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Results on main elasmobranches species from 2001 to 2015 Porcupine Bank (NE Atlantic) bottom trawl surveys

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Abstract

This working document presents the results on the most significant elasmobranch species of the Spanish survey on Porcupine Bank in 2015. The main species in biomass terms in this survey were Galeus melastomus (blackmouth catshark), Deania calcea (birdbeak dogfish), Deania profundorum (arrowhead dogfish), Scymnodon ringens (Knifetooth dogfish), Etmopterus spinax (velvet belly lantern shark), Scyliorhinus canicula (lesser spotted dogfish), Dalatias licha (Kitefin shark), Hexanchus griseus (bluntnose sixgill shark), Leucoraja circularis (sandy ray), Leucoraja naevus (cuckoo ray), Dipturus nidarosiensis (Norwegian skate), Dipturus cf. flossada and Dipturus cf. intermedia (common skate). Biomass, distribution and length ranges were analysed. The most remarkable trend in biomass found on this last survey was the return to the mean values of the time series after the peak in 2014, except G. melastomus, L. naevus, L. circularis, Dipturus nidarosiensis and Dipturus cf. flossada.

Introduction

The Porcupine Bank bottom trawl survey has been carried out annually since 2001 to provide data and information for the assessment of the commercial fish species in the area (ICES divisions VIIc and VIIk) (ICES, 2010, 2011).
The aim of this working document is to update the results (abundance indices, length frequency distributions and geographic distributions) on the most common elasmobranch species in Porcupine bottom trawl surveys, after the results presented previously (Fernández-Zapico *et al*., 2013; Ruiz-Pico *et al*., 2014; Fernández-Zapico *et al*., 2015). The species analysed were: *Galeus melastomus* (blackmouth catshark), *Deania calcea* (birdbeak dogfish), *Deania profundorum* (arrowhead dogfish), *Scymnodon ringens* (Knifetooth dogfish), *Etmopterus spinax* (velvet belly lantern shark), *Scyliorhinus canicula* (lesser spotted dogfish), *Dalatias licha* (Kitefin shark), *Hexanchus griseus* (bluntnose sixgill shark), *Leucoraja circularis* (sandy ray), *Leucoraja naevus* (cuckoo ray), *Dipturus nidarosiensis* (Norwegian skate), *Dipturus cf. flossada* and *Dipturus cf. intermedia* (common skate).

Material and methods

The area covered in the Spanish Ground Fish Survey on the Porcupine bank (SP PorcGFS) (Figure 1) extends from longitude 12° W to 15° W and from latitude 51° N to 54° N following the standard IBTS methodology for the western and southern areas (ICES, 2010).The sampling design was random stratified (Velasco and Serrano, 2003) with two geographical sectors (North and South) and three depth strata (> 300 m, 300 – 450 m and 450 - 800 m) (Figure 2). Hauls allocation is proportional to the strata area following a buffered random sampling procedure (as proposed by Kingsley *et al*., 2004) to avoid the selection of adjacent 5×5 nm rectangles. More details on the survey design and methodology are presented in ICES (2010, 2011).

Biomass, geographical distribution and length compositions were analyzed. In addition, the mean stratified biomass of the most abundant species in the last two years and in the previous five years was compared for the first time.

Trying to change the abundance estimation from time based to swept area, previous abundance estimates based on 30 min of trawling from the end of warp shooting, were corrected to time from net-ground contact to the start of net hauling, as reported in last year WD (Fernández-Zapico *et al*., 2015). During 2014 survey, the net monitoring system (SIMRAD ITI) was also used to detect the moment of ground contact and 30 minutes of effective trawling were performed since then. One problem detected in this last survey was that, with the increment in total catch (Figure 3), and bearing in mind that trawling during 30 minutes produced larger catches, and made it much longer and harder sorting the catch (see in Figure 3 that the increase in catch is even larger when trawling for 30 minutes and the remarkable increase in 2015). Trawling shorter for hauls, 20 min instead 30 min, could be a better sampling strategy and a solution for the problems on board in this area, also considering that catching more than 120 tones is more similar to commercial vessels catches than *sampling*, as should be the purpose of scientific research vessels.

Results and discussion

In 2015, 80 standard hauls and 5 additional hauls were carried out (Figure 2).

As described above, the total catch of the whole time series has increasing sharply from previous years, from a mean total catch per haul around 780.1 kg in the 12 first years, to 1329.8 kg this last survey (Figure 3), total catches are almost twofold those from the previous years.

In this last survey, fishes represented about 96% of the total catch and elasmobranchs made up ca. 7% of this total fish catch. The shark species registered in 2015 in the sampling area, and their respective percentages of the total elasmobranches stratified catch were: *Galeus melastomus* (73%), *Deania calcea* (7%), *Deania profundorum* (0.06%), *Scymnodon ringens* (4%), *Scyliorhinus canicula* (3%), *Etmopterus spinax* (2%), *Hexanchus griseus* (1%) and *Dalatias licha* (0.1%). The skate and rays species were: *Leucoraja naevus* (0.5%), *Leucoraja circularis* (2%), *Dipturus* spp. (*Dipturus nidarosiensis* (4%), *Dipturus cf. flossada* (1.6%) and *Dipturus cf. intermedia* (0.05%)).

The general result in 2015 was that the levels of most of the species, returned to the mean levels of the time series. Exceptions are *G. melastomus*, *L. naevus, L. circularis* and *Dipturus spp.* whose biomass increased, reaching their peaks of the time series and pointing out that the 2014 peak was not so marked.

Galeus melastomus **(**Blackmouth catshark)

The biomass and abundance follow the increasing trend of the overall time series in general terms, although sharply this last year and reaching the highest values of the time series, even more than the peak of 2012 (Figure 4; Figure 5).
G. melastomus is distributed mainly in the southern area, although this last year showed higher biomass in that area, than previous years (Figure 6).
The length sizes remained similar to the previous year with two clear modes instead three as in 2012 and 2013. The sizes ranged from 7 cm to 78 cm and showed a main mode around 60 cm and a "*recruitment signal*" around 20 cm. This last year, a bit larger specimens than in 2014 were found, between 54 cm and 72 cm, and a bit smaller between 17 cm and 23 cm (Figure 7).

Deania calcea (Birdbeak dogfish**) and *Deania profundorum* (Arrowhead dogfish)**

D. calcea and *D. profundorum* were analysed separately in the present working document like it has been done in previous reports, since it was identified for the first time in 2012 Porcupine survey (Fernández-Zapico et al., 2013).
Biomass and abundance of *D. calcea* remained much higher than *D. profundorum* this last year, and both species decreased after the highest value of the time series of the previous year (Figure 9; Figure 10), although the mean stratified biomass of both species in the last two years increased compared to the five previous years (Figure 8).
In the overall time series, both species showed a deep distribution, mainly from 550 m to 800 m. In 2015, *D. calcea* was found in thirteen deep trawls mainly from 550 m to 650 m in the northern, western and southern area of the Bank, whereas *D. profundorum* was only caught in five hauls, three of them below 700 m and the other two more abundant around 500 m in the southernmost area. The biomass was scarcer this last year in the southernmost and western part of the survey area and at depths between 700 to 800 m (Figure 11; Figure 12).
As shown in previous years, individuals caught of *D. calcea* were larger than those of *D. profundorum*, although this last survey, the differences were not as large as in the two previous years, when a mode around 105 cm was found. In 2015, length size of *D. calcea* ranged from 26 cm to 116 cm, although only one mode around 86 cm was found. The few specimens of *D. profundorum* caught were mainly small specimens, between 27 cm to 41 cm with just one larger specimen (Figure 13).

Scymnodon ringens **(Knifetooth dogfish)**

This last year, the biomass and abundance of *S. ringens* was nearly halved, reaching the values of 2013, but still within in the ranges of the time series around 3 kg and 1 individual per haul (Figure 15). Even so, the mean stratified biomass of *S. ringens* in the last two years increased regarding the five previous years (Figure 14).
The geographical distribution of this species was similar to that found in 2014, being more abundant in the deeper hauls in the southeast study area, although lower than the previous year (Figure 16).
Size distribution similar to the previous years was found, with a mode around 75 cm and sizes between 31 cm and 113 cm, although the abundance by sizes was lower this last survey (Figure 17)

Scyliorhinus canicula **(Lesser spotted dogfish)**

The mean stratified biomass of *S. canicula* in the last two years is at almost the same level as in the five previous years, but due to the peak found in 2013, that compensates he low levels from 2009 to 2012 (Figure 18). The biomass and abundance of this species remained around the values of the previous year, 2.8 kg·haul^{-1} slightly over the mean values of the time series, keeping the peak of 2013 around 5.7 kg·haul^{-1} as an unusual value (Figure 19).

The geographical distribution of *S. canicula* also was similar to 2014, with larger abundances in the northwest area of the Bank, instead on the Irish shelf (Figure 20) where this species was reported and related with before, especially in 2013 (Ruiz-Pico *et al.*, 2014; Fernández-Zapico *et al.*, 2015).

The length sizes also remained similar to the previous year, with one mode around 62 cm and sizes between 25 cm to 78 cm, but higher abundance of specimens between 34 and 56 cm than 2014 (Figure 21).

Etmopterus spinax (Velvet belly)

Biomass and abundance of *E. spinax* dropped this last survey, after the peak in 2014, although they did not reach the lowest values of the time series, found in 2005 and 2007 (Figure 22). The decrease in abundance is steeper than in biomass this last year, due to the decrease in the abundance of smaller individuals between 12 cm and 16 cm, whereas abundance of individuals bigger than 35 cm was larger than in the two previous year (Figure 23).

Geographical distribution of *E. spinax* was quite different this last survey, since the species was more abundant in the northernmost part of the study area than in the southeast part as in other years (Figure 24).

Regarding length distributions, and as shown before, larger individuals of *E. spinax* were caught and no signal of "*recruitment*" was found. The species ranged from 12 cm to 52 cm like the two previous years but a wide mode was found around 37 cm instead around 28 cm as in 2014. This pattern of larger sizes is similar to 2008-2010 and 2012 (Figure 23).

Hexanchus griseus (Bluntnose sixgill shark)

The biomass of this scarce shark decreased reaching the mean values of the time series, after the peak of the previous survey, but the abundance slightly increased (Figure 25). The absence of large individuals which contributed to that peak in 2014, when the largest sizes of the time series were found, 145 cm, 149 cm and 178 cm, explain the drop of the biomass this last survey.

The main abundance of *H. griseus* this last survey was concentrated in the northernmost study area instead being widespread like previous years (Figure 26).

H. griseus length distribution ranged mainly from 66 cm to 104 cm in 2015 like the main sizes values of the time series, except the unusual large specimens found in 2014, as shown before. However, an unusual individual of 42 cm was found, the second smallest record of the time series after the size of 33 cm in 2006 (Figure 27).

Dalatias licha (Kitefin shark)

Like *H. griseus*, *D. licha* in 2015 survey showed a similar drop after 2014 peak, when an unusually large value was found, but in this case nearly the lowest values of the time series in term of biomass, around 0.1 kg·haul^{-1}. However, and unlike *H. griseus*, the abundance decreased, even more than biomass, reaching the lowest record of the time series (Figure 25). The few specimens found and their small sizes, compared to the previous year contribute to the pattern found in this survey.

This scarcity did not allow us to infer patterns in spatial distribution and remarked the absence of biomass in the southeast study area, where in 2014 was found abundantly (Figure 26).

The few specimens caught this year were mainly small, as mentioned before, between 41 cm to 49 cm, although two records of larger specimens, 79 cm and 92 cm, were also found (Figure 27).

***Leucoraja circularis* (Sandy ray) and *Leucoraja naevus* (Cuckoo ray)**

The biomass increased in both species this last year following the increasing trend from 2014 in *L. naevus* and from 2011 in *L. circularis* and reaching the highest value of the time series in the latter. The abundance followed the same trend in *L. circularis*, whereas in *L. naevus* remained steady regarding the previous year (Figure 28) because larger individuals contributed to a higher biomass than expected (Figure 30).

The geographical and depth distribution remained similar to previous years in both species, *L. circularis* deeper in the southwest and northwest area and *L. naevus* shallower around the mound bank, but this last survey the biomass is higher in the northwest area in both species (Figure 29)

Regarding length distributions, only a few small specimens of *L. naevus* were found this last survey and the main sizes ranged between 53 and 61 cm, whereas a few more large specimens of *L. circularis*, particularly females from 94 cm to 113, were found than previous years, although the main sizes ranged between 49 cm and 85 cm, and a few small specimens ranged from 21 cm and 44 cm (Figure 30).

***Dipturus* spp. (Common skate)**

After the detailed identification of the species of genera *Dipturus* since 2011 (Ruiz-Pico et al., 2014; Fernández-Zapico et al., 2015), now we can focus on the species *Dipturus nidarosiensis, Dipturus cf. flossada* and *Dipturus cf. intermedia*, which are the only species of the genera found since then.

An important increase in the mean stratified biomass of *Dipturus* spp. was found in the last two years (Figure 31), although a little decrease in biomass is observed, an increase in number was found in 2015 (Figure 32). Particularly, the biomass and abundance of *D. nidarosiensis* and *D. cf. intermedia* decreased whereas *D. cf. flossada* increased markedly this last year (Figure 33).

The geographical and depth distribution of these species remained similar to 2014. *D. nidarosiensis* was found deeper, and mainly caught in the southeast part of the study area; whereas *D. cf. flossada* and *D. cf. intermedia* were found shallower and mainly around the central mound of Porcupine Bank. Nevertheless, this last year, the only specimen of *D. cf. intermedia* was found in the north of the Irish shelf (Figure 34; Figure 35; Figure 36).

Regarding length distribution, *D. nidarosiensis*, the largest of the three species of the genera *Dipturus* found in the study area, ranged mainly from 117 cm to 186 cm although the smallest individual (38 cm) was caught.

D. cf. flossada, the most abundant of the three species but smaller than *D. nidarosiensis,* ranged from 32 cm to 133 cm and showed smaller specimens than large (Figure 37). The only specimen of *D. cf. intermedia* sized 83 cm.

Other elasmobranch species

Other species were found scarcely in the area, namely *Centroscymnus coelolepis, Centroscymnus crepidater*, *Centrophorus squamosus, Galeus murinus, Galeorhinus galeus*, *Squalus, acanthias*, *Raja clavata*, *Raja brachyura*, *Leucoraja fullonica* and *Rajella fyllae*. However, in 2015 only one specimen *C. crepidater* were caught at 729 m and one specimen (pending identification) of the family Rajidae at 623 m.

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Figures

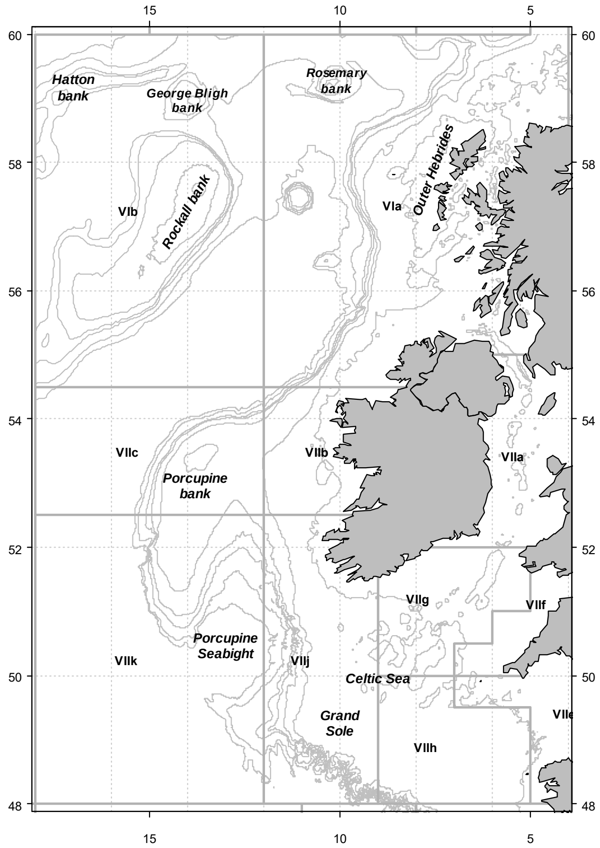

Figure 1 North eastern Atlantic showing the Porcupine bank, Porcupine Seabight, and ICES divisions.

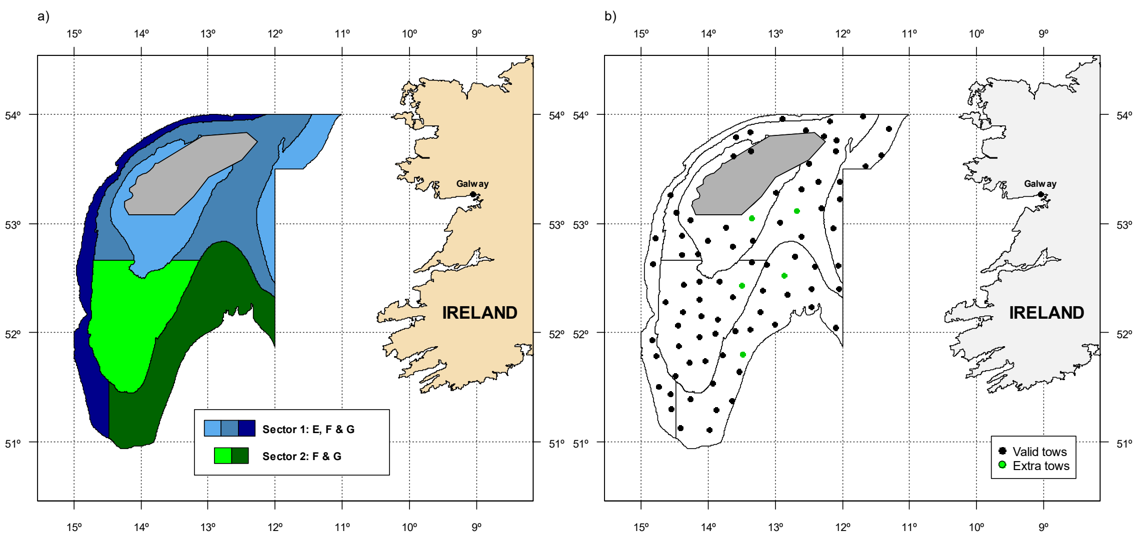

Figure 2 **a)** Stratification design and hauls in 2015 Porcupine surveys; Straight lines show geographical sectors (North in blue and South in green) and the isobaths delimit the three depth strata (> 300 m light blue, 300 – 450 m medium blue and green and 450 - 800 m dark blue and green).
b) hauls performed during 2015 Porcupine Survey.

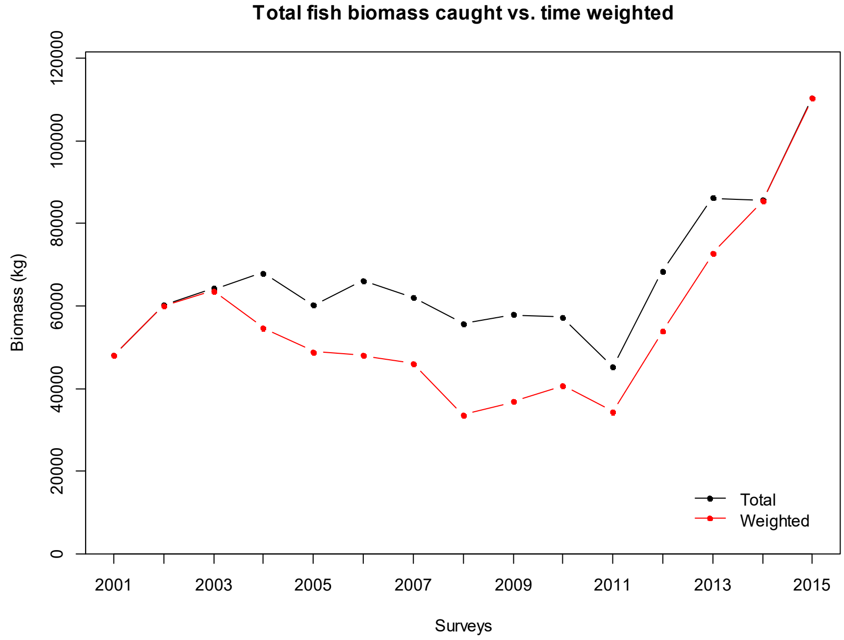

Figure 3 Evolution and comparison between total catch and weighted catch in Porcupine survey time series (2001-2015)

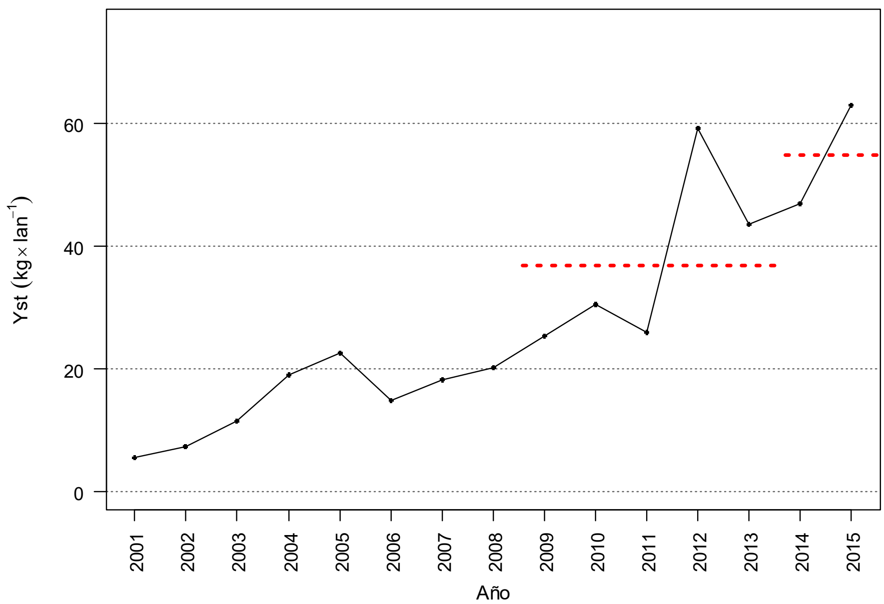

Figure 4 Changes in *Galeus melastomus* biomass index during Porcupine survey time series (2001-2015). Dotted lines compare mean stratified biomass in the last two years and in the five previous years.

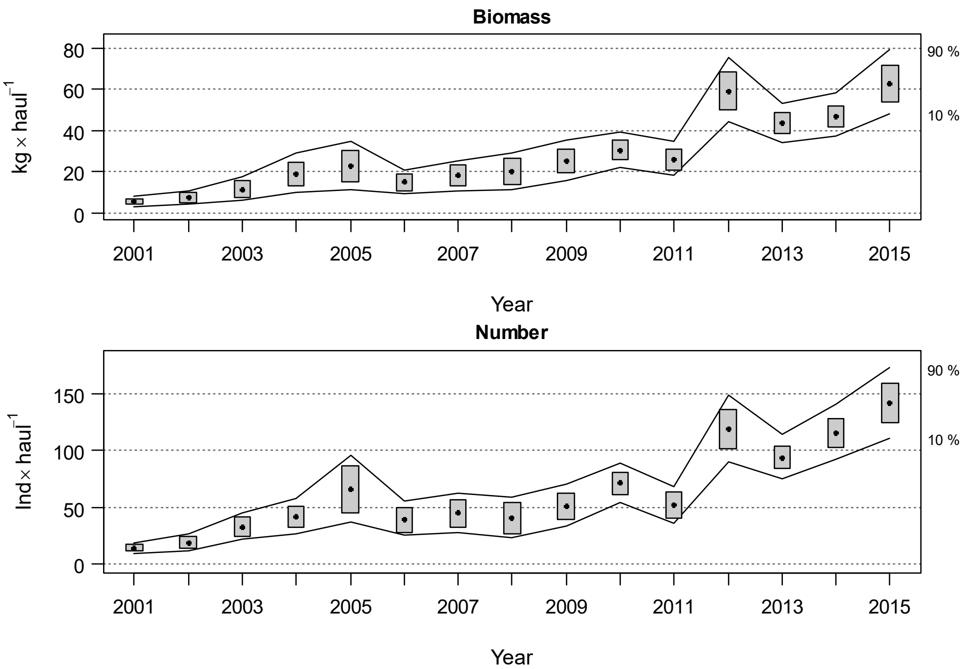

Figure 5 Changes in *Galeus melastomus* biomass index and abundance during Porcupine survey time series (2001-2015). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000).

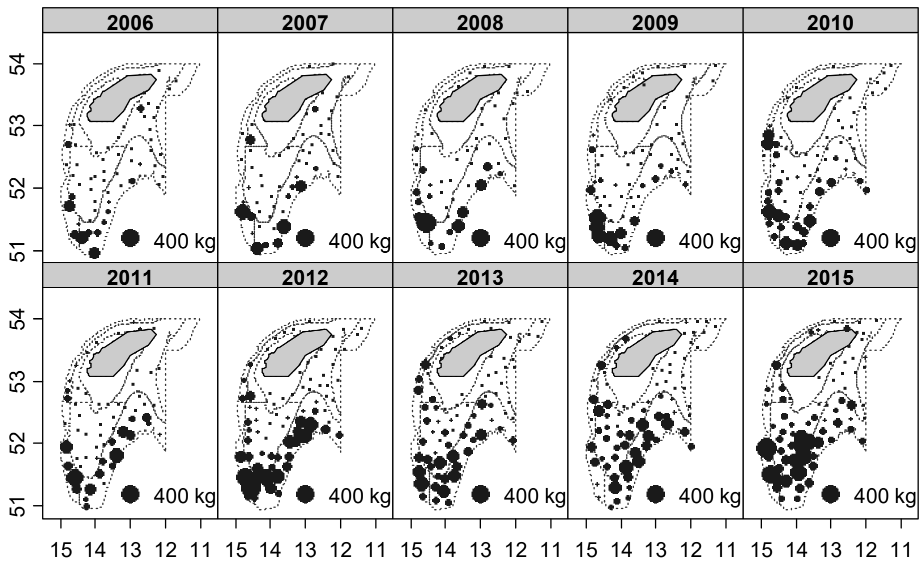

Figure 6 Geographic distribution of *Galeus melastomus* catches (kg·haul^{-1}) during Porcupine survey time series (2006- 2015)

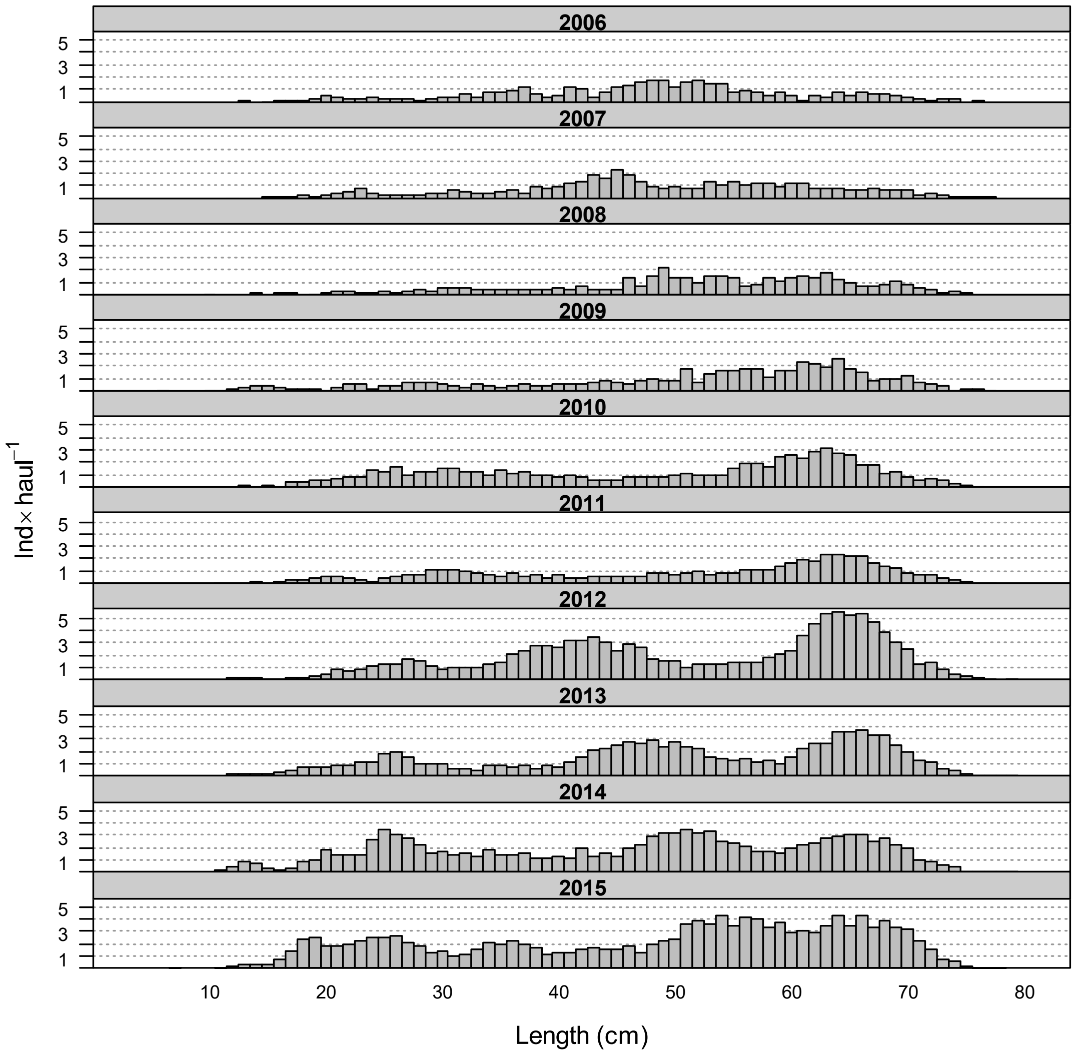

Figure 7 Mean stratified length distributions of *Galeus melastomus* from 2006 to 2015 Porcupine survey.

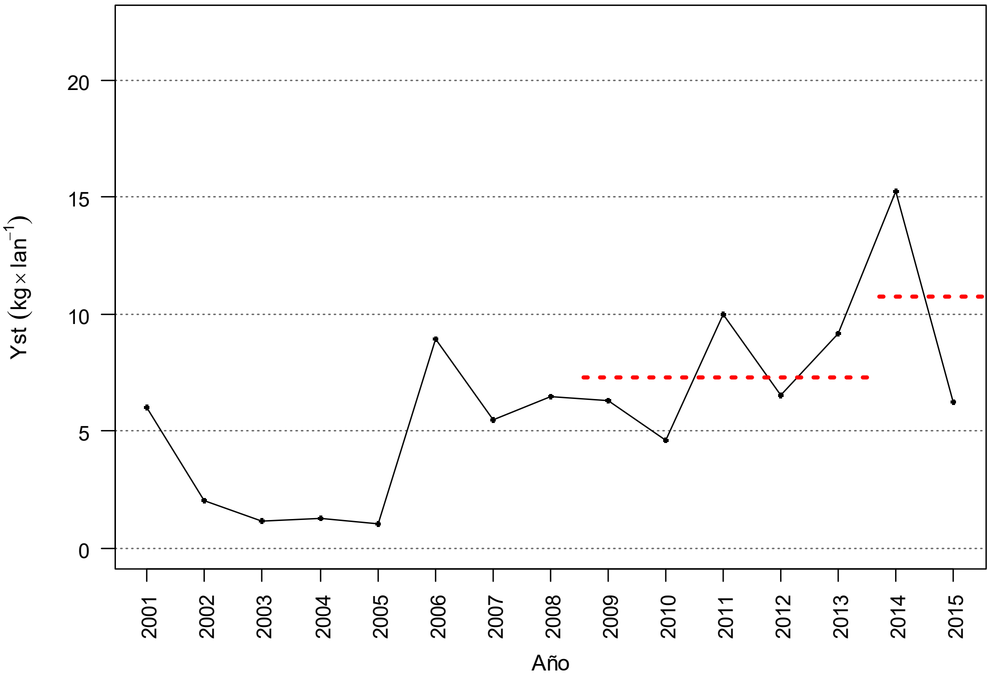

Figure 8 Changes in *Deania* spp. (mainly *D. calcea)* biomass index during Porcupine survey time series (2001-2015). Dotted lines compare mean stratified biomass in the last two years and in the five previous years.

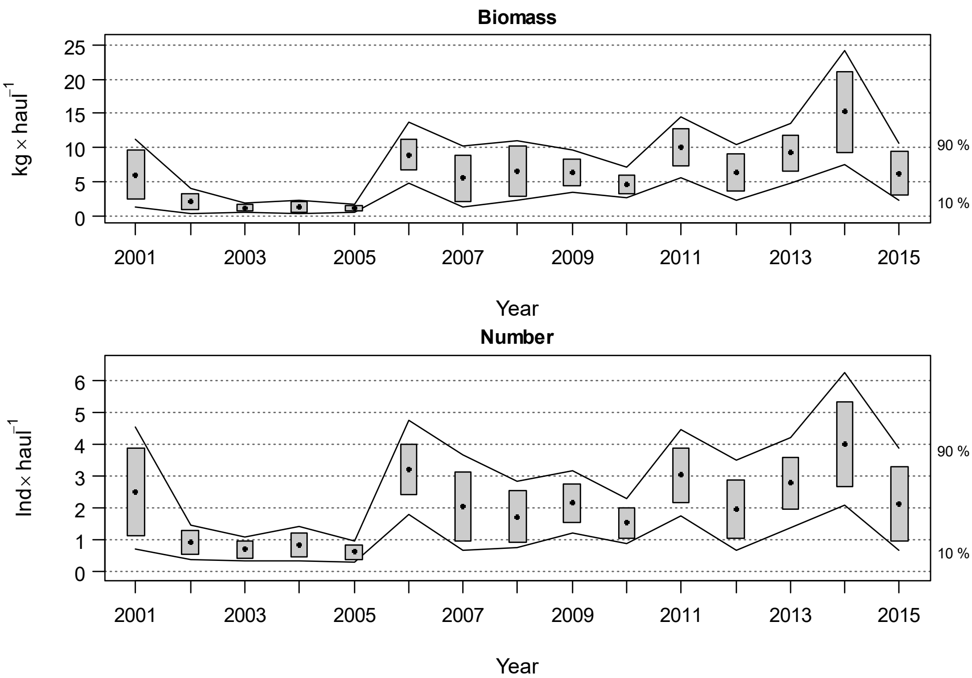

Figure 9 Evolution of *Deania* spp. (mainly *D. calcea)* biomass index (kg·haul^{-1}) during Porcupine survey time series (2001-2015). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations =1000).

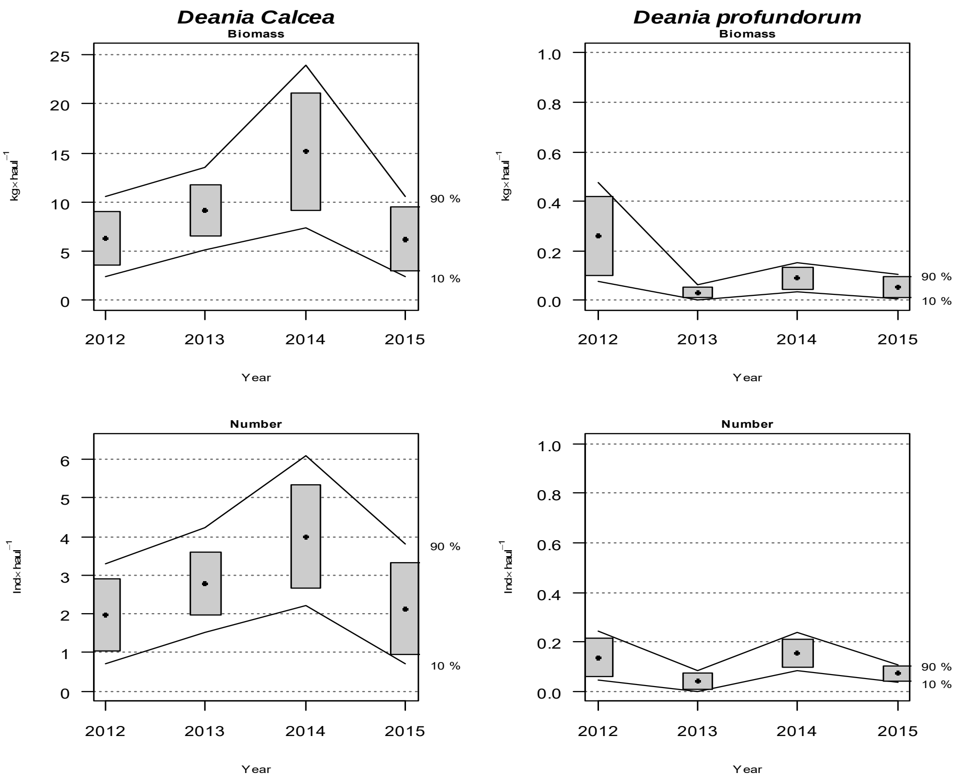

Figure 10 Evolution of *Deania calcea* and *Deania profundorum* biomass index (kg·haul^{-1}) from 2012 and 2015 Porcupine surveys. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations =1000).

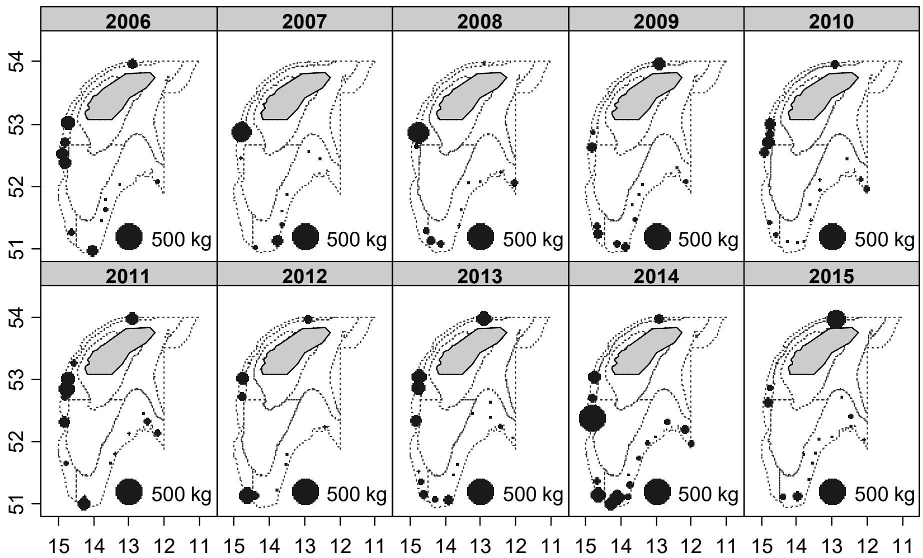

Figure 11 Geographic distribution of *Deania* spp. (mainly *D. calcea*) catches (kg·haul^{-1}) during Porcupine survey time series (2006- 2015).

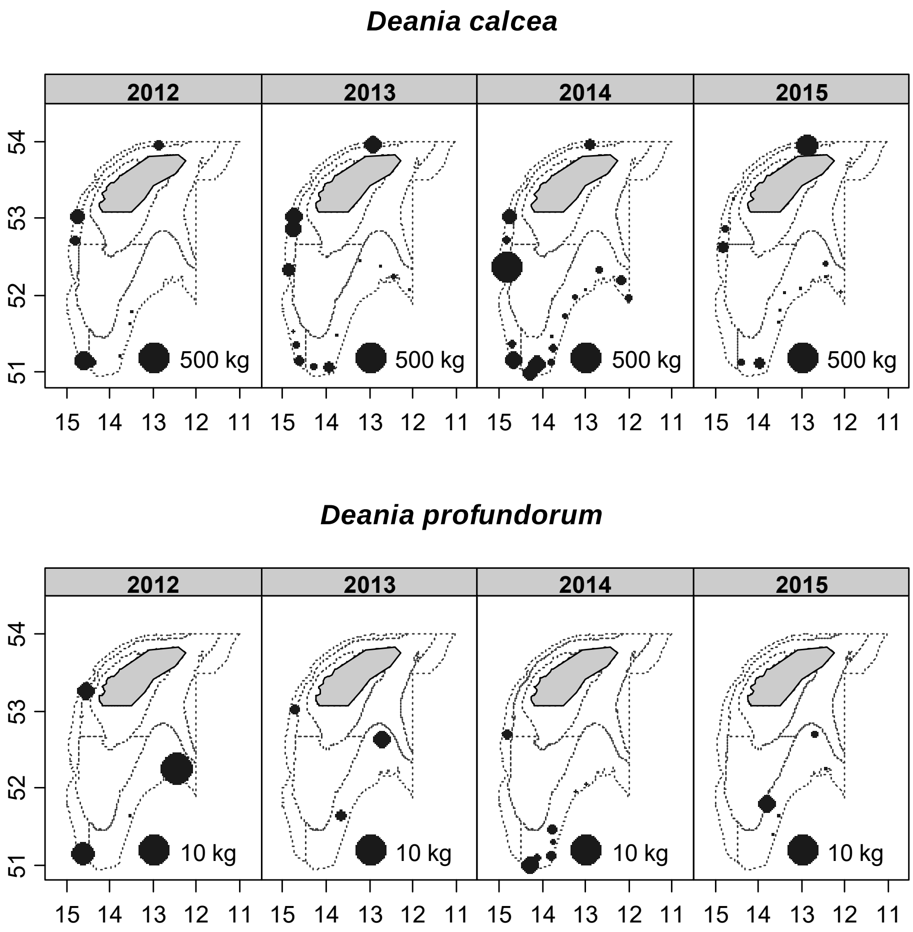

Figure 12 Geographic distribution of *Deania calcea* and *Deania profundorum* catches (kg·haul^{-1}) 2012 and 2015 Porcupine surveys.

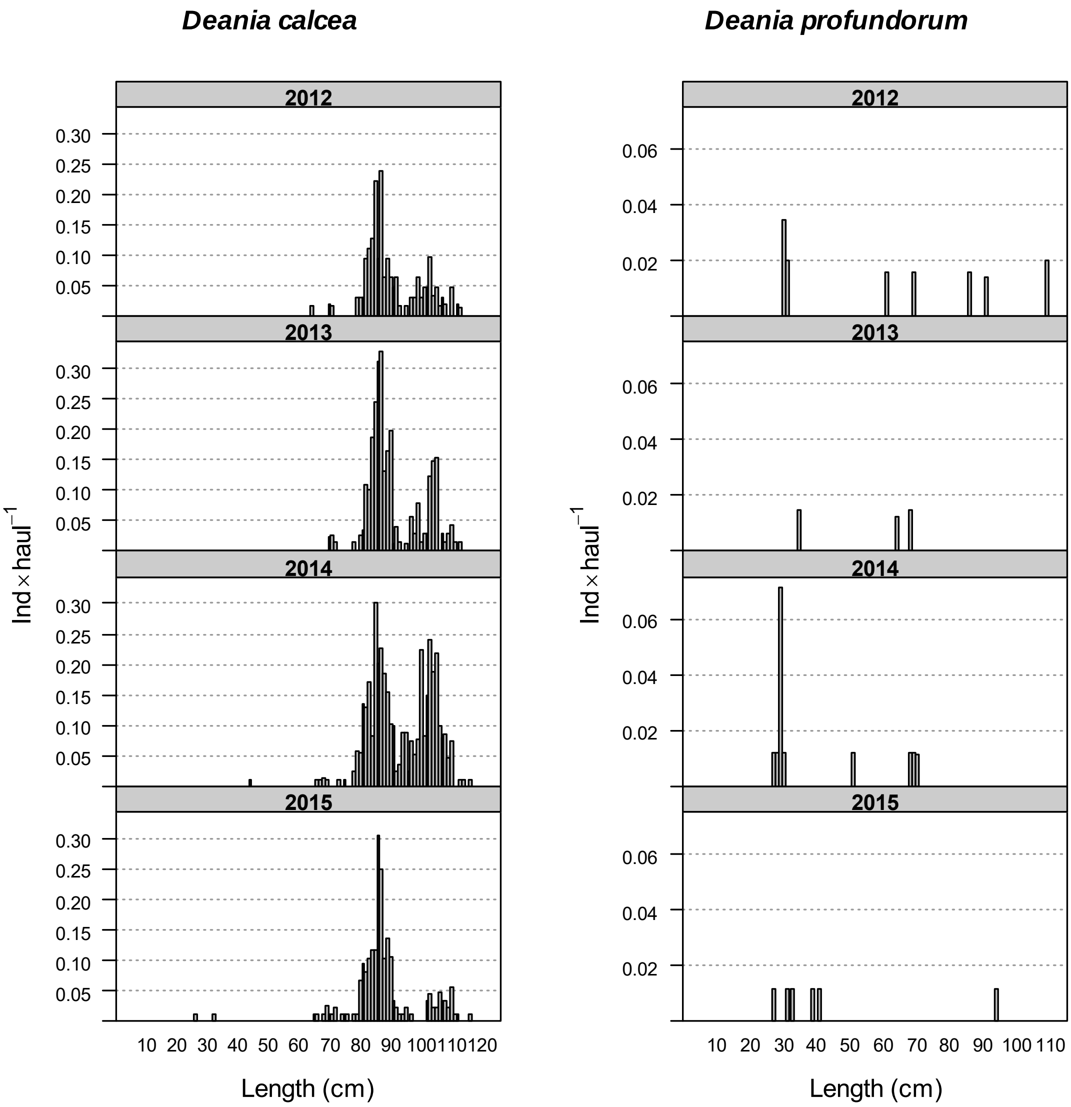

Figure 13 Mean Stratified length distribution of *Deania calcea* and *Deania profundorum* from 2012 Porcupine surveys.

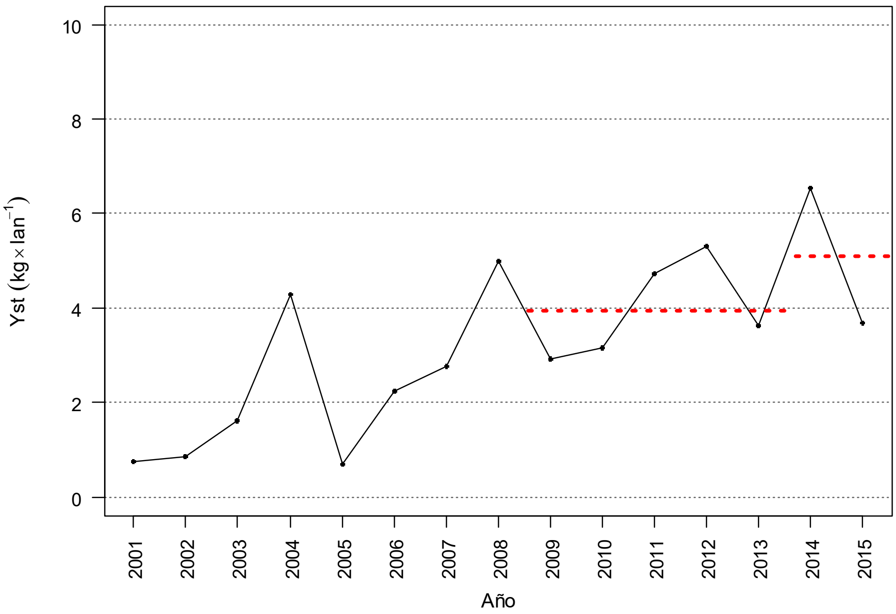

Figure 14 Changes in *Scymnodom ringens* biomass index during Porcupine survey time series (2001-2015). Dotted lines compare mean stratified biomass in the last two years and in the five previous years.

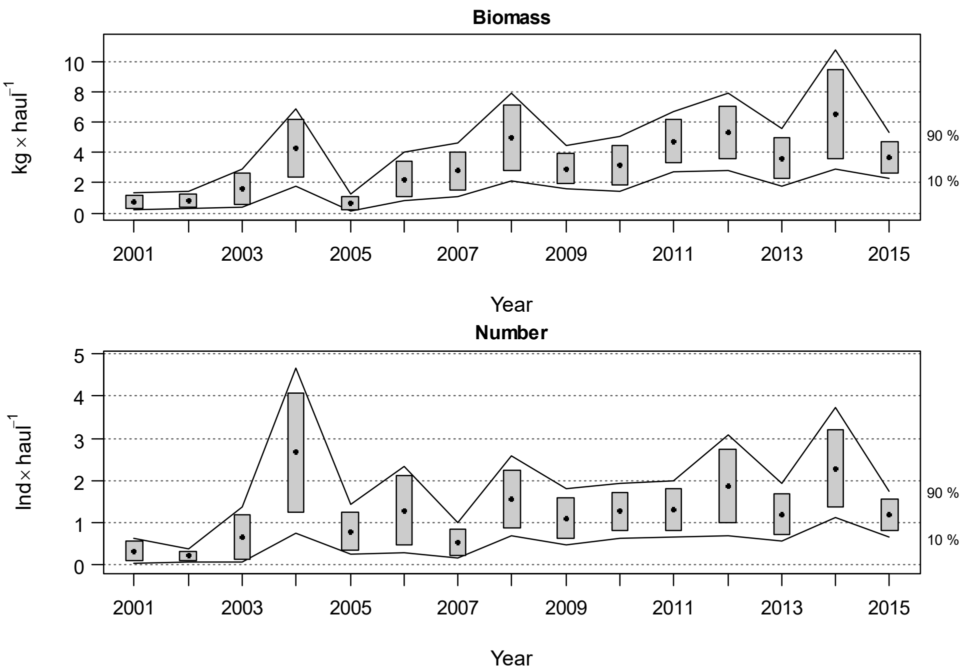

Figure 15 Evolution of *Scymnodom ringens* biomass index (kg·haul^{-1}) during Porcupine survey time series (2001-2015). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000).

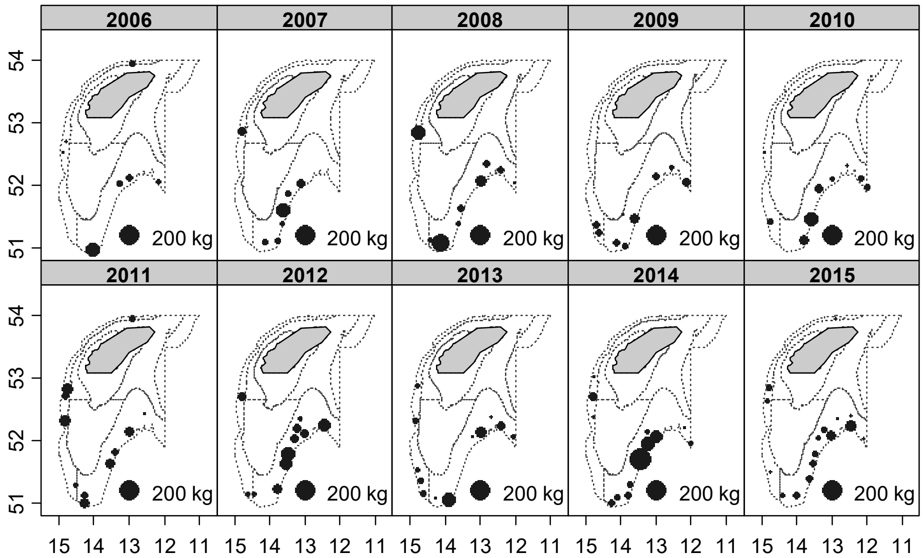

Figure 16 Geographic distribution of *Scymnodon ringens* catches (kg·haul^{-1}) during Porcupine survey time series (2006- 2015).

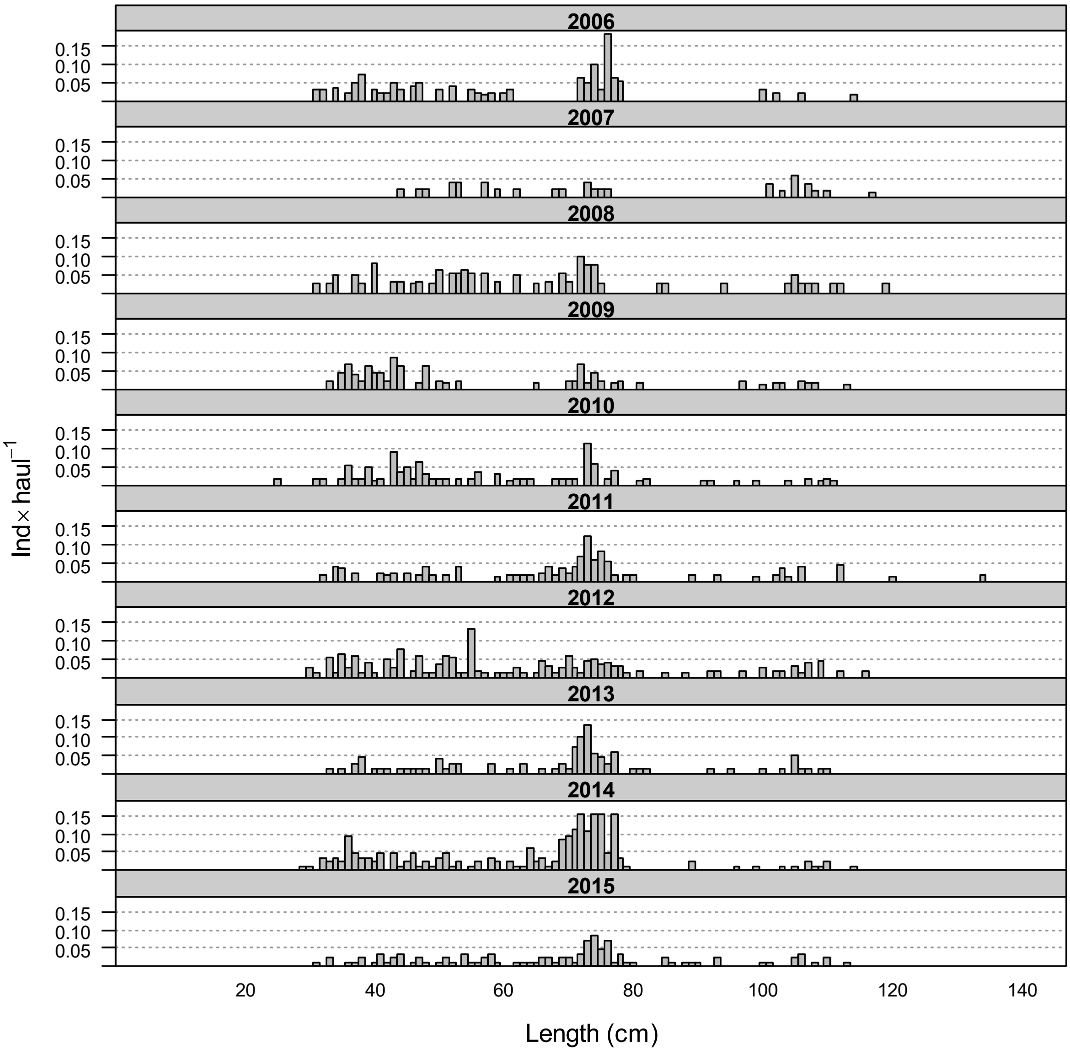

Figure 17 Stratified length distribution of *Scymnodon ringens* from 2006 Porcupine survey.

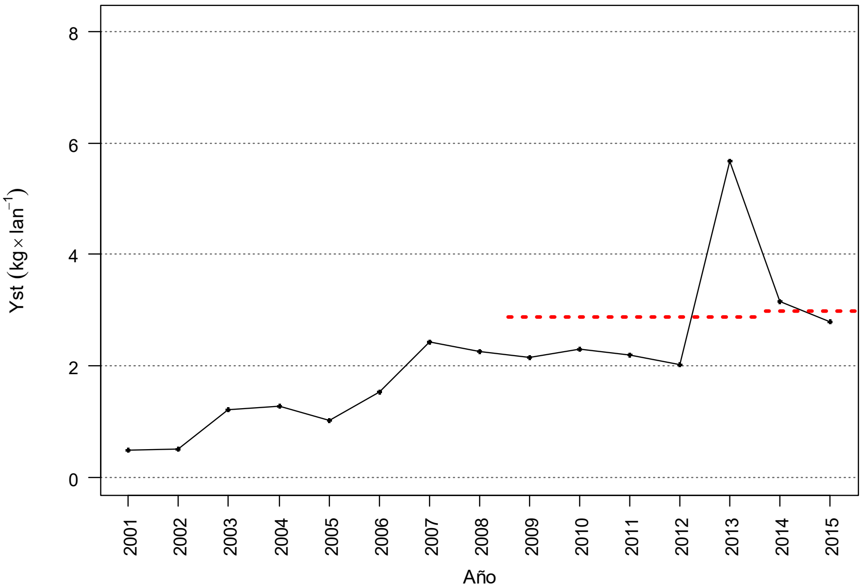

Figure 18 Changes in *Scyliorhinus canicula* biomass index during Porcupine survey time series (2001-2015). Dotted lines compare mean stratified biomass in the last two years compared to the five previous years.

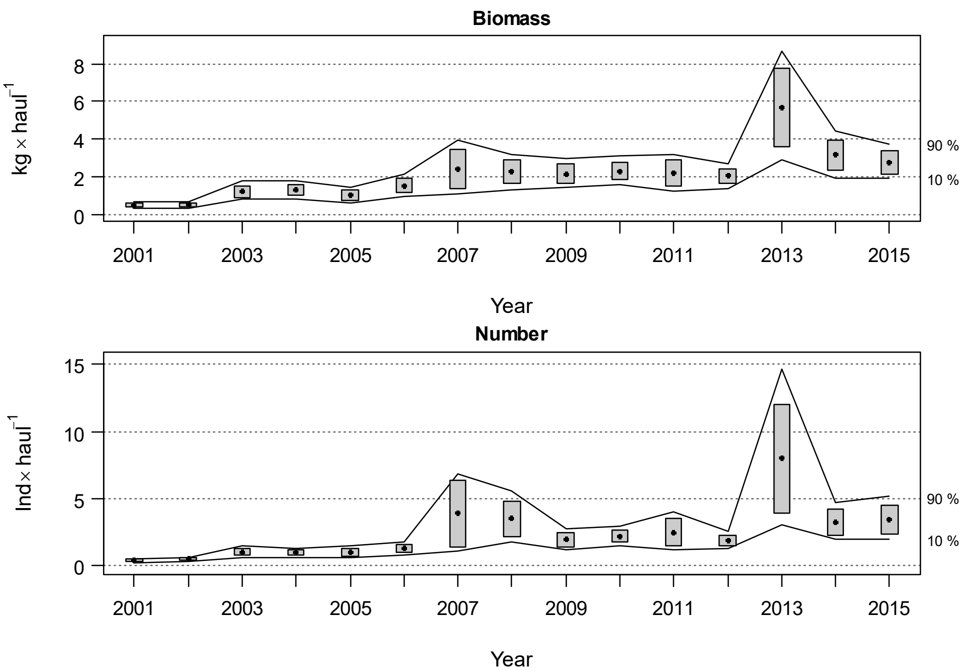

Figure 19 Evolution of *Scyliorhinus canicula* biomass index (kg·haul^{-1}) during Porcupine survey time series (2001-2015). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000).

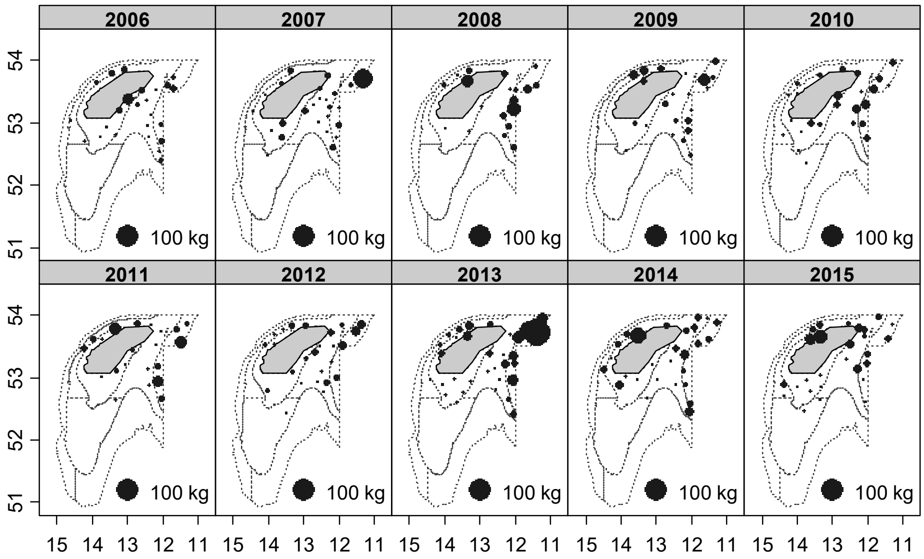

Figure 20 Geographic distribution of *Scyliorhinus canicula* catches (kg·haul^{-1}) in Porcupine survey time series (2006-2015).

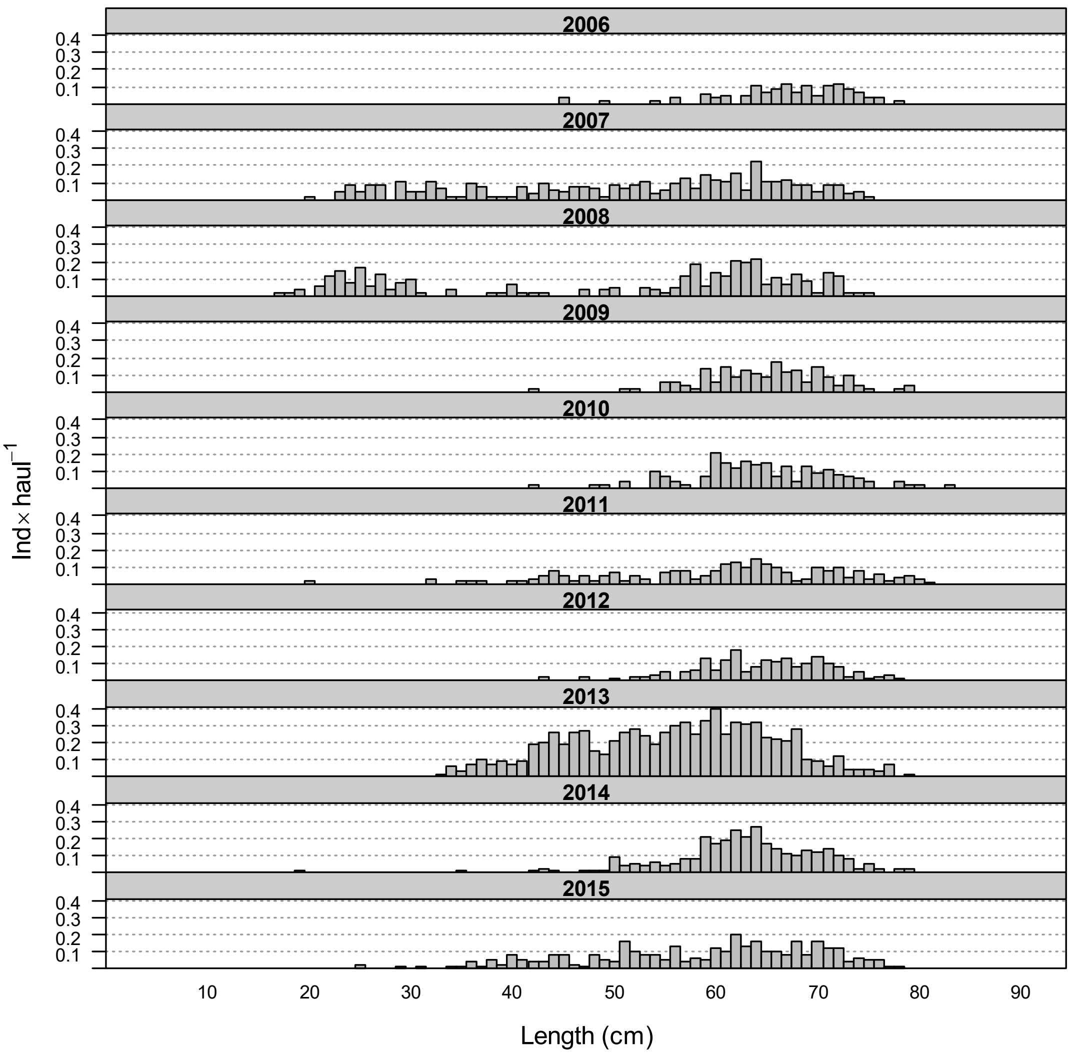

Figure 21 Mean Stratified length distributions of *Scyliorhinus canicula* from 2006 to 2015 Porcupine survey.

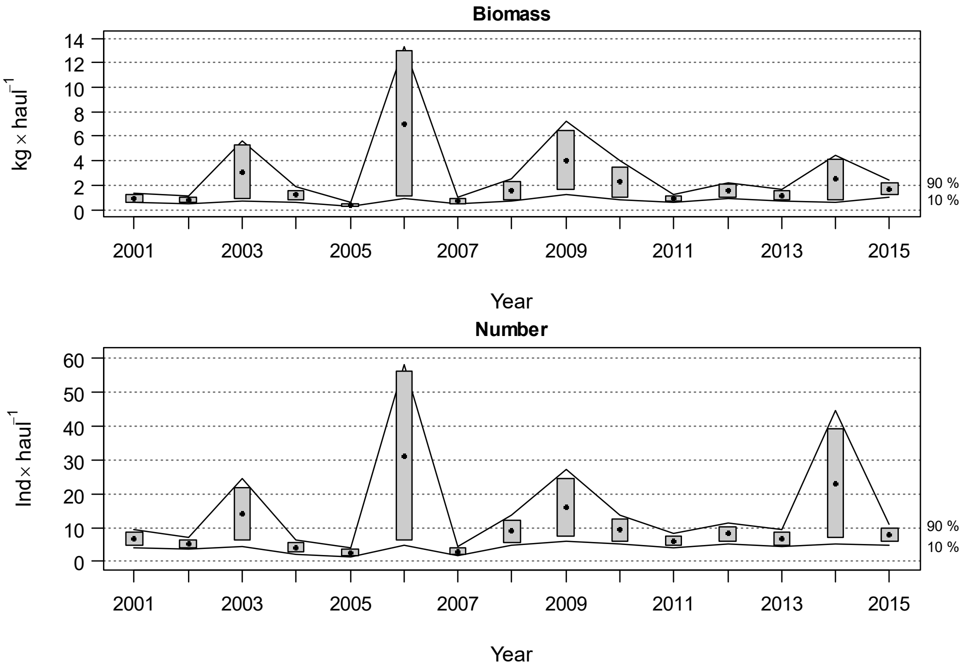

Figure 22 Evolution of *Etmopterus spinax* biomass index (kg·haul^{-1}) during Porcupine survey time series (2001-2015). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000).

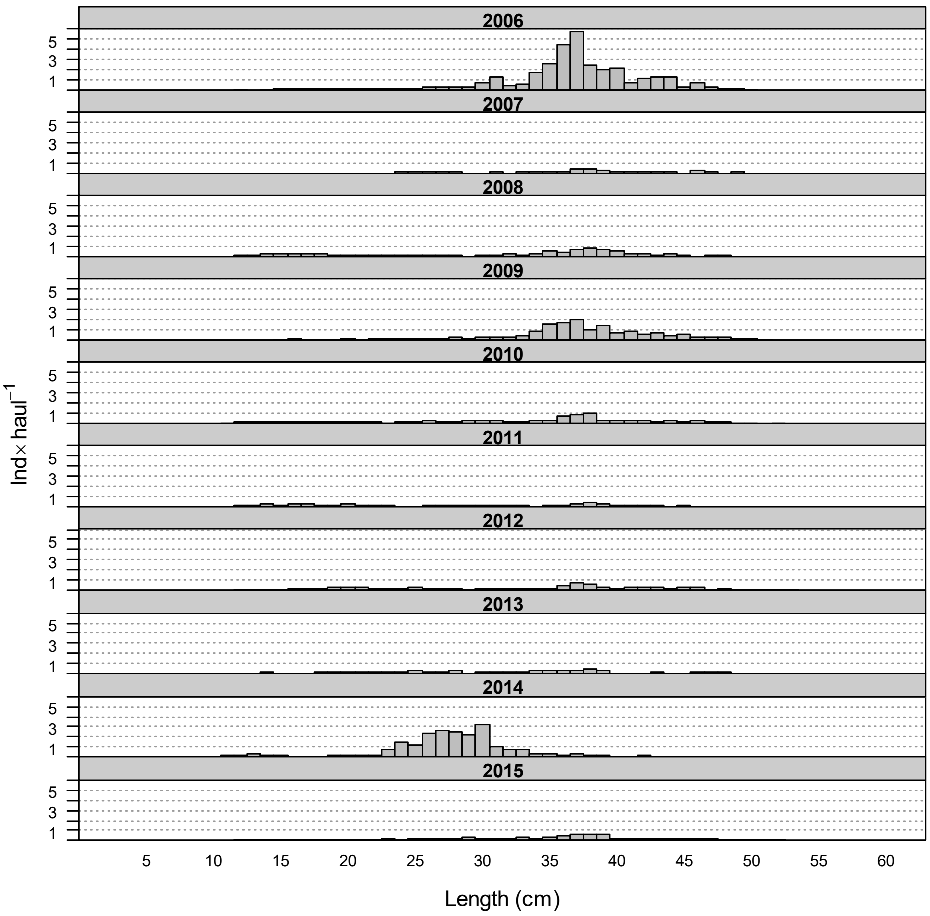

Figure 23 Mean Stratified length distributions of *Etmpterus spinax* from 2006 to 2015 Porcupine survey.

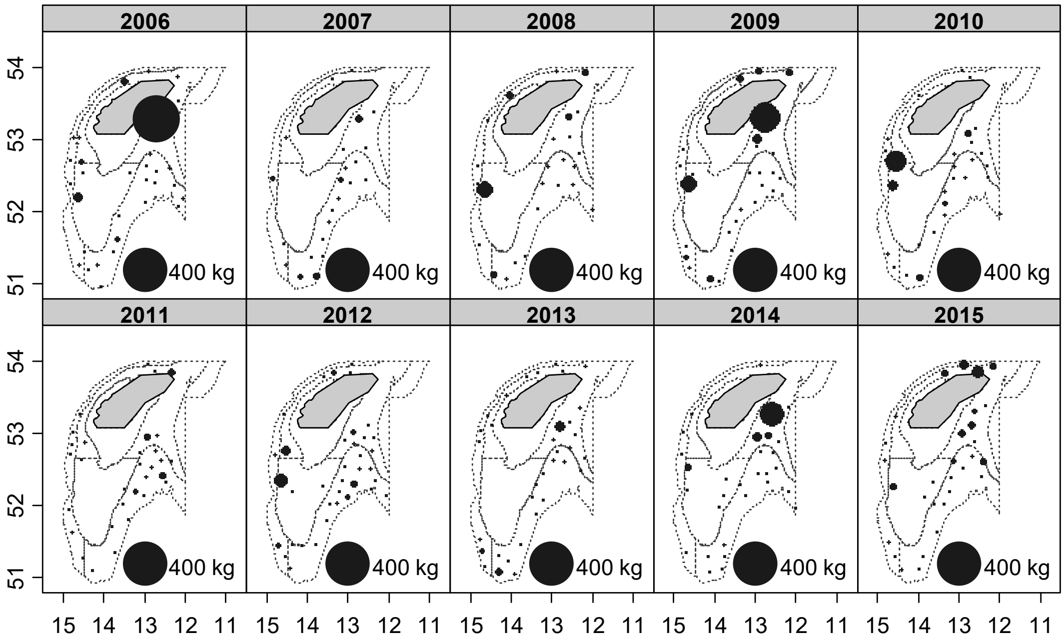

Figure 24 Geographic distribution of *Etmopterus spinax* catches (kg·haul^{-1}) in Porcupine survey time series (2006-2015).

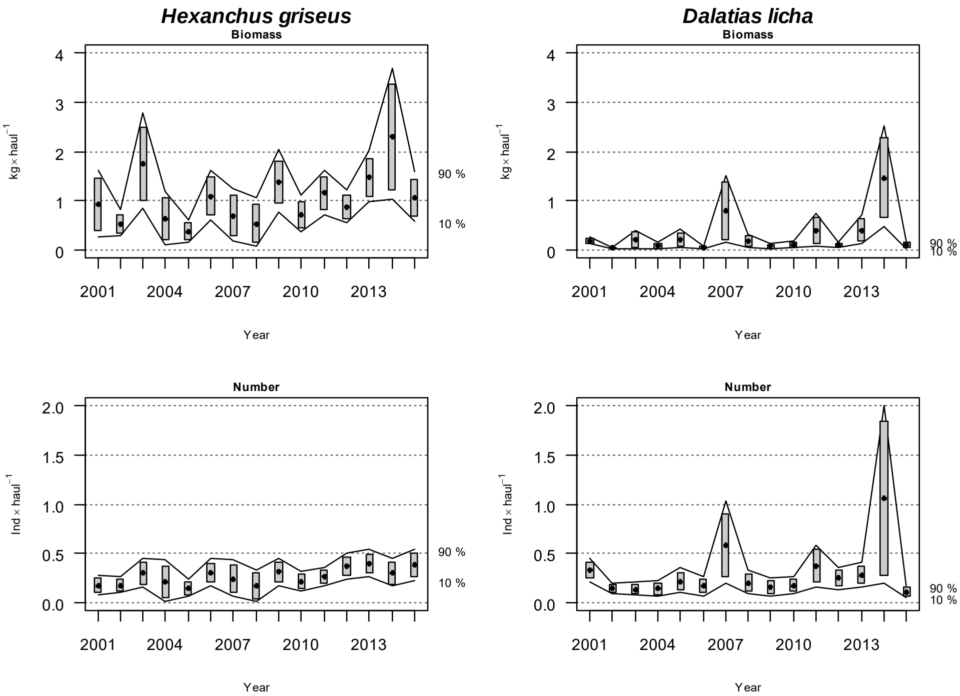

Figure 25 Evolution of *Hexanchus griseus* and *Dalatias licha* biomass index (kg·haul^{-1}) during Porcupine survey time series (2001-2015). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000).

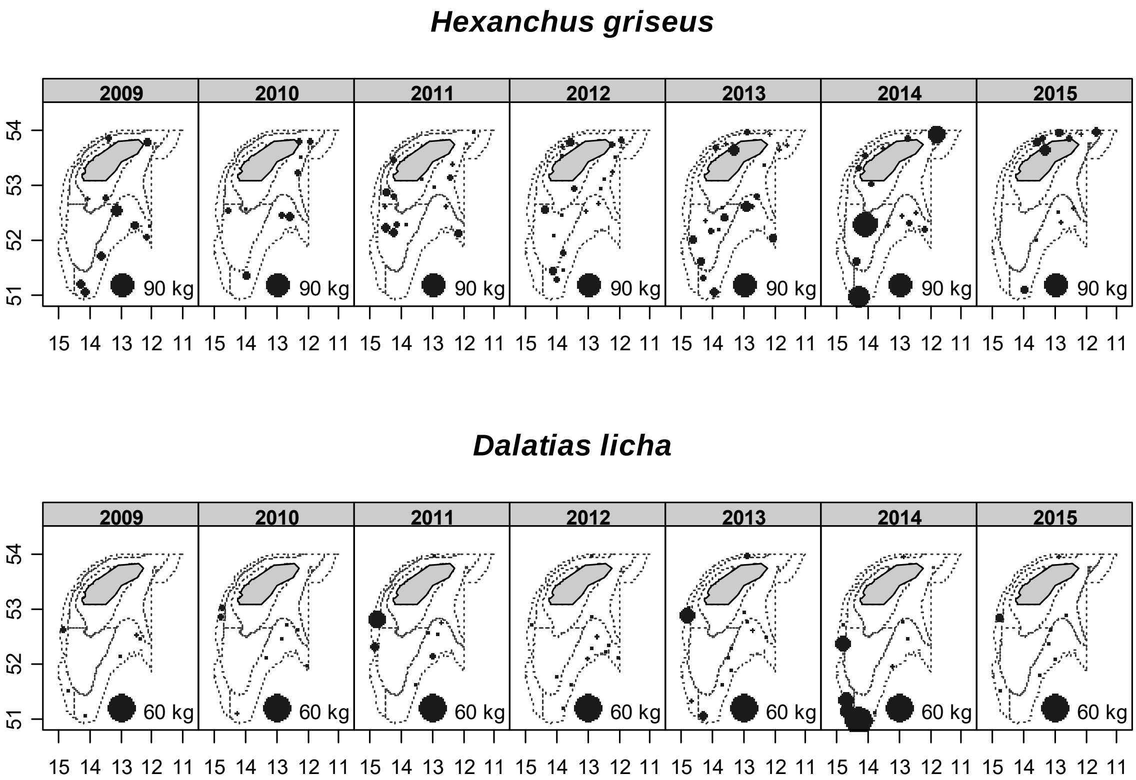

Figure 26 Geographic distribution of *Hexanchus griseus* and *Dalatias licha* catches (kg×30 min haul^{-1}) in Porcupine surveys during 2009-2015

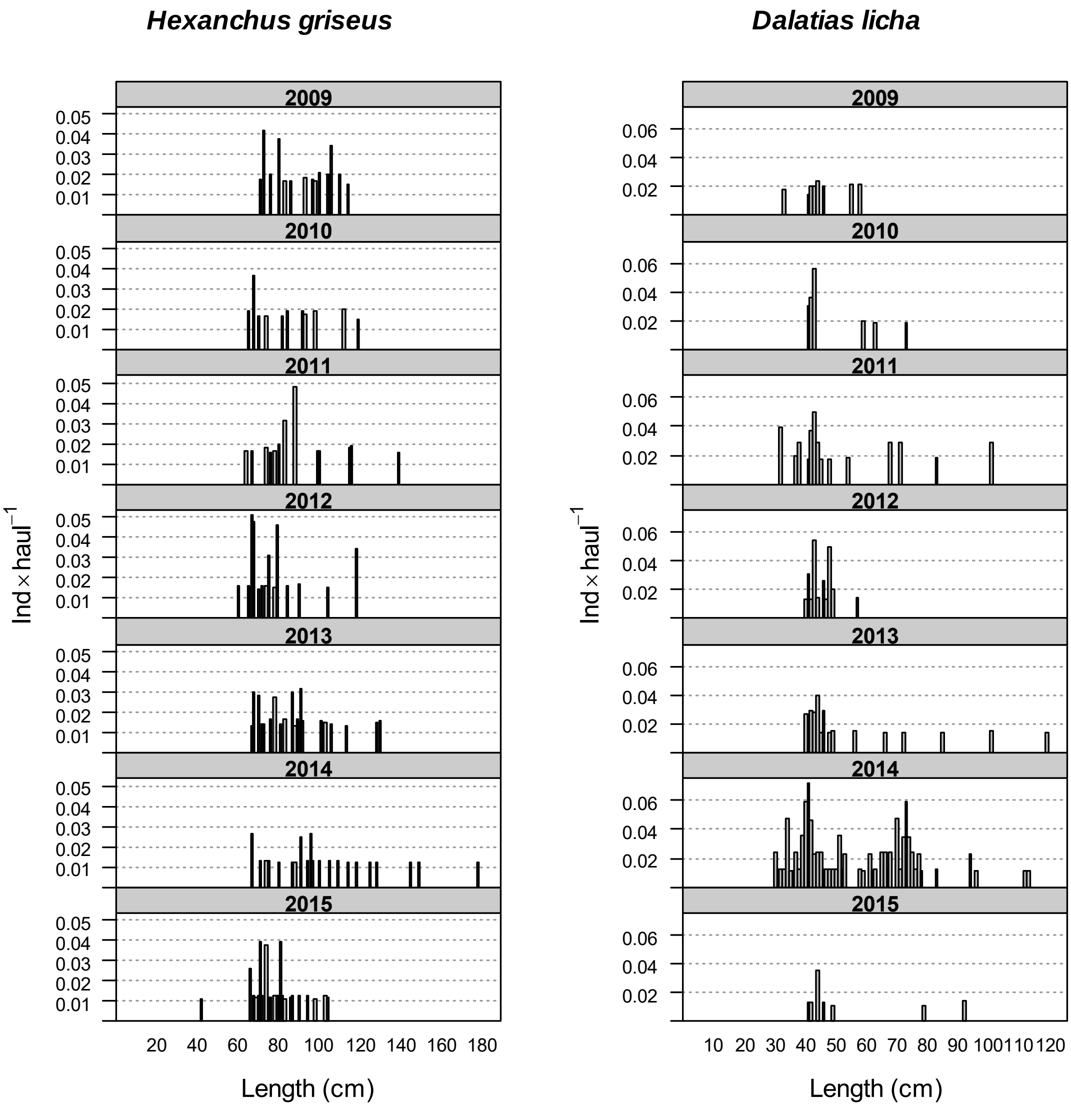

Figure 27 Mean Stratified length distribution of *Hexanchus griseus* and *Dalatias licha* from 2009 Porcupine surveys

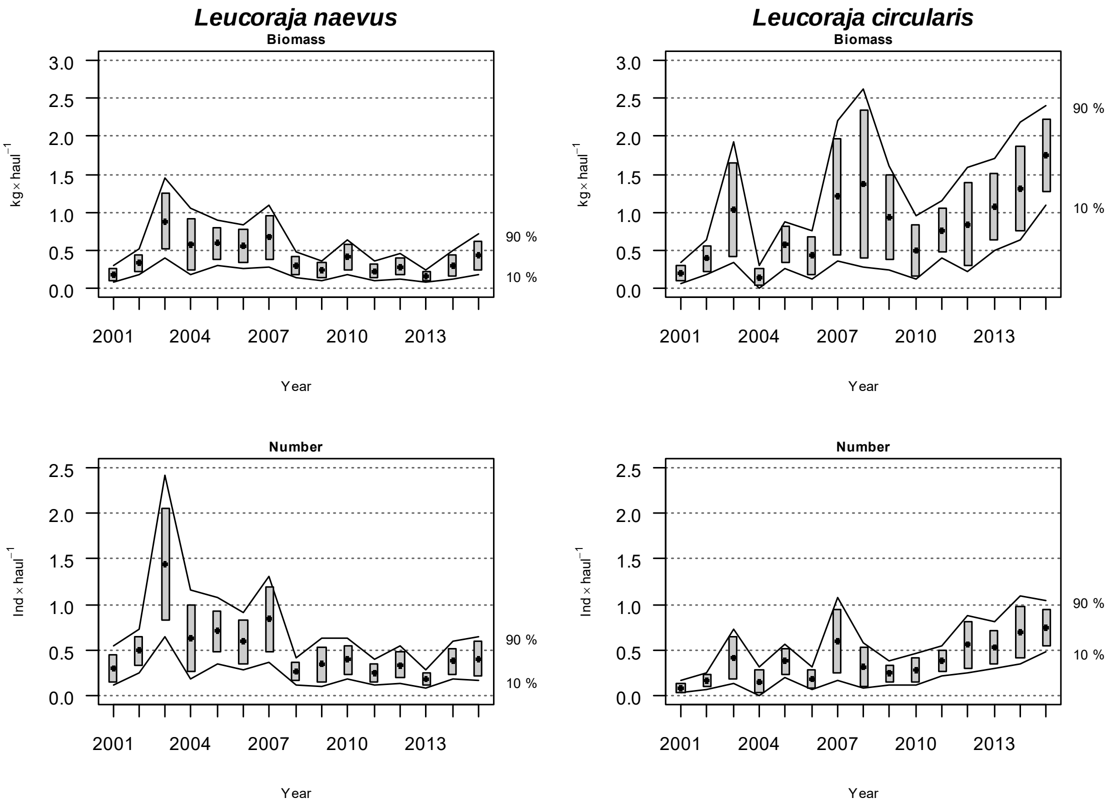

Figure 28 Changes in *Leucoraja naevus* and *Leucoraja circularis* biomass index (kg·haul^{-1}) during Porcupine survey time series (2001-2015). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations =1000).

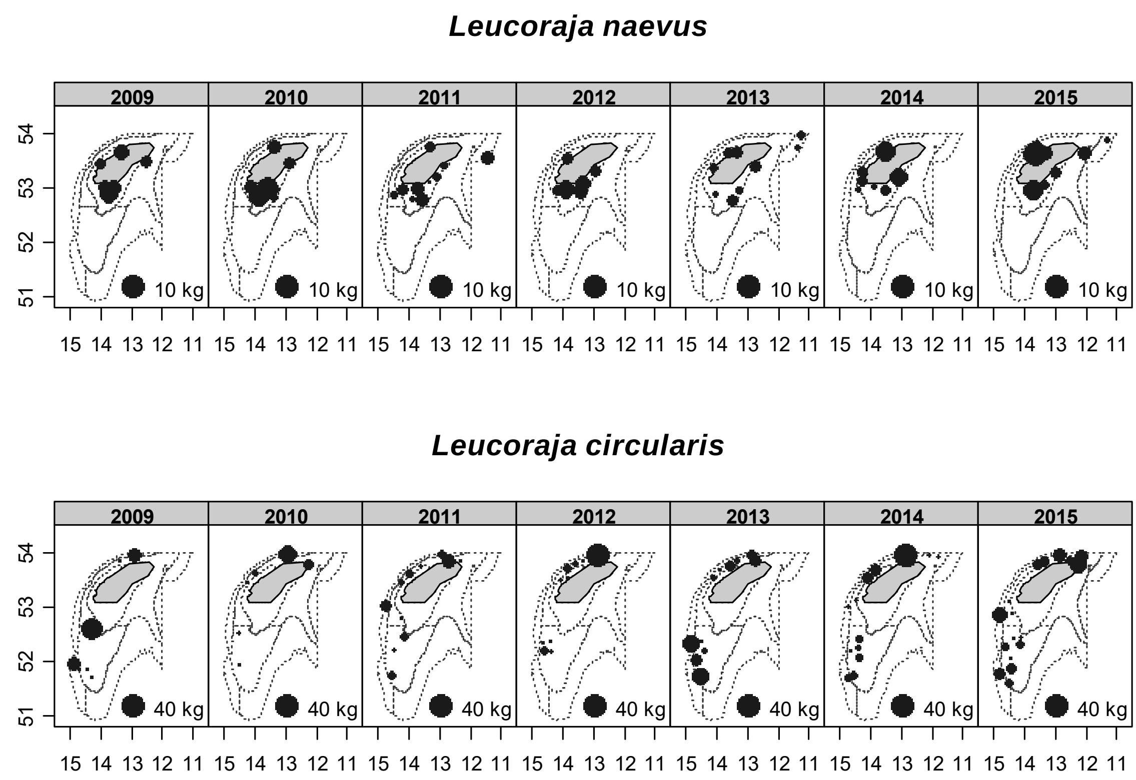

Figure 29 Geographic distribution of *Leucoraja naevus* and *Leucoraja circularis* catches (kg·haul^{-1}) in Porcupine survey time series (2009-2015).

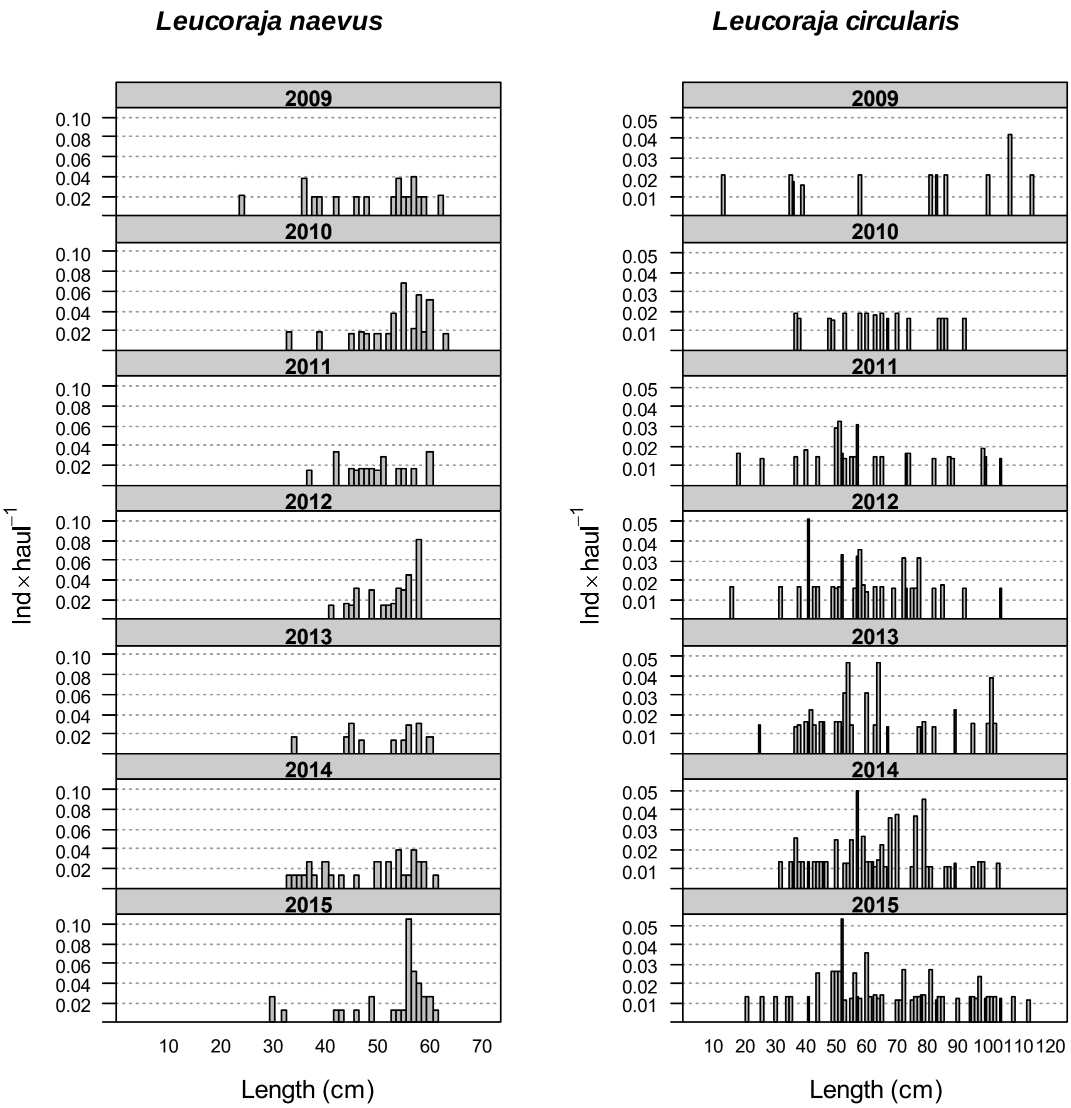

Figure 30 Mean Stratified length distribution of *Leucoraja naevus* and *Leucoraja circularis* from 2009 Porcupine surveys

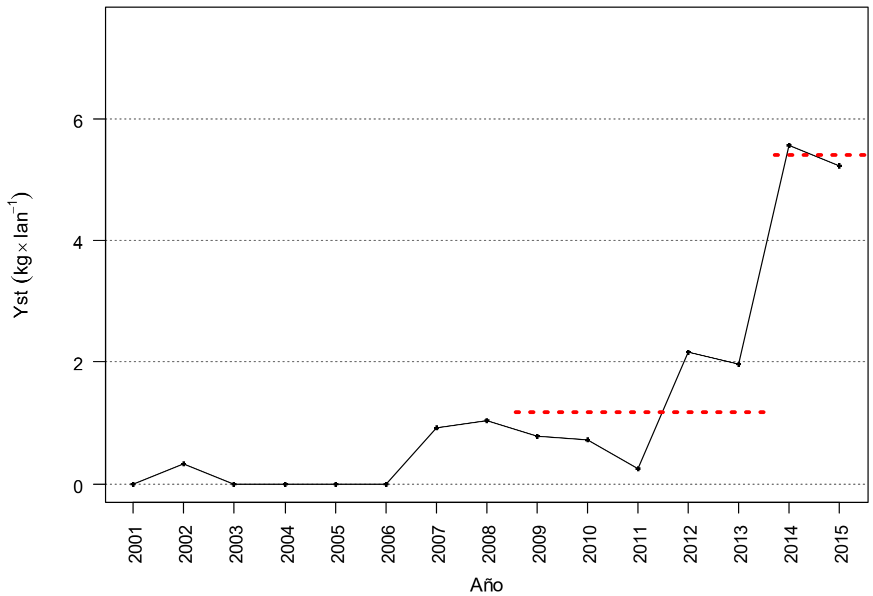

Figure 31 Changes in *Dipturus* spp. biomass index during Porcupine survey time series (2001-2015). Dotted lines compare mean stratified biomass in the last two years and in the five previous years.

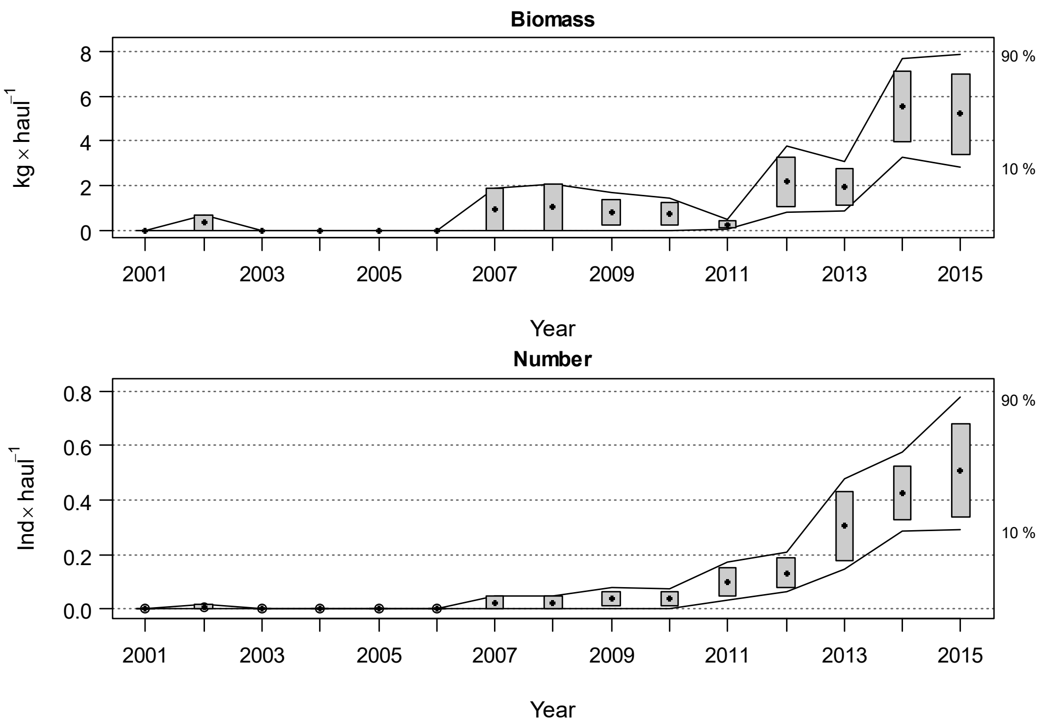

Figure 32 Evolution of *Dipturus* spp. biomass index ($kg \cdot haul^{-1}$) during Porcupine survey time series (2001-2015). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000).

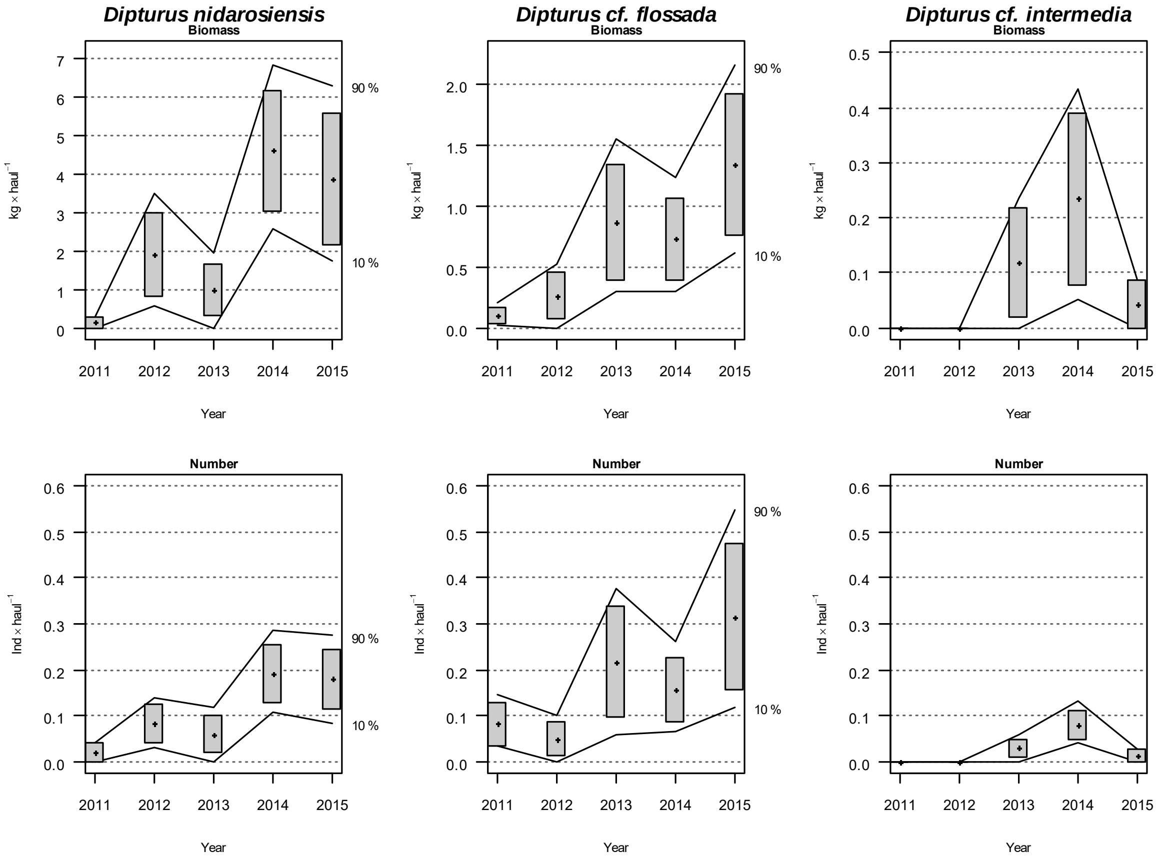

Figure 33 Evolution of *Dipturus nidarosiensis*, *Dipturus cf. flossada* and *Dipturus cf. intermedia* biomass index (kg·haul^{-1}) during Porcupine survey time series (2011-2015). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000).

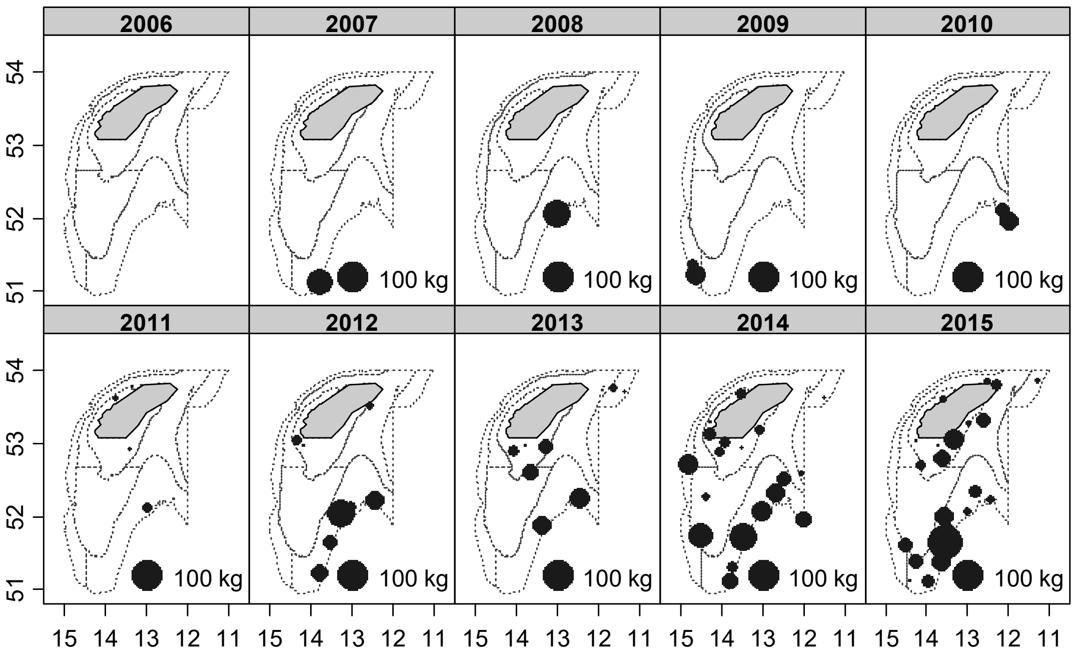

Figure 34 Geographic distribution of *Dipturus* spp. catches (Kg· haul^{-1}) in Porcupine survey time series (2006-2015).

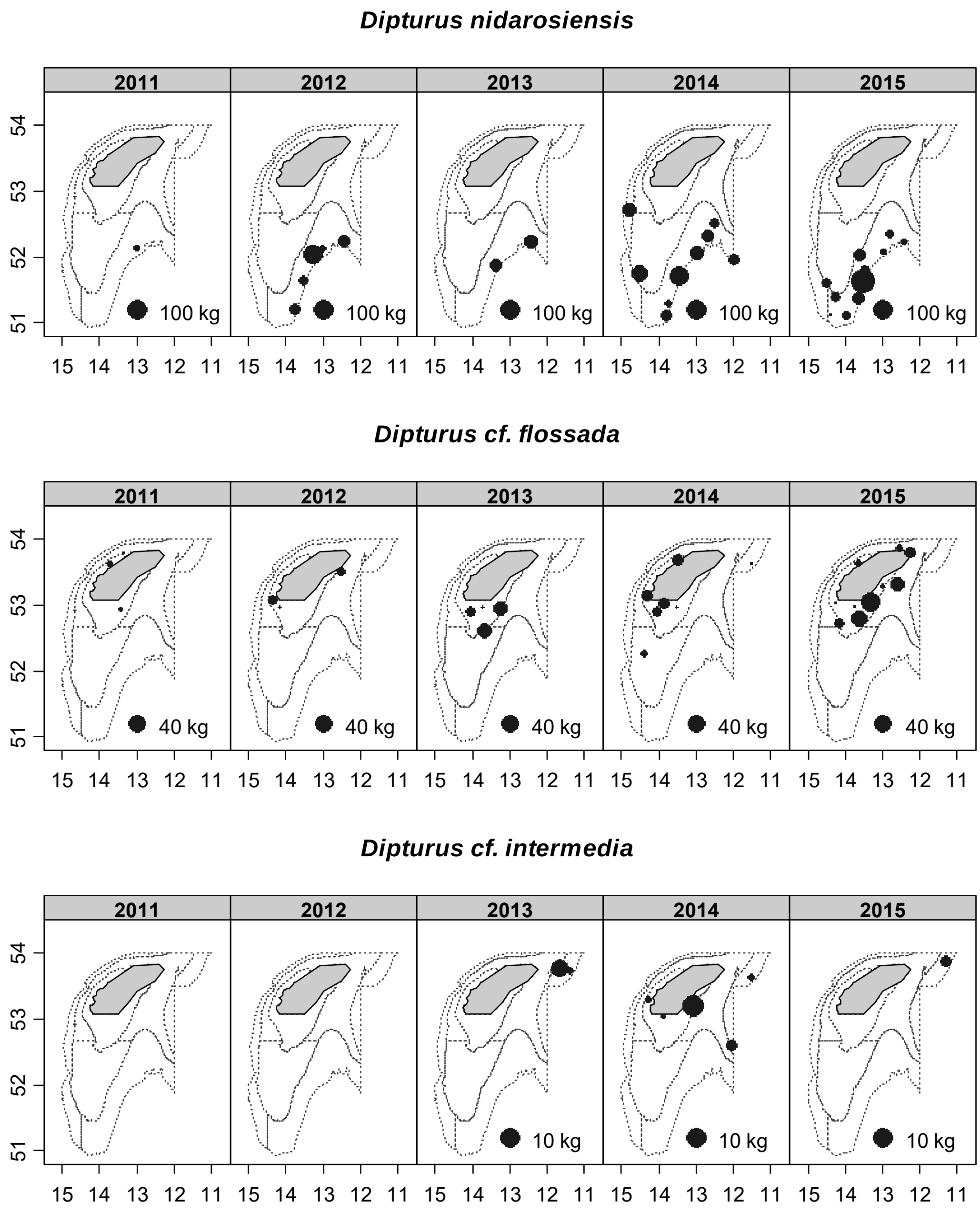

Figure 35 Geographic distribution of *Dipturus nidarosiensis*, *Dipturus cf. flossada* and *Dipturus cf. intermedia* catches (Kg· haul^{-1}) in Porcupine survey time series (2011-2015).

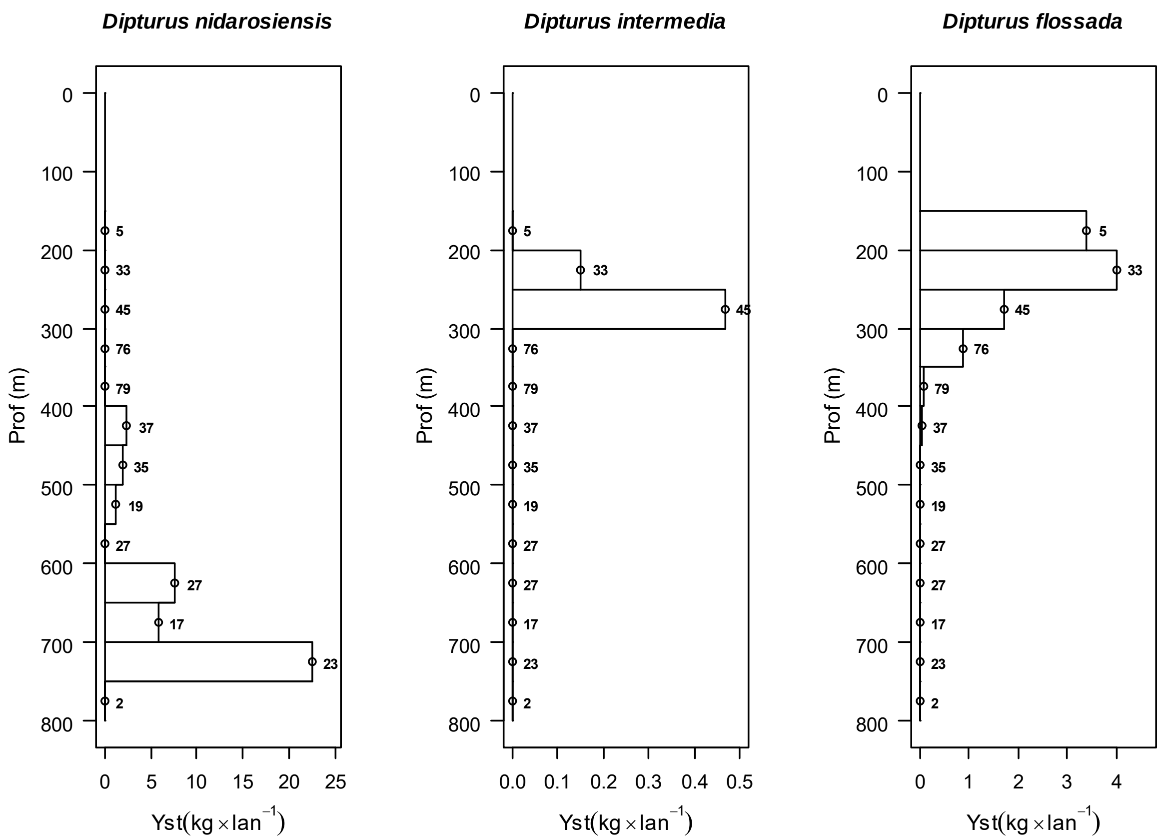

Figure 36 Depth distribution of *Dipturus nidarosiensis*, *Dipturus cf. flossada* and *Dipturus cf. intermedia* catches (kg/30 min haul) in North Spanish Shelf bottom trawl surveys from 2011 to 2015. Numbers mark total hauls.

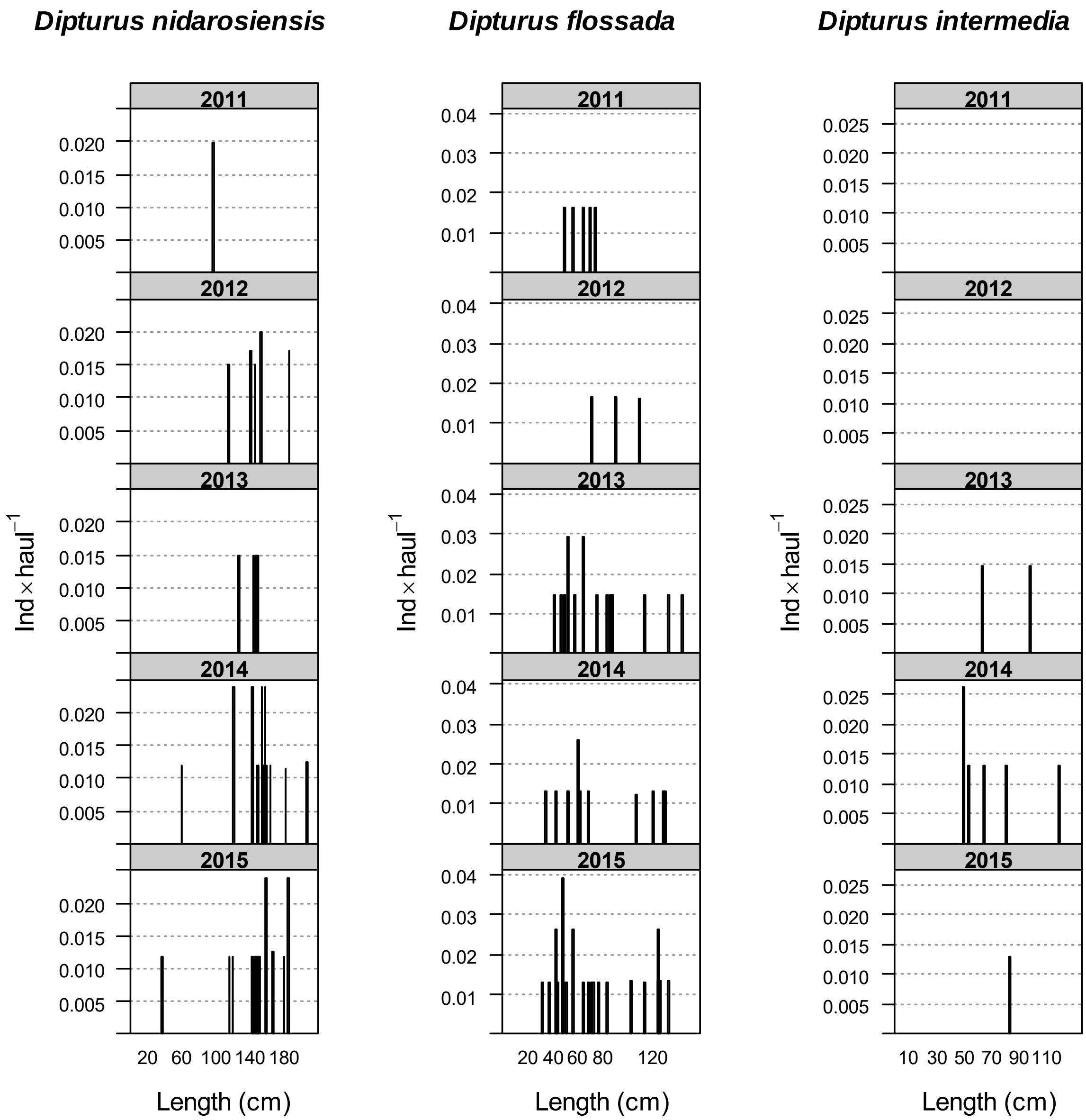

Figure 37 Mean Stratified length distribution of *Dipturus nidarosiensis*, *Dipturus cf. flossada* and *Dipturus cf. intermedia* from 2011 Porcupine surveys