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 Spanish Ground Fish Survey on the Porcupine bank (NE Atlantic)

S. Ruiz-Pico[1], M. Blanco[1], O. Fernández-Zapico[1], F. Velasco[1] & F. Baldó[2]

Instituto Español de Oceanografía

(1)
Centro Oceanográfico de Santander
Promontorio San Martín s/n
39004 Santander, Spain

(2)
Centro Oceanográfico de Cádiz
Muelle de Levante (Puerto Pesquero)
P.O. Box 2609
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 2018. Biomass, abundance, distribution and length frequency were analysed. Biomass indices of these target species decreased this last survey. However the abundance of *L. budegassa* and both species of megrims increased due to the increase of specimens from 18 to 28 cm and from 15 to 20 cm respectively.

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 Porcupine bottom trawl surveys after the results presented previously (Blanco *et al.* 2017; Ruiz-Pico *et al* 2018).

Material and methods

The Spanish Ground Fish Survey on the Porcupine bank (SP-PORC-Q3) has been annually carried out 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 reduction in the tow duration (20 instead of 30 minutes) applied in the last three surveys worked successfully. Now the catches have been reduced and are easier to handle for the team who sort it, but they are still abundant enough to be representative samples. The biomass indices of the entire time series are not affected by this reduction because the results of these last surveys were extrapolated to 30 minutes of trawling time to keep up the time series.

Results

In 2018, 85 standard hauls and 3 additional hauls were carried out (Figure 1).

The total mean catch per haul decreased slightly the last year (Figure 2). Fish represented 93% of the total stratified catch and the species analyzed in this report represented 8% of the total stratified fish catch, with the following percentages per species: hake (44%), anglerfishes (23%) and megrims (33%).

In 2018, the biomass of these species decreased. Species such as *Merluccius merluccius*, *Lophius budegassa* and *Lepidorhombus boscii* have been following a downward trend since the last three or two years. However, the biomass of *L. piscatorius* and *L. whiffiagonis,* which had been high for several years, decreased in this latest survey. The abundance of small specimens of these target species was lower than the previous year but the specimens of around 18 cm were more abundant, specifically in *L. budegassa* and both species of megrims.

Merluccius merluccius (hake)

The biomass of *M. merluccius* has been decreasing since 2015 and this last year decreased even more (29.3 ± 1.9 kg haul^{-1}) (Figure 3). The abundance that increased in 2017, decreased in the last survey because the peak of specimens from 18 to 30 cm was weakened.

M. merluccius was widespread in the study area, but this last survey fewer and smaller spots of biomass were found than in previous years (Figure 4). Fewer spots of recruits (< 23 cm) were found but were concentrated in the Irish shelf and in the south of the bank as usual (Figure 5).

The length distribution showed a smooth modes of specimens around 19 cm and another from 31 to 46 cm (Figure 6) where is clear the decrease of the importance of large individuals on the length density plot. Individuals larger than 50 cm were barely found in contrast to previous years.

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

L. budegassa was scarcer than *L. piscatorius* in the area. In this last survey, the biomass of *L. budegassa* decreased while the abundance increased due the increment of specimens from 18 to 28 cm. The biomass and abundance of *L. piscatorius* were lower than the previous five years (Figure 7).

In 2018, specimens of *L. budegassa* were found mainly on the Irish shelf and were almost not found in the south and around the bank as usual (Figure 8). *L. piscatorius*, although widespread, showed fewer spots of biomass around the bank than the previous years, which makes a difference in the depth distribution of both species even more than in previous years. Recruits of *L. budegassa* (< 20 cm) were on the Irish shelf and small specimens of *L. piscatorius* were around the bank and on the Irish shelf (Figure 9).

The abundance of small specimens (*L. budegassa* around 8 cm and *L. piscatorius* below 10 cm) was slightly lower than the previous year. However, the specimens of *L. budegassa* from 18 to 28 cm were more abundant than previous years. Regarding adults, no mode was found in *L. budegassa* as usual, and the maximum size was 66 cm this last survey in contrast to specimens around 80 cm in

the previous years. The mode of adults of *L. piscatorius* was around 65 cm and the maximum size was 122 cm this last year (Figure 10).

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

L. boscii has been slightly scarcer than *L. whiffiagonis* in the area, although in this last survey their biomass were similar, around 11 kg haul^{-1}. The biomass of both species decreased this last survey whereas the abundance increased due to the increase of specimens from 15 to 20 cm (Figure 11).

Both species were distributed as usual but with fewer spots of biomass in the north and western area, *L. whiffiagonis* around the bank and on the Irish shelf shallower than *L. boscii* (Figure 12). The recruits of both species were concentrated closer around the bank than the previous year, specifically in the east and the south of the bank, although some spots of biomass were found in the north (Figure 13 and Figure 14). Recruits of *L. whiffiagonis* that are usually distributed in the shallower waters of Irish shelf were not found this last survey (Figure 14).

The length distribution of *L. boscii* showed that the recruits around 12 cm were hardly found this last survey, while the specimens around 17 cm increased. The usual adult mode around 22 cm was weakened this last survey. The length distribution of *L. whiffiagonis* showed that specimens around 17 cm also increased (Figure 15) while recruits of age 1 decreased this last survey (Figures 16, Figure 17 and Figure 18).

Acknowledgements

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Figures

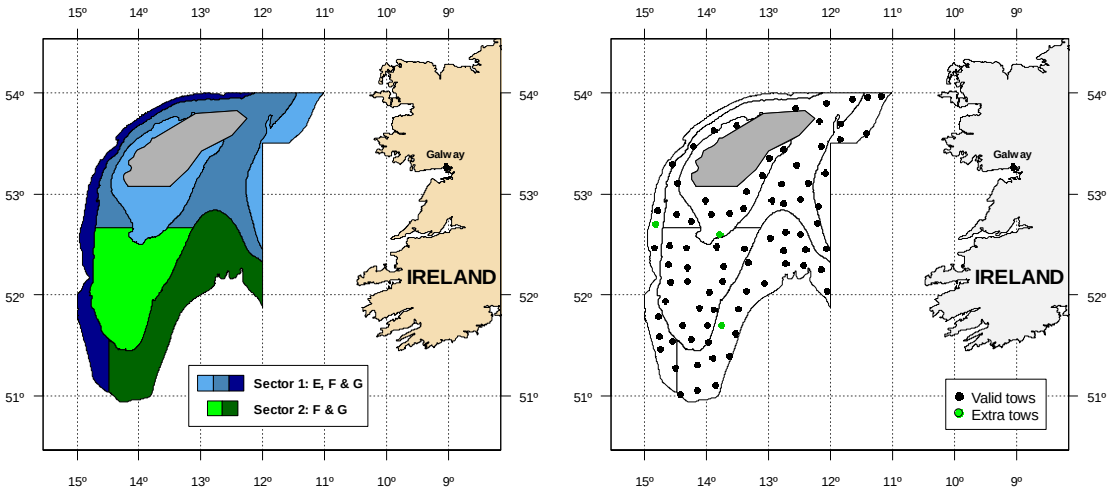

Figure 1. Left: Stratification design used in Porcupine surveys from 2003, previous data were re-stratified. Depth strata are: E) shallower than 300 m, F) 301 – 450 m and G) 451 – 800 m. Grey area in the middle of Porcupine bank corresponds to a large non-trawlable area, not considered for area measurements and stratification. Right: distribution of hauls performed in 2018

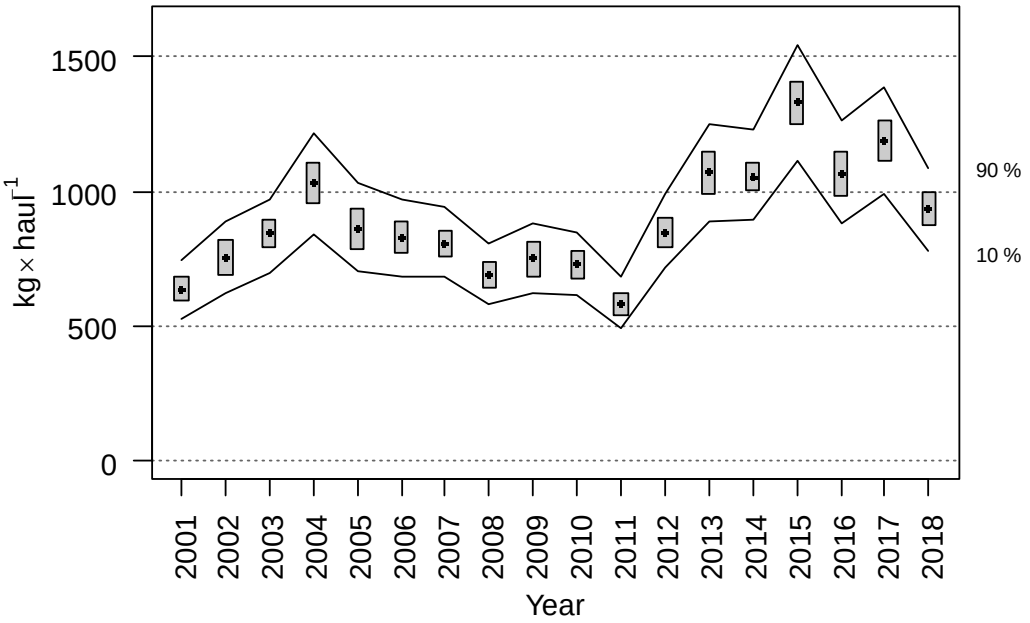

Figure 2. Evolution of the total catch in Porcupine surveys (2001-2018)

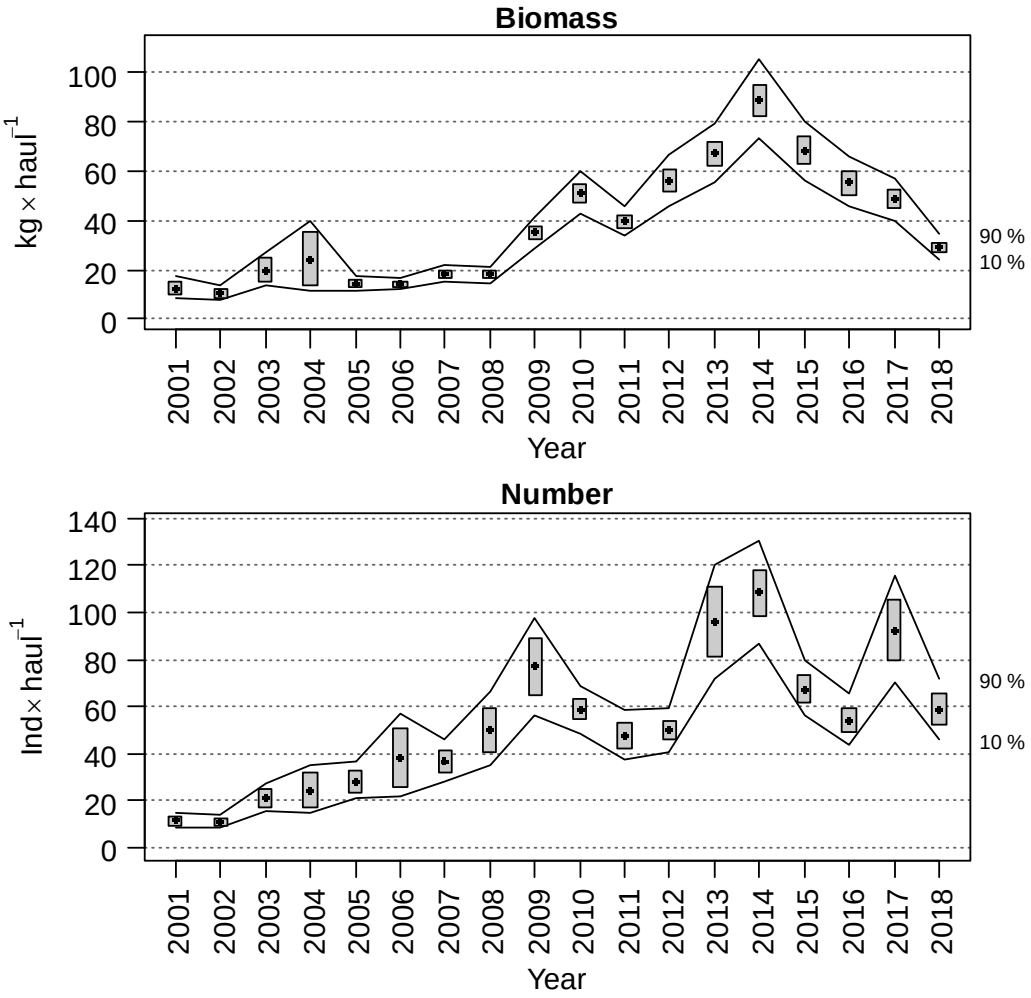

Figure 3. Evolution of *Merluccius merluccius* biomass and abundance indices in Porcupine surveys (2001-2018). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (α = 0.80, bootstrap iterations = 1000)

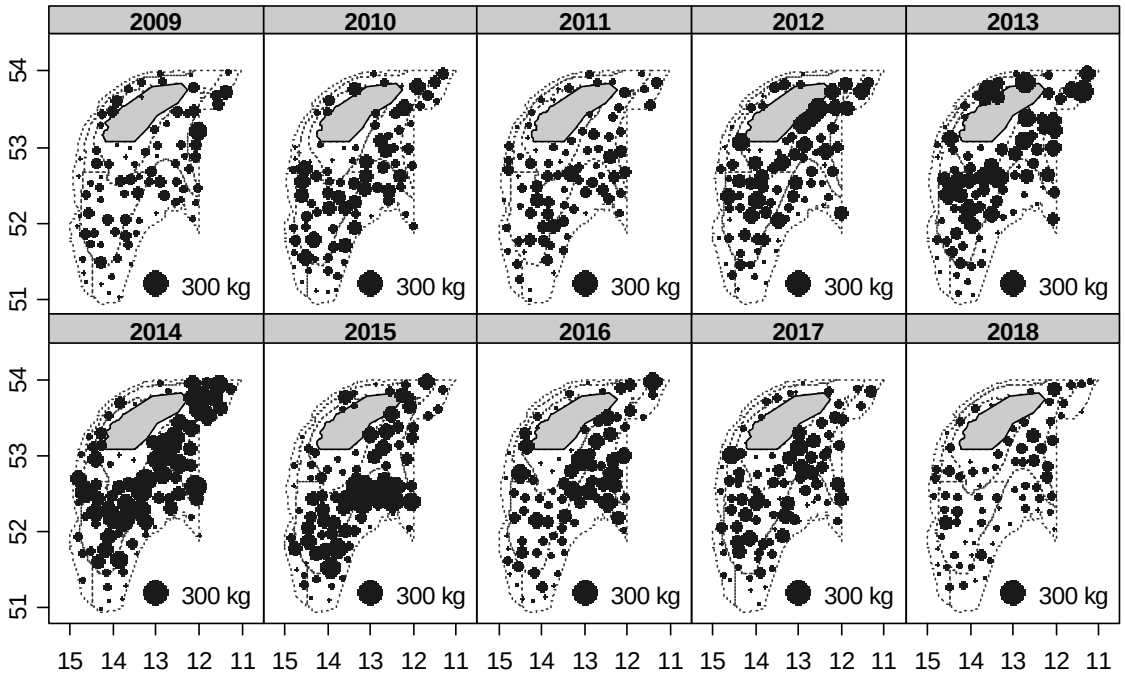

Figure 4. Geographic distribution of *Merluccius merluccius* catches (kg/30 min haul) in Porcupine surveys (2009-2018)

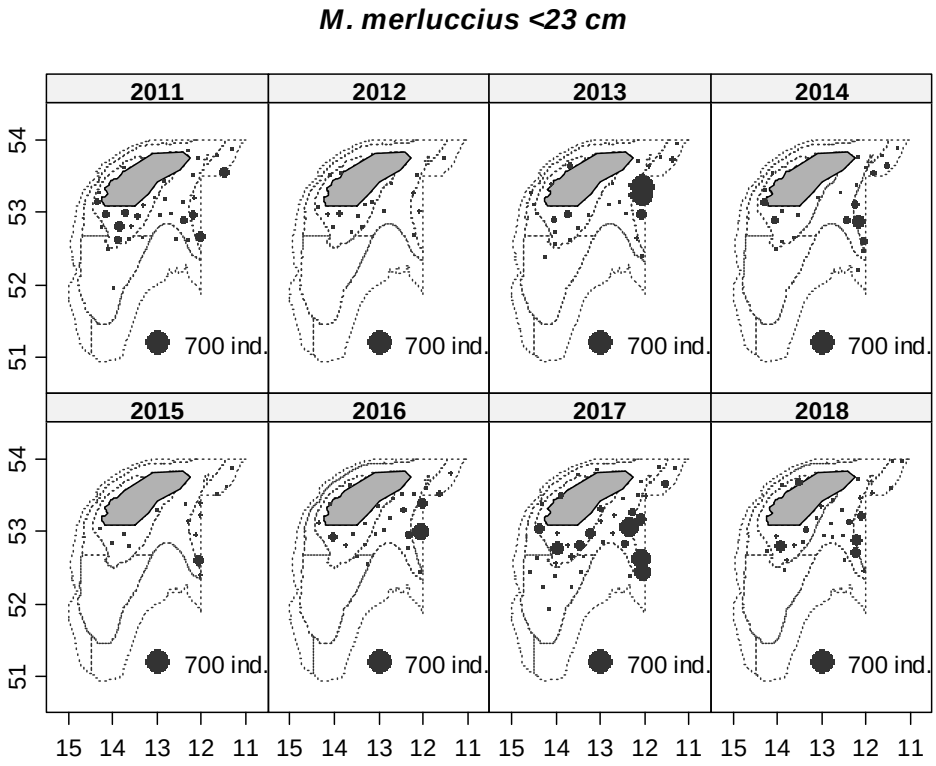

Figure 5. Geographic distribution of *Merluccius merluccius* recruits (<23 cm) in Porcupine surveys (2011-2018)

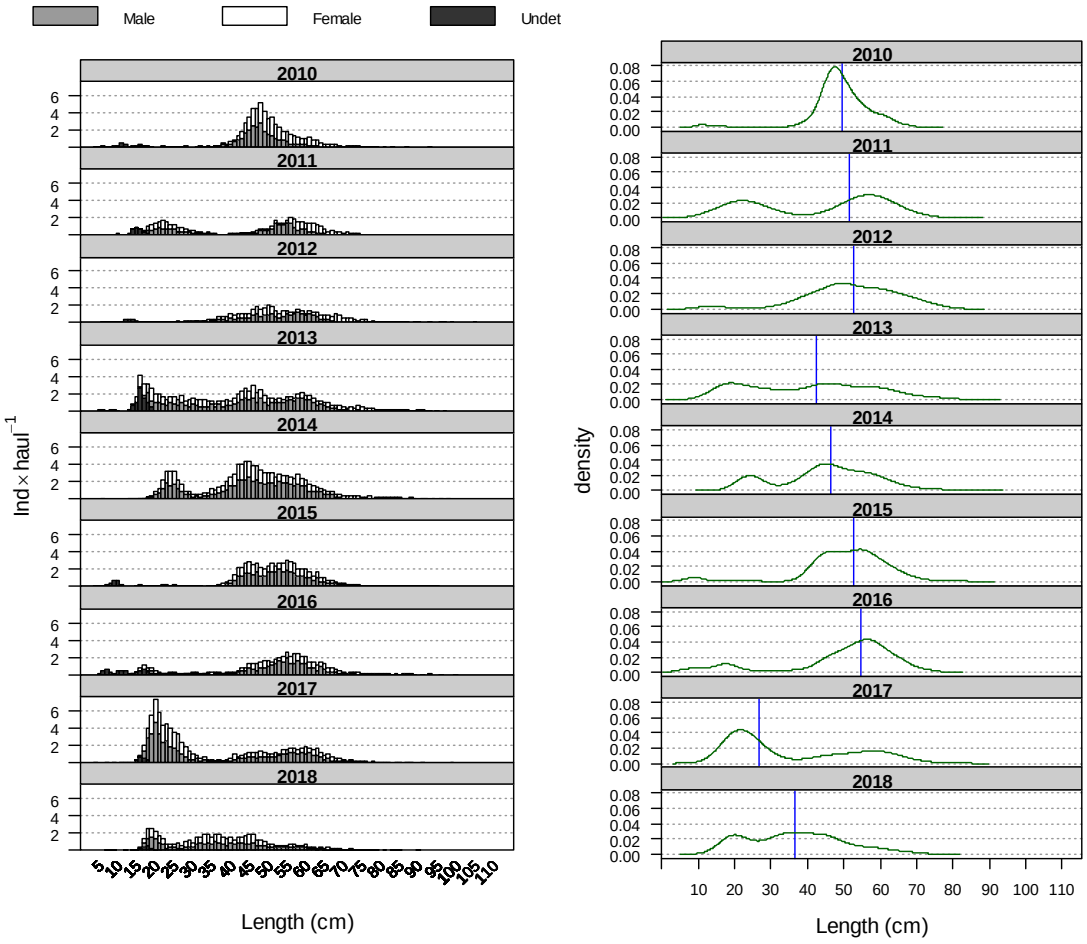

Figure 6. Mean stratified length distributions and length density plots of hake in Porcupine surveys (2010-2018)

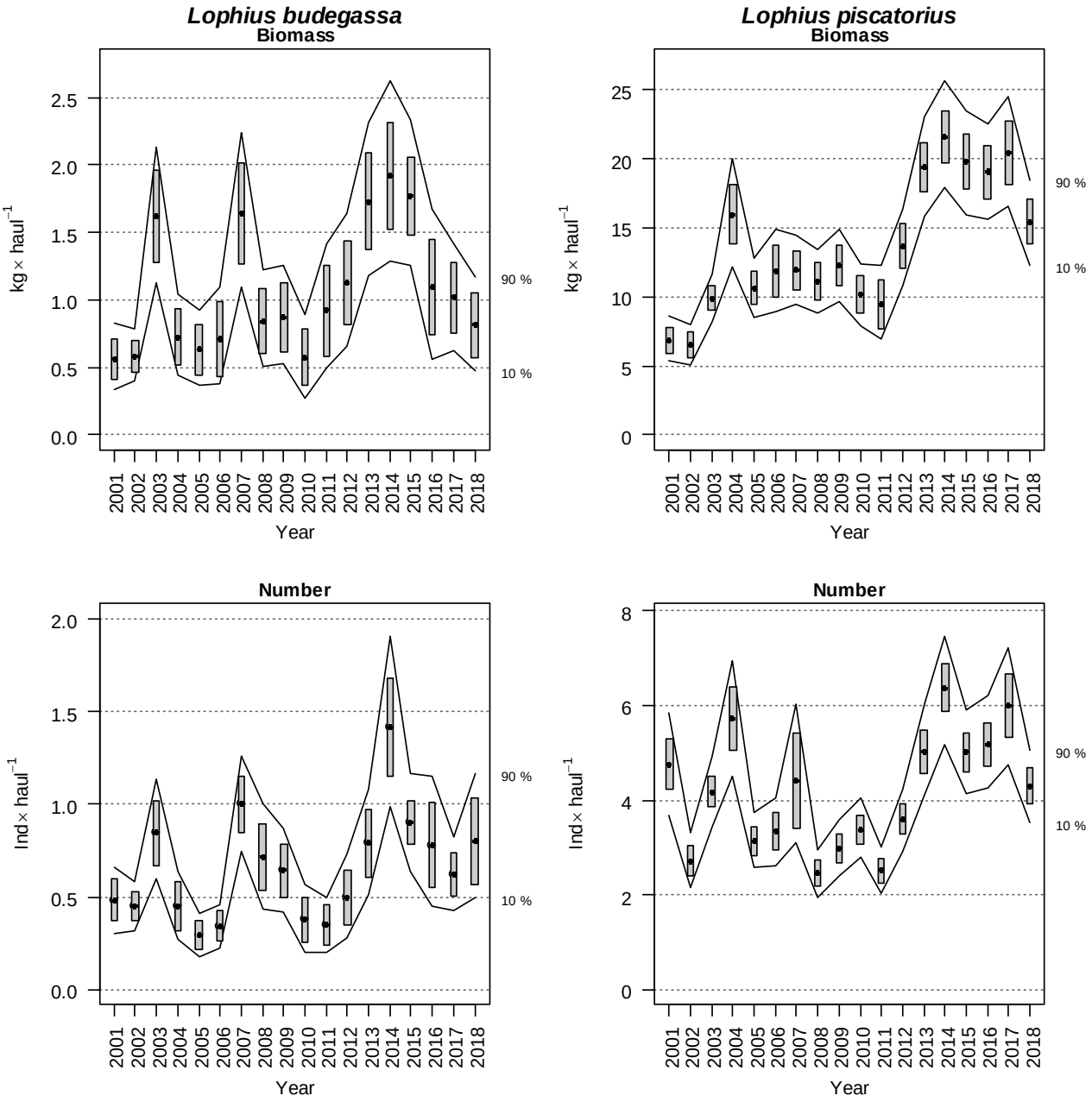

Figure 7. Evolution of *Lophius budegassa* and *Lophius piscatorius* biomass and abundance indices in Porcupine surveys (2001-2018). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals ($\alpha = 0.80$, bootstrap iterations = 1000)

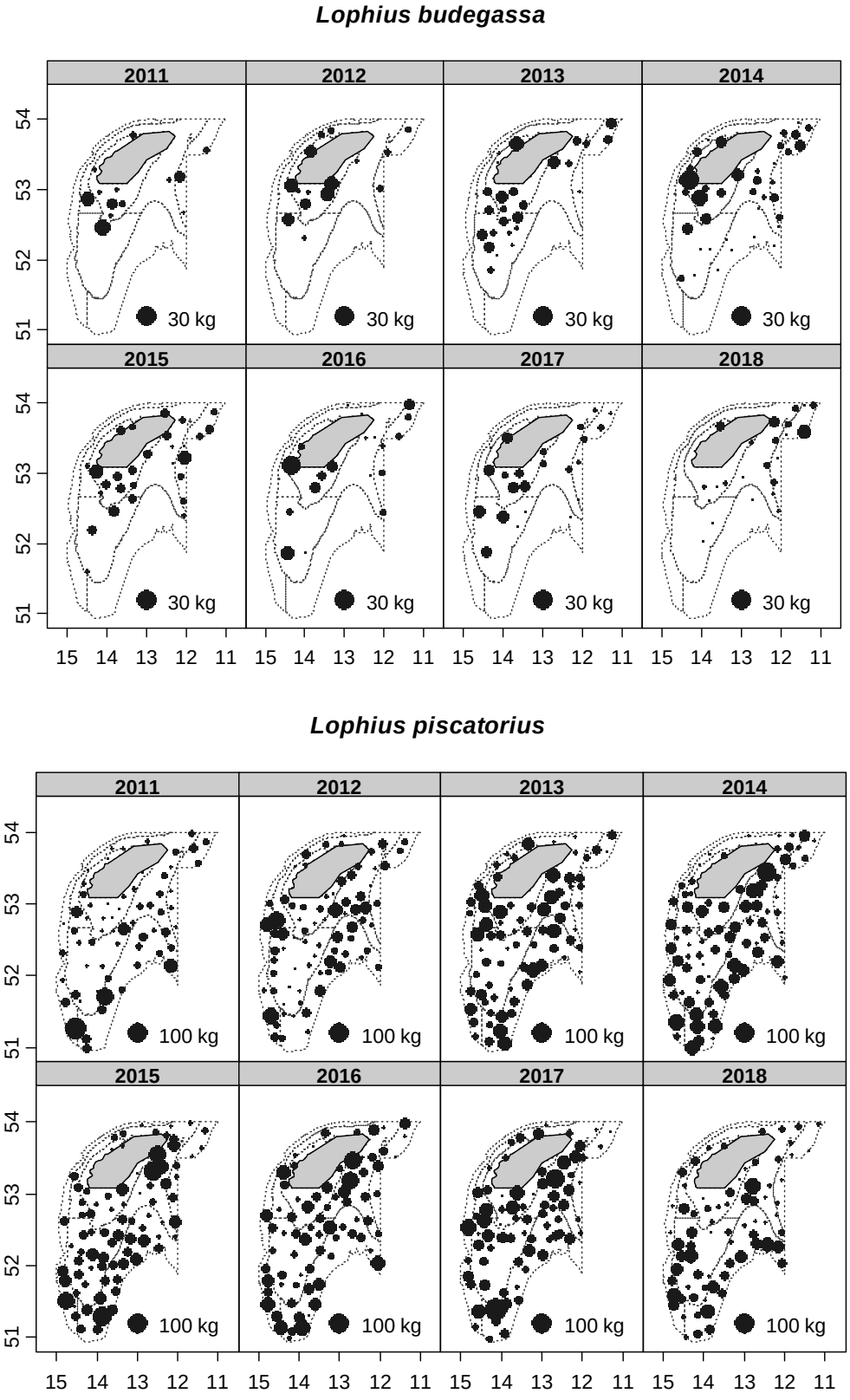

Figure 8. Geographic distribution of *Lophius budegassa* and *Lophius piscatorius* catches (kg×30 min haul^{-1}) in Porcupine surveys (2011-2018)

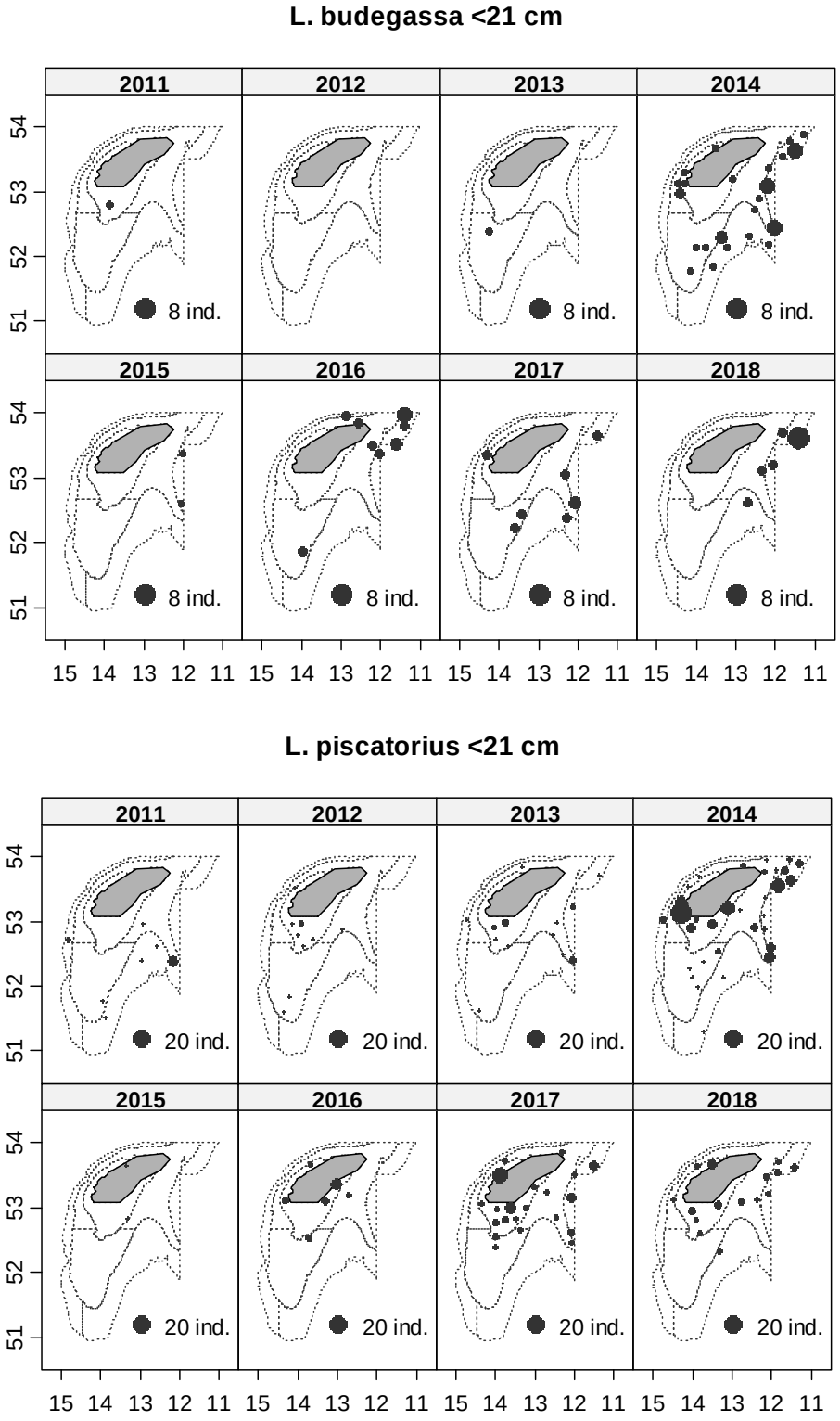

Figure 9. Geographic distribution of *Lophius budegassa* and *Lophius piscatorius* recruits in Porcupine surveys (2011-2018)

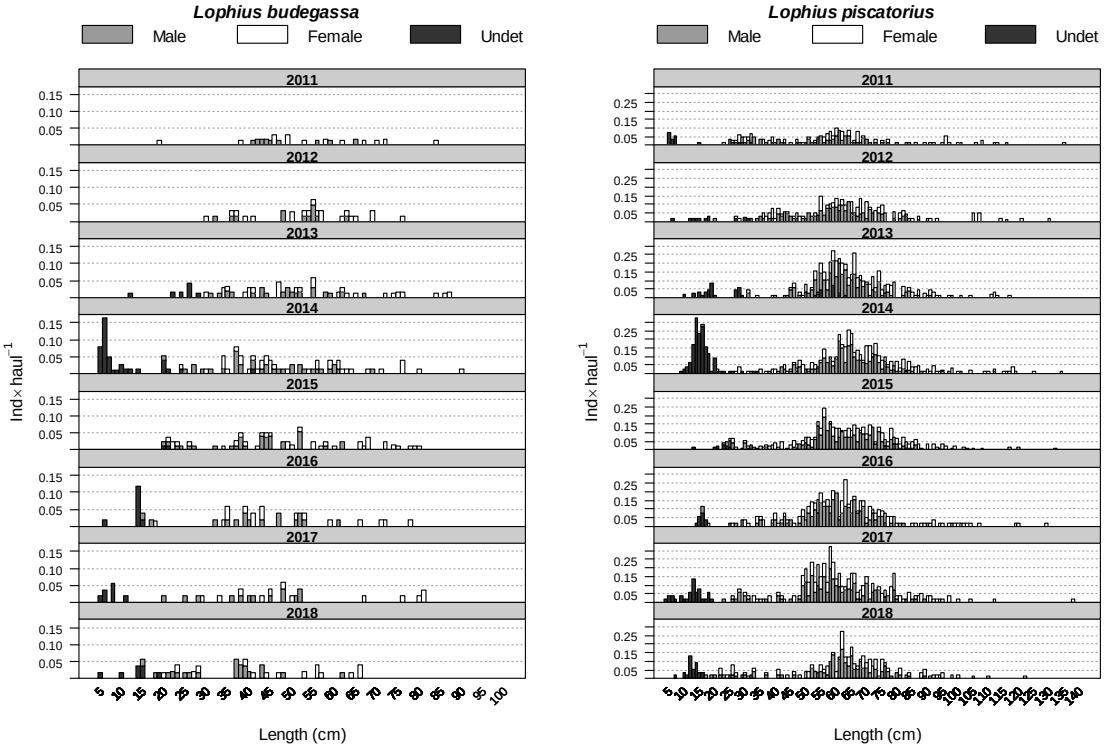

Figure 10. Mean stratified length distributions of *Lophius budegassa* and *Lophius piscatorius* in Porcupine surveys (2011-2018)

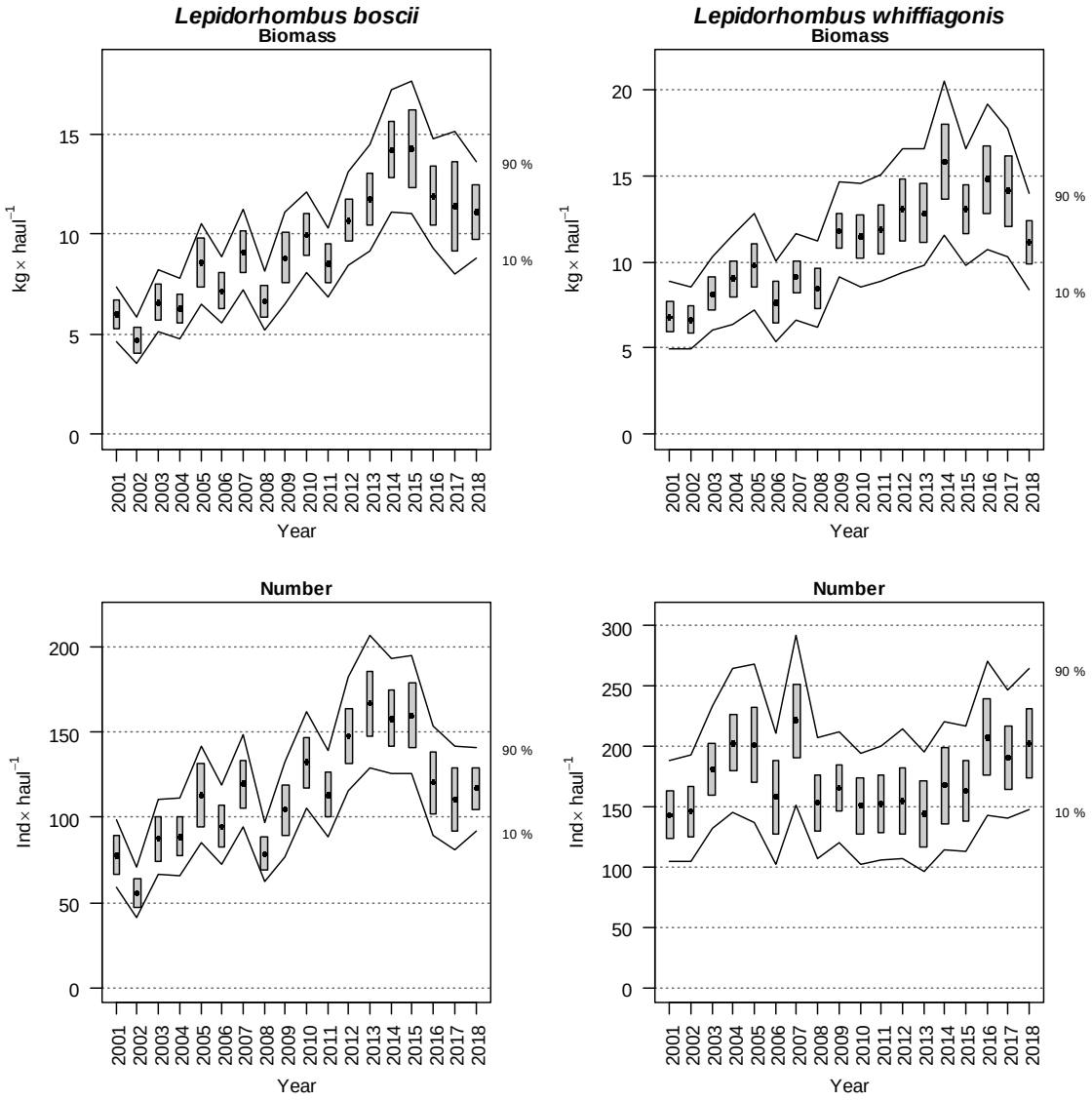

Figure 11. Evolution of *Lepidorhombus boscii* and *Lepidorhombus whiffiagonis* biomass and abundance indices in Porcupine surveys (2001-2018). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals ($\alpha = 0.80$, bootstrap iterations = 1000)

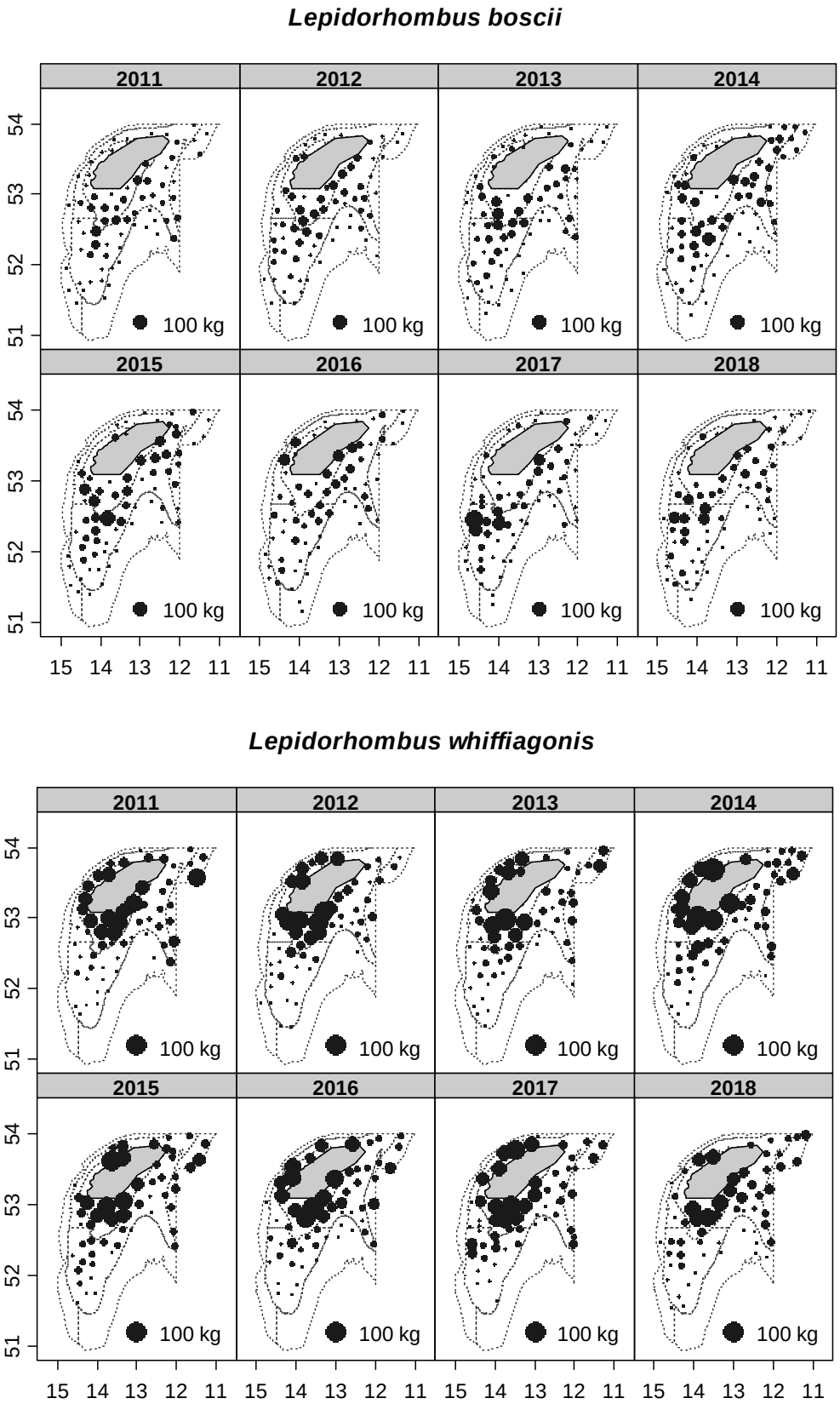

Figure 12. Geographic distribution of *Lepidorhombus boscii* and *Lepidorhombus whiffiagonis* catches (kg×30 min haul^{-1}) in Porcupine surveys (2011-2018)

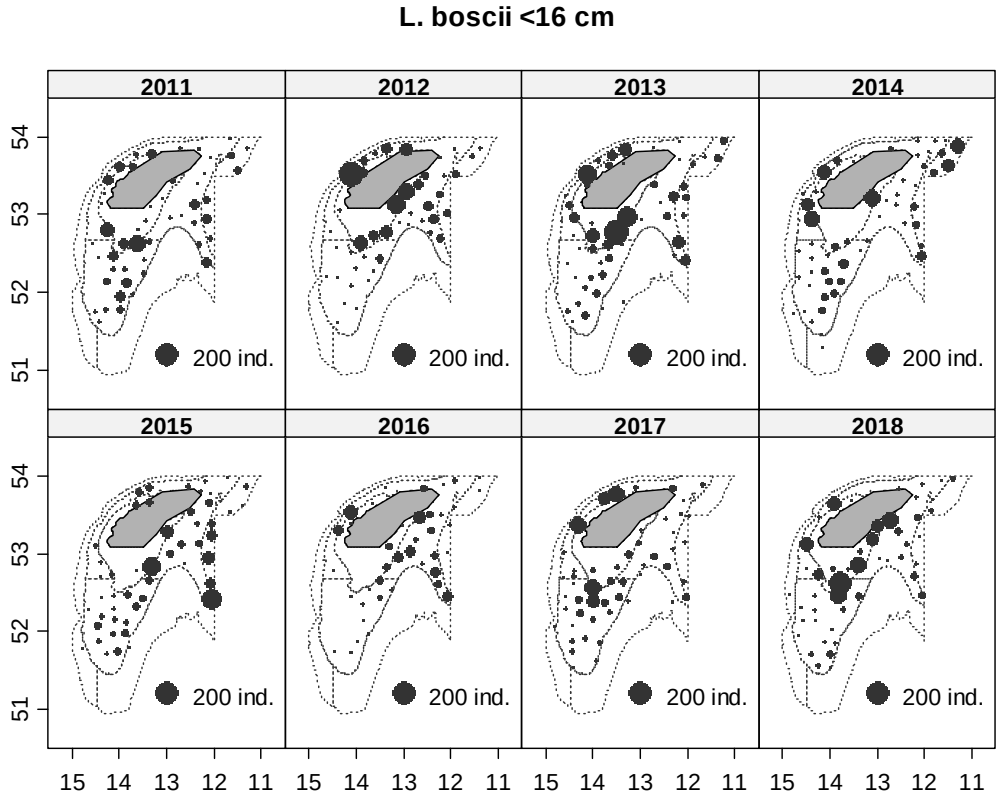

Figure 13. Geographic distribution of *Lepidorhombus boscii* recruits (≤16 cm) in Porcupine surveys (2011-2018)

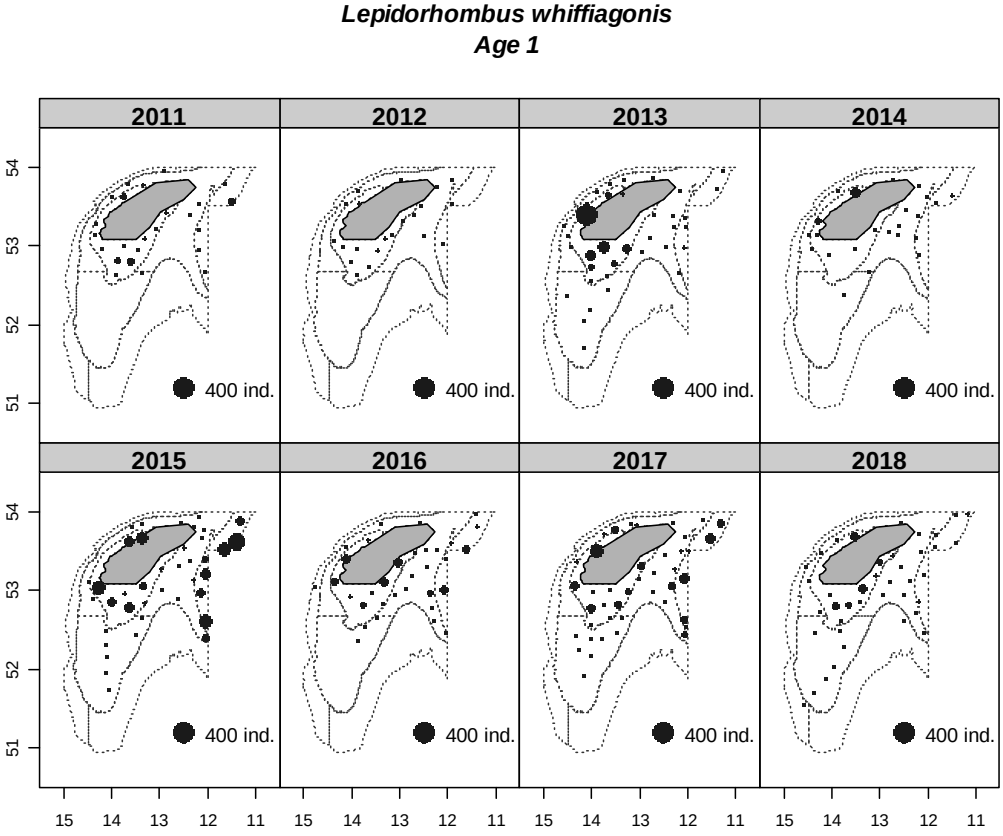

Figure 14. Geographic distribution of *Lepidorhombus whiffiagonis* recruits (age 1) in Porcupine surveys (2011-2018)

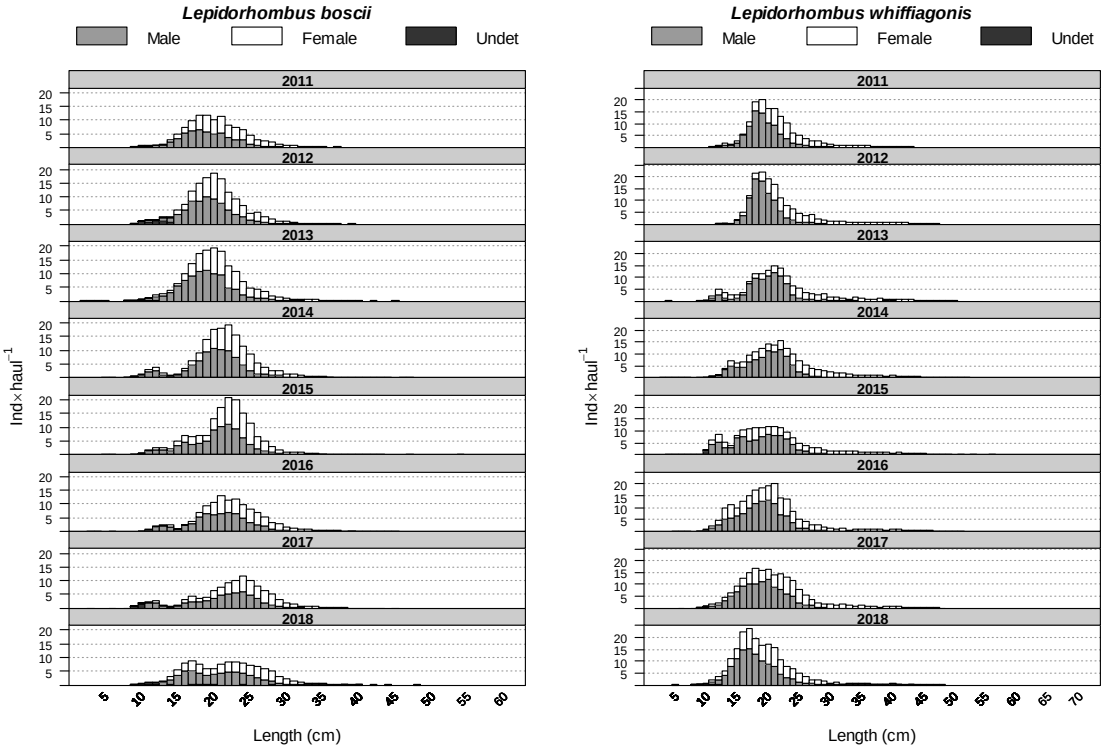

Figure 15. Mean stratified length distributions of *Lepidorhombus boscii* and *Lepidorhombus whiffiagonis* in Porcupine surveys (2011-2018)

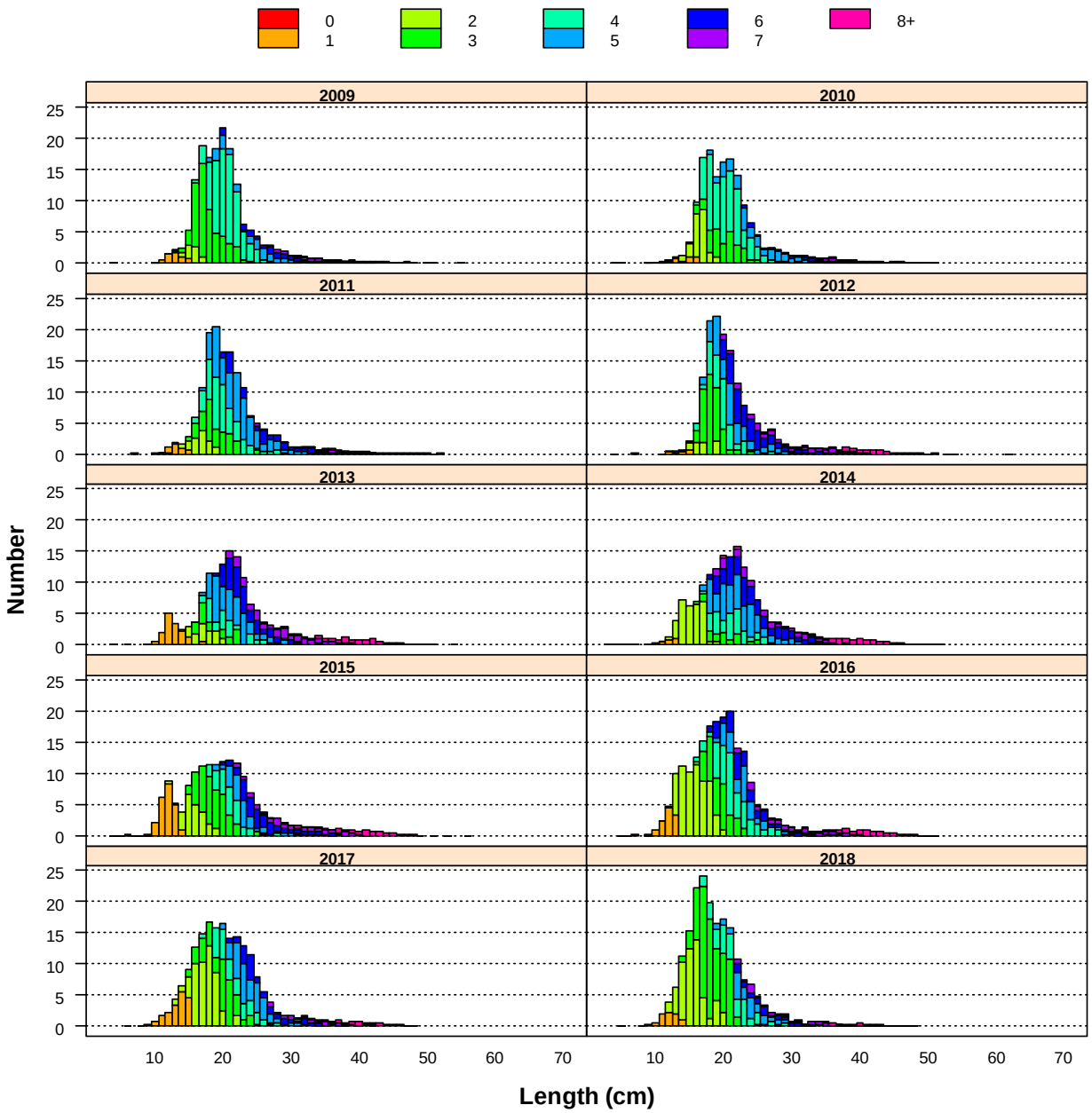

Figure 16. Mean stratified length distributions of *Lepidorhombus whiffiagonis* with the age classes in Porcupine surveys (2009-2018)

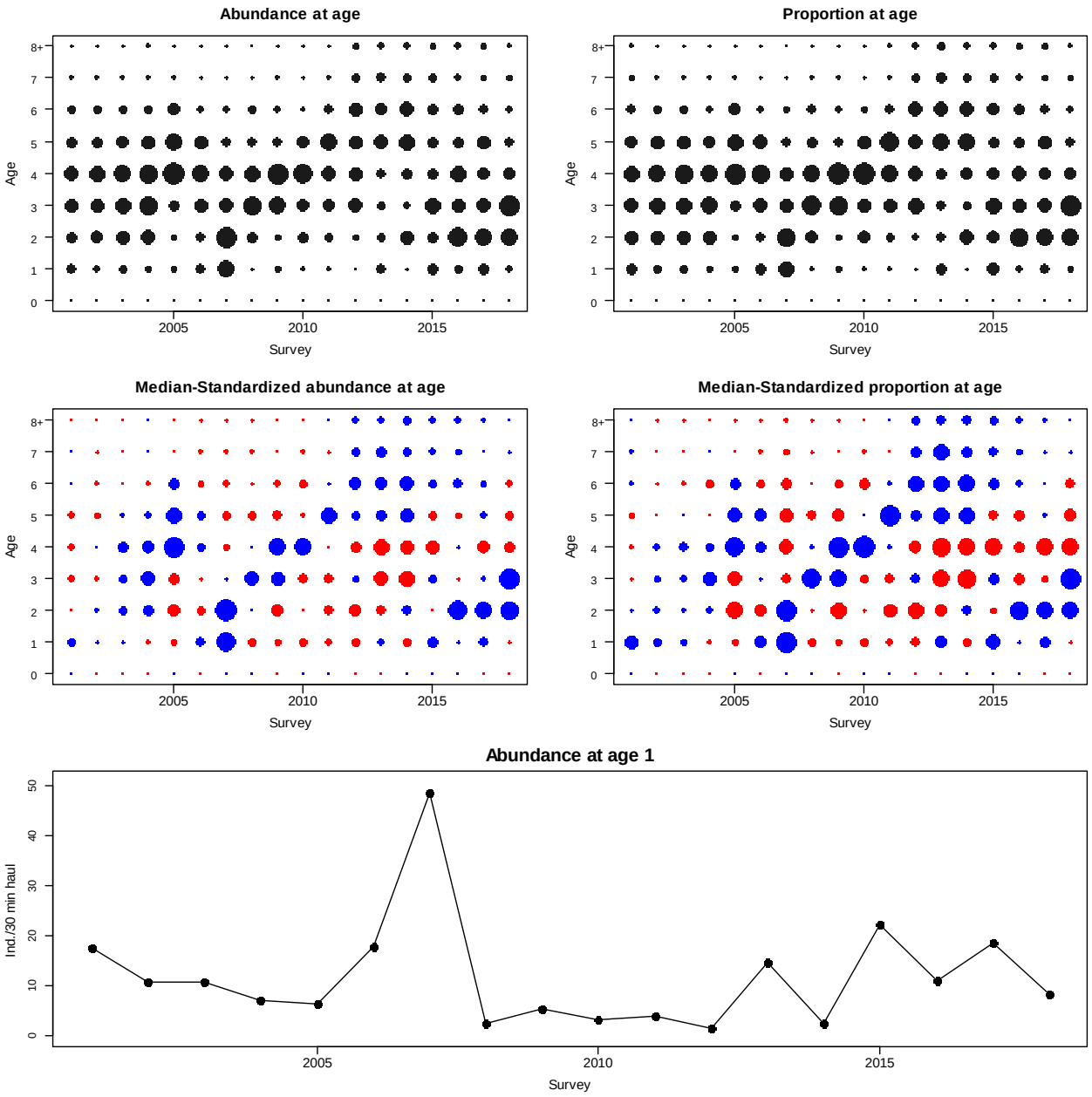

Figure 17. Bubble-plot of *Lepidorhombus whiffiagonis* abundances at age, proportion at age, median standardized abundances at age (year-median years) and median standardized proportion at age in Porcupine surveys time series. Blue bubbles are above the median value, red ones are below it and the cross marks the year with the median value.

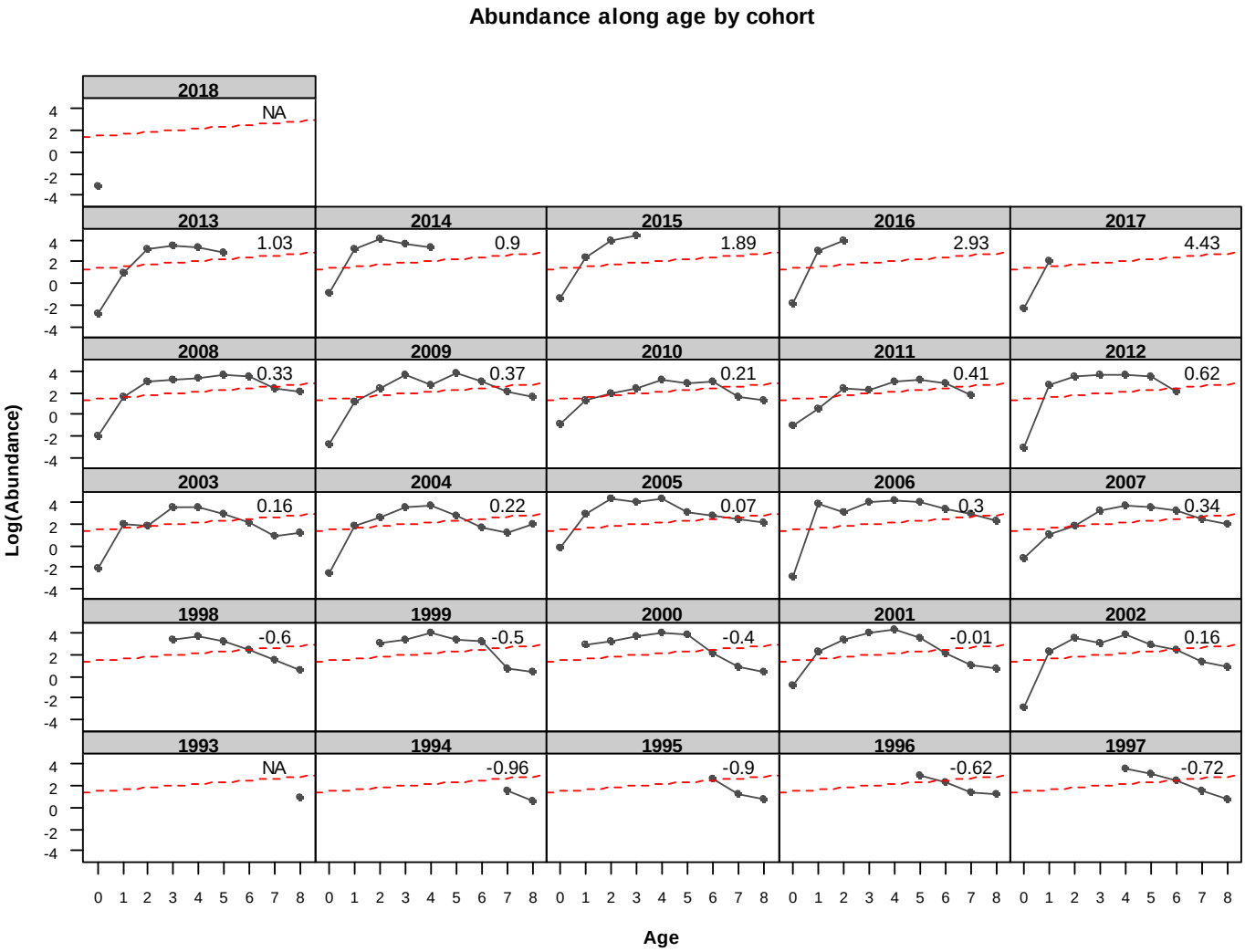

Figure 18. *Lepidorhombus whiffiagonis* abundance (No./30 min haul) evolution in logarithmic scale along each cohort sampled in Porcupine surveys time series. Solid lines mark the linear regression fitted by cohort to the log(abundance)~age, the figure in the lower right corner of each panel corresponds to the slope. Dashed line marks the linear regression fitted to the overall time series.