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Results on main elasmobranch species captured during the 2001-2011 Porcupine Bank (NE Atlantic) bottom trawl surveys

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Abstract

This working document presents the results on nine of the most important elasmobranch species of the Porcupine bank Spanish surveys during the last decade (2001-2011). The shark species more abundant in these surveys in biomass terms were blackmouth catshark (Galeus melastomus), birdbeak dogfish (Deania calcea), Knifetooth dogfish (Scymnodon ringens), velvet belly lantern shark (Etmopterus spinax), lesser spotted dogfish (Scyliorhinus canicula) and bluntnose sixgill shark (Hexanchus griseus); while sandy ray (Leucoraja circularis), cuckoo ray (Leucoraja naevus) and common skate (Dipturus spp. / Dipturus cf. flossada) were the more frequent Rajidae. Biomass, distribution and length ranges were analysed. Many of these species occupy mainly the deep areas covered in the survey, especially D. calcea and S. ringens.

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, 2011a).

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 following the results presented previously (Velasco *et al.*, 2010; Fernández-Zapico *et al.*, 2011). The species analysed are: blackmouth catshark (*Galeus melastomus*), birdbeak dogfish (*Deania calcea*), Knifetooth dogfish (*Scymnodon ringens*), velvet belly lantern shark (*Etmopterus spinax*), lesser spotted dogfish (*Scyliorhinus canicula*), bluntnose sixgill shark (*Hexanchus griseus*), sandy ray (*Leucoraja circularis*), cuckoo ray (*Leucoraja naevus*), and common skate (*Dipturus* spp. */ Dipturus cf. flossada*).

Material and methods

The area covered in the Spanish Ground Fish Survey on the Porcupine bank (SPPGFS) (Figure 1) extends from longitude 12° W to 15° W and from latitude 51° N to 54° N, covering depths between 180 and 800 m. The cruises are carried out annually in

September/October on board R/V "Vizconde de Eza", a stern trawler of 53 m and 1800 Kw.
The sampling design used in this survey is 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, 2011a).
The distribution of the most common elasmobranch fish species is analysed in biomass and number terms for the eleven years of the overall time series and the length distribution. Two different methods were used to estimate abundance variability: (i) the parametric standard error derived from the random stratified sampling (Grosslein and Laurec, 1982), and (ii) a non-parametric bootstrap procedure implemented in R (R Development Core Team, 2008): re-sampling randomly with replacement stations within each stratum and maintaining the sampling intensity, and using 80% bootstrap confidence intervals from the 0.1 and 0.9 quantiles of the resultant distribution of bootstrap replicates (Efron and Tibshirani, 1993).

Results and discussion

In 2011, 80 standard hauls and 5 additional hauls were carried out (Figure 2). Mean total catch per haul was 437.9 ± 32.42 kg. Fishes represented about 93% of the total catch and elasmobranchs made up ca. 4% of the total fish catch.
The shark species with larger stratified biomass indices were blackmouth catshark (*Galeus melastomus*), then birdbeak dogfish (*Deania calcea*) and lastly knifetooth dogfish (*Scymnodon ringens*), velvet belly lantern shark (*Etmopterus spinax*), lesser spotted dogfish (*Scyliorhinus canicula*) and bluntnose sixgill shark (*Hexanchus griseus*). The skate species with larger stratified biomass were sandy ray (*Leucoraja circularis*), then cuckoo ray (*Leucoraja naevus*) and common skate (*Dipturus* spp).
D. calcea and *S. ringens* showed deeper distribution than *G. melastomus, E. spinax* and *S. canicula*. On the other hand, *L. naevus and Dipturus* spp. was mainly found around the central mound of Porcupine bank while *L. circularis* showed a wider distribution.
Regarding the length distribution, the shark species which showed wider range sizes were *D. calcea, S. ringens* and *H. griseus* and regarding the skates, *L. naevus* showed narrower size range than *L. circularis*.

Blackmouth catshark (*Galeus melastomus*)

This species represented about 56% of the elasmobranchs mean stratified biomass caught and about 73% of the elasmobranchs mean stratified abundance. The stratified biomass and abundance trend were similar. Although a lower capture was found in 2011, *G. melastomus* showed a steady increasing trend during the last four years after the remarkable drop in 2006 (Figure 3).
G. melastomus was mainly found in the southern part of the survey area. Higher biomass was found in the deepest South sector between 450 and 800 m (Figure 4).
Catshark length size in the last survey ranged from 11 cm to 77 cm. In 2011, the sizes were similar to the mean values of the series with a marked mode around 60 cm (Figure 5).

Birdbeak dogfish (*Deania calcea*)

This species represented a small percentage of the elasmobranchs mean stratified biomass caught (13%) and of the stratified abundance caught (3%). Although higher capture was found in 2011 (Figure 6), the stratified biomass and abundance was quite variable in the overall time series may be due to the fact that this species dwells in the depth limits covered in this survey as pointed out in Velasco *et al.* (2010). It was found between 490 m and 800 m in the overall time series and the highest biomass was in the westernmost area, resembling the 2006 and 2010 pattern (Figure 7).

Far fewer small specimens were found in 2011. Although the length size of this last survey ranged from 39 cm to 111 cm, it has been the year with less individuals smaller than 65 cm in the time series, with an abundance of only 0.02 individuals per haul (Figure 9). In 2011, one marked mode was evident around 84 cm and a smaller one around 100 cm, similar to the modes found years before (Figure 8).

Knifetooth dogfish (*Scymnodon ringens*)

This species represented a small percentage of the elasmobranchs mean stratified abundance caught (8%) and of the stratified biomass caught (2%). The stratified biomass showed a rise after the drop in 2005, while the stratified abundance have remained fairly stable in the last six years (Figure 10).

S. ringens appears in the muddy slopes of the Porcupine Seabight southeast of the survey area, as shown in Velasco *et al.* (2010). The last survey showed as well this pattern, but high biomass was also found in the westernmost area, that before were found in just one haul in 2007 and 2008 (Figure 11). It was found between 465 m and 800 m in the overall time series.

The *S. ringens* sizes ranged between 32 cm and 134 cm in 2011, although a marked mode was found around 73 cm (Figure 12). That last survey showed the largest size range in the eleven years of the series.

Velvet belly lantern shark (*Etmopterus spinax*)

E. spinax just represented about 7% of the elasmobranchs mean stratified biomass caught while it showed about 17% of the stratified abundance caught. The stratified biomass and abundance were low in the overall time series, although a marked peak was found in 2006 and another two smaller ones in 2003 and 2009. The capture in 2011 was markedly low (Figure 13).

No clear pattern was found in the geographical distribution of *E. spinax.* Higher biomass were found in the eastern part of the central mound of Porcupine Bank around 350 m, but was also found frequently close to the 450 m boundary in the western and Northern area and between 450 m and 800 m in the southern part of the survey area (Figure 14).

E. spinax showed the narrowest length range of the elasmobranchs reported in these surveys. Specimens ranged from 10 cm to 52 cm in 2011 and no clear mode was found.

Lesser spotted dogfish (*Scyliorhinus canicula*)

This species represented a small percentage of the elasmobranchs mean stratified abundance caught (5%) and biomass caught (3%). The biomass and abundance of this species have shown an increasing trend in the last years. In 2011 this trend was again confirmed with a higher biomass value around 1.8 Kg per haul (Figure 16).

In 2011, geographic distribution of biomass was also clearly related to the Irish shelf, as reported before (Velasco *et al.*, 2010; Fernández-Zapico *et al.*, 2011) but also higher capture was shown in the northwest of the bank around 300 m (Figure 17).

The minimum length size of *S. canicula* in 2011 was 20 cm and the maximum 81 cm. Some individuals smaller than 40 cm were shown in the last survey in contrast with the lack of sizes smaller than 40 cm in the previous two years. Although individuals smaller than 55 cm are relatively scarce in this area, peaks in biomass and abundance related with small sizes, were reported in 2007 and 2008 (Velasco *et al.*, 2010). The higher biomass and abundance in 2011 may also correspond to the apparition of these small sizes (Figure 18).

Bluntnose sixgill shark (*Hexanchus griseus*)

This species represented a small percentage of the elasmobranchs mean stratified abundance caught (4%) and of the stratified biomass caught (0.4%). The stratified biomass and abundance was quite steady over the previous seven years between 0.5 and 1 Kg per haul, as the capture around 0.9 Kg per haul during the last survey (Figure 19).
H. griseus extended throughout the Porcupine area with no clear pattern in the geographical distribution, but in 2011 although no catches were found in the southernmost tip of the area, the species was more spreaded along the area (Figure 20).
H. griseus length distribution ranged from 64 cm to 139 cm in 2011(Figure 21).

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

These two species of rays represented small percentages of the elasmobranchs mean stratified biomass caught (around 2%) and abundance caught (around 1%) in the time series. The increasing trend of biomass and abundance of *L. circularis* in the last years were confirmed with the higher value in 2011 (around 0.6 Kg per haul) in the same way as the low biomass and abundance of *L. circularis* in 2011 (around 0.2 Kg per haul) confirmed the decreasing trend in the last years (Figure 22; Figure 25).
In 2011, *L. circularis* extended throughout the west Porcupine area, with higher biomass in the northwest than previous years, while *L. naevus* was mainly around the central mound of Porcupine bank with lesser biomass located in the south than previous surveys (Figure 23; Figure 26).
L. circularis sizes ranged between 18 cm and 104 cm in 2011, while *L. naevus* showed a narrower length range from 37 cm to 60 cm. Some small specimens of *L. circularis* were shown during the last survey despite the fact that individuals smaller than 32 cm are very scarce, whereas no specimen of *L. naevus* smaller than 37 cm appeared in contrast with previous years (Figure 24; Figure 27).

Common skate (*Dipturus* spp.)

The common skate *Dipturus batis,* has been recently separated in two species, *Dipturus cf. flossada and Dipturus cf. intermedia* (Iglésias *et al,* 2009). Up to date, the information these species was not split for the Porcupine survey, and it was identified as *Dipturus batis* complex. A special request is addressed to ICES for advice on an individual species basis for the two components of the common skate. The results previously reported in the Porcupine area as *Dipturus batis* are now merged into *Dipturus* spp. Meanwhile in 2011, a careful identification was made in order to split the components of the *D.batis* complex, and all the individuals found were identified as *Dipturus cf. flossada,* therefore data for this species in the that last survey is presented below, together with the trends of *Dipturus* spp. in the overall time series.
Dipturus spp. only represented about 1% of the elasmobranchs mean stratified biomass caught and about 0.2% of the stratified abundance caught. The WGCSE (Working Group for the Celtic Seas Ecoregion) (ICES, 2011b) noted that this species has declined in inshore areas of northern Europe, but the common skate in the Porcupine area showed a steady pattern in the overall time series, although the abundances are small,

especially in terms of number, given that the biomass is greatly influence by the appearance of big skates. Nevertheless, the stratified biomass in 2011, which correspond with *Dipturus cf. flossada*, decreased after the remarkable peak in the previous year, although the stratified abundance remained at stable values around 0.05 kg per haul during the last four years (Figure 28).
Dipturus spp. was mainly found around the mound in the centre of the bank (Figure 29) and it showed a wide bathymetric range between 190 m and 740 m in the overall time series. In 2011, *Dipturus cf. flossada* also showed a similar distribution (Figure 30) and was found between 230 m and 320 m.
Regarding the length distribution, *Dipturus* spp. captured in the time series ranged from 20 cm to 177 cm, while *Dipturus cf. flossada* captured in 2011 showed a narrower range from 49 cm to 74 cm (Figure 31).

Other elasmobranch species

Other species with less abundance have been previously reported in the area (Velasco *et al.*, 2010; Fernández-Zapico *et al*., 2011), namely *Centroscymnus coelolepi*, *Centroscymnus crepidater*, *Centrophorus squamosus*, *Dalatias licha*, *Galeus murinus*, *Galeorhinus galeus*, *Raja clavata*, *Leucoraja fullonica*, *Dipturus nidarosiensis* and *Rajella fyllae.* However, in 2011 only *D. nidarosiensis and R. clavata* were caught.

Acknowledgements

We would like to thank R/V Vizconde de Eza crews and the scientific teams from IEO, Marine Institute and AZTI that made the Porcupine Surveys possible.

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Figures

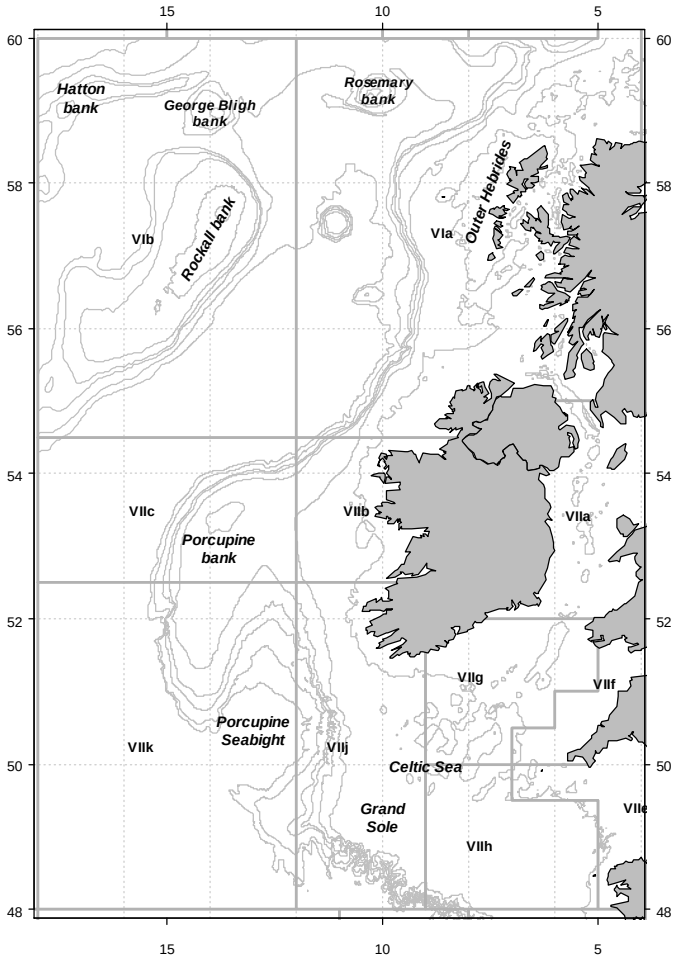

Figure 1. North eastern Atlantic showing the Porcupine bank, Porcupine Seabight, and ICES divisions.

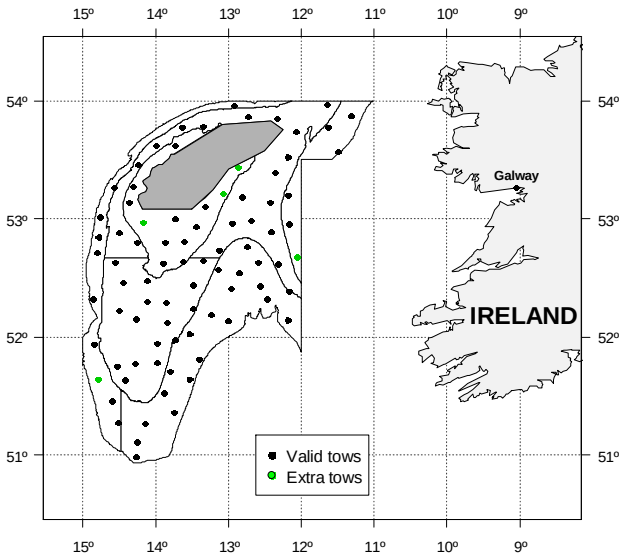

Figure 2. Stratification design and hauls in 2011 Porcupine surveys; Straight lines show geographical sectors (North and South) and the isobaths delimit the three depth strata (> 300 m, 300 – 450 m and 450 - 800 m).

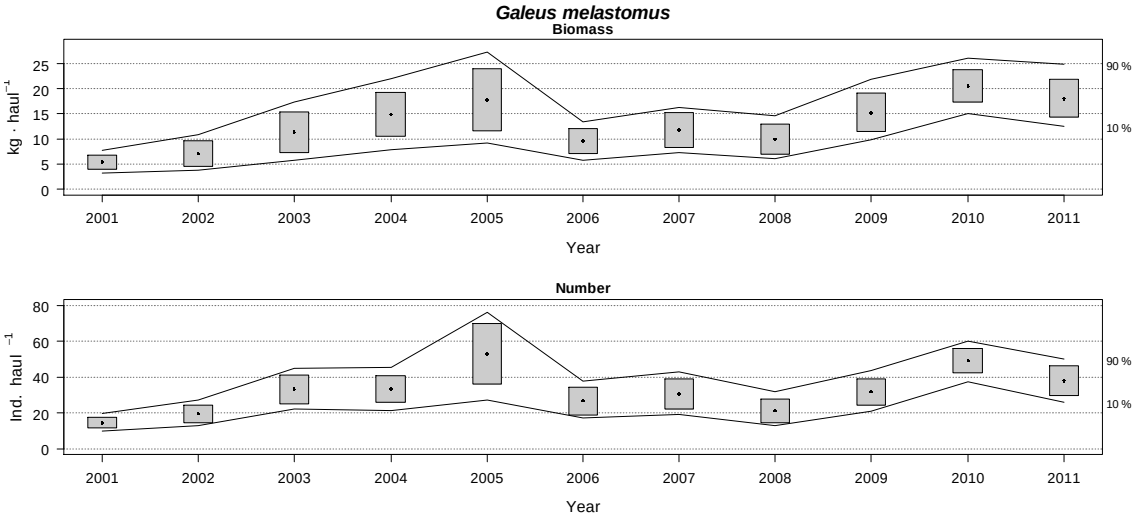

Figure 3. Changes in blackmouth catshark (*Galeus melastomus*) biomass index and abundance during Porcupine survey time series (2001-2011). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000).

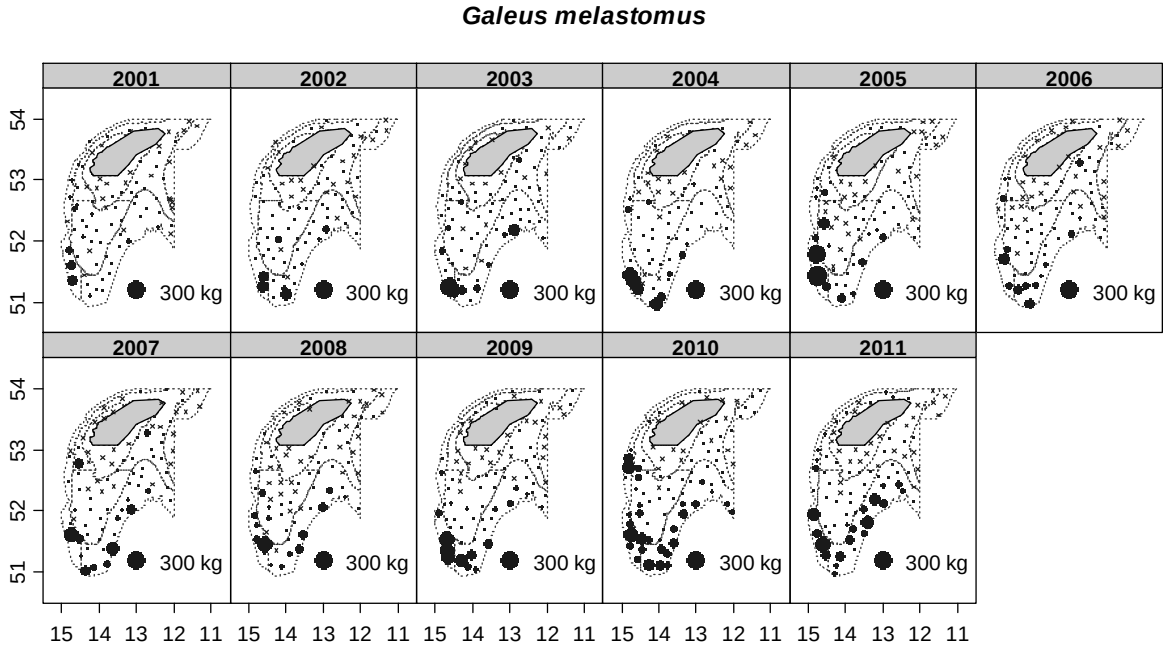

Figure 4. Geographic distribution of blackmouth catshark (*G. melastomus*) catches (kg·haul^{-1}) during Porcupine survey time series (2001- 2011).

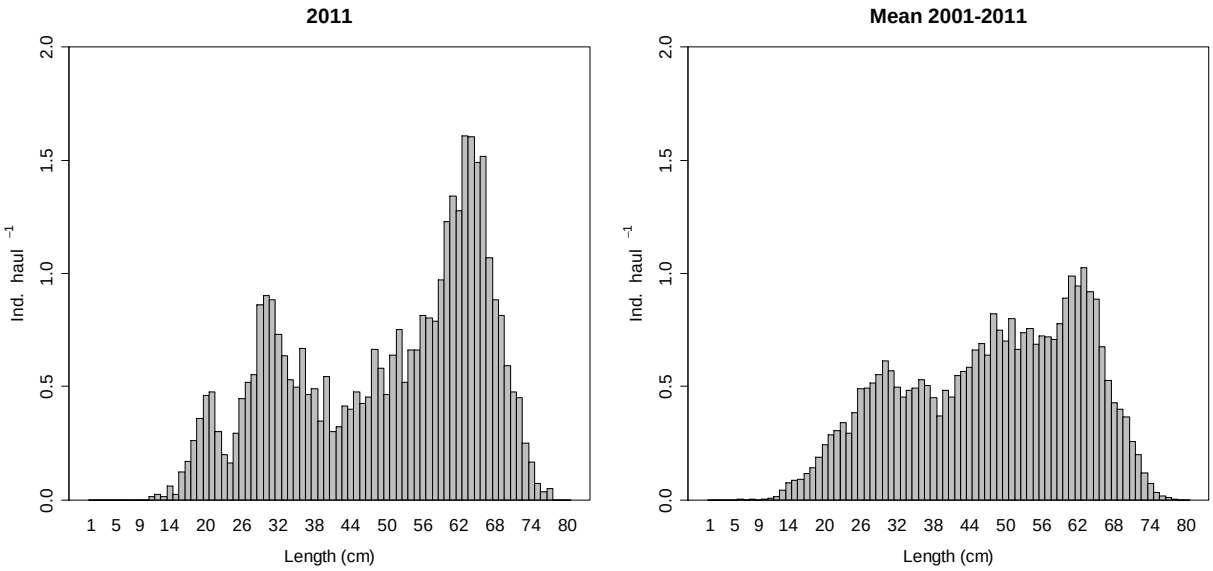

Figure 5. Stratified length distributions of blackmouth catshark (*G. melastomus*) in 2011 Porcupine survey, and mean values during Porcupine survey time series (2001-2011).

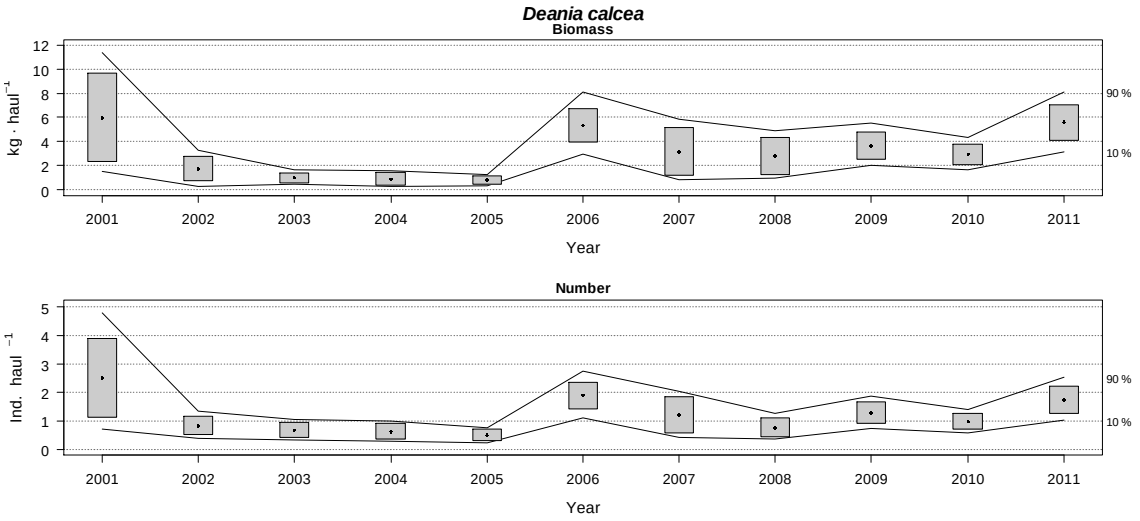

Figure 6. Changes in birdbeak dogfish (*Deania calcea*) biomass index (kg·haul-1) during Porcupine survey time series (2001-2011). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations =1000).

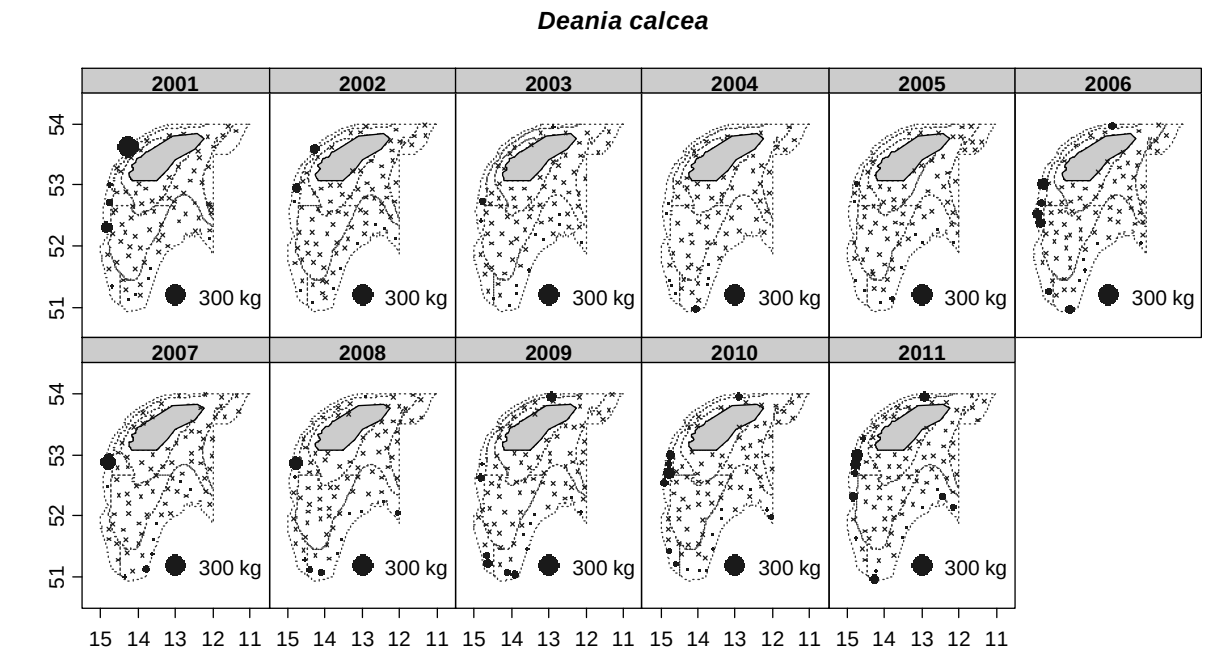

Figure 7. Geographic distribution of birdbeak dogfish (*D. calcea*) catches (kg·haul^{-1}) during Porcupine survey time series (2001- 2011).

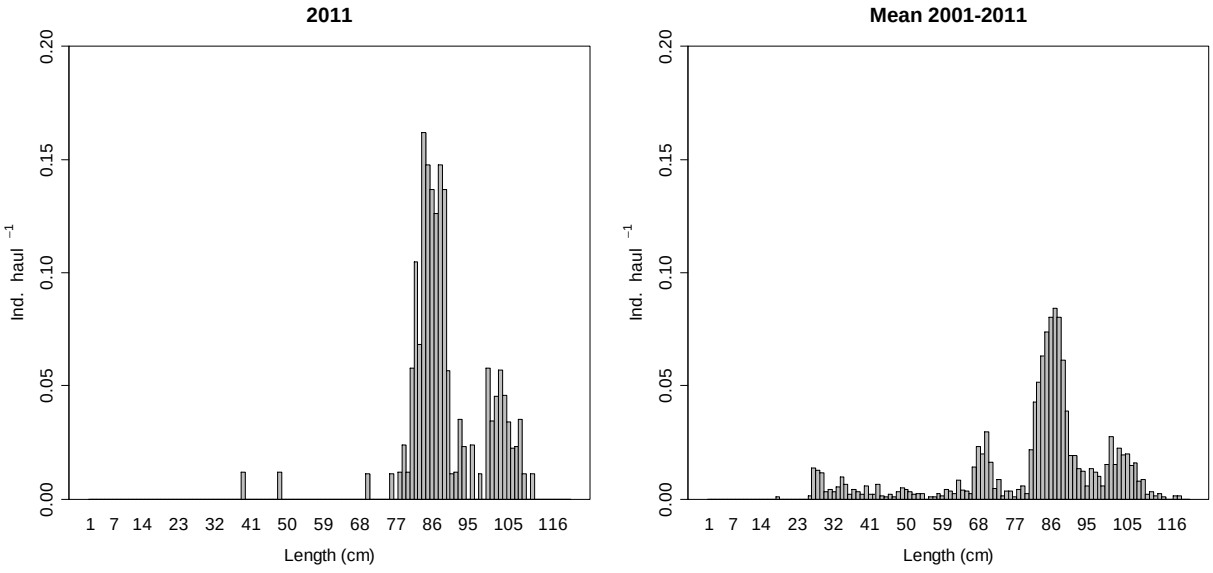

Figure 8. Stratified length distributions of *Deania calcea* in 2011 Porcupine survey, and mean values during Porcupine survey time series (2001-2011).

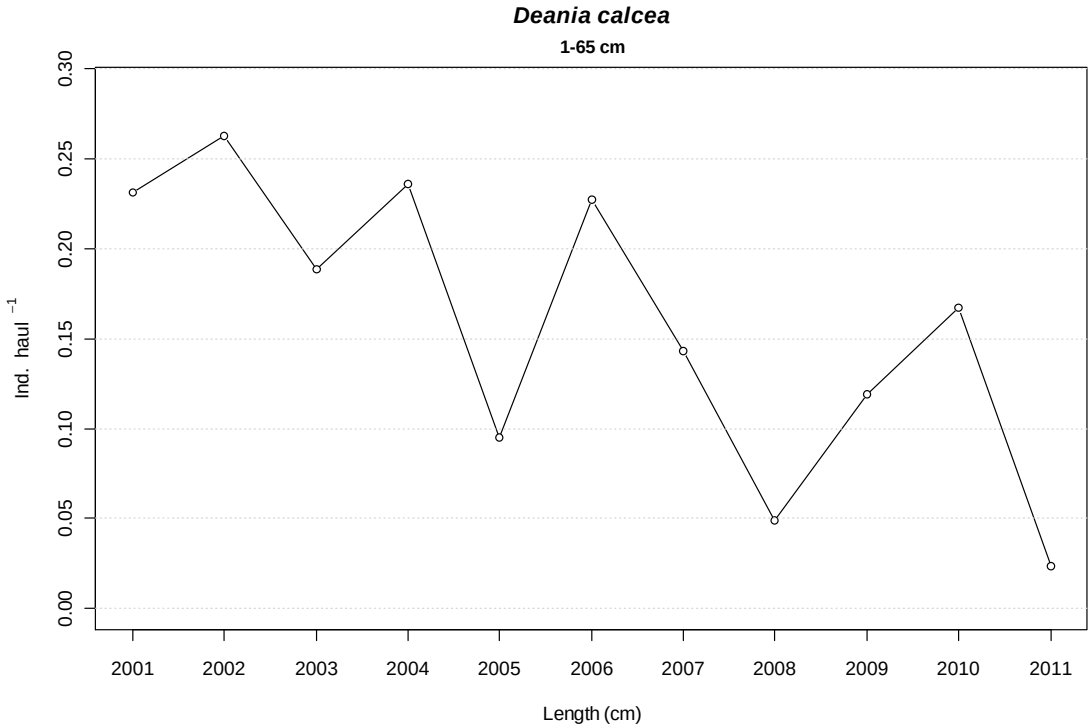

Figure 9. Abundance of *Deania calcea* smaller than 65 cm during Porcupine survey time series (2001-2011).

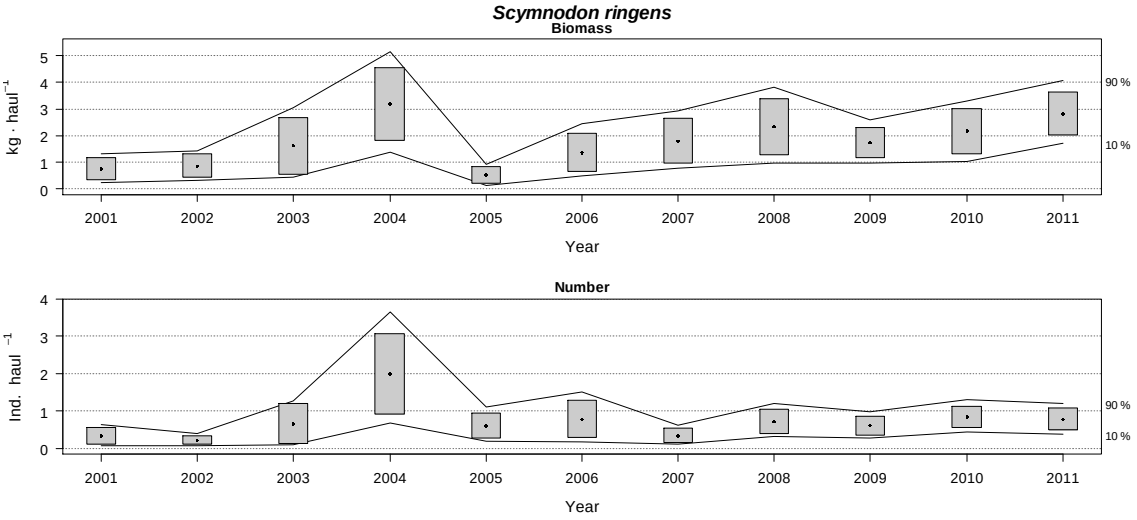

Figure 10. Changes in knifetooth dogfish (*Scymnodom ringens*) biomass index (kg·haul-1) during Porcupine survey time series (2001-2011). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000).

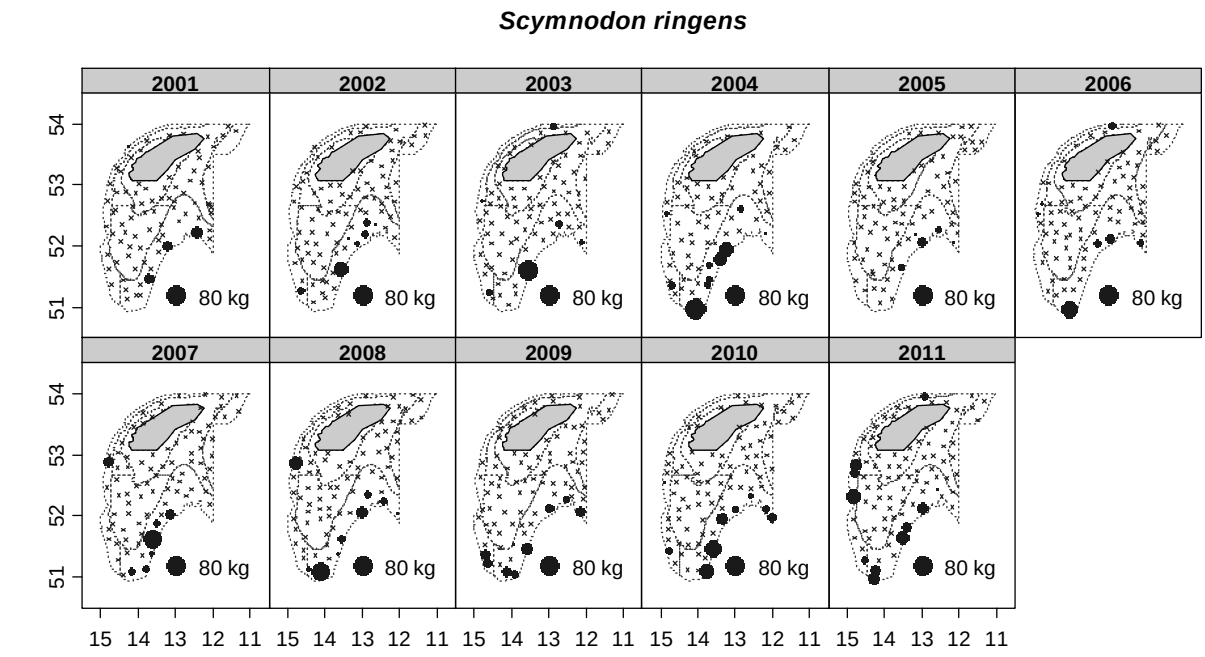

Figure 11. Geographic distribution of knifetooth dogfish (*S. ringens*) catches (kg·haul^{-1}) during Porcupine survey time series (2001- 2011).

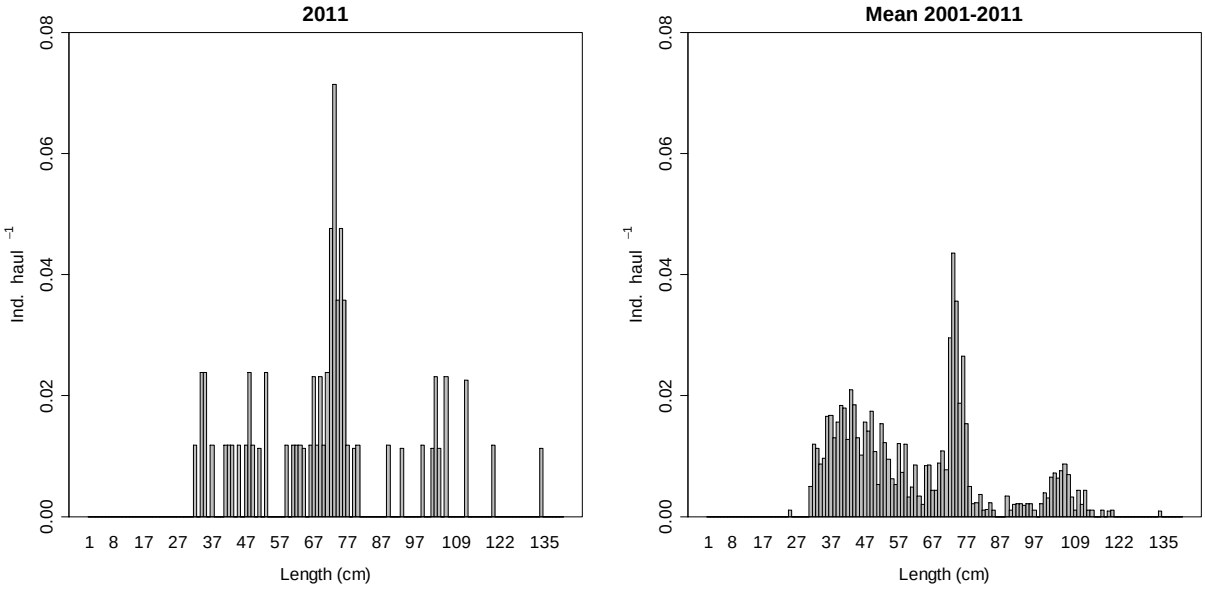

Figure 12. Stratified length distributions of knifetooth dogfish (*S. ringens*) in 2010 in Porcupine survey, and Mean values during Porcupine survey time series (2001-2010).

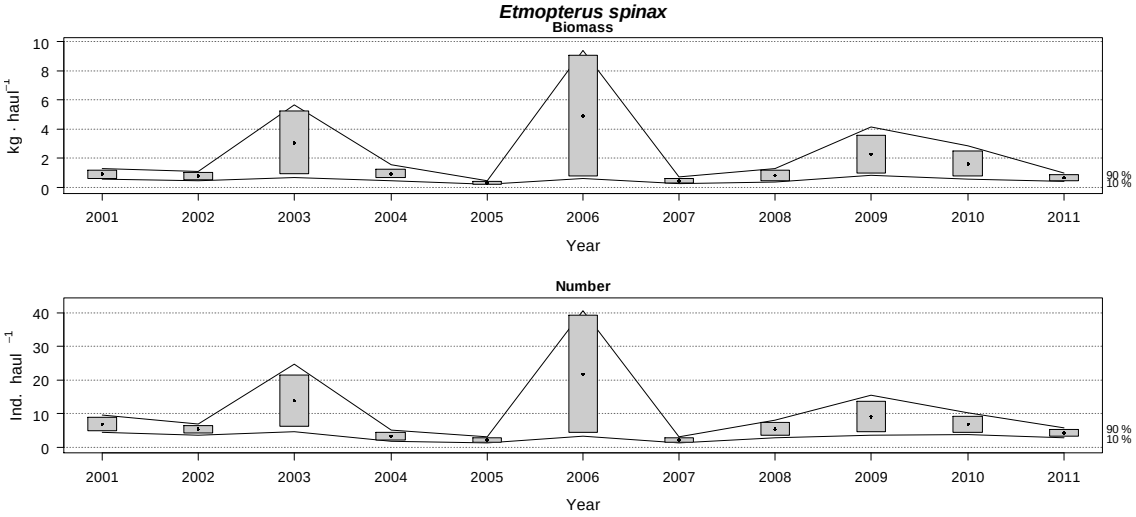

Figure 13. Changes in velvet belly (*Etmopterus spinax*) biomass index (kg·haul^{-1}) during Porcupine survey time series (2001-2011). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations =1000).

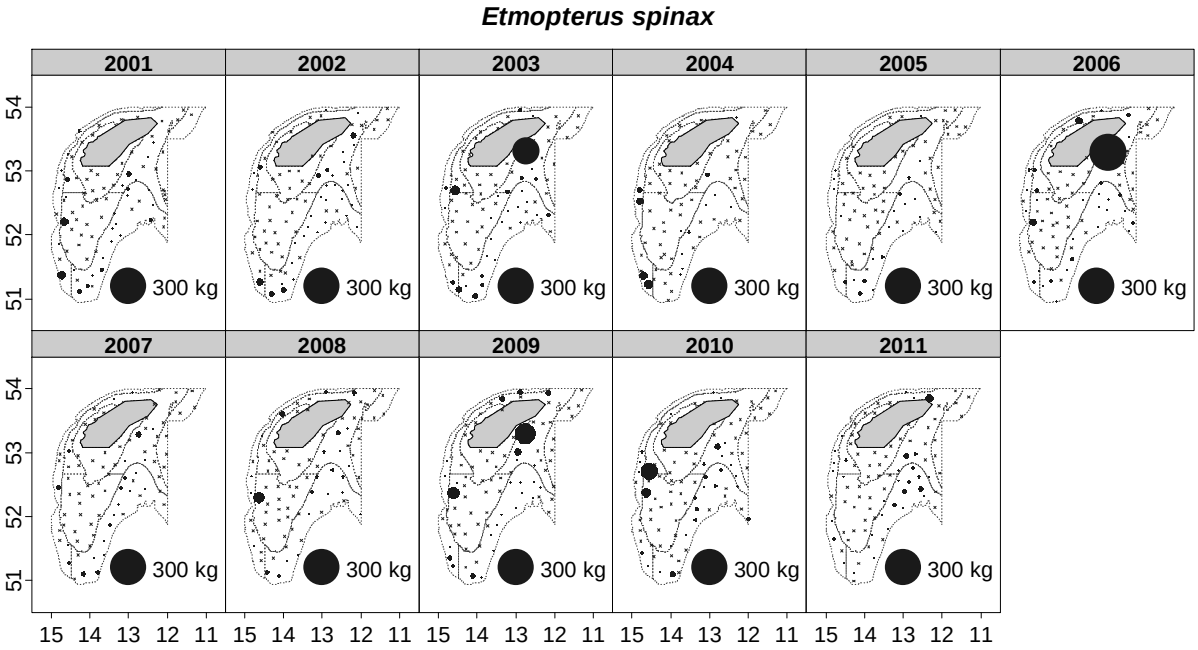

Figure 14. Geographic distribution of velvet belly (*E. spinax*) catches (kg·haul^{-1}) during Porcupine surveys time series (2001- 2011).

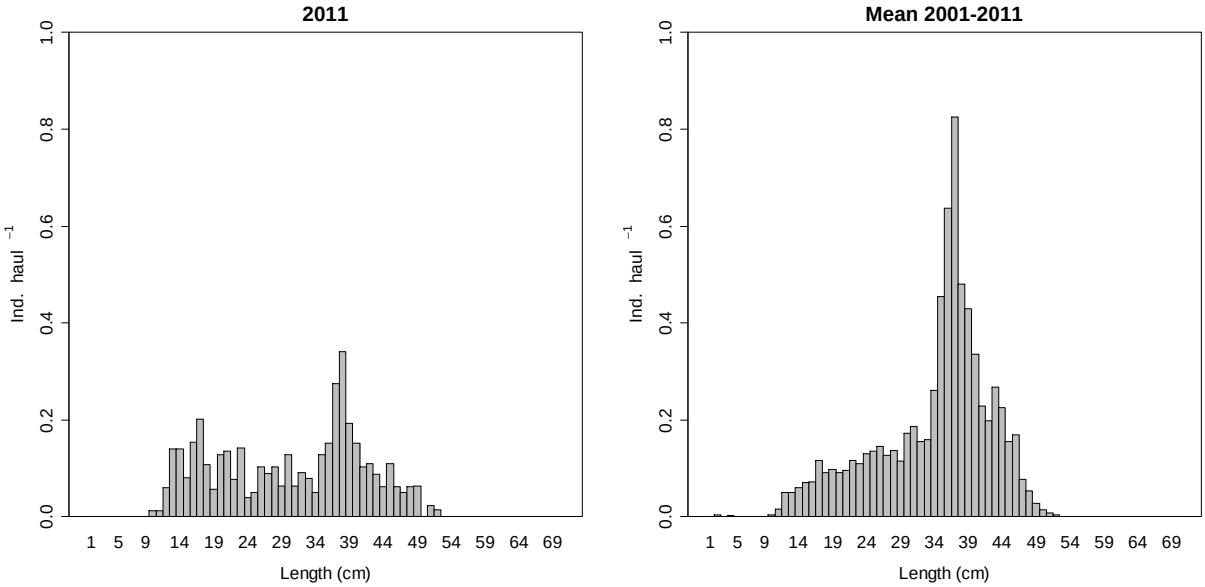

Figure 15. Stratified length distributions of velvet belly (*E. spinax*) in 2011 Porcupine survey, and mean values during Porcupine survey time series (2001-2011).

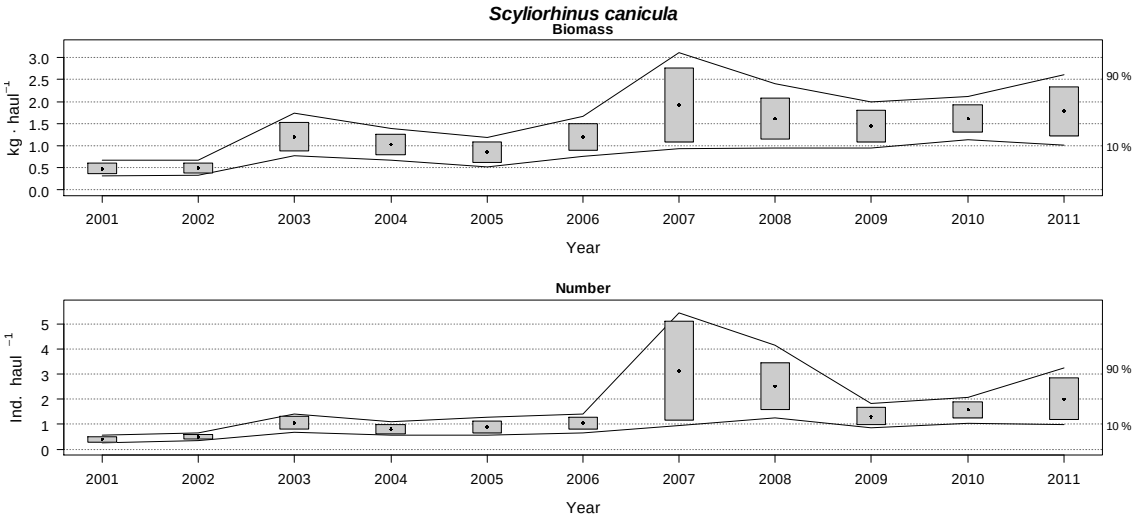

Figure 16. Changes in lesser-spotted dogfish (*Scyliorhinus canicula*) biomass index (kg·haul^{-1}) during Porcupine survey time series (2001-2011). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000).

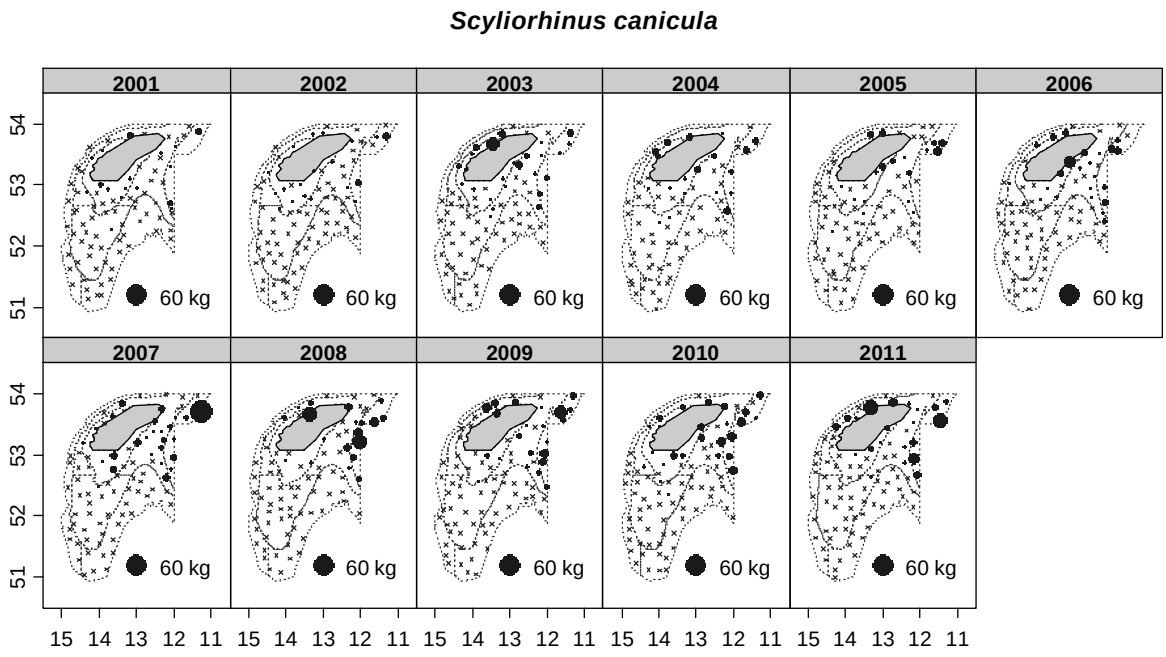

Figure 17. Geographic distribution of lesser spotted dogfish (*S. canicula*) catches (kg·haul-1) in Porcupine survey time series (2001-2011).

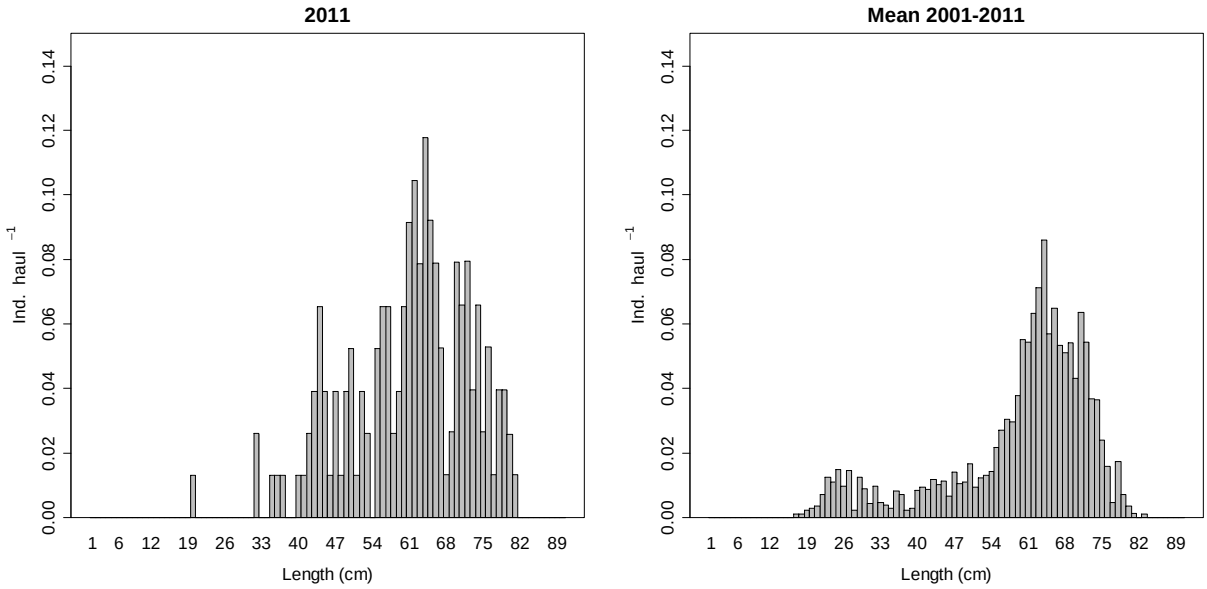

Figure 18. Stratified length distributions of lesser spotted dogfish (*S. canicula*) in 2011 in Porcupine survey, and mean values during Porcupine survey time series (2001-2011).

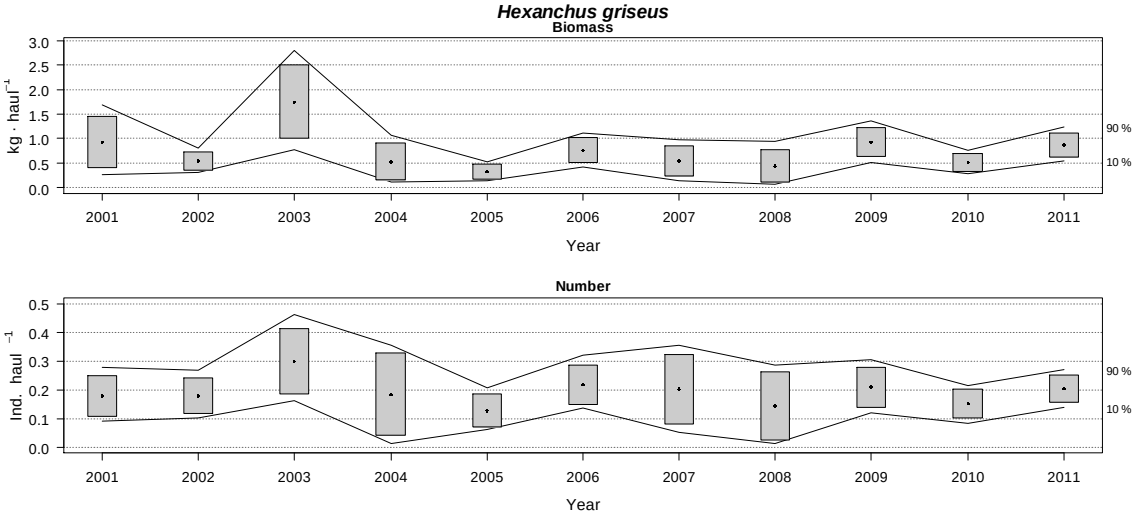

Figure 19. Changes in bluntnose sixgill shark (*Hexanchus griseus*) biomass index (kg•haul-1) during Porcupine survey time series (2001-2011). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000).

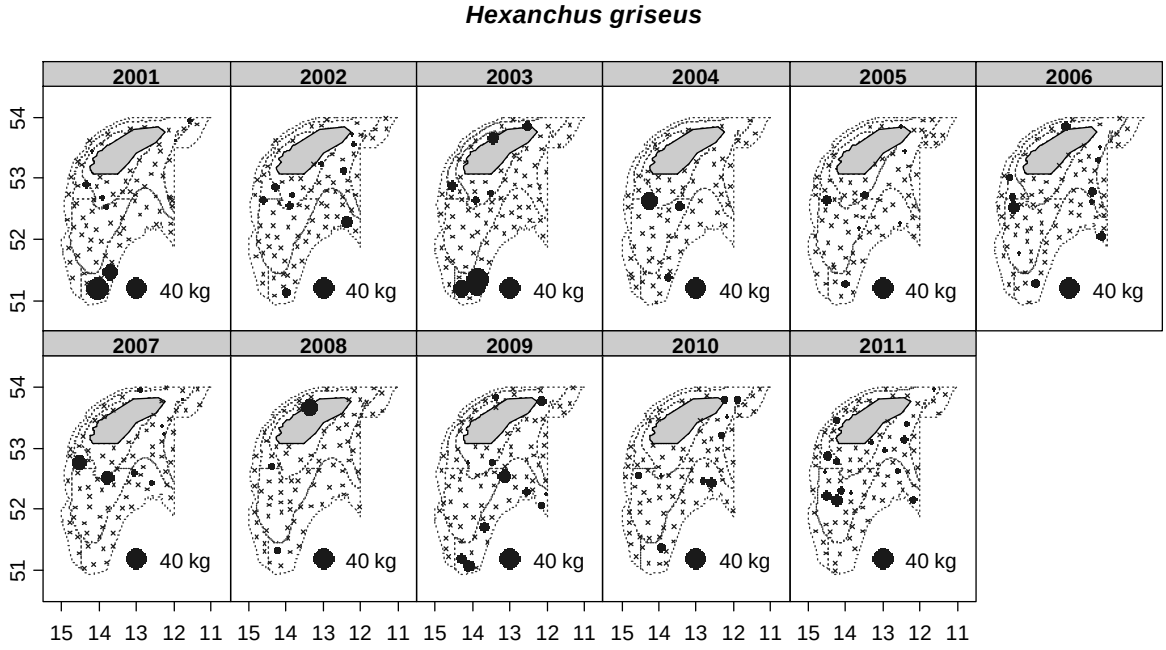

Figure 20. Geographic distribution of bluntnose sixgill shark (*H. griseus*) catches (ind · haul^{-1}) in Porcupine surveys (2001-2011).

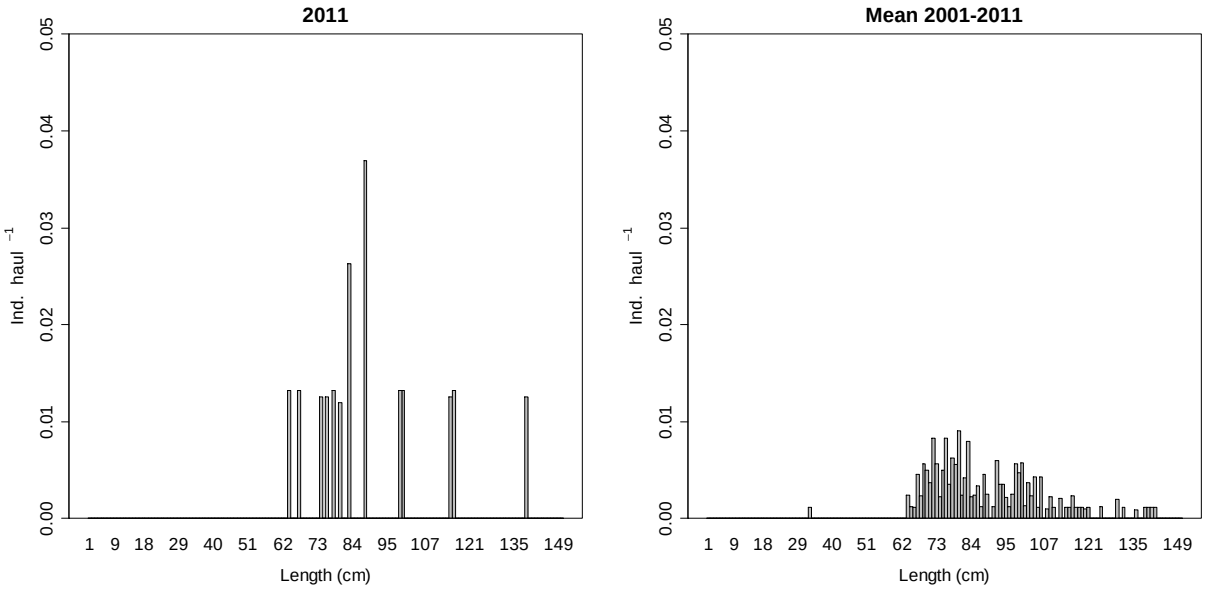

Figure 21. Stratified length distributions of bluntnose sixgill shark (*H. griseus*) in 2011 Porcupine survey and mean values during Porcupine survey time series (2001-2011).

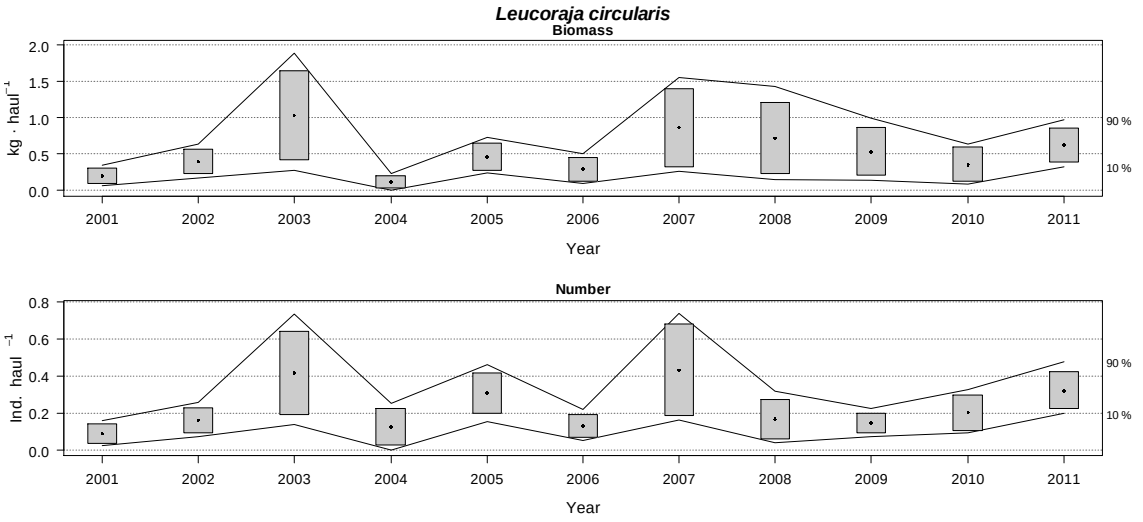

Figure 22. Changes in sandy ray (*Leucoraja circularis*) biomass index (kg·haul^{-1}) during Porcupine survey time series (2001-2011). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations =1000).

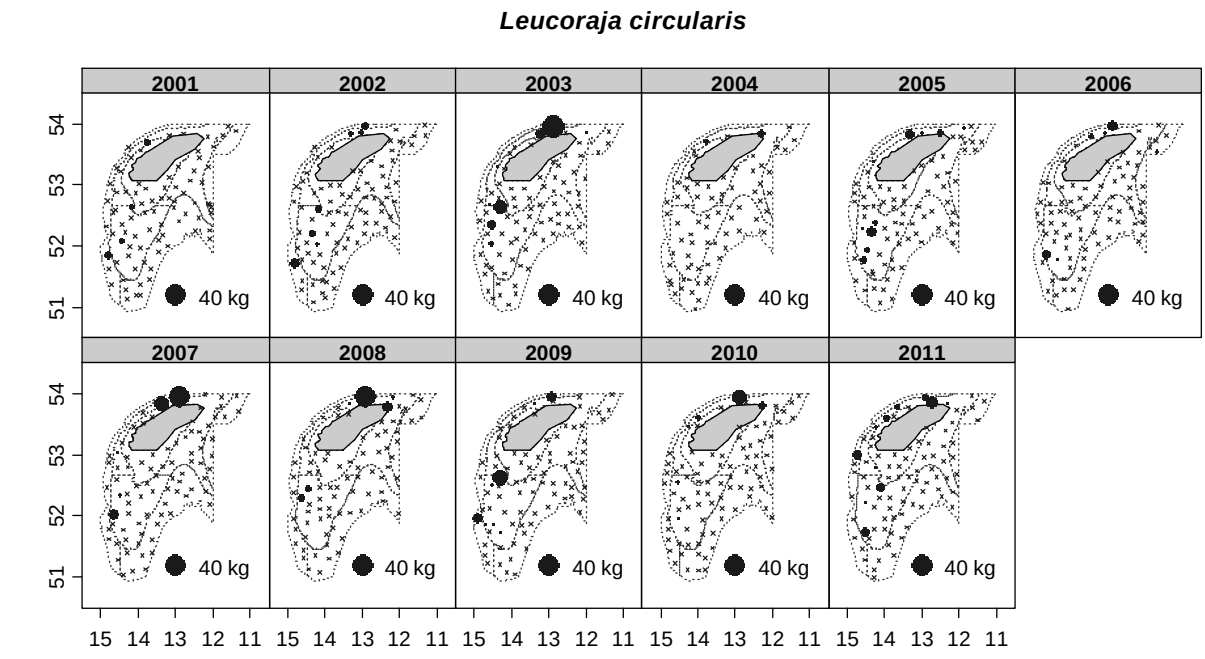

Figure 23. Geographic distribution of sandy ray (*L. circularis*) catches (kg·haul^{-1}) in Porcupine survey time series (2001-2011).

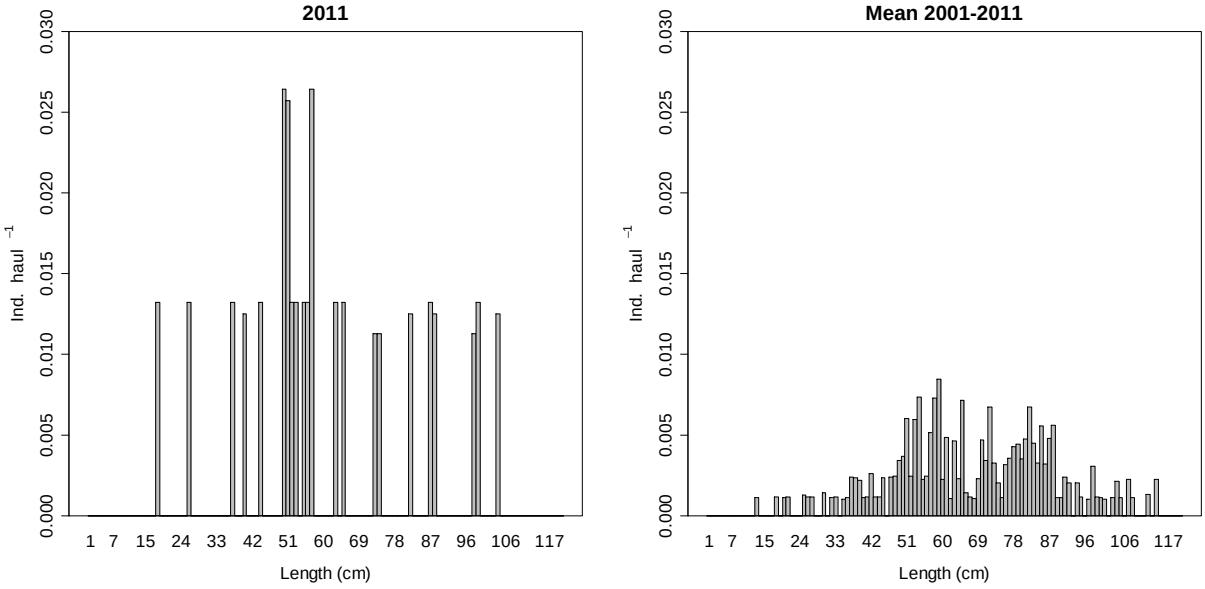

Figure 24. Stratified length distributions of sandy ray (*L. circularis*) in 2011 Porcupine survey, and mean values during Porcupine survey time series (2001-2011).

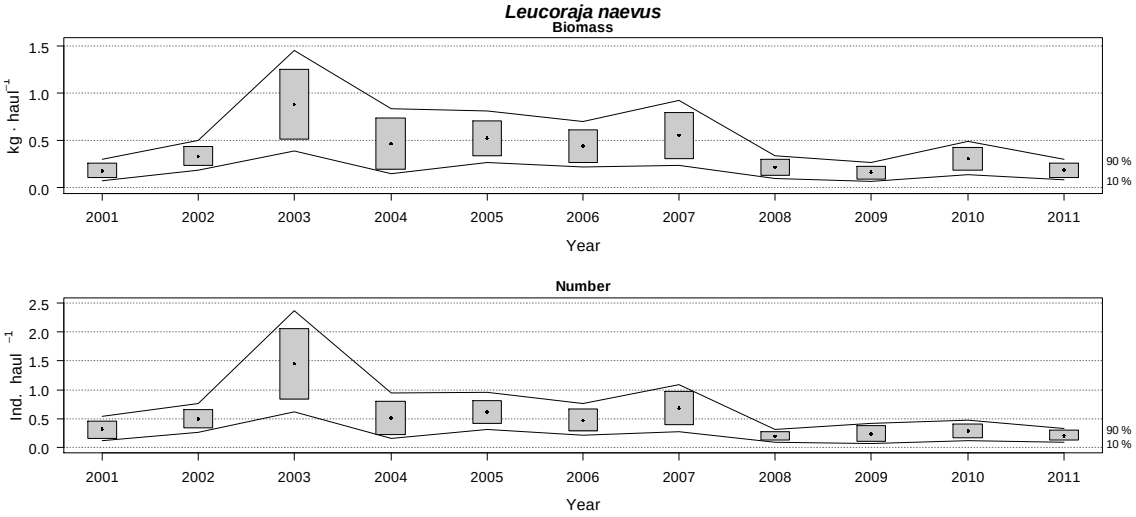

Figure 25. Changes in Cuckoo ray (*Leucoraja naevus*) biomass index (kg·haul^{-1}) during Porcupine survey time series (2001-2011). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000).

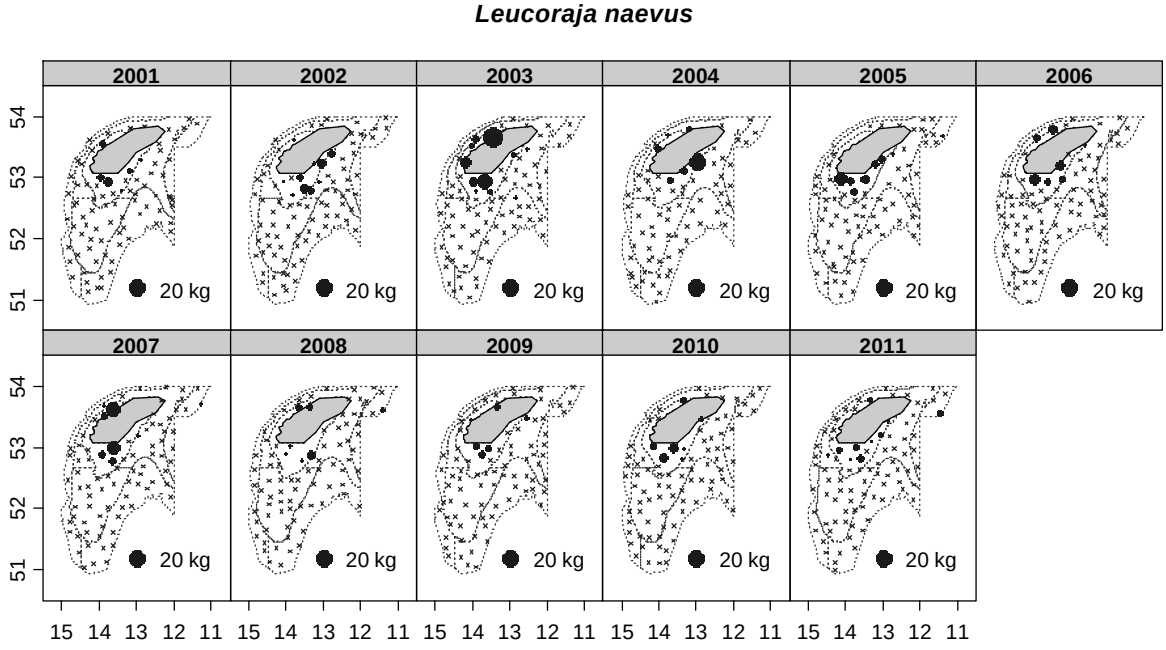

Figure 26. Geographic distribution of cuckoo ray (*L. naevus*) catches (ind · haul^{-1}) during Porcupine survey time series (2001- 2011).

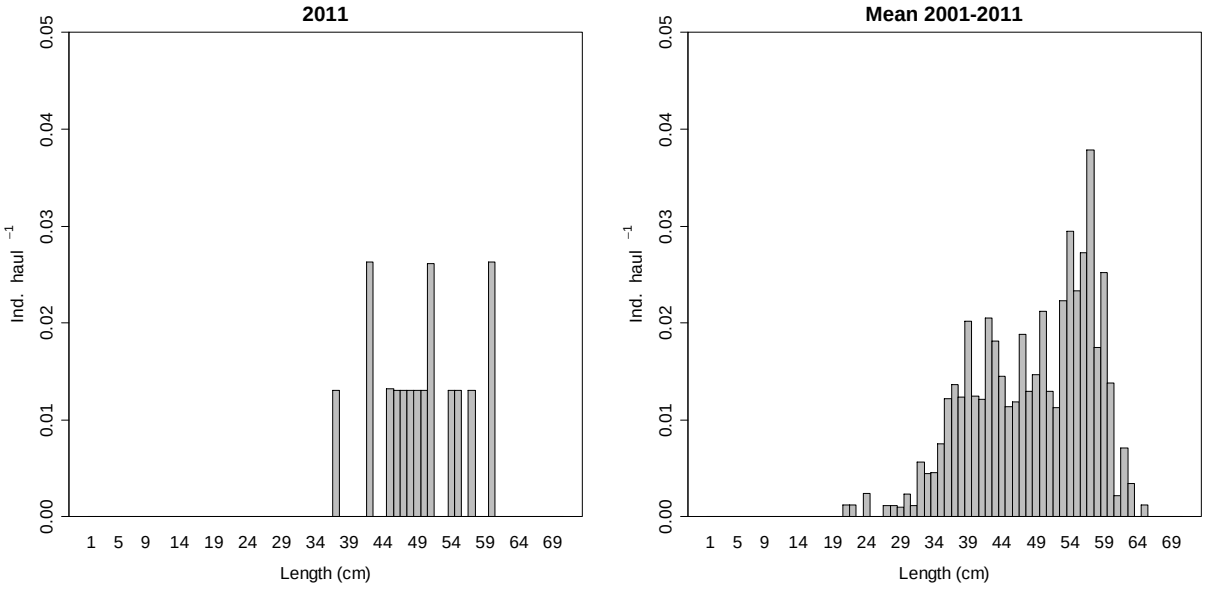

Figure 27. Stratified length distributions of cuckoo ray (*L. naevus*) in 2011 Porcupine survey, and mean values during Porcupine survey time series (2001-2011).

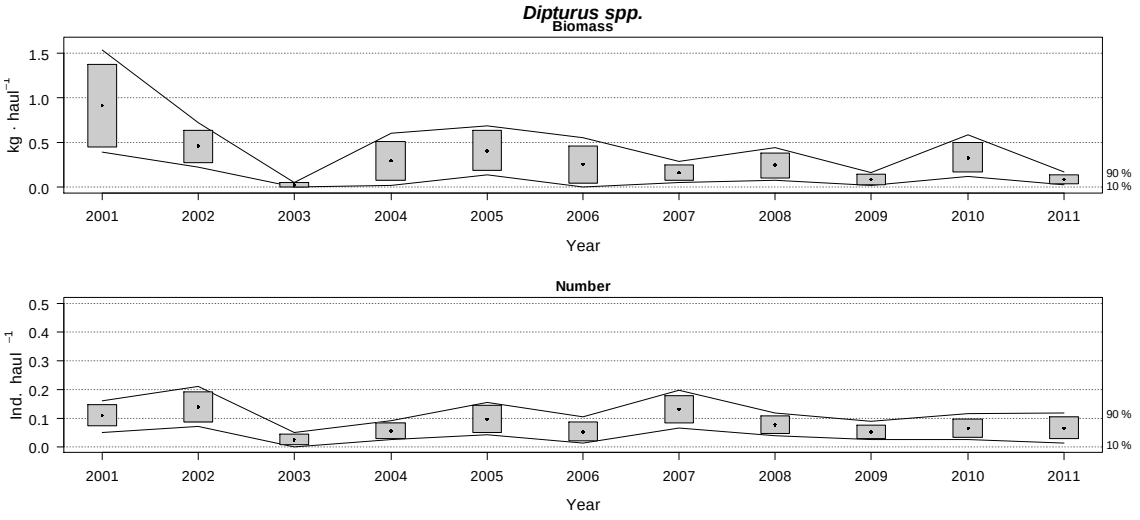

Figure 28. Changes in common skate (*Dipturus* spp.) biomass index (kg.haul^{-1}) during Porcupine survey time series (2001-2011). Boxes mark parametric standard error of the stratified index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000).

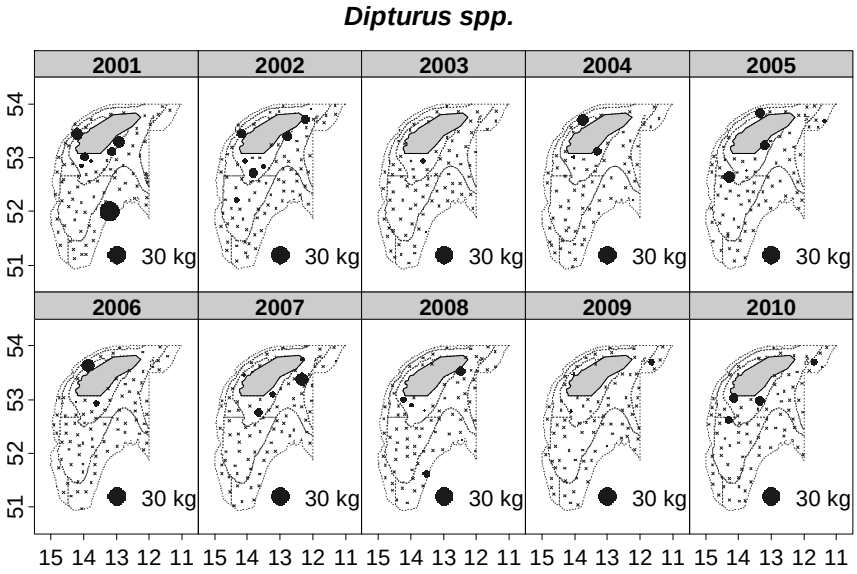

Figure 29. Geographic distribution of common skate (*Dipturus* spp.) catches (ind. · haul-1) in Porcupine survey time series (2001-2010).

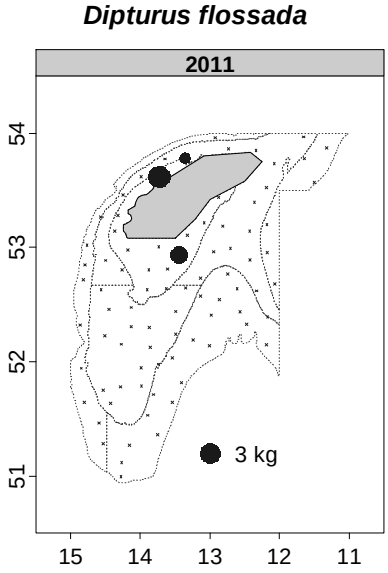

Figure 30. Geographic distribution of common skate (*Dipturus cf. flossada*) catches (ind. · haul-1) in 2011 Porcupine survey.

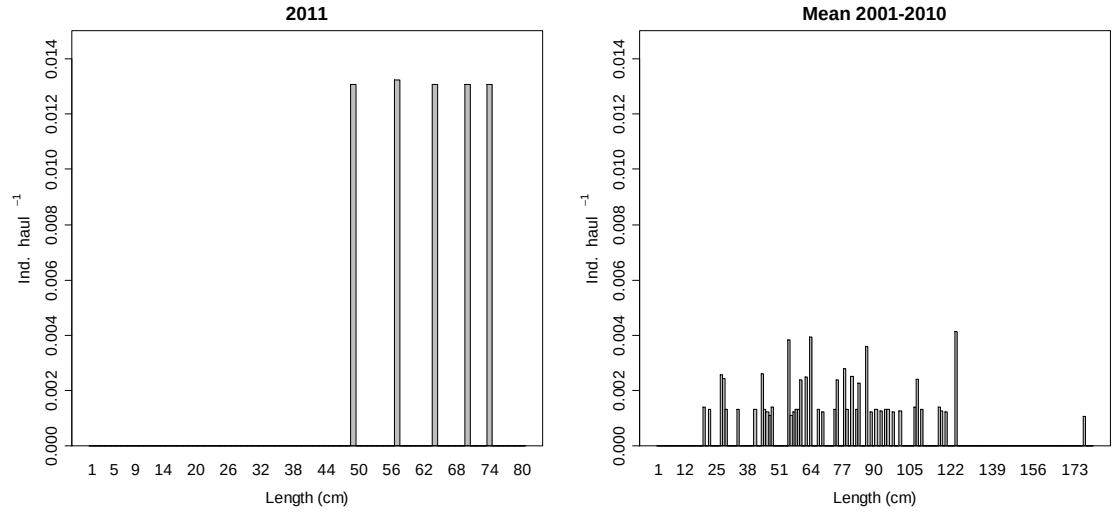

Figure 31. Stratified length distributions of *Dipturus cf. flossada* in 2011 Porcupine survey, and mean values of *Diptururs* spp. during Porcupine survey time series (2001-2010).