Working document presented to the ICES Benchmark Workshop for selected Megrim Stocks (WKMegrim)

Data revision workshop – 24th to 27th January 2022

Portuguese survey data for *Lepidorhombus boscii* (ICES division 9a)

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1. Introduction

The four-spotted megrim *Lepidorhombus* boscii and the megrim *Lepidorhombus whiffiagonis* are important fisheries resources in Portugal mainland. Both species are found in landings but *L. boscii* is more frequent, representing between 82 to 95% of the national landings (in weight) of both megrims in the last decade (ICES, 2021).

Both the Portuguese Autumn Groundfish Survey and the Crustacean Survey are likely to catch megrims (Table 1)

Table 1. Summary of the surveys catching megrims (*L. whiffiagonis* and *L. boscii*).

Survey	Quarter	Area surveyed	Period	Notes
Portuguese International Bottom Trawl Survey (Portuguese Autumn Groundfish Survey) Code: G8899	4	All coast, 20-500 m deep	1981-2018	Survey was not conducted in 1984, 2012, 2019 and 2020; different vessel/net in 1996, 1999, 2003 and 2004; doubts in the continuity of the series due to vessel change in 2021.
Nephrops Survey Offshore (Crustacean survey) Code: G2913	2/3	Southwest and southern coast, 150- 750 m deep	1997-2018	Survey was not conducted in 2012, 2019 and 2020; different vessels were used in 1999 and in 2004; doubts in the continuity of the series due to vessel change in 2021.

The Portuguese Autumn Groundfish Survey (PtGFS-WIBTS-Q4) has been carried out annually in Portuguese continental waters since 1979 in the fourth quarter. The survey covers the whole Portuguese continental waters (ICES Division 9.a) from 20 to 500 m depth (Figure 1). The main objectives of the survey are to monitor the abundance and distribution of hake and horse mackerel recruitment (more information in ICES, 2017). Both *L. boscii* and *L. whiffiagonis* are caught in these surveys but their catchability is low, which might be related to the gear configuration (Figure 2). Both species seem to co-occur in the same areas and depths (Annex, Figures A1-A3), but *L. whiffiagonis* is less frequent, being mostly caught in the southwest coast. *Lepidorhombus boscii* occurs along the whole coast being more frequent in the western waters. The low occurrence of *Lepidorhombus* spp. in these surveys makes this series unsuitable to assess their abundance or biomass trends.

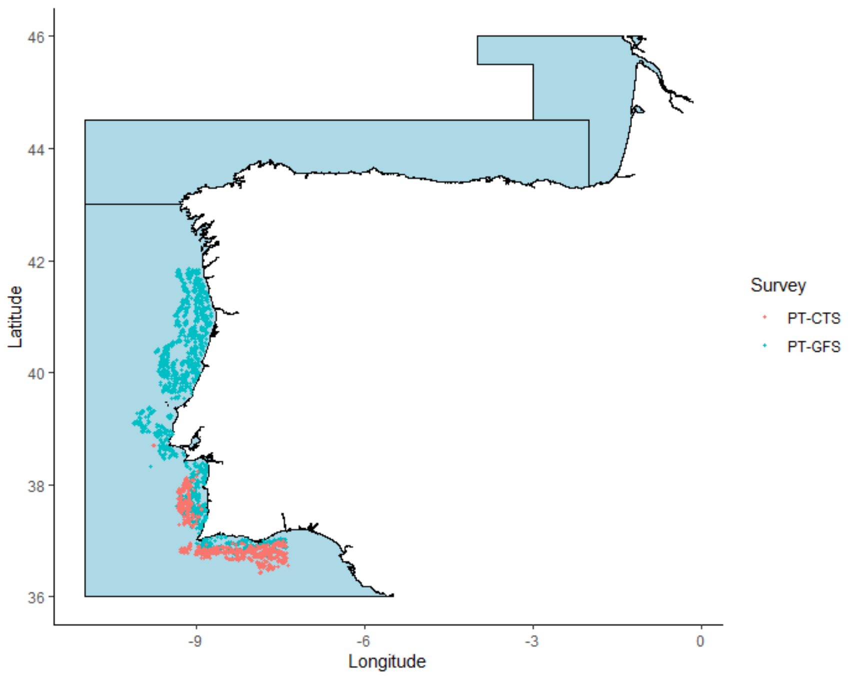

Figure 1. Location of fishing hauls conducted by the Portuguese Autumn Groundfish Survey and the Crustacean Survey between 1981-2018.

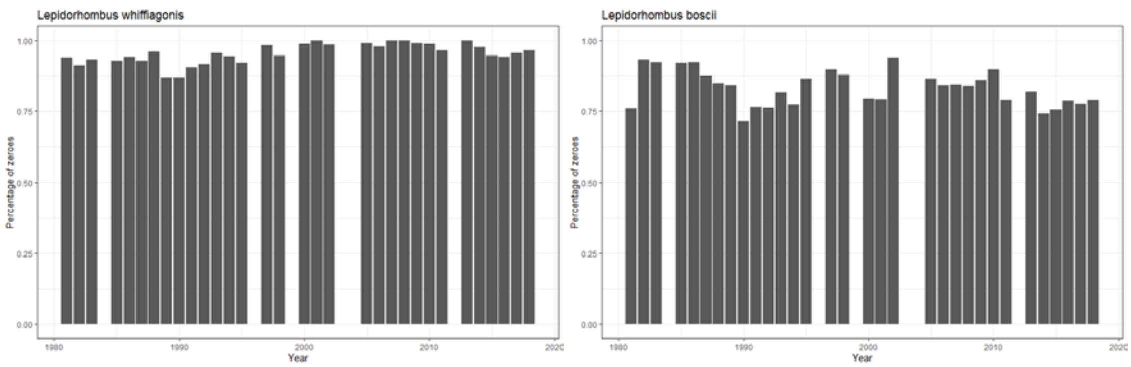

Figure 2. Percentage of zeros of a) *Lepidorhombus whiffiagonis* and b) *Lepidorhombus boscii* in demersal surveys (1981-2018).

The Crustacean Survey (PT-CTS (UWTV (FU 28–29))) is carried out in May–July and covers the southwest coast (Alentejo or FU 28) and the south coast (Algarve or FU 29). The main objectives are to estimate the abundance of the main crustacean species, Norway lobster, rose shrimp and red shrimp (2016). Both megrims *(L. boscii* and *L. whiffiagonis*) occur in these surveys, with *L. whiffiagonis* occurring in 5% to 15% of the hauls, depending on the year (Figure 3). The species is more frequent in the south-western coast, where relatively few high catches were registered

(Annex, Figure A4). *Lepidorhombus boscii* occurs in 13 – 51% of the hauls. The data for this survey is presented and discussed below for further use in the assessment of the stock ldb.27.8c9a.

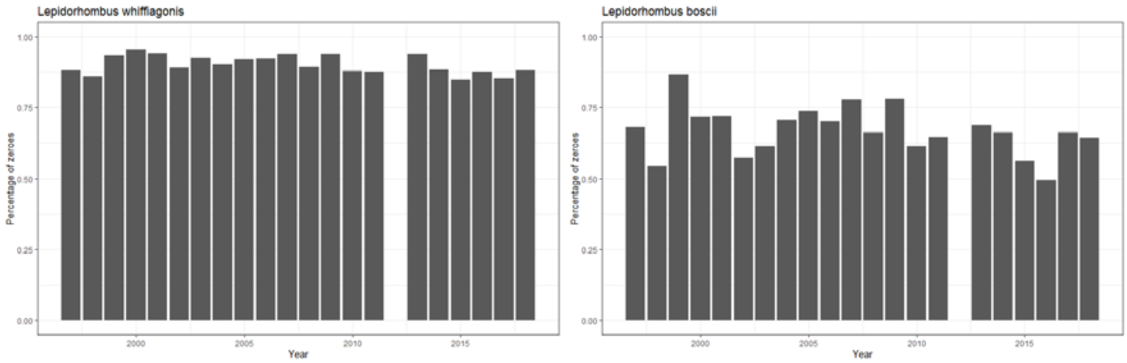

Figure 3. Percentage of zeros of a) *Lepidorhombus whiffiagonis* and b) *Lepidorhombus boscii* in crustacean surveys (1997-2018).

2. Methods

Data for *L. boscii* were recorded from the PT-CTS (UWTV (FU 28–29)) from 1997 to 2018. This survey was based on a stratified random sampling, with at least two stations by strata, for the period 1997-2004. The sector and depth strata were the same used for the PT-WIBTS-Q4 survey, from 200 to 750 meters in southwest and from 100 to 750 m in the south. The number of hauls was set to a minimum of two hauls per strata. Since 2005, sampling is based on a regular grid superimposed on the area of *Nephrops norvegicus* distribution, as it is the target species for this survey. The regular grid is composed by 77 rectangles with 6.6 minutes of latitude by 5.5 minutes of longitude for the southwestern coast and vice-versa for the South coast. In each rectangle, one haul is performed and the abundance observed will reflect the relative abundance of the resource in that area and be assigned at the center of the rectangle. The stations may be grouped *a posteriori* in the strata used previously and the results compared with the former surveys.

No surveys were conducted in 2012, 2019 and 2020 and a different vessel was used in 1999 and 2004 but the same net was used. The survey conducted in 1999 only covered the southern area and was excluded from the biomass and abundance indices. In addition, a new vessel started to operate in 2021 and the continuity of the series is still under study.

All catch (or a subsample) is sorted by species, counted and weighted. Length distributions are recorded for all fish, crustaceans and cephalopods and target species are weighted by length class. *Lepidorhombus* spp. are a target species for both Crustaceans and GroundFish surveys. A subsample of 10 individuals by length class is also sampled for length and for maturity assessment following an adaptation of the maturity scale described in ICES (2007).

Abundance (number per hour) and biomass (kg per hour) estimation and their standard deviations are computed for the surveyed area and based on the methodology presented by Cochran (1977) for calculation of estimators for the stratified random sampling.

Age estimates of *L. boscii* from Portuguese waters corresponding to the time series studied are not available. However, age-length-keys (ALK) by combined sexes of *L. boscii* from otolith direct age estimations are available for each annual IBTS Spanish bottom survey (SP-WIBTS-Q4) from 1997–2018, performed in September-October.

The estimated age range was 0–12 years and the length range of these ALKs (mainly 5-36 cm) represented the vast majority of the lengths caught in the Portuguese crustacean surveys (mainly based on 9-40 cm). However, some lengths from the length distribution (LD) of the Portuguese surveys corresponding to large individuals (generally lengths between 36 and 42 cm) did not have age composition in their corresponding ALK from SP-WIBTS-Q4. To complete the age composition in those length ranges, a usual procedure was carried out, which is to take the corresponding age composition from the combined ALK of several years, and apply it in those lengths with lacks, always taking into account the distribution and strength of the cohorts of each specific year in those lengths. Usually this process had to be performed each year in only about 3 lengths.

3. Results

3.1. Catch distribution

High catch rates ($kg.h^{-1}$) are consistently attributed to the south-western coast at depths ranging from 200 to 400 m deep (Figures 4 and 5). Individuals <15 cm also occur all along the coast with higher frequency in the south-western coast (Figure 6).

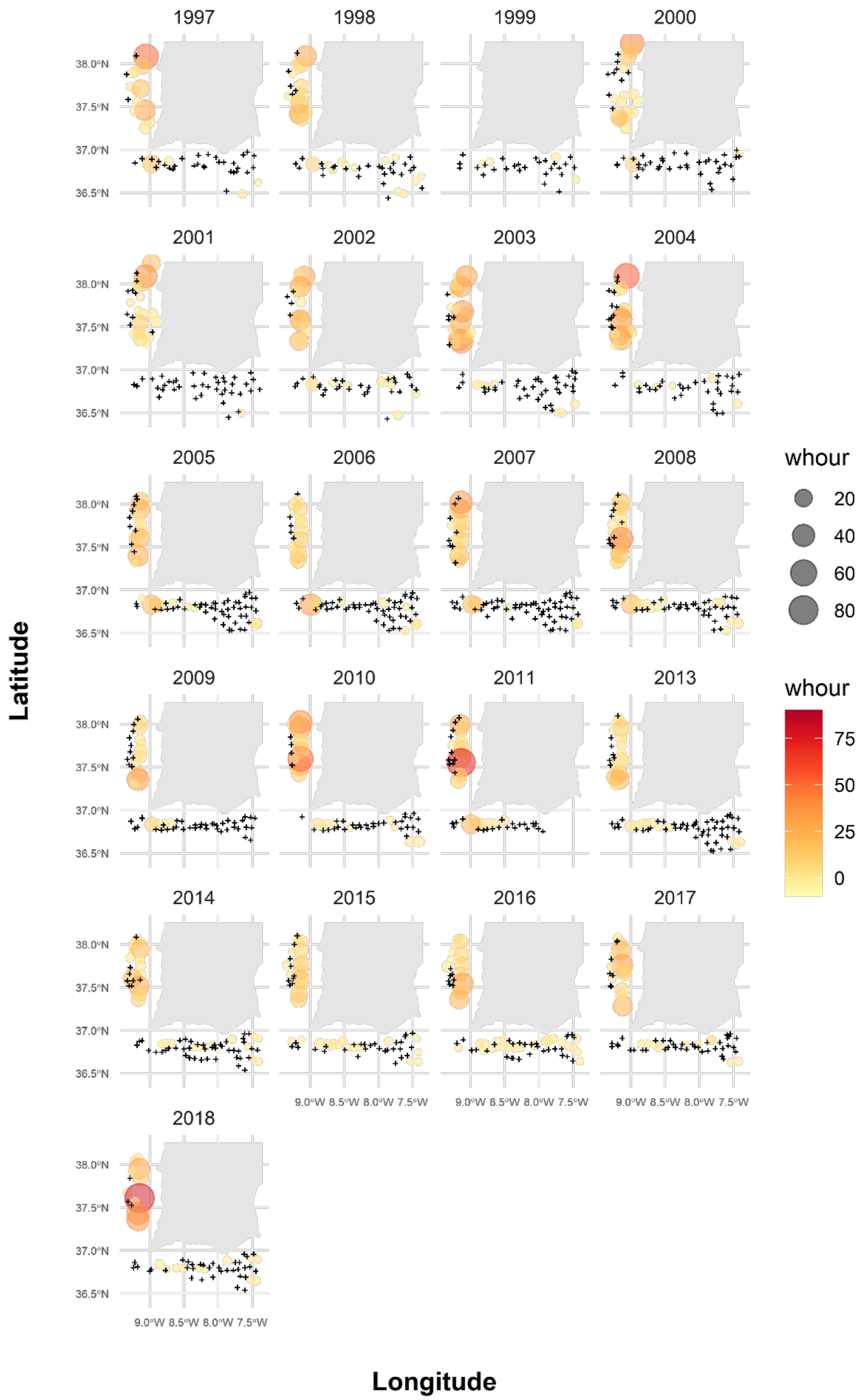

Figure 4. Occurrences and catch distribution (kg.h^{-1}) of *Lepidorhombus boscii* in the PT Crustacean Survey from 1997 to 2018. Surveys were not conducted in 2012, 2019 and 2020. Black crosses represent hauls with zero catch of *L. boscii*.

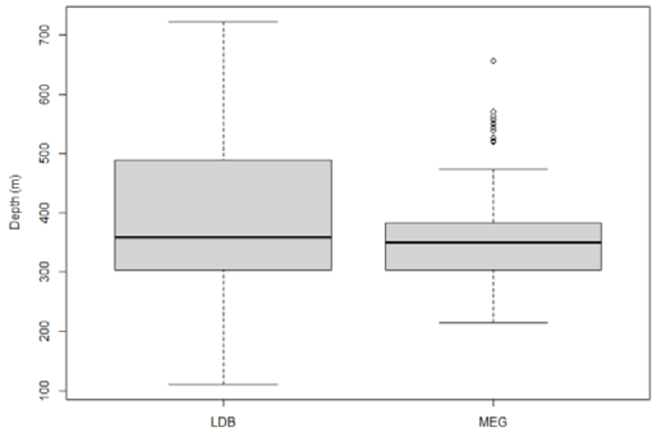

Figure 5. Boxplot of the depth distribution of both *Lepidorhombus boscii* (LDB) and *Lepidorhombus whiffiagonis* (MEG).

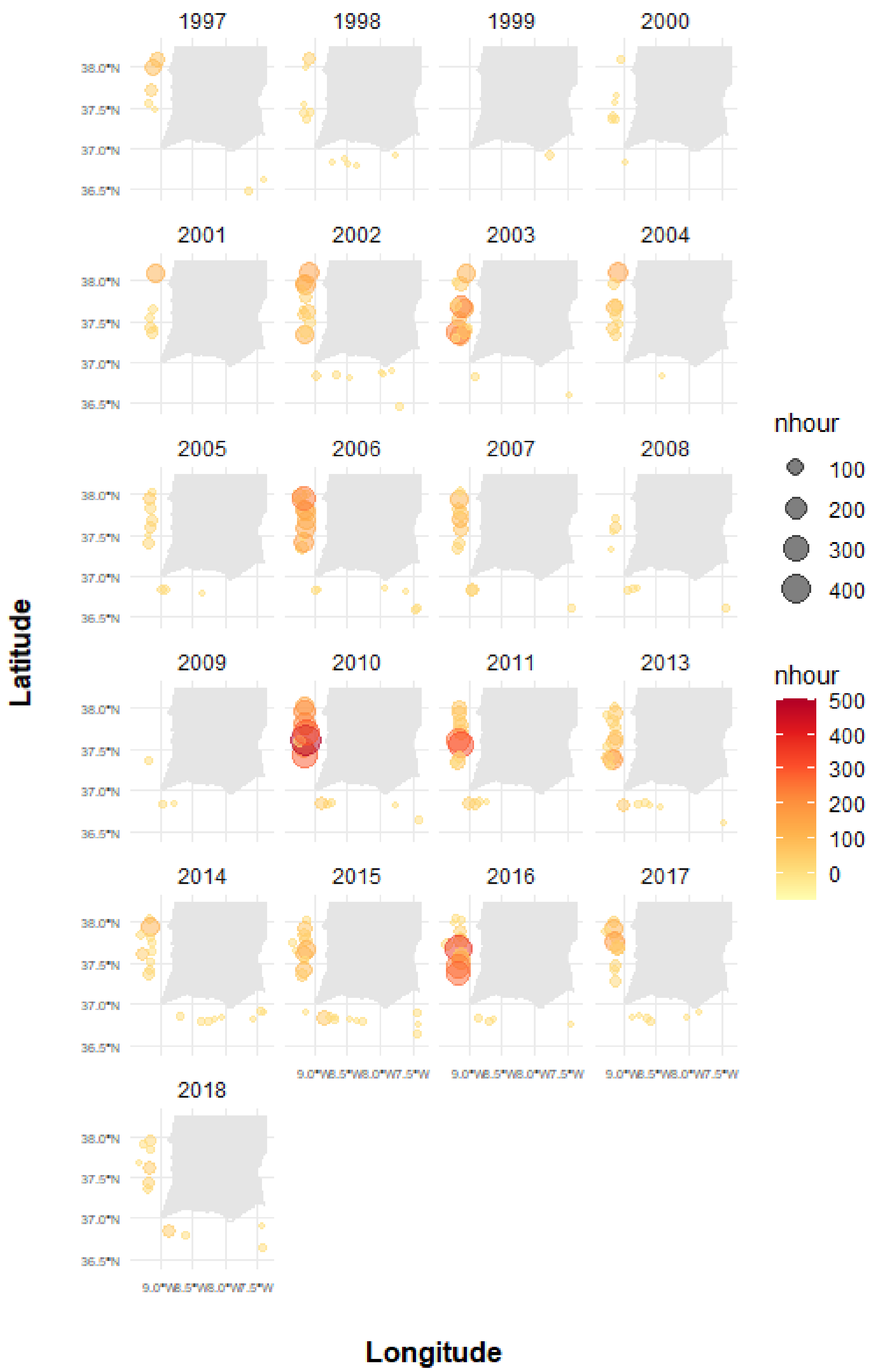

Figure 6. Catch distribution (n.h^{-1}) of *Lepidorhombus boscii* < 15 cm in the PT Crustacean Survey from 1997 to 2018. Surveys were not conducted in 2012, 2019 and 2020.

3.1.1. *Biomass and abundance indices*

Stratified biomass and abundance indices are presented in Table 2 and Figures 7 and 8 for *L. boscii*.

Table 2. Stratified biomass index for *Lepidorhombus boscii* caught in the Portuguese Crustacean survey

	Biomass (kg.h^{-1})		Abundance (n.h^{-1})	
Year	**Index**	**variance**	**Index**	**variance**
1997	4.04	3.19	41.77	251.67
1998	2.62	0.28	28.05	72.57
1999	---	---	---	---
2000	1.15	0.11	11.10	11.72
2001	1.35	0.14	14.22	13.01
2002	2.63	0.30	38.90	43.23
2003	3.71	0.34	60.82	98.16
2004	2.79	0.35	42.59	90.21
2005	2.62	0.41	31.72	71.08
2006	1.82	0.07	32.81	35.01
2007	3.08	0.37	46.74	69.87
2008	3.08	0.25	32.86	34.41
2009	1.77	0.16	14.68	14.68
2010	4.91	0.93	80.59	360.69
2011	4.24	0.89	65.44	182.87
2013	2.37	0.47	36.91	96.36
2014	2.15	0.44	32.40	123.72
2015	2.22	0.06	37.35	32.35
2016	2.65	0.10	53.47	19.96
2017	2.82	0.67	54.03	215.08
2018	8.98	22.83	146.28	6409.79

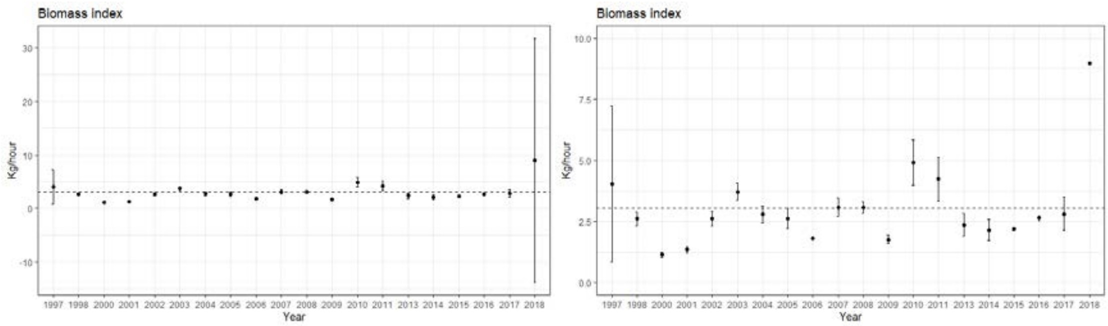

Figure 7. Biomass index (kg.h^{-1}) for *Lepidorhombus boscii* in the PT Crustacean survey (1997-2018; no data for 1999, 2012, 2019 and 2020). Right plot is similar to the left one but excluding the error bar in 2018.

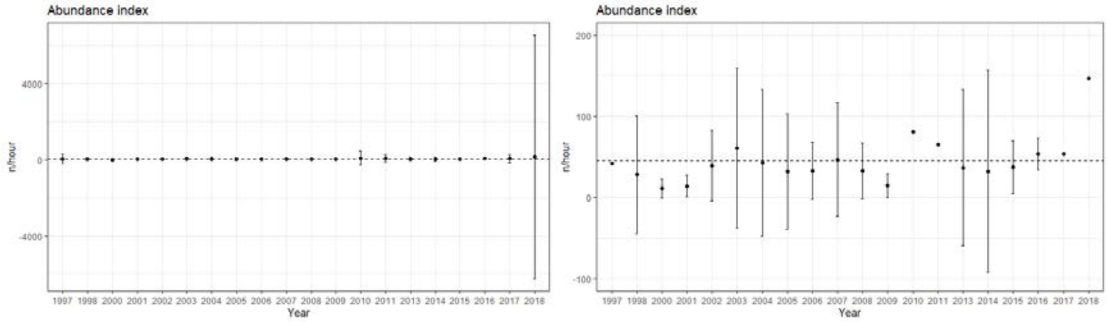

Figure 8. Abundance index (n.h^{-1}) for *Lepidorhombus boscii* in the PT Crustacean survey (1997-2018; no data for 1999, 2012, 2019 and 2020). Right plot is similar to the left one but excluding the error bars in 1997, 2010, 2011 and 2018.

3.1.2. Length composition

Stratified mean length is presented in Figure 9, by year.

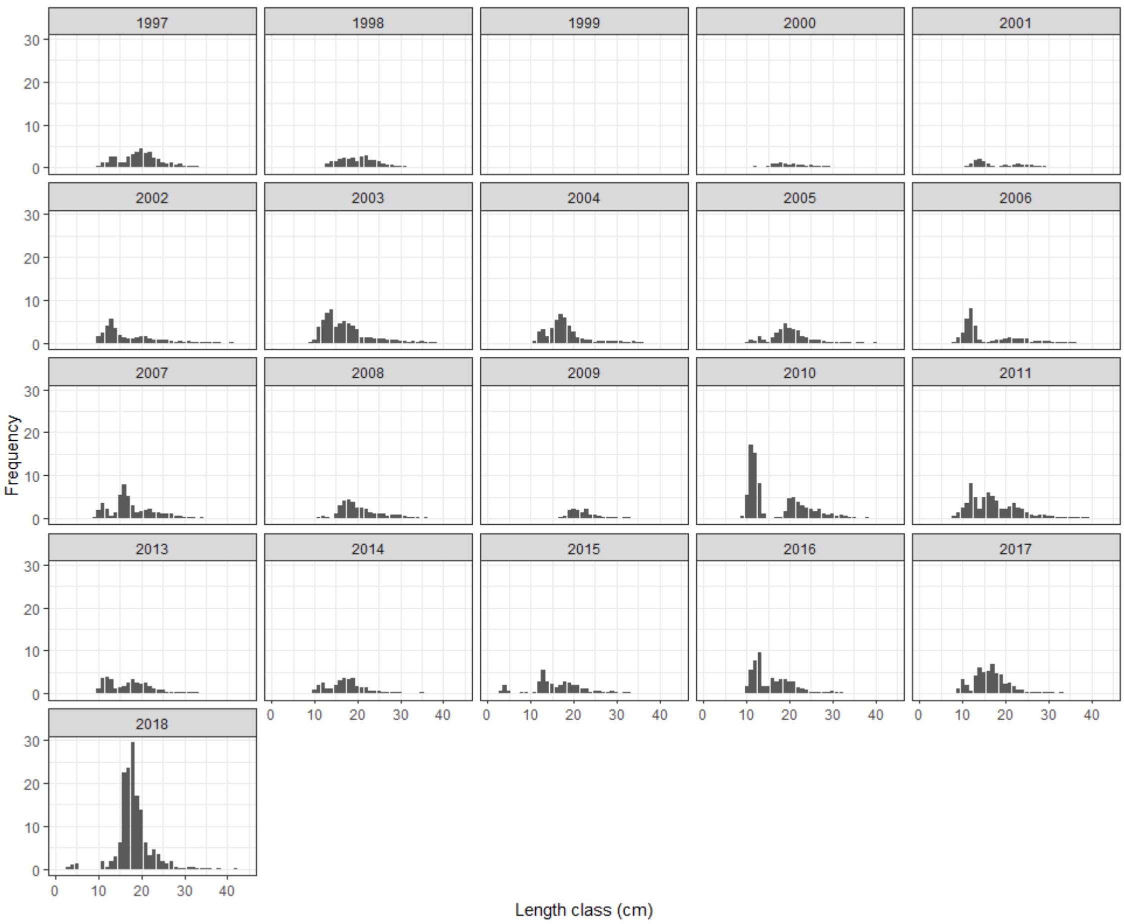

Figure 9. Length frequency distribution of *Lepidorhombus boscii* in the PT Crustacean Survey (1997-2018).

3.1.3. Age-length keys

A matrix of abundance indices at Age and year (AaA) was obtained (Table 3) after applying the age-length-key obtained from direct age estimation in each Spanish bottom survey (1997–2018) to their respective length distribution from the Portuguese crustacean surveys

The ALKs from SP-WIBTS-Q4 come from September-October, while the LDs from the Portuguese crustacean surveys were performed annually three months before (June-July). That means that the growth applied to the Portuguese LDs is slightly biased, slightly overestimating the mean lengths at age thus obtained. However, when this procedure is applied to the whole time series, all the years are similarly biased and distinguishing trends in cohort dynamics is not seriously influenced.

The mean age composition of the time series in the AaA matrix indicates that ages 1, 2 and 3 are the mainly captured in these surveys (78%) (Table 3). The range up to 4 years constitutes 90% of the catch, and up to age 6 it represents 97% of it. Specimens <8 cm are not usually collected in these crustacean surveys (there are only any individuals <8 cm in some recent years of the time series) and in several years there are no specimens <12 cm. So those Portuguese crustacean surveys are not representative for estimating age class 0, and age class 1 is therefore the best indicator of cohort strength in those surveys. Thus the main range of ages (1-8) well represented in the AaA matrix is shown between lines in Table 3.

Two years of the time series could not be taken into account: 2012 without survey information, and 1999 due to the very low representation of individuals in the LD (only individuals in 6 length ranges, between 12 and 25 cm).

A high variability is also observed in the abundance indices between the years of the Portuguese crustacean surveys, with extremely low values in 2000, 2001 and 2009 and extremely high values in 2010, 2011 and 2018 (Table 3). These extreme years are not due to the emergence of an extreme recruitment, since the frequency values increase in all lengths in the LD and logically in all age classes (Table 3). It seems rather that it is due to a "year effect" probably caused to an extremely higher or lower catchability in those aforementioned years.

Several cohorts of *L. boscii* can be preliminary tracked in the first ages in the AaA matrix, from age 1 and, in several of them, up to age 8, although they are really well tracked in the most abundant age classes (1 to 4) (Table 3, Figure 10).

To analyze in more detail, the cohort tracking avoiding that bias due to the "year effect", the AaA matrix (in % for each surveys) was estimated, so that the annual indices were comparable (Table 4). Thus, in addition to those abundant cohorts (2002,2003,2005, 2006,2009,2014,2015) which are more clearly detectable in Table 4 and Figure 11, other scarce cohorts can also be observed (1998, 1999, 2007, 2008), which were not so clearly observable in Table 3.

As in any other species, it is more appropriate to apply ALKs from age estimates of L. boscii collected in the same surveys, than ALKs from another area or stock. However, one of the most remarkable results presented here can be considered that despite that, applying the estimates of the northern (Spanish) area of the stock, it is possible to analyze and obtain a preliminary view of the cohort dynamics of this southern (Portuguese) area of the stock.

Table 3. Abundance at age matrix (in number) of *L.boscii* after applying the age-length-key obtained from direct age estimation in each Spanish bottom survey (1997–2018) to their respective length distribution from the Portuguese crustacean surveys. The mean value and % of the abundance of each age group is showed on the right. The main range of ages (1-8) well represented in the catch-at-age matrix is shown between lines. Diagonal lines encompass clear some strong cohorts.

			NA (only 8 ind.)													NA									
Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	mean	%	% aggregated
0	0	0		0	0	0	0	0	0	0	0	0	0	0	0		0	0	3	0	0	3	0	1	1
1	5	2		1	6	17	31	14	4	20	12	2	0	45	22		13	7	12	22	12	2	12	28	29
2	13	6		2	2	7	13	18	12	4	22	13	2	8	21		8	12	8	19	17	42	13	28	57
3	15	10		2	1	4	9	6	9	4	6	10	5	10	9		8	6	7	6	18	52	10	22	79
4	2	6		2	1	1	3	2	3	2	4	3	5	9	6		5	2	3	2	3	37	5	11	90
5	3	1		1	1	1	1	1	1	1	1	1	1	4	3		1	3	1	1	1	5	2	4	94
6	2	2		1	1	1	1	0	0	1	1	2	1	1	1		1	1	1	1	1	3	1	3	97
7	1	1		1	0	1	1	1	0	0	1	1	0	2	1		1	0	0	1	1	0	1	1	98
8	0	0		0	0	1	1	0	0	0	0	0	0	1	1		0	0	0	0	0	1	0	1	99
9	0	0		0	0	1	1	0	0	0	0	0	0	1	1		0	0	0	0	0	1	0	1	100
10	0	0		0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	100
11	0	0		0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	100
12	0	0		0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	100
Total	42	28		11	14	33	61	43	32	33	47	33	15	80	65		37	32	37	53	54	146	45	100	

Table 4. Abundance at age matrix (in % for each year) of *L.boscii* after applying the age-length-key obtained from direct age estimation in each Spanish bottom survey (1997–2018) to their respective length distribution from the Portuguese crustacean surveys. Solid diagonal green lines encompass clear strong cohorts and diagonal red lines encompass clear weak ones.

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
0	0	0		0	0	0	0	0	0	0	0	0	0	0	0		0	0	9	0	0	2
1	12	6		12	43	52	50	32	13	62	26	5	1	56	34		36	23	31	41	23	1
2	30	22		20	17	22	21	43	39	13	46	41	13	10	32		21	38	23	36	32	29
3	36	37		21	9	12	15	15	29	12	13	30	33	13	14		23	18	20	12	33	35
4	5	20		18	10	4	5	4	10	5	8	10	31	11	10		13	8	8	4	6	26
5	7	4		10	8	2	2	2	4	2	3	4	10	5	5		3	8	4	3	3	4
6	6	7		6	6	2	2	1	1	2	2	5	4	2	2		2	2	3	2	1	2
7	2	2		5	3	2	1	2	1	1	1	3	3	2	1		2	1	1	1	1	0
8	1	1		4	2	2	1	0	1	1	0	1	2	1	1		1	1	1	1	1	0
9	0	1		2	1	2	1	0	0	1	0	0	1	1	1		0	0	0	0	0	0
10	0	0		1	0	0	0	0	1	0	0	0	0	0	0		0	0	0	0	0	0
11	0	0		1	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0
12	0	0		0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0
Total	100	100		100	100	100	100	100	100	100	100	100	100	100	100		100	100	100	100	100	100

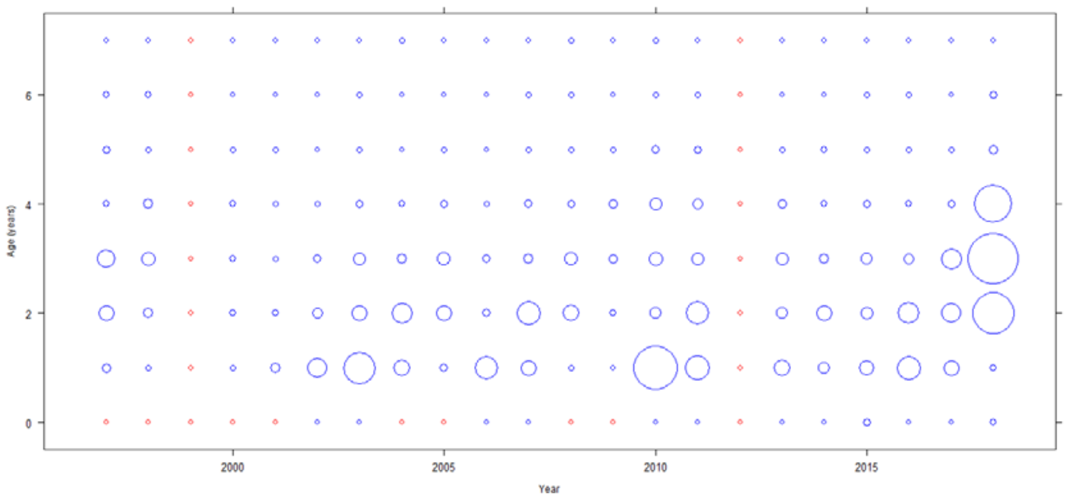

Figure 10. Bubble plots of abundance at age (in number) of *L.boscii* after applying the age-length-key obtained from direct age estimation in each Spanish bottom survey (1997–2018) to their respective length distribution from the Portuguese crustacean surveys. The size of the bubble is proportional to abundance at that year's age.

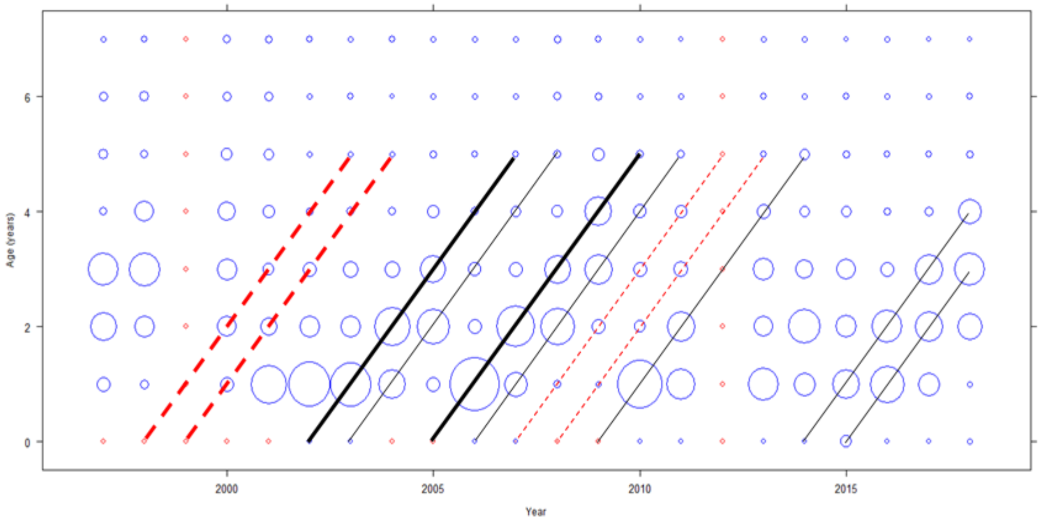

Figure 11. Bubble plots of abundance at age (in % for each year) of *L.boscii* after applying the age-length-key obtained from direct age estimation in each Spanish bottom survey (1997–2018) to their respective length distribution from the Portuguese crustacean surveys. The size of the bubble is proportional to abundance at that year's age. Solid diagonal black lines encompass clear strong cohorts and diagonal red lines encompass clear weak ones

3.1.4. *Biological information*

In general, the crustacean survey catches more males than females and, regardless of the sex, immature specimens (Figure 12). No segregation by depth with maturity stage seems to occur but larger females seem to distribute at deeper depth strata (Figures 13 and 14).

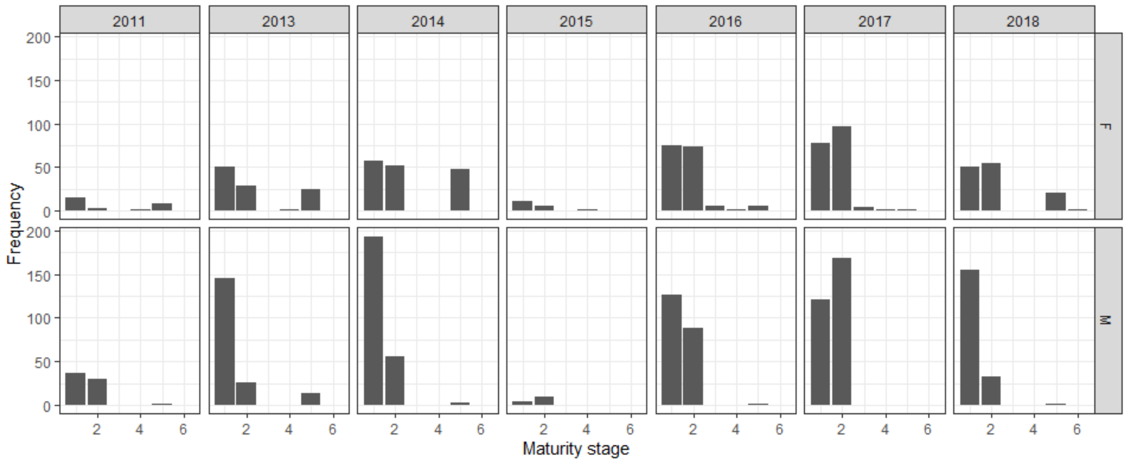

Figure 12. Frequency of males and females by maturity stage and by year in PT Crustacean Survey (2011-2018).

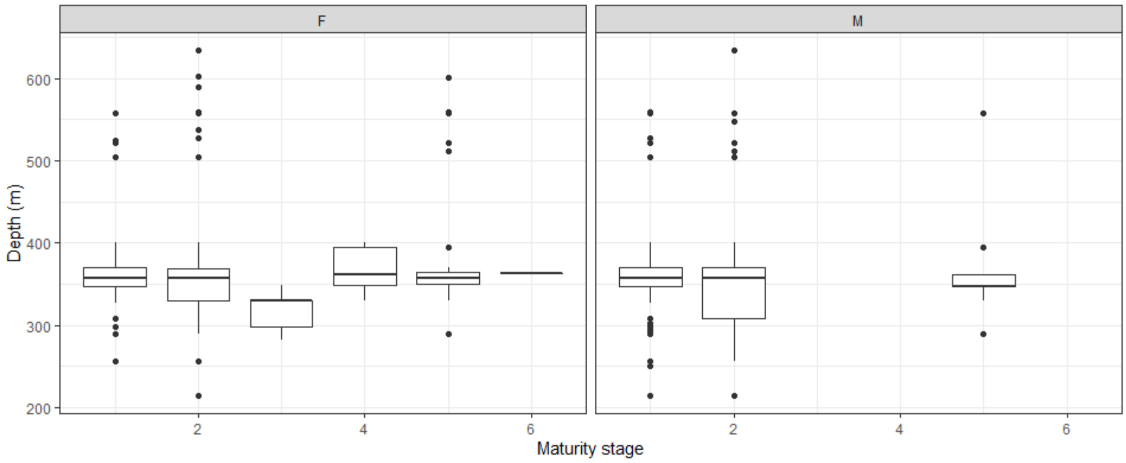

Figure 13. Boxplot of the depth distribution by maturity stage and sex of *Lepidorhombus boscii* in the PT Crustacean Survey (2011-2018).

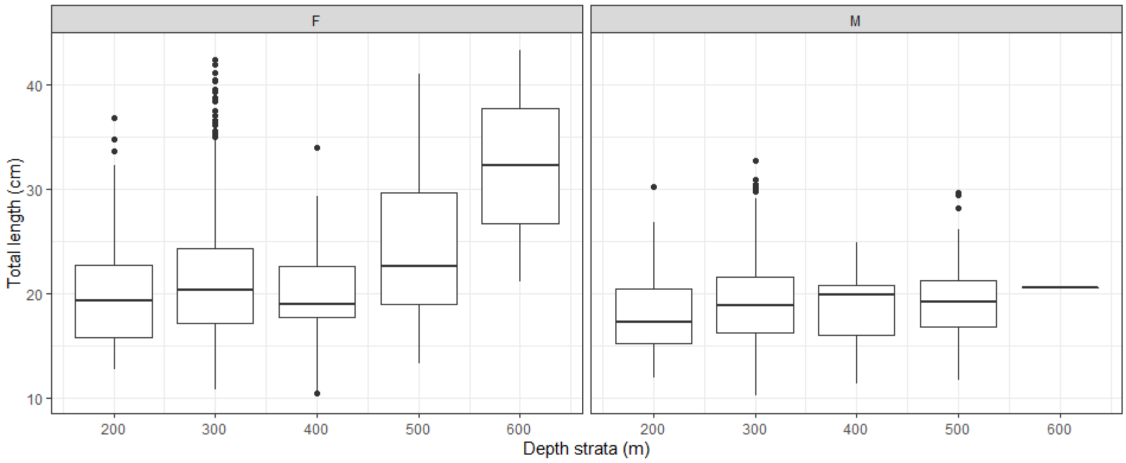

Figure 14. Boxplot of the total length by sex and depth strata of *Lepidorhombus boscii* in the PT Crustacean Survey (2011-2018).

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ANNEX

Portuguese Autumn Groundfish Survey

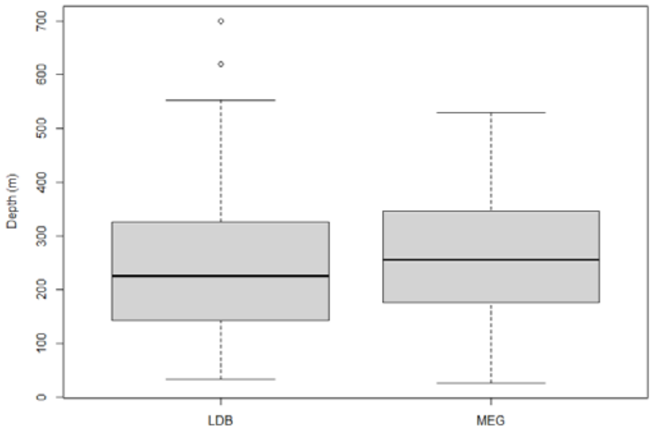

Figure A1. Boxplot of the depth distribution of both *Lepidorhombus boscii* (LDB) and *Lepidorhombus whiffiagonis* (MEG) in the Portuguese Autumn Groundfish Survey.

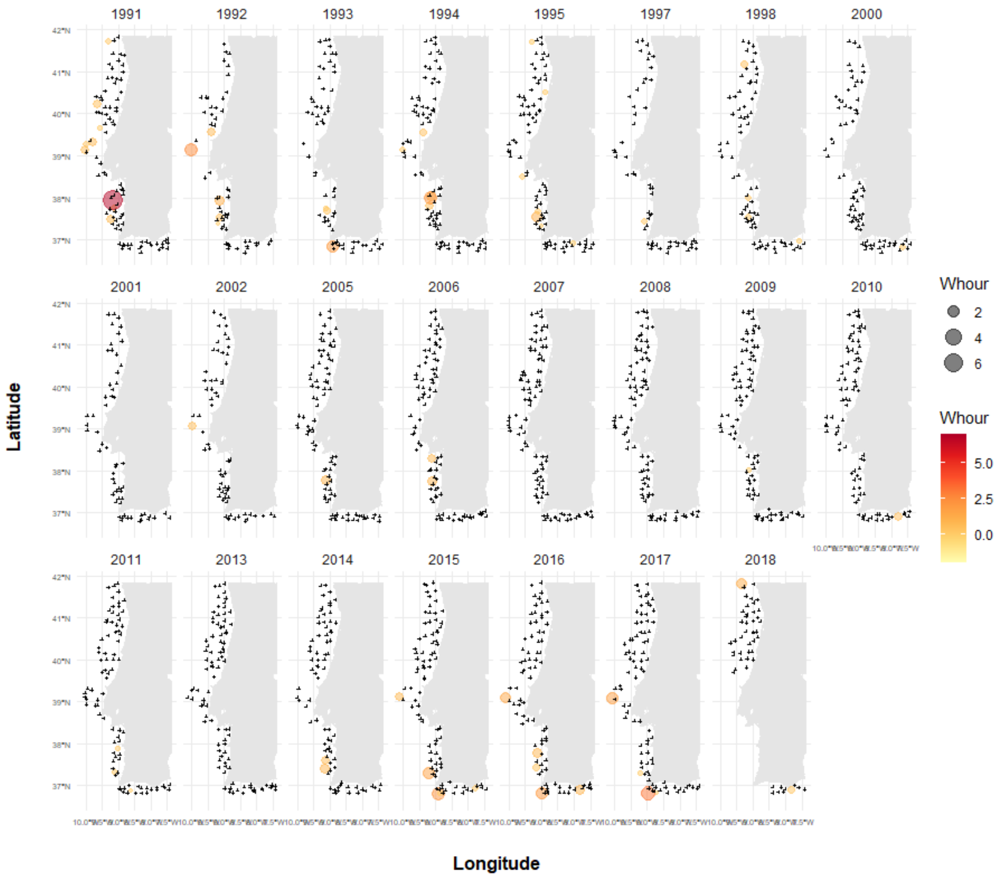

Figure A2. Occurrences and distribution of *Lepidorhombus whiffiagonis* in the Portuguese Autumn Groundfish Survey from 1991 to 2018. Surveys were not conducted in 2012, 2019 and 2020. Black crosses represent hauls with zero catch of *L. whiffiagonis*.

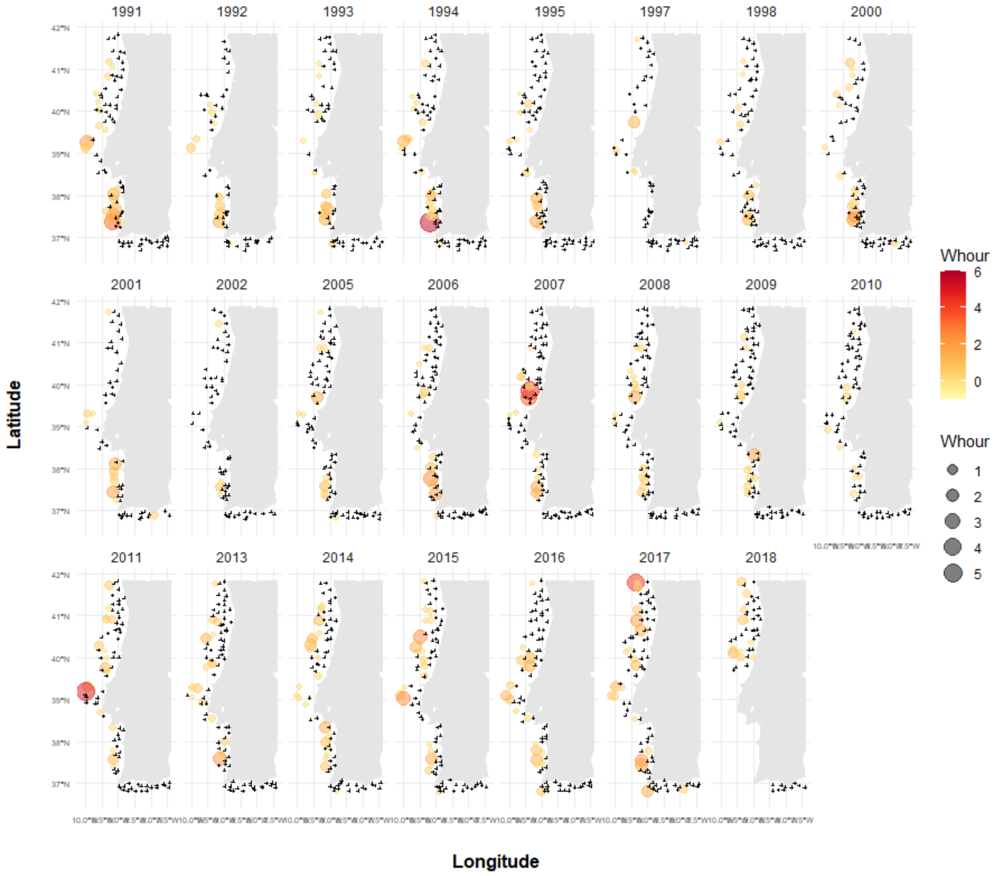

Figure A3. Occurrences and distribution of *Lepidorhombus boscii* in the Portuguese Autumn Groundfish Survey from 1991 to 2018. Surveys were not conducted in 2012, 2019 and 2020. Black crosses represent hauls with zero catch of *L. boscii*.

Portuguese Crustacean Survey

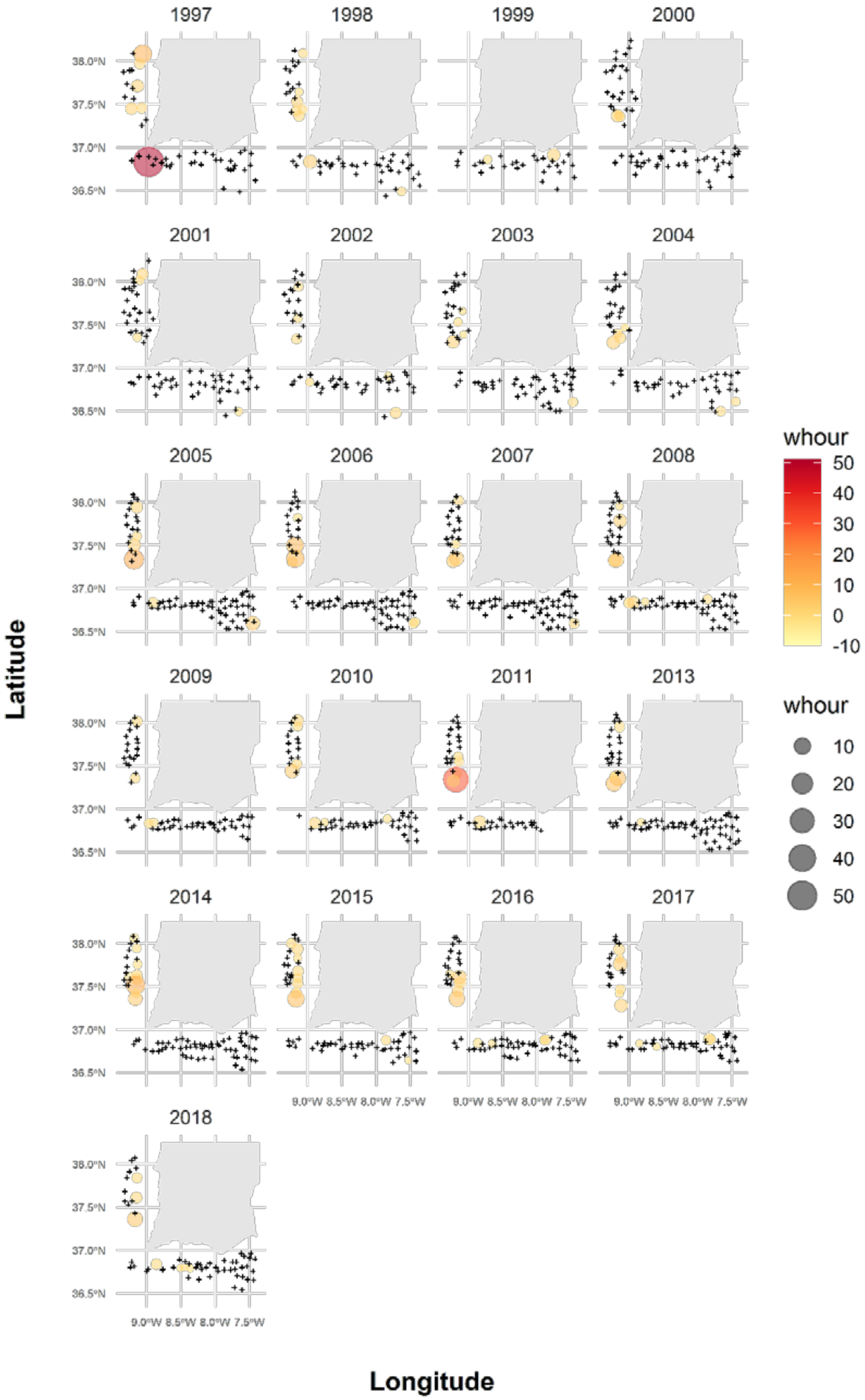

Figure A4. Occurrences and distribution of *Lepidorhombus whiffiagonis* in the PT Crustacean Survey from 1997 to 2018. Surveys were not conducted in 2012, 2019 and 2020. Black crosses represent hauls with zero catch of *L. whiffiagonis*.