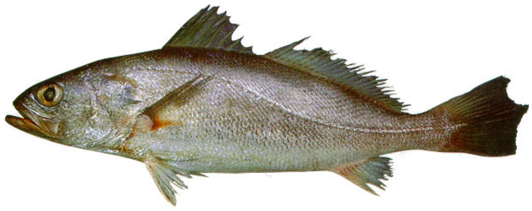
Resource identification [link 1]

Taxonomy
Class: Actinopterygii
Order: Perciformes
Family: Sciaenidae
Specie: *Cynoscion guatucupa* (Cuvier, 1830)



Nombres comunes
Argentine: pescadilla de red
Uruguay: pescadilla de calada
Brazil: maría mole, pescada olhuda
English name: *Stripped weakfish*
Other scientific names synonymous in use: *Cynoscion striatus*.

External distinguishing characteristics

Fusiform body, covered with regular to large scales, ctenoid. The lateral line runs parallel to the line of the back to the height of the middle of the second dorsal fin. Pointed snout. Narinas of regular size, very close to the eyes. Without barbel. Large eyes, contained 5-6 times in the length of the head. Dorsal fin in V, forming two contiguous crests, the first with spiny rays only, the second with a spiny radius and the other soft. Truncated flow. Anal cuts. The pectorals are inserted at the level of the posterior edge of the operculum. The ventral ones originate below the pectorals, end at the same level. Back of bluish grey body, clearing on the flanks, whitish abdominal area. Dorsal and dark grey caudal fin, pectoral, ventral and clearer anal.

Distinction of similar species in the area

It is distinguished from *Macrodon ancylodon*, king weakfish, mainly by the pattern of coloration and the shape of the caudal fin [link 2]. Recently, Pinter dos Santos-Ninim (2008) analyzed the morphometry in its phases of transformation of the family Scienidae in coastal waters of the southern and southeastern regions of Brazil distinguishing diagnostic characters for its identification. In the early stages of development (standard lengths between 11 and 87 mm) he determined that the morphometric characters, such as body height, head length, orbit diameter and upper jaw length, were less for *C. guatucupa* than *M. ancylodon* [link 3].

Geographical distribution

The striped weakfish (*Cynoscion guatucupa*) is a widespread pelagic-demersal fish predominantly found on the coast of South America, ranging from Rio de Janeiro, Brazil (22°S), to Chubut province, Argentina (43°S) (Cousseau and Perrotta, 2013). *C. guatucupa* belongs to a group of about 20 species corresponding to a multispecific demersal fishery (Carozza *et al*., 2001). Within this group, *C. guatucupa* is considered the second species in commercial importance after the whitemouth croaker (*Micropogonias furnieri*) (Ruarte and Aubone, 2004). The striped weakfish body size is close to 320 mm at maturity; its spawning period ranges from October to early April, with a main peak in October–November (Ruarte and Aubone 2004; Ruarte *et al*., 2004). It is a long-lived species (20-23 years). Argentine landings of striped weakfish come from catches from Samborombón Bay, part of the Zona Comun de Pesca (34°S to 39°S), and from El Rincon zone to the South of Buenos Aires province (39°S to 41°S)

Figura 1. Distribution of striped weakfish (*Cynoscion guatucupa*) on the coast of South America and in the Zona Comun de Pesca (ZCP). Fuente: J. M. Caballero, Dirección Nacional de Recursos Acuáticos (DINARA) Proyecto FAO-DINARA UTF/URU/025/URU "Gestión de la Pesca en Uruguay”.

Population and management units

Cynoscion guatucupa shows latitudinal differences in some population and biological parameters, such as growth, natural mortality, age / size of first maturity, fecundity as well as morphometric and meristic characters and its genetic structure. This has made it possible to postulate the existence of different population groups.

Based on meristic and morphometric comparisons, Díaz de Astarloa and Bolasina (1992) suggested that striped weakfish from southern Uruguay and northern Buenos Aires Province, Argentina could be a single stock, isolated from those striped weakfish from El Rincon, southern Buenos Aires Province, Argentina. Previous studies based on fecundity (Cassia, 1986), length-mass ratios and presence of both eggs and juveniles in both zones (Cordo, 1986), support this view.

Although it was not possible to determine significant differences between these two areas from the comparative study of the morphology and morphology of *C. guatucupa* otoliths (Volpedo, 2001), the analysis of the chemical composition of otoliths from these same locations showed significant differences in the Mg/Ca, Mn/Ca and Sr/Ca ratios. From these results it is postulated the existence of two populations, one in the north (Partido de la Costa and Mar del Plata) and another in the south of the province of Buenos Aires (El Rincón) (Volpedo and Fernández Cirelli, 2006).

Volpedo *et al*. (2007) postulate that the fish stocks of the striped weakfish on the South American coast would be at least three. The first located on the south coast of Brazil and Uruguay, the second in the northern area of the Buenos Aires coast (Bahia Samborombón and Partido de la Costa) and the third in the Buenos Aires south (El Rincón and Bahia San Blas) [link 4].

Timi *et al*., (2005) analyzed the parasites of *Cynoscion guatucupa* along South American Atlantic coasts. Two stocks of striped weakfish in the south-west Atlantic Ocean were identified using parasites as biological tags. Similarity within Argentinean and Uruguayan samples was similar to those between them, indicating the integrity of the southern stock. The low values of similarity between zones involving Brazilian striped weakfish support their separation as a different stock.

In contrast to these results, Haimovici (1997) and Vieira and Haimovici (1997) postulate that the population that inhabits the Treaty area could be part of the same population that extends to the Cape of Santa Marta (29° S). The authors base these conclusions on the reproductive dynamics of the species, the distribution of their breeding areas and seasonal migratory movements of the adults of southern Brazil accompanying the displacement of the cold water masses. Vieira Castelli (1990) analyzed the reproductive period of the striped weakfish landed in Rio Grande do Sul, did not identify important spawning areas in the area, concluding that the spawning of the species coincides with the movement of adults towards the coasts of Uruguay and Argentina during the spring.

Figure 2. Population units of the *Cynoscion guatucupa* in the South-West Atlantic. Modified from Fernández Iriarte *et al* 2011.

Likewise, Haimovici (1997) and Vieira and Haimovici (1997) found similarity in the growth parameters, seasonality of reproduction and sizes and age at first maturity. Subsequently, Volpedo *et al*. (2009) analyze the chemical composition of the otoliths of this species by comparing samples from the ZCP and El Rincon. They determined in the ZCP a great variability in the concentration of seven chemical elements (Cr, Cu, Mg, Mn, Pb, Sr and Zn). In the El Rincon specimens, the variability in chemical composition is reduced, presenting values similar to those determined in the ZCP. The authors suggest from these results that there is connectivity between these two areas (ZCP and El Rincon) due to the displacements of the species, in the same way, could occur with specimens that would move between the coast of Brazil and the ZCP.

Sabadin *et al.,* (2010) analyzed the morphometric, microsatellite loci and mitochondrial control region variation of the striped weakfish from two feeding and spawning grounds in the coastal area of Buenos Aires province (Bahia San Borombon and El Rincon). The characterization of the body shape proved to be different between sites. Genetic structure analysis showed that the main source of genetic variation was within populations rather than among populations and low genetic differentiation was observed between sites. The striped weakfish inhabiting the coastal areas of Buenos Aires would exhibit two management units in agreement with other fishes studied in both areas.

The most recent information (Marques 2012) comes from the use of sequences from the mitochondrial control region to know the genetic structure of *Cynoscion guatucupa* throughout its range of distribution in the South West Atlantic. Although the author finds differences between Montevideo and La Paloma, Bahía Blanca and Torres, when analyzing the whole area he found a high variability within the populations, which is an indicator of the lack of genetic structuring. According to the author, this population homogeneity from the south of Brazil to Bahía Blanca would form a single management unit [link 5].

The results obtained from genetic analysis as with otoliths chemistry are not necessarily contradictory. In this sense, Thorrold *et al.* (2001) [link 6] referring to the fidelity of the natal homing in a metapopulation of a species of northwest Atlantic, *Cynoscion regalis*. The authors show that in spite of not being able to establish genetic structure, given that genetic methods are very sensitive to low rates of population exchange, the analysis of otolith chemical components such as Mg, Mn, Sr and Ba, showed a high degree of **aquerenciamiento** to spawning sites. The authors suggest that this finding may have direct implications in the management of this population or of this stock under the metapopulation concept.

Beyond these results and considerations, the management of *Cynoscion guatucupa* fisheries in the South West Atlantic is carried out from three management units: the first corresponds to the stock from Santa Catarina-Rio Grande do Sul (Ministerio da Agricultura, Pecuária e Abastecimento), the second corresponds to the area of the Treaty and is administered jointly by the CTMFM and CARP and the third, corresponding to El Rincon, is in charge of the Argentine Fishing Application Authority.

Biology and Ecology

Initial ontogenesis

Cynoscion guatucupa eggs are pelagic and spherical, 700 µ 840 µ in diameter and with single oil globule of 210 µ a 240 µ. The yolk is homogeneus and the corion has a smooth surface.

The embryonic and larval development of striped weakfish in the ZCP has been described by Ciechomski and Cassia (1982). The trend of development, from egg activation to larval hatching, was studied by artificial fertilization, using spawning adults and embryos under controlled experimental conditions. The embryonic and larval development of striped weakfish of the ZCP has been described in detail by Ciechomski and Cassia (1982) [link 7].

From specimens fixed, the authors found that striped weakfish larvae at birth measure between 1.7mm and 1.9mm (TL) and are relatively undeveloped. The details of the evolution of the initial ontogeny are described in [link 8]. When reaching 17 cm (TL) the juveniles already present the meristic characters of the species. They describe the following characteristics of this stage: "*the height of the body at the level of the base of the pectoral fin represents 29% of the standard length, reducing this proportion in adults. At the level of the beginning of the anal fin, the height equals 18% and the peduncle caudal to 93% of standard length. The head is large occupying its length of 34% of the body. The preorbital distance and the diameter of the eye represent 15% and 28% of the length of the head respectively. The mouth is large and reaches to the middle of the eye. Premaxillary teeth are very pointed, arranged in two rows. On the front, there are two canines on each side*"

Growth

Larval, post-larval and metamorphosis phases

Ciechomski and Cassia (1978) [link 9], studied the growth of striped weakfish juvenile between 20 - 140 mm TL, based on data of the species in its natural habitat and under experimental conditions. The monthly growth of juveniles at sea was determined through the analysis of distribution of size frequencies of 5,000 individuals collected in a year. The fish in the aquarium were measured and weighed every two weeks. On the analysis of size frequency distribution and retro- calculation, it was concluded that the formation of the first annual ring in juveniles of this species occurs in specimens between 45 - 100 mm TL and 1.16 - 10.0 g weight. The average size of the marking of the first annual ring occurs between 70 - 80 mm. In juveniles between 79-102 mm at a temperature of 15 to 22 ° C the increase in length and weight was 2.01 mm and 0.896 g per week respectively.

Pereira (1986, cited in Viera and Haimovici 1993) identified striped weakfish juvenile from 30 to 40 mm TL in the Laguna de los Patos estuary only in December, April, May and June. He did not observe juveniles so small with a translucent mark, which was attributed to the fact that probably those born in summer form this complete mark only from the second winter and would be larger than the specimens of the same age class from Mar del Plata.

Juvenile and adult stage

The striped weakfish is a long-lived and slow-growing fish. Based on otoliths analysis, Ruarte and Sáez (2006) and Lorenzo (2009) determined the age and growth of specimens catches in research cruises carried out during the years 1998 - 1999 and 2007 respectively in the Treaty area. In both cases, the maximum age observed was 14 years. The estimated growth parameters according to the von Bertalanffy equation are presented in Table 1. Ruarte and Sáez (2006) found differences in the age and growth between ZCP and El Rincon, confirming those found when comparing the respective size-weight relationships (Cordo, 1986). The maximum ages observed in El Rincon were 21 and 23 years, in specimens up to 53 cm (Ruarte *et al*., 2000). The striped weakfish in the El Rincon area has a faster growth than in the ZCP since it reaches 80% of the L_∞ during the first 4 years of life. These differences in growth parameters and maximum ages can be related to the amplitude of environmental conditions in which the species inhabits, which tolerates temperatures between 13.1° C and 20.8° C and typical marine salinities (33-34 ups) (Ruarte *et al*., 2004). The average density of the population of the El Rincon area is three times lower than in the Uruguayan-Buenos Aires region.

Likewise, López Cazorla (2000) studied the age of striped weakfish in the Bahia Blanca estuary (39° S) with samples collected between April 1991 and May 1993. She concluded that the formation of the annual ring would occur between June and August. Age 0 was assigned to individuals between 5 and 15 cm LT. Adult females from 5 to 23 years were distributed in sizes between 40 and 52 cm TL while males from 7 to 22 years old between 50 and 51 cm TL.

Castelli-Viera and Haimovici (1993) proposed the existence of a latitudinal gradient in the north-south direction both in growth and observed maximum ages. The authors observed that the specimens between Cabo Frio and Torres would mark 8 years at 32 cm while those from Rio Grande do Sul, at 44 cm. Likewise, the maximum ages observed were 9 and 15 years respectively. Ruarte and Sáez (2003) verified the mentioned hypothesis of the latitudinal gradient with data from El Rincon. Later, Ruarte and Sáez, (2006) estimated maximum age and K minor values, suggesting that this decrease may be due to the increase in fishing in recent years.

A periodicity was observed in the formation of the growth zones, verifying that the translucent zones are formed in the winter months coinciding with the low temperatures and the gonadal maturation.

Table 1. von Bertalanffy parameters for females, males and pooled sexes of striped weakfish collected in the ZCP and El Rincon and Rio Grande do Sul.

		Machos	Hembras	Sexos agrupados
ZCP	1997 - 1998	Lt = 59,33 $[1-e^{-0,15(t-(-1,77))}]$	Lt = 55,52 $[1-e^{-0,19(t-(-1,44))}]$	Lt = 57,02 $[1-e^{-0,19(t-(-1,53))}]$
	2007	Lt = 55,60 $[1-e^{-0,21(t-(-1,11))}]$	Lt = 54,13 $[1-e^{-0,21(t-(-1,40))}]$	Lt = 54,18 $[1-e^{-0,22(t-(-1,21))}]$
El Rincón	1997 - 1998	Lt = 46,64 $[1-e^{-0,42(t-(-0,15))}]$	Lt = 48,48 $[1-e^{-0,39(t-(-0,05))}]$	Lt = 47,75 $[1-e^{-0,39(t-(-0,17))}]$
Río Grande do Sul	1977 - 1981	Lt = 48,04 $[1-e^{-0,28(t-(-0,214))}]$	Lt = 51,69 $[1-e^{-0,23(t-(-0,34))}]$	Lt = 50,12 $[1-e^{-0,26(t-(-0,19))}]$

The annual parameters of the height/weight relationship showed significant differences between sexes. The values corresponding to the curve adjusted to measurements come from the sampling of two research cruises conducted by the B/I "Dr. E.L. Holmberg" in the ZCP in December 1998 and November 1999 [link 10] are the following:

Males $P = -0{,}0198*Lt^{2,78}$ N = 530
Females $P = -0{,}0189*Lt^{2,80}$ N = 582

In the Southeast region of Brazil, the size/weight ratio was estimated from 6,598 specimens between the 58 and 575 mm obtained from commercial fishing samplings carried out in Rio Grande do Sul, with the following parameters: a = 1.94 x 10^{-5}, b = 2.87 (Haimovici and Velasco, 2000).

Reproduction

The striped weakfish is a multiple spawner with indeterminate annual fecundity. The reproductive activity in the coastal waters of Buenos Aires province ranges from October to March whit a main peak in November. The same pattern was found in samples from the landing in Rio Grande do Sul by Vieira and Haimovici (1997). Macchi (1998) finds spawning females in the El Rincon area during November, while most of the individuals were in maturation for the ZCP. Eggs and larvae of the species have been found in two zones, one corresponding to El Rincon and another that extends from Mar del Plata to 36° 30'S with the 50 m isobath as the external limit (Cassia and Booman, 1986). Juveniles of less than 10 cm are abundant in very coastal areas, detecting the highest concentrations near of Cabo San Antonio (Lasta and Acha, 1993).

The reproductive biology of the striped weakfish, inhabiting the estuarine waters of the Rio de la Plata and adjacent marine zone, was studied using macroscopic and histological analysis of the gonads by Milliteli (2007). Highly significant differences between males and females (28.4 cm TL and 31.3 cm TL, respectively) were obtained. The estimated length at first sexual maturity for both sexes was 29.8 cm LT. Also from a macroscopic analysis, Lorenzo (2009) estimated the age of first maturity for females in 3.1 years, (L_{50} females = 32 cm) and for males in 2.5 years (L_{50} males = 29.4 cm). For pooled sexes (L_{50} = 30.7 cm), was 3 years. The ratio L_{50}/t_{50} indicated that males showed a higher growth rate than females (11, 9 and 10.7 cm / year respectively).

The distribution of the maturity stage of this specie in the ZPP and El Rincon during the spawning season (November) was analyzed by Macchi and Acha (1998). The authors showed a predominance of mature individuals, with the exception of the Montevideo coastal where a high proportion of juveniles was identified. In El Rincon, the composition of stages showed a predominance of spawning females. In the trawl group closest to the coast, made between Bahía Blanca and Claromecó, a high proportion of juveniles and the absence of spawning females were observed [link 11]. Subsequently, Militelli (2004) [link 12], with the same aim, showed a predominance of juvenile specimens (stage 1), with the exception of zone 2, where a greater number of maturing and spawning females was observed, although in a very low proportion (stage 2 and 3 respectively). The proportions of sexes in the different zones, (ZCP and El Rincon), showed no relationship with the percentage of spawning individuals (Fig. 3).

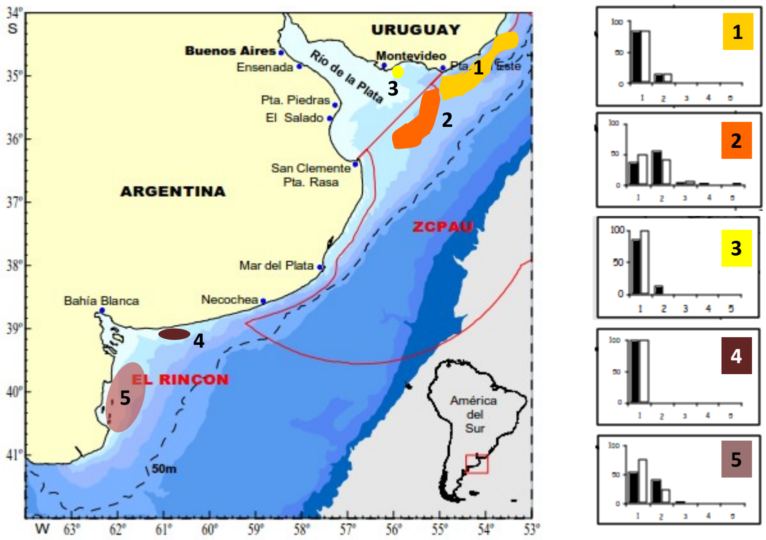


Figure 3. Stages of maturity composition of *Cynoscion guatucupa* for the different zones considered. Black bars: males; white bars: females. Modified from Militelli (2004, 2007).

Feeding

The striped weakfish occupies tertiary and quaternary consumer levels in the trophic chain, with a degree of cannibalism, seasonal variations in diet and an ichthyophagous tendency of adult individuals. The juvenile stages are preferably carcinogens and the basic component of their diet in the Mar del Plata area is *Peisos petrunkewitchi* (Ciechomski and Ehrlich, 1977). The adult specimens have a preference for fish, mainly *E. anchoita* and *A. marinii* and *A. longinaris* (shrimp) and *P. muelleri* (shrimp), especially when there is not enough availability of anchovy (Cordo, 1986).

Garcia (2012) analyzed the feeding habits of *C. guatucupa* through the stomach content of specimens between 38° 30'S - 41° 30'S, covering the ZCP and the El Rincon area during 2004 and 2005. Were identified 39 prey items, corresponding to 4 Phyla. Using the Relative Abundance Index (IRI), determined that the most important item (72.53% IRI) in the diet of the striped weakfish was the fish, followed by the crustaceans (27.44% IRI); with smaller values polychaetes and mollusks were also found (0.2% IRI). Pelagic fish had the greatest contribution to the diet, with *Engraulis anchoita* (75.02% IRI) being the dominant prey, throughout the annual cycle in both areas. Other fish identified were the horse mackerel (*Trachurus lathami*, 2.56% IRI) and the anchovy (*Anchoa marinii*, 0.56% IRI). Within the crustaceans, *Peisos petrunkevitchi* (11.75% IRI) was the most important and in second place was the shrimp (*Artemesia longinaris*, 0.81% IRI) and the shrimp (*Pleoticus muelleri*, 0.51% IRI) [link 13]. No differences between sexes were found in the diet analysis. The food strategy was that of a predator specialist in pelagic fish. The trophic level of the striped weakfish (4.01) was that of a tertiary consumer. Likewise, highly significant differences were found when comparing the diet between the specimens from both study areas. In the ZCP a greater degree of ichthyophagy was observed with respect to the southern zone, which had a preponderantly carcinogenic diet in juveniles and ichthyophagous adults. The amplitude of the trophic niche was limited in the northern sector and broad in the southern sector, maintaining this difference in the two regions by also discriminating values between sexes and sizes. The existence of overlap in the diet was found among all the size groups for the northern zone, while in the southern zone, there was no overlap between the smaller and larger groups.

López Cazorla (1996), analyzing individuals from the Bahia Blanca estuary area, determined that the group of crustaceans constitutes the main item, both in adult and juvenile individuals. Likewise, Sardiña and Lopez Cazorla (2005) verified ontogenetic changes of diet in juvenile individuals in this same area. The first was observed when reaching a TL close to 4 cm, which implied a change in the type of prey, from demersal-pelagic (mysidáceos) to demersal benthic (*Peisos petrunkevitchi*). The second change occurs when reaching an LT of 8 cm, showing a progressive increase in ichthyophagia (*E. anchoita*).

In the Brazilian southeast, Lucerna *et al*., (2000) found that the main prey of the striped weakfish were the fish, crustaceans and occasionally squid. The seasonal variation in the diet, related to the availability of prey in the area confirmed the opportunistic feeding of this species. Although anchovy was an important component of the diet throughout the year, *A. longinaris* predominated in autumn, *Umbrina canosai* in winter, and *Trachurus latami* and eufáusidos in spring. During the summer, *C. guatucupa* was mainly fed on *Artemesia longinaris* and *Paralonchurus brasiliensis* and, to a lesser extent, on anchovy, and also cases of cannibalism were observed on juvenile individuals.

Natural mortality

The values of M obtained by the different methods fluctuated between 0.23 and 0.41 year-1 for females and 0.23 and 0.42 year-1 for males. Pauly's method, considering the von Bertalanffy growth parameters and an average temperature of 16.5 ºC gave an estimate of M = 0.41 yr^{-1} for females and 0.42 yr^{-1} for males. With a temperature range of 13.1 to 21.8 the average values of M were 0.42 $year^{-1}$ in all cases. The methods of Hoenig and Alagaraja taking the maximum age observed (10 for males and 14 years for females) indicated the values of M in 0.25 and 0.27 $year^{-1}$ for females and M = 0.38 and 0, 42 $year^{-1}$ for males respectively. With the estimated maximum expected longevity ($A_{0.95}$) M values of 0.32 for males and 0.35 $year^{-1}$ for females were obtained.

Distribution of the species in the area of the Treaty

Habitat

The area of the Treaty constitutes an area recognized for its high biological productivity. It is a hydrologically complex and dynamic habitat with marked horizontal and vertical density gradients [link 14] [link 15]. Forces of this variability are linked to the seasonal and inter-annual changes of the Rio de la Plata discharges, the seasonal regimes of the winds strongly associated to the latitudinal variations of the South Atlantic high-pressure cell, the nearness of the shelf with the Brazil and Malvinas currents as well as the contribution of nutrients from the southwest of the area transported by the Subantarctic waters of the Argentine shelf.

In the area of the Treaty, the coastal habitat of the species is limited topographically by the isobath 50-60 m, which separates the coastal regime from the continental shelf. In relation to the water masses Negri *et al*. 2016 [link 16] they indicate that waters of sub-Antarctic origin flow south of 38° S, and to the north of 36.5° S diluted waters by the discharge of the Rio de la Plata and waters of subtropical origin are added, principally in summer. Subantarctic Shelf Water, transported from the south, extend parallel to the bathymetry with SW-NE direction with salinity between 33.5 and 34.2 ups.

In the Subantarctic Shelf Water there are three components: the external one with salinity between 33.7 and 34.2 ups, which is located in the outer of the continental shelf; in the middle on the central shelf with lowest salinity resulting from the contribution of diluted waters by continental runoff in the south of the continent; and the coastal one with relatively high salinity values (S> 33.8 ups), coming from the east of El Rincon and originating in the interior of the Golfo San Matías due to the effect of restricted circulation and the predominance of evaporation over local precipitation. The Subtropical waters present are the Tropical Water and the South Atlantic Central Water, transported to the south by the Brazil current, which predominate during the summer and autumn. The Rio de la Plata water is mixed with continental shelf waters, forming a low - salinity layer over the Subantarctic and Subtropical Water, induces a high vertical stratification, isolating the deep layer.

The topography, together with the contributions of continental water and the modifications due to the exchange with the atmosphere, generate a complex ecological and oceanographic system. In the Rio de la Plata, the Barra del Indio constitutes a geomorphological barrier that divides the area internal and external. The internal corresponds with the river discharge and the external to a mixohaline regime where the intrusion of shelf water along the bottom, in the form of a salt wedge, generates a two-layered structure with a strong vertical stratification that decreased towards the outside of the Rio de la Plata. The interfaces between the mentioned regimes originate two salinity fronts, the bottom one as the boundary between the fluvial regime and the mixohaline, and the surface one as the boundary between the mixohaline regime and the shelf waters.

The entrance to the platform of the diluted water of the Rio de la Plata and its seasonal variation influences the shelf ecosystem modifying the physical-chemical properties of the area, the concentration of nutrients and the biological productivity. The distribution of surface salinity varies seasonally and is forced by winds and continental discharge. In autumn-winter the winds are continental and fresh water discharge reaches maximum values. In that period, there is a drift of water coming from the discharge of the Rio de la Plata in the northeast direction along the Uruguay coast. In spring summer, they show an extension in south-easterly direction, towards the Argentina coast, as a consequence of the oceanic winds and a minimum in the continental discharge. There are also areas whose waters are locally modified by continental contributions, which promote the formation of fronts in the coastal littoral, of importance due to their biological implications.

Areas of concentration and size structure

In the Treaty area, the greatest abundance of the species is 50 m deep (Macchi 1998). In winter it concentrates in deep waters, while in autumn and spring it moves to shallower waters, close to the coast, probably in a movement associated with reproduction. From the analysis of research cruises conducted during 1998 and 1999 in the spring and summer, it emerged that the highest concentrations of this species were recorded north of the ZCP (Punta del Este and El Chuy) between 25 and 100 m. This area was characterized by high densities of juvenile between 10 cm and 30 cm TL (individuals from 1 year to 3 years). Within the Rio de la Plata, Bahia Samborombón and the Mar del Plata, low densities were found. In El Rincon the highest densities were located forward of Bahia Blanca, being the highest percentage of adult individuals.

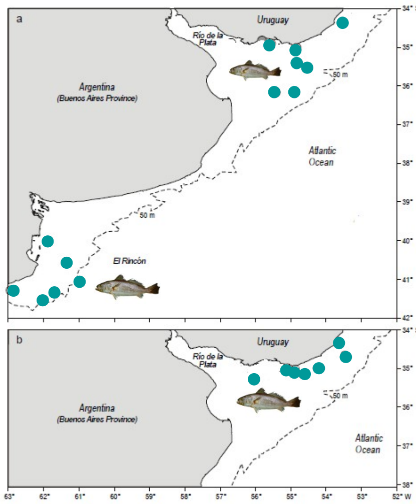
Jaureguizar *et al.* (2006) and Jaureguizar and Guerrero (2009) found a temporal space pattern in the abundance of age classes correlated with environmental variables. Although the juveniles (<3 years) predominated in the ZCP throughout the year, its observed seasonal changes in abundance. Age class 0+ predominated in autumn while in winter and spring they were 1+ individual. Individuals> 4+ were abundant in winter and early spring. The structure of the juvenile population of striped weakfish was associated with low salinities, this occurs when the wind forces fresh water from the Rio de la Plata to the coastal marine area, while adults were associated with high salinities. The authors conclude that the short-term environmental synoptic condition has a greater influence on the distribution and population structure of *C. guatucupa* than long-term environmental variability.

The specific analysis of the distribution by age group in the spring of 2007 marked the prevalence of age 0 individuals in a range of 30 to 37 m depth between Punta del Este and Chuy. Although the distribution for age group 1, 2 and 3 was similar to the previous one, they had higher density of individuals north of 35ºS at depths between 45 and 65 m. From age 4, concentrations predominated compared to Punta del Este at depths of less than 20 m. It should be noted that it was from this age that a difference in concentrations was found by sex, with females predominating in number up to age 7+ [link 17].

Spawning and breeding in the Treaty area

In the Treaty area, spawning of this species is always located in saline waters (values higher than 30 ups), mainly in a small area off the coast of Punta del Este (Macchi and Acha 1998, Militelli and Macchi 2006). With the aim of describing the spawning strategy of the sciaenid in the coastal waters of Argentina, Militelli *et al*. (2013) analyzed the influence of environmental factors on the spawning. During the peak of the reproductive period, spawning females were mainly located in waters with mean temperature values of 15.2° C in the range of 13.1 to 18.5° C and average salinity of 33.4 ups (between 31.9 and 34.2 ups) characteristic of marine waters of the coastal region. The spawning females were concentrated mainly in a reduced area with salinity values between 33 and 34 ups and a temperature that varied between 19 and 22 ° C (Fig. 4). These results agree with López Cazorla (2000) who described the spawning of the striped weakfish in the El Rincon area, particularly in the Bahia Blanca estuary. This author concludes that the spawning takes place in the external zone of the estuary and that their eggs and larvae are transferred to the inner zone of the same by the tidal currents, using it as a breeding area up to an average size of 12 cm. From there the juveniles migrate again to the marine environment.

Batch fecundity was estimated for March 2000 between 14,500 to 208,000 hydrated oocytes and was positively correlated with total length and ovary-free female weight. These values showed a power function of total length and linear function of ovary-free body weight, similar to that reported by Macchi (1998). Relative fecundity estimated for the 3 years sampled ranged between 37 and 276 hydrated oocytes/g. During December 2003, fecundity values were significantly lower than those obtained in March 2000 and 2001. However, in December the oocyte dry weight was greater than in March, when the spawning activity of striped weakfish decreases.



a

Figure 4. Spatial distribution of sciaenid spawning females (a) at the time of peak spawning activity and (b) at the end of the spawning season. Modified from Militelli *et al.* 2013.

Exploitation

Fishery Indicators

Striped weakfish is a resource exploited by Brazil, Uruguay and Argentina. In Brazil, nearly all landing is made in Rio Grande do Sul, being landed by the industrial fleet mode pair and otter trawlers and gillnet throughout the year (Haimovici 1997) and the mediumscale coastal fleet with gillnets during the winter months. Between 2009 and 2011 the landed volumes averaged 6,000 t (MPA 2012).

In Uruguay, striped weakfish landings occupy the third place and it is considered the second most important species among the coastal demersal resources of the Treaty area, after the whitemouth croaker (*Micropogonias furnieri*). It is catches mainly by the industrial fleet pair bottom trawl nets (Cordo 1986, Nion 1998). The coastal Uruguayan industrial trawls fleet Category B operate with bottom trawls, either independently using gates, or the pair trawlers. The average length of these vessels are 23 m in length, 129 GRT and 415 HP. Currently there is no industrial fleet whose target species is the catch of whiting, a situation that was recorded until 2001.

In Argentine, the largest landing of this species occurs in the port of Mar del Plata, by the bottom trawl fleet with gates and the drag net to the couple (Ruarte *et al.,* 2004). The coastal fleet denominated Ic (lengths between 18 and 25 m) is the one of greater activity on the striped weakfish in particular. Landings from the fishing fleet to the couple increased, becoming one of the preferred modalities for the coastal fleet, reaching more than 50% of the catches in the ZCP as of 2010. The main area and the fishing season of the Argentine fleet are in the Rincon, the Faro San Antonio area and the Uruguayan coast, there being a peak in the catches in the winter-spring period (Ruarte and Rico 2014, Ruarte 2015).

The landings of this species made by the Uruguayan fleet between 2000 and 2003 exceeded the volumes of Argentine catch by averaging 10,800 t and 2,500 t respectively. Between 2004 and 2008, the landings of both countries stabilized at approximately 10,000 t. From this year, the catch by Argentina doubled to that made by the Uruguayan fleet (Fig.8). In 2014, there was a slight increase in the Uruguayan fleet and a decrease in the landing in Argentina compared to 2013. Although in 2015 Argentine increased the catch of this species, in 2016 it decreased to 5,000 t with respect to the previous year. Uruguay averages 3,500 t between 2014 and 2016 (Fig. 5, Table 2).

Table 2. Landings reported for the Treaty area (t) and total values that include catches of the species made in Argentine adjacent jurisdictional waters.

Year	Uruguay	**Argentine** north of 39ºS	Total
2000	13.424	2.107	15.531
2001	10.464	1.665	12.129
2002	8.856	2.969	11.826
2003	10.457	2.958	13.415
2004	10.778	10.408	21.186
2005	8.383	6.890	15.273
2006	10.457	11.362	21.819
2007	7.317	9.844	17.161
2008	9.967	9.703	19.670
2009	5.806	9.473	15.279
2010	5.235	10.256	15.491
2011	6.613	12.036	18.649
2012	5.527	13.066	18.593
2013	3.520	12.669	16.189
2014	3.967	11.439	15.406
2015	3.169	13.274	16.443
2016	3.554	8.571	12.125

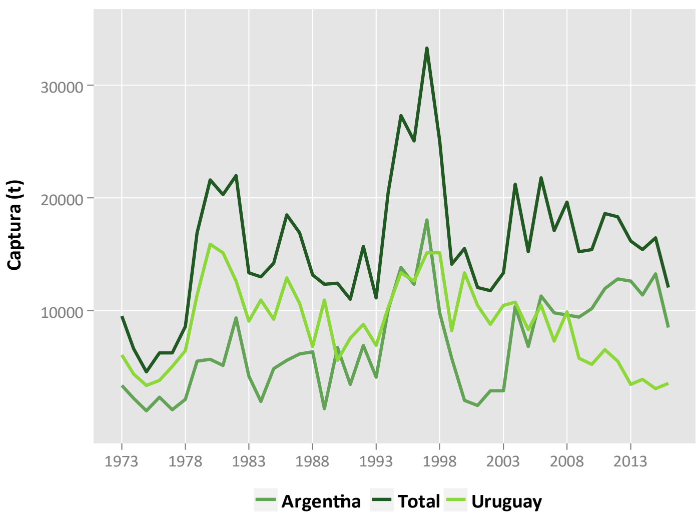


Figure 5. Landings of whiting from Uruguay and Argentina (north of 39º S). Period 1973-2016.

The catch of striped weakfish with respect to the total landed of whitemouth croaker, by the *Category B* Uruguay industrial fleet indicated that between 2002 and 2016 it varied between 63 to 77 and 16 to 27% respectively. Together these two species represent on average 93% of the catches of the category. As of 2010, the striped weakfish catch systematically declined until 2015 and then recovered in 2016. In turn, the proportion of whitemouth croaker landed remained stable, also increasing in 2016 compared to 2015 (Fig. 6). The trend of the whitemouth croaker fishery was the indicator of the fishing effort and the total catch of the coastal fleet, which was not observed with the striped weakfish. In general terms, the catch of striped weakfish was higher in the third and fourth trimester. In 2016, there was a significant increase (1,900 t) in landings, exceeding even the value of whitemouth croaker in the spring season (Fig. 7).

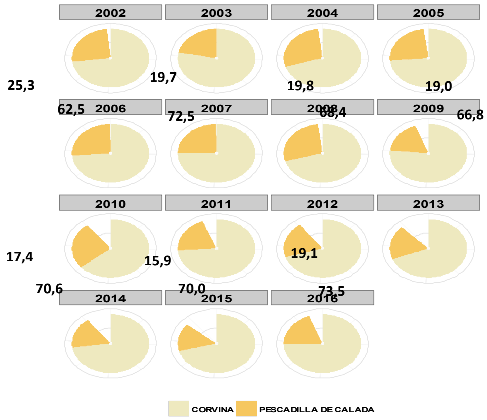


Figure 6. Proportion of whitemouth croaker and **striped weakfish** on the total catch of the Category B fleet for the period 2002-2016.

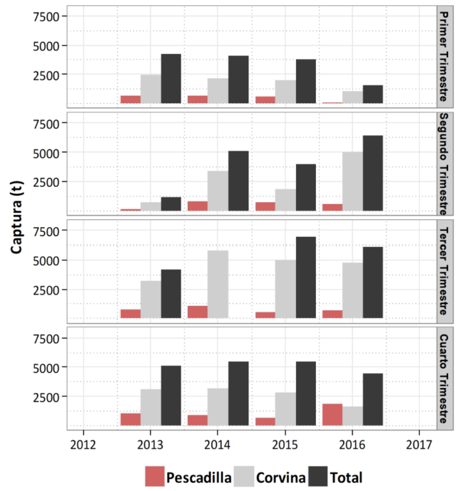


Figura 7. Catch (tonnes) and fishing effort (hours trawled) for **striped weakfish**, whitemouth croaker and total of Category B fleet. Period 2013-2016.

Seasonally, it is observed that in the last 4 years, the largest landings of striped weakfish occur during February-April and during September-November, although with some fluctuations depending on the year (Fig. 8). The average catch and fishing effort in those months was 250 t and 1,600 h respectively. The low volume of landings registered in 2013 is due to the fact that the coastal fleet in the months of May to June did not have activity. In 2016, the highest catch value of the period was reached in October with 900 t.

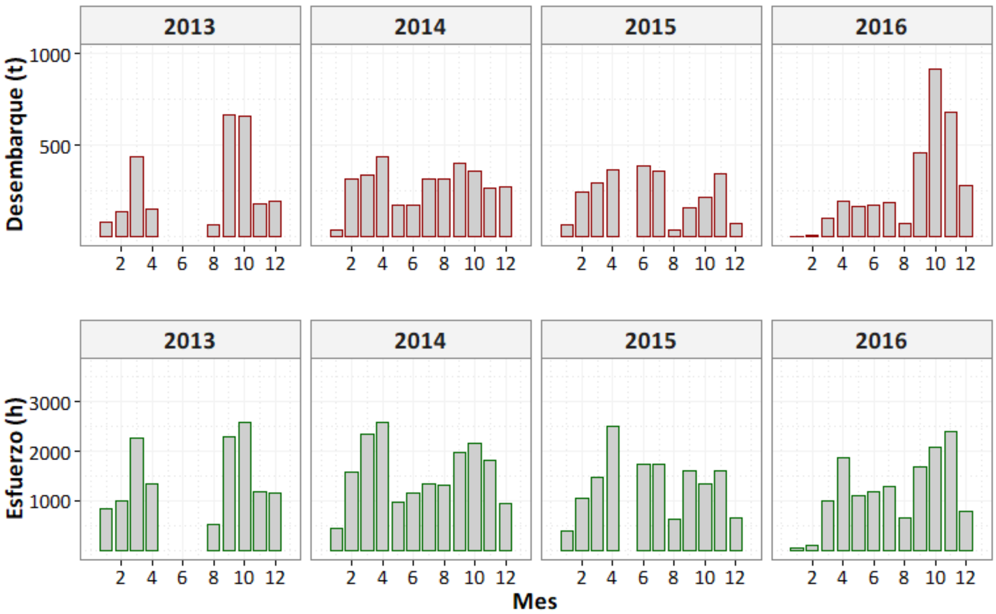


Figure 8. Monthly trend of the catch (t) of striped weakfish and fishing effort (h)of the Uruguayan coastal fleet in the years 2012 to 2016.

Figure 9 shows the distribution of fishing haul with striped weakfish catch carried out by fishing fleet. The area of greatest catch is the Rio de la Plata. From 2014, the Uruguayan Atlantic coastal area represents more than a quarter of the catches. When considering the fishing quadrangles (Fig. 10), between 2013 and 2015 the greatest activity was carried out in the area 355 and 356, since this fleet is directed to whitemouth croaker and these are the areas of greatest concentration of the species. In fishing quadrangles 355, the catch is maintained at the highest levels with an average of 1,200 t and 5,000 h. In the coastal ocean region quadrant 344 presents an increasing trend of landings in 2016 reaching 1,500 t.

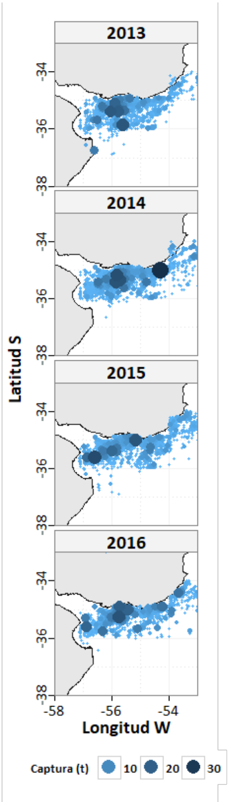


Figure 9. Distribution of fishing haul with striped weakfish catch from Category B fleet.

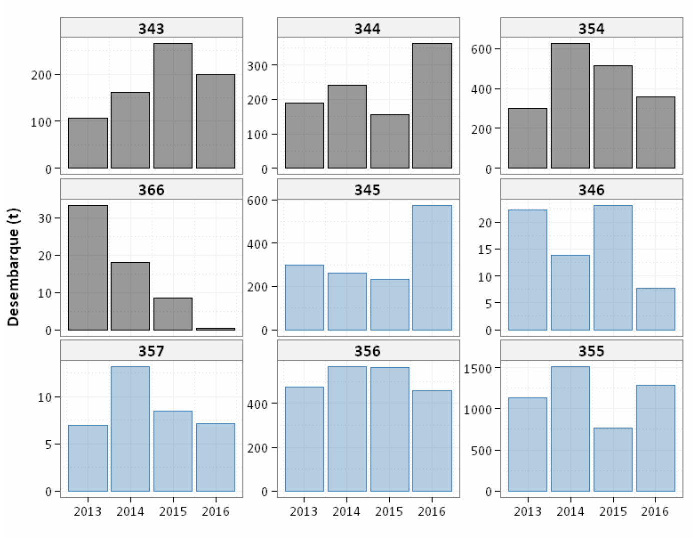


Figure 10. Catch of striped weakfish (tons) and fishing effort (hours trawled) per fishing quadrangle between 2013 and 2016.

Abundance indices

CPUE standardization was performed using a Generalized Linear Model), which allows incorporating the most important factors and interactions that generate changes in the CPUE.

Argentine industrial fleet

The factors considered that were included in the GLM were: Year; Quarter; demersal Pair trawling and Fishing Rectangle.

Two models were formulated: (a) (CPUE A kg/h) that considers the information of the 6 fishing rectangles with representation in all the years of the period (3554, 3555, 3556, 3655, 3656, 3756) and incorporates an interaction between the year and the fishing area; and (b) a model based on CPUE estimated on fishing days (CPUE A kg/day).

(a) **Model (CPUE A kg/h):** $ln\ (CPUE_{ijkl}) = \mu + Year_i + Quarter_j + Pair\ trawling_k + Fishing\ Rectangle + (Year * Quarter)_{ij} + (Year * Fishing\ rectangle)_{il} + \epsilon_{ijkl}$

(b) **Model (CPUE A kg/día**): $ln\ (CPUEd_{ijk}) = \mu + Year_i + Quarter_j + Pair\ trawling_k + (Year * Quarter)_{ij} + \epsilon_{ijk}$

The trend of each of these indices and their confidence intervals that arise from the application of the respective models are presented in the Figures 11 y 12.

Figure 11. Trend of the standardized annual CPUE (kg/ h) and confidence intervals estimated. Model A kg/h. Period 2004-2016

Figure 12. Trend of the standardized annual CPUE (kg/day) and confidence intervals estimated. Model A kg/day. Period 2004-2016

An index derived from research cruises of coastal demersal species carried out by Argentine vessels in the study area in spring was also used (Table 3). These were carried out with a stratified random design and the average densities of the years 1994, 1998, 1999, 2003 and 2013 were used.

Table 3. Average densities (t/mn^2) of *C. guatucupa* estimated from data from spring research cruises.

Código de Campaña	*Año*	*Densidad media*
		t/mn^2
EH-13/94	1994	9,6
EH-10/98	1998	9,0
EH-09/99	1999	9,4
EH-06/03	2003	5,8
EH-06/13	2013	5,2

Uruguayan industrial fleet

For the Uruguayan industrial fleet, the General Linear Models (GLM) were applied using as basic data the CPUE values corresponding to the haul-to-haul of each tide, expressed in kilograms per trawl hour. To estimate the CPUE, catch data (t) of striped weakfish from the Uruguayan commercial fleet and fishing effort (hs) of the same were used in the period 2002-2016. The models considered the following factors and interactions of the first order:

a) **Model U1**: ln(CPUE) = µ + $Year_i$ + *Month* + *Fishing Rectangle* $_k$ + $Vessel_l$ + $_{ijkl}$
Para este modelo se consideran los lances positivos de pescadilla con el 20% o más de captura.

b) **Model U2**: ln(CPUE) = µ + $Year_i$ + $Trimester_j$ + *Fishing Rectangle* $_k$ + $Vessel_l$ + $(Year{:}Trimester)_{ij}$ + $(Trimester{:}\ Fishing\ Rectangle)_{jk\ +\ ijkl}$

Positive fishing haul of striped weakfish with 30% or more of catch are considered.

The annual mean values of the abundance series according to the models estimated in the GLM are presented in Figure 13.

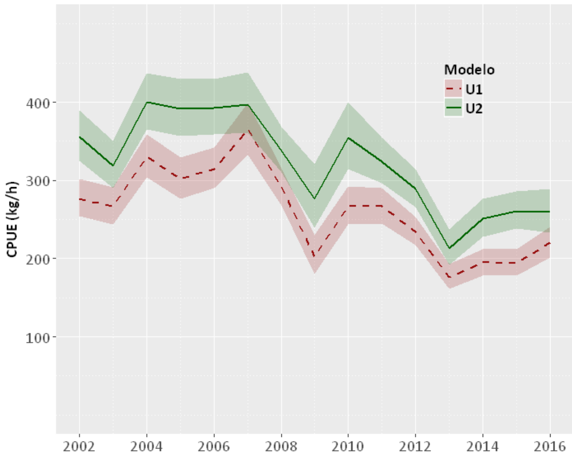


Figure 13. Annual trend of the CPUE (kg/h) of the Uruguayan fleet (U1, U2).

For the purpose of this stock assessment, the CPUE index estimate was incorporated for the first time based on the effort measured in days of fishing trips of the Argentine fleet. This estimate introduces a limitation to the model because the area factor can not be used. For this and other reasons, its application requires further analysis in the future.

After review the different abundance series available and evaluating the different models and adjustments, there was consensus among the researchers to consider that the series that best describes the current situation of the resource is the CPUE kg/h of the Argentine fleet and the U2 model of the Uruguayan fleet series (CPUE kg/h). In order to describe the variations in the stock biomass of striped weakfish, estimate the biologically acceptable catches (CBA) for 2017 and make the projections considering different exploitation scenarios, the logistic model of surplus biomass of Schaefer and the integrated model structured by age was applied. .

Status of fishery resource

1. 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), (Hilborn and Walters, 1992; Polacheck *et al*., 1993).

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.

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*.

Bayesian nonlinear state–space model

The parameters of the model, its uncertainty and the management strategy indicators were estimated with Bayesian methods. These methods allow using in simple way previous information on the parameters to construct the prior distributions. In this statistical framework, the probability of the hypothesis given the data or posterior probability distribution Pr {Hi / dada} was estimated with the following equation:

$$Pr\{H_i/data\} = \frac{L\{data/H_i\}Prior\{H_i\}}{\sum_j L\{data/H_j\}Prior\{H_j\}}$$

The incorporating uncertainty in the natural variability underlying the annual biomass dynamics transitions (process error) and uncertainty in the observed abundance indices due to measurement and sampling error (observation error) is possible calculate using a state–space model (Meyer and Millar, 1999). State–space models relate times series observations {CPUEt} to unobserved "states" $\{B_t\}$ through a stochastic observation model for $CPUE_t$ given B_t. The states are assumed to follow a stochastic transition model. We assumed lognormal error structures and used a reparametrization ($P_t = B_t/K$) by expressing the annual biomass as a proportion of carrying capacity as in Millar and Meyer (1999a) to speed mixing (i.e., sampling over the support of the posterior distribution) of the Gibbs sampler. The state equations are rewritten as:

$$\begin{cases} P_1|\sigma^2 = exp(u_1) \\ P_t|P_{t-1}, r, K, \sigma^2 = \left(P_{t-1} + rP_{t-1}(1-P_{t-1}) - \frac{C_{t-1}}{K}\right) exp(u_t) \\ CPUE_t|P_t, q, \tau^2 = (qKP_t)\, exp(v_t) \end{cases}$$

where u_t are i.i.d. normal with mean 0 and variance σ^2 and v_t are iid normal with mean 0 and variance τ^2 .

Bayesian inference is then based on the posterior distribution of the unobservable given the data. In the sequel, its will denote the probability density function of a parameter q by p(q). We assume that the parameters *K*, *r*, *q*, σ^2, and τ^2 are independent a priori. By a successive application of Bayes theorem and conditional independence of subsequent states, the joint prior density is given by

$$\mathrm{P}(K,r,q,\tau^2,\sigma^2,P_1,...,P_N / CPUE_1,...,CPUE_N)$$
$$\mathrm{P}(K,r,q,\tau^2,\sigma^2,P_1,...,P_N)\mathrm{P}(CPUE_1,...,CPUE$$

$$\mathrm{P}(K,r,q,\tau^2,\sigma^2,P_1,...,P_N) = \mathrm{P}(K)\mathrm{P}(r)\mathrm{P}(q)\mathrm{P}(\tau^2)\mathrm{P}(\sigma^2)\mathrm{P}(P_1,...,P_N)$$

$$\mathrm{P}(P_1,...,P_N) = \mathrm{P}(P_1/\sigma^2)\prod_{t=2}^{t=N}\mathrm{P}(P_t/P_{t-1},K,r,\sigma^2)$$

Because of the conditional independence assumption of the relative abundance indices given the unobserved states, the sampling distribution is:

$$\mathrm{P}(CPUE_1,...,CPUE_N / K,r,q,\tau^2,\sigma^2,P_1,...,P_N) = \prod_{t=1}^{t=N}\mathrm{P}(CPUE_t / q,\tau^2,P_t)$$

Then, by Bayes theorem, the joint posterior distribution of the unobservable given the data, p(K, r, q, σ^2 , τ^2 , P_1,..., P_N| $CPUE_1$,...,$CPUE_N$), is proportional to the joint posterior distribution of all unobservable and observables:

$$\mathrm{P}(K,r,q,\tau^2,\sigma^2,P_1,...,P_N / CPUE_1,...,CPUE_N) \propto$$
$$\mathrm{P}(K)\mathrm{P}(r)\mathrm{P}(q)\mathrm{P}(\tau^2)\mathrm{P}(\sigma^2)\mathrm{P}(P_1/\sigma^2)\prod_{t=2}^{t=N}\mathrm{P}(P_t/P_{t-1},K,r,\sigma^2)\prod_{t=1}^{t=N}$$

A no -informative prior is chosen for q. Lognormal prior distributions for K, r and inverse-gamma for σ^2, τ^2 are specified using biological knowledge.

The posterior probability distribution of carrying capacity, the intrinsic growth rate, catchability coefficient, σ^2, τ^2, the current biomass (2017) was estimated. The posterior probability distributions of the parameters were estimated with simulations of the Markov-Monte Carlo chains (MCMC). A total of 100,000 simulations were made using the OpenBUGS software with an initial "*burn-in*" period of 50,000 iterations.

Results

Figure 14 shows the total landed catches of striped weakfish in the Treaty area by Argentina and Uruguay and the indices of abundance considered.

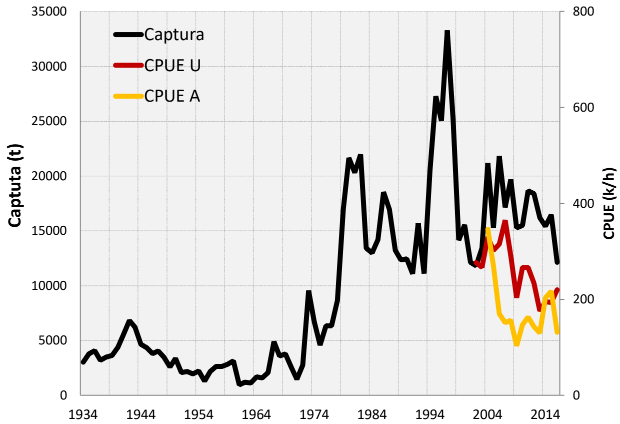


Figure 14. Trend of the standardized CPUE (kg/h) and total catch landed of striped weakfish in the ZCP, jurisdictional waters and Rio de la Plata declared by both countries. CPUE Uruguayan fleet (2002-2016) and index of the Argentine fleet (2004-2014).

Schaefer model fit to the CPUE (kg/h) data is presented in Figure 15.

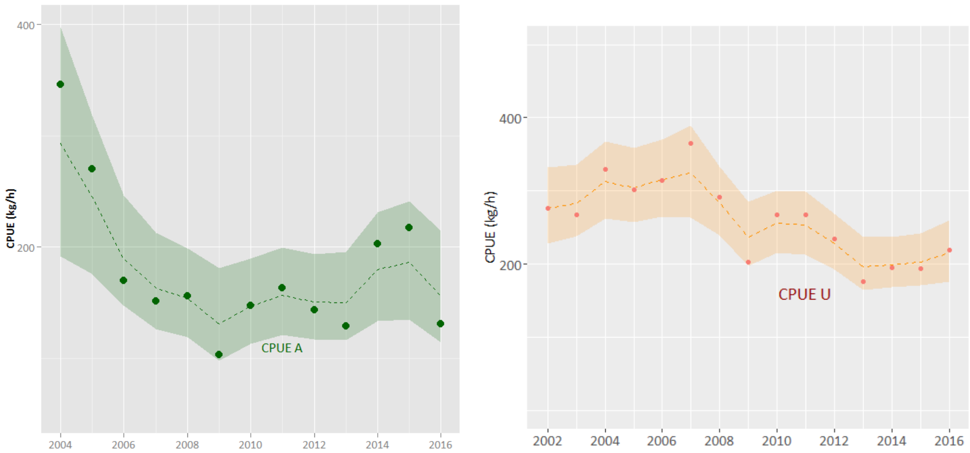


Figure 15. Catch-per-unit-effort (CPUE) indices of abundance CPUE (Kg/h) observed (crosses) and predicted (solid line) in the base case runs for surplus model. CPUE A (2004-2016). CPUE U (2002-2016).

The estimates of the model parameters are presented in Table 4. The K estimates were 297,600 t ($IP_{95\%}$ from 198,600 t to 448,400 t) for Argentine CPUE series and 308,000 t (IP95% from 227,400 t to 428,500 t) for Uruguayan CPUE series.

Table 4. Parameter estimated Surplus Model: *K* carrying capacity, *r* rate of growth; *q* coefficient catchability, σ^2: variance of the model error, τ^2: CPUE variance. A) Argentine CPUE series. B) Uruguayan CPUE series.

	Media	Desvío	MC_error	Percentil 2,5	Mediana	Percentil 97,5
A						
r	0,28	0,08	0,00	0,19	0,27	0,39
K	297.600	64.230	1.530	198.600	289.000	448.400
q	0,00125	0,00014	0,00000	0,00108	0,00124	0,00143
σ^2	0,04081	0,02524	0,00046	0,01315	0,03624	0,07374
τ^2	0,04454	0,03853	0,00040	0,01116	0,03422	0,08876
U						
r	0,29	0,09	0	0,15	0,27	0,49
K	308.000	51.580	1.294	227.400	300.700	428.500
q	0,0013	0,0001	0	0,0010	0,0012	0,0016
σ^2	0,02	0,01	0	0	0,02	0,05
τ^2	0,02	0,01	0	0	0,01	0,04

Total biomass in 2017 estimates was 133,500 t (IP95% from 88,700 t to 193,300 t) for Argentine CPUE series and 181,600 t (IP95% from 133,200 t to 236,600 t) for Uruguayan CPUE fleet (Table 5, Figures 16 and 17).

Table 5. MSY: Maximum sustainable yield, CR*2017*: replacement yield, stock biomass giving MSY (B_{MSY}), B_{2016}, biomass estimated to 2017, B_{2017}/B_{RMS}: ratio of final-year biomass to biomass at MSY, B_{2017}/K: ratio of final-year biomass to carrying capacity, F_{RMS} fishing mortality rate at MSY. A) serie de CPUE flota argentina. B) serie de CPUE flota uruguaya.

	Media	Desvío	MC_error	Percentil 2.5	Mediana	Percentil 97.5
A						
MSY	20.470	5.112	77,53	12.330	19.850	32.330
CR_{2017}	18.860	4.851	65,51	13.190	18.350	25.220
B_{2017}	133.500	26.660	272.5	88.700	130.800	193.300
B_{RMS}	148.800	32.120	765	99.300	144.500	224.200
B_{2017}/B_{MSY}	0,8864	0,2457	0,0052	0,4888	0,8581	1,445
B_{2017}/K	0,4665	0,1257	0,002693	0,2548	4,55E-01	0,7415
F_{MSY}	1,41E-01	3,80E-02	6,97E-04	0,0951	0,1372	0,1945
U						
MSY	21.400	5.345	87,5	12.850	20.730	33.850
CR_{2017}	19.250	4.581	62,66	11.300	18.880	29.450
B_{2017}	181.600	26.450	357,5	133.200	180.300	236.600
B_{MSY}	154.000	25.790	647,1	113.700	150.400	214.200
B_{2017}/B_{MSY}	1,20	0,22	0,01	0,77	1,21	1,63
B_{2017}/K	0,60	0,11	0	0,38	0,60	0,81
F_{MSY}	0,14	0,04	0	0,08	0,14	0,24

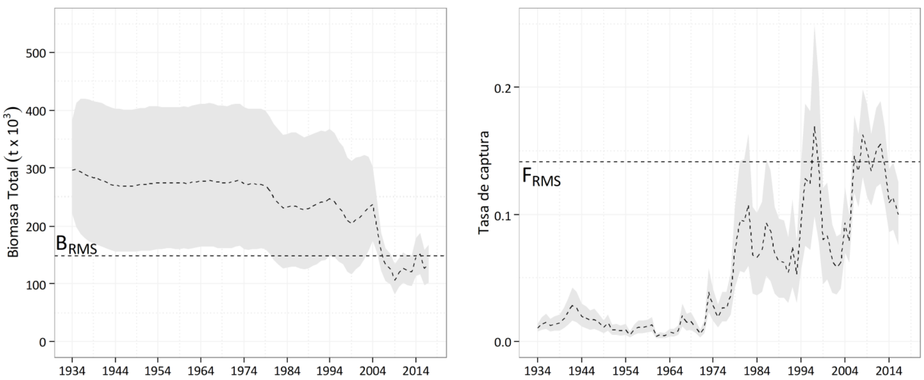


Figure 16. Trend of total biomass (thousands of tons) and exploitation rate. The shaded band indicates the 95% probability interval. The horizontal lines indicate B_{MYS} (148.800 t) y F_{MSY} (0,14). Argentine CPUE.

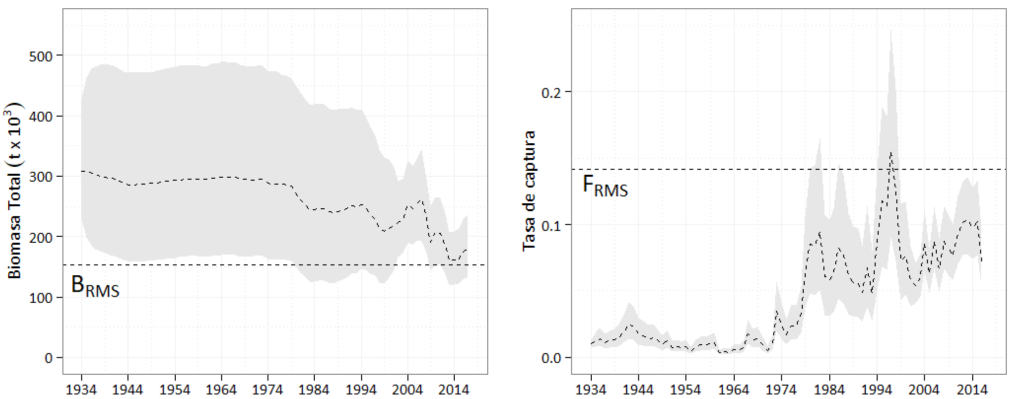


Figure 17. Trend of total biomass (thousands of tons) and exploitation rate. The shaded band indicates the 95% probability interval. The horizontal lines indicate B_{MYS} (154.000 t) y F_{MSY} (0,14). Uruguayan CPUE.

2 Integrated age - structured model.

An integrated age - structured model was applied in the *Stock Synthesis* (SS3). Stock Synthesis provides a statistical framework for calibration of a population dynamics model using a diversity of fishery and survey data. It is designed to accommodate both age and size structure in the population and with multiple stock sub-areas. Selectivity can be cast as age specific only, size-specific in the observations only, or size-specific with the ability to catch the major effect of size-specific survivorship. The overall model contains subcomponents which simulate the population dynamics of the stock and fisheries, derive the expected values for the various observed data, and quantify the magnitude of difference between observed and expected data. Some SS features include ageing error, growth estimation, spawner-recruitment relationship, movement between areas. SS is most flexible in its ability to utilize a wide diversity of age, size, and aggregate data from fisheries and surveys. The ADMB C++ software in which SS3 is written searches for the set of parameter values that maximize the goodness-of-fit, then calculates the variance of these parameters using inverse Hessian and MCMC methods. A management layer is also included in the model allowing uncertainty in estimated parameters to be propagated to the management quantities, thus facilitating a description of the risk of various possible management scenarios, including forecasts of possible annual catch limits. The structure of Stock Synthesis allows for building of simple to complex models depending upon the data available.

The basic information used in the application of the age-structured models is detailed below:

- 12 age classes, with the last class corresponding to a plus group (12+);
- Individual growth parameters of Von Bertalanffy : L_{inf} = 52,06*;* *k* = 0,226*;* t_0*:* -1,148.
- Instantaneous rate of natural mortality (M) 0.30
- Parameters of the length-weight relationship: a = 0.002228 and b = 3.173278.
- Ratio mature females to age group: 0; 0,25; 0,50; 0,80; 1; 1, 1, 1, 1, 1, 1, 1.
- Age distributions from the samplings of Argentine fleet: data of 1982, period 2009-2015.
- Length distributions from annual landing samples in 1992-1997 y 2001-2016 periods.
- Reporter catch: official fishing statistics, the annual landings declared of striped weakfish between 1874 and 2016

The basic assumptions considered in the models were the following:

- von Bertalanffy growth curve
- Beverton and Holt's yield per recruit models, including annual LogNormal error variability take into account a deviation of 0.4. The R_0 parameter (recruitment at the beginning of the period) was estimated in the model and different exercises were performed according to the value of the *h* (steepness) parameter. This last parameter was estimated using a priori information (normal distribution, mean value of h = 0.82 and deviation: 0.1). The a priori information for the estimation of the parameter h was estimated from biological information of the species using the method of Mangel *et al*., (2009).
- The year 1874 (year of the founding of Mar del Plata city) was considered, year that is considered a structure in equilibrium of the population and the beginning of the model.
- The vulnerability or selection pattern was considered logistic for both indices of abundance. These patterns were estimated in two periods: 1874-1983 and 1984-2016.
- Minimum observation error in the total catches of the species (CV = 0.01).
- Proportional relationship between biomass and indices (fleet and cruises), with an error of type LogNormal
- Coefficient of variation associated with the fleet index. Period 2004-2016: this value arises from considering an average CV of 0.2 and the standard annual errors of the GLM used to estimate the index, in order to re-escalate the variability of the CV.
- Coefficient of variation associated with the cruises index with an average CV of 0.3 in the years 1994, 1998, 1999, 2003 and 2013.
- Parameter *h* (steepness) prior or *h* free

Results

Figures 18 to 21 show the fit of the indices of abundance, the trends of total and spawning biomass, recruitment, stock-recruitment relationship, instantaneous rates of fishing mortality, vulnerability patterns and the fit to the lengths and ages distributions for each exercise performed. The main results for each of the models are presented in Table 6.

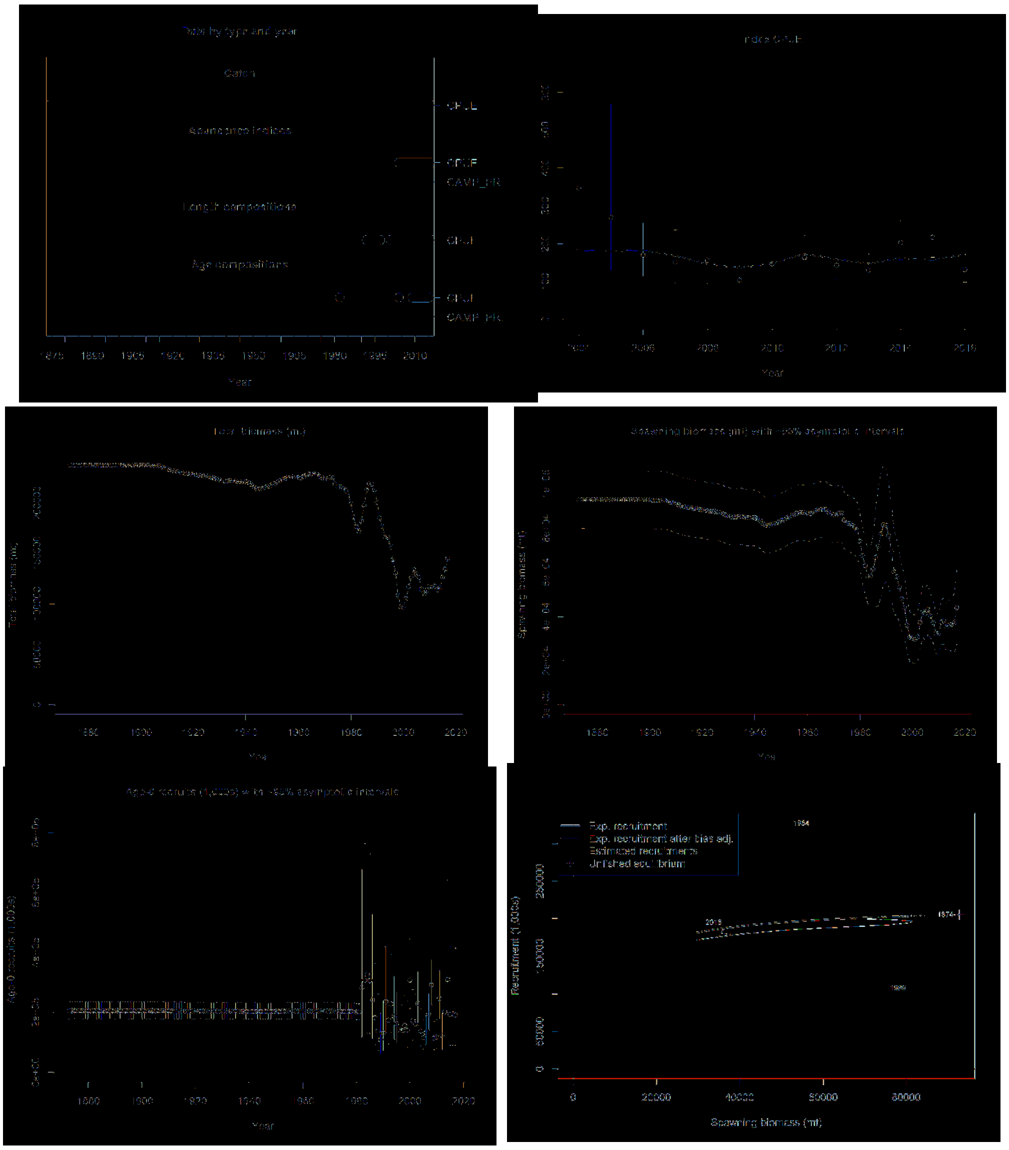


Figure 18. Model CPUE A (kg/h) of striped weakfish. Fit to the index; trend of total and spawning biomass, recruitment (with associated uncertainty) and stock-recruit relationship.

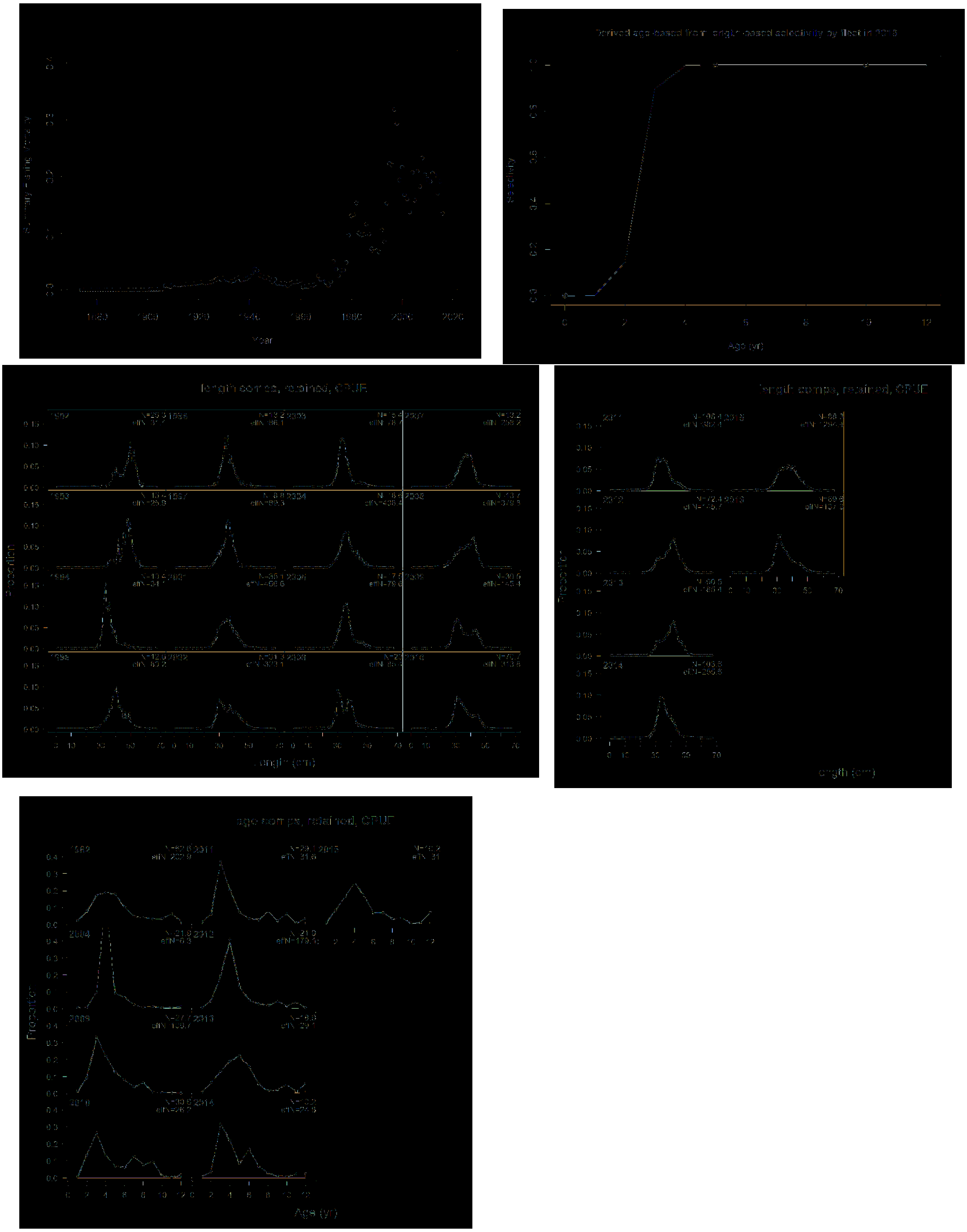


Figure 19. Model CPUE A (kg/h) of striped weakfish. Instantaneous fishing mortality rates with associated uncertainty, vulnerability pattern and fit to the lengths and age distributions.

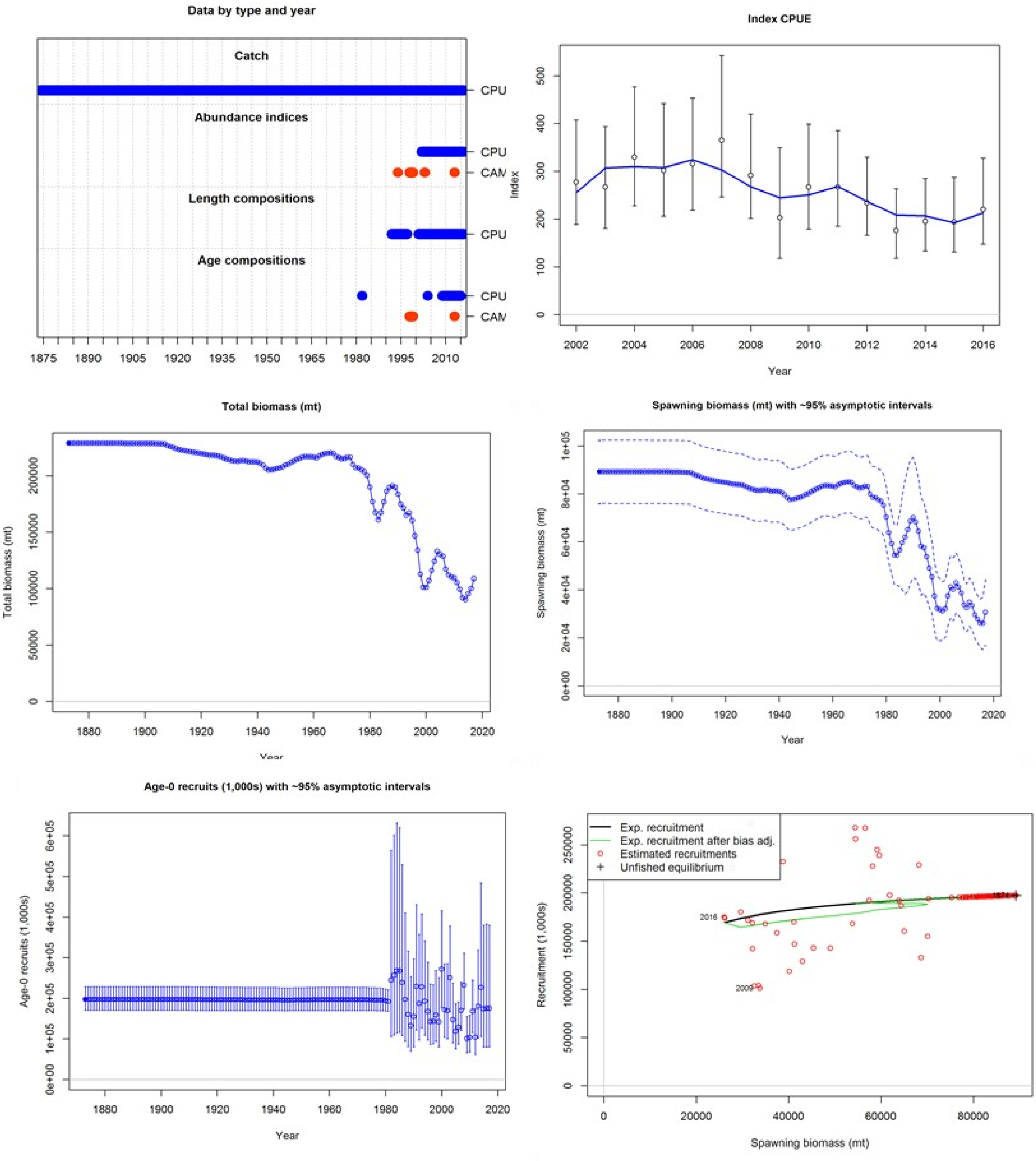


Figure 20. Model CPUE U (kg/h) of striped weakfish. Fit to the index; trend of total and spawning biomass, recruitment (with associated uncertainty) and stock-recruit relationship.

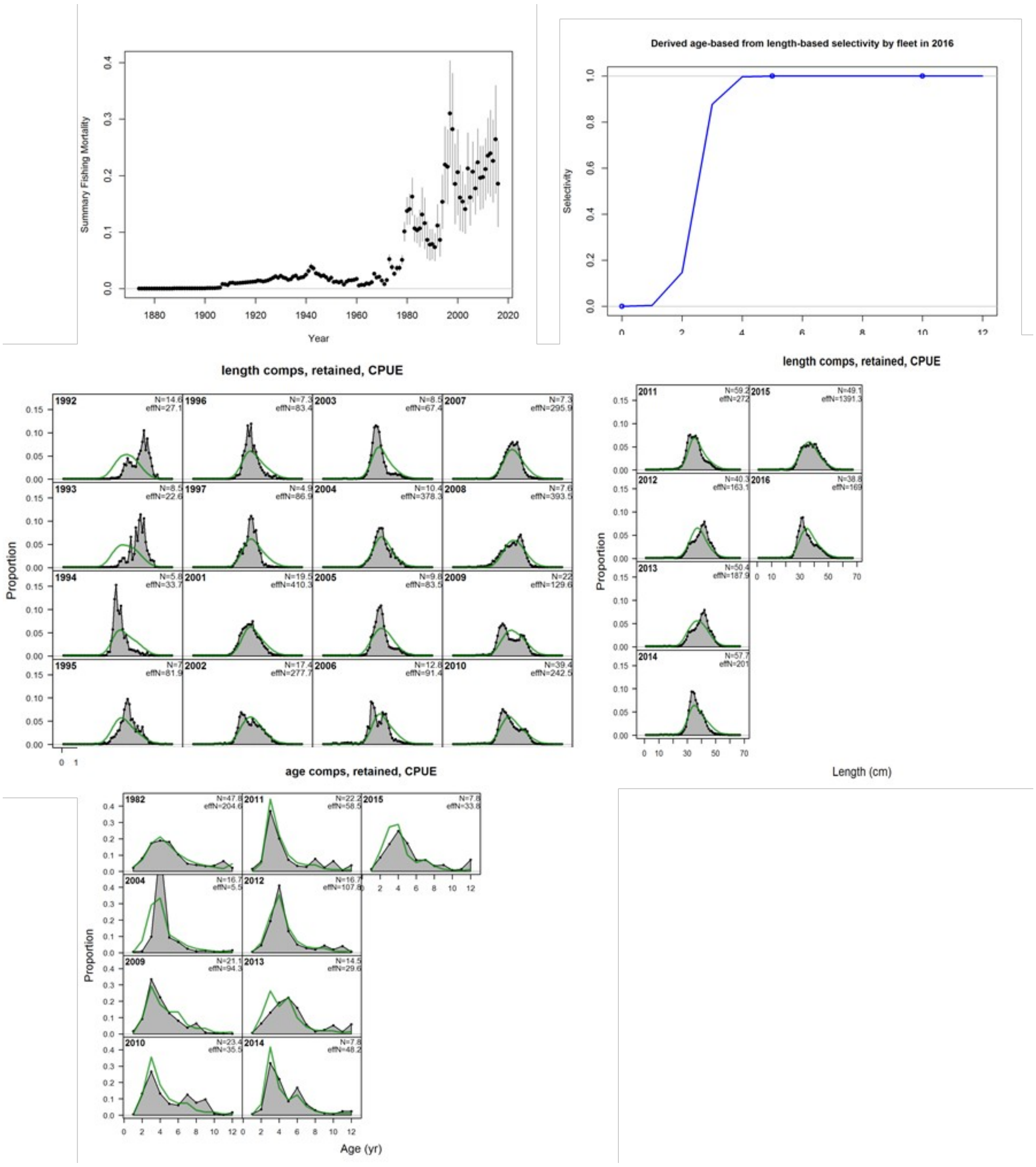


Figure 21. Model CPUE U (kg/h) of striped weakfish. Instantaneous fishing mortality rates with associated uncertainty, vulnerability pattern and fit to the lengths and age distributions.

The total biomass in 2016 resulting from the application of the integrated stock assessment models with the different indices of abundance were estimated between 71,000 and 134,000 t and the spawning biomasses between 18,000 and 37,000 t. The ratio between the spawning biomass in 2016 and the virgin spawning biomass is between 0.21 and 0.40 according to the index used. For the index of the Argentine industrial fleet the (CPUE A kg/h) ratio BD_{2016}/BDV is above (0.4) of the biological reference point (BRP: SB_{2016}/SBV = 0.3); for the index of the Argentine fleet based on days, this ratio would be below the BRP (0.21), while the model based on the Uruguayan index indicates an intermediate value close to the BRP (0.29) (Table 6).

Table 6. Main results obtained from the fit of the integrated models. *h*: 'steepness' of the stock–recruit relationship; Biomass final year (B_{2016}), Virgin Biomass (VB), Spawning Biomass final year (SB_{2016}), Virgin Spawn Biomass (VSB), Depletion: relationship between BR_{2016}/BRV, f_{2016}: proportional factor of the annual fishing mortality rate in 2016 for each of the models.

Variables	CPUE A kg/h Cruises	CPUE U kg/h Cruises
VB (t)	237.953	228.781
B_{2016} (t)	134.532	100.034
SBV(t)	92.791	89.214
SB_{2016} (t)	37.199	26.054
B_{2016}/VB	0.57	0,44
SB_{2016}/SBV	0.40	0,29
h	0,80	0,79
f	0,14	0,20

Risk analysis and biomass projections

Surplus production model

The total biomass projections from 2017 to 2031 for different levels of constant catch from the estimates of the surplus model with the Argentine fleet index are presented in Figure 22 and Table 7. Maintaining constant catch levels between 12,125 t values (corresponding to the catch made in the Treaty area in 2016) and 17,247 t (decrease of 15% of the MSY) the projections of biomass to 15 years would remain above the BRP (B_{MSY}) from the year 2023. The risk of not reaching the BRP value for each increment constant catch is presented in Table 8.

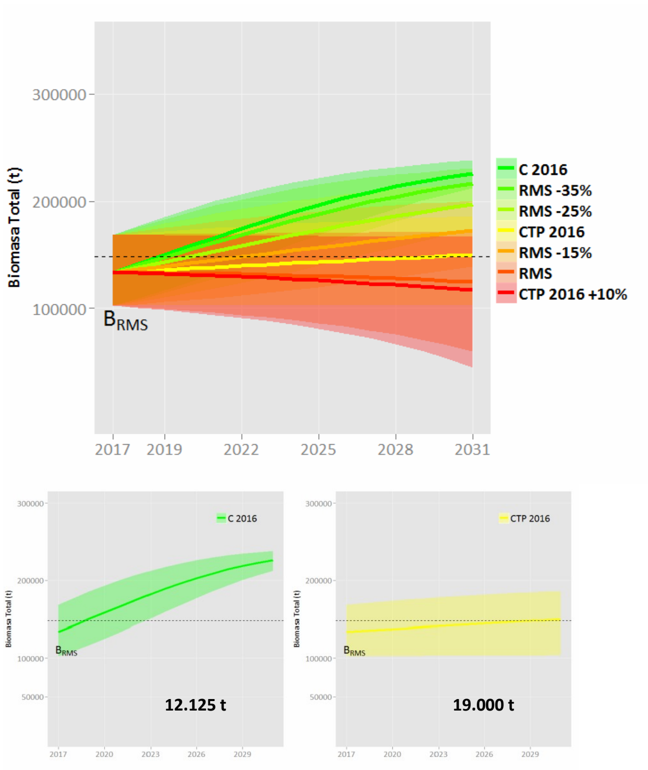


Figure 22. Total biomass values projected for striped weakfish considering: a) constant decrease (-15% to 35% with intervals of 10%) with respect to the catch value of the MSY (20,470 t), b) total catch 2016 (12,125 t), c) the value of TAC for 2016 (19,000 t) and d) increase of 10% of the value of the TAC (20,900 t). B_{MSY} = 148,800 t. Argentine CPUE series.

Table 7. Total biomass values of striped weakfish (t) projected increasing from 15% to 35% of the MSY, the catch corresponding to 2016 in the Treaty area, the TAC for 2016 and the increase of the same by 10%. Index of abundance Argentine fleet. Green highlights the total biomass values that exceed the B_{MSY} (148,800 t).

	MSY -15%	MSY -25%	MSY -35%	C2016	TAC 2016	TAC 2016 +10%	MSY
Catch (t)	**17.247**	**15.218**	**13.189**	**12.125**	**19.000**	**20.900**	**20.290**
2018	136.427	138.474	140.521	141.701	134.826	132.926	133.356
2019	139.266	143.405	147.535	149.913	136.025	132.171	133.044
2020	142.149	148.399	154.608	158.170	137.234	131.367	132.698
2021	145.061	153.416	161.657	166.357	138.447	130.501	132.309
2022	147.987	158.417	168.600	174.363	139.656	129.561	131.866
2023	150.914	163.360	175.359	182.082	140.857	128.532	131.359
2024	153.827	168.208	181.860	189.422	142.042	127.407	130.780
2025	156.712	172.924	188.042	196.305	143.206	126.186	130.133
2026	159.556	177.475	193.853	202.674	144.354	124.860	129.413
2027	162.346	181.832	199.255	208.493	145.482	123.434	128.619
2028	165.076	185.970	204.223	213.745	146.588	121.923	127.760
2029	167.734	189.873	208.745	218.430	147.667	120.351	126.849
2030	170.313	193.526	212.823	222.565	148.726	118.718	125.909
2031	172.805	196.921	216.467	226.179	149.761	117.038	124.932

Table 8. Risk associated to the B_{MSY} taking into account the projections of total biomass of striped weakfish in different scenarios of constant rates of catch extraction. Index of abundance Argentine fleet.

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
B_{MSY}														
MSY -15%	0,70	0,66	0,61	0,56	0,50	0,45	0,40	0,35	0,31	0,27	0,23	0,20	0,17	0,15
MSY -25%	0,68	0,60	0,52	0,44	0,35	0,28	0,22	0,16	0,12	0,09	0,06	0,05	0,04	0,03
MSY -35%	0,65	0,54	0,43	0,32	0,22	0,14	0,09	0,05	0,03	0,02	0,01	0,01	0,01	0
C2016	0,64	0,50	0,37	0,25	0,16	0,09	0,05	0,03	0,01	0,01	0	0	0	0
TAC 2016	0,72	0,70	0,67	0,64	0,62	0,59	0,56	0,53	0,50	0,47	0,45	0,43	0,40	0,38
TAC 2016 +10%	0,74	0,74	0,74	0,73	0,73	0,73	0,73	0,73	0,72	0,72	0,72	0,72	0,72	0,72
MSY	0,74	0,73	0,72	0,72	0,71	0,70	0,69	0,69	0,68	0,67	0,67	0,66	0,65	0,64

Figure 23 and Table 9 show the 15-year projections of the total biomass with the Uruguayan fleet CPUE. The results indicate that constant catch levels equal to the value of the MSY (21,400 t), the projections of the average total biomass remain above the BRP (B_{MSY}) with a constant tendency and with an average risk of falling below said point of 0.11 (Table 9). Considering an increase of 15% of the MSY, the biomass decreases until falling below the BRP in the year 2026. The risks associated with the different levels of constant catch considered for the projection are presented in Table 10.

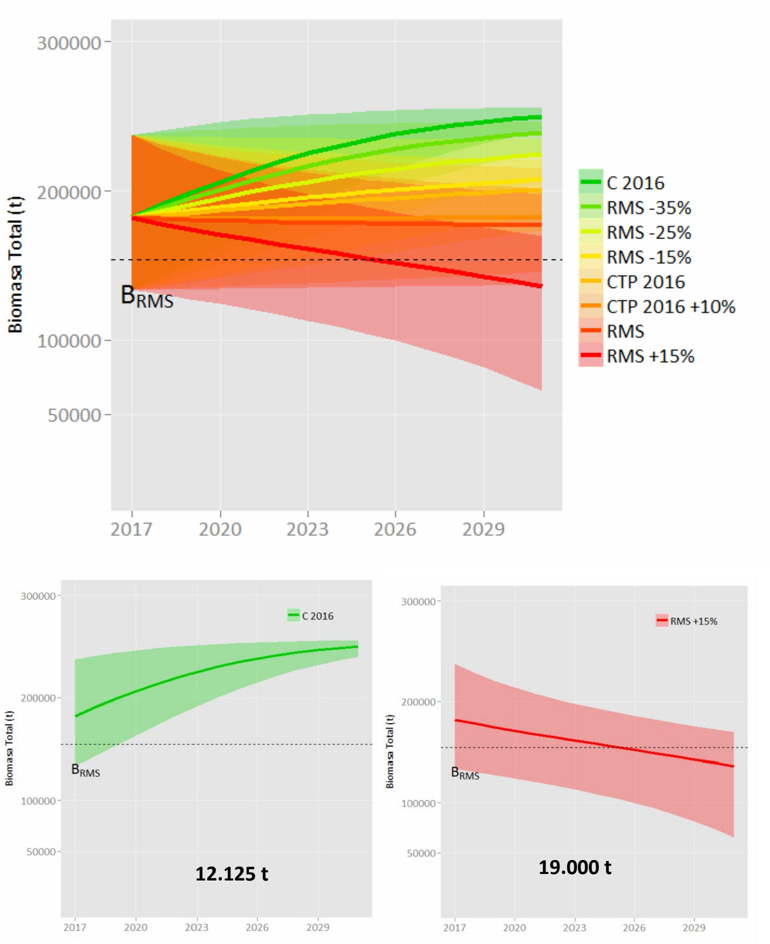


Figura 23. Total biomass values projected for striped weakfish considering: a) constant decrease (-15% to 35% with intervals of 10%) with respect to the catch value of the MSY (20,470 t), b) total catch 2016 (12,125 t), c) the value of TAC for 2016 (19,000 t) and d) increase of 10% of the value of the TAC (20,900 t). Uruguayan CPUE series.

Table 9. Total biomass values of striped weakfish (t) projected increasing from 15% to 35% of the MSY, the catch corresponding to 2016 in the Treaty area, the TAC for 2016 and the increase of the same by 10%. In red, the biomass values lower than the BMSY (154,000 t) are highlighted.

	C 2016	RMS -35%	RMS -25%	RMS -15%	CTP 2016	CTP 2016 +10%	RMS	RMS +15%
Captura (t)	12.125	13.910	16.050	18.190	19.000	20.900	21.400	24.610
2017	181.600	181.600	181.600	181.600	181.600	181.600	181.600	181.600
2018	190.457	188.672	186.532	184.392	183.582	181.682	181.182	177.972
2019	198.517	195.065	190.918	186.763	185.188	181.489	180.514	174.247
2020	206.050	201.083	195.093	189.062	186.768	181.367	179.940	170.728
2021	212.987	206.683	199.031	191.275	188.312	181.302	179.443	167.367
2022	219.285	211.834	202.718	193.395	189.811	181.283	179.010	164.127
2023	224.925	216.521	206.140	195.412	191.257	181.302	178.632	160.974
2024	229.913	220.741	209.294	197.323	192.647	181.353	178.301	157.880
2025	234.273	224.505	212.180	199.123	193.976	181.429	178.011	154.819
2026	238.042	227.832	214.802	200.812	195.242	181.526	177.756	151.764
2027	241.271	230.747	217.169	202.389	196.442	181.641	177.531	148.693
2028	244.012	233.284	219.294	203.855	197.576	181.769	177.332	145.583
2029	246.322	235.475	221.190	205.213	198.644	181.908	177.157	142.408
2030	248.255	237.357	222.874	206.466	199.647	182.057	177.002	139.152
2031	249.864	238.965	224.362	207.617	200.584	182.211	176.864	135.800

Table 10. Risk associated to the B_{MSY} taking into account the projections of total biomass of striped weakfish in different scenarios of constant rates of catch extraction. Index of abundance Uruguayan fleet.

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
B_{MSY}															
C 2016	0,14	0,07	0,03	0,01	0	0	0	0	0	0	0	0	0	0	0
MSY -35%	0,14	0,08	0,04	0,02	0,01	0	0	0	0	0	0	0	0	0	0
MSY -25%	0,14	0,09	0,06	0,04	0,02	0,01	0,01	0	0	0	0	0	0	0	0
MSY -15%	0,14	0,11	0,08	0,06	0,05	0,03	0,02	0,02	0,01	0,01	0,01	0	0	0	0
TAC 2016	0,14	0,12	0,09	0,08	0,06	0,05	0,04	0,03	0,02	0,02	0,01	0,01	0,01	0,01	0
TAC 2016 +10%	0,14	0,13	0,12	0,12	0,11	0,10	0,09	0,08	0,08	0,07	0,07	0,06	0,06	0,05	0,05
MSY	0,14	0,14	0,13	0,13	0,12	0,12	0,11	0,11	0,10	0,10	0,09	0,09	0,09	0,08	0,08
MSY + 15%	0,14	0,17	0,20	0,23	0,26	0,30	0,34	0,39	0,43	0,48	0,53	0,58	0,64	0,69	0,75

Kobe plot

History of the fishery and current status

In the Kobe phase diagram it was observed that, for the Argentine series would indicate values of Ft <F_{MSY}, while the values of total biomass estimates for 2016 (B_{2016}) are lower than the B_{MSY}. With the results of the estimation of total biomass from the CPUE of the Uruguayan fleet, the biomass estimated for 2016, the population would be at low levels of fishing mortality (Ft <F_{MSY}) and higher total biomass in relation to the B_{MSY} (Fig. 24). The variability associated with biomass and the corresponding total effort is presented for the estimation of 2016. The isolines correspond to intervals of 10% probability.

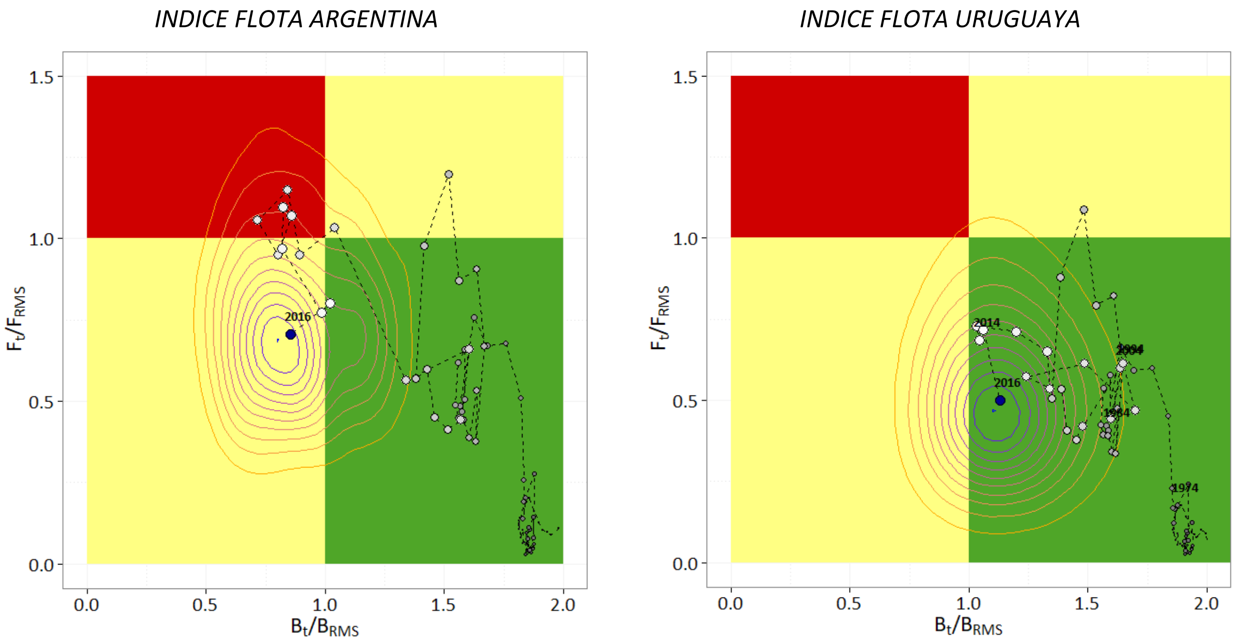
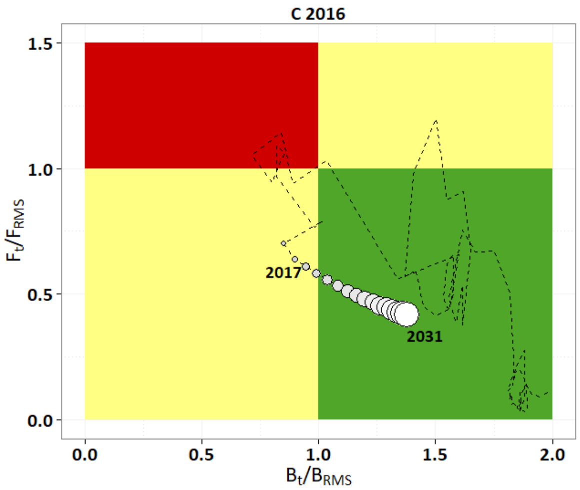


Figure 24. Trend and current status of the striped weakfish. CPUE A and CPUE U.

Projections based on information from the Argentine fleet

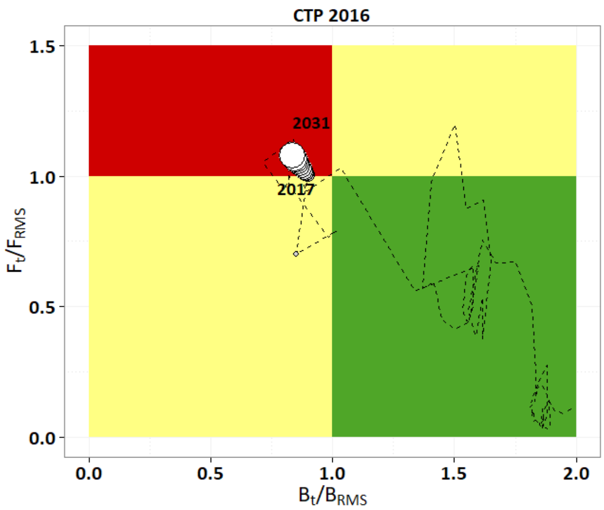
Figure 25 shows the estimated trajectories of the total biomasses and the catch rates with the catch made in 2016 and the TAC 2016. The projection with the catch made in 2016, the fishing mortality decreases and the biomass increases, maintaining in the area that does not indicate current overfishing or overexploitation by the year 2031. On the other hand, with catch values of 19,000 t, in 2031 the population would be found in values of F> F_{MSY} and BT <B_{MSY}.

The population's probability of reaching or maintaining a state of non-overfishing and overexploitation of the Kobe diagram ($F < F_{MSY}$ and $BT > B_{MSY}$) for the different levels of fishing mortality and future constant catch is presented. With 19,000 t of constant catch, the probability of being in the green quadrant begins at low levels, but with an increasing tendency. With this level of catch the population would recover above the BRP, but not as quickly as if they were considered lower values.



Captura 2016

	B>Brms	F<Frms	B>Brms F<Frms	B>Brms F>Frms	B<Brms F<Frms	B<Brms F>Frms
2017	0,26	0,98	0,26	0,00	0,73	0,02
2018	0,36	0,99	0,36	0,00	0,63	0,01
2019	0,50	0,99	0,50	0,00	0,50	0,01
2020	0,63	1,00	0,63	0,00	0,37	0,00
2021	0,75	1,00	0,75	0,00	0,25	0,00
2022	0,84	1,00	0,84	0,00	0,15	0,00
2023	0,91	1,00	0,91	0,00	0,09	0,00
2024	0,95	1,00	0,95	0,00	0,05	0,00
2025	0,97	1,00	0,97	0,00	0,03	0,00
2026	0,99	1,00	0,99	0,00	0,01	0,00
2027	0,99	1,00	0,99	0,00	0,01	0,00
2028	1,00	1,00	1,00	0,00	0,00	0,00
2029	1,00	1,00	1,00	0,00	0,00	0,00
2030	1,00	1,00	1,00	0,00	0,00	0,00
2031	1,00	1,00	1,00	0,00	0,00	0,00



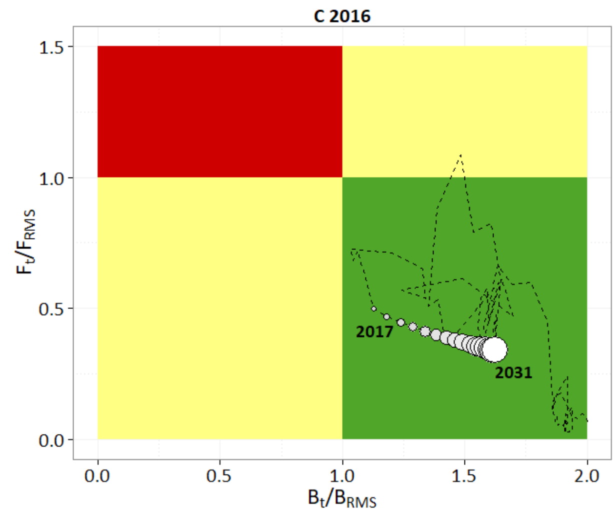
CTP 2016

	$B>B_{RMS}$	$F<F_{RMS}$	$B>B_{RMS}$ $F<F_{RMS}$	$B>B_{RMS}$ $F>F_{RMS}$	$B<B_{RMS}$ $F<F_{RMS}$	$B<B_{RMS}$ $F>F_{RMS}$
2017	0,26	0,45	0,26	0,00	0,19	0,55
2018	0,28	0,48	0,28	0,00	0,20	0,52
2019	0,30	0,51	0,30	0,00	0,20	0,49
2020	0,33	0,53	0,33	0,00	0,20	0,47
2021	0,36	0,56	0,36	0,00	0,20	0,44
2022	0,38	0,58	0,38	0,00	0,20	0,42
2023	0,41	0,61	0,41	0,00	0,20	0,39
2024	0,44	0,63	0,44	0,00	0,19	0,37
2025	0,47	0,65	0,47	0,00	0,19	0,35
2026	0,50	0,67	0,50	0,00	0,18	0,33
2027	0,53	0,69	0,53	0,00	0,17	0,31
2028	0,55	0,71	0,55	0,00	0,16	0,29
2029	0,57	0,72	0,57	0,00	0,15	0,28
2030	0,60	0,74	0,60	0,00	0,14	0,26
2031	0,62	0,75	0,62	0,00	0,13	0,25

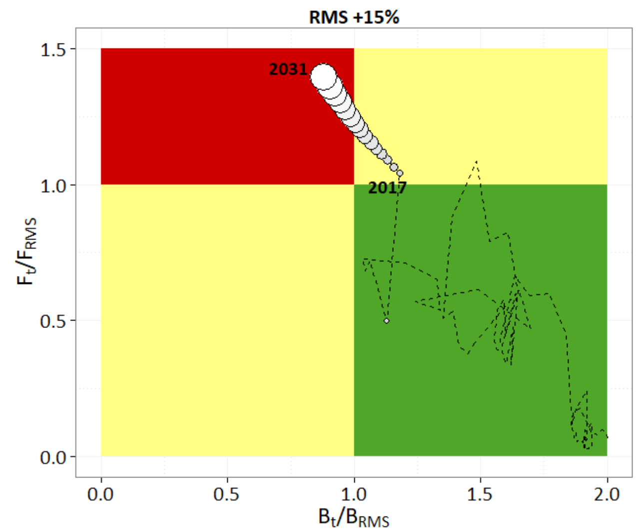
Figura 25. Kobe diagram. Total biomass (B/B_{MSY}) and fishing mortality (F/F_{MSY}) projections respect to the MSY estimated by the surplus production model. A constant catch of 12,125 t and 19,000 t was considered. Index A Argentine fleet.

Projections based on information from the Uruguayan fleet

With constant catches equal to that of 2016, fishing mortality would continue to decrease and biomass increase ($Ft < F_{RMS}$ and $Bt > B_{RMS}$) (Fig. 26). Considering 24,600 t of constant catch, the probability increases year by year that the fishing mortality is higher than the reference value and the biomass less than the B_{MSY}.



	$B>B_{RMS}$	$F<F_{RMS}$	$B>B_{RMS}$ $F<F_{RMS}$	$B>B_{RMS}$ $F>F_{RMS}$	$B<B_{RMS}$ $F<F_{RMS}$	$B<B_{RMS}$ $F>F_{RMS}$
2017	0,86	1	0,86	0	0,14	0
2018	0,93	1	0,93	0	0,07	0
2019	0,97	1	0,97	0	0,03	0
2020	0,99	1	0,99	0	0,01	0
2021	1	1	1	0	0	0
2022	1	1	1	0	0	0
2023	1	1	1	0	0	0
2024	1	1	1	0	0	0
2025	1	1	1	0	0	0
2026	1	1	1	0	0	0
2027	1	1	1	0	0	0
2028	1	1	1	0	0	0
2029	1	1	1	0	0	0
2030	1	1	1	0	0	0
2031	1	1	1	0	0	0



	$B>B_{RMS}$	$F<F_{RMS}$	$B>B_{RMS}$ $F<F_{RMS}$	$B>B_{RMS}$ $F>F_{RMS}$	$B<B_{RMS}$ $F<F_{RMS}$	$B<B_{RMS}$ $F>F_{RMS}$
2017	0,86	0,63	0,63	0,23	0	0,14
2018	0,83	0,58	0,58	0,25	0	0,17
2019	0,80	0,53	0,53	0,27	0	0,20
2020	0,77	0,49	0,49	0,28	0	0,23
2021	0,74	0,43	0,43	0,31	0	0,26
2022	0,70	0,38	0,38	0,32	0	0,30
2023	0,66	0,32	0,32	0,34	0	0,34
2024	0,61	0,27	0,27	0,35	0	0,39
2025	0,57	0,21	0,21	0,35	0	0,43
2026	0,52	0,16	0,16	0,36	0	0,48
2027	0,47	0,12	0,12	0,35	0	0,53
2028	0,42	0,08	0,08	0,34	0	0,58
2029	0,36	0,05	0,05	0,31	0	0,64
2030	0,31	0,03	0,03	0,28	0	0,69
2031	0,25	0,01	0,01	0,24	0	0,75

Figure 26. Kobe diagram. Total biomass (B/B_{MSY}) and fishing mortality (F/F_{MSY}) projections respect to the MSY estimated by the surplus production model. A constant catch of 12,125 t and 24.600 t was considered. Index U Uruguayan fleet.

2. Age – structured model

Based on the results of the stock assessment, projections of abundance and yields were made under a long-term management objective that allows reaching an abundance of reproductive equal to or greater than 30% of the reproductive biomass existing at the beginning of the exploitation (virgin reproductive biomass, VRB).

To measure sustainability in the long term (15 years), different extraction levels were simulated, based on different factors that multiply the selection pattern to obtain instantaneous fishing mortality rates by age.

In order to measure the risk, simulations were carried out starting from the state of the resource at the beginning of 2016. The proportionality of the annual fishing mortality rate, the total biomass, the number of individuals by age, the weight by age to start of the year, the average weight by age and the selection pattern resulting from the adjustment of the model. The spawning biomass and the mean, minimum (R_{min}) and maximum (R_{max}) recruitment value of the whole period were also used. Uncertainty was incorporated into the analysis by randomly generating recruitment values in each simulation, based on the mean value and deviation estimated in the diagnosis under the assumption of a LogNormal distribution. In this way, the CBA is determined, which allows the population to be kept at such levels that the risk of reaching the PBR defined above is lower than 10%.

The constant yield projections of the different stock assessment model and CPUE used with the associated uncertainty are presented in Figures 27 and 28. It is observed that when applying the CPUE A index with the effort expressed in hours, the current state of the resource as the projections are located above the PBR.

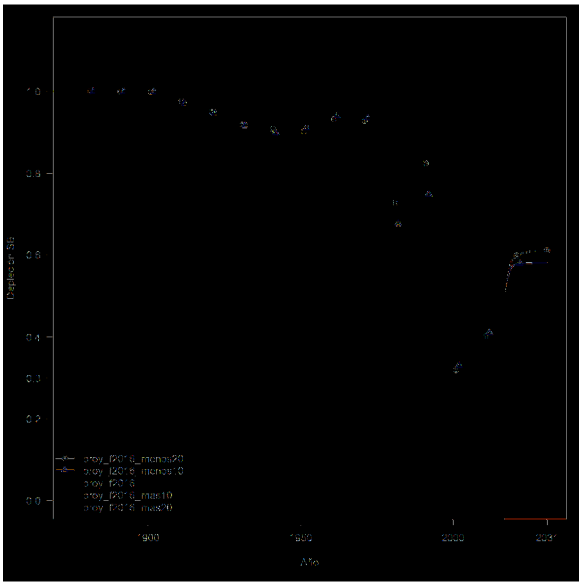


Figure 27. Spawning biomass depletion estimated by the model with CPUE index A kg/h and research cruises.

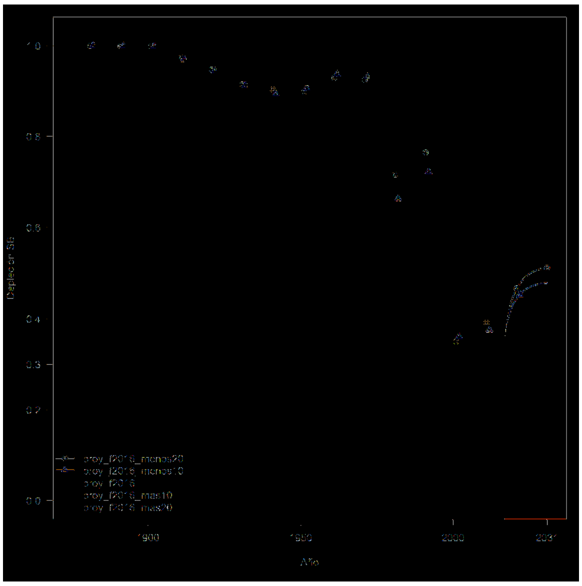


Figure 28. Spawning biomass depletion estimated by the model with CPUE index U kg/h and research cruises.

Synthesis of the results and management

After reviewing the different abundance series available and assess the different models and fits, the GT- COSTERO agreed to base the recommendations on CBA for the establishment of TACs for stripped weakfish in 2017, in the values presented in the table follow:

	Modelo Global*		Modelo integral**	
Índices	**RMS**	**CR_{2017}**	***BRLP > 0,3 BRV***	
U - campañas	**21.400**	**19.250**	**14.470**	
A – campañas	**20.470**	**18.860**	**20.132**	
U - campañas	RMS	21.400	BV(t)	228.781
	CR_{2017}	19.250	B_{2016} (t)	100.034
	B_{2017}	181.600	BR(t)	89.214
	B_{RMS}	154.000	BR_{2016} (t)	26.054
	B_{2017}/B_{RMS}	1,20	B_{2016}/BV	0,44

	B_{2017}/K	0,60	BR_{2016}/BRV	0,29
	F_{RMS}	0,14		
A – campañas	RMS	20.470	BV(t)	237.953
	CR_{2017}	18.860	B_{2016} (t)	134.532
	B_{2017}	133.500	BR(t)	92.791
	B_{RMS}	148.800	BR_{2016} (t)	37.199
	B_{2017}/B_{RMS}	0.8864	B_{2016}/BV	0,57
	B_{2017}/K	0.4665	BD_{2016}/BRV	0,40
	F_{RMS}	0,141		
¿Qué nos dice cada modelo sobre el estado del stock?	*La CR_{2017} y el RMS resultan similares dado que La biomasa del stock está próxima a la $B_{RMS.}$ CTP's del orden de la establecida en 2016 permiten una explotación biológicamente sustentable.*		*La biomasa reproductiva del stock se encontraría en o por encama del PBR. CTP's del orden de la establecida en 2016 permiten una explotación biológicamente sustentable.*	

CBA estimada para 2017: 19.000 t

* Modelo dinámico de Schaefer: Indicadores del estado actual del recurso: Rendimiento Máximo Sostenible (RMS), CR_{2017}: Captura de reemplazo, que permite que la biomasa de 2017 sea igual a la de 2016, biomasa correspondiente al RMS (B_{RMS}), B_{2017}, biomasa estimada para 2017, B_{2017}/B_{RMS}: proporción de la biomasa en 2017 respecto de la biomasa RMS, B_{2017}/K: proporción de la biomasa actual en función de K, F_{RMS} tasa de explotación para el RMS.
** Estimaciones de biomasa y biomasa reproductiva virgen correspondientes al año 2016, así como la depleción de la biomasa reproductiva.

Current management measures

1. **Resolución CTMFM Nº 5/99** Pescadilla. Norma estableciendo talla mínima de desembarque

- 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 Conjunta CARP-CTMFM Nº 02/06. Norma estableciendo criterios a tener en cuenta para la investigación de los recursos corvina y pescadilla, a fin de dictar las resoluciones de manera conjunta que sean convenientes.
- Resolución Conjunta CARP - CTMFM Nº 01/17. Norma estableciendo la captura total permisible para la especie pescadilla (*Cynoscion guatucupa*) en el área del Tratado para el año 2017, en el área geográfica del Tratado del Río de la Plata y su Frente Marítimo, en 17.000 toneladas y una reserva administrativa adicional de hasta 2.000 toneladas, que las Comisiones podrán habilitar mediante Resolución fundada.

Commercialisation

The stripped weakfish is marketed fresh in the domestic market and frozen in the external.

With regard to physical volume, Argentine exports of stripped weakfish in the 2011-2015 periods have averaged 14,000 t, remaining relatively stable with a maximum of 15,326 t in 2013 and a minimum of 13,332 t in 2014. The share stripped weakfish in the total exports of fishery products did not exceed 3.5% in the period considered (Fig. 31).

The average price per ton of Argentine exports of stripped weakfish fell between 2011 and 2015, reaching values, expressed in US dollars (USD) FOB, of 1,424 and 1,253, respectively. In 2012, stripped weakfish exports had a value of USD 19,734,000, equivalent to 1.5% of the total exported in fishery products while, in 2015, the exports value (USD 17,067,000) it contributed 1.1% to the total exported.

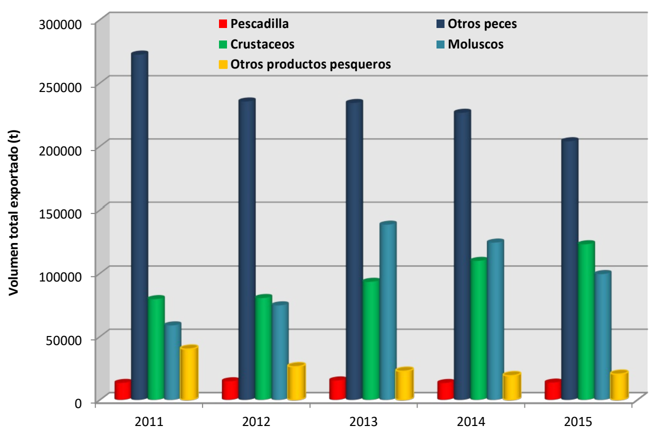


Figure 31. Stripped weakfish contribution to the total volume (t) of fishery products exported by Argentine in the 2011-2015 periods.

The main destinations of Argentine exports of stripped weakfish in 2015 were Cameroon and China, which together account for almost 70% of the total exports. The export volumes, price and destination of each of these products vary as indicated in the report prepared by the *Dirección de Economía Pesquera de la SSPyA* of Argentine. For example, whole stripped weakfish was exported mainly to Cameroon (6,925 t at an average price of USD 1,004) while frozen fillets were exported to the USA (963 t, average price USD 3,027) [link 18].

The *Boletín Estadístico Pesquero* prepared by [DINARA] from data from the *Dirección Nacional de Aduanas del Uruguay*, indicates that, as of 2012, the stripped weakfish decreased to the contribution of exports from the fishing sector as a whole from 6 to 3 % in 2014. This is equivalent to a decrease in export volume from 4,877 to 1,999 t respectively (Fig. 32). In 2012, the export of this species had a value of USD 8,060,000 while in 2014, this value decreased to USD 3,103,000.

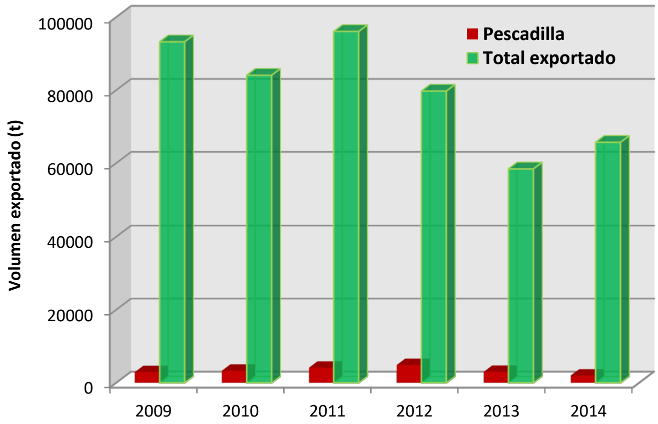


Figure 32. Stripped weakfish contribution to the total volume (t) of fishery products exported by Uruguay between 2009 and 2014.

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