

## **Results on *Merluccius merluccius* (hake), *Lophius budegassa* (black anglerfish) and *Lophius piscatorius* (white anglerfish), *Lepidorhombus boscii* (four-spot megrim) and *Lepidorhombus whiffiagonis* (megrim) from the 2021 Spanish Ground Fish Survey on the Porcupine bank (NE Atlantic)**

O. Fernández-Zapico<sup>1</sup>, M. Blanco<sup>1</sup>, S. Ruiz-Pico<sup>1</sup>, F. Velasco<sup>1</sup> & F. Baldó<sup>2</sup>

Instituto Español de Oceanografía (IEO-CISC)

(1)

Centro Oceanográfico de Santander  
Promontorio San Martín s/n  
39004 Santander, Spain

(2)

Centro Oceanográfico de Cádiz  
Muelle de Levante s/n (Puerto Pesquero)  
11006 Cádiz, Spain

### **Abstract**

This working document presents the results of *Merluccius merluccius* (hake), *Lophius budegassa* (black anglerfish), *Lophius piscatorius* (white anglerfish), *Lepidorhombus boscii* (four-spot megrim) and *Lepidorhombus whiffiagonis* (megrim) caught on the Porcupine Spanish Groundfish Survey (SP-PORC-Q3) in 2021. Biomass, abundance, distribution and length frequency were analysed. Biomass indices of these target species increased in this last survey, except for *L. piscatorius* and recruitment increased for all of them, except for *M. merluccius*.

### **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 study the distribution, relative abundance and biological parameters of commercial species in the area (ICES 2017).

The aim of this working document is to update the results (abundance indices, length frequency and geographic distributions) of the species *Merluccius merluccius* (hake), *Lophius budegassa* (black anglerfish) and *L. piscatorius* (white anglerfish), *Lepidorhombus boscii* (four-spot megrim) and *L. whiffiagonis* (megrim) on the Porcupine Bottom Trawl Surveys after the results presented previously (Blanco *et al.* 2017; Ruiz-Pico *et al.* 2018, 2019, 2020; Fernández-Zapico *et al.* 2021).

### **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, following the standard IBTS methodology for the western and southern areas (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 1). 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.

## Results

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 1).

The total stratified catch per haul decreased significantly in 2021 compared to the previous year (Figure 2). Fish represented 96% of the total catch and the species analyzed in this report represented 7% of the total stratified fish catch, with the following percentages by species: hake (39%), anglerfishes (18%) and megrims (43%).

In 2021 the biomass of *M. merluccius* increased slightly, whereas it increased considerably for *L. budegassa* and also for both megrim species. However, it decreased markedly for *L. piscatorius*. Signs of recruitment can be observed for all these target species, except for hake.

### ***Merluccius merluccius* (hake)**

The biomass of *M. merluccius* increased very slightly compared to the previous year, whereas the abundance decreased notably (Figure 3).

*M. merluccius* was widespread throughout the study area, although in this last survey fewer and smaller spots were found in the northern part of the study area (Figure 4).

Isolated spots of recruits (< 23 cm) were found to the south and west of the bank and also on the Irish shelf (Figure 5).

The length distribution and length density plot showed a bimodal distribution with modes around 28 and 48 cm (Figure 6).

### ***Lophius budegassa* (black anglerfish) and *Lophius piscatorius* (white anglerfish)**

As usual, *L. budegassa* was scarcer than *L. piscatorius* in the area. The biomass of black anglerfish increased considerably in 2021, whereas its abundance skyrocketed, after falling sharply the previous year, due to a peak of recruitment. Abundance also increased markedly for white anglerfish, also due to high recruitment, but in contrast biomass decreased considerably (Figure 7).

*L. budegassa* was found mainly on the Irish shelf and near the central bank, as usual, although in this last survey it was especially abundant south of the bank. However, *L. piscatorius* was widely distributed, although predominantly in the deepest southern and western sectors (Figure 8). The spots of *L. budegassa* recruits (< 21 cm) were found on the Irish shelf and also south of the bank, as well as *L. piscatorius* but from the latter large points of biomass were also captured to the northwest of the bank (Figure 9).

Regarding the length distribution, peaks of recruitment can be observed for both anglerfish species. As for black anglerfish, a small group of recruits between 5 and 6 cm can be distinguished, as well as a group of larger individuals between 15 and 27 cm, with a mode of 20 cm. A third group of specimens can be observed between 32 and 77 cm, drawing a mode between 45 and 58 cm. However, a group of recruits between 7 and 19 cm is clearly distinguished for *L. piscatorius*, with a mode of 11 cm, and also another group of larger specimens with a mode of around 61 cm (Figure 10).

### ***Lepidorhombus boscii* (four-spot megrim) and *Lepidorhombus whiffiagonis* (megrim)**

Both megrim species have increased strongly in 2021, both in terms of biomass and abundance, especially *L. whiffiagonis*, reaching the highest values of the time series. However, it must be taken into account that both species have followed an upward trend since the beginning of the time series (Figure 11).

*L. whiffiagonis* was distributed around the bank and on the Irish shelf at less depth than *L. boscii*, as is usual (Figure 12). Recruits followed a similar distribution, deeper those of *L. boscii* (Figure 13 and Figure 14). The abundance of the *L. boscii* juveniles ( $\leq 12$  cm) increased considerably in 2021, after falling the previous year (Figure 15). No individuals smaller than 8 cm of the species *L. boscii* were found and a mode at 20 cm was drawn. Length range was from 9 to 50 cm for *L. whiffiagonis* in 2021, which presented a mode around 18 cm (Figure 16). The 1-year-old *L. whiffiagonis* recruits increased slightly compared to the previous year, although they kept low levels in the time series (Figure 17, Figure 18 and Figure 19).

### **Acknowledgements**

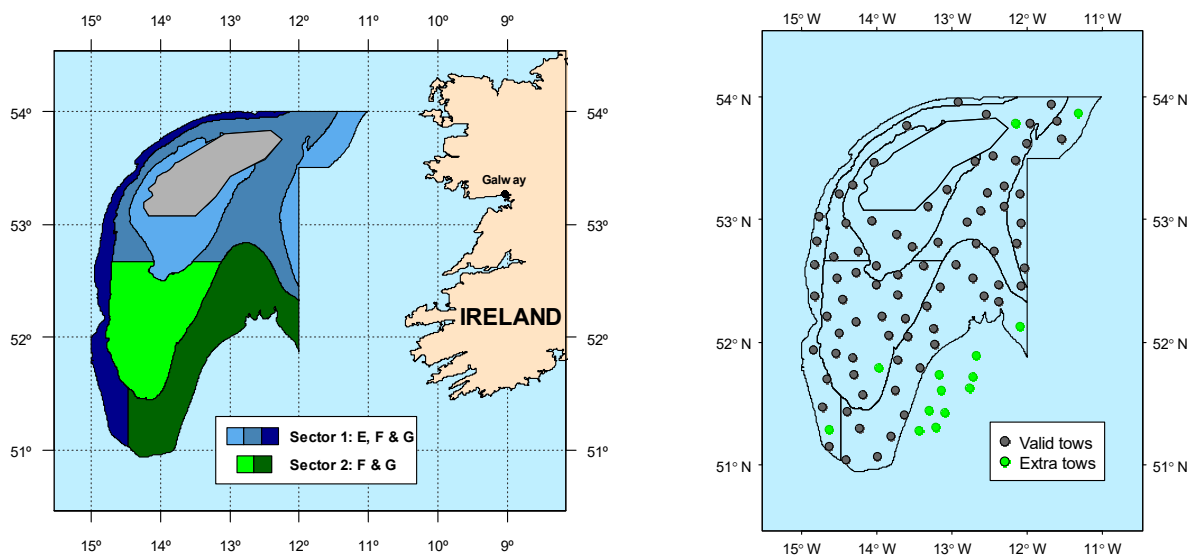
We would like to thank R/V *Vizconde de Eza* crew and the IEO scientific teams that made the Porcupine Spanish Groundfish Survey possible. They are included in the ERDEM project, which has been co-funded by the EU through the European Maritime and Fisheries Fund (EMFF) within the National Program of collection, management and use of data in the fisheries sector and support for scientific advice regarding the Common Fisheries Policy.

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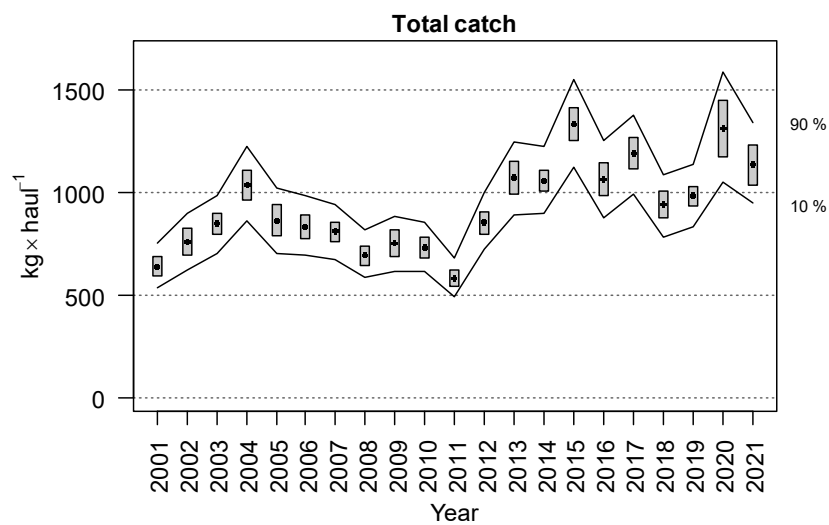
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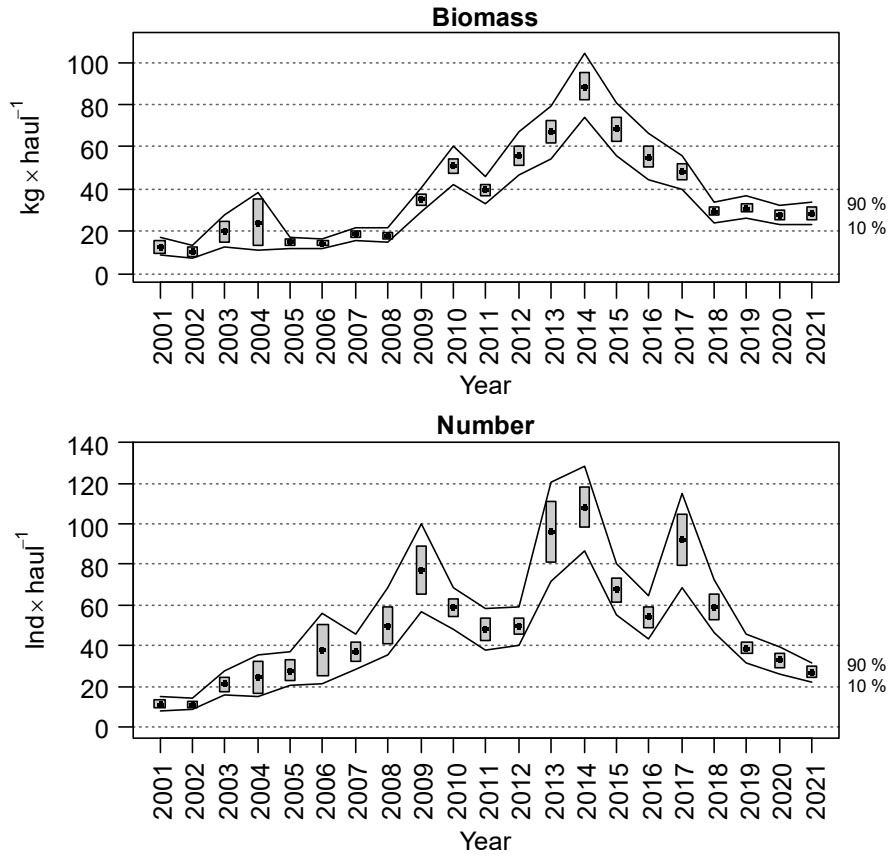
## Figures



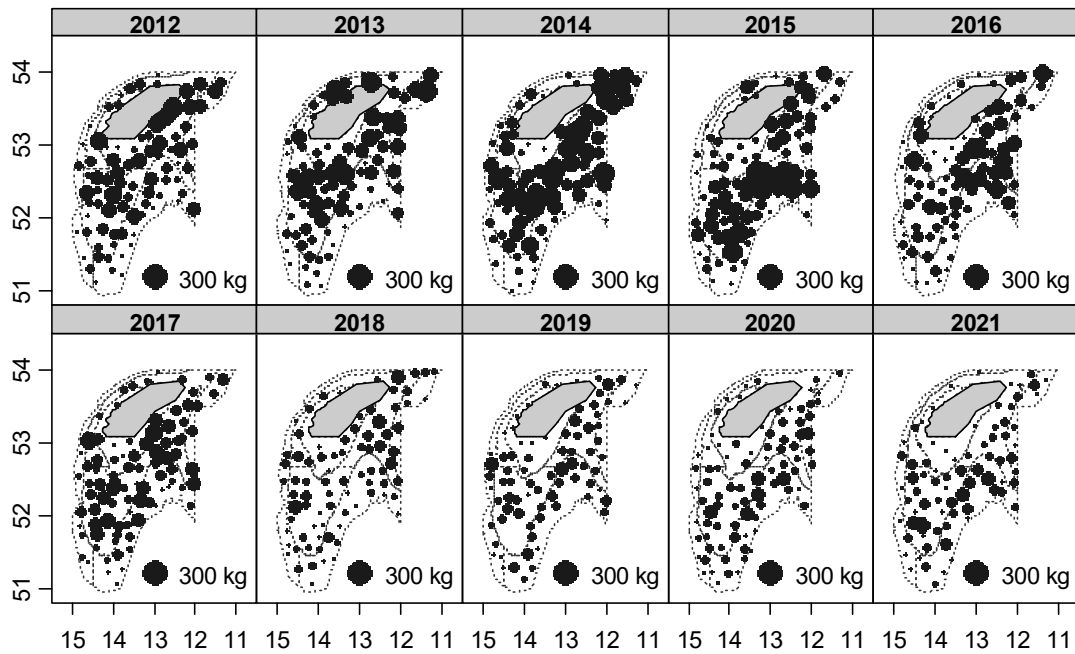
**Figure 1.** Left: Stratification design used in Porcupine surveys from 2003, previous data were re-stratified. Depth strata are: E) shallower than 300 m, F) 301 – 450 m and G) 451 – 800 m. Grey area in the middle of Porcupine bank corresponds to a large non-trawlable area, not considered for area measurements and stratification. Right: distribution of hauls performed in 2021



**Figure 2.** Evolution of the total catch in biomass on Porcupine surveys (2001-2021)

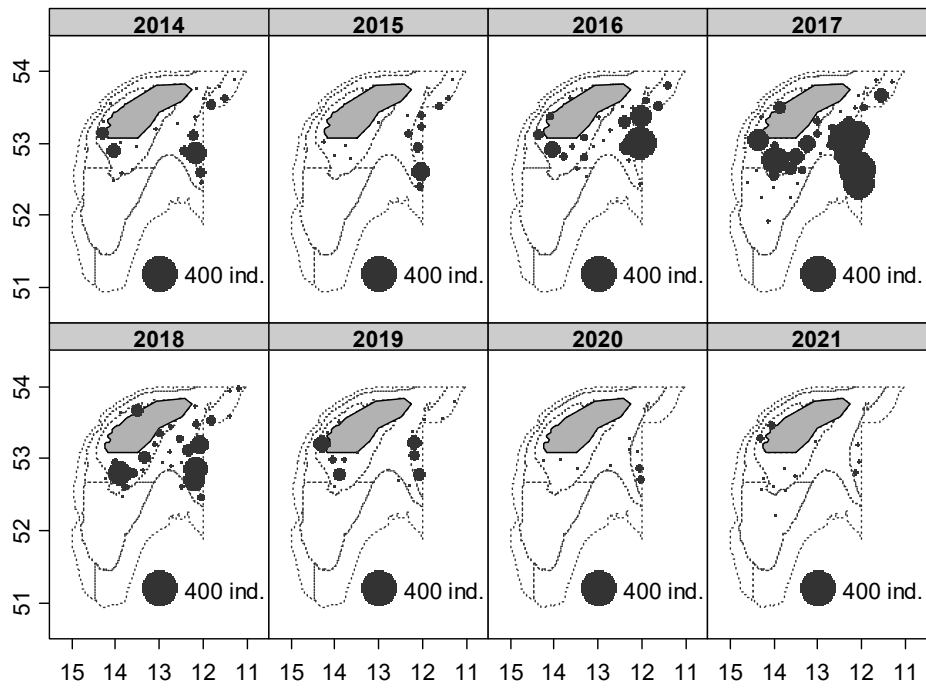


**Figure 3.** Evolution of *Merluccius merluccius* biomass and abundance indices in Porcupine surveys (2001-2021). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals ( $\alpha = 0.80$ , bootstrap iterations = 1000)

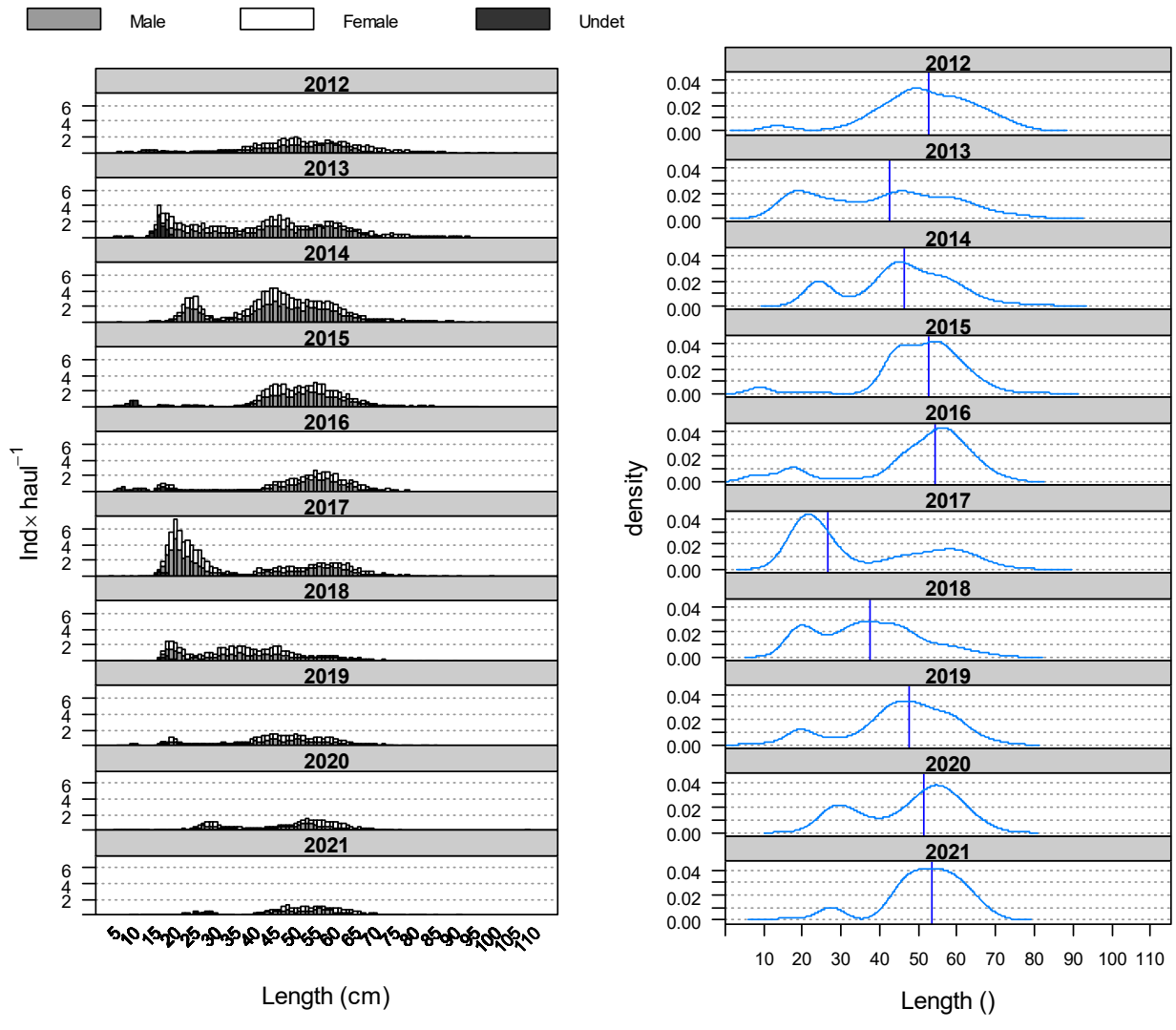


**Figure 4.** Geographic distribution of *Merluccius merluccius* catches (kg/30 min haul) in Porcupine surveys (2012-2021)

*M.merluccius* <23 cm

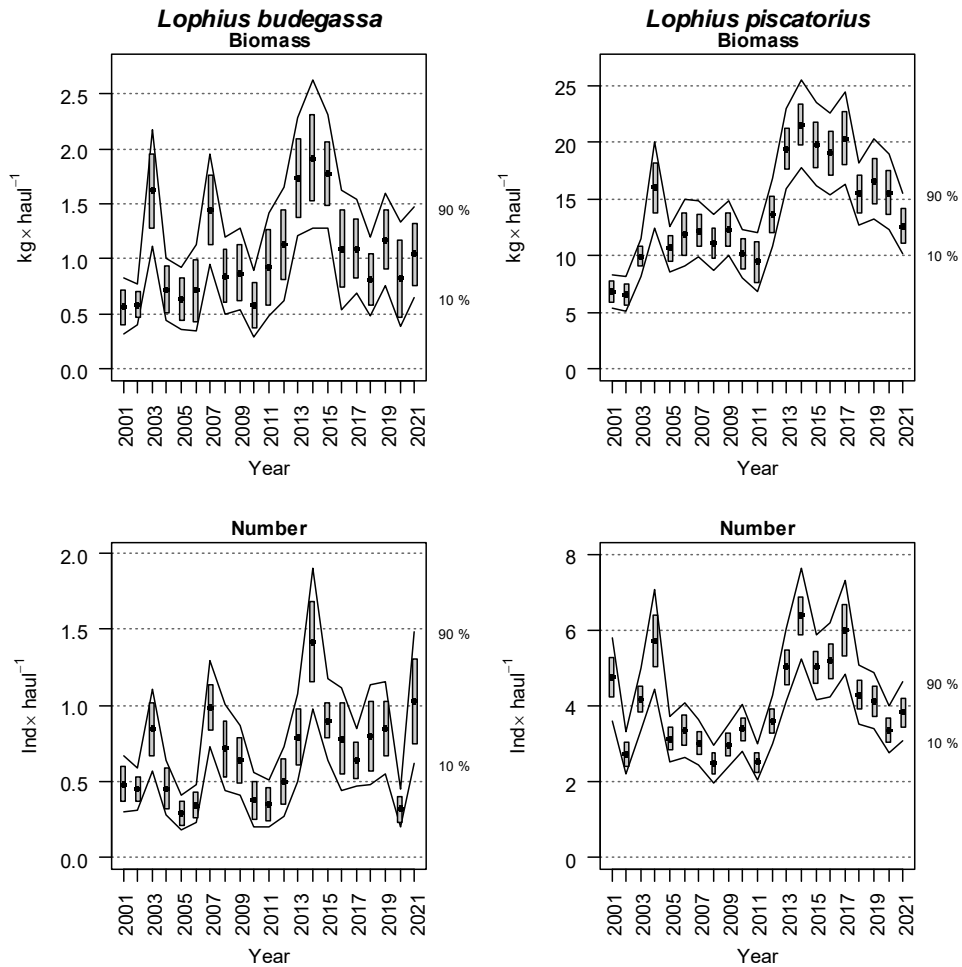


**Figure 5.** Geographic distribution of *Merluccius merluccius* recruits (<23 cm) in Porcupine surveys (2014-2021)

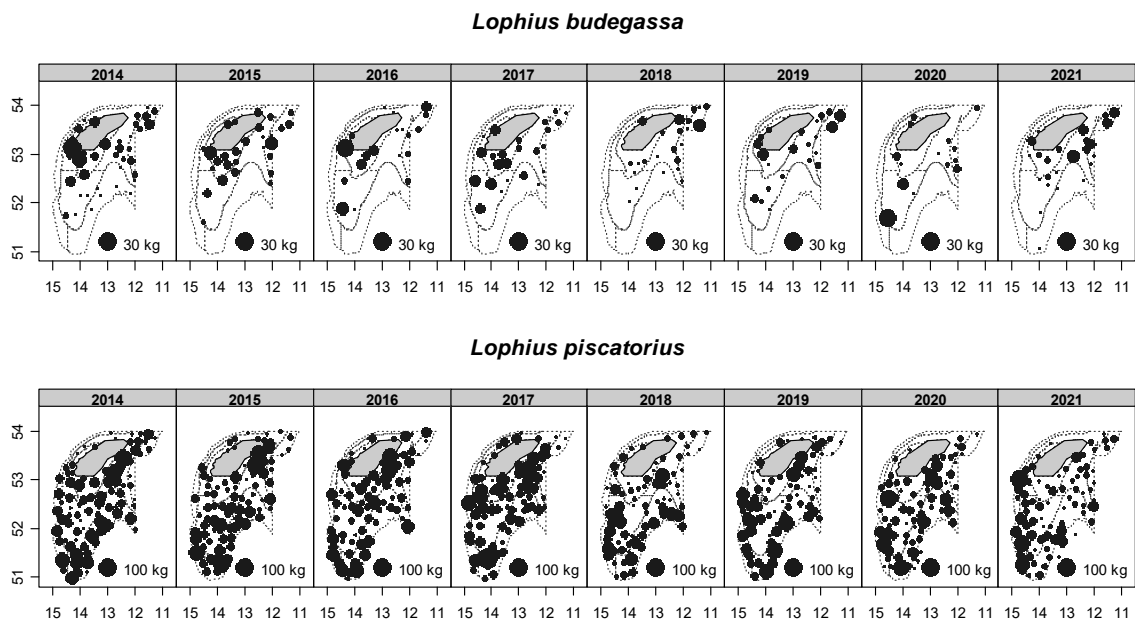


**Figure 6.** Mean stratified length distributions and length density plots of hake in Porcupine surveys (2012-2021)

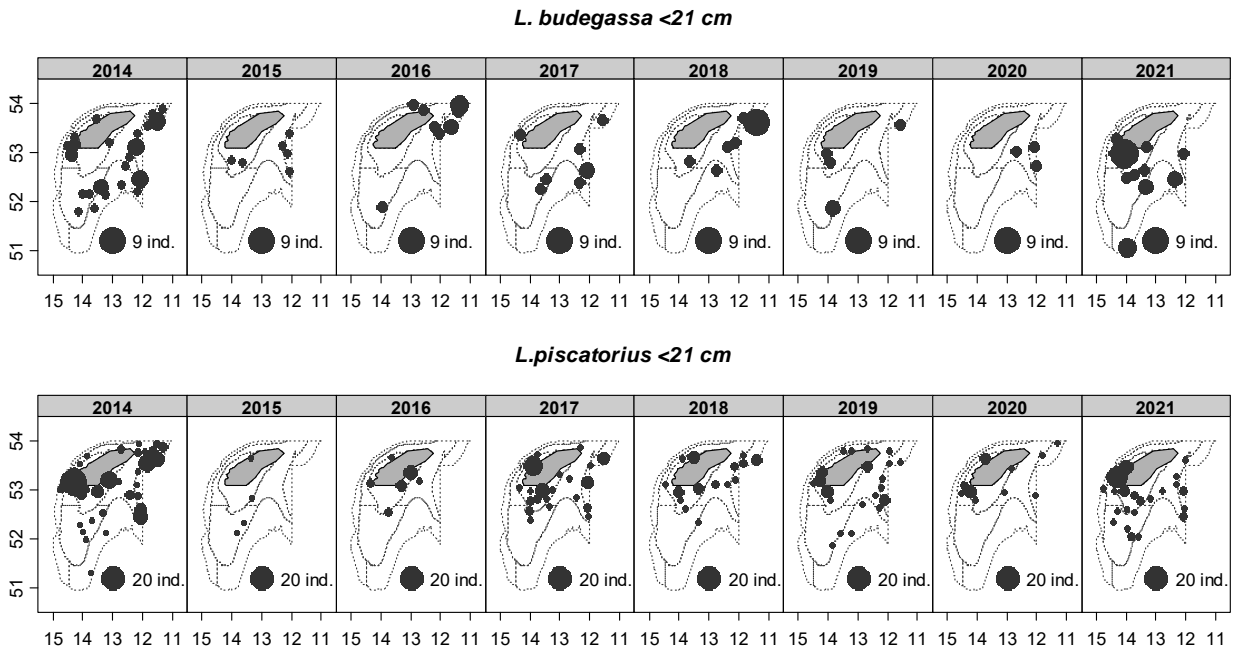




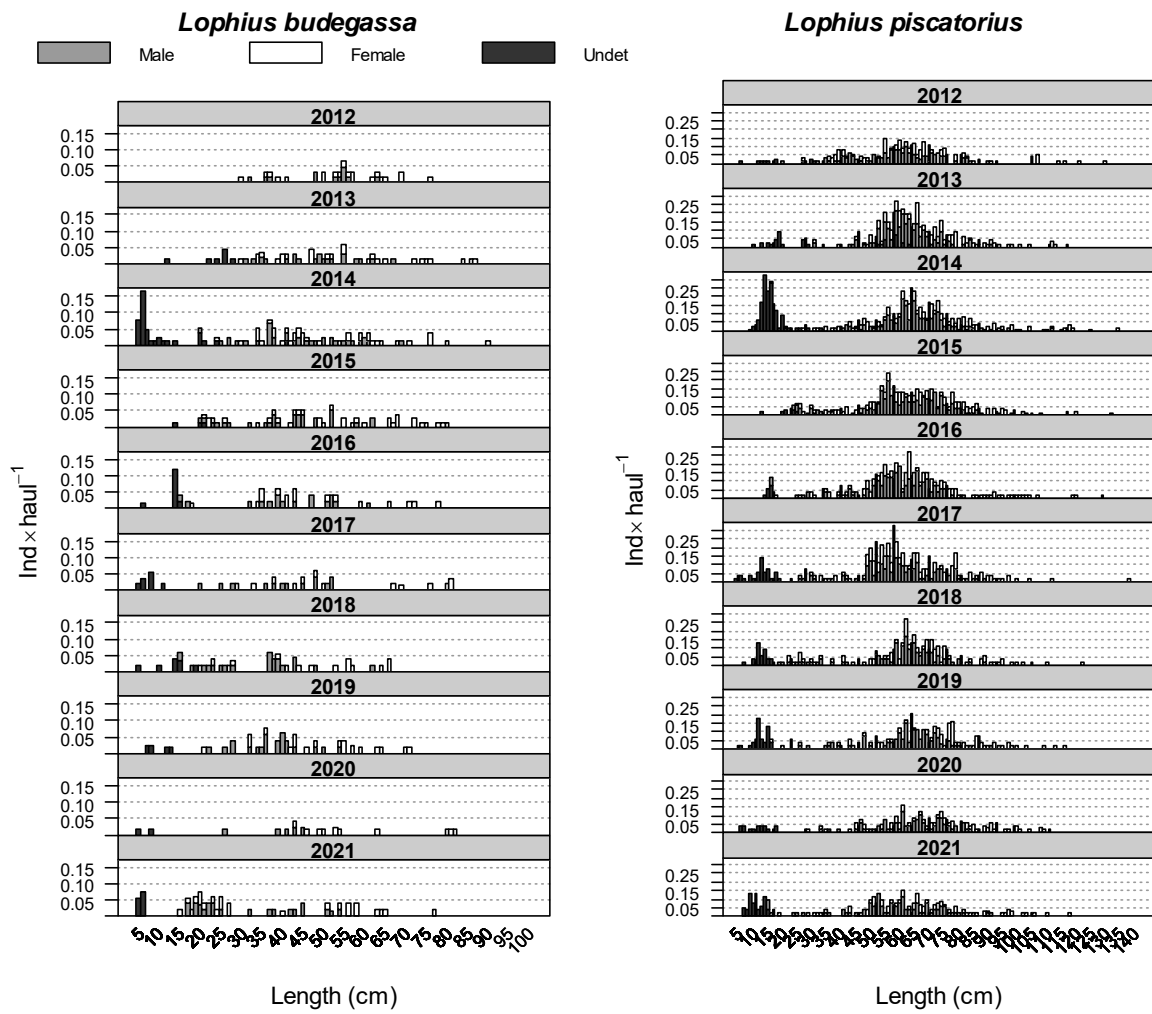
**Figure 7.** Evolution of *Lophius budegassa* and *Lophius piscatorius* biomass and abundance indices in Porcupine surveys (2001-2021). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals ( $\alpha = 0.80$ , bootstrap iterations = 1000)



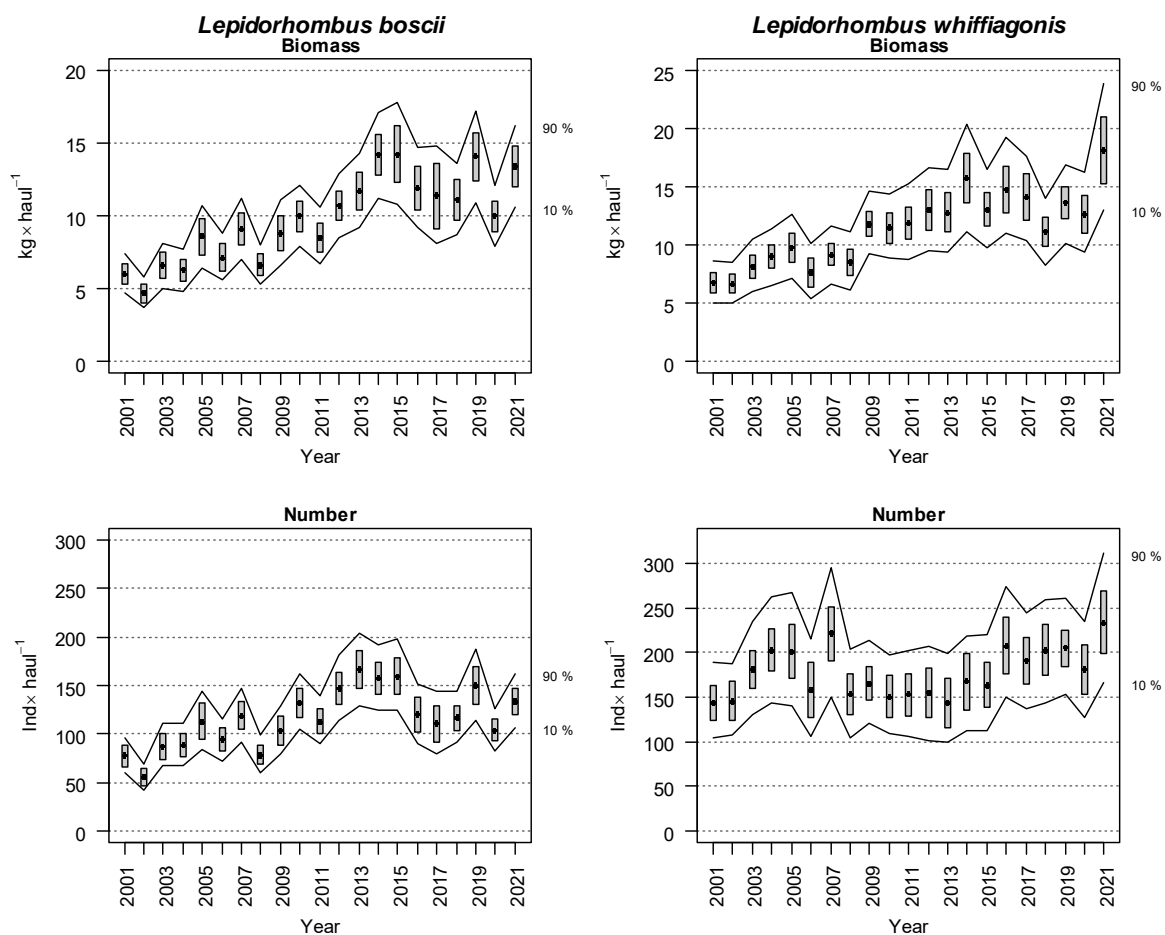
**Figure 8.** Geographic distribution of *Lophius budegassa* and *L. piscatorius* catches (kg×30 min haul<sup>-1</sup>) in Porcupine surveys (2014-2021)



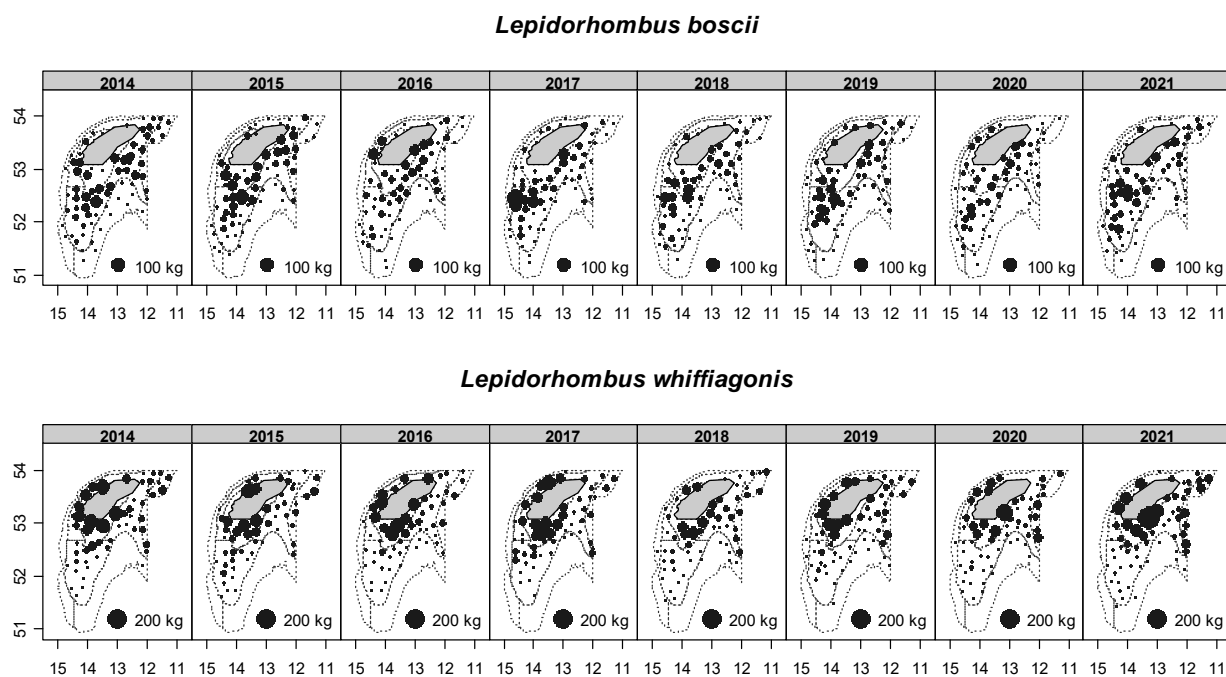
**Figure 9.** Geographic distribution of *Lophius budegassa* and *Lophius piscatorius* recruits in Porcupine surveys (2014-2021)



**Figure 10.** Mean stratified length distributions of *Lophius budegassa* and *Lophius piscatorius* in Porcupine surveys (2012-2021)

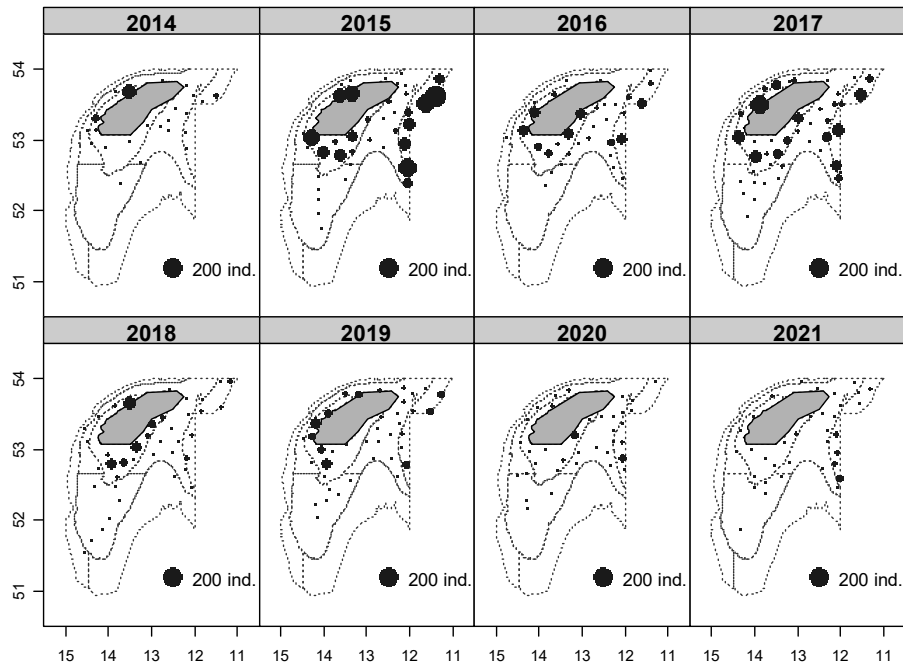


**Figure 11.** Evolution of *Lepidorhombus boscii* and *Lepidorhombus whiffiagonis* biomass and abundance indices in Porcupine surveys (2001-2021). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals ( $\alpha = 0.80$ , bootstrap iterations = 1000)



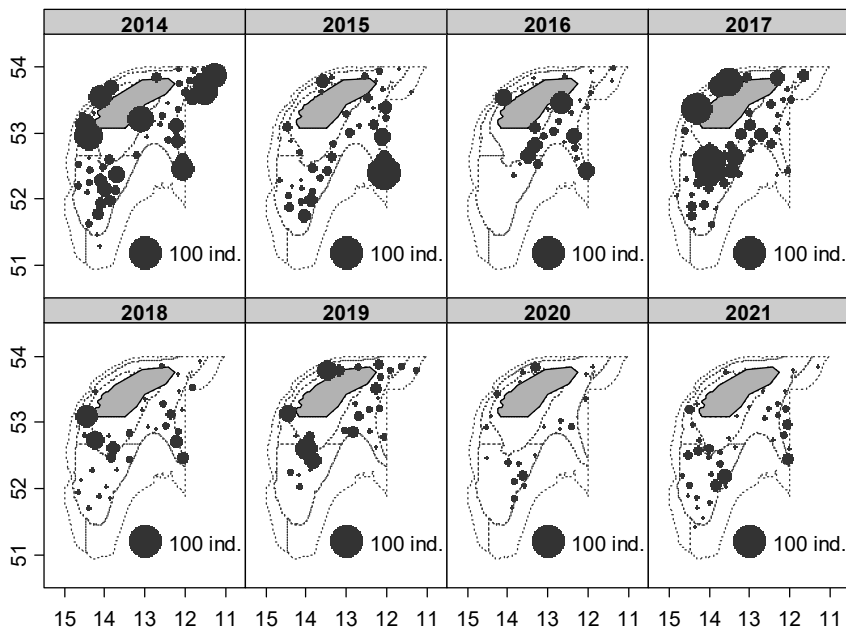
**Figure 12.** Geographic distribution of *Lepidorhombus boscii* and *L. whiffiagonis* catches ( $\text{kg} \times 30 \text{ min haul}^{-1}$ ) in Porcupine surveys (2014-2021)

***Lepidorhombus whiffiagonis***  
Age 1

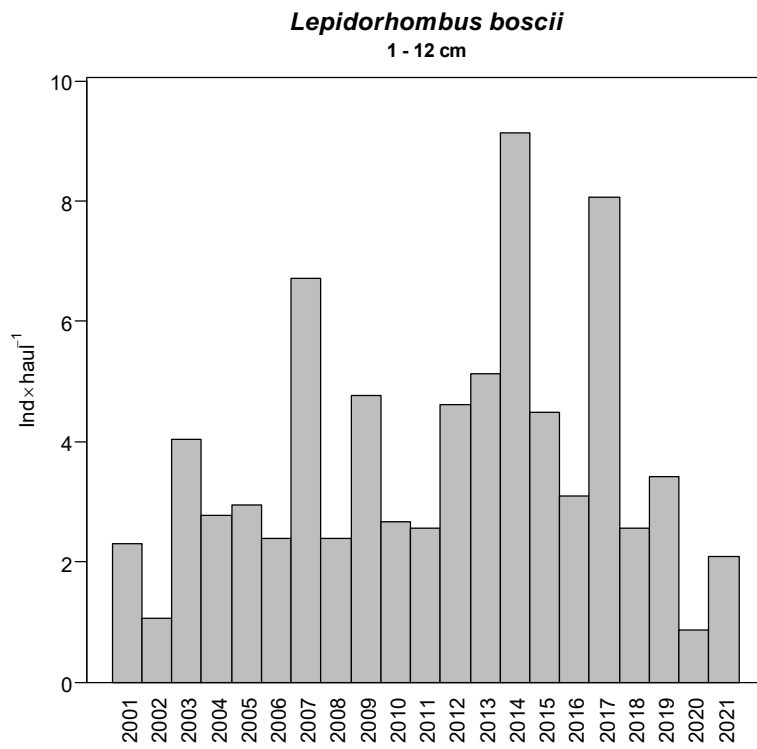


**Figure 13.** Geographic distribution of *Lepidorhombus whiffiagonis* recruits (age 1) in Porcupine surveys (2014-2021)

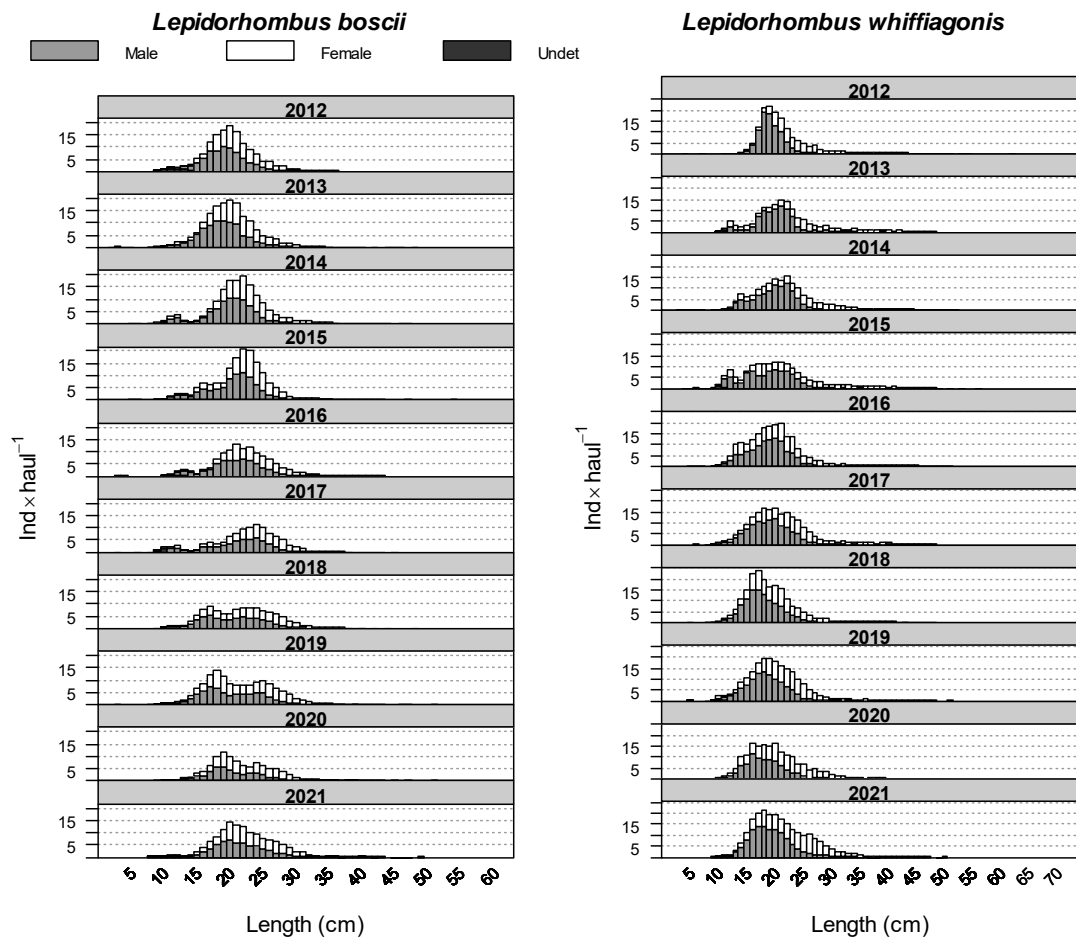
***L. boscii* 1-12 cm**



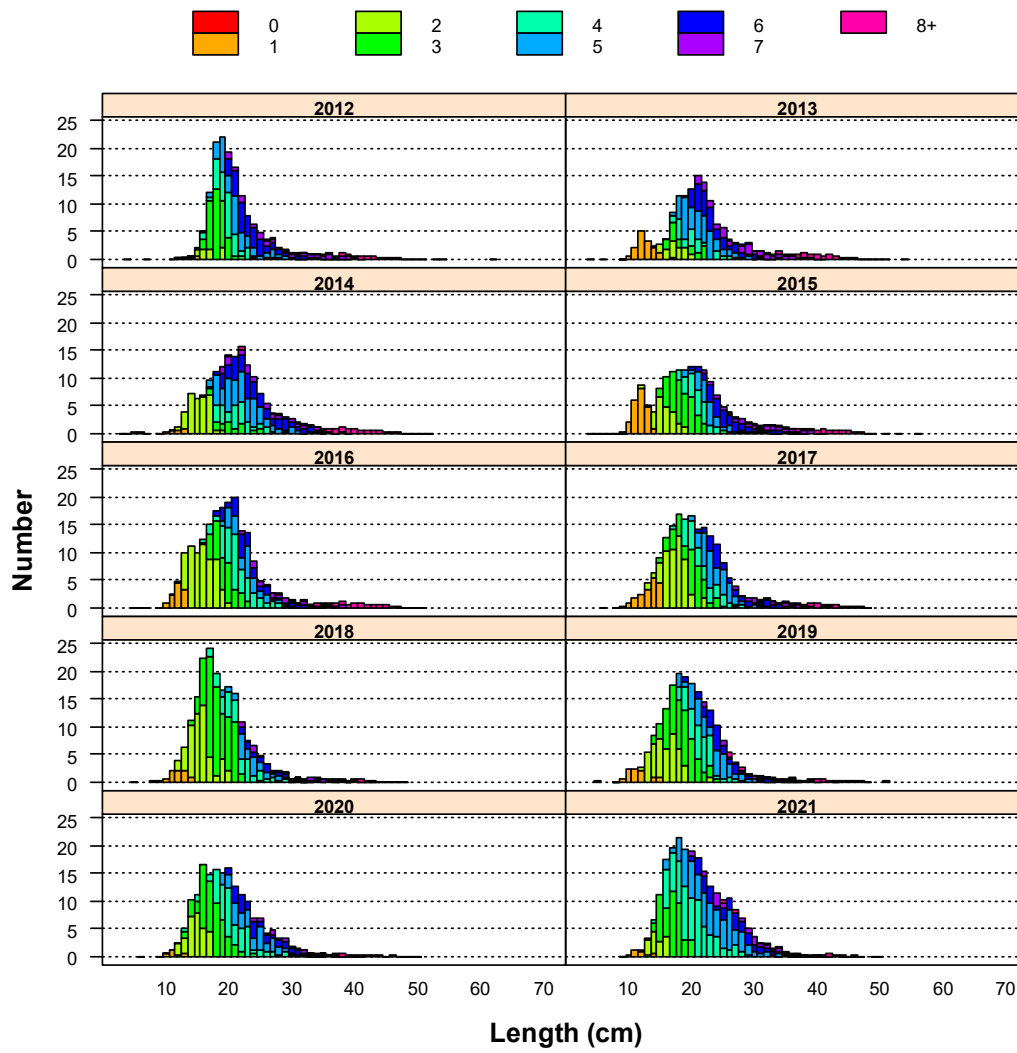
**Figure 14.** Geographic distribution of *Lepidorhombus boscii* juveniles ( $\leq 12$  cm) in Porcupine surveys (2014-2021)



**Figure 15.** Evolution of the *Lepidorhombus boscii* juveniles ( $\leq 12$  cm) on Porcupine surveys (2001-2021)

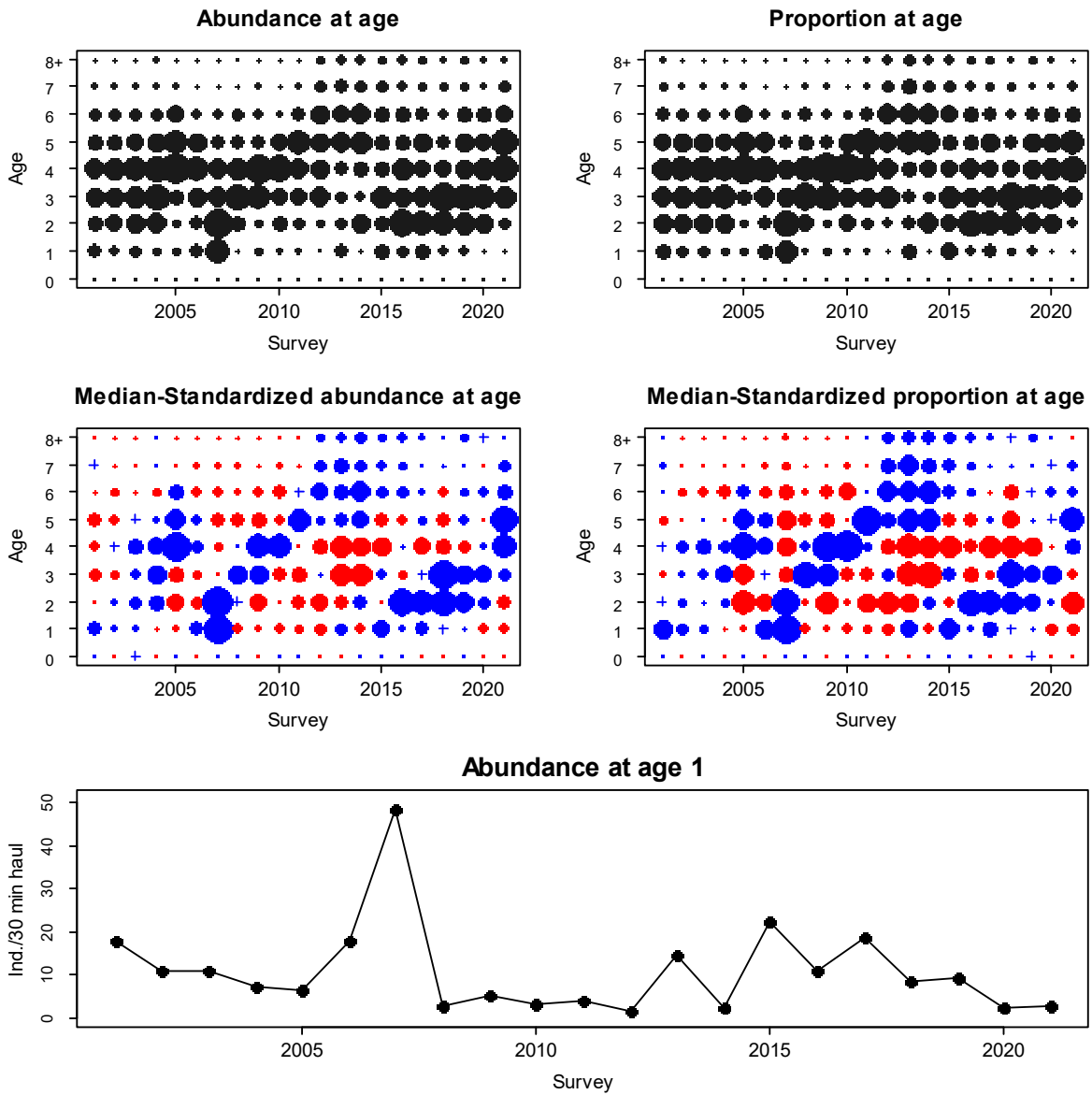


**Figure 16.** Mean stratified length distributions of *Lepidorhombus boscii* and *Lepidorhombus whiffiagonis* in Porcupine surveys (2012-2021)



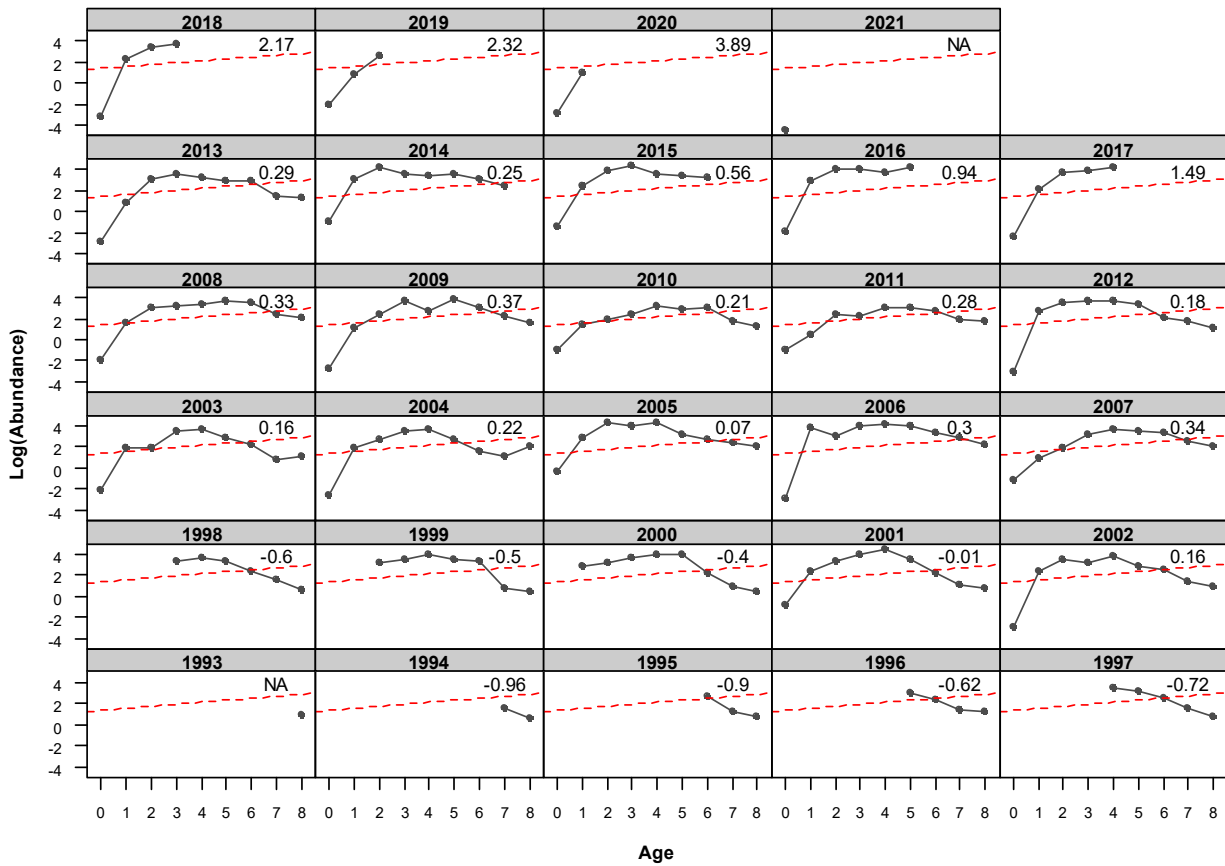
**Figure 17.** Mean stratified length distributions of *Lepidorhombus whiffiagonis* with the age classes in Porcupine surveys (2012-2021)





**Figure 18.** Bubble-plot of *Lepidorhombus whiffiagonis* abundances at age, proportion at age, median standardized abundances at age (year-median years) and median standardized proportion at age in Porcupine surveys time series. Blue bubbles are above the median value, red ones are below it and the cross marks the year with the median value.

### Abundance along age by cohort



**Figure 19.** *Lepidorhombus whiffiagonis* abundance (No./30 min haul) evolution in logarithmic scale along each cohort sampled in Porcupine surveys time series. Solid lines mark the linear regression fitted by cohort to the log(abundance)~age, the figure in the lower right corner of each panel corresponds to the slope. Dashed line marks the linear regression fitted to the overall time series.