Results on main elasmobranch species from 2001 to 2021 Porcupine Bank (NE Atlantic) bottom trawl surveys

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Abstract

This working document presents the results of the most significant elasmobranch species caught on the Porcupine Spanish Groundfish Survey (SP-PORC-Q3) in 2021. Biomass and abundance index, distribution and length frequency information is presented for *Galeus melastomus* (blackmouth catshark), *Deania calcea* (birdbeak dogfish), *Deania profundorum* (arrowhead dogfish), *Scymnodon ringens* (knifetooth dogfish), *Scyliorhinus canicula* (lesser spotted dogfish), *Etmopterus spinax* (velvet belly lantern shark), *Dalatias licha* (kitefin shark), *Hexanchus griseus* (bluntnose sixgill shark), *Dipturus nidarosiensis* (Norwegian skate), *Dipturus batis* (common skate), *Dipturus intermedius* (common skate), *Leucoraja circularis* (sandy ray) and *Leucoraja naevus* (cuckoo ray), *Squalus acanthias* (picked dogfish), *Raja clavata* (thornback ray) and *Raja montagui* (spotted ray). In 2021 the biomass of *G. melastomus, D. calcea, S. ringens, D. licha, S. acanthias, L. naevus, L. circularis and D. batis* increased, whereas it decreased for *D. nidarosiensis*, *H. griseus, S. canicula* and *E. spinax*. Signs of recruitment were found for *G. melastomus, D. calcea, S. ringens, D. licha, D. nidarosiensis and D. batis*. Only a few specimens of *R. clavata, R. montagui, Centroscymnus coelolepis, Oxynotus paradoxus, Centroscymnus crepidater, Apristurus laurussonii, Galeus murinus and Centrophorus squamosus were caught. The species Centroscyllium fabricii and Neoraja caerulea were captured for the first time in the survey*. The species *D. profundorum and D. intermedius*, with regular presence in the historical series, were not found in 2021 survey.

Introduction

The Spanish bottom trawl survey on the Porcupine Bank (ICES Divisions 7c and 7k) has been carried out annually in the third-quarter (September) since 2001 to provide data and information for the assessment of the commercial fish species in the area (ICES, 2017).

The aim of this working document is to update the results (biomass and abundance indices, length frequency and geographic distributions) of the most common elasmobranch species on Porcupine Bottom Trawl Surveys, after the results presented previously (Ruiz-Pico *et al.* 2014; Fernández-Zapico *et al*. 2015; Ruiz-Pico *et al.* 2016; Fernández-Zapico *et al*. 2017; Ruiz-Pico *et al.* 2018, 2019, 2020; Fernández-Zapico *et al*. 2021). 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 batis* and *Dipturus intermedius* (common skate), *Squalus acanthias* (picked dogfish), *Raja clavata* (thornback ray) and *Raja montagui* (spotted ray).

Material and methods

The Spanish Ground Fish Survey on the Porcupine Bank (SP-PORC-Q3) has been carried out annually since 2001 onboard the R/V *Vizconde de Eza*, a stern trawler of 53 m and 1800 Kw. The area covered extends from longitude 12° W to 15° W and from latitude 51° N to 54° N (Figure 1), following the standard methodology for the IBTS North Eastern Atlantic surveys (ICES, 2017). The sampling design was random stratified to the area (Velasco and Serrano, 2003) with two geographical sectors (Northern and Southern) 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 (2017).

The tow duration is 20 min since 2016, but the results were extrapolated to 30 min of trawling time to keep up the time series.

Biomass, geographical distribution and length compositions were analysed, and the mean stratified biomass of the most abundant species of the last two years was compared with the mean of the previous five years.

Results and discussion

Despite the problems created by the pandemic, the Porcupine Groundfish Survey was carried out without major problems.

In 2021, 80 valid standard hauls and 14 additional hauls were carried out. Among the additional hauls, five of them have been carried out into the standard stratification, to improve coverage in the gaps left by random sampling and nine of them, between 994 and 1484 m, to explore the continuity of the fish community in Porcupine Seabight (Figure 2).

The total stratified catch per haul decreased significantly in 2021 compared to the previous year (Figure 3). Fish represented 96% of the total stratified catch and the elasmobranchs were the 8% of that total fish catch, with the following percentages per species: *Galeus melastomus* (71.3%), *Scymnodon ringens* (9.5%), *Deania calcea* (9.7%), *Scyliorhinus canicula* (1.9%), *Etmopterus spinax* (1.4%), *Hexanchus griseus* (0.9%), *Dalatias licha* (0.9%), *Squalus acanthias* (0.5%). The skate and rays species were: *Leucoraja circularis* (1.1%), *Leucoraja naevus* (0.6%), *Raja clavata* (0.01%), *Dipturus nidarosiensis* (1.8%) and *Dipturus batis* (1%).

In 2021 the biomass of *G. melastomus, D. calcea, S. ringens, D. licha, S. acanthias, L. naevus, L. circularis and D. batis* increased, whereas it decreased for *D. nidarosiensis*, *H. griseus, S. canicula* and *E. spinax.* Regarding recruitment, it was in general low for most of the species except a slight increase was found for *G. melastomus, D. calcea, S. ringens, D. licha, D. nidarosiensis and D. batis.*

Only a few specimens of *R. clavata*, *R. montagui*, *Centroscymnus coelolepis*, *Oxynotus paradoxus*, *Centroscymnus crepidater*, *Apristurus laurussonii*, *Galeus murinus* and *Centrophorus squamosus* were found. The species *Centroscyllium fabricii* and *Neoraja caerulea* were captured for the first time in the survey, both in the deep hauls of the Porcupine Seabight, between 994 and 1484 m, whereas the species *D. profundorum* and *D. intermedius*, with regular presence in the temporal series, were not captured in this last survey.

***Galeus melastomus* (blackmouth catshark)**

In 2021, both the biomass and the abundance index of *G. melastomus* doubled compared to the previous year, returning to the highest values of the temporal series (Figure 4). Even so, the comparative of the biomass value in the last two years with respect to the previous five decreased significantly (Figure 5).

Similarly to previous years, the species was mainly distributed in the southern deepest area (Figure 6).

The length distribution ranged from 11 cm to 76 cm in this last survey. There was an increase in small sizes, with a mode in 13 cm. In 2021 high abundance was observed in the largest sizes from 58 to 60 cm in comparison with the mean time series (Figure 7).

***Deania calcea* (birdbeak dogfish) and *Deania profundorum* (arrowhead dogfish)**

Although *D. profundorum* was rather scarcer than *D. calcea* in the area, it has been found every survey since *D. profundorum* was first identified in 2012. However, in 2021 was not found in the survey.

The biomass and abundance of *Deania spp.* (only *D. calcea* in the last survey) have increased, recovering the mean values of the last five years (Figure 8, Figure 9 and Figure 10).

The specimens of *D. calcea* were mainly found in western deepest strata, as usual, as well as some spots of biomass in the southern deepest strata in this last survey (Figure 11). They ranged from 30 cm to 110 cm, with two modes, in 84-88 cm and 110 cm, consistent with the mean of the historical series, although the increase in individuals below 65 cm is notable (Figure 12).

***Scymnodon ringens* (knifetooth dogfish)**

Both biomass and abundance of *S. ringens* increased strongly in 2021 compared to the previous year. Not only it doubled the value of the previous year but also reached the highest value of the temporal series. The biomass index of the last two years increased strongly compared to the previous five years (Figure 13 and Figure 14).

As usual, *S. ringens* was found in the deepest strata, in the southern area (Figure 15).

The length distribution ranged from 33 cm to 112 cm in this last survey and three modes can be distinguished (44 cm, 72 cm and 108 cm). The increase in abundance of all size groups in comparison with the mean value of the historical series is remarkable, especially those of medium size and the smallest, showing signs of recruitment (Figure 16).

***Scyliorhinus canicula* (lesser spotted dogfish)**

The biomass and abundance of *S. canicula* continued decreasing in this last survey (Figure 17) and the mean biomass of the last two years was lower than in the previous five years (Figure 18).

S. canicula was distributed around the bank itself and on the Irish shelf, as usual, but with fewer and smaller spots of biomass (Figure 19).

The length distribution ranged from 44 cm to 81 cm in this last survey, with a mode around 64 cm. However, the smaller individuals from the temporal series were not found in 2021 (Figure 20).

***Etmopterus spinax* (velvet belly)**

Regarding *E. spinax*, in 2021 both biomass and abundance values remained very similar to those of the previous year, although the biomass decreased and the abundance slightly increased (Figure 21). The mean stratified biomass in the last two years remained lower than in the previous five years (Figure 22).

E. spinax was distributed in the southeast area, as usual, and there was also another remarkable spot in the deepest southern area, as well as in the northern area, around the bank (Figure 23).

The length distribution of *E. spinax* showed a conspicuos mode in 21 cm and also a less remarkable mode in 39 cm compared to the mean values of the historical series (Figure 24).

***Hexanchus griseus* (bluntnose sixgill shark)**

The abundance of this scarce shark has fallen sharply in 2021 to reach the historical minimum of the temporal series (Figure 25), the mean biomass of the last two years remained well below the value of the previous five years (Figure 26).

The geographical distribution usually does not show a clear pattern, but in this last survey all of the specimens were found south to the bank (Figure 27).

Only two hauls showed presence of *Hexanchus griseus*, between 196 and 230 m deep, with two individuals, a female of 72 cm and a male of 81 cm length (Figure 28).

***Dalatias licha* (kitefin shark)**

Both biomass and abundance index of *D. licha* increased slightly in this last survey (Figure 29). The mean biomass of the last two years was high compared to the value of the previous five years (Figure 30). A total of 11 hauls showed presence of this species, between 419 and 751 m deep, where individuals with sizes from 39 to 109 cm were found, mainly in the deepest strata in the south and west of the study area (Figure 31 and Figure 32).

***Squalus acanthias* (picked dogfish)**

In 2021, especially the biomass and also the abundance of this scarce elasmobranch increased strongly, reaching one of the highest values of biomass in the temporal series and maintaining the average values in abundance terms (Figure 33).

Only six specimens among 100 and 107 cm length were found in one haul at 196 m deep southwest of the bank (Figure 34).

Other shark species

Other shark species scarcely caught in this last survey were *Centroscymnus coelolepis*, *Oxynotus paradoxus*, *Centroscymnus crepidater*, *Apristurus laurussonii*, *Galeus murinus*, *Centrophorus squamosus* and *Centroscyllium fabricii*.

Centroscymnus coelolepis was only found in five additional deep hauls out of the standard stratification carried out to explore the continuity of the fish community in Porcupine Seabight, among 1348 and 1484 m, in the southeast part of the bank. One individual, 82 cm length, of the species *Oxynotus paradoxus* was found in a single haul at 705 m depth, southern the bank. The species *Centroscymnus crepidater* was captured in three hauls, mostly in deep hauls out of the standard stratification, but also one specimen, 85 cm length, was found in a haul at 738 m depth. Thirteen individuals of the species *Apristurus laurussonii* were captured in three hauls in the deeper hauls out of the standard stratification, among 1354 and 1484 m depth. Fifteen individuals of the species *Galeus murinus* were found in six hauls in the deeper hauls out of the standard stratification, among 1105 and 1484 m depth. Three specimens of the species *Centrophorus squamosus* were captured in two hauls in Porcupine Seabight, among 1348 and 1484 m, in the southeast part of the bank. Two individuals of the species *Centroscyllium fabricii* were found in two hauls in Porcupine Seabight, among 1354 and 1435 m, in the southeast part of the study area (Figure 35).

***Leucoraja naevus* (cuckoo ray) and *Leucoraja circularis* (sandy ray)**

L. naevus has been slightly scarcer than *L. circularis* in the area, although the abundance of the former has been marginally higher in the last year. In 2021, both biomass and abundance increased for the two species, except the abundance value for *L. circularis*, that decreased very slightly (Figure 36).

In 2021, as usual, specimens of *L. naevus* were found in the shallower stratum around the bank itself, whereas *L. circularis* was caught in a deeper stratum to the southwest and north of the bank (Figure 37 and Figure 38).

In this last survey, specimens of *L. naevus* ranged from 30 to 60 cm, showing a mode in 54 cm, according to the mean values of the last ten years, and a scarce presence of individuals below 45 cm (Figure 39).

Although *L. circularis* usually presents a wider range of sizes, in 2021 it ranged from 27 to 111 cm, showing two modes in 34 and 80 cm (Figure 40).

***Dipturus* spp. (common skate)**

Dipturus nidarosiensis, *Dipturus cf. flossada* and *Dipturus intermedius* were comparatively analysed since 2011, unlike previous reports, when *D. batis* was split into *D. cf. flossada* and *D. cf. intermedia* (Iglésias et al., 2009). Recently, *Dipturus cf. flossada* has been accepted as *D. batis, whereas D. cf. intermedia* has kept its original name as *D. intermedius* (Last et al., 2016). The three rays together as *Dipturus* spp. were also analysed.

The biomass of *Dipturus* spp. decreased slightly in 2021 whereas its abundance increased strongly, doubling the value of the previous year (Figure 41). The mean biomass index of the last two years remained lower than the previous five years (Figure 42). Specifically, both the biomass and the abundance of *D. batis* increased strongly with respect to the previous year, returning to the medium-high values of the temporal series. However, *D. nidarosiensis* slightly decreased in biomass terms whereas slightly increased in abundance terms, remaining among the medium values of the temporal series. On the other hand, *D. intermedius* has not been captured in this last survey (Figure 43).

A total of nine hauls, between 610 m and 1355 m deep, showed presence of the species *D. nidarosiensis*, in the deeper stratum to the south and east of the study area, most of them in the deeper hauls out of the standard stratification in Porcupine Seabight (six out of nine hauls with presence of the species). However, as usual, the other *Dipturus* with presence in the last survey, the species *D. batis*, was found shallower, specifically, in eleven hauls, between 196 m and 455 m deep, around the bank (Figure 44 and Figure 45).

In 2021, the specimens of *D. nidarosiensis* captured in the three hauls in the stratified area ranged from 28 cm to 168 cm (Figure 46). However, the specimens of *D. batis* (from 20 to 114 cm) were smaller, as usual. They showed a higher abundance in the size of 33 cm. Furthermore, the largest individuals of the last 10 years were almost not found (Figure 47).

***Raja clavata* (thornback ray) and *Raja montagui* (spotted ray)**

In 2021 only one specimen of *R. clavata*, was found in the northeastern area of the Irish shelf, at 237 m depth, whereas the species *R. montagui* was captured in two hauls, between 196 and 200 m, south of the bank, after its absence in the survey the previous year. The shallow habits of these two rays (major skates) might explain their scarcity in the study area (Figure 48 and Figure 49).

Other skates species

The skate species *Neoraja caerulea* was captured for the first time in the survey in 2021. It was found in three hauls, among 1348 and 1484 m depth, in the deeper hauls out of the standard stratification in Porcupine Seabight, southeast the study area (Figure 50). A total 6 specimens were caught in this hauls ranging from 25 to 33 cm.

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Figures

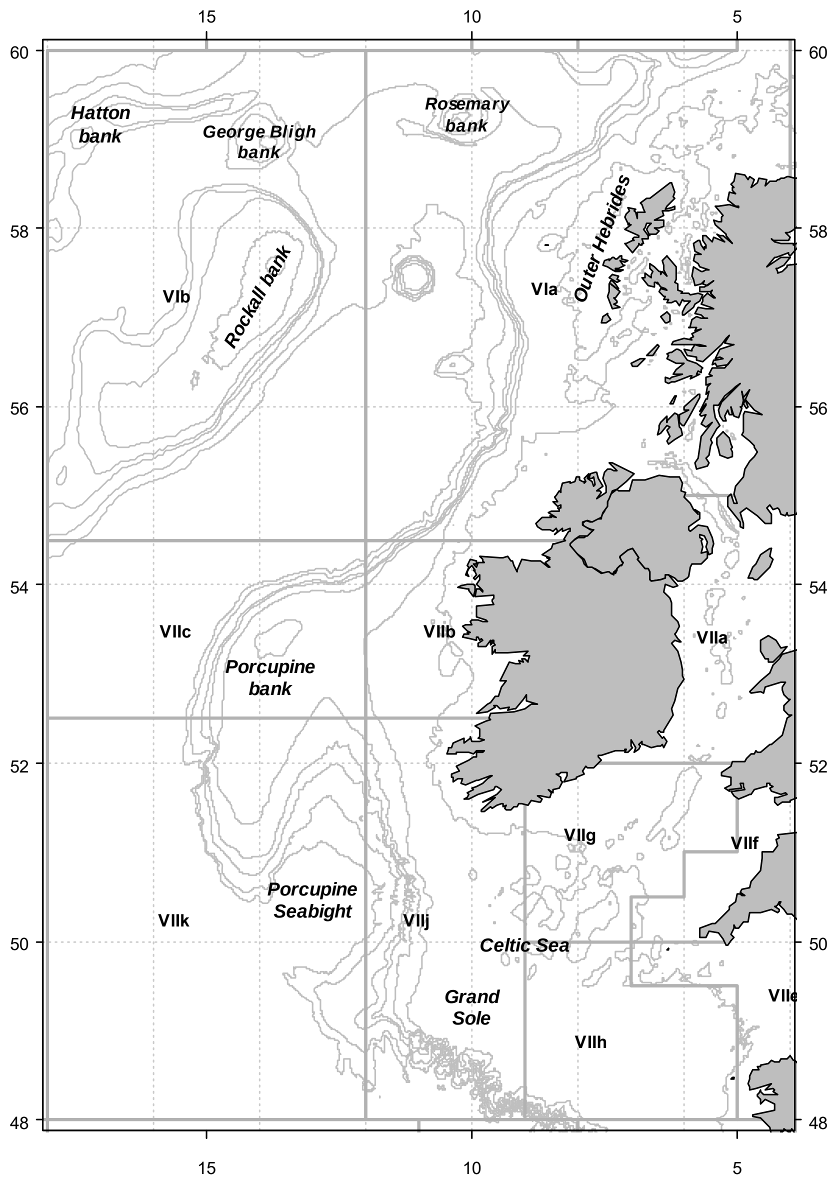


Figure 1. North eastern Atlantic showing the Porcupine bank, Porcupine Seabight, and ICES divisions

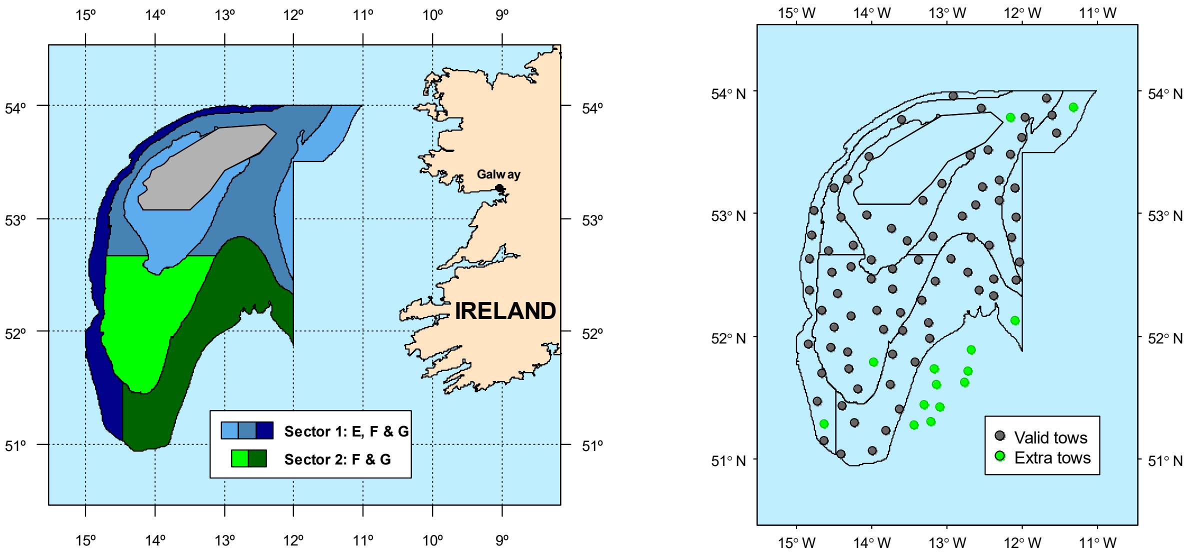


Figure 2. Left: Stratification design used in Porcupine surveys from 2003, previous data were re-stratified. Depth strata are: E) shallower than 300 m, F) 301- 450 m and G) 451-800 m. Grey area in the middle of Porcupine bank corresponds to a large non-trawlable area, not considered for area measurements and stratification. Right: hauls performed in 2021

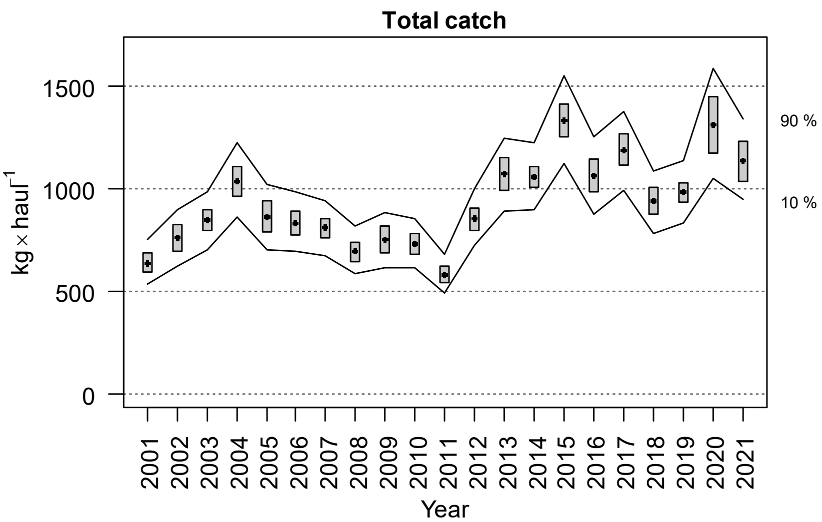


Figure 3. Evolution of the total stratified catch in Porcupine surveys (2001-2021)

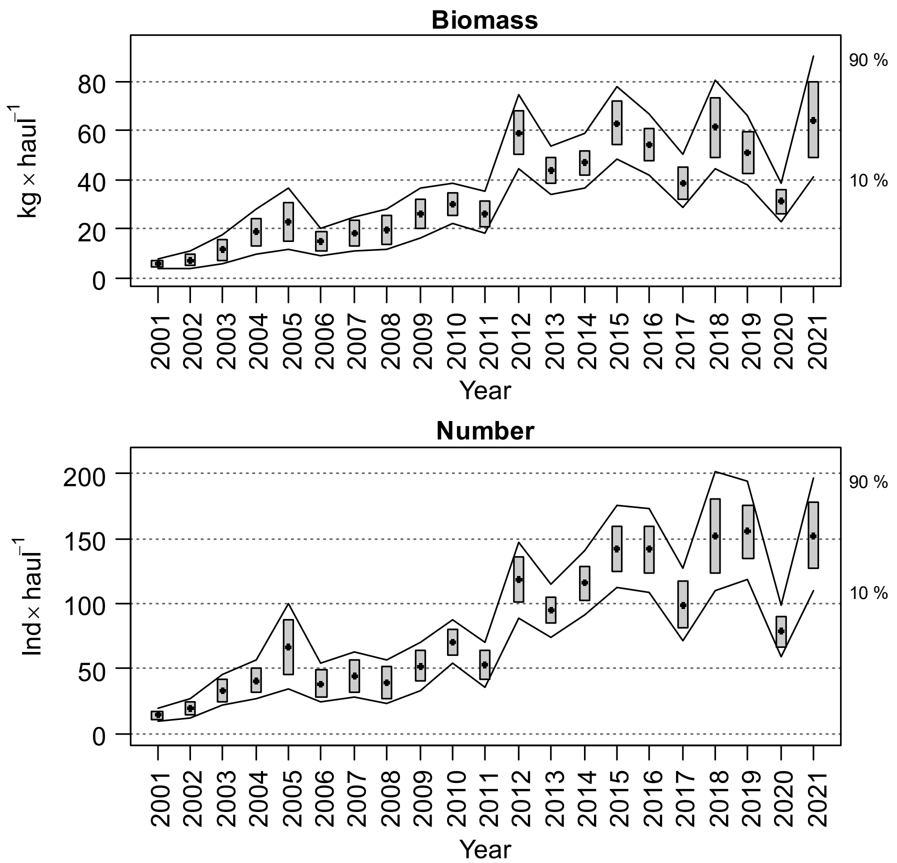


Figure 4. Evolution of *Galeus melastomus* biomass and abundance indices in Porcupine surveys (2001-2021). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000)

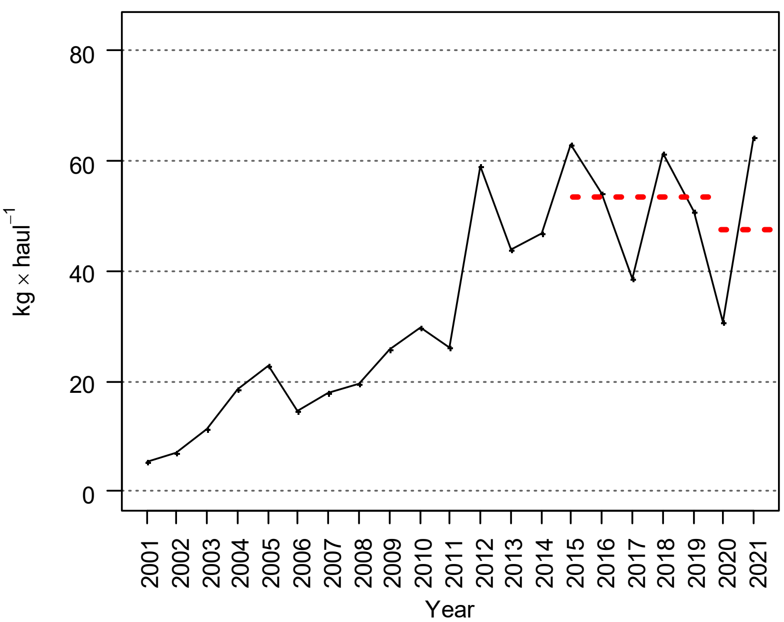


Figure 5. Evolution of *Galeus melastomus* biomass index in Porcupine surveys (2001-2021). Dotted lines compare mean stratified biomass in the last two years with the five previous years

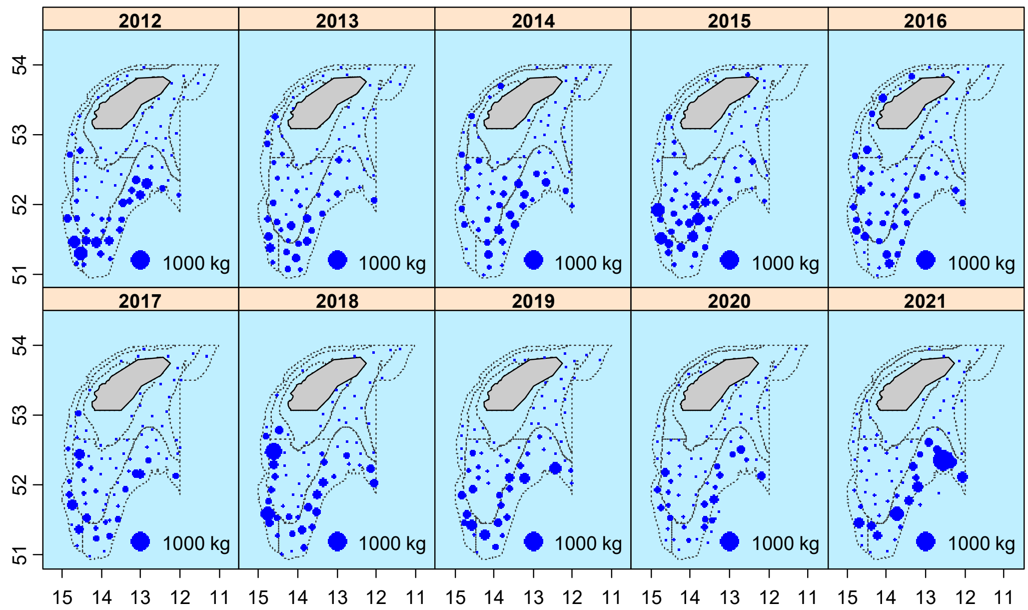


Figure 6. Geographic distribution of *Galeus melastomus* catches (kg·haul^{-1}) in Porcupine surveys (2012-2021)

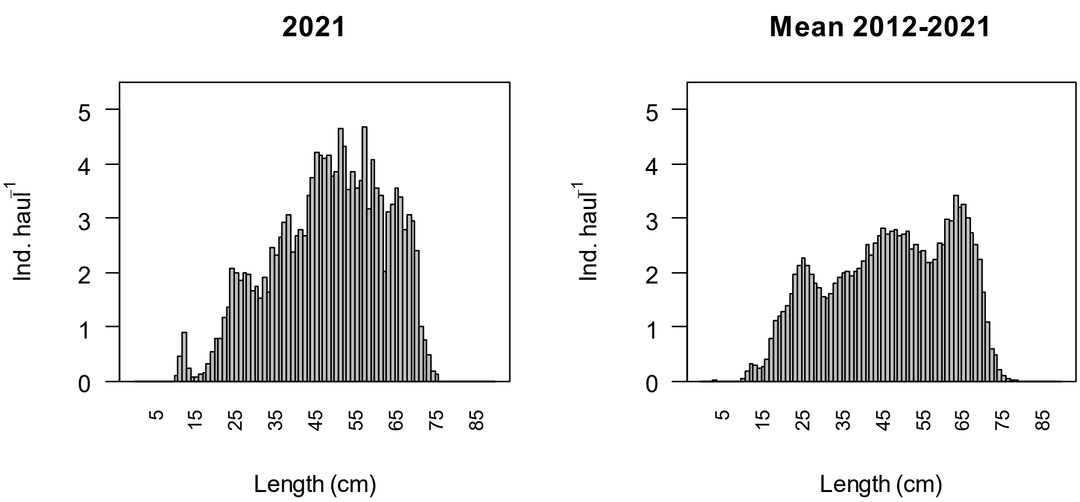


Figure 7. Stratified length distributions of *Galeus melastomus* in the last Porcupine survey, and mean values in Porcupine surveys (2012-2021)

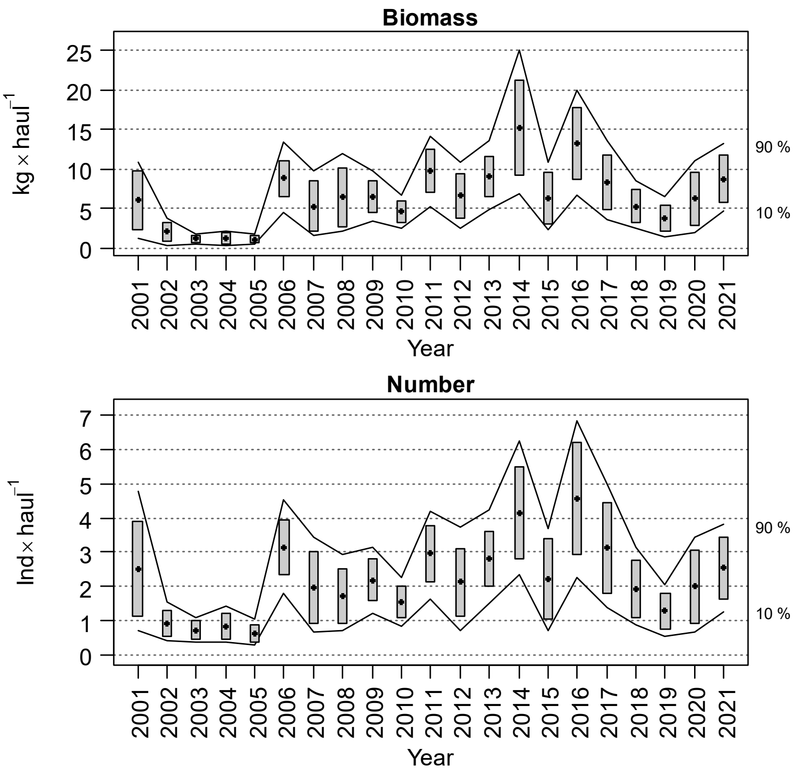


Figure 8. Evolution of *Deania* spp. (mainly *D. calcea*) biomass and abundance indices in Porcupine surveys (2001-2021). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations =1000)

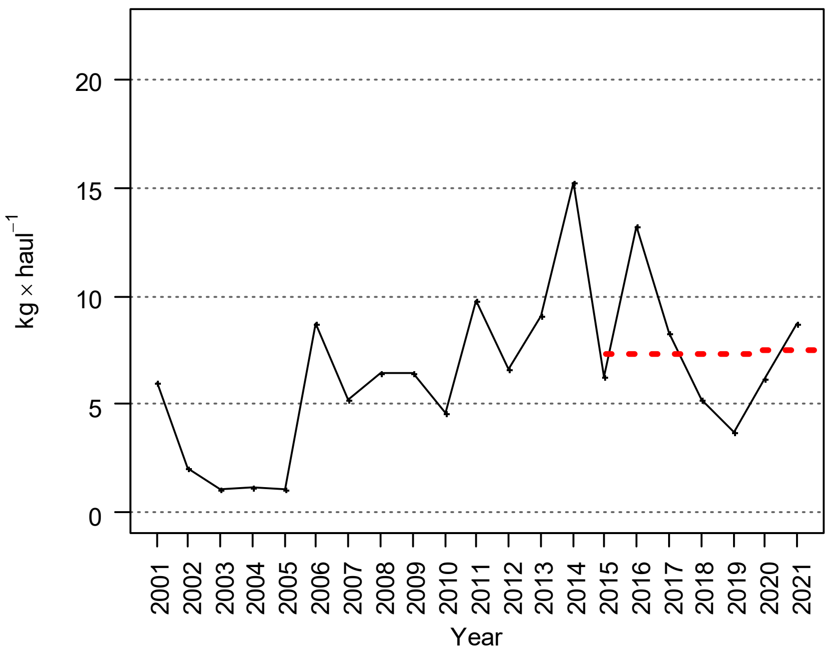


Figure 9. Evolution in *Deania* spp. (mainly *D. calcea*) biomass index in Porcupine surveys (2001-2021). Dotted lines compare mean stratified biomass in the last two years with the five previous years

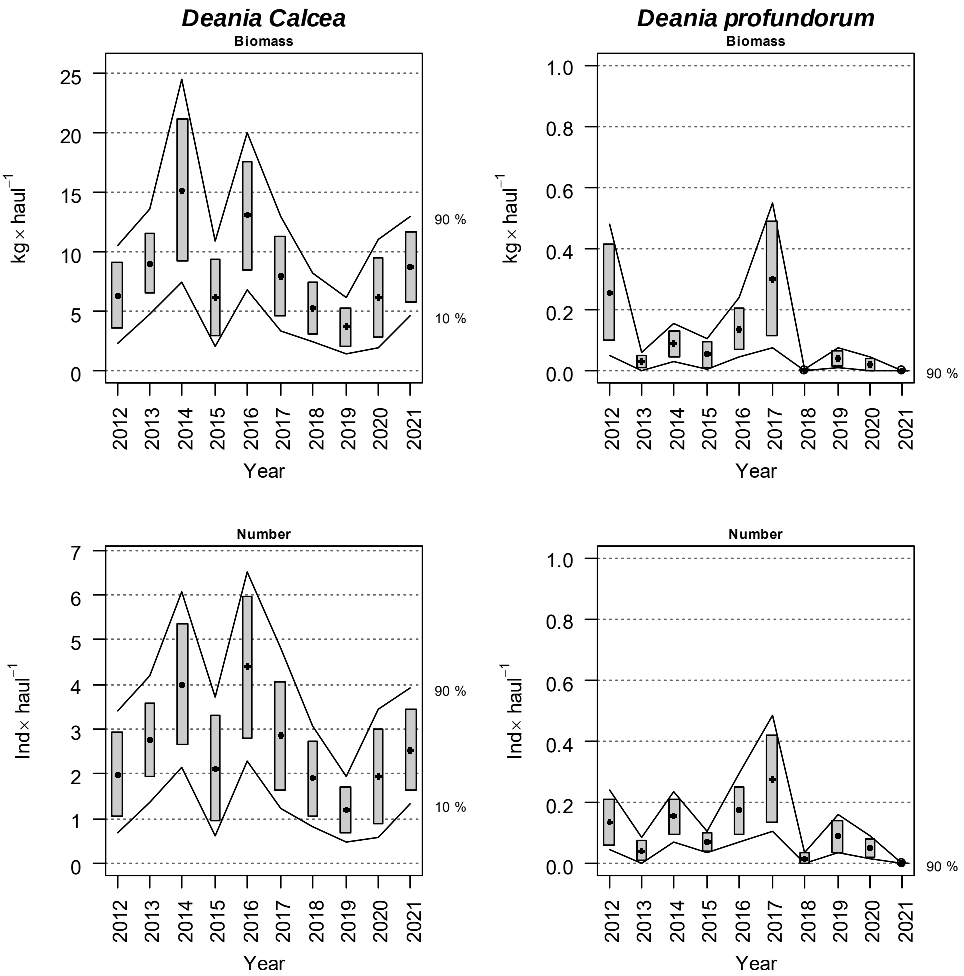


Figure 10. Evolution of *Deania calcea* and *Deania profundorum* biomass and abundance indices from 2012 and 2021 Porcupine surveys. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations =1000)

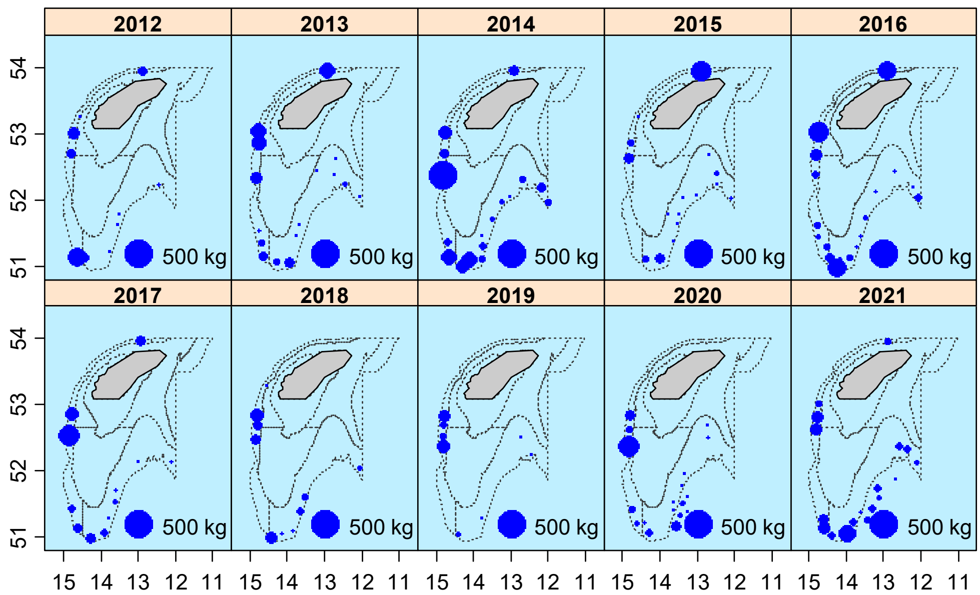


Figure 11. Geographic distribution of *Deania* spp. (mainly *D. calcea*) catches (kg·haul^{-1}) in Porcupine surveys (2012-2021)

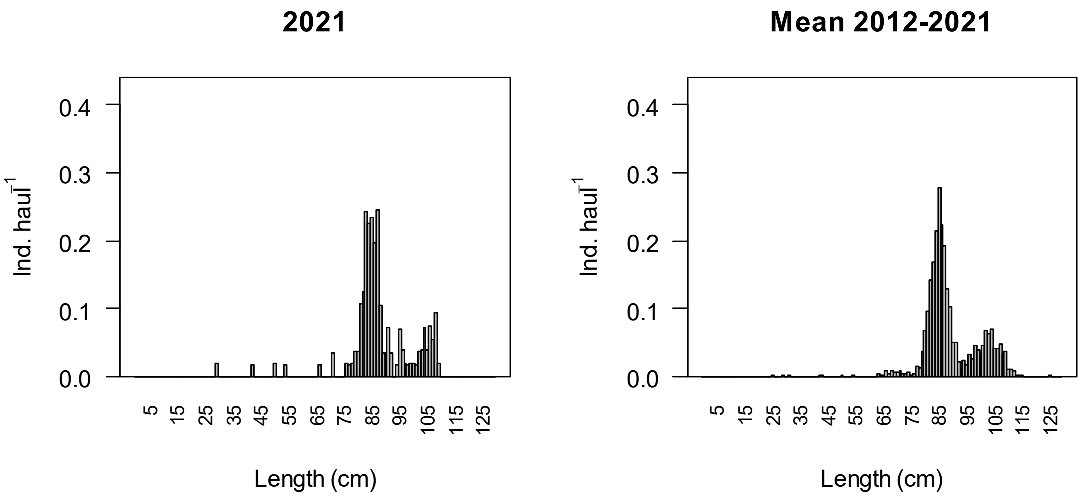


Figure 12. Stratified length distribution of *Deania calcea* in the last Porcupine survey, and mean values in Porcupine surveys (2012-2021)

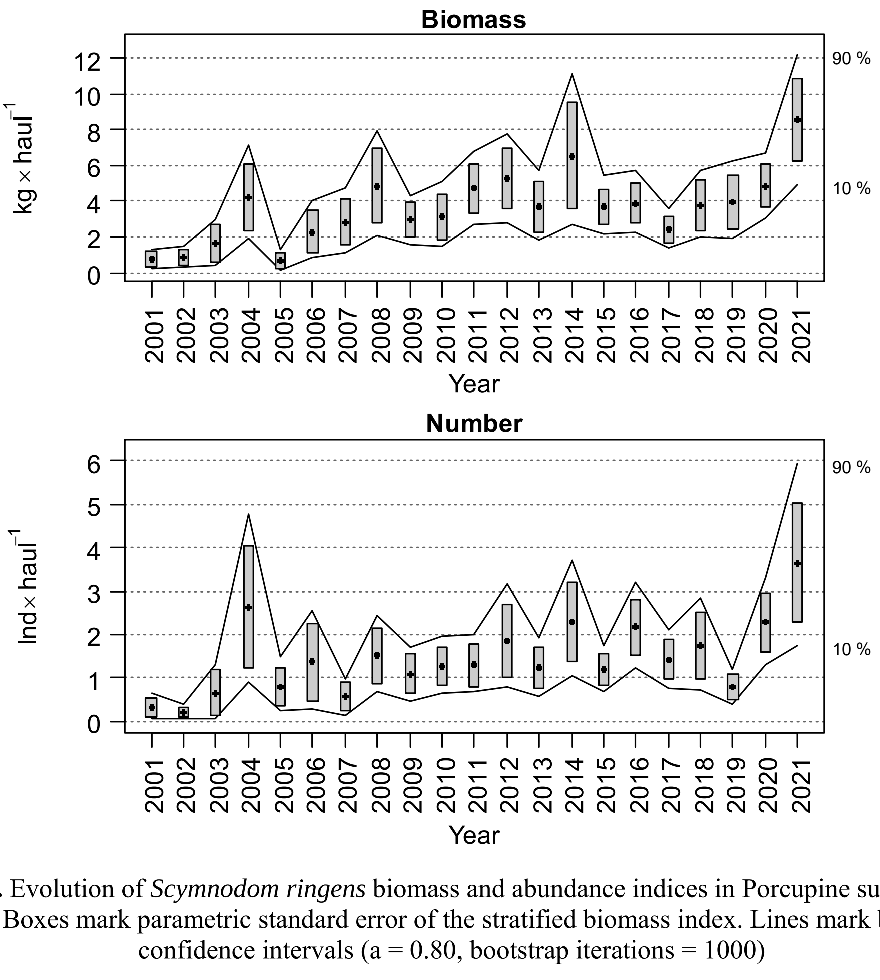


Figure 13. Evolution of *Scymnodom ringens* biomass and abundance indices in Porcupine surveys (2001-2021). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000)

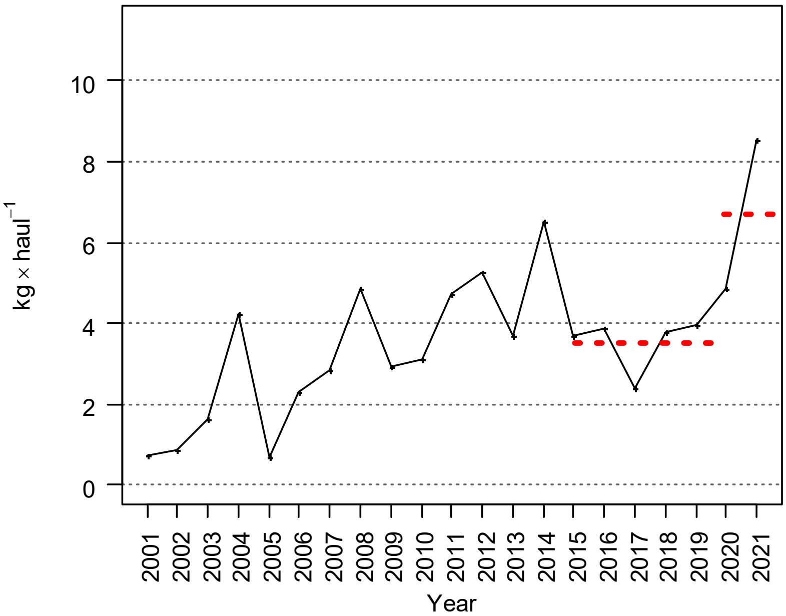


Figure 14. Evolution in *Scymnodom ringens* biomass index in Porcupine surveys (2001-2021). Dotted lines compare mean stratified biomass in the last two years with the five previous years

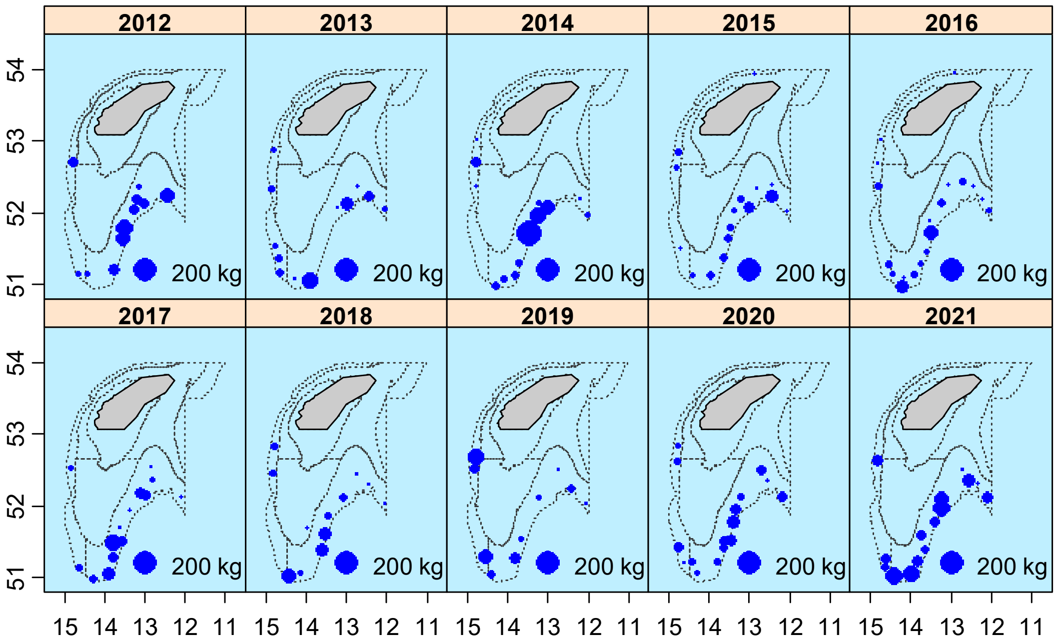


Figure 15. Geographic distribution of *Scymnodon ringens* catches (kg·haul^{-1}) in Porcupine surveys (2012-2021)

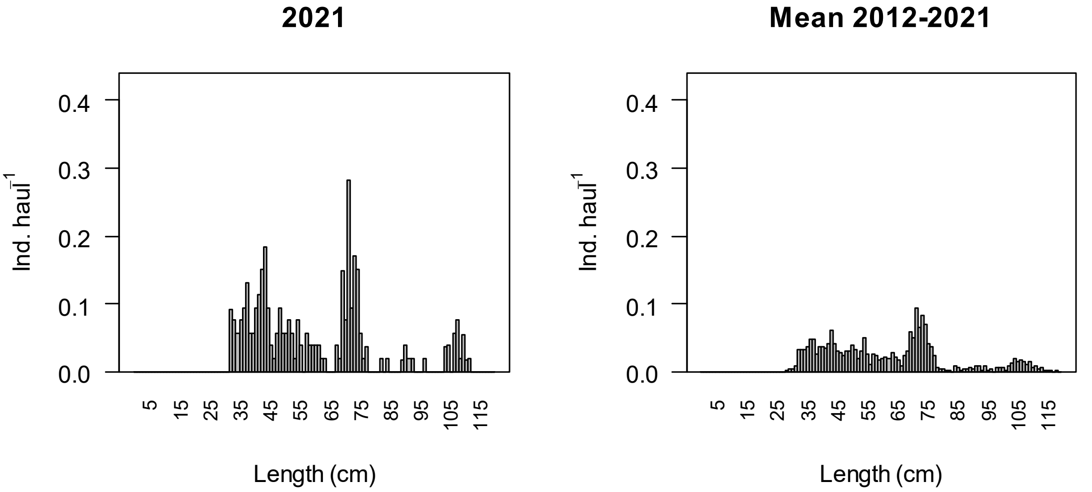


Figure 16. Stratified length distributions of *Scymnodon ringens* in the last Porcupine survey, and mean values in Porcupine surveys (2012-2021)

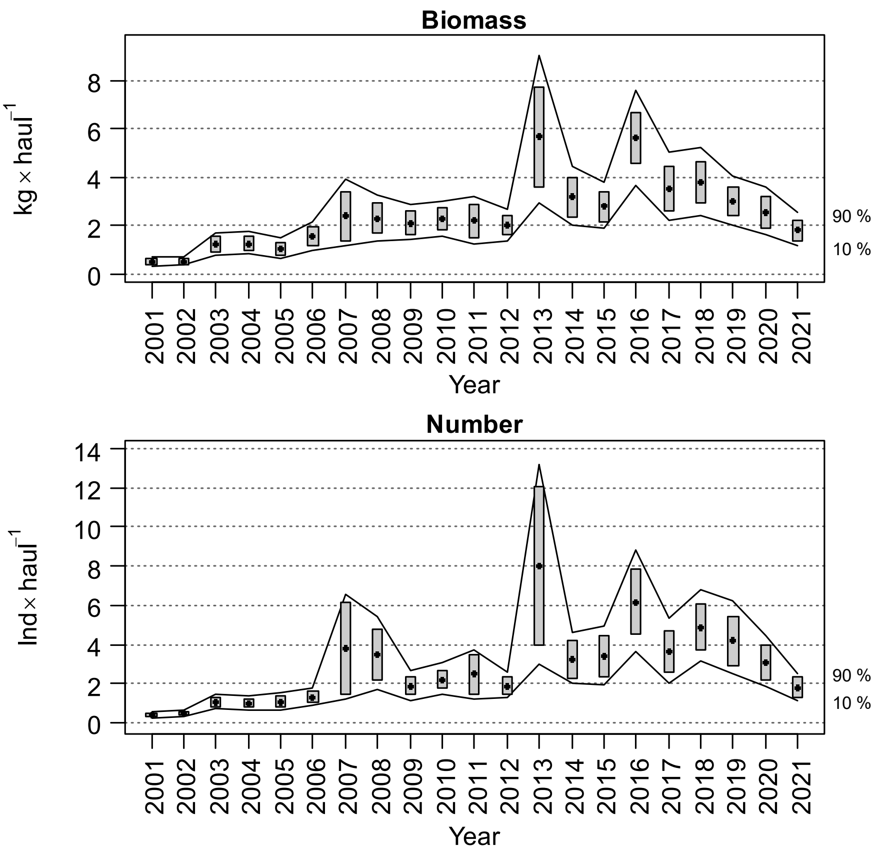


Figure 17. Evolution of *Scyliorhinus canicula* biomass and abundance indices in Porcupine surveys (2001-2021). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000)

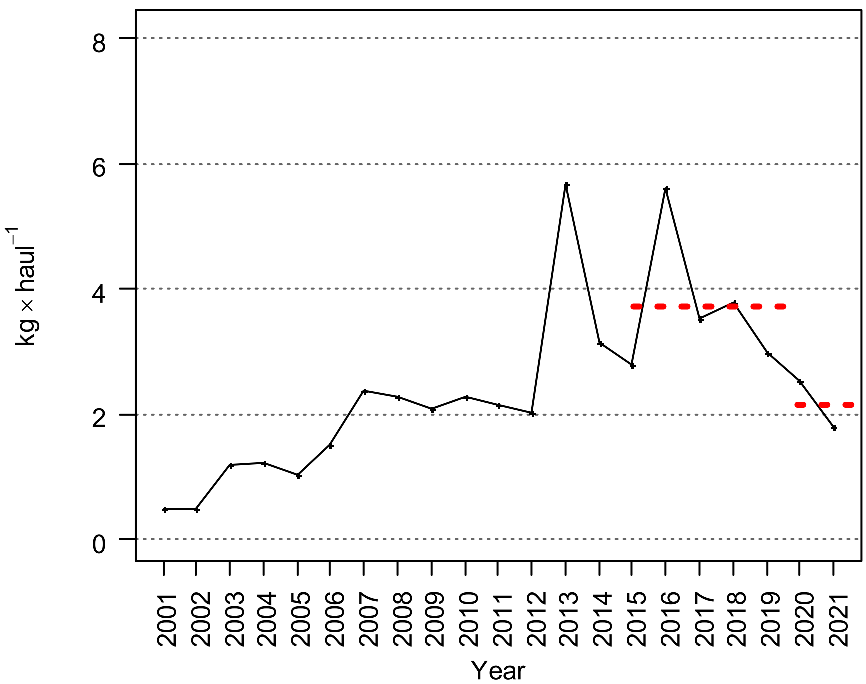


Figure 18. Evolution in *Scyliorhinus canicula* biomass index in Porcupine surveys (2001-2021). Dotted lines compare mean stratified biomass in the last two years with the five previous years

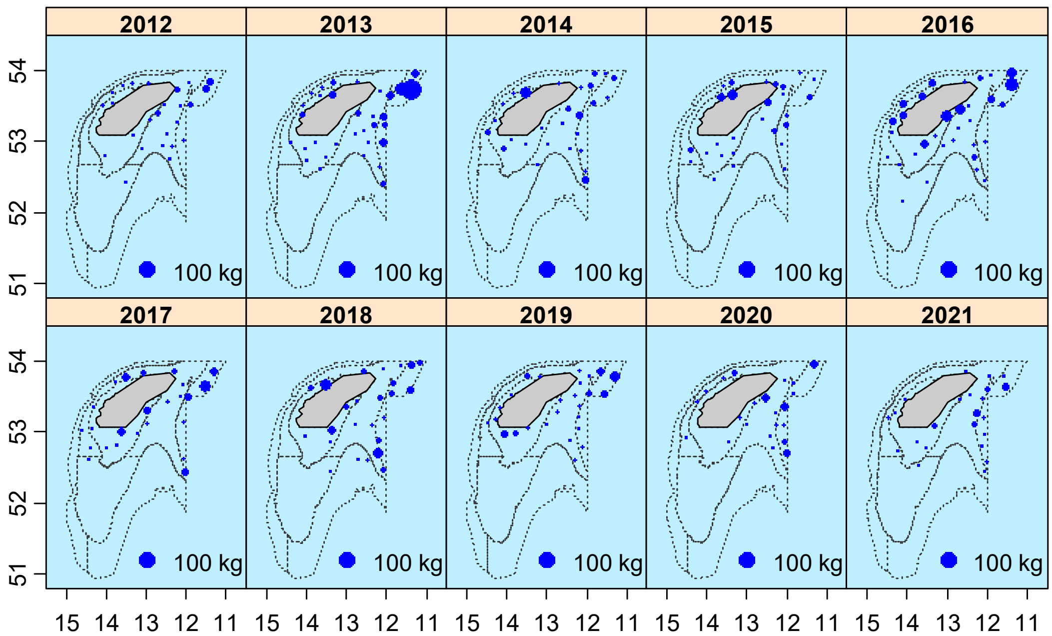


Figure 19. Geographic distribution of *Scyliorhinus canicula* catches (kg·haul^{-1}) in Porcupine surveys (2011-2021)

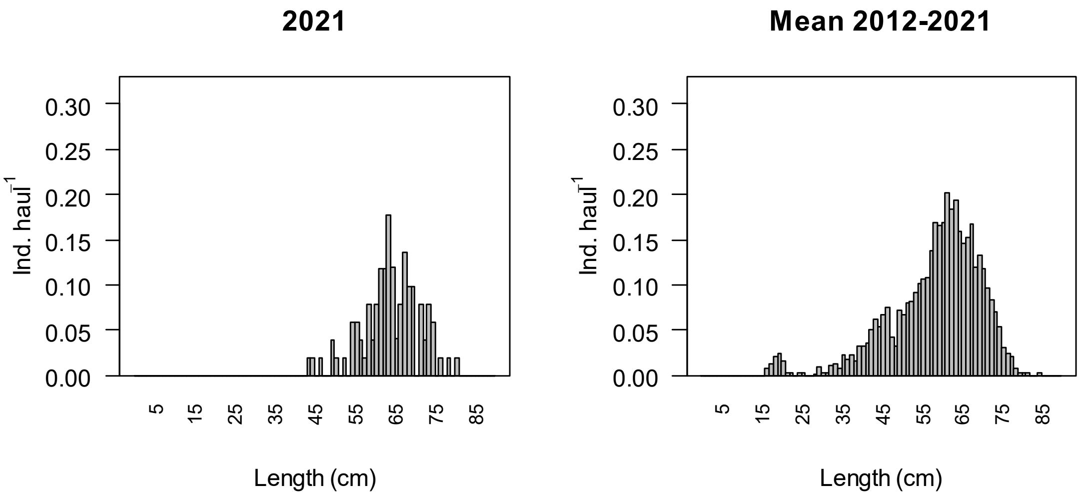


Figure 20. Stratified length distribution of *Scyliorhinus canicula* in the last Porcupine survey, and mean values in Porcupine surveys (2012-2021)

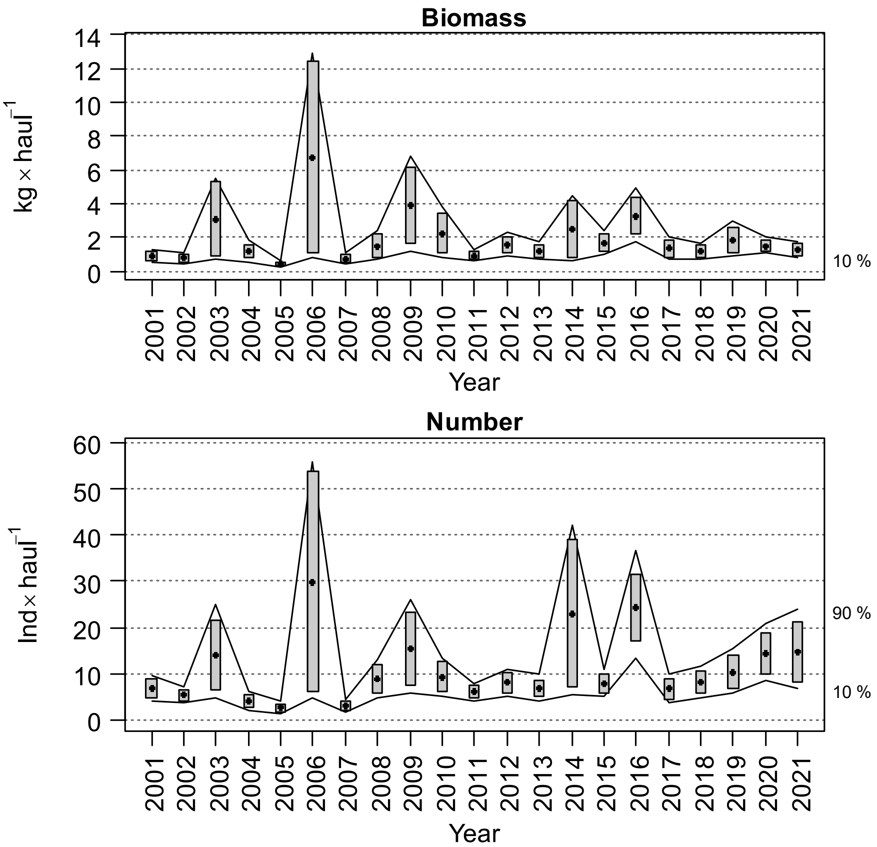


Figure 21. Evolution of *Etmopterus spinax* biomass and abundance indices in Porcupine surveys (2001-2021). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000)

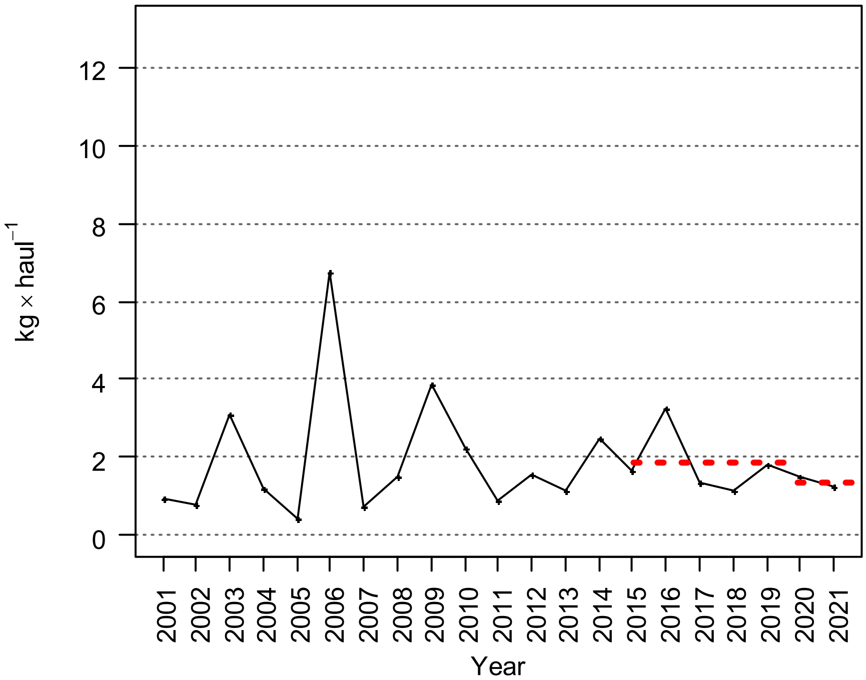


Figure 22. Evolution in *Etmopterus spinax* biomass index in Porcupine surveys (2001-2021). Dotted lines compare mean stratified biomass in the last two years with the five previous years

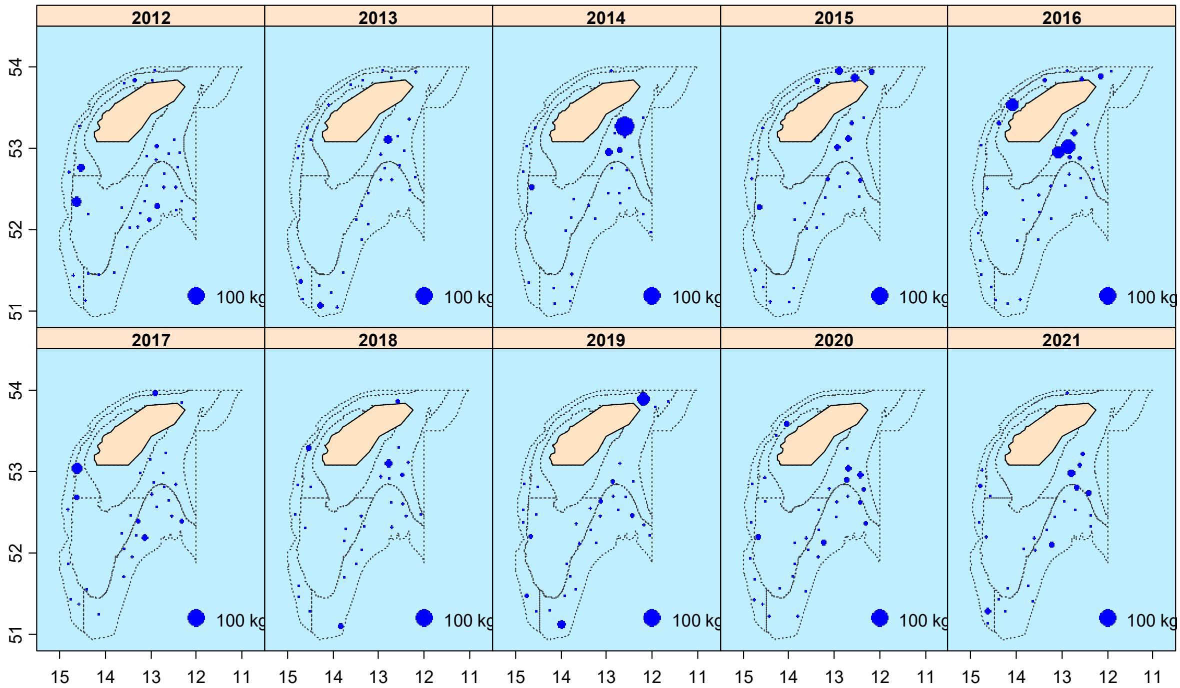


Figure 23. Geographic distribution of *Etmopterus spinax* catches (kg·haul^{-1}) in Porcupine surveys (2011-2021)

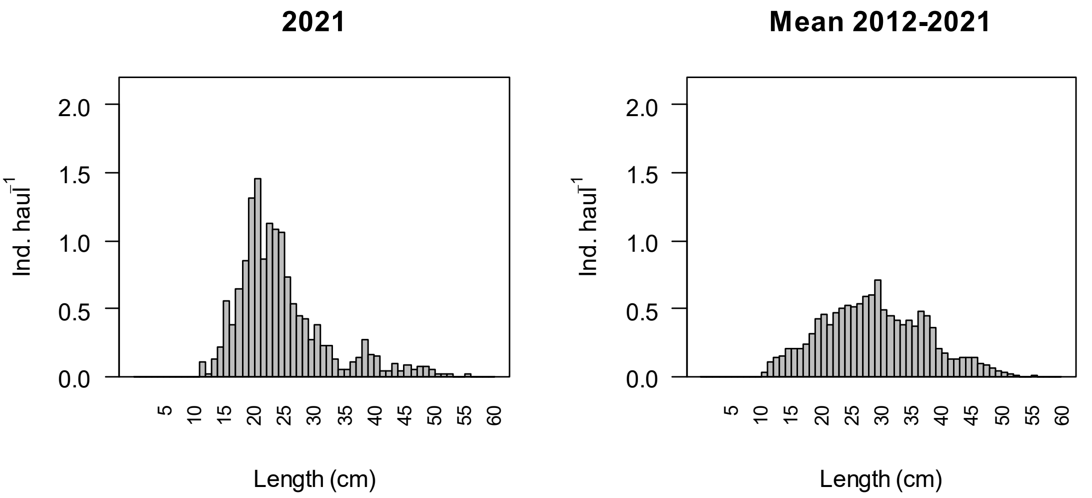


Figure 24. Stratified length distribution of *Etmopterus spinax* in the last Porcupine survey, and mean values in Porcupine surveys (2012-2021)

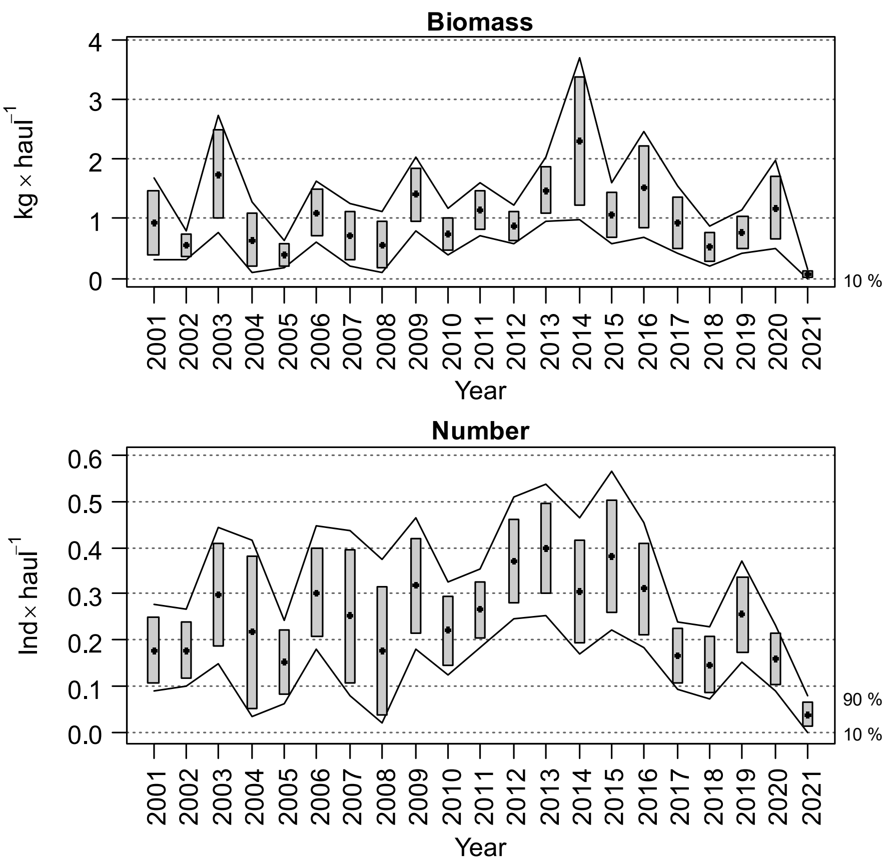


Figure 25. Evolution of *Hexanchus griseus* biomass and abundance indices in Porcupine surveys (2001-2021). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000)

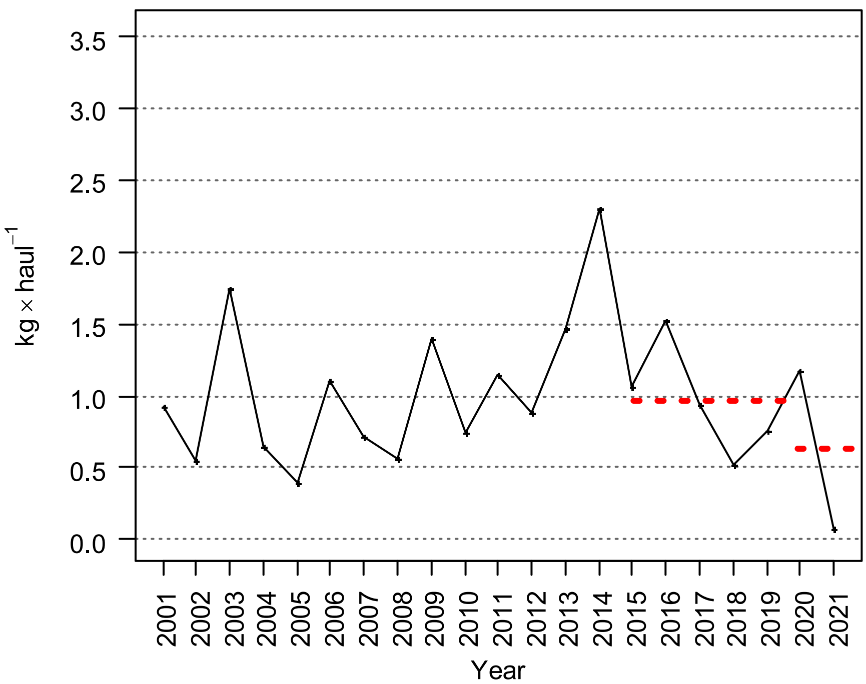


Figure 26. Evolution in *Hexanchus griseus* biomass index in Porcupine surveys (2001-2021). Dotted lines compare mean stratified biomass in the last two years with the five previous years

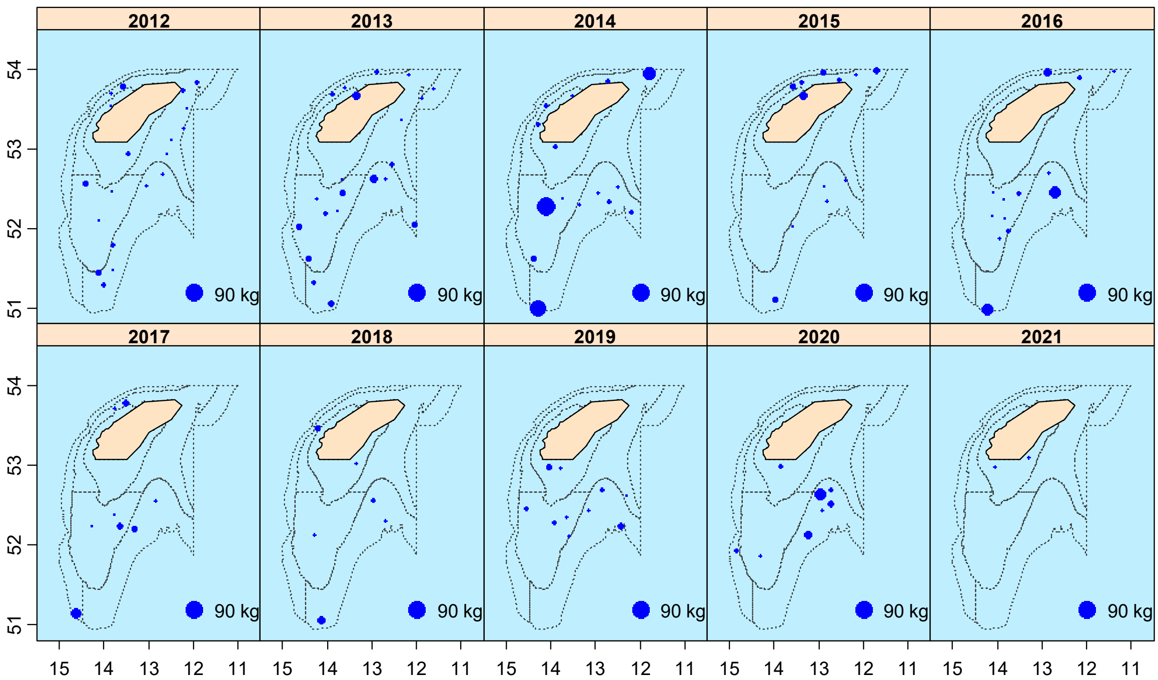


Figure 27. Geographic distribution of *Hexanchus griseus* catches (kg×30 min haul^{-1}) in Porcupine surveys (2012-2021)

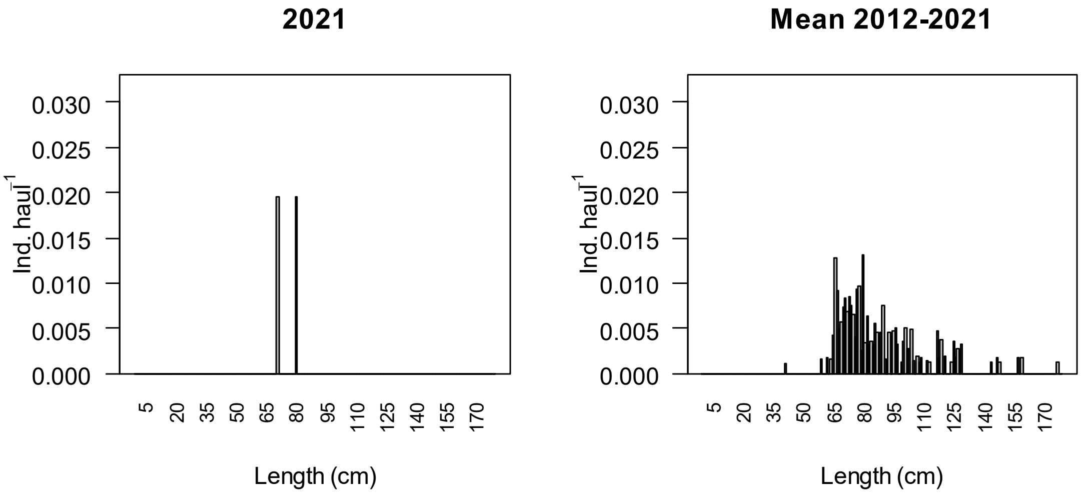


Figure 28. Stratified length distribution of *Hexanchus griseus* in the last Porcupine survey, and mean values in Porcupine surveys between 2012 and 2021.

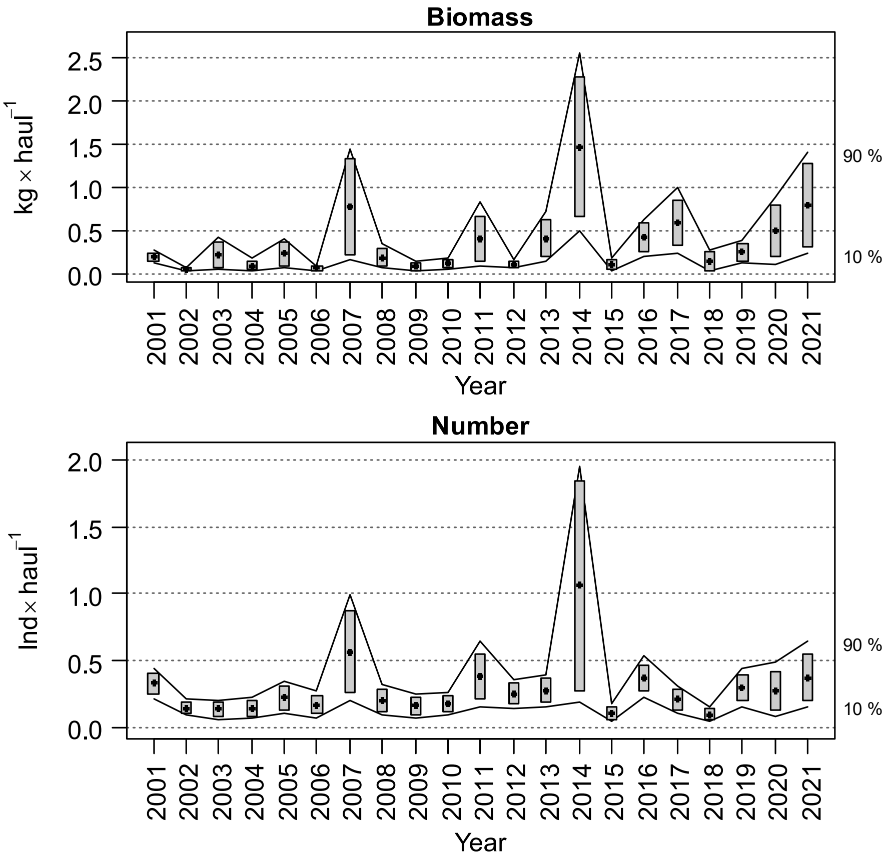


Figure 29. Evolution of *Dalatias licha* biomass and abundance indices in Porcupine surveys (2001-2021). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000)

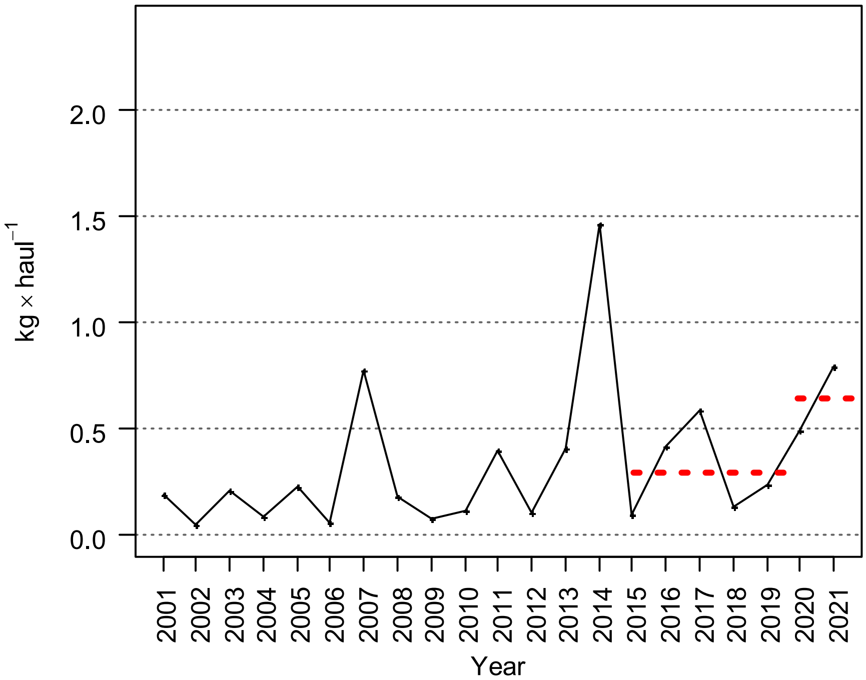


Figure 30. Evolution in *Dalatias licha* biomass index in Porcupine surveys (2001-2021). Dotted lines compare mean stratified biomass in the last two years with the five previous years

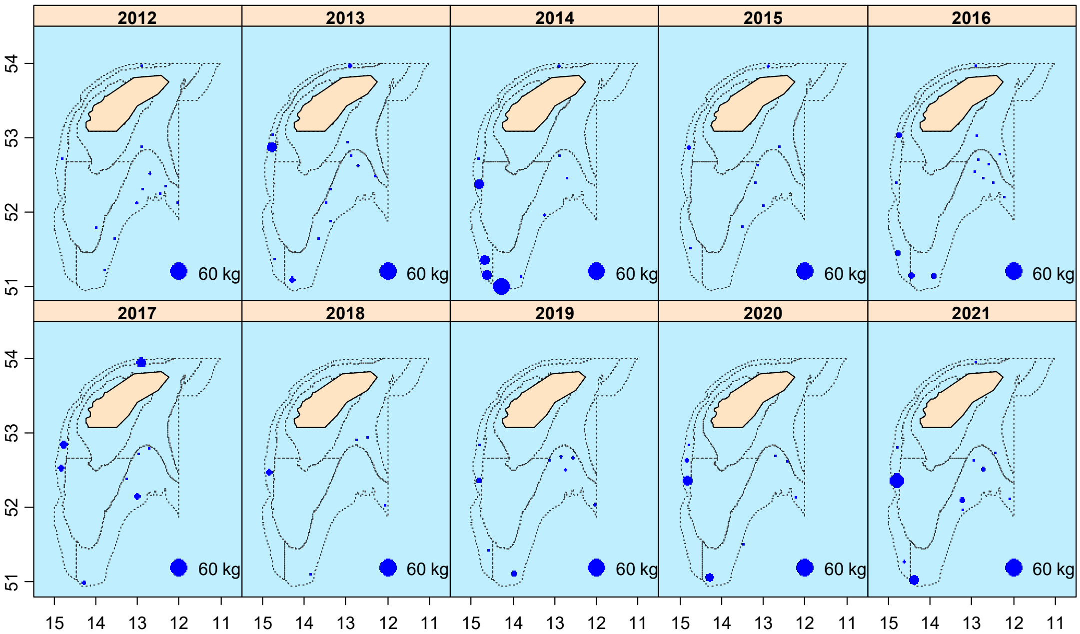


Figure 31. Geographic distribution of *Dalatias licha* catches (kg×30 min haul^{-1}) in Porcupine surveys (2012-2021)

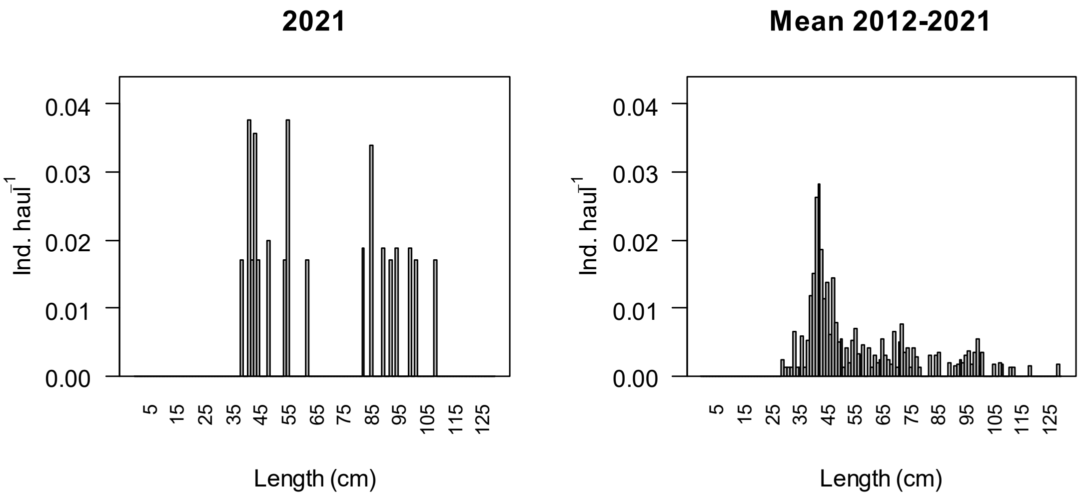


Figure 32. Stratified length distribution of *Dalatias licha* in the last Porcupine survey, and mean values in Porcupine surveys between 2012 and 2021.

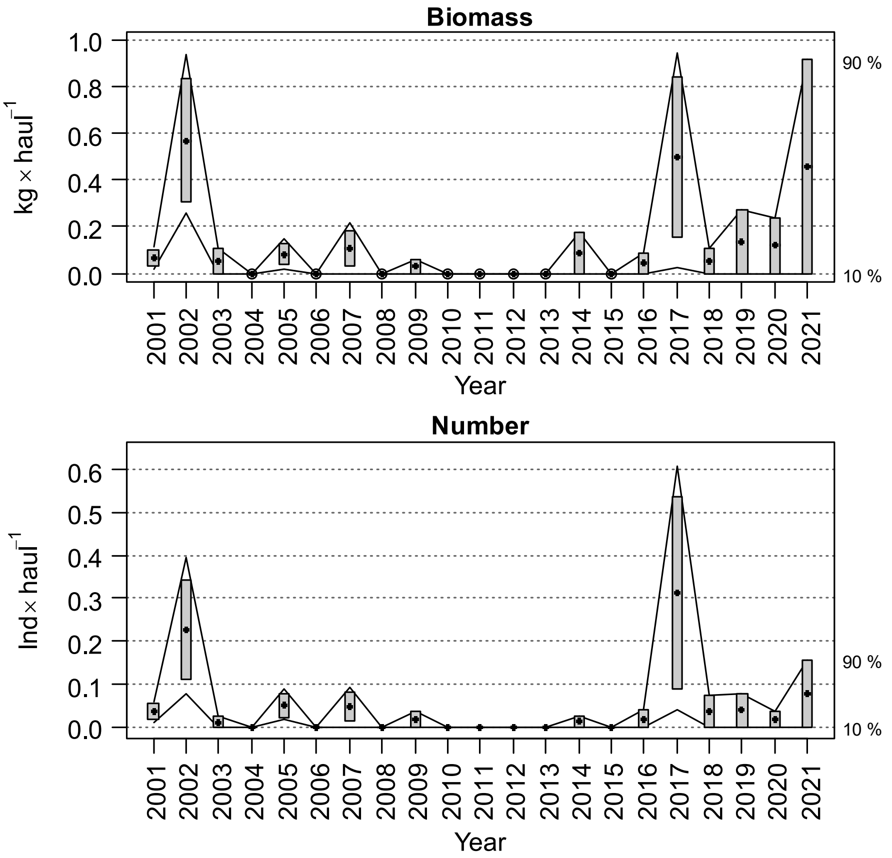


Figure 33. Evolution of *Squalus acanthias* biomass and abundance indices in Porcupine surveys (2001-2021). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000)

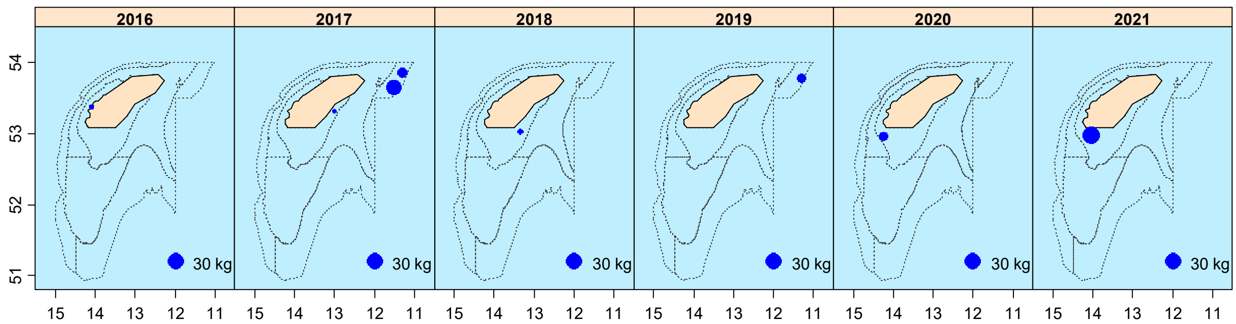
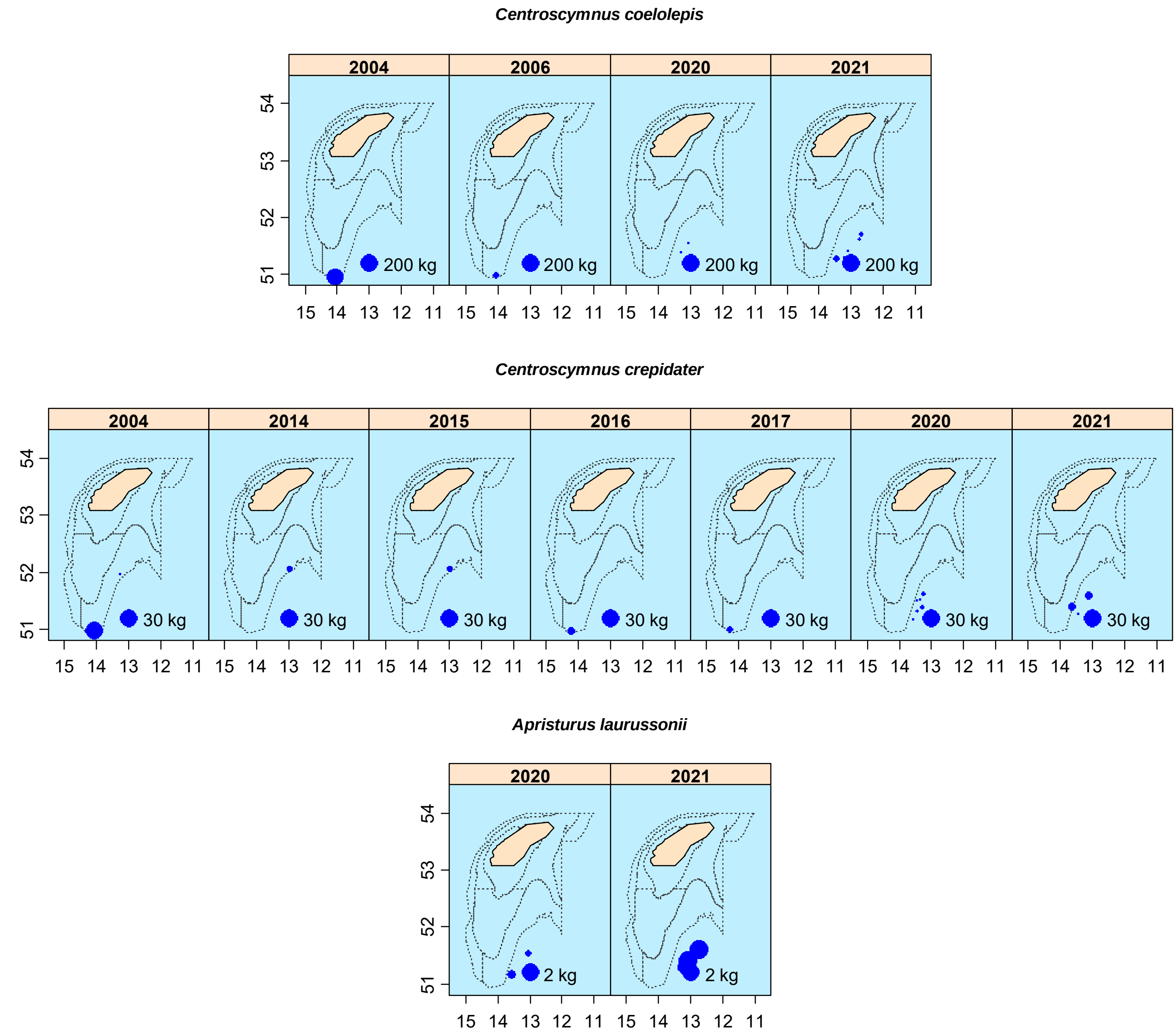


Figure 34. Geographic distribution of *Squalus acanthias* catches (Kg· haul^{-1}) in Porcupine surveys 2016-2021



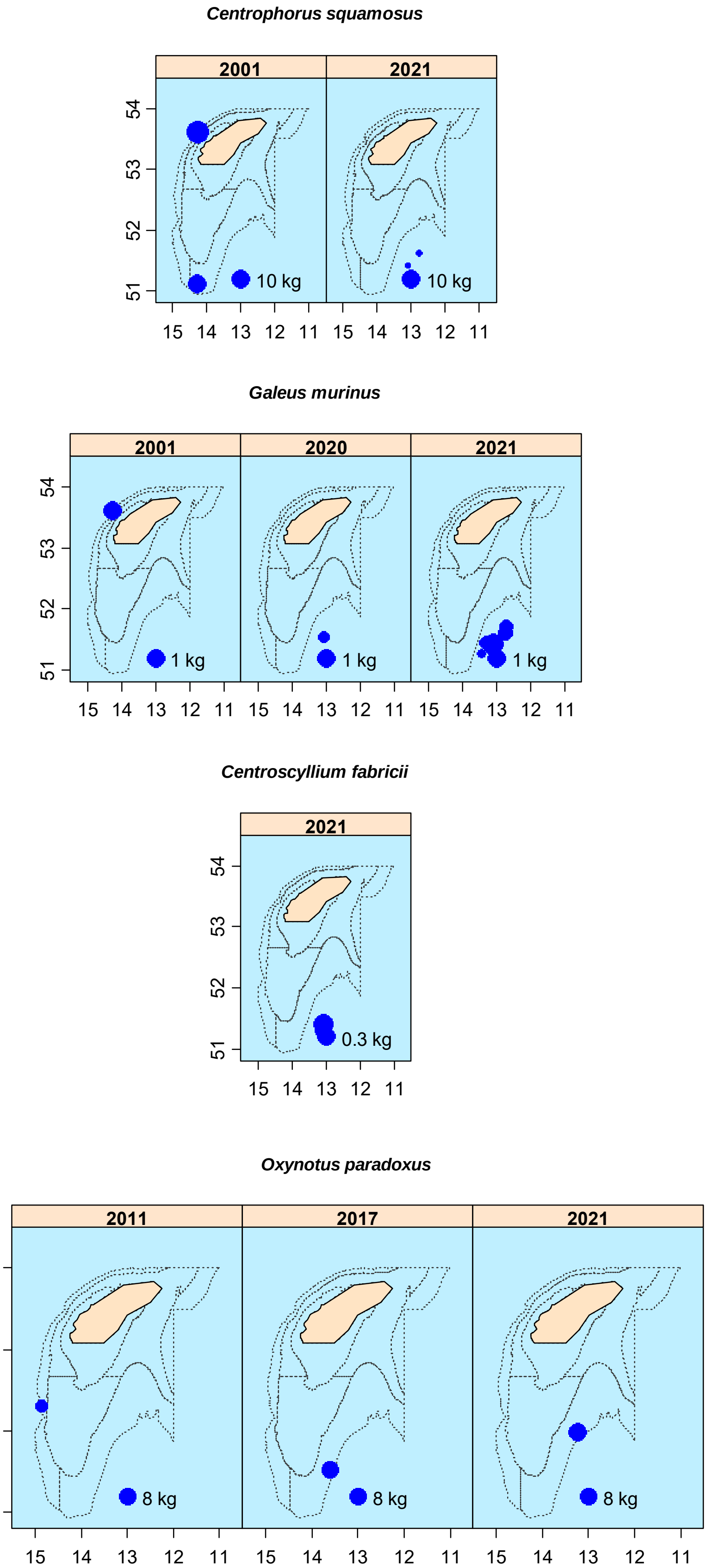


Figure 35. Geographic distribution of the shark scarce species *C. coelolepis*, *C. crepidater*, *A. laurussonii*, *C. squamosus*, *G. murinus*, *C. fabricii* and *O. paradoxus* catches (Kg· haul^{-1}) in Porcupine surveys 2001-2021

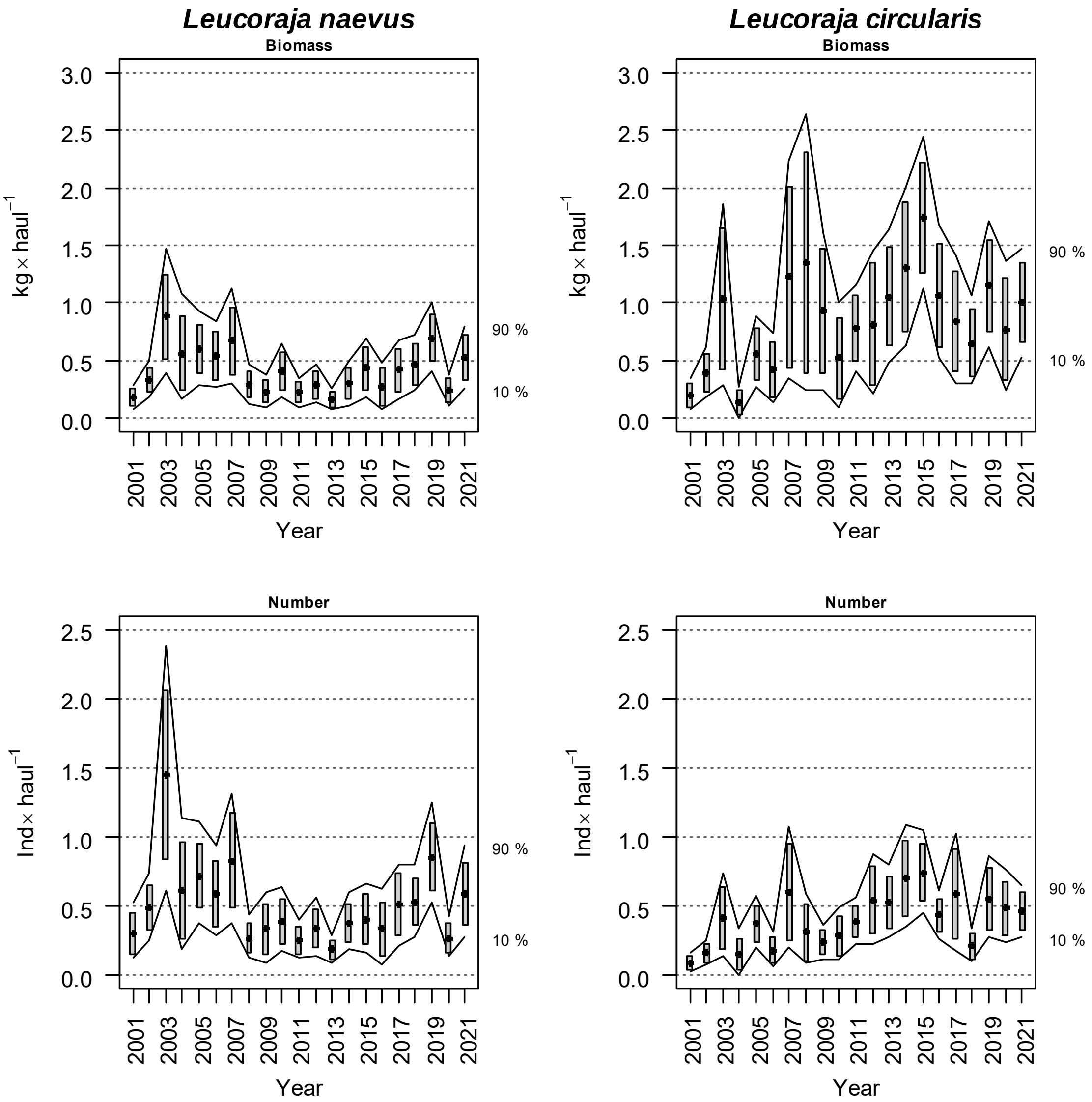


Figure 36. Changes in *Leucoraja naevus* and *Leucoraja circularis* biomass and abundance indices in Porcupine surveys (2001-2021). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations =1000)

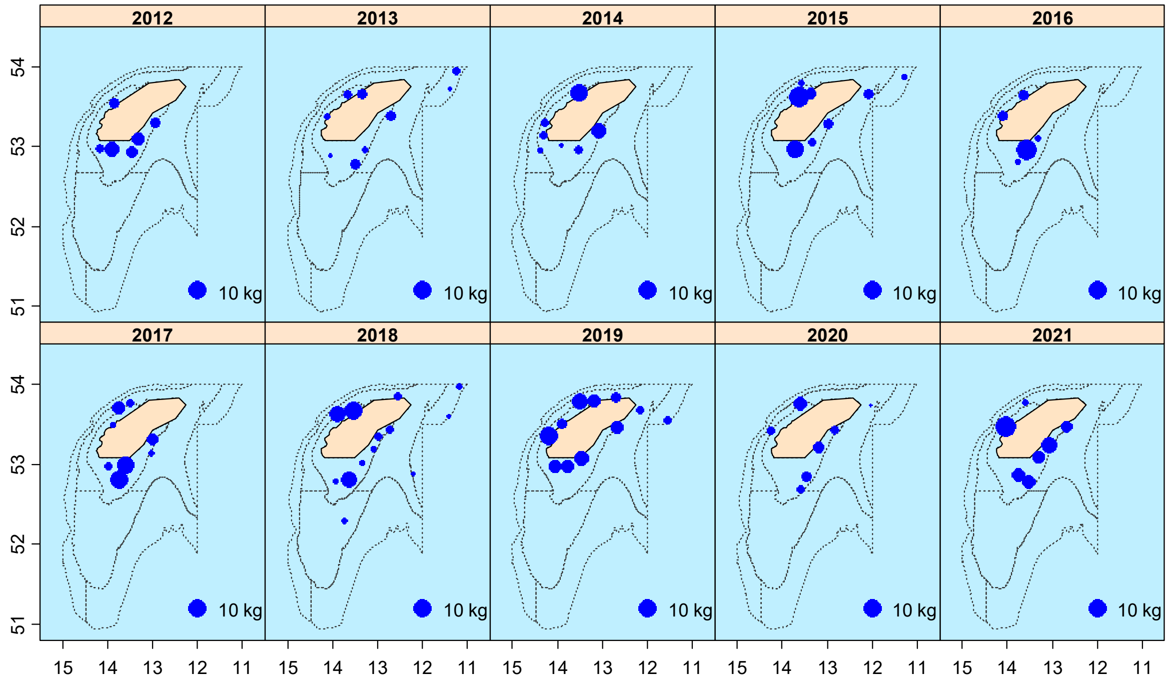


Figure 37. Geographic distribution of *Leucoraja naevus* catches (kg·haul^{-1}) in Porcupine surveys (2012-2021)

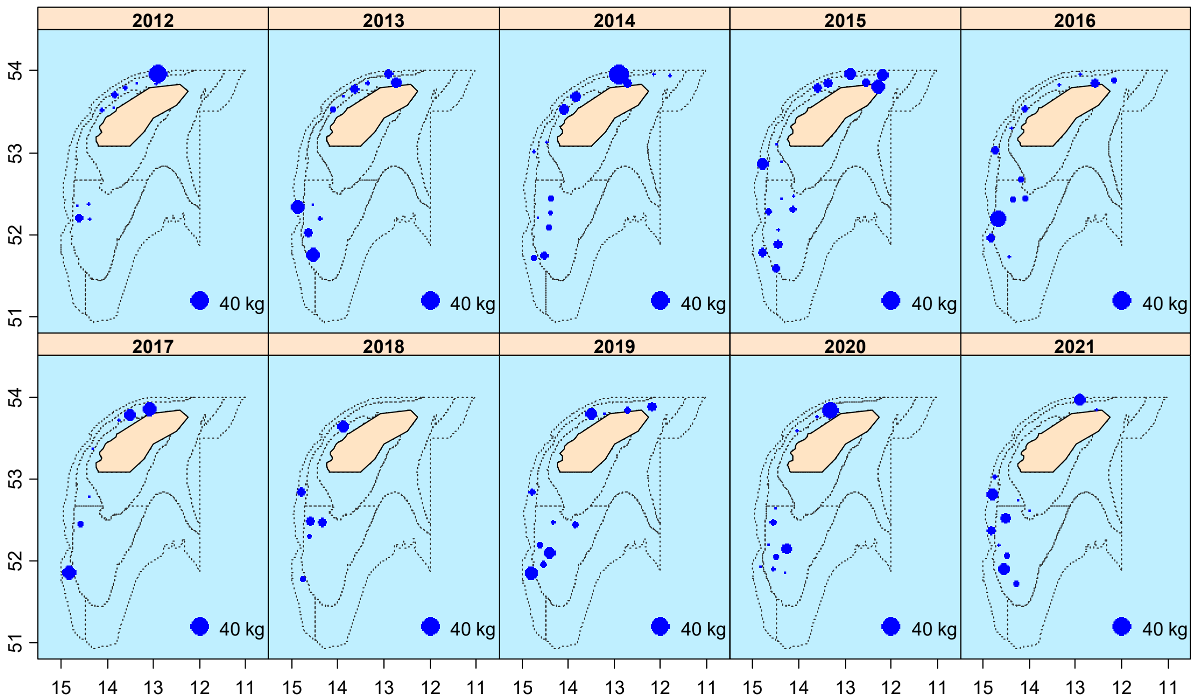


Figure 38. Geographic distribution of *Leucoraja circularis* catches (kg·haul^{-1}) in Porcupine surveys (2012-2021)

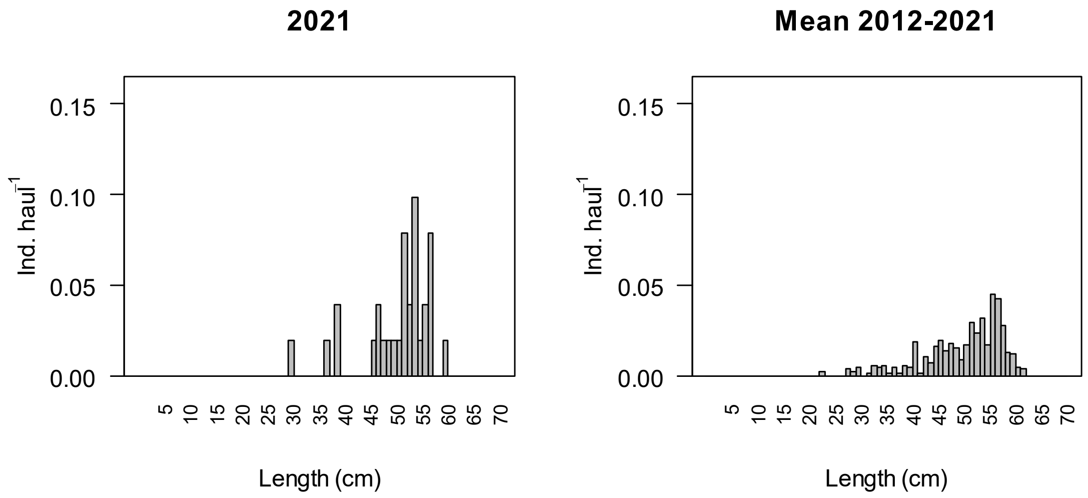


Figure 39. Stratified length distribution of *Leucoraja naevus* in the last Porcupine survey, and mean values in Porcupine surveys between 2012 and 2021

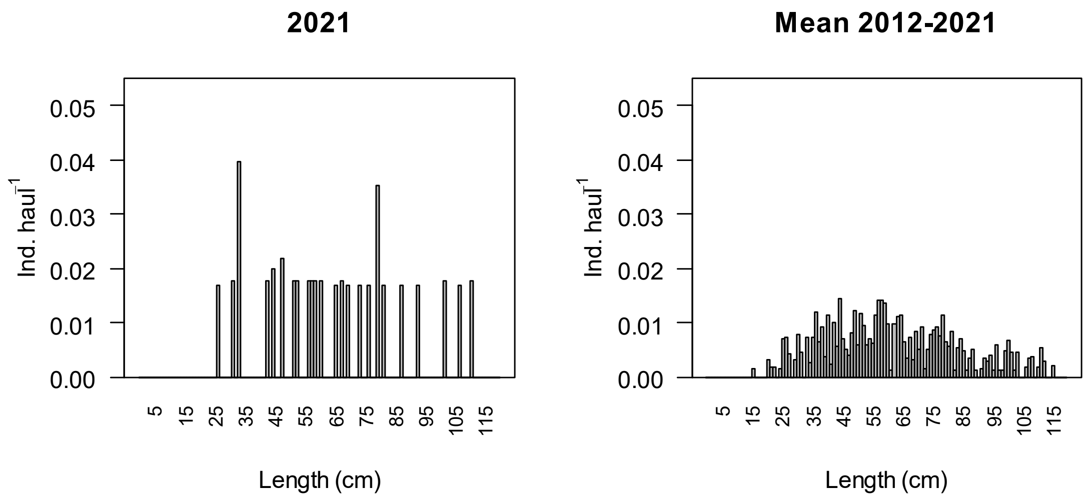


Figure 40. Stratified length distribution of *Leucoraja circularis* in the last Porcupine survey, and mean values in Porcupine surveys between 2012 and 2021

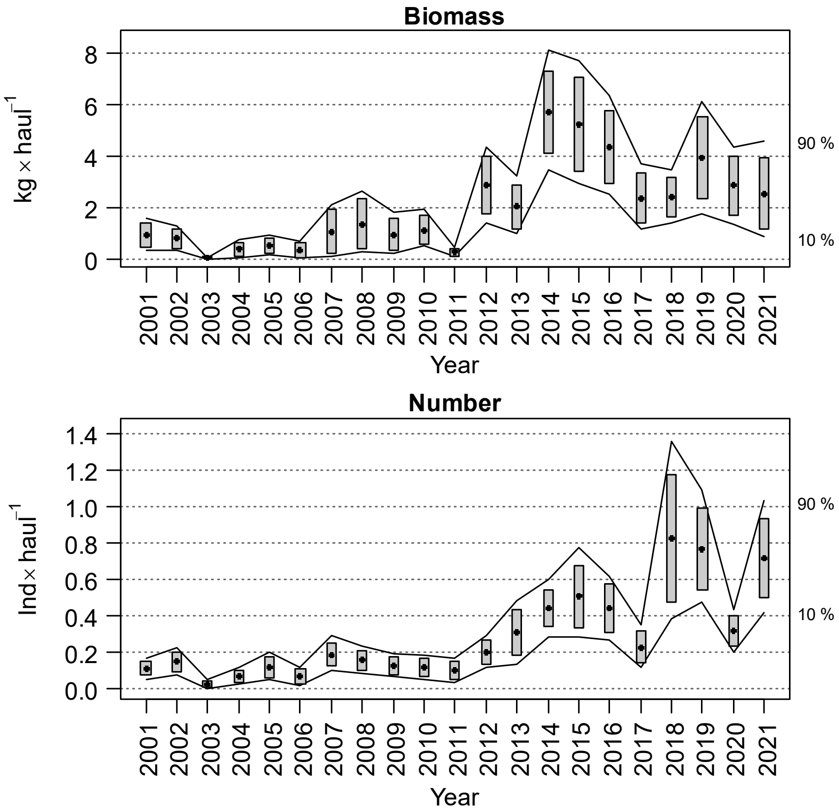


Figure 41. Evolution of *Dipturus* spp. biomass and abundance indices in Porcupine surveys (2001-2021). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000)

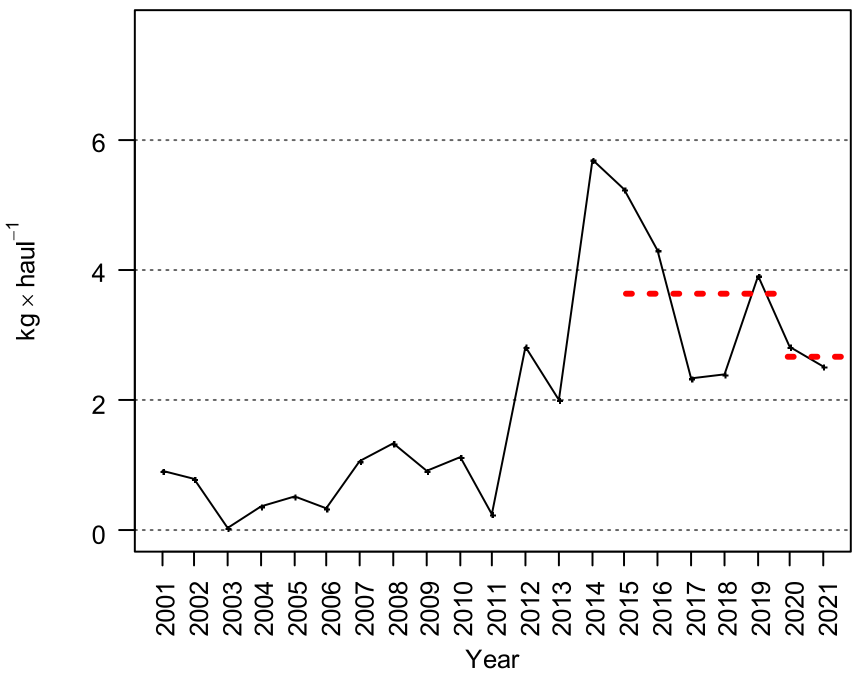


Figure 42. Evolution in *Dipturus* spp. biomass index in Porcupine surveys (2001-2021). Dotted lines compare mean stratified biomass in the last two years with the five previous years

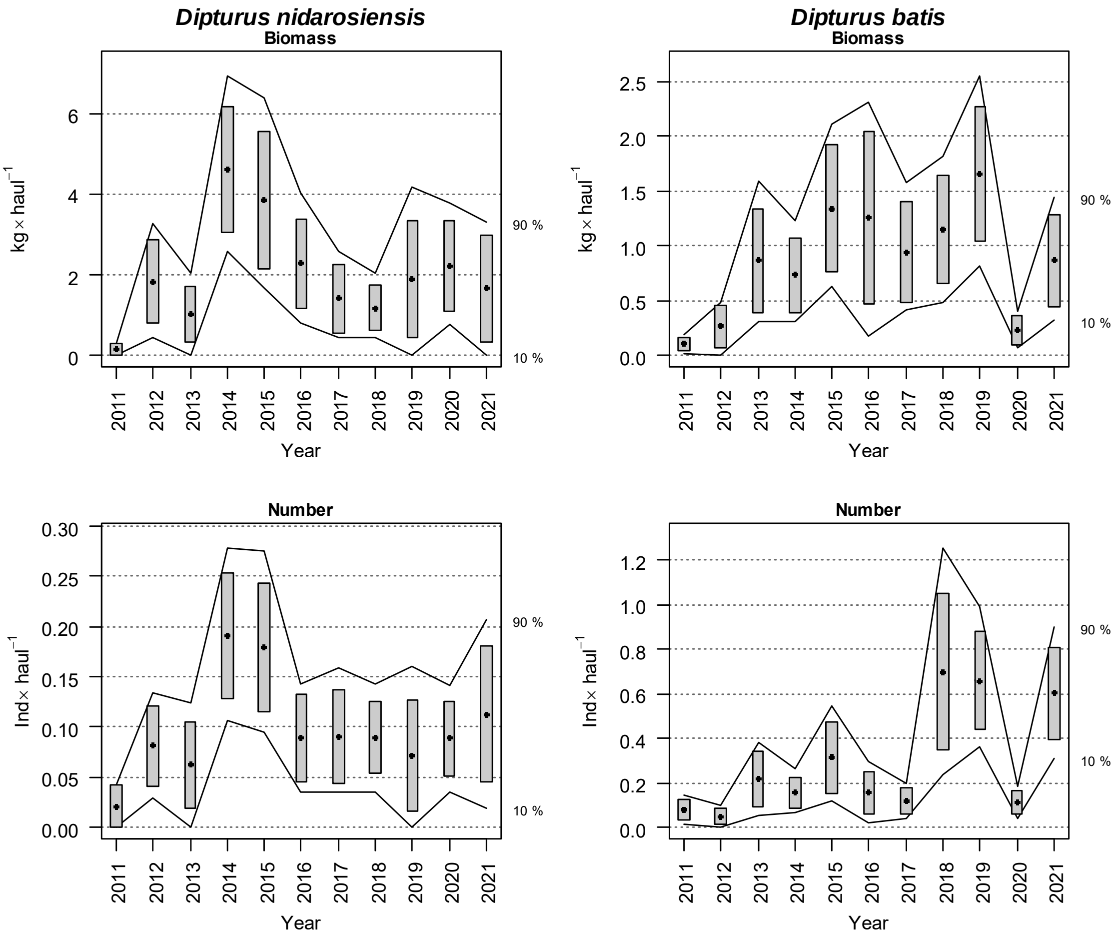


Figure 43. Evolution of *Dipturus nidarosiensis* and *Dipturus batis* biomass and abundance indices in Porcupine surveys (2011-2021). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations = 1000)

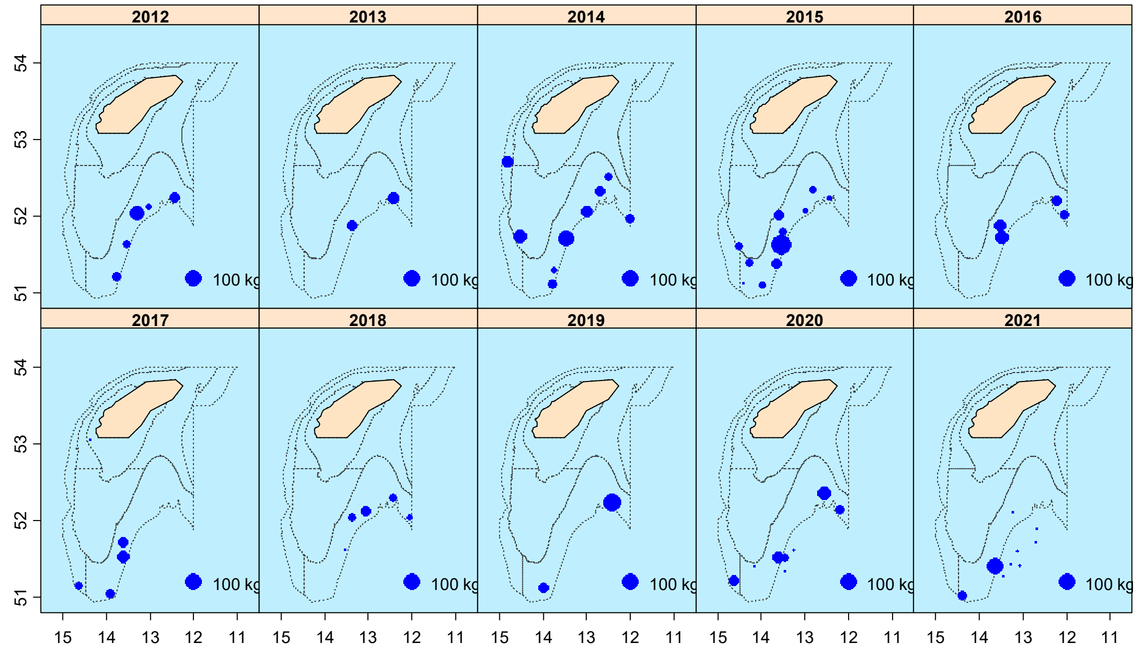


Figure 44. Geographic distribution of *Dipturus nidarosiensis* catches (Kg· haul^{-1}) in Porcupine surveys (2012-2021)

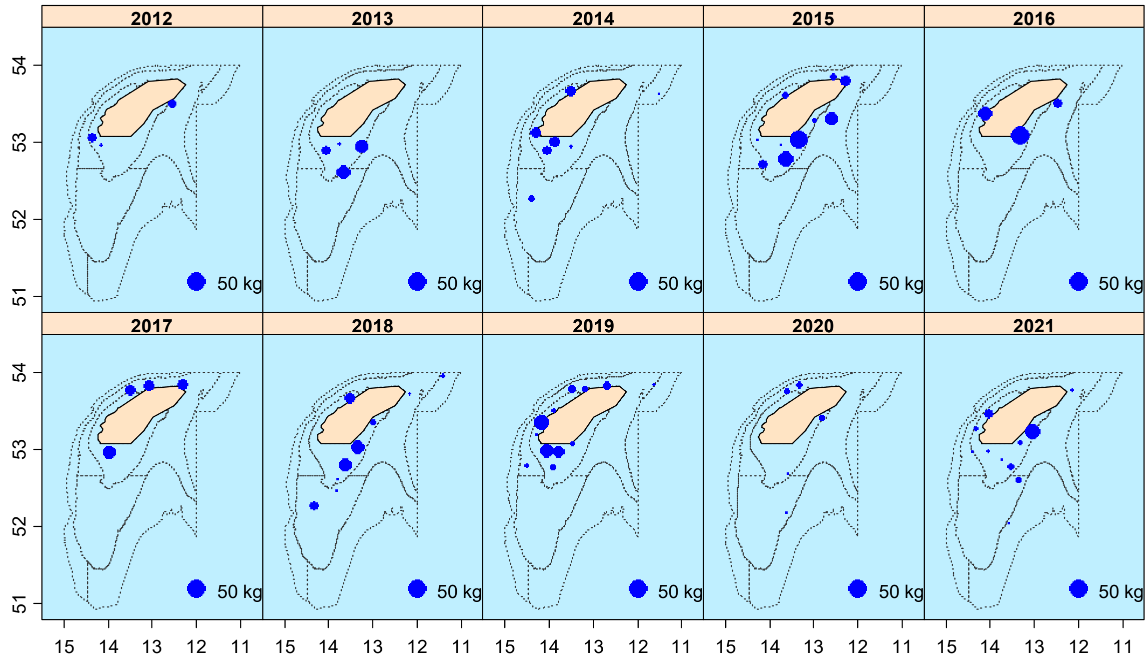


Figure 45. Geographic distribution of *Dipturus batis* catches (Kg· haul^{-1}) in Porcupine surveys (2012-2021)

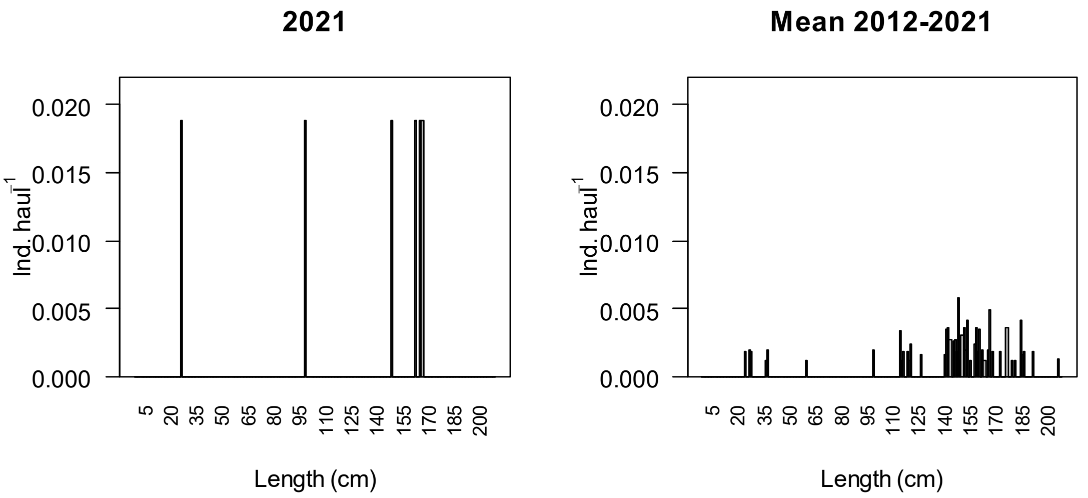


Figure 46. Stratified length distribution of *Dipturus nidarosiensis* in the last Porcupine survey, and mean values in Porcupine surveys between 2012 and 2021.

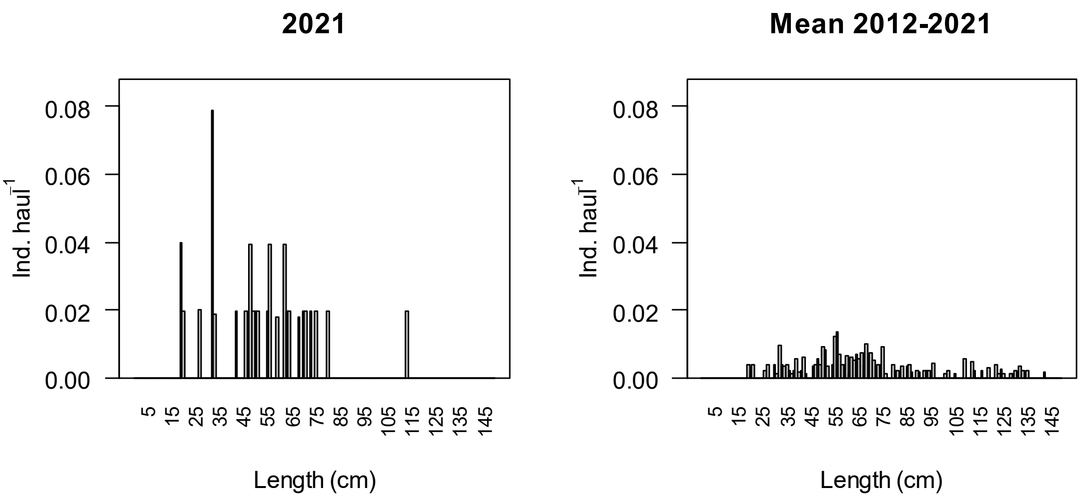


Figure 47. Stratified length distribution of *Dipturus batis* in the last Porcupine survey, and mean values in Porcupine surveys between 2012 and 2021.

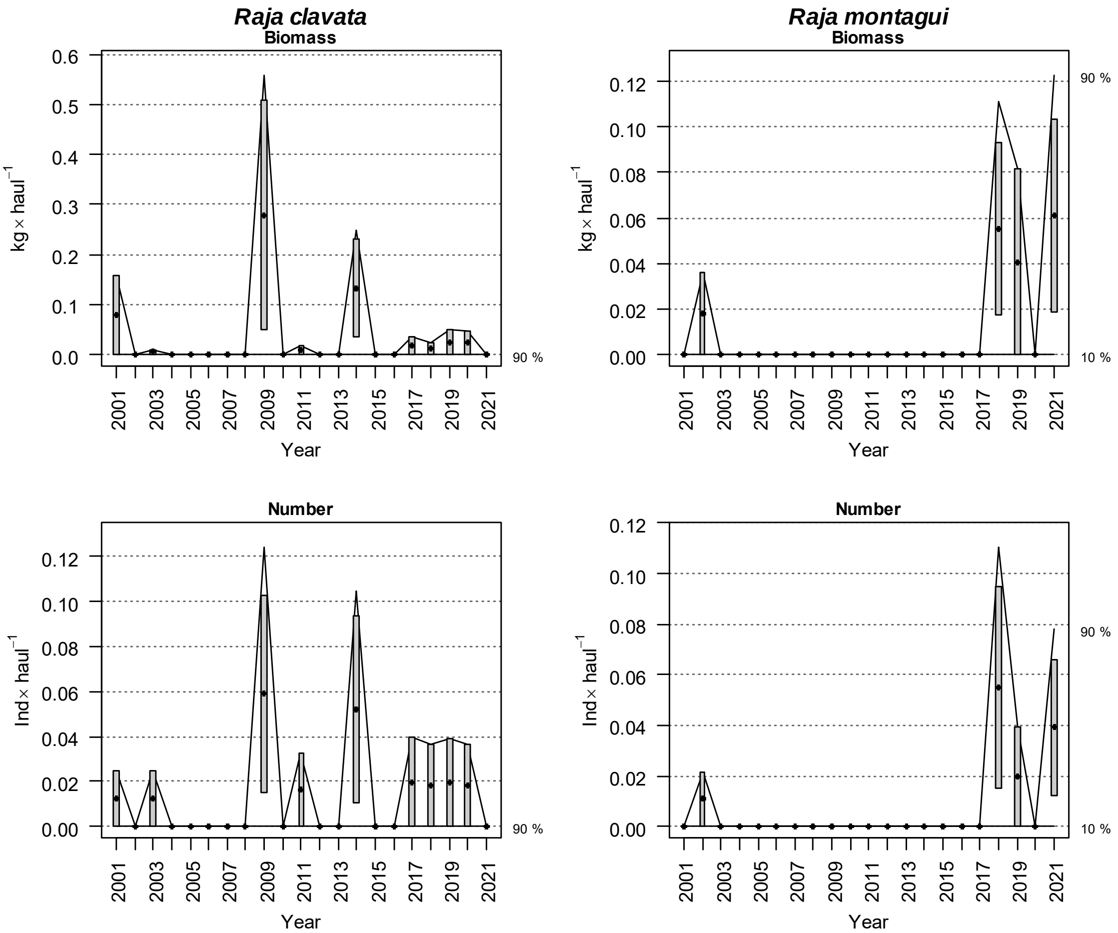


Figure 48. Evolution of *Raja clavata* and *Raja montagui* biomass and abundance indices from 2001 and 2021 Porcupine surveys. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (a = 0.80, bootstrap iterations =1000)

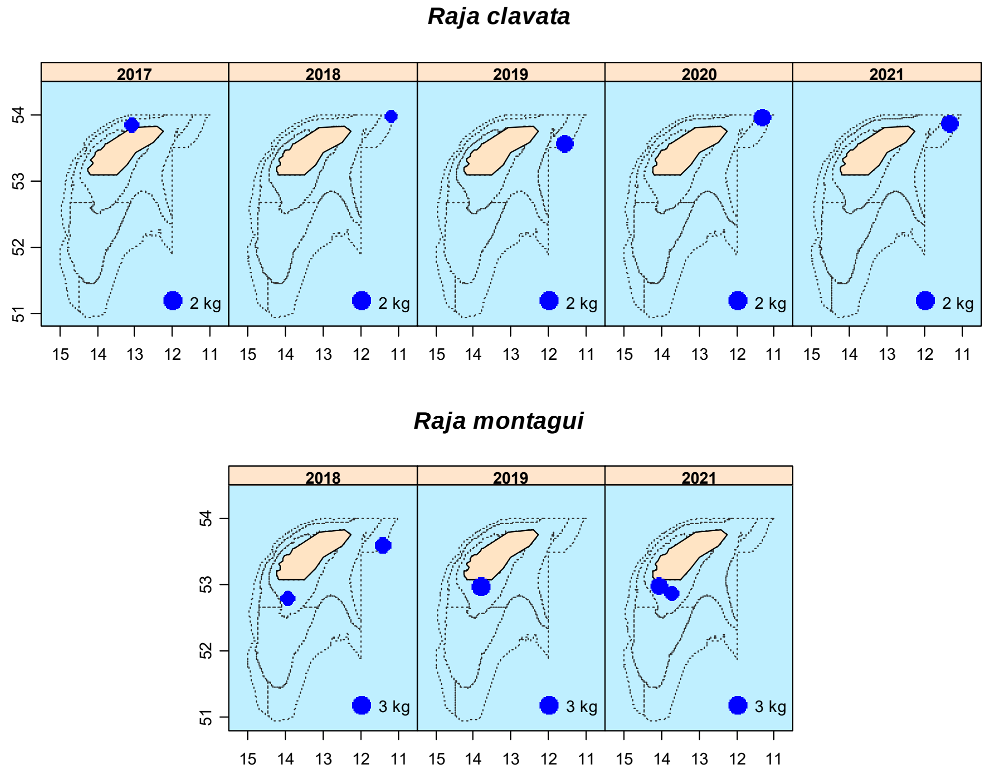


Figure 49. Geographic distribution of *Raja clavata* and *Raja montagui* catches (Kg· haul^{-1}) in Porcupine surveys (2017-2021)

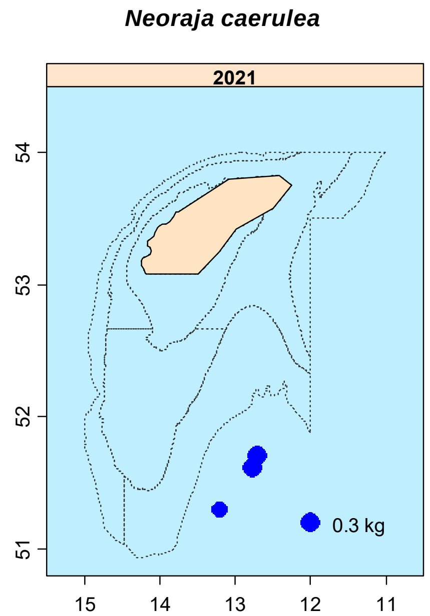


Figure 50. Geographic distribution of the scarce skate species *Neoraja caerulea* catches (Kg· haul^{-1}) in Porcupine surveys 2021