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Results on main elasmobranch species captured during the 2001-2009 Porcupine Bank (NE Atlantic) bottom trawl surveys

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Abstract

This paper presents the results on nine of the most important elasmobranch fish species of the nine years (2001-2009) of the Porcupine bank Spanish surveys. The main species in biomass terms in Porcupine bank bottom trawl survey, in decreasing biomass abundance order, are: blackmouth catshark, birdbeak dogfish, velvet belly, Knifetooth dogfish, lesser spotted dogfish, bluntnose sixgill shark, sandy ray, cuckoo ray and common skate. Many of these species occupy mainly the deep areas covered in the survey, especially birdbeak dogfish, knifetooth dogfish and velvet belly. Less confined to deeper grounds are blackmouth catshark and sandy ray, while lesser spotted dogfish and cuckoo ray inhabit mainly the shallower grounds close to the Irish shelf or the central mound in the bank. Length distributions of these species along the survey series are also presented and discussed. The few available data on siki sharks from the Porcupine bank survey are also summarized.

1. Introduction

Since 2001 a Spanish bottom trawl survey has been carried out annually in the areas surrounding the Porcupine Bank (ICES Divisions VIIc and VIIk) to study the distribution, relative abundance and biological parameters of commercial fish in the area (ICES, 2010a). The main target species for this survey series are hake, monkfish, white anglerfish and megrim, which abundance indices are estimated by age (Velasco *et al.*, 2005; Velasco *et al.*, 2007). Nevertheless data are also collected for all the fish species captured, Norway lobster (*Nephrops norvegicus*) and other benthic invertebrates.

The aim of this working document is to update since 2008 (Velasco & Blanco, 2008) the results (abundance indices, length frequency distributions and geographic distributions) on the most common elasmobranch fish species in Porcupine bottom trawl surveys, namely blackmouth catshark (*Galeus melastomus*), birdbeak dogfish (*Deania calcea*), velvet belly lantern shark (*Etmopterus spinax*), Knifetooth dogfish (*Scymnodon ringens*), lesser spotted dogfish (*Scyliorhinus canicula*), bluntnose sixgill shark (*Hexanchus griseus*), sandy ray (*Leucoraja circularis*), cuckoo ray (*Leucoraja naevus*) and common skate (*Dipturus batis*). These data and the information from the Porcupine Survey were presented to the WGEF for the first time in 2007 (ICES 2007)

2. Material and methods

The area covered in Porcupine surveys is the Porcupine bank (Figure 1) extending 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 every year in September/October on board the 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 defined by the >300, 450 and 800 m isobaths, resulting in 5 strata, given that there are no grounds shallower than 300 m in the Southern sector (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 (2010a, 2010b).

In order to compare the abundances and assess their variability between years two methods have been used: the parametric standard error derived from the random stratified sampling (Grosslein and Laurec, 1982), and a non parametric bootstrap procedure. The bootstrap method was implemented in R (R Development Core Team, 2009) using the boot library (Canty and Ripley, 2010) and resampling randomly with replacement stations within each stratum, to obtain the same number of stations per strata as in the original sample. Sampling intensity in each stratum, which was proportional to the stratum area, was thus conserved. A total of 1000 resamples were performed for each survey and 80% bootstrap confidence intervals were estimated using the 0.1 and 0.9 quantiles of the resultant distribution of bootstrap replicates (Efron and Tibshirani, 1993).

3. Results and discussion

3.1. Blackmouth catshark (*Galeus melastomus*.)

G. melastomus represents an average of 1.99 % of the total fish stratified biomass caught in Porcupine Survey's series. It presented a steady increasing trend in biomass between 2001 and 2005, with a remarkable drop in 2006 to 2002 levels and slight recovery in 2009 (Figure 3). Catshark length sizes in this survey (Figure 4) range from 6 to 77 cm in 2009, and to 78 cm in overall time series, with modes in 54-59 cm and ca. 65 cm. In 2009 the sizes were similar to the mean values of the series with a marked mode in 60-69 cm. Geographically, blackmouth catshark is distributed in all the survey area, except the shallower areas of the Irish shelf and the central mound, and it presents important concentrations in the southern tip of the area, in the limit of the muddy grounds of the Porcupine Seabight (Figure 5). The percentage of the total fish biomass catch rate represented by blackmouth catshark has ranged between 0.9% in 2001 (5.4 kg haul^{-1}) and 3.5% in 2009 (15.3 kg haul^{-1}).

3.2. Birdbeak dogfish (*Deania calcea*)

Birdbeak dogfish represents as an average a 0.5% of the fish stratified biomass abundance in these surveys, nevertheless its abundance is quite variable, with peaks in 2001 and 2006 (Figure 6), and relatively abundant values in the last three years. This variability may be due to the fact that this species dwells in the depth limits covered in this survey, as shown in Velasco and Blanco (2008). Regarding geographical distribution, birdbeak dogfish appears in the outer limits of the surveyed area, especially in the westernmost ones (Figure 8), in the steep and abrupt shelf break found in this area. The *D. calcea* sizes found in these surveys range between 18 and 118 cm, presenting two noteworthy modes in 70-72 cm, and a more marked one in 85-99 cm (Figure 7).

3.3. Velvet belly lantern shark (*Etmopterus spinax*)

Velvet belly presents an irregular abundance in this surveys, with blooms in 2003 and 2006 (Figure 9), also in 2009 the abundance was high compared to the rest of years, which were produced by a couple of hauls with remarkable captures in the southern part of the central mound of Porcupine Bank (Figure 11), nevertheless in years without these blooms velvet belly is distributed in the deepest strata (450-800 m) and the inner part of the Porcupine Seabight. In average velvet belly only represents a 0.28% of the total fish catch rate in biomass, though ranges from 0.8% in 2006 to 0.05% in 2005.
Mean biomass abundance indices throughout the time series were 1.6 kg $haul^{-1}$ ranging between 0.3 kg $haul^{-1}$ and 4.9 kg $haul^{-1}$. Length frequency distributions (Figure 10) showed a clear mode in 36-37 cm along the years, and a length range from newborns or pups of 2 cm to adults of 60 cm.

3.4. Knifetooth dogfish (*Scymnodon ringens*)

Knifetooth dogfish also presented a pulse in biomass abundance index in 2004 and 2008 (Figure 12), and lower values in the rest of the series. In average, it only represents a 0.3% of the total fish biomass catch rate throughout the time series, ranging between 3.2 kg $haul^{-1}$ in 2004, and only 0.5 kg $haul^{-1}$ in 2005, with an average of 1.57 kg $haul^{-1}$. Length frequency distributions (Figure 13) show three modes in the average of the seven years: 40-41 cm, 72-74 cm and 104-107 cm, but quite reduced in some years as 2007. In this species is also noticeable that higher abundances concentrate in the slopes of the Porcupine Seabight (Figure 14**)** with important concentrations in particular hauls. reflects the deep habits of this species that only occurs in grounds deeper than 600 m and mainly deeper than 700 m, where we found more than 16 $ind.haul^{-1}$, also in this species it is evident that an important part of its population occupies grounds deeper than those covered in this survey since no decrease in abundance at this depth is apparent in our results.

3.5. Lesser spotted dogfish (*Scyliorhinus canicula*)

The abundance of this species remains at low levels around or below 1kg/haul (Figure 15), and a peak in 2007 with almost 2 kg/haul, clearly related to a large catch in a haul in the shallowest area closer to the Irish shelf (Figure 17). In average *S. canicula* only represented 0.21 % of the total fish stratified biomass catch, reaching a 0.41 % in 2008, though this result could be slightly biased due to problems with the gear in this year that produced a reduction in the catches that could have affected differently to different species. The peak abundance value of 2007 corresponded with relatively high abundances of sizes smaller than 40 cm that scarcely had occurred in the previous surveys (Figure 16), in any case individuals smaller than 55 cm are relatively scarce in this area. Geographic distribution of abundances is clearly related to the Irish shelf, where the species is more frequent and apparently is becoming more abundant in the last three years, when the species has been more abundant, but also around the mound in the centre of the bank in the area shallower than 300 m belonging to strata A.

3.6. Bluntnose sixgill shark (*Hexanchus griseus*)

This species, that represents a 0.13% of the biomass catches of fish species along the time series, is the sixth demersal elasmobranch in biomass abundance within the Porcupine bank, according to the results of the bottom trawl survey performed in the area. Its stratified abundance (Figure 18) varies between 0.5 and 1 kg per haul, except in

2003 when it reached a peak of 1.75 kg · haul^{-1}. Regarding the geographic distribution, the bluntnose sixgill shark appears scattered along the survey area (Figure 20), with no special aggregations in any areas or depths.

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

These two species of rays have similar abundance values and trends in abundance the surveys series, each one corresponds to less than a 0.1 % of the total fish biomass in stratified index terms, and both present a peak in 2003 and a smaller new peak in 2007 and lower abundances in the last two years (Figure 21 and Figure 24). Cuckoo ray ranges from 0.9 and 0.2 kg haul^{-1} in 2003 and 2001 respectively, while sandy ray varies from 1.0 and 0.2 kg haul^{-1}. Cuckoo ray sizes in the survey range between 21 and 65 cm, being individuals smaller than 32 cm very scarce (Figure 22). Sandy ray individuals caught in the surveys vary from 13 and 112 cm (Figure 25), though in this case the individuals smaller than 40 cm and larger than 90 cm are very scarce. The area occupied by cuckoo ray is around the central mound of Porcupine bank (Figure 23**)** being very scarce in the rest of the survey area, while sandy ray distribution is less defined (Figure 26), nevertheless in years with higher abundances it appears in a couple of hauls northern to the central mound, and it also appears quite constantly in the western central part of the study area.

3.7. *Dipturus batis* **–** Common or blue skate

The WGCSE (Working Group for the Celtic Seas Ecoregion) noted that this species has declined in inshore areas of northern Europe. Nevertheless, though being a low-abundance species in the survey, its abundance (Figure 27) and distribution (Figure 29) of this species has not presented remarkable changes along the time series. Common skate has appeared almost every year, around the mound in the centre of the bank and sparse individuals on the margins of the Porcupine Seabight (see Figure 1). Regarding the length distribution, along the time series, sizes of common skates captured rank between 20 and 177 cm.

3.7. Deepwater "siki" sharks (*Centroscymnus coelolepis* and *Centrophorus squamosus*)

These two deep water species with relatively big commercial importance, have been rarely caught during the Porcupine bottom trawl survey time series, being less than the 0.05% of the stratified fishes caught in almost all the surveys, but in 2004 when as a group they were 0.24% of the fish stratified catches in biomass.

As a whole three individuals of *C. squamosus* were taken in 2001 (107-112 cm), and 19 individuals of *C. coelolepis* caught, 16 in one haul in 2004, and then two more in another haul in 2004, all females, and finally one single shark captured in 2006. All the sharks were caught in hauls deeper than 700 m, except one *C. squamosus* that was fished at 620 m, most of them were caught in the southernmost tip of the Porcupine bank (Figure 30).

3.7. Other elasmobranch species

Other species caught during the surveys, but with less abundance and not in all years include: *Dalatias licha*, *Galeus murinus*, *Galeorhinus galeus*, *Raja clavata*, *Leucoraja fullonica*, *Dipturus nidarosiensis* and *Rajella fyllae*, together with the chimaerids *Chimaera monstrosa* and *Hydrolagus mirabilis*, which are also abundant in the deepest grounds but are not addressed in the present working document.

4. Acknowledgements

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

5. References

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5. Figures

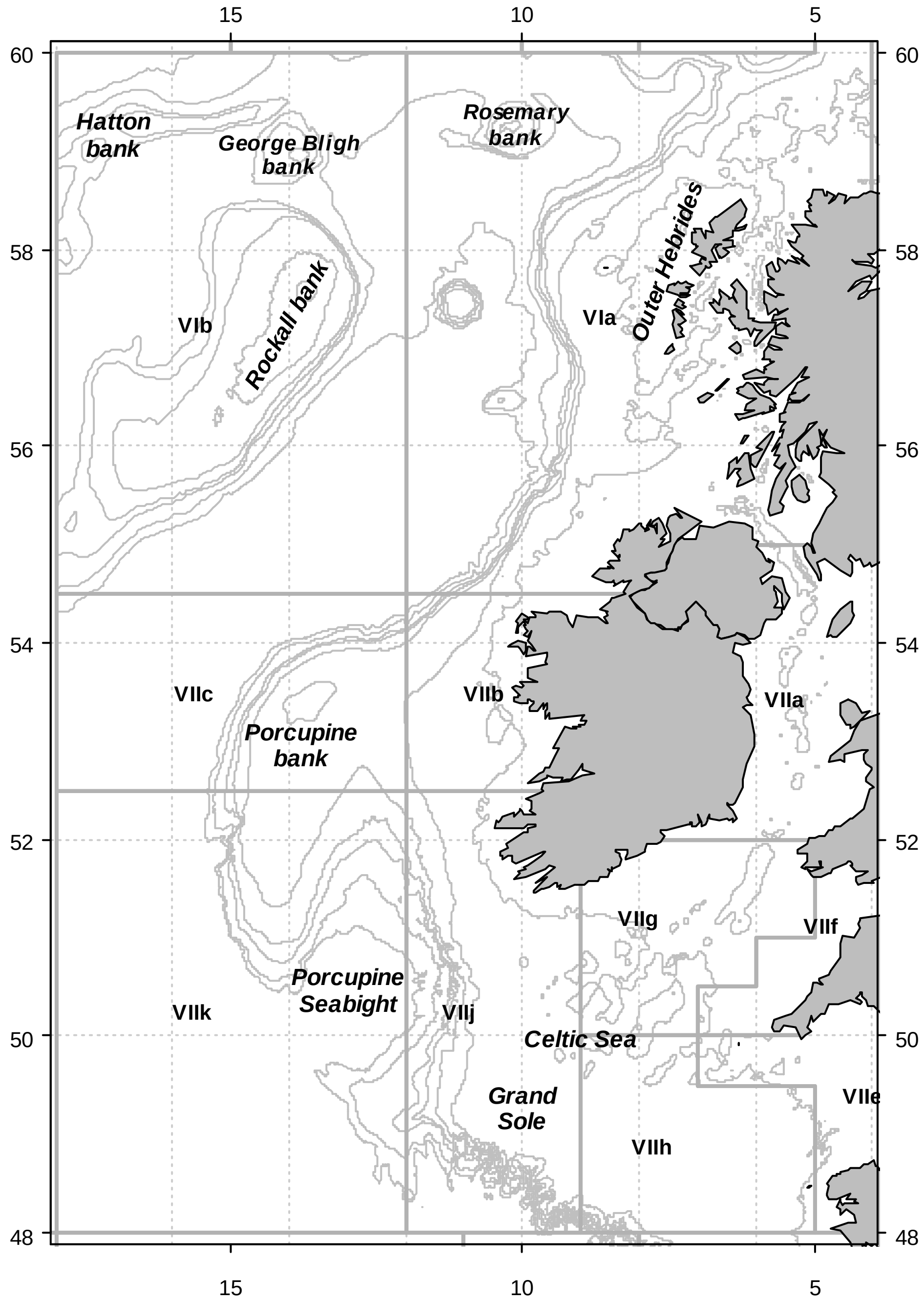

Figure 1. North eastern Atlantic showing the Porcupine bank, Porcupine Seabight, and ICES divisions

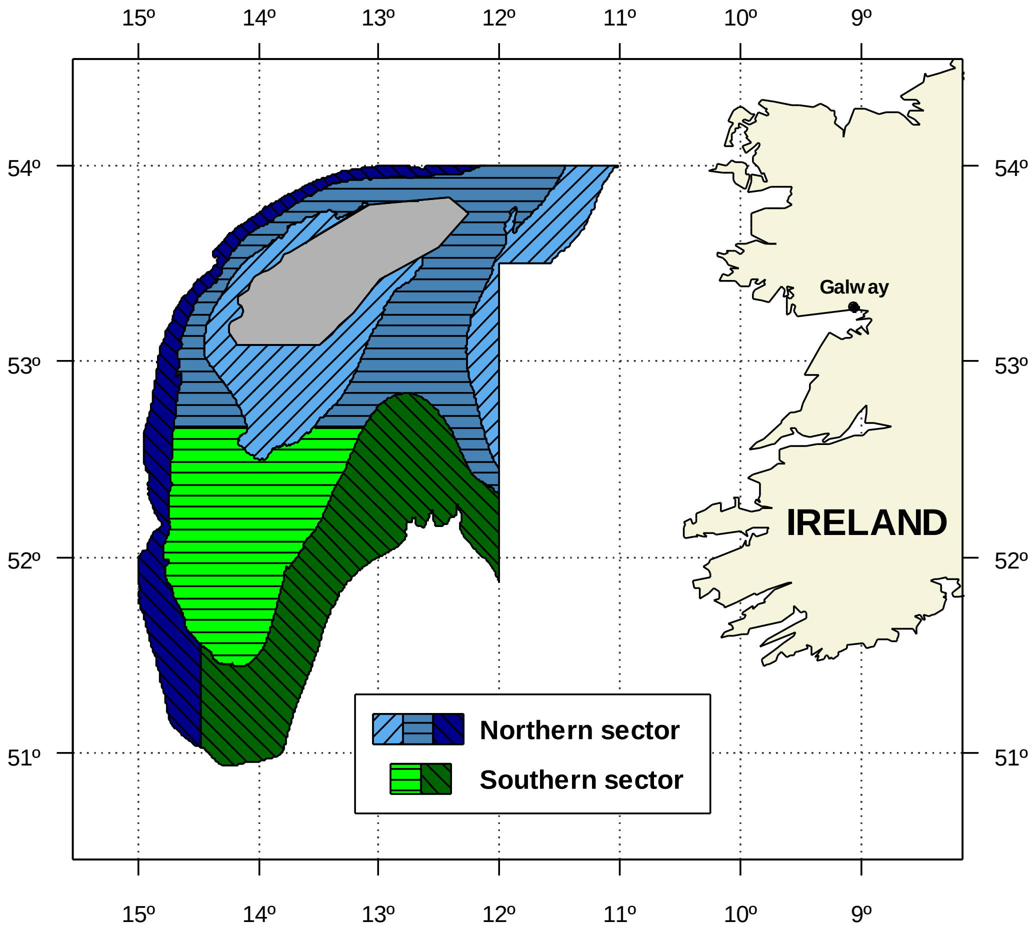

Figure 2. Stratification design used in Porcupine surveys from 2003; depth strata are: A) shallower than 300 m, B) 301 – 450 m and C) 451 – 800 m. The grey area in the centre of Porcupine bank corresponds to a large non-trawlable area, not considered for area measurements and stratification

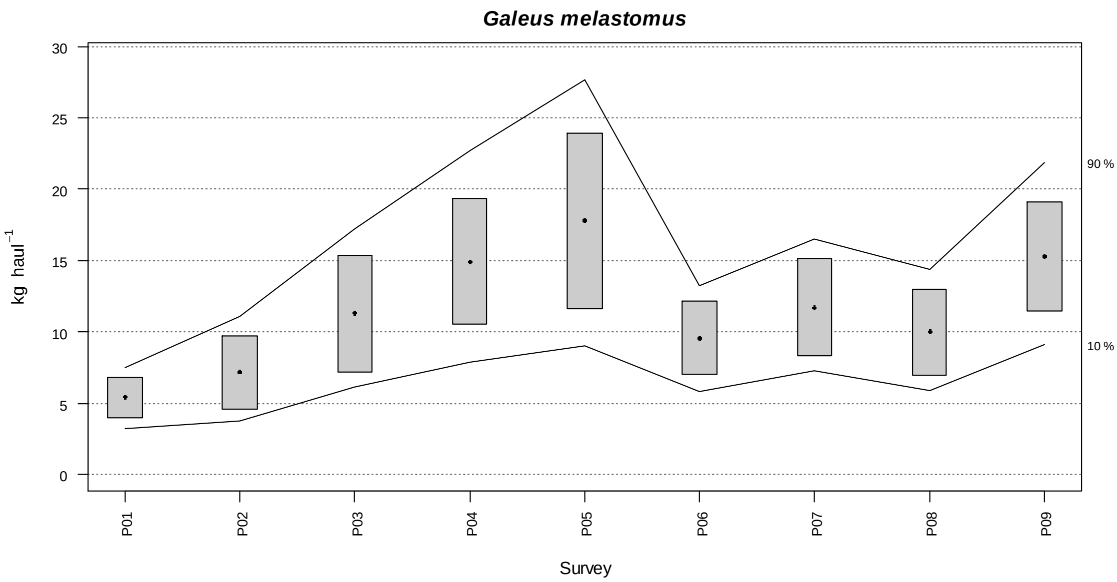

Figure 3. Changes in blackmouth catshark (*Galeus melastomus*) biomass index during Porcupine Survey time series (2001-2009). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000)

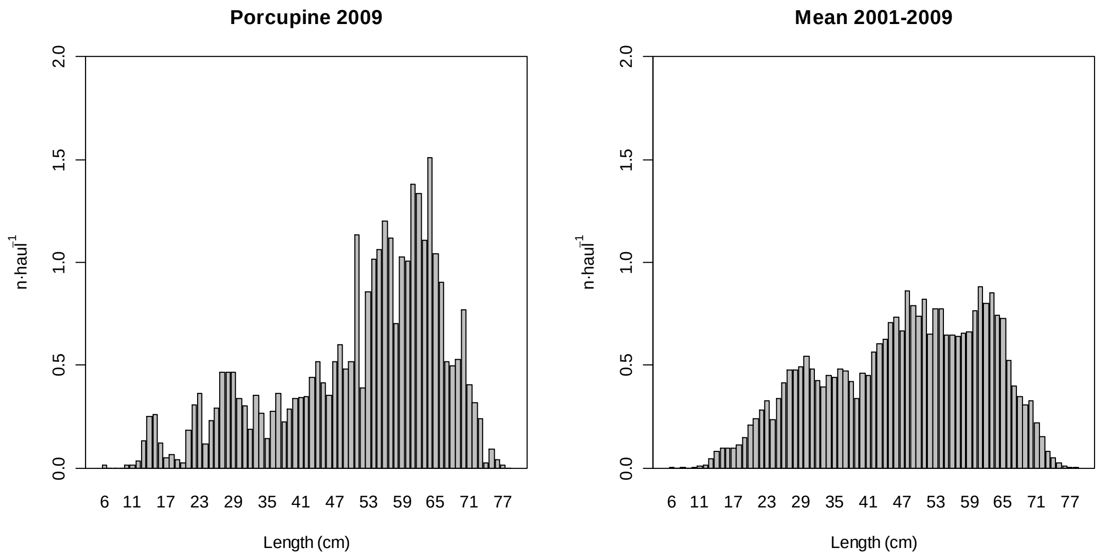

Figure 4. Stratified length distributions of blackmouth catshark (*G. melastomus*) in 2009 in Porcupine survey, and mean values during Porcupine Survey time series (2001-2009)

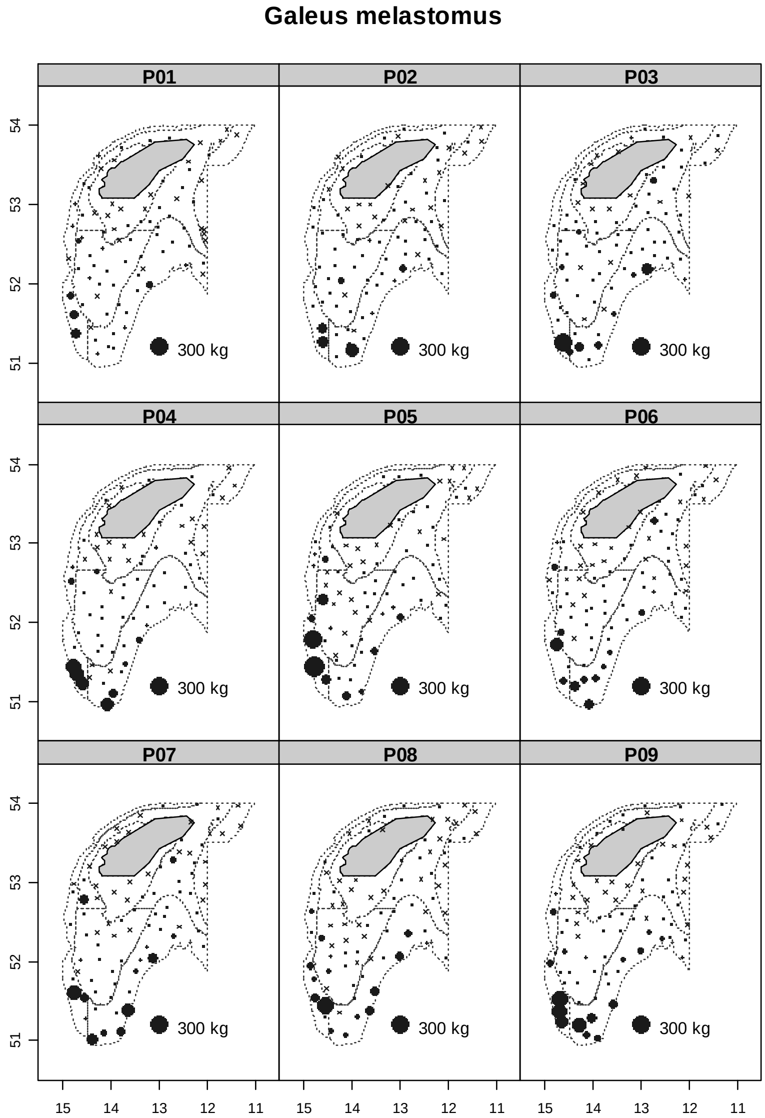

Figure 5. Geographic distribution of blackmouth catshark (*G. melastomus*) catches (kg·haul^{-1}) during Porcupine surveys time series (2001- 2009)

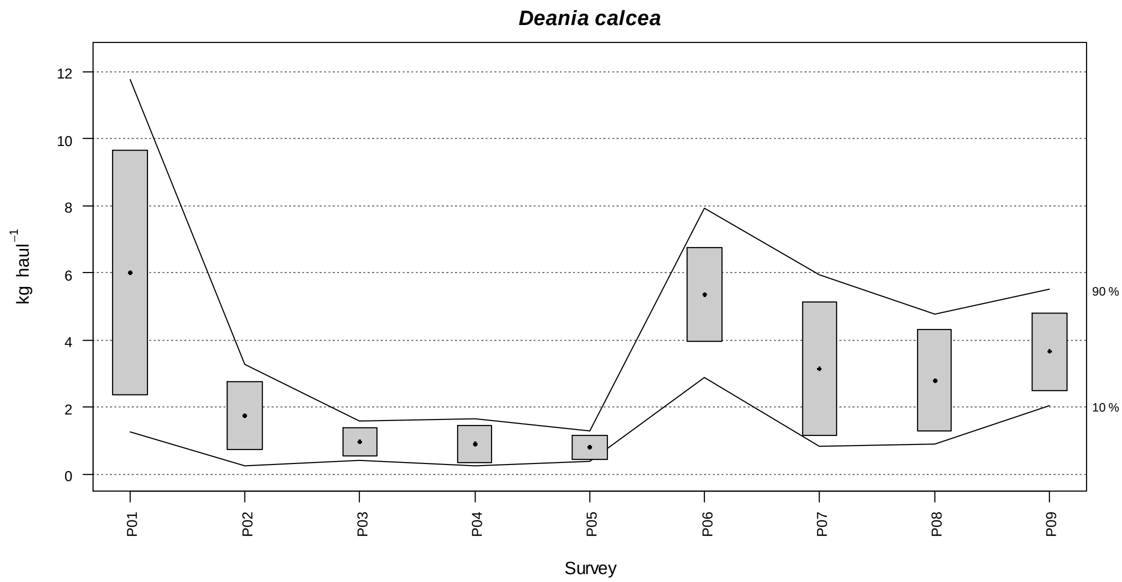

Figure 6. Changes in birdbeak dogfish (*Deania calcea*) biomass index (kg·haul^{-1}) during Porcupine Survey time series (2001-2009). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000)

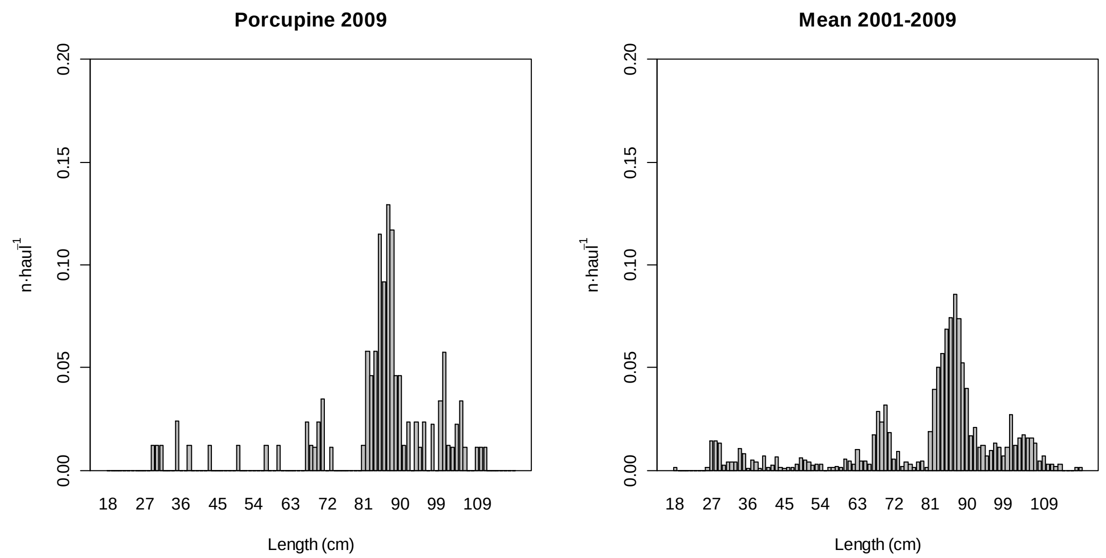

Figure 7 Stratified length distributions of *Deania calcea* in 2009 in Porcupine survey, and Mean values during Porcupine Survey time series (2001-2009)

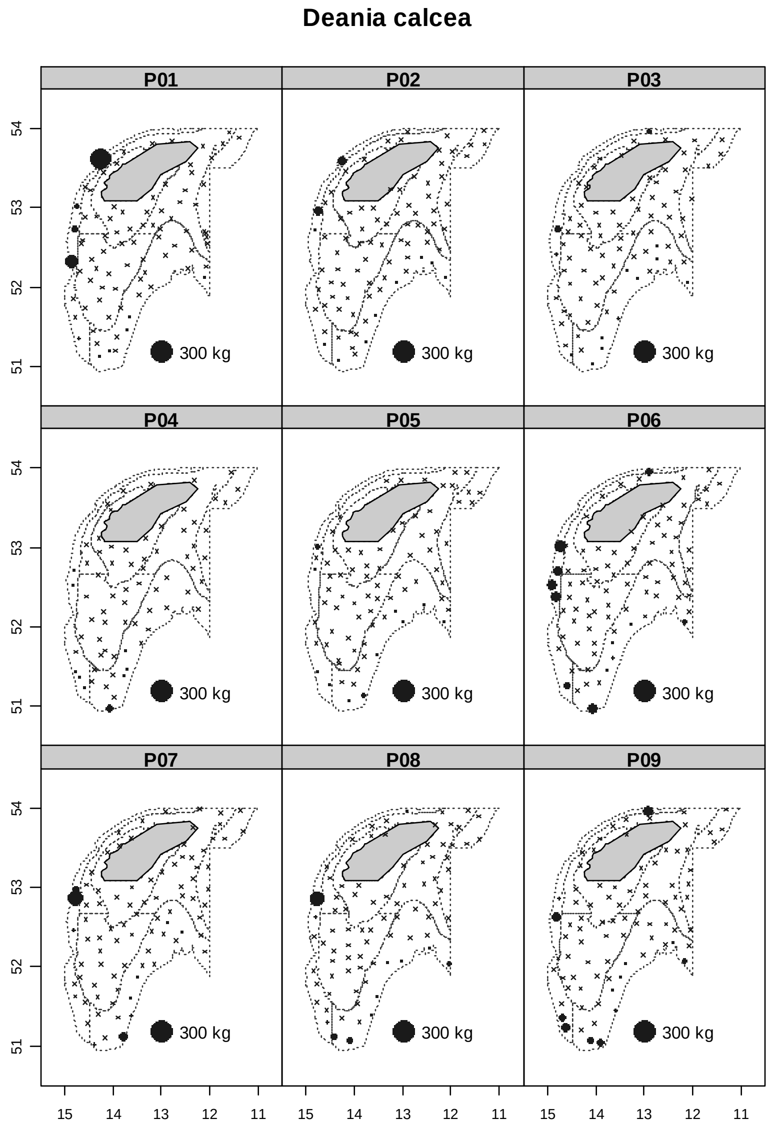

Figure 8. Geographic distribution of birdbeak dogfish (*D. calcea*) catches (kg·haul^{-1}) during Porcupine surveys time series (2001- 2009)

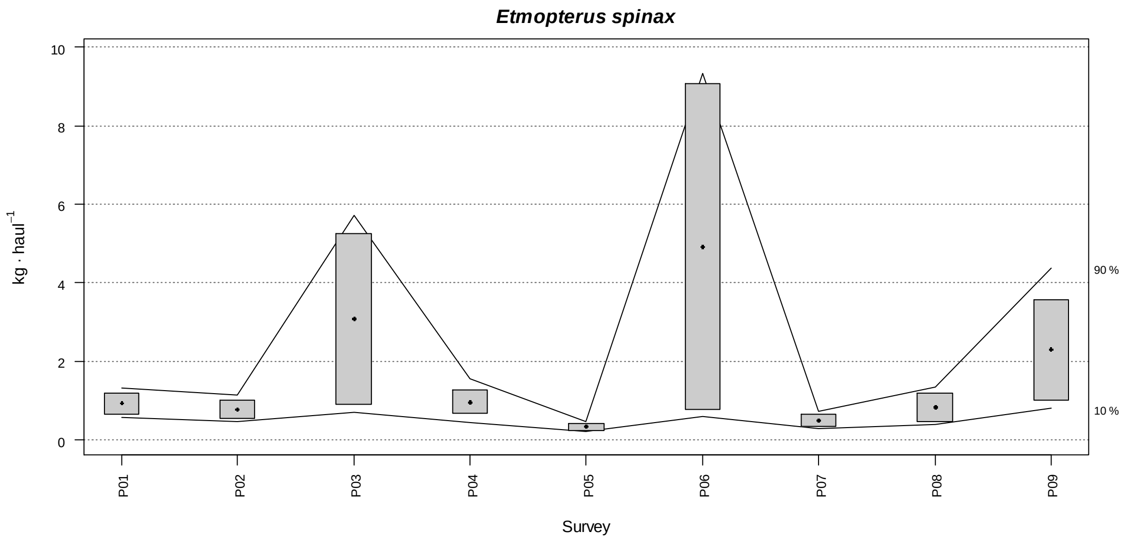

Figure 9. Changes in velvet belly (*Etmopterus spinax*) biomass index (kg·haul^{-1}) during Porcupine Survey time series (2001-2009). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000)

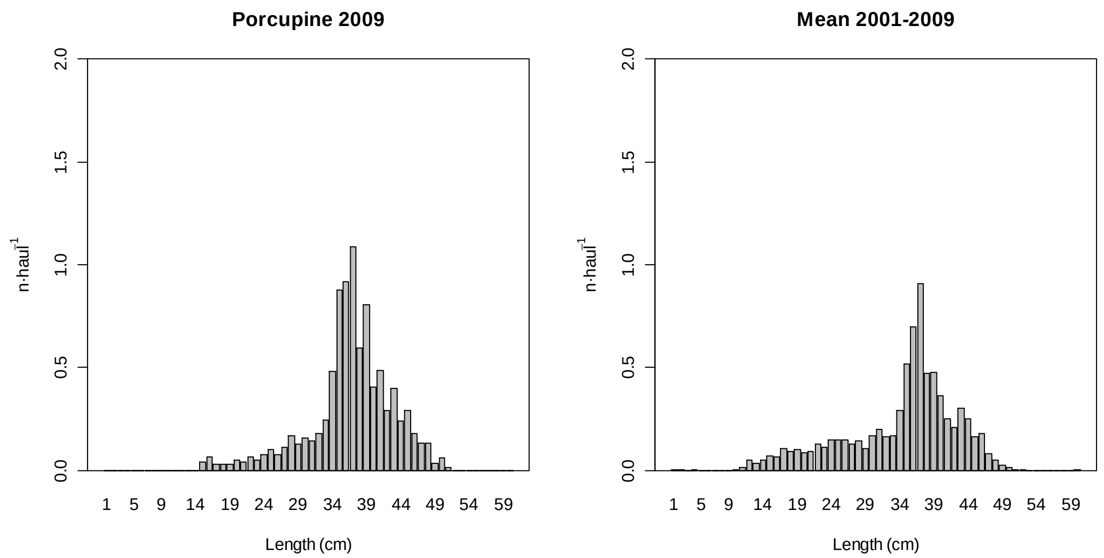

Figure 10. Stratified length distributions of velvet belly (*E. spinax*) in 2009 in Porcupine survey, and mean values during Porcupine Survey time series (2001-2009)

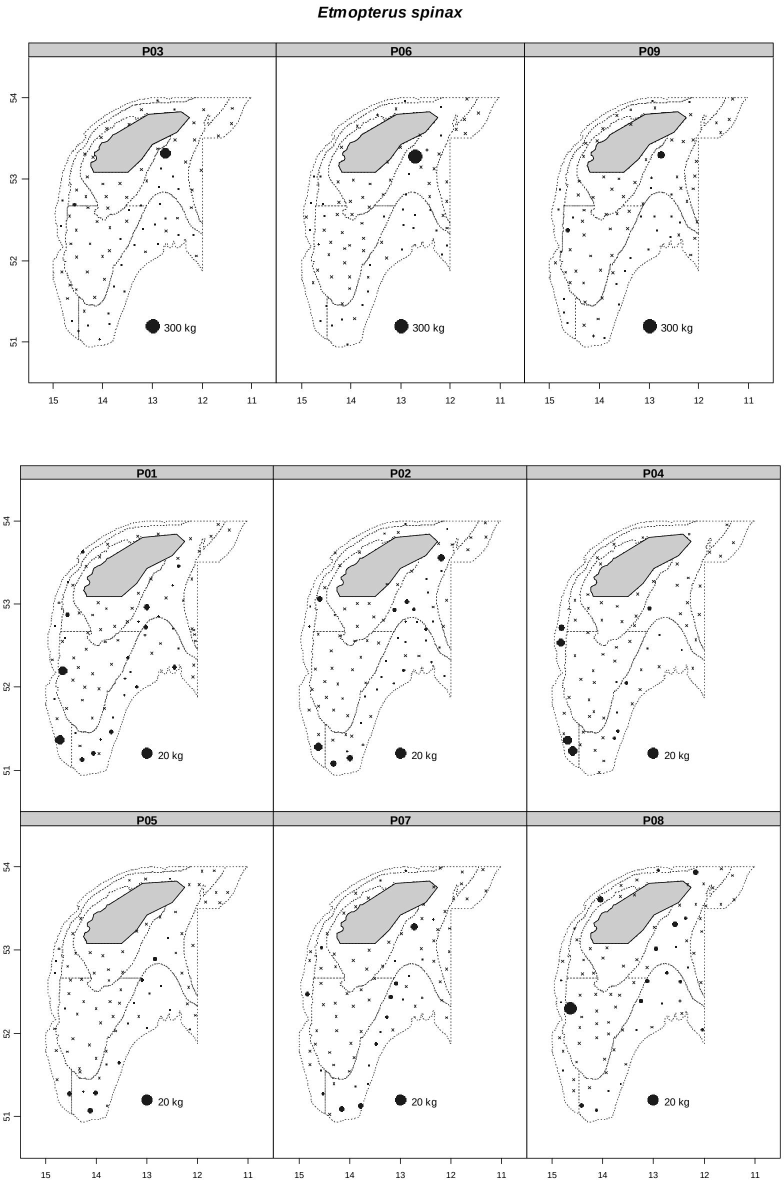

Figure 11. Geographic distribution of velvet belly (*E. spinax*) catches (kg·haul^{-1}) during Porcupine surveys: in years of high biomass abundance (2003, 6 and 9), and low abundances (2001-2, 4-5 and 7-8), respectively upper and lower panels.

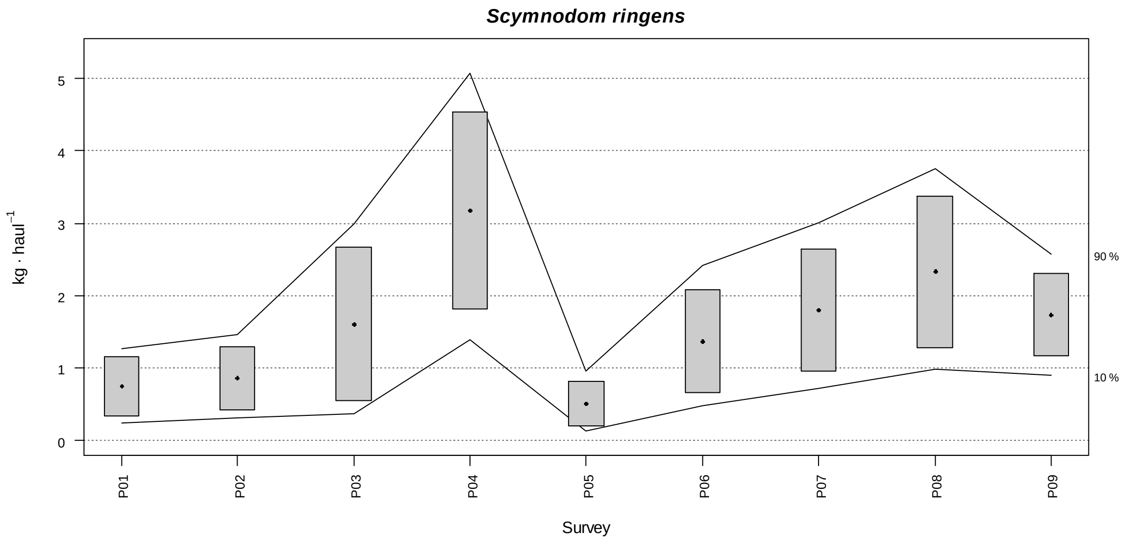

Figure 12. Changes in knifetooth dogfish (*Scymnodom ringens*) biomass index (kg·haul^{-1}) during Porcupine Survey time series (2001-2009). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000)

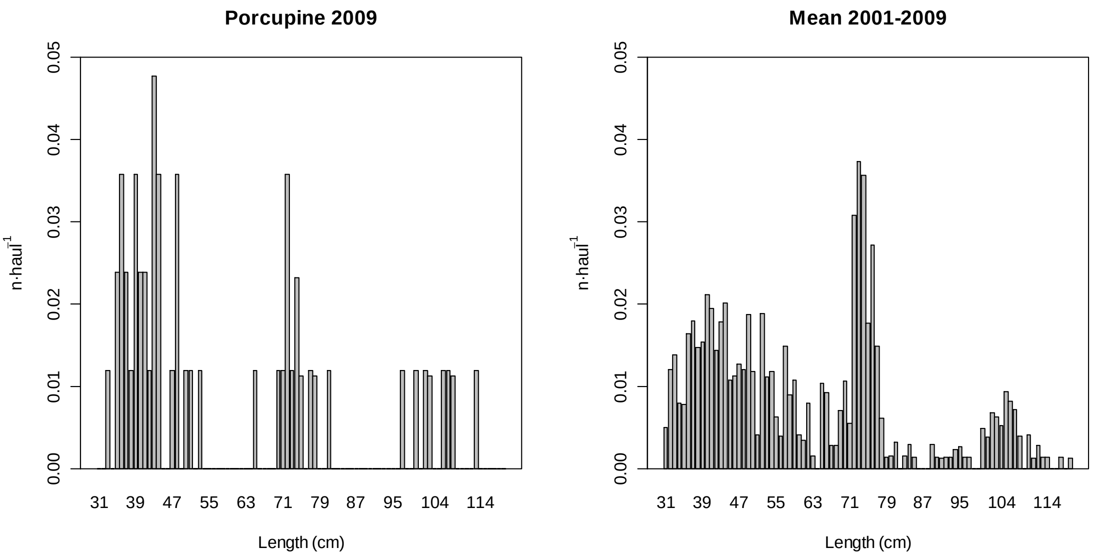

Figure 13. Stratified length distributions of knifetooth dogfish (*S. ringens*) in 2009 in Porcupine survey, and Mean values during Porcupine Survey time series (2001-2009)

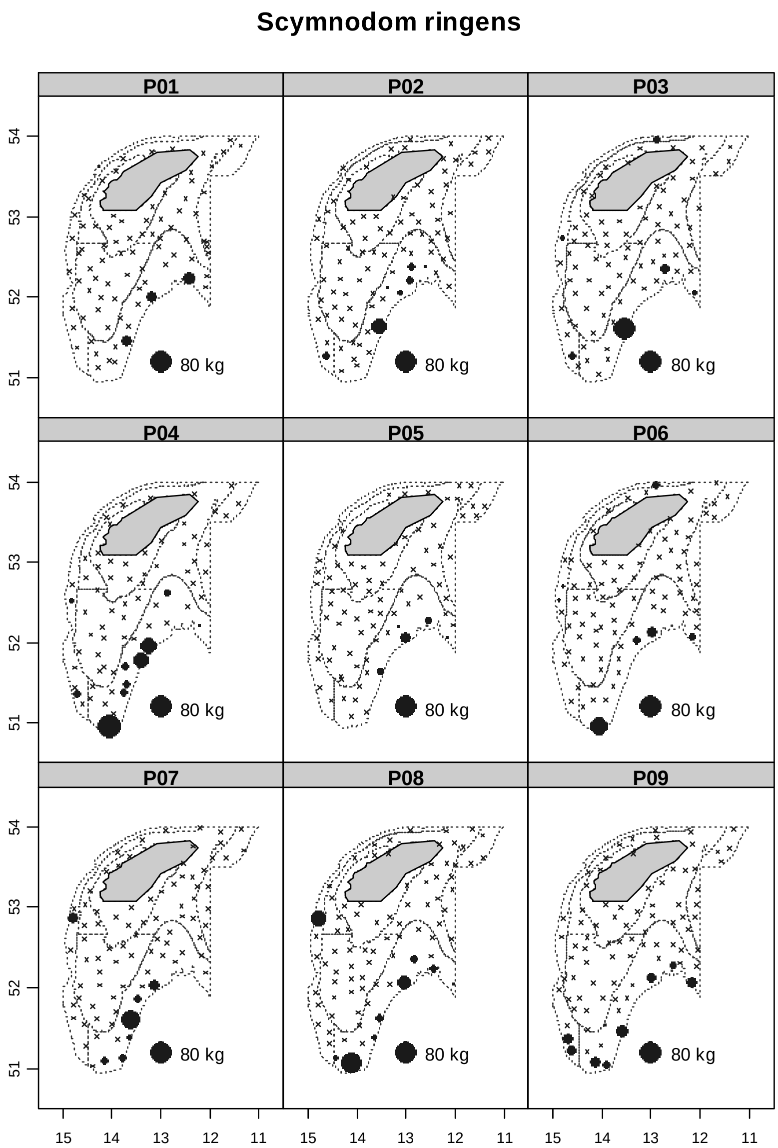

Figure 14. Geographic distribution of knifetooth dogfish (*S. ringens*) catches (kg·haul^{-1}) during Porcupine surveys time series (2001- 2009)

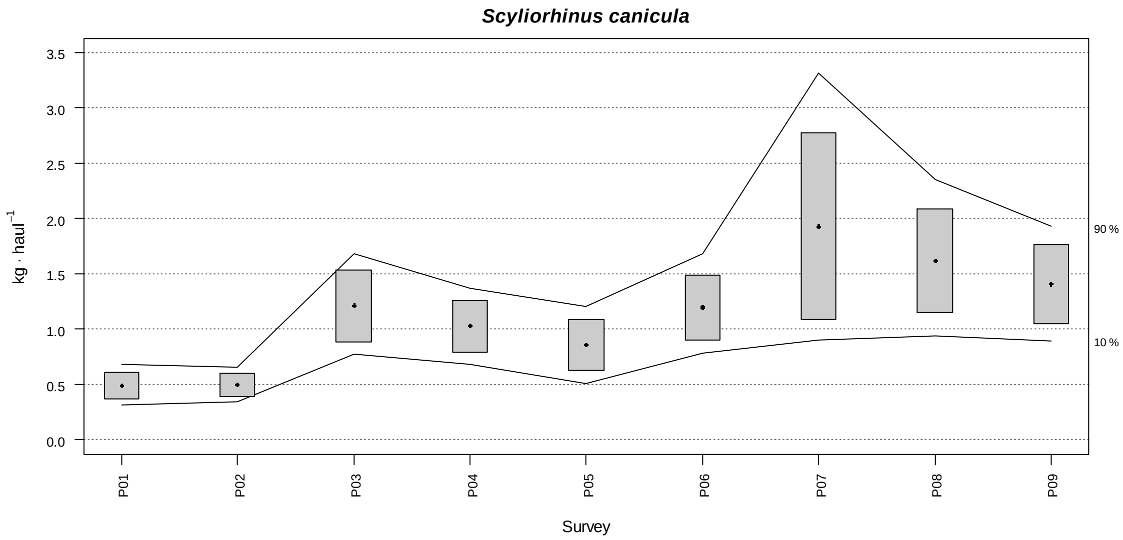

Figure 15. Changes in lesser-spotted dogfish (*Scyliorhinus canicula*) biomass index (kg·haul^{-1}) during Porcupine Survey time series (2001-2007). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000)

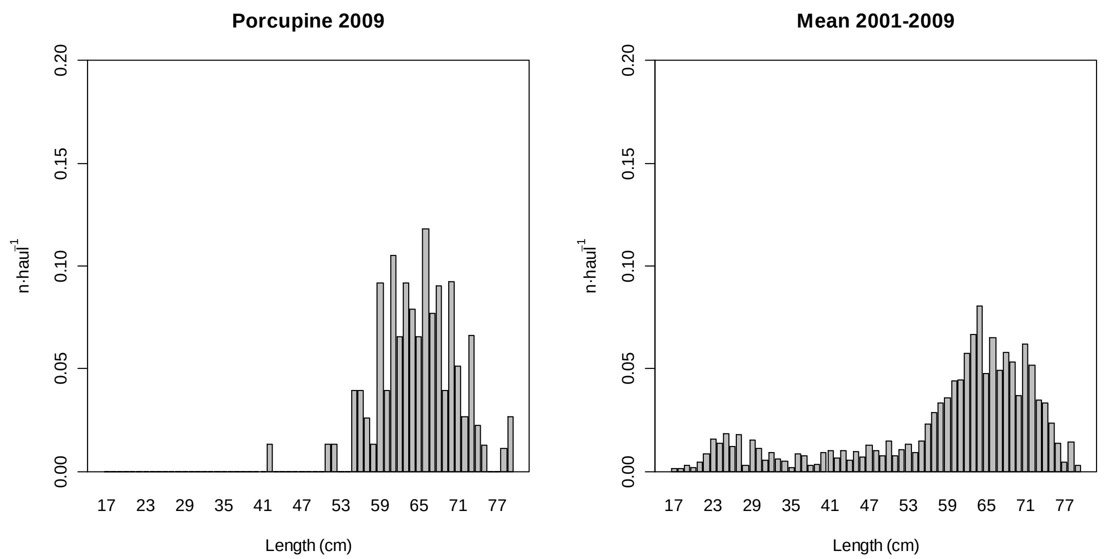

Figure 16. Stratified length distributions of lesser spotted dogfish (*S. canicula*) in 2009 in Porcupine survey, and Mean values during Porcupine Survey time series (2001-2009)

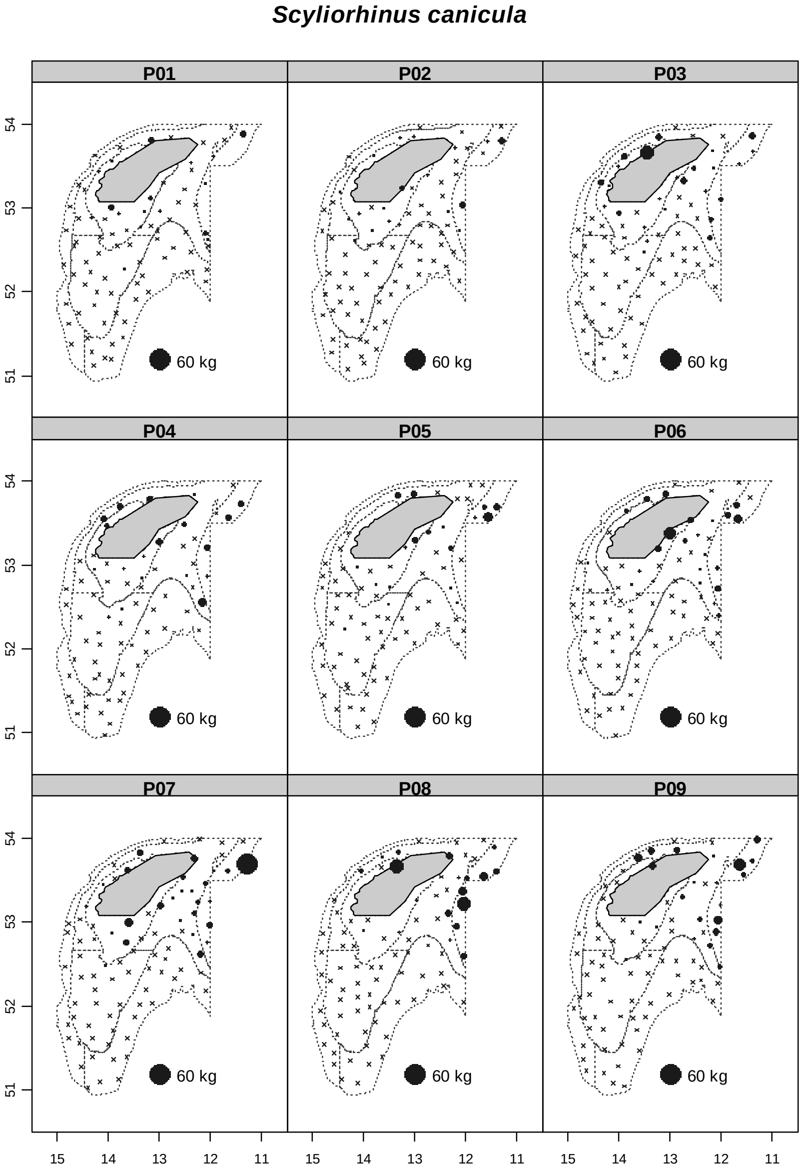

Figure 17. Geographic distribution of lesser spotted dogfish (*S. canicula*) catches (kg·haul^{-1}) in Porcupine surveys (2001-2009).

Figure 18. Changes in *Hexanchus griseus* biomass index (kg·haul^{-1}) during Porcupine Survey time series (2001-2009). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000)

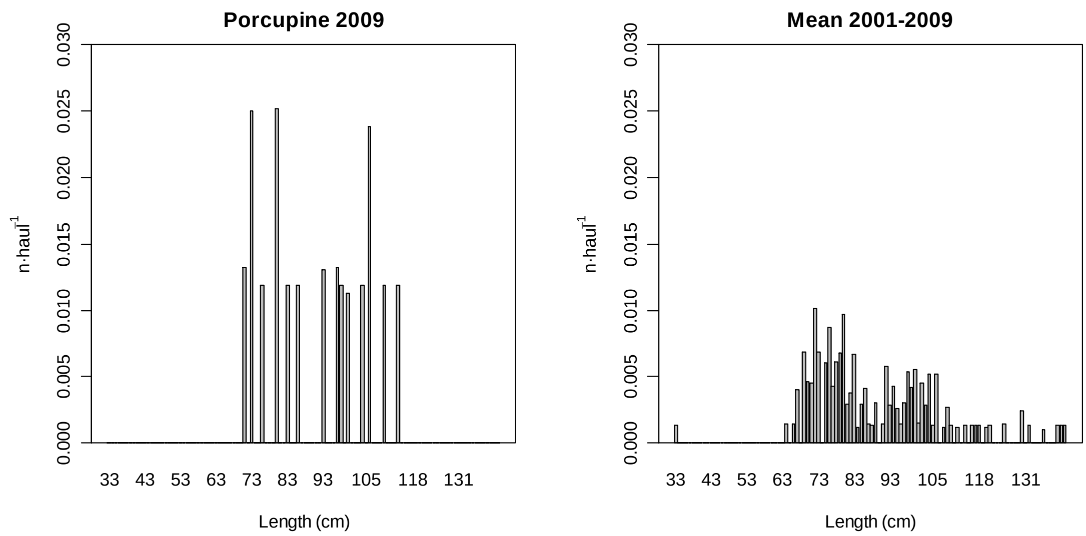

Figure 19. Stratified length distributions of bluntnose sixgill shark (*H. griseus*) in 2009 in Porcupine survey and mean values during Porcupine Survey time series (2001-2009)

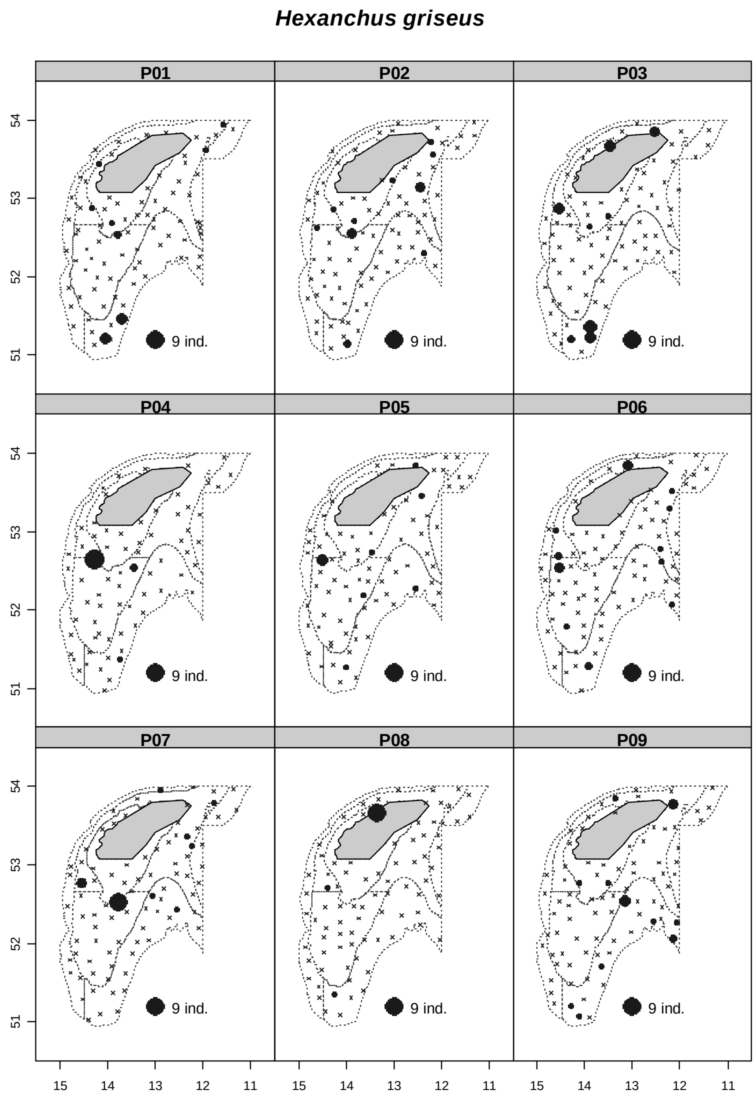

Figure 20. Geographic distribution of bluntnose sixgill shark (*H. griseus*) catches (ind · haul^{-1}) in Porcupine surveys (2001-2009)

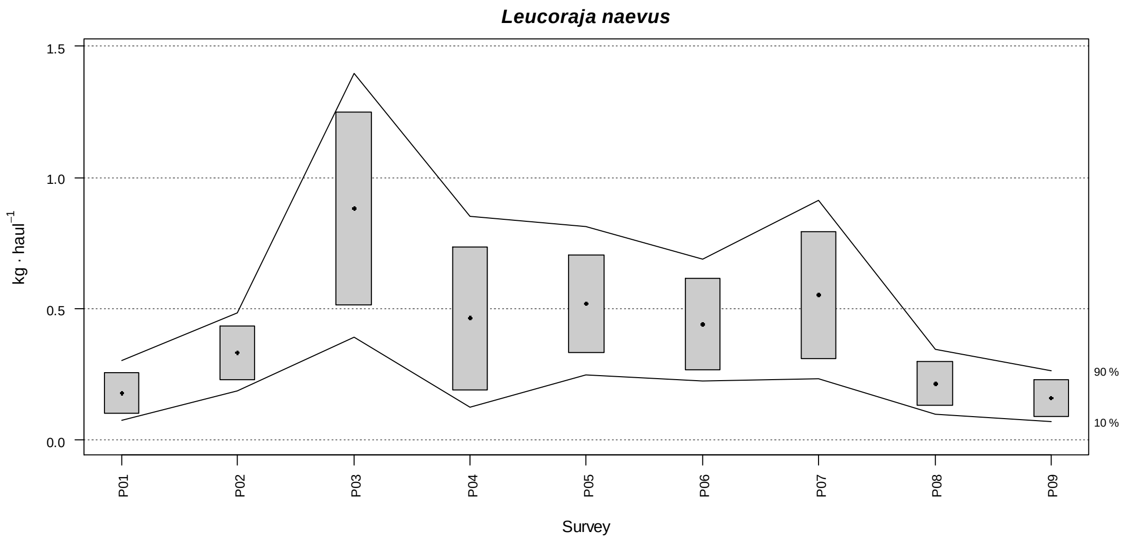

Figure 21. Changes in *Leucoraja naevus* biomass index (kg·haul^{-1}) during Porcupine Survey time series (2001-2009). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000)

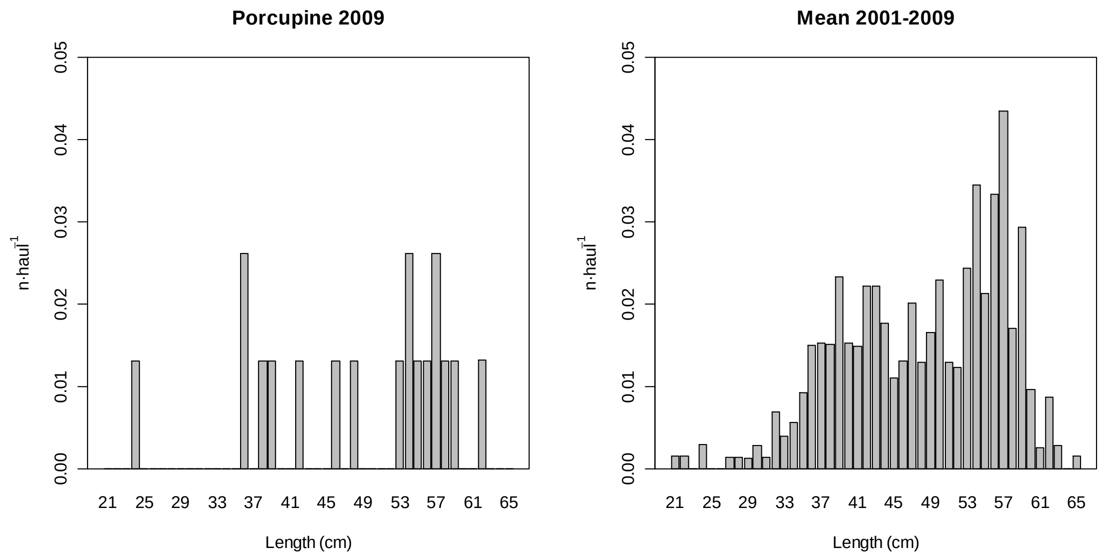

Figure 22. Stratified length distributions of cuckoo ray (*L. naevus*) in 2009 in Porcupine survey, and Mean values during Porcupine Survey time series (2001-2009)

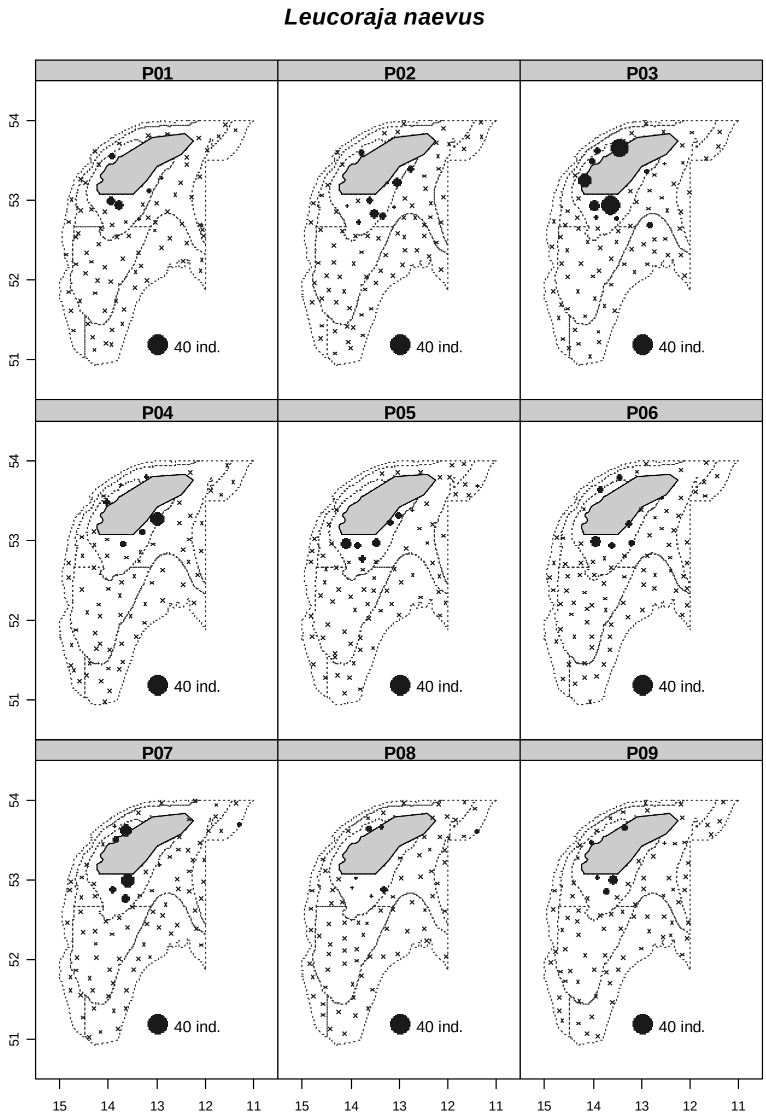

Figure 23. Geographic distribution of *Leucoraja naevus* catches (ind · haul^{-1}) during Porcupine surveys time series (2001- 2009)

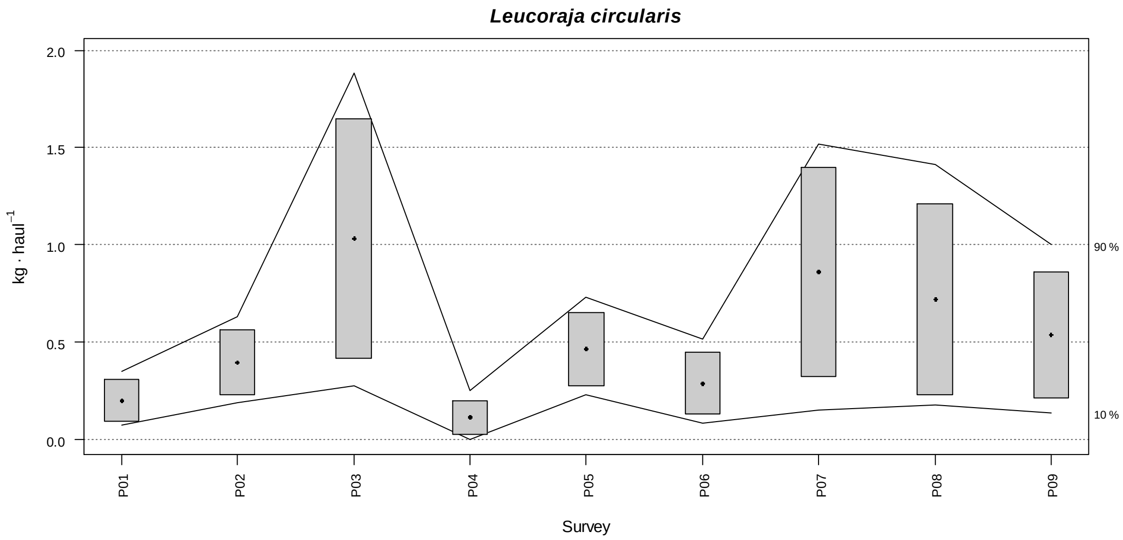

Figure 24. Changes in sandy ray (*Leucoraja circularis*) biomass index (kg·haul^{-1}) during Porcupine Survey time series (2001-2007). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000)

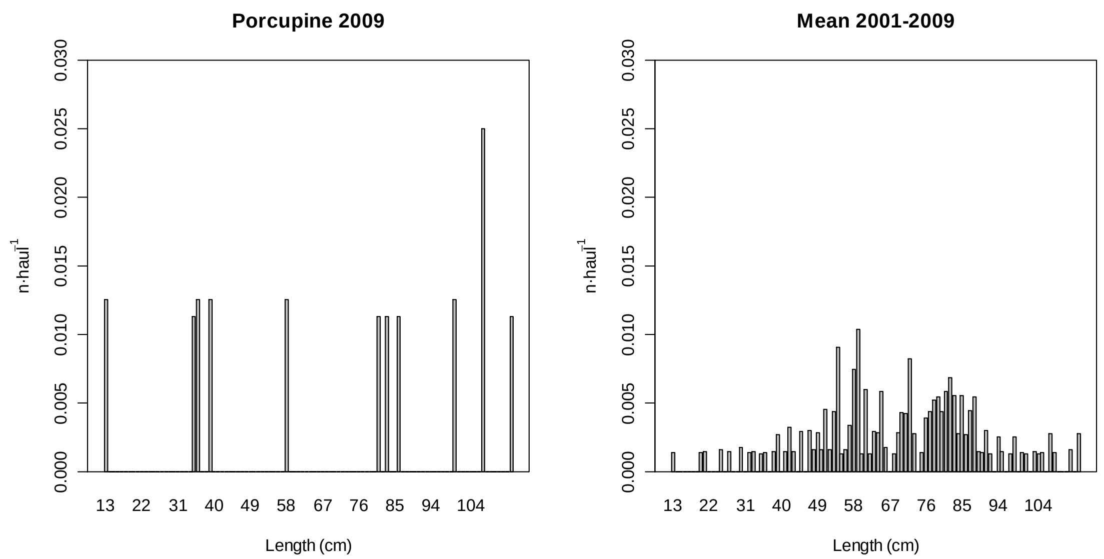

Figure 25. Stratified length distributions of sandy ray (*L. circularis*) in 2009 in Porcupine survey, and Mean values during Porcupine Survey time series (2001-2009)

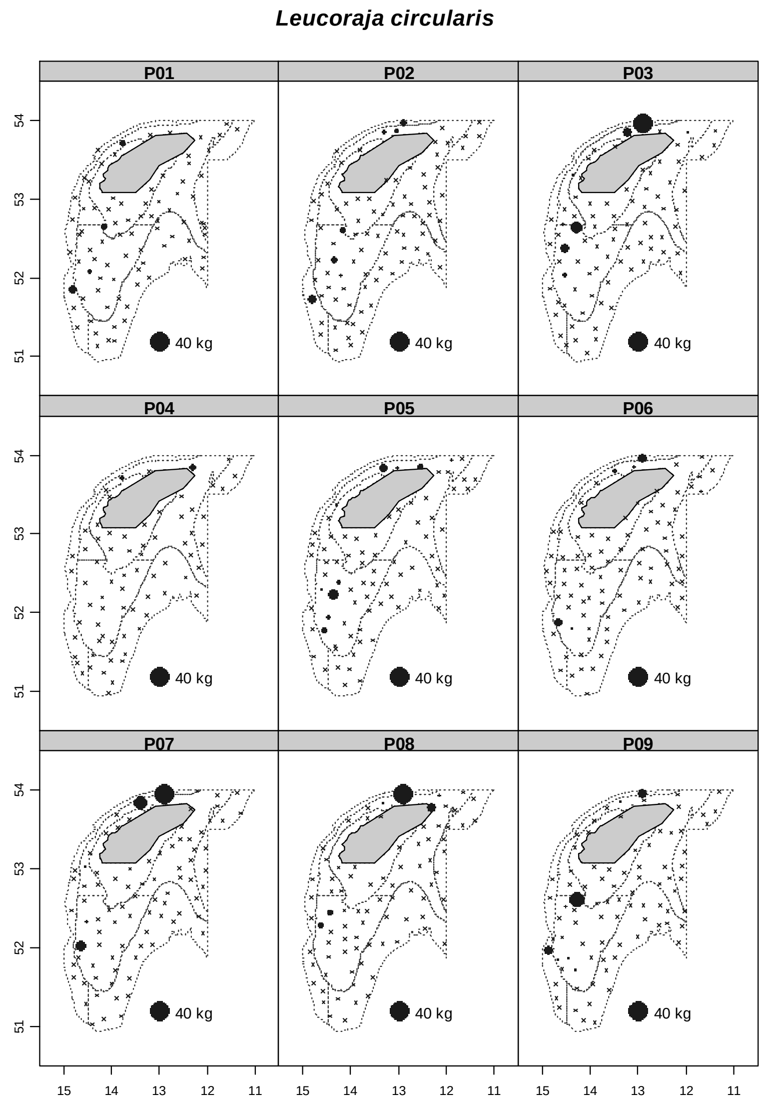

Figure 26. Geographic distribution of sandy ray (*L. circularis*) catches (kg·haul^{-1}) in Porcupine surveys (2001-2009)

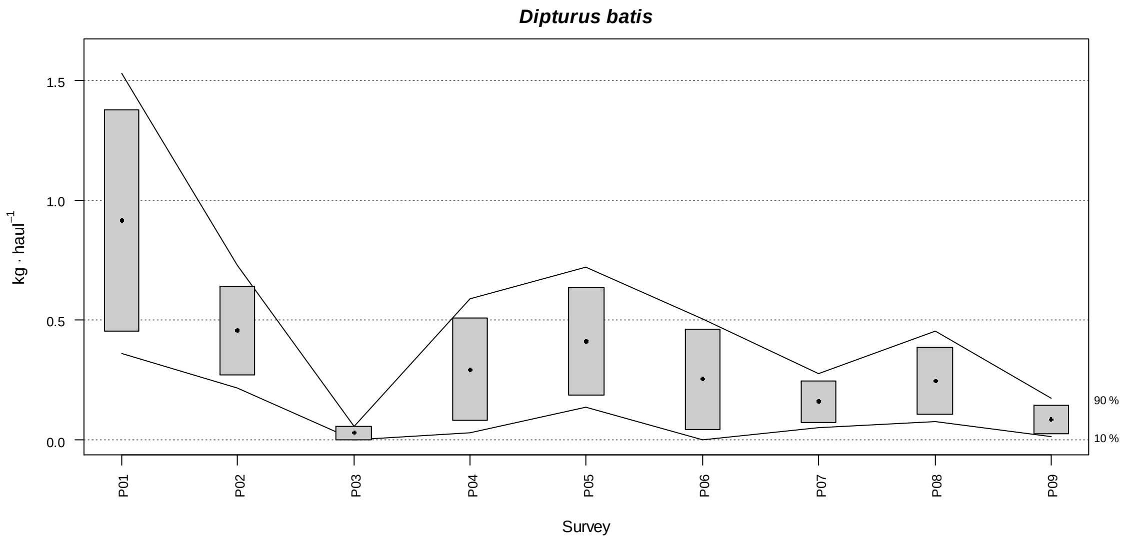

Figure 27. Changes in common skate (*Dipturus batis*) biomass index (kg.haul^{-1}) during Porcupine Survey time series (2001-2009). Boxes mark parametric standard error of the stratified index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000)

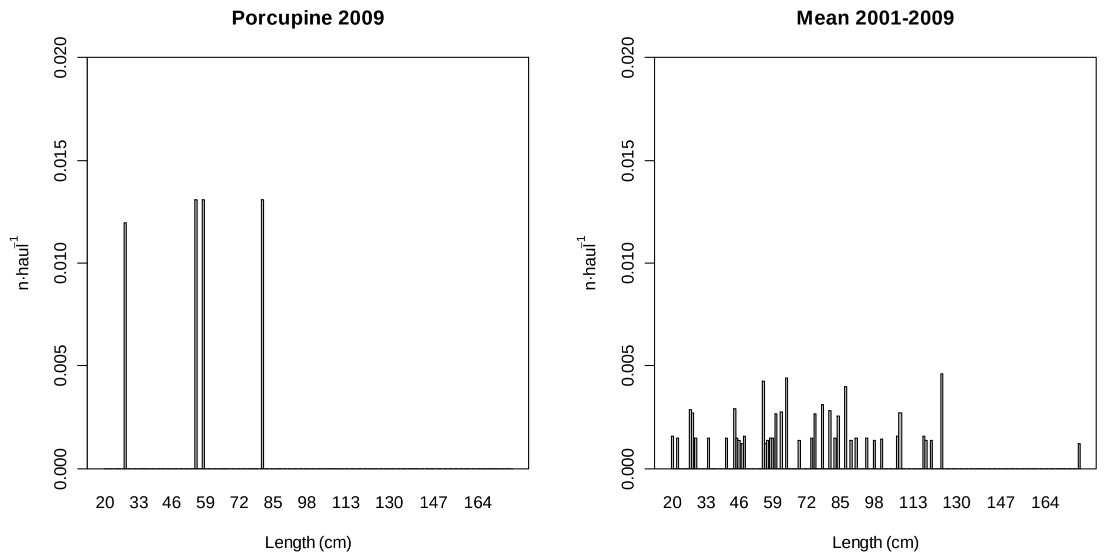

Figure 28. Stratified length distributions of common skate (*D. batis*) in 2009 in Porcupine survey, and Mean values during Porcupine Survey time series (2001-2009)

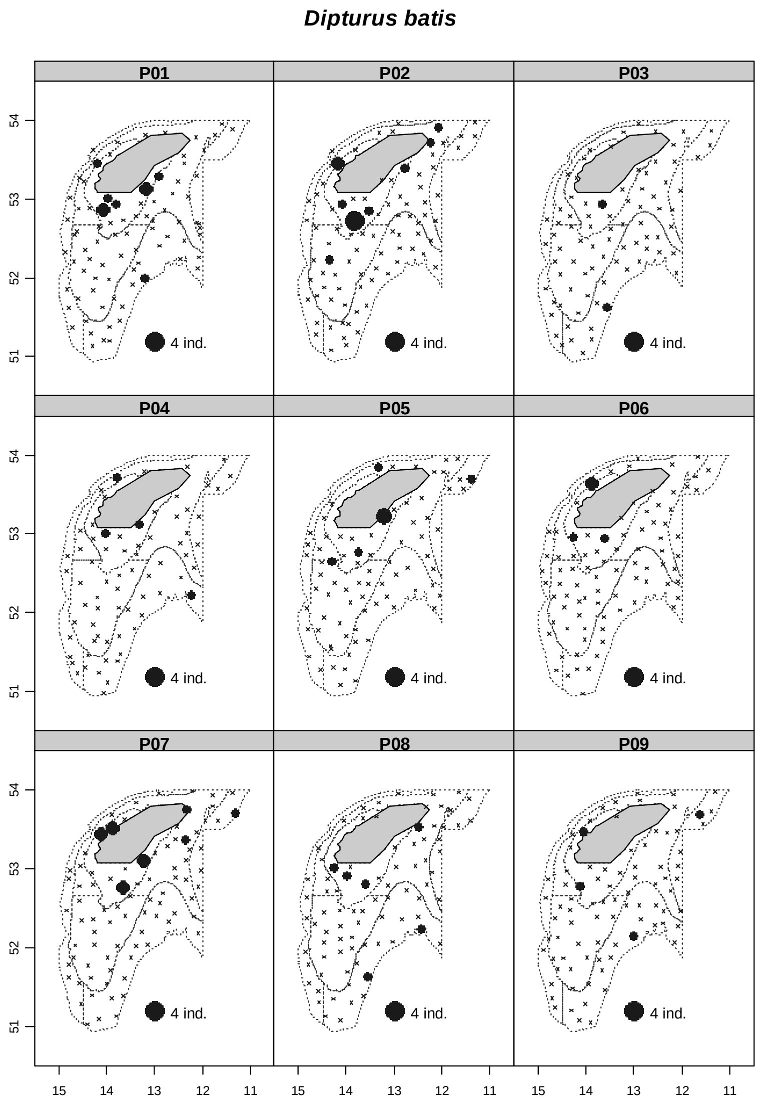

Figure 29. Geographic distribution of common skate (*D. batis*) catches (ind. · haul^{-1}) in Porcupine surveys (2001-2009)

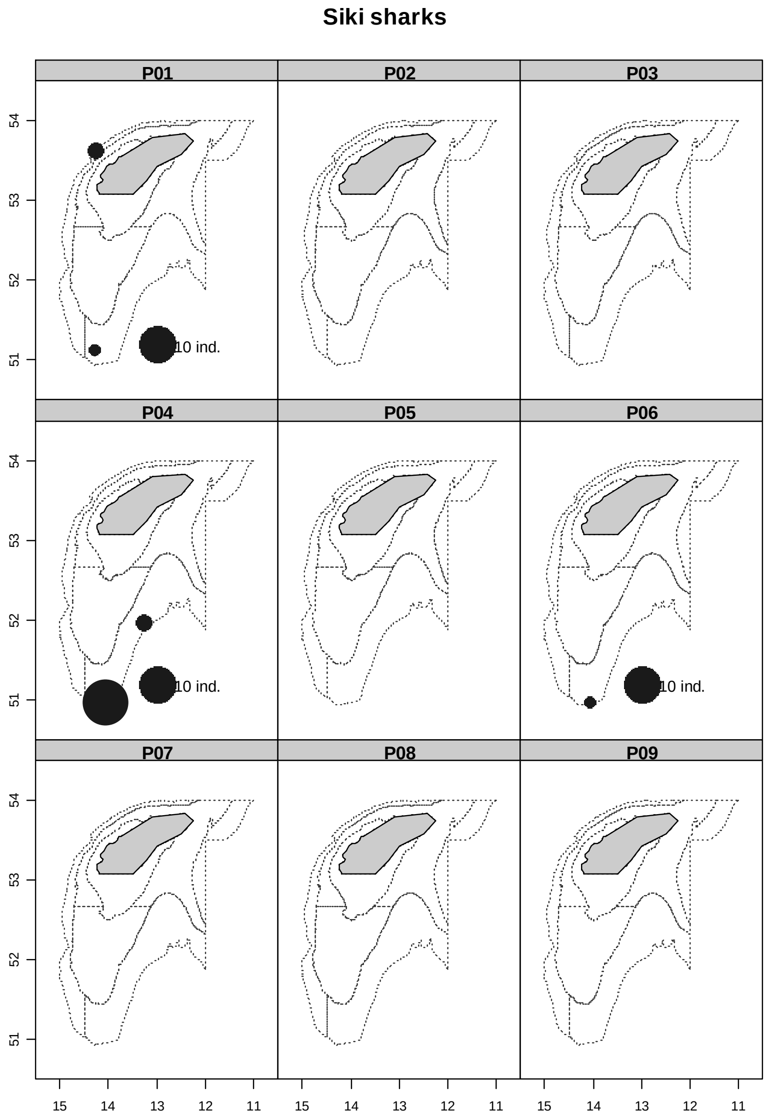

Figure 30. Geographic distribution of Siki shark catches (ind.·haul^{-1}) in Porcupine bank surveys (2001-2009). Note: Points marking the hauls without catches have been removed to help distinguishing small catches, see other species figures to get a complete idea of the sampling.