icat mar
Institut Català de Recerca per a la Governança del Mar

State of fisheries in Catalonia 2023, Part 1:

Report on the monitoring of the commercial fishing fleet

www.icatmar.cat

Co-funded by the European Union

Generalitat de Catalunya
Departament d'Acció Climàtica, Alimentació i Agenda Rural

CSIC
Consejo Superior de Investigaciones Científicas

ICM Institut de Ciències del Mar

This report presents the state of fisheries in Catalonia in 2023. Section 1 describes the methods of biological and fisheries monitoring throughout the five years of icatmar monitoring program, Section 2 describes the results of the bottom trawling monitoring, Section 3 describes the results of the purse seine fishing monitoring and Section 4 describes the results of the small-scale fisheries monitoring (sand eel, common octopus and blue crab fisheries).

Scientific team: Pere Abelló, Marc Balcells, Marta Blanco (Coord.), Ferran Bustos, Marta Carreton, Joan B. Company, Eve Galimany, Mariona Garriga-Panisello, Mireia G. Mingote, Antoni Lombarte, Cristina López-Pérez, David Nos, Patricia Poch, Xènia Puigcerver-Segarra, Marta Pujol-Baucells, Laura Recasens, Jordi Ribera, Alberto J. Rico, Alba Rojas, Ana Sabatés, Joan Sala-Coromina, Pilar Sánchez, Ricardo Santos-Bethencourt, Mireia Silvestre, Roger Villanueva, Laia Viure.

Collaboration:
Oscar Escolar, Verónica López

How to cite this document
Institut Català de Recerca per a la Governança del Mar (ICATMAR). State of fisheries in Catalonia 2023, Part 1: report on the monitoring of the commercial fishing fleet (ICATMAR, 24-05) 219 pp, Barcelona. DOI: 10.20350/digitalCSIC/16493

Image credits:

Front page, section 2, section 3, section 4, references and annexes (Mireia G. Mingote)
Section 1 (Ricardo Santos)

Table of contents

Figures

Tables

Annexes

Glossary

CL: Cephalohtorax Length
CPUE: Catch Per Unit Effort
CW: Carapace width
GFCM: General Fisheries Commission for the Mediterranean
GSA: Geographical Sub-Area
GSI: Gonadosomatic index
GT: Gross Tonnage
HSI: Hepatosomatic index
LF: Length Frequency
LPUE: Landing Per Unit Effort
MAP: Multi-Annual Plan
MCRS: Minimum Conservation Reference Size
MCRW: Minimum Conservation Reference Weight
MÉTIER: Group of fishing operations targeting a specific assemblage of species
ML: Mantle Length
OTB: Bottom Otter Trawl
PS: Purse Seine
STECF: Technical and Economic Committee for Fisheries
TL: Total Length
VL: Vessel Length
VMS: Vessel Monitoring System
WF: Weight Frequency
WMS: Geoserver a Web Map Service

Executive summary

This report presents the state of fisheries in Catalonia in 2023. Section 1 describes the methods of biological and fisheries monitoring over the five years of the ICATMAR monitoring program, Section 2 describes the results of the bottom trawl fishery monitoring, Section 3 describes the results of the purse seine fishery monitoring and Section 4 describes the results of the small-scale fisheries monitoring (sandeel, common octopus and blue crab fisheries).

Section 1: Introduction and methods of biological and fishery monitoring

Sampling procedures varied according to the species studied and the fishing gear used. This section explains the methodology used for each gear sampled (bottom trawl, purse seine and small-scale fisheries). Regarding bottom trawling, eight species were monitored, chosen on the basis of their importance in terms of catch and economic value: hake (*Merluccius merluccius*), red mullet (*Mullus barbatus*), Norway lobster (*Nephrops norvegicus*), blue and red shrimp (*Aristeus antennatus*), deep-water rose shrimp (*Parapenaeus longirostris*), horned octopus (*Eledone cirrhosa*), spottail mantis squillid and (*Squilla mantis*) and caramote prawn (*Penaeus kerathurus*). In the purse seine fishing, the two main target species of the fishery were monitored: European sardine (*Sardina pilchardus*) and anchovy (*Engraulis encrasicolus*). And in the case of small-scale fisheries, the species included in co-management plans were monitored: sandeels – including Mediterranean sand eel (*Gymnammodytes cicerelus*), smooth sand eel (*G. semisquamatus*) and transparent goby (*Aphia minuta*) –, common octopus (*Octopus vulgaris*) and blue crab (*Callinectes sapidus*).

Section 2: Bottom trawling

In 2023, a total of 105 bottom trawl sampling hauls were conducted. Of the total catch, 70% was landed, 27% was discarded, 3% was natural debris mass and 1% was marine litter. A total of 478 species were identified in the 2023 samples: 141 of them belonging to the landed fraction and 337 to the discarded fraction (some species occur in both fractions).

Within the commercial fraction in 2023, each *métier* had a different composition, with *Sphyraena sphyraena*, *Merluccius merluccius*, *Pagellus erythrinus, Trachurus trachurus, Phycis blennoides* and *Aristeus antennatus* being the most abundant species in the coastal Delta shelf, continental shelf, middle Delta shelf, coastal shelf, deeper shelf, upper slope and lower slope, respectively. For the discarded fraction, *Pagellus erythrinus* and *Anthozoa sp*. were the most abundant species in the coastal Delta shelf and middle Delta shelf, respectively. In the coastal shelf and deeper shelf, the most abundant discarded species were *Boops boops* and *Scyliorhinus canicula,* respectively. In the upper slope the most abundant discarded species was *Scyliorhinus canicula,* while *Galeus melastomus* was the most abundant in the lower slope. In terms of natural debris, the most abundant element was marine organic debris at all *métiers* but the upper slope, where the most abundant element were shells. For the marine litter fraction, the main identifiable category at all *métiers* was plastic, although "Other waste" predominated in the middle Delta shelf and the upper and lower slopes.

For each of the eight commercial species monitored, distribution maps, length-weight relationship parameters, length at first maturity (L50) models, length frequency distributions *métier* and gonadal cycle and a table with the number of measured individuals for the previous period sampled (2019-2022) and for 2023 are presented.

Data on catch composition for the bottom trawl fishery are shown by port for each of the nine ports sampled from north to south: Roses, Palamós, Blanes, Arenys de Mar, Barcelona, Vilanova i la Geltrú, Tarragona, L'Ametlla de Mar and La Ràpita.

Section 3: Purse seine fishing

A total of 70 purse seine samplings were carried out in 2023, of which 45 were fish market samplings and 25 were on-board samplings. The catch composition of the on-board sampling in 2023 was 90% target species (either European sardine or anchovy), 3% other commercial species and 7% discards.

For each of the purse seine fishery target species – European sardine (*Sardina pilchardus*) and anchovy (*Engraulis encrasicolus*) –, spatial distribution maps, length-weight relationship parameters, length at first maturity (L50) models, gonadal cycles, mesenteric fat content cycle, length frequency distributions and a table with the number of measured individuals for the previous period sampled (2019-2022) and for 2023 are presented.

Section 4: Small-scale fisheries

The monitoring of small-scale fisheries includes the sandeel fishery – including Mediterranean sandeel (*Gymnammodytes cicerelus*), smooth sandeel (*Gymnammodytes semisquamatus*), and transparent goby (*Aphia minuta*) –, the common octopus (*Octopus vulgaris*) fishery and the blue crab (*Callinectes sapidus*) fishery. The sand eel fishery is the subject of a co-management plan since 2014, the common octopus fishery is co-managed in two different areas of the territory (Central Catalonia and the Ebre Delta) and the blue crab fishery is also co-managed in the Ebre Delta area.

SECTION 1
Introduction and methods

Biological and fishery monitoring

Introduction

The Mediterranean Sea is an area with long-established oceanographic and fishing traditions. The exploitation of marine living resources started thousands of years ago becoming an area of observations and descriptions in which fishing has always been of main importance (Margalef, 1989). Within the Mediterranean Sea, fisheries activities are deeply rooted in the Catalan culture and have historically been the main source of income and identity for its coastal communities. However, to ensure future provision of marine resources, there's a need to develop science-based management strategies and implement monitoring programs. For this purpose, the Catalan Research Institute for the Governance of the Sea (ICATMAR; https://icatmar.cat/) was created in Catalonia in 2018 as a cooperation body between the General Directorate of Fisheries and Maritime Affairs and the Institute of Marine Sciences (ICM-CSIC). Its aim is to develop the program of the Maritime Strategy of Catalonia, which bases the governance of the maritime policies of the territory on scientific data, long-term monitoring, and the model of co-management.

Method

Based on their importance in terms of catch and economic value, the target species of the biological sampling are hake (*Merluccius merluccius*), red mullet (*Mullus barbatus*), Norway lobster (*Nephrops norvegicus*), blue and red shrimp (*Aristeus antennatus*), deep-water rose shrimp (*Parapenaeus longirostris*), horned octopus (*Eledone cirrhosa*), spottail mantis squillid (*Squilla mantis*), caramote prawn (*Penaeus kerathurus*), common octopus (*Octopus vulgaris*), European sardine (*Sardina pilchardus*), anchovy (*Engraulis encrasicolus*), sandeels – including Mediterranean sandeel (*Gymnammodytes cicerelus*), smooth sandeel (*G. semisquamatus*) and transparent goby (*Aphia minuta*) – and blue crab (*Callinectes sapidus*).

The sampling procedures varied depending on the species studied and the fishing modality used to catch them. An overview of the total sampling trips in the three fishing modalities during the year 2023 is shown in Figure 1.

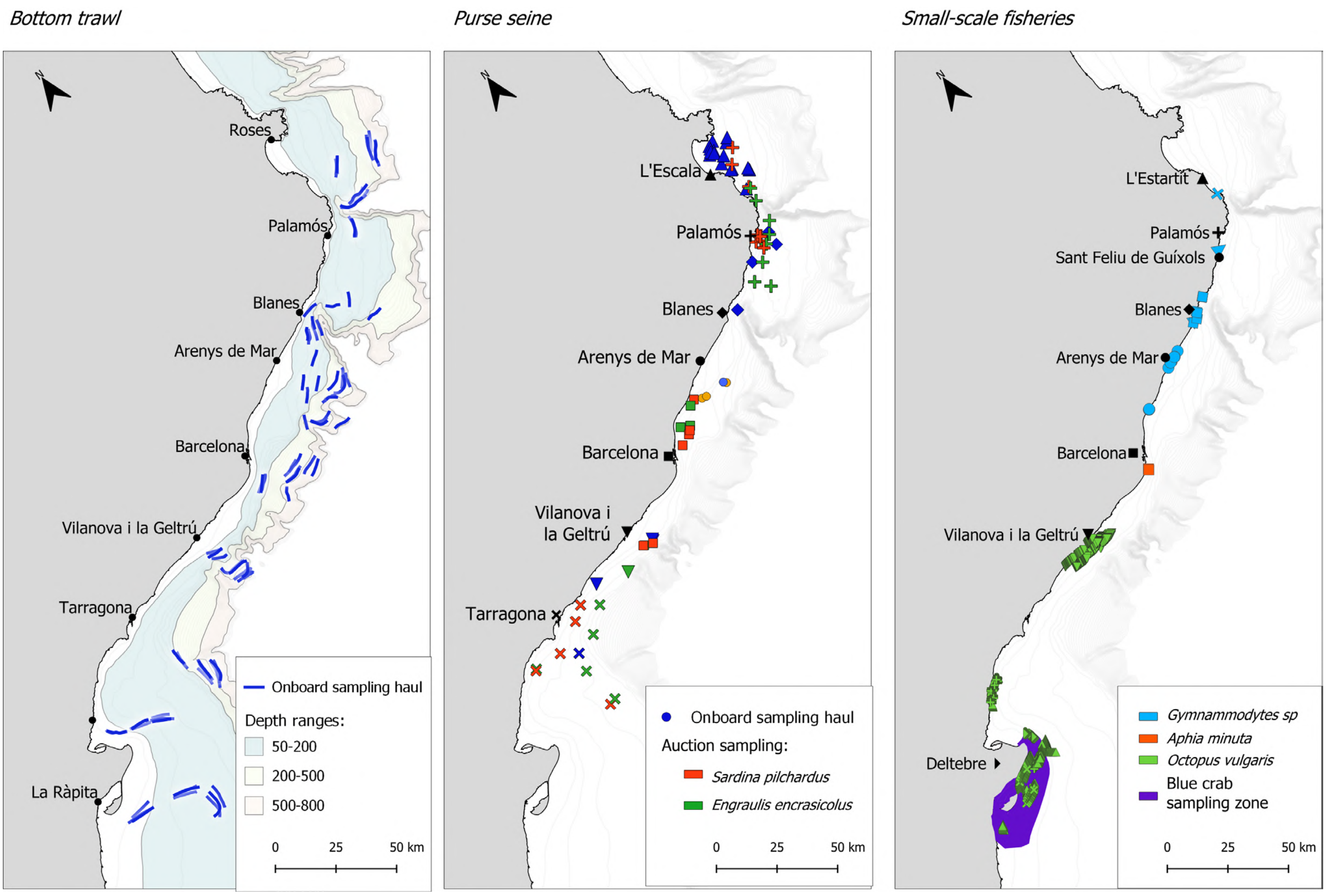


Figure 1. Fisheries monitoring sampling conducted in Catalonia in 2023.

Bottom trawling sampling

For the bottom trawl fishery, sampling was carried out through experimental hauls at different depths in fishing grounds defined, for the first time within the report on the monitoring of the commercial fishing fleet published annually, by *métiers*. The underlying reason for this change in approach is to align with the European Common Fisheries Policy, which recognizes the importance of accounting for heterogeneity in fishing practices promoting a *métier*-based sampling as the core of the EU Data Collection Framework.

A *métier* is defined as a group of fishing operations that aim for a similar group of species using similar fishing gear during the same period and/or in the same area and with a similar pattern of exploitation (DCF, Regulation (EC) No 949/2008 and Commission Decision 2010/93 / EU). In the study area, the Catalan continental margin, the daily fishing landings of a vessel correspond to one effective fishing day, as vessels land their catch daily. Therefore, as each sampling haul is allocated to a specific *métier*, the sampled length frequencies can be weighed and extrapolated to the fishing landings by *métier*.

As described in detail in ICATMAR, 22-04, by performing dendograms and cluster analysis using daily landings data from 2002 to 2021, six *métiers,* related to different depths, areas and catch composition, were defined for the Catalan bottom trawling fleet (Figure 2). Based on this *métier* approach, the bathymetric ranges sampled in previous reports on the monitoring of the commercial fishing fleet (ICATMAR 23-07, 22-04) have been assigned to their corresponding *métiers* in the present report. Furthermore, as a result of this categorization, a *métier* that so far was not being sampled, coastal shelf, was identified and included in the monitoring program starting in 2023.

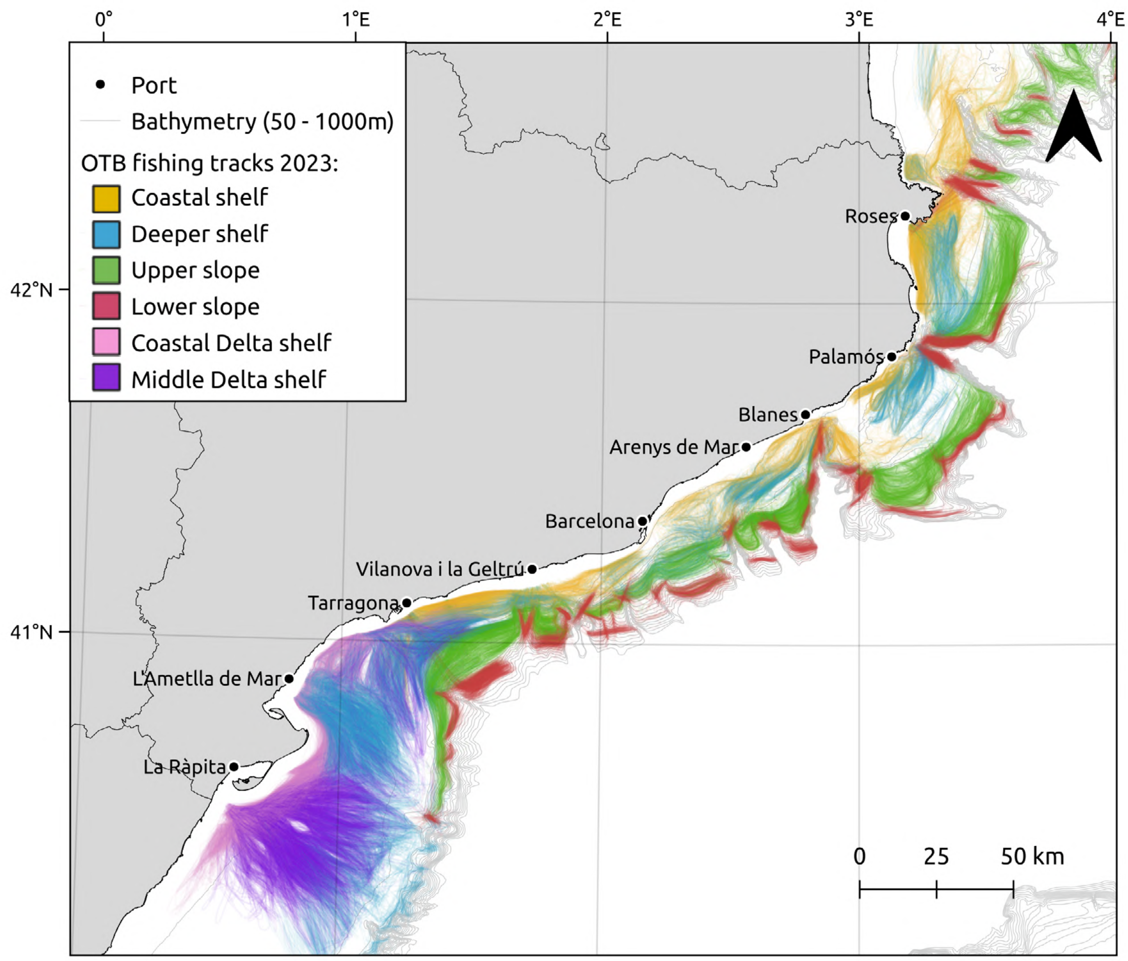


Figure 2. Spatial distribution of the bottom trawl fishery (OTB) tracks. Colors represent the different OTB *métiers* identified for the Catalan trawl fishery.

Sampling was carried out from 9 main commercial ports, with a quarterly frequency per port. The division of the study area in three zones (North, Center and South) is made according to oceanographic features and geomorphological traits occurring in the Catalan sea (Clavel-Henry et al., 2021). The ports of the zones where the sampling took place are:

North zone: Roses, Palamós, Blanes, and Arenys de Mar.

Center zone: Barcelona, Vilanova i la Geltrú and Tarragona.

South zone: L'Ametlla de Mar and La Ràpita.

Each sampling day includes three experimental hauls on board the same vessel, each one at a different depth range corresponding to a specific *métier*. Each haul is GPS-recorded with a start and end point, fishing time and gear width. These measurements allow the calculation of the swept area to standardize species biomass and abundance values. The *métiers* sampled for the North and Center zones and their corresponding most common target species are:

Coastal shelf (51 – 85 m): red mullet. *Métier* sampled for the first time in 2023 and only from the ports of Blanes and Vilanova i la Geltrú.

Deeper shelf (76 – 200 m): hake, horned octopus and deep-water rose shrimp.

Upper slope (201 – 500 m): Norway lobster, hake and deep-water rose shrimp.

Lower slope (501 – 800 m): blue and red shrimp.

However, due to the different geomorphological structure of the Ebre Delta, where commercial fishing activity takes place exclusively on the broad continental shelf, two distinctive shelf *métiers* were defined in the South zone, together with a third one shared with the North and Center zones. The *métiers* sampled for the South zone and their most common corresponding target species are:

Coastal Delta Shelf (21 – 50 m): spottail mantis squillid and red mullet.

Middle Delta shelf (40 – 80 m): spottail mantis squillid and hake.

Deeper shelf (76 – 200 m): spottail mantis squillid and hake.

Average depth for each haul is then estimated by calculating an average point between the start and end points of each haul. Mesh size is 40-mm square for all hauls except in Palamós lower slope, where the co-management measures for the blue and red shrimp fishery require a 50-mm squared mesh. On board, the fishers sort the catch into two categories: commercial, i.e. individuals of commercial species to be sold at the fish market, and discard, which can include individuals of non-commercial species and/or undersized or damaged individuals of commercial species, as well as marine litter and natural debris. Fish, crustacean and cephalopod individuals of the commercial fraction are identified and measured on board (total length, cephalothorax length and mantle length, respectively). For the target species, a subsample of a little over 30 individuals is preserved in coolers to transport to the laboratory. As for the discard fraction, either the total sample or a subsample – depending on the total size of the catch – is preserved in coolers and transported to the laboratory for further analysis. The process is repeated for each of the three hauls.

Debris definition and composition

The samples used to characterize and analyze the debris and its composition, were obtained from the discard fraction gathered during the bottom trawling sampling.

The term debris includes two different types of items. On one side, the non-organic materials caught during fishing operations, also known as marine litter, and, on the other, organic materials with terrestrial and marine origin such as shells, algae and plants. Debris have been classified following REGULATION (EU) 2022/92, ICATMAR, 22-04, and Balcells et al., 2023).

For the analysis and plots of the debris, the categories analyzed were the 10 with the highest weight and representing over 2% of the total catch.

Purse seine fishing sampling

For the purse seine fishery, sampling was done through the acquisition of batches of European sardine and anchovy at the fish market and, since 2022, also through sampling of these two species on board purse seiners. Data gathered during onboard sampling allowed to complete the estimation of the biological parameters and the length-weight relationship of these target species. In addition, it allowed to describe the whole catch composition, including data on by-catch (non-target commercial species) and the discarded fraction, and to estimate the fishing effort of the purse seine fleet along the Catalan coast.

In both types of sampling, the fishing trips were not experimental but strictly planned by the vessel skippers according to their own interests. Furthermore, in neither of the two types was the area of the Ebre Delta sampled as no significant catch of these species lands in ports south of Tarragona and, thus, the purse seine fleet does not usually labor there.

For the acquisition of batches, a standard batch of fish (approximately 10 kg) of each of the target species – when both were available – was bought directly at the sampled port market three times per month. Each of the three monthly batches was purchased in different ports, so that the entire length of the Catalan coast where this type of fishing takes place was covered. One of the batches was purchased in the northern port of Palamós, one in the central port of Barcelona, and one in the southern port of Tarragona. Data on the batch origin (vessel, catch coordinates and total catch) were gathered at the fish market or from the fisher who provided it.

On the other hand, sampling on board purse seiners was carried out twice a month from five main commercial ports: L'Escala, Blanes, Arenys de Mar, Vilanova i la Geltrú and Tarragona. One of the monthly samplings was always carried out in the port of L'Escala, in the north, while the other alternated between ports of the more central area (Blanes or Arenys de Mar) and ports of the southernmost area (Vilanova i la Geltrú or Tarragona).

Once in the laboratory, at the ICM-CSIC, the same protocol was followed in both types of sampling: all the individuals from a subsample of approximately 3 kg from each of the target species – when both were available – were measured to the nearest 0.5 cm and classified by size categories to obtain size frequencies. Then, 30 individuals from each species, distributed by all size categories, were measured and weighed individually, their reproductive state and fat content was assessed and their gonads were weighed. Furthermore, only in the onboard sampling, if by-catch and/or discarded species were present in the samples, they were identified and their individuals measured and weighted.

Small-scale fisheries sampling

Small-scale fisheries sampling includes sandeels, common octopus and blue crab fisheries.

Sandeel fishery sampling

For the sandeel fishery, sampling was carried out on board boat seine ("sonsera") fishing vessels where biological batches were obtained. The fishing trips were not experimental but strictly planned by the vessel skippers according to their own interests. During closure periods, one sampling per month was carried out to check the state of the population before the opening of the fishery.

Sampling for Mediterranean and smooth sandeel was carried out from the ports of l'Estartit, Sant Feliu de Guíxols, Palamós and Blanes, in the northernmost province of Girona, and from the port of Arenys de Mar, in the central province of Barcelona. On the other hand, sampling for the transparent goby was carried out from the ports of Barcelona and Badalona.

Two monthly samplings were conducted where biological batches of 1 kg sandeels (either Mediterranean, smooth sandeel or a mixture of both species) were obtained: one from the port of Arenys de Mar and the other from one of the ports in the province of Girona. Batches were preserved in coolers to transport to the laboratory. When transparent goby was available, two monthly batches of 1 kg were obtained from the ports of Barcelona and Badalona (one from each location).

Once in the laboratory, at the ICM-CSIC, a random subsample of 100-200 individuals was classified by species (either Mediterranean or smooth sandeel), measured to the nearest 0.5 cm, and classified by size categories to obtain size frequencies. Then, 50 individuals, distributed by all size categories, were measured and weighed individually, and, for the ones with a length above 6 cm, their reproductive state was assessed. If discard species were present, they were identified and their individuals measured and weighted. For the transparent goby, the same protocol was followed.

Common octopus fishery sampling

For the common octopus fishery, sampling was carried out on board fishing vessels, using pots and traps as fishing gears, where biological batches were obtained. The fishing trips were not experimental but strictly planned by the vessel skippers according to their own interests.

Sampling was carried out from five main ports, within the two zones that host a co-management plan for the species:

Central Catalonia: Vilanova i la Geltrú.

Ebre Delta: L'Ametlla de Mar, Deltebre, La Ràpita and Les Cases d'Alcanar.

Six monthly samplings were conducted: four from the port of Vilanova i la Geltrú, two with pots and two with traps, and the other two alternating from the port of L'Ametlla de Mar, with traps, and the ports of Deltebre, La Ràpita or Les Cases d'Alcanar, with pots. For every sampling, batches of up to 30 individuals of common octopus – above minimum conservation reference weight (MCRW), established at 1000 g – were obtained and preserved in coolers to transport to the laboratory. If more than 30 individuals were caught, the extra individuals were measured (mantle length), weighted and sexed in situ. All individuals below MCRW were weighed and sexed in situ and released back to the sea. In addition, as of 2023, all captured males weighing more than 2000 g were not transported to the laboratory, more than 95% are considered sexually mature and, therefore, it is not necessary to evaluate their reproductive status.

Once in the laboratory, at the ICM-CSIC, all individuals were measured (mantle length), weighed, sexed and their reproductive status was assessed.

Blue crab fishery sampling

For the blue crab fishery, sampling was exclusively carried out in the Ebre Delta area, where it is an allochthonous species. Samples were collected once a month at the fish market in La Ràpita and data were taken from different vessels, ensuring that all sampling strata were represented for each sampling day. The depth and the approximate location of the catch was provided by the fishers (general fishing grounds or areas).

Between 30 and 50 individuals were sampled on each vessel and the total weight of individuals sampled per vessel was recorded. Prior to sale, samples were analyzed: individuals were measured (carapace length and width), sexed, assessed for maturity (adult or juvenile) and, in females, the presence of eggs and their developmental stage were determined.

Calculations and data analysis

The methods applied in this report for the calculation and analysis of the data were defined in Ribera-Altimir et al. (2023), while the information and data systems used can be found in ICATMAR, 22-04.

For each target species, the annual length frequency (weight frequency in the case of common octopus) by *métier* (bottom trawling), depth strata or area was represented, as well as the size at first maturity (L_{50}), monthly proportion of each maturation stage and monthly average value of gonadosomatic index (GSI). For hake and red mullet, monthly average value of hepatosomatic index (HIS) was also represented. In the case of bottom trawling sampling, the length frequency distribution is only shown for the *métiers* where each species is naturally present. For the first time in this report, the L_{50} shown in the length-frequency distribution figures for the target species is calculated as the mean between the L_{50} values of the previous four years sampled, or those available, and the year analyzed. GSI and L_{50} values in the crustaceans analyzed are only shown for females, since males present stable GSI values throughout the year and the visual identification of immature males was not possible. A table with length-weight relationship parameters is provided for each species, using the relationship $W = a*TL^b$, where W is weight (g) and TL is total length (cm). For crustacean species TL is replaced by CL, i.e., carapace length (mm), and for cephalopod species by ML, i.e., mantle length (cm).

Although the present report is focused on the year 2023, data are in general presented for the years 2019, 2020, 2021, 2022 and 2023. Information on previous years sampled is also available in previous reports (ICATMAR 23-07, 22-04, 21-02, 19-01), but is presented here again in a unified format for clarity and ease of reference.

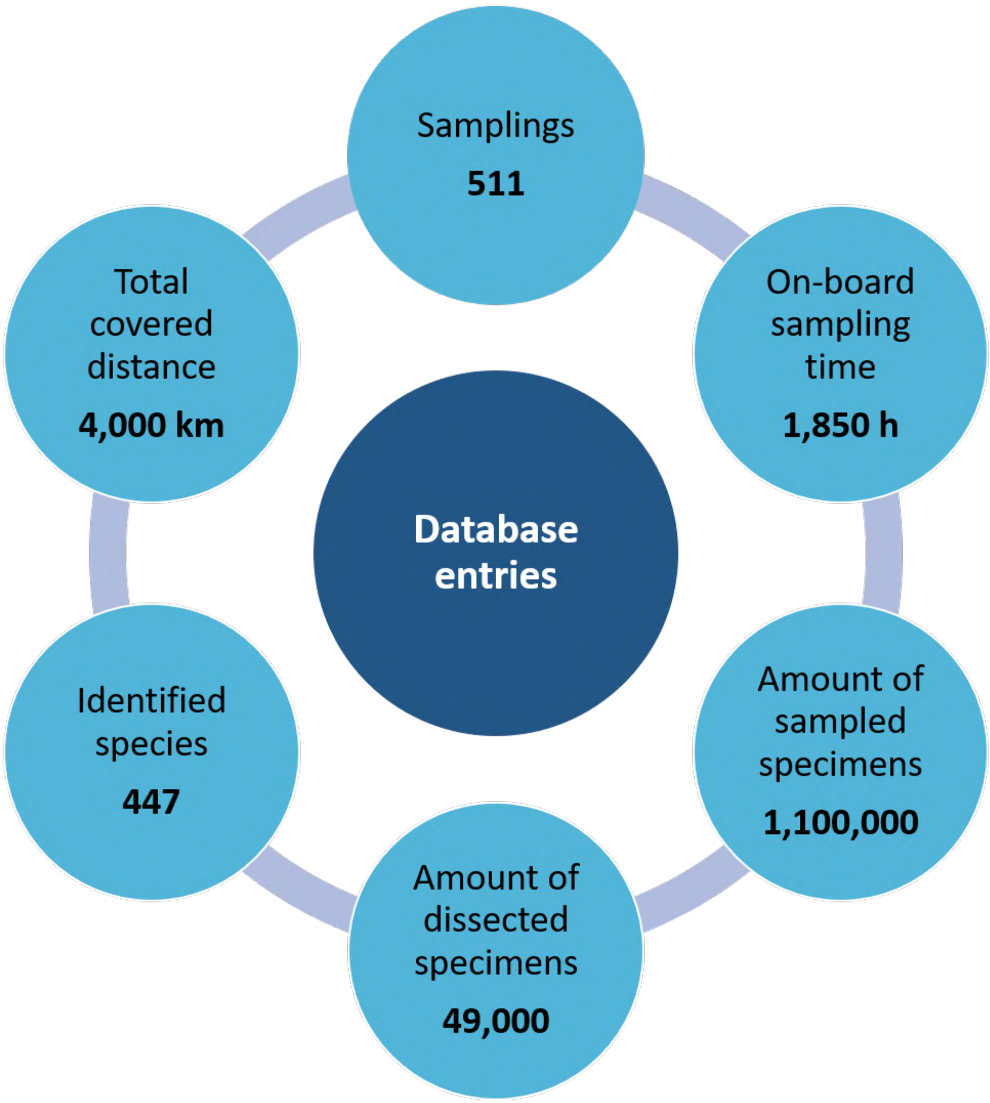


Figure 3. Amount of records of the fishing sampling data stored in the data base from 2019 to 2023.

SECTION 2
Bottom trawling

Fishery monitoring of bottom trawl fishery in Catalonia

Bottom trawl fishery in Catalonia

A total of 105 bottom trawling sampling hauls were carried out in 2023: 7 in the coastal Delta shelf, 7 in the middle Delta shelf, 7 in the coastal shelf, 32 in the deeper shelf, 28 in the upper slope and 24 in the lower slope (Figure 4).

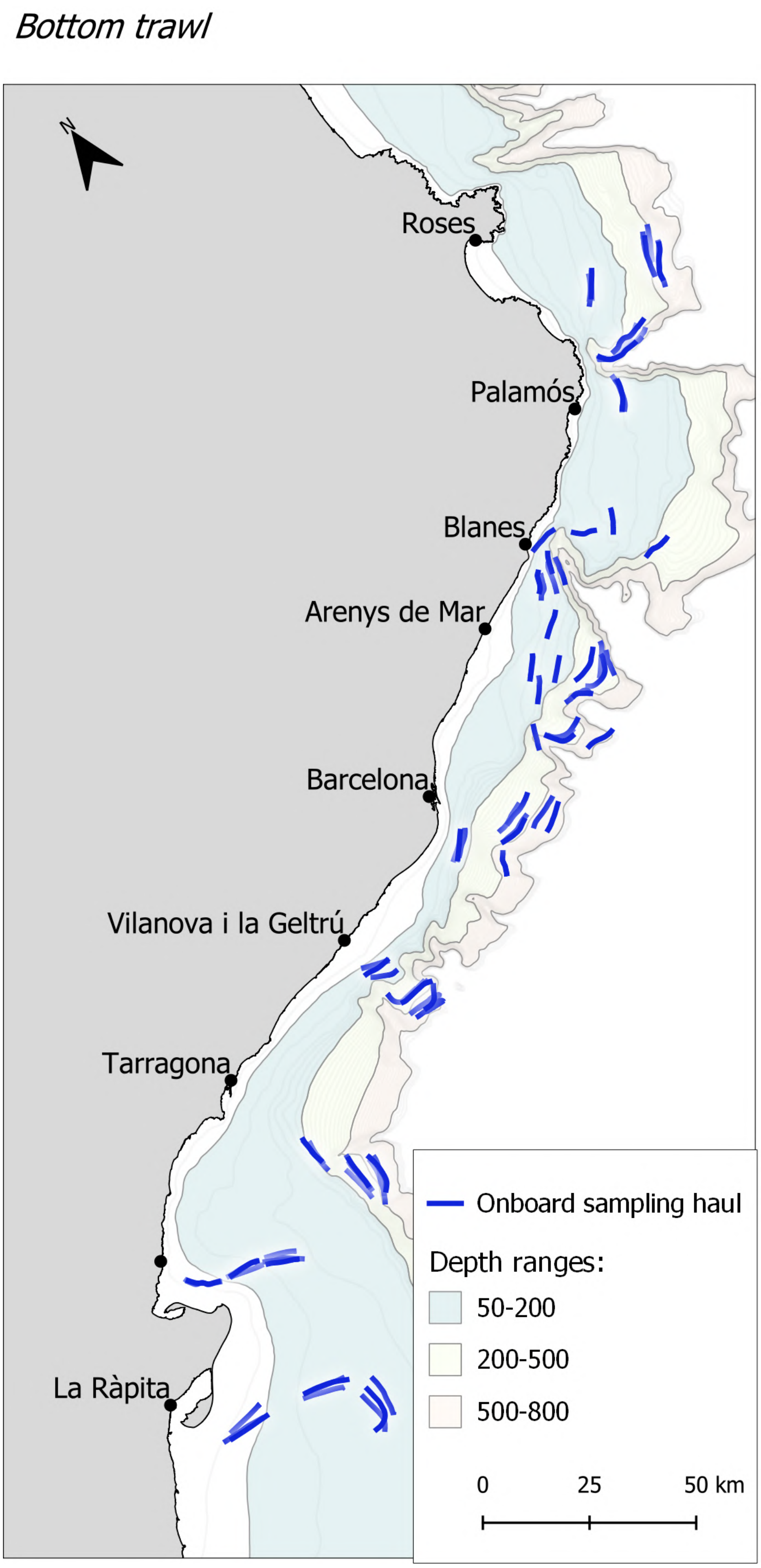


Figure 4. Bottom trawling hauls conducted in Catalonia in the year analyzed.

Table 1. Number of bottom trawling sampling hauls carried out along the zones sampled in each season and *métier*.

Fishery	Year	Zone	Coastal Delta shelf				Middle Delta shelf				Coastal shelf				Deeper shelf				Upper slope				Lower slope			
			W	Sp	Su	A	W	Sp	Su	A	W	Sp	Su	A	W	Sp	Su	A	W	Sp	Su	A	W	Sp	Su	A
Bottom trawl	2019	North													1	7	4	4	1	7	4	4	1	6	4	4
Bottom trawl	2019	Center													3	3	2	4	3	3	2	4	3	3	2	4
Bottom trawl	2019	South	2	2	3	2	2	2	3	2					3	2	3	2	1	0	0	0	1	0	2	1
Bottom trawl	2020	North													3	2	4	4	3	2	4	4	3	2	3	4
Bottom trawl	2020	Center													2	2	3	3	2	2	3	3	2	2	3	3
Bottom trawl	2020	South	1	1	2	2	1	1	2	2					1	1	2	2					1	0	1	1
Bottom trawl	2021	North													4	4	4	4	4	4	4	4	4	4	4	4
Bottom trawl	2021	Center													3	3	3	2	3	3	3	2	3	3	3	2
Bottom trawl	2021	South	2	1	2	2	2	1	2	2					2	1	2	2								
Bottom trawl	2022	North													3	4	4	4	3	4	4	4	3	4	4	4
Bottom trawl	2022	Center													3	2	3	3	3	2	3	3	3	2	3	3
Bottom trawl	2022	South	1	2	2	2	1	2	2	2					1	2	2	2								
Bottom trawl	2023	North									1	1	1	1	4	4	4	4	4	4	4	4	3	3	3	3
Bottom trawl	2023	Center									0	1	1	1	3	2	2	2	3	3	3	3	3	3	3	3
Bottom trawl	2023	South	2	2	2	1	2	2	2	1					2	2	2	1								
Total number of hauls per depth						**36**				**36**				**7**				**166**				**133**				**133**
Total number of hauls in the studied period																										**511**

In the whole sampling period from 2019 to 2023, 511 hauls: 36 in the coastal Delta shelf, 36 in the middle Delta shelf, 7 in the coastal shelf, 166 in the deeper shelf, 133 in the upper slope and 133 in the lower slope (Table 1).

In the period 2019-2022 the mean landed catch was 62% while in 2023 it was 70% (Figure 5). The mean discarded catch was 31% for the period 2019-2022 and 27% in 2023. The mean natural debris mass was 4% for the period 2019-2022 and 3% for 2023. The mean marine litter mass was 2% for the period 2019-2022 and 1% for 2023.

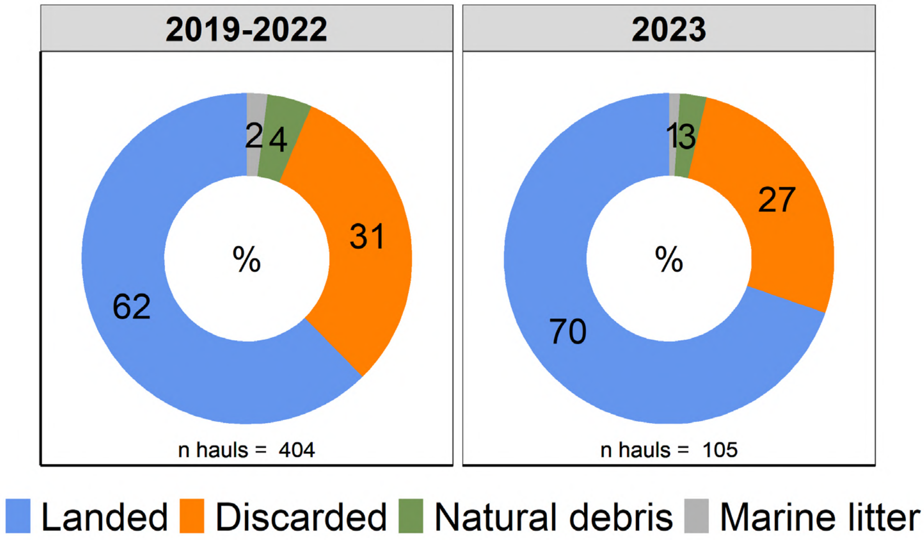


Figure 5. Catch composition in Catalonia. Percentage by weight of landings, discarded, natural debris and marine litter.

The number of species commercialized (without considering discards) was 193 in the period 2019-2022 and 141 in 2023 (Figure 6). At the level of Catalonia, comparing the period 2019-2022 with 2023, the most important species remained relatively constant over the years. However, it is worth noting the rise of *Trachurus trachurus,* reaching 19% of landed species biomass in 2023, and the decline of *Eledone cirrhosa* which does not appear in the top 10 most important commercialized species in 2023. *Aristeus anntenatus,* despite a slight decrease in comparison with the previous period, was the most important crustacean species in 2023. For detailed tables on the landed catch composition see Annex 1, Annex 2, Annex 3 and Annex 4.

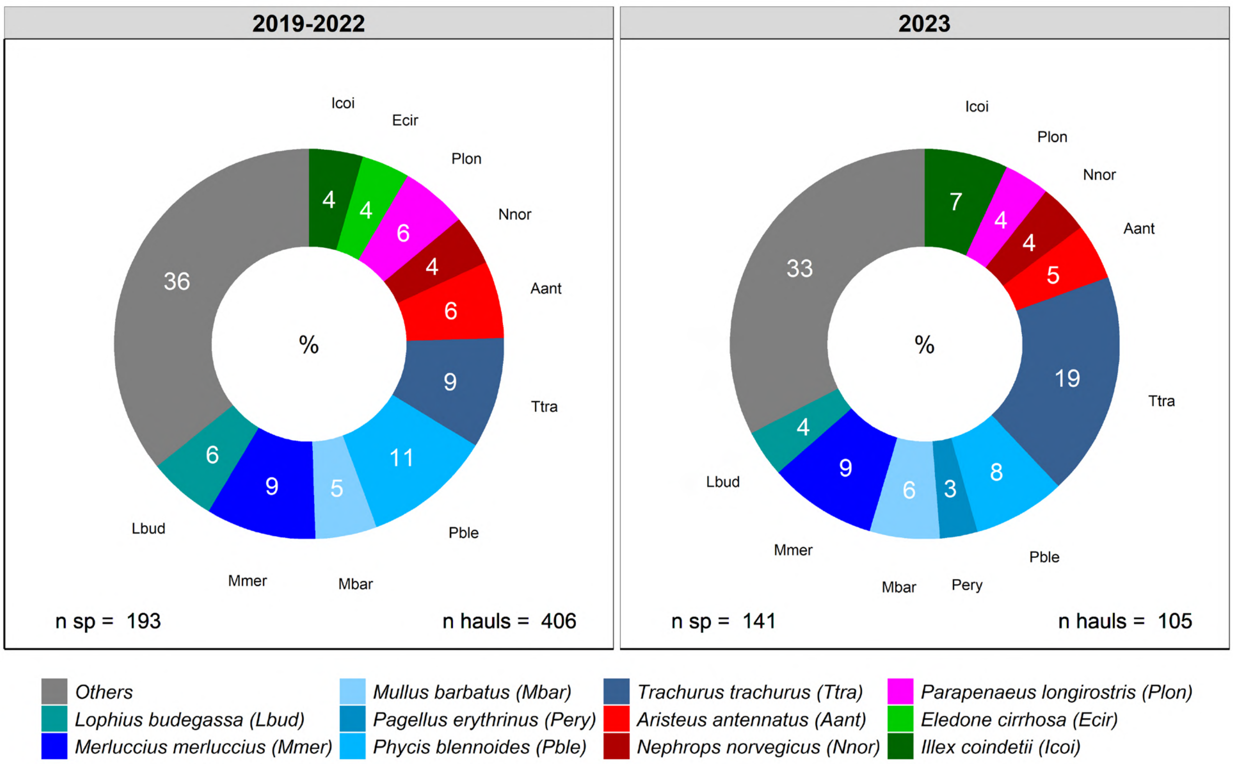


Figure 6. Landed species with most biomass including all hauls in each period.

The number of species discarded was 501 in the period 2019-2022 and 337 in 2023 (Figure 7). The most important species in the discarded catch was *Scyliorhinus canicula*. Comparing both periods, it is notable the rise of *Trachurus trachurus* and *Lophius budegassa*, and the decrease of *Engraulis encrasicolus* in the discarded fraction of bottom trawling in 2023. For a detailed tables on the discarded catch composition see Annex 5, Annex 6, Annex 7 and Annex 8.

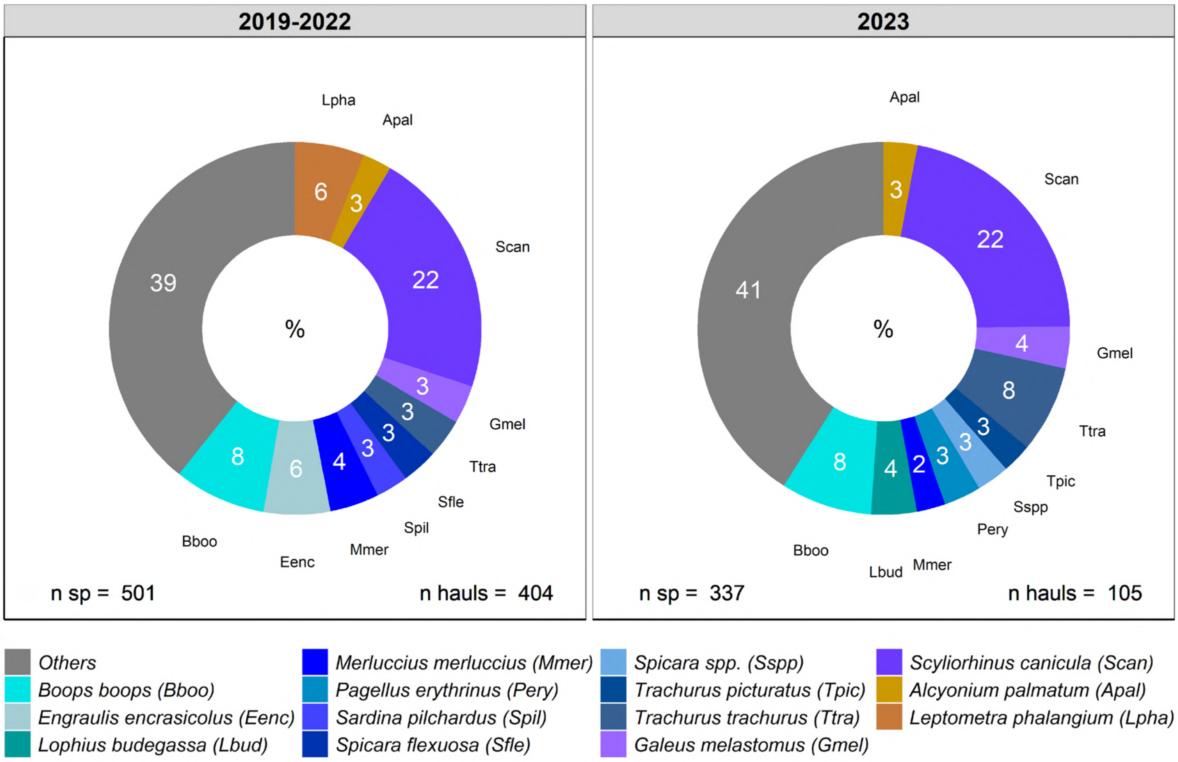


Figure 7. Discarded species with most biomass including all hauls in each period.

As for the natural debris, the predominant categories present in the bottom trawling samples were terrestrial plants, marine organic debris and shells in both periods analyzed (Figure 8). For detailed tables on the natural debris composition see Annex 9 and Annex 10.

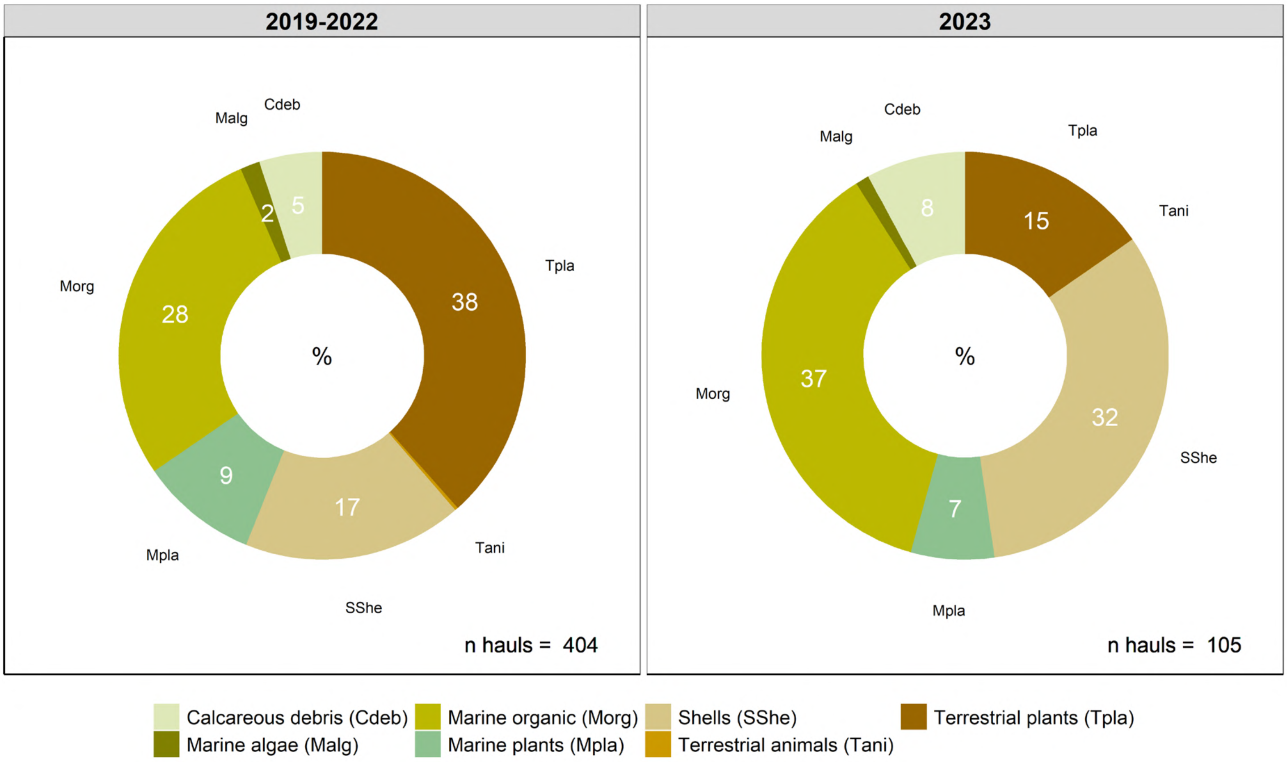


Figure 8. Categories of natural debris with higher biomass including all hauls in each period.

For marine litter, i.e. anthropogenic waste, the categories with the highest proportions were plastic in both periods compared (Figure 9). For detailed tables on marine litter composition see Annex 11 and Annex 12.

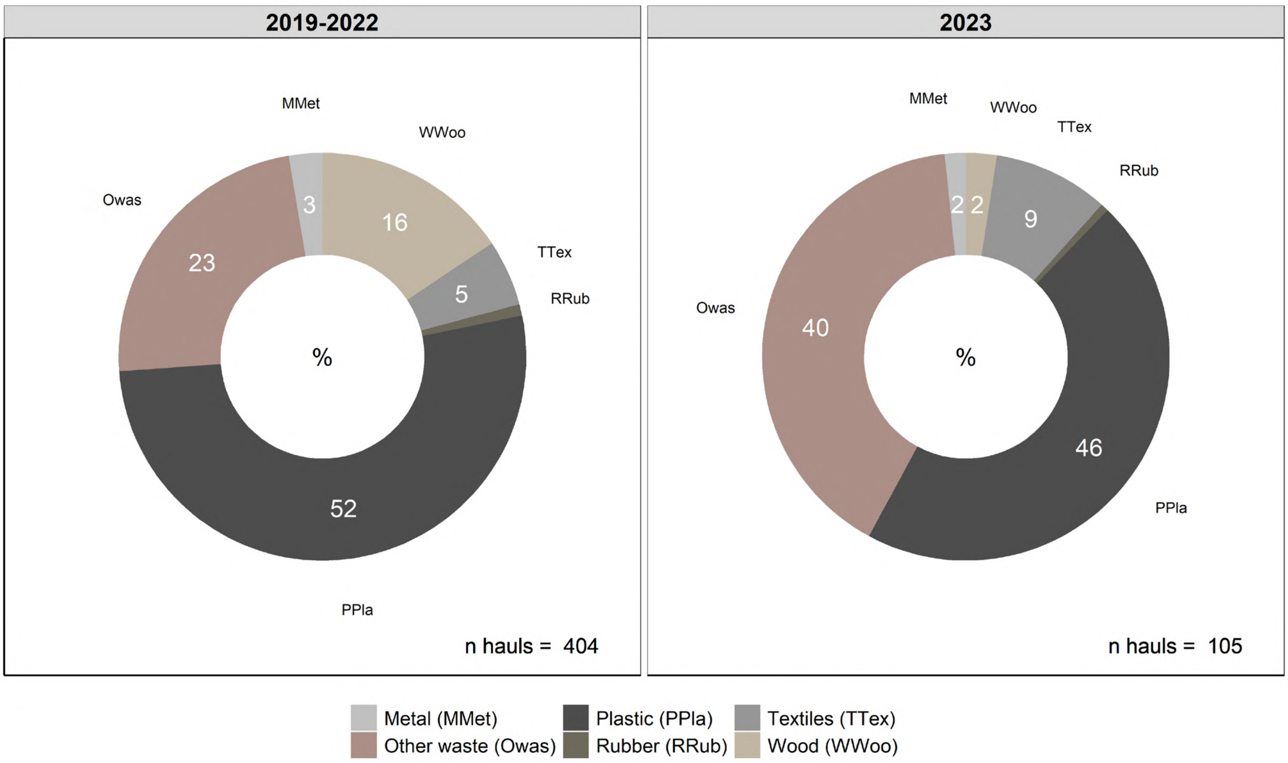


Figure 9. Categories of marine litter with higher mass including all hauls in each year.

Comparing the different fractions of the catch, the proportion of discards was similar in both periods, with the highest proportion found in the shelf stratums (middle Delta shelf, coastal shelf and deeper shelf) (Figure 10). However, in the middle Delta shelf the fraction of discards was reduced by 23% in 2023 compared to the previous period, mainly by the decrease of discarded anchovy in L'Ametlla de Mar (Figure 113). The coastal shelf, a *métier* that started being sampled in 2023, showed the highest proportion of discarded catch in 2023. As for the proportion of natural debris, this was higher in the coastal Delta shelf, but with a higher proportion during the previous period (2019-2022), as a large part of it (terrestrial plants) comes from river mouths after rainfall events and in 2023 rain events were scarce.

Regarding the species with the highest biomass landed, the main species on the coastal Delta shelf in the period 2019-2022 were similar for 2023: *Pagellus erythrinus* and *Sphyraena sphyraena*, *Trachurus mediterraneus* and *Mullus barbatus* (Figure 11). In the middle Delta shelf, the main species in both periods were *Merluccius merluccius* and *Illex coindetii,* while in 2023, an increase of *Scomber scombrus* and *Lophius budegassa* was observed in the landed fraction. In the coastal shelf (only sampled in 2023) the most important species landed were *Pagellus erythrinus*, *Mullus barbatus* and *Mullus surmuletus* (Figure 11, Figure 85, Figure 101). In the deeper shelf, the main species in both periods compared was *Trachurus trachurus*, which proportion increased by 20% (19 to 39%) in 2023 (Figure 11). Also in the deeper shelf, it is worth noting the case of *Merluccius merluccius*, which accounted for 12% of the landed biomass in the period 2019-2022 and decreased to 8% in 2023. In the upper slope, the main species was *Phycis blennoides* accounting for 28% and 24% of the biomass landed in both periods analyzed, followed by *Nephros norvegicus*, the second species in biomass landed in both periods, which increased by 2% (15 to 17%) in 2023. Another crustacean, *Parapenaeus longirostris*, decreased by 4% (11 to 8%) its biomass landed in the upper slope in 2023. In the lower slope, *Aristeus antennatus* was the main species, accounting for more than 40% of the biomass landed in both periods. In the ports of Palamós and Arenys de Mar, the proportion of *Aristeus antennatus* accounted for more than 70% in the landed catch (Figure 80 and Figure 90).

As for the discarded fraction of the catch, in the coastal Delta shelf the main species in terms of biomass was *Sardinella aurita* in the period 2019-2022 and *Pagellus erythrinus* in 2023 (Figure 12). In the middle Delta shelf, the most important discarded species in the period 2019-2023 was *Engraulis encrasicolus,* but it decreased from 33% to 4% in 2023. The same pattern was observed in the also small pelagic fish *Sardina pilchardus*, decreasing from 18 to 11%. This reduction is particularly evident in the port of L'Ametlla de Mar (Figure 113). In the coastal shelf, the most important discarded species was *Boops boops* followed by *Trachurus picturatus* (Figure 12). In the deeper shelf, the main species within the discarded fraction of the catch was *Scyliorhinus canicula* in both periods, accounting for 16% and 20% of the discarded biomass. In the upper slope, *Scyliorhinus canicula* was also the most abundant discarded species in both periods, accounting for 60 and 65% respectively. Finally, in the lower slope, *Galeus melastomus* was the main species in both periods analyzed, followed by *Scyliorhinus canicula*.

The composition of the natural debris shows that the main categories in both periods and across all depth strata were marine organic debris and terrestrial plants (Figure 13). The high proportion of terrestrial plants could come from river mouths following rainfall events. In terms of marine litter, plastic was the category that accounted for the highest proportion in most depth strata (Figure 14). Wood is another relevant category in terms of mass, especially in the coastal Delta shelf, as this type of items are heavy (Balcells et al., 2023).

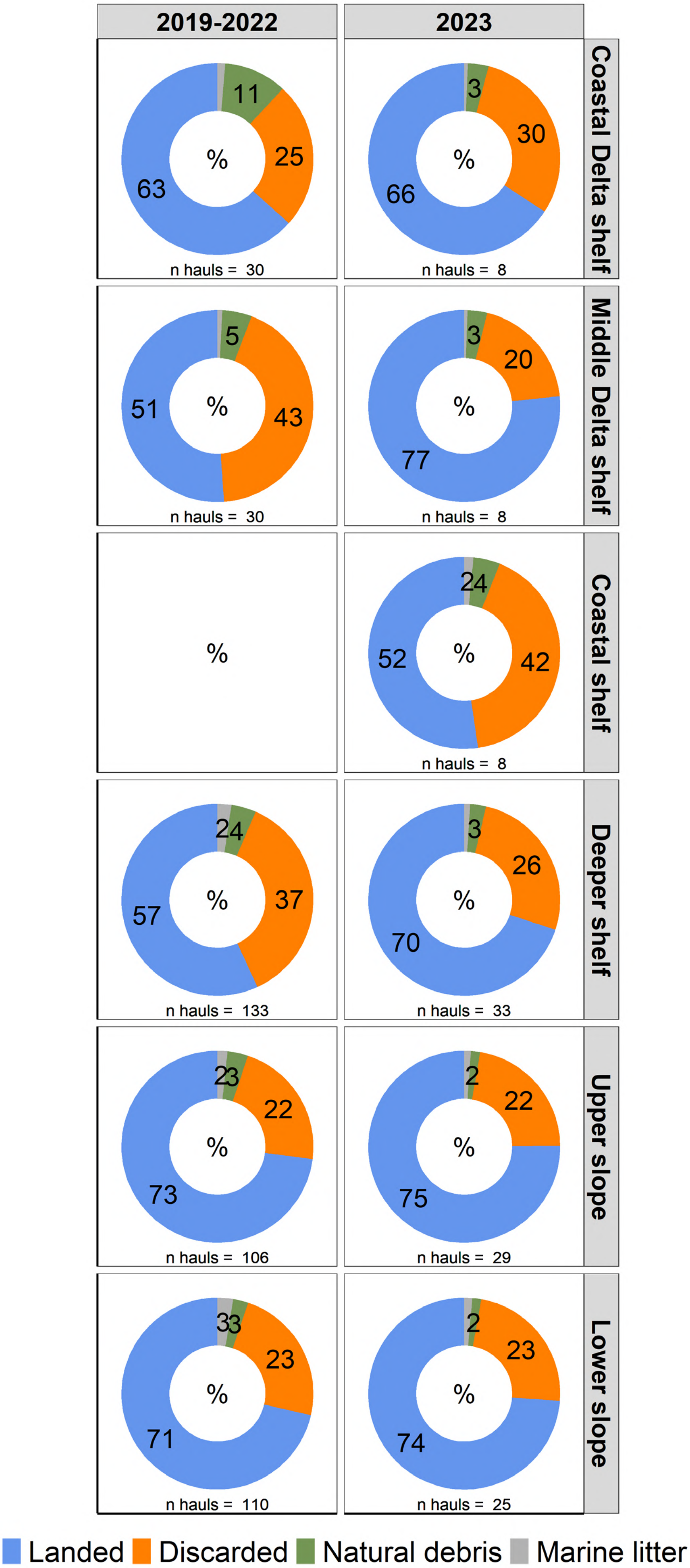


Figure 10. Catch composition for Catalonia. Percentage by weight of landings, discarded, natural debris and marine litter fraction in each *métier* including all hauls in each period.

Figure 11. Landed species with most biomass. Percentage in weight including all hauls within each period and *métier*.

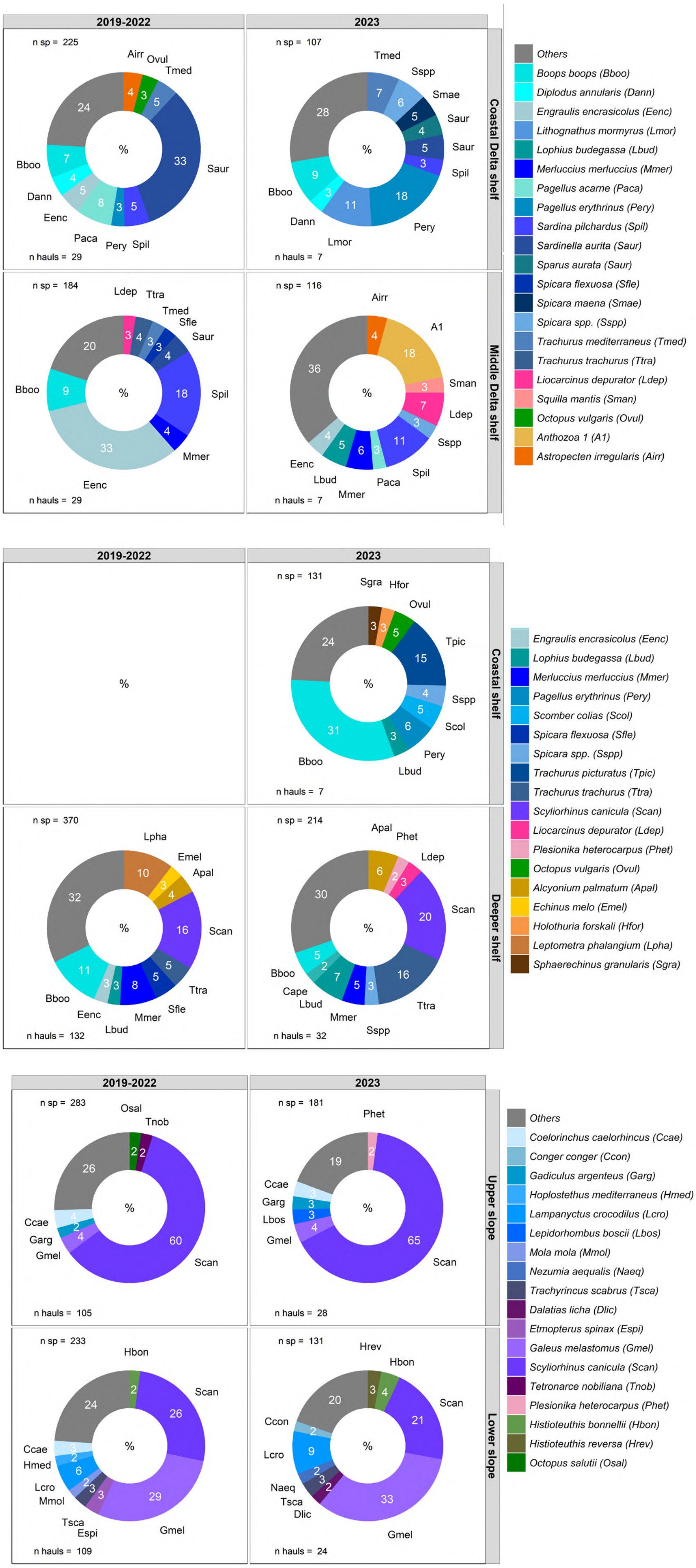


Figure 12. Discarded species with most biomass. Percentage in weight including all hauls within each period and *métier*.

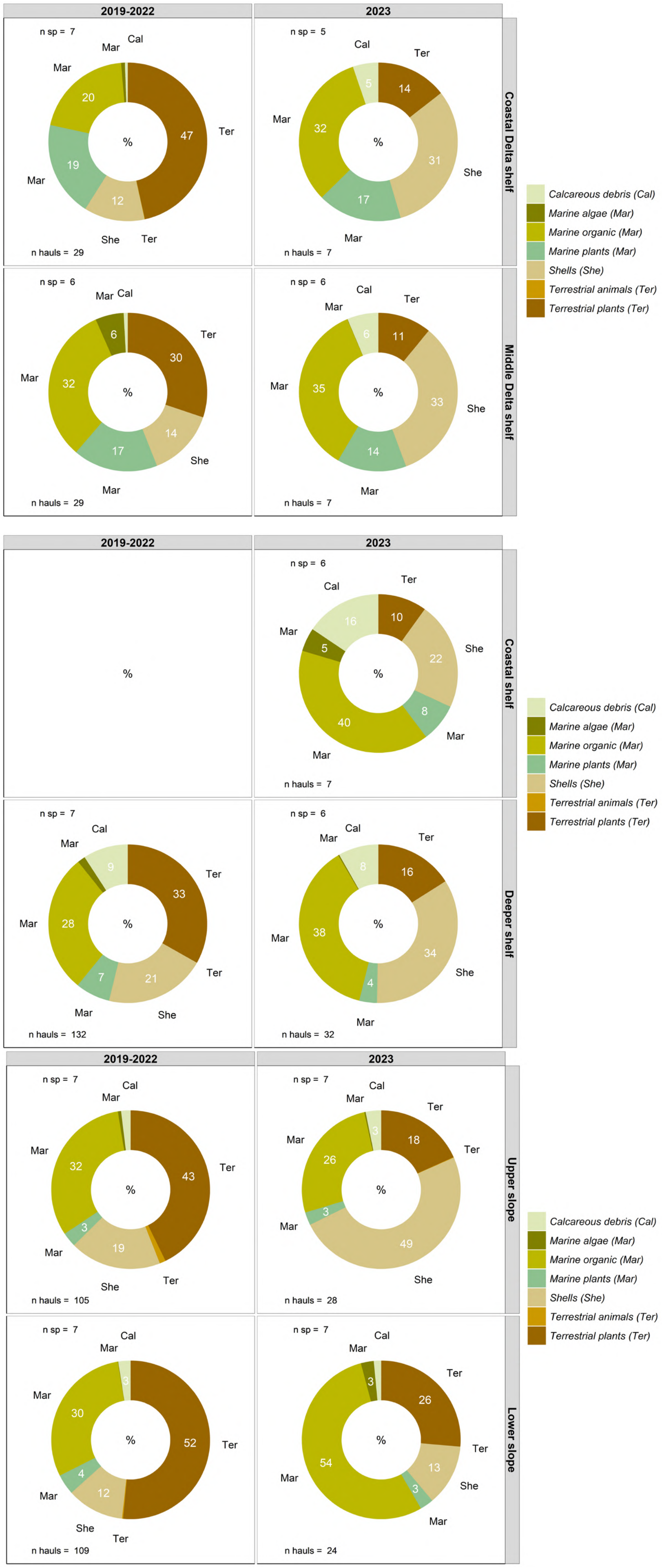


Figure 12. Categories of natural debris with higher biomass. Percentage in weight including all hauls within each period and depth strata.

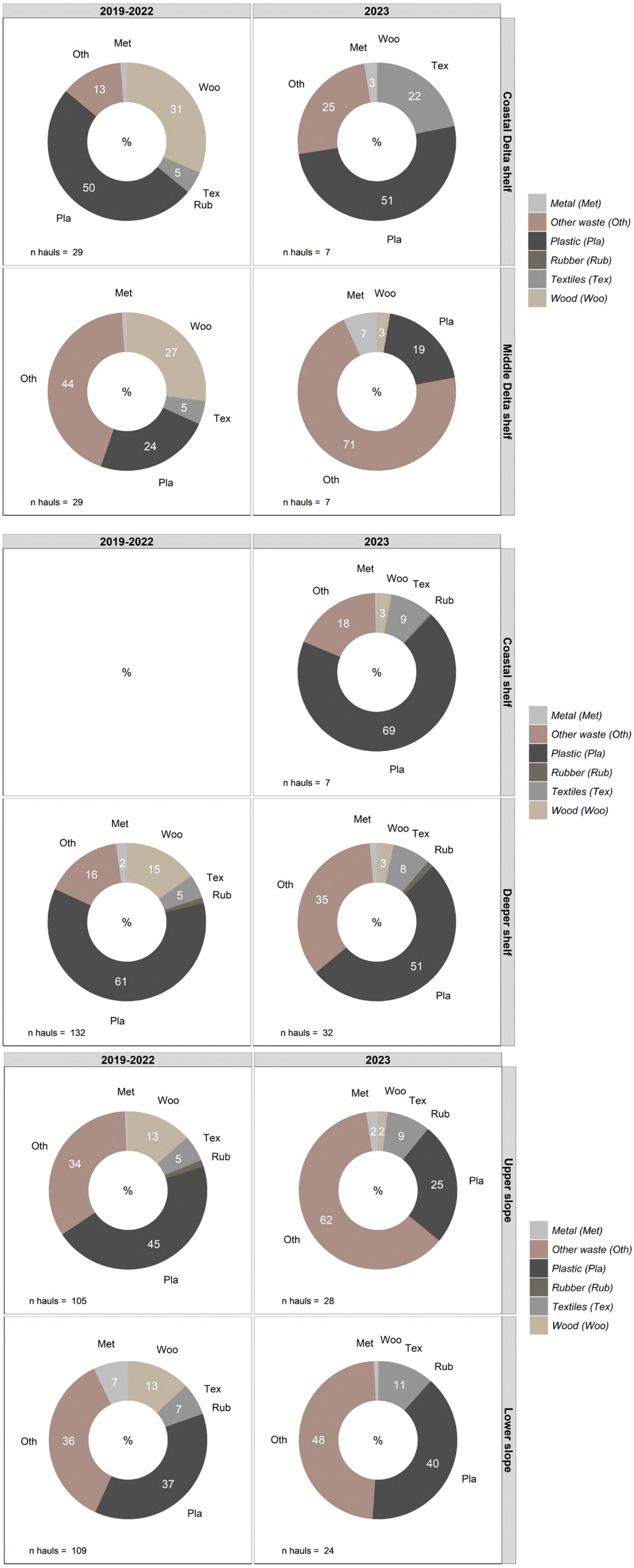


Figure 14. Categories of marine litter with higher mass. Percentage in weight including all hauls within each period and *métier*.

Figure 15 and Figure 16 show the spatial representation of fishing effort (h/km^2) in 2023 and from 2018 to 2022, respectively. Fishing effort is generally focused on submarine canyons in the North and Center zones, with more emphasis in the shallow continental slope in the Ebre Delta. The maximum fishing time in Catalonia for the bottom trawl fishery during 2023 was 347 h/km^2.

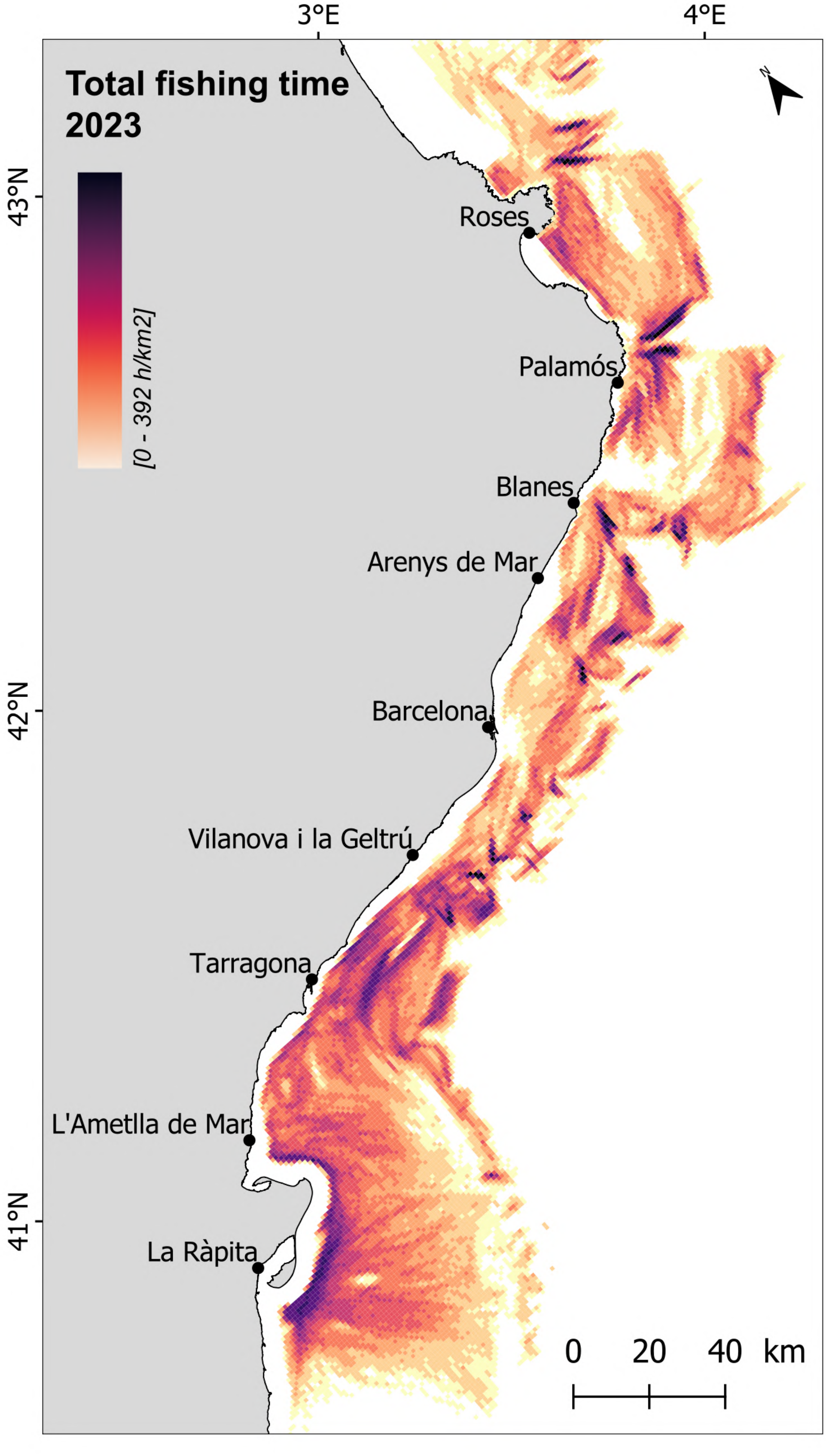


Figure 15. Spatial distribution of fishing effort (h/km2) in the year analyzed.

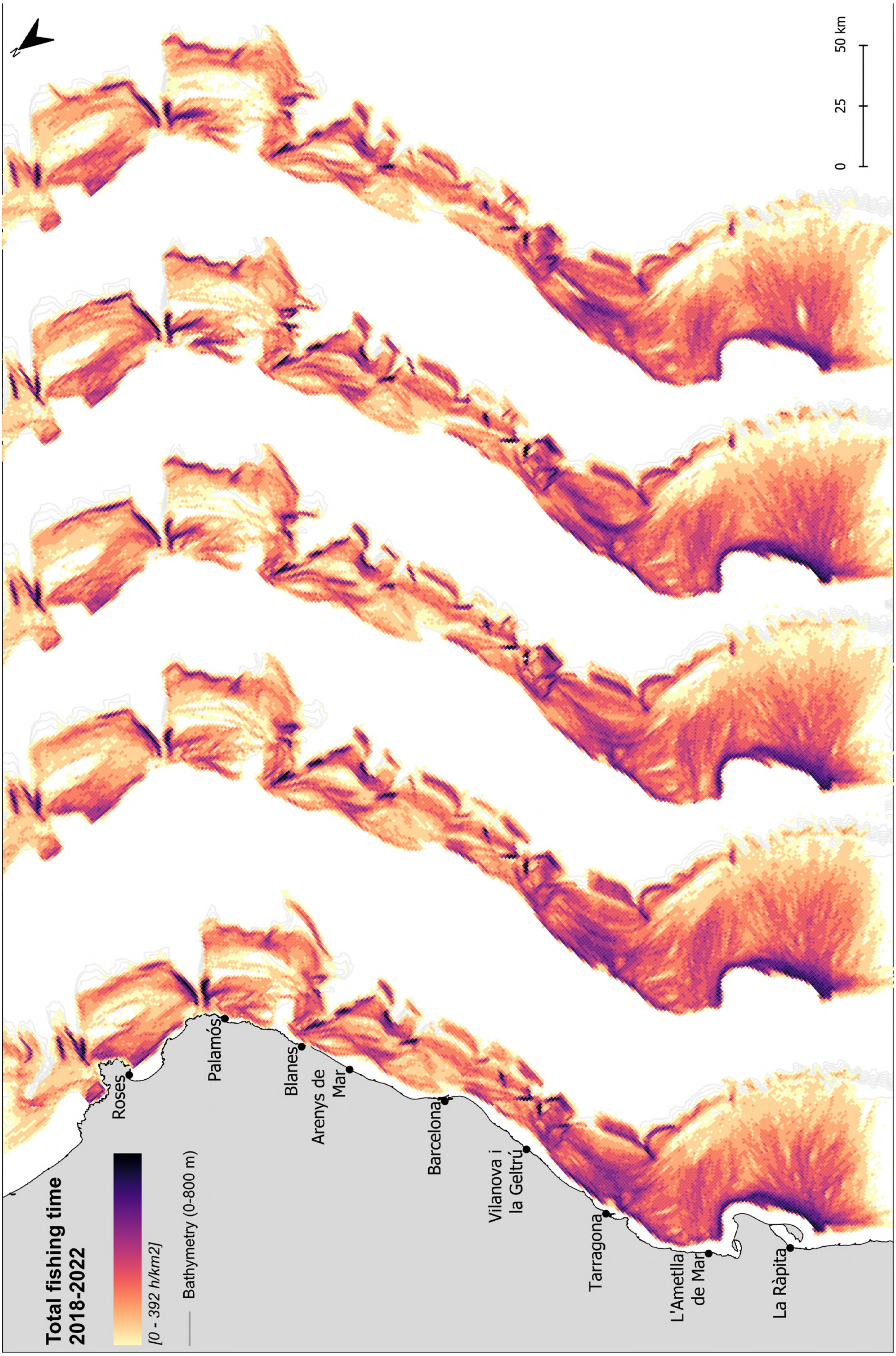


Figure 16. Spatial distribution of fishing effort (h/km2) for the five years prior to the year analyzed.

Figure 17 and Figure 18 show the spatial representation of total catches (kg) in 2023 and from 2018 to 2022, respectively. Total catch is concentrated around the shallower waters of the Ebre Delta and along the Center zone. The maximum catches in Catalonia for the bottom trawl fishery in 2023 was 4 048 kg/km^2.

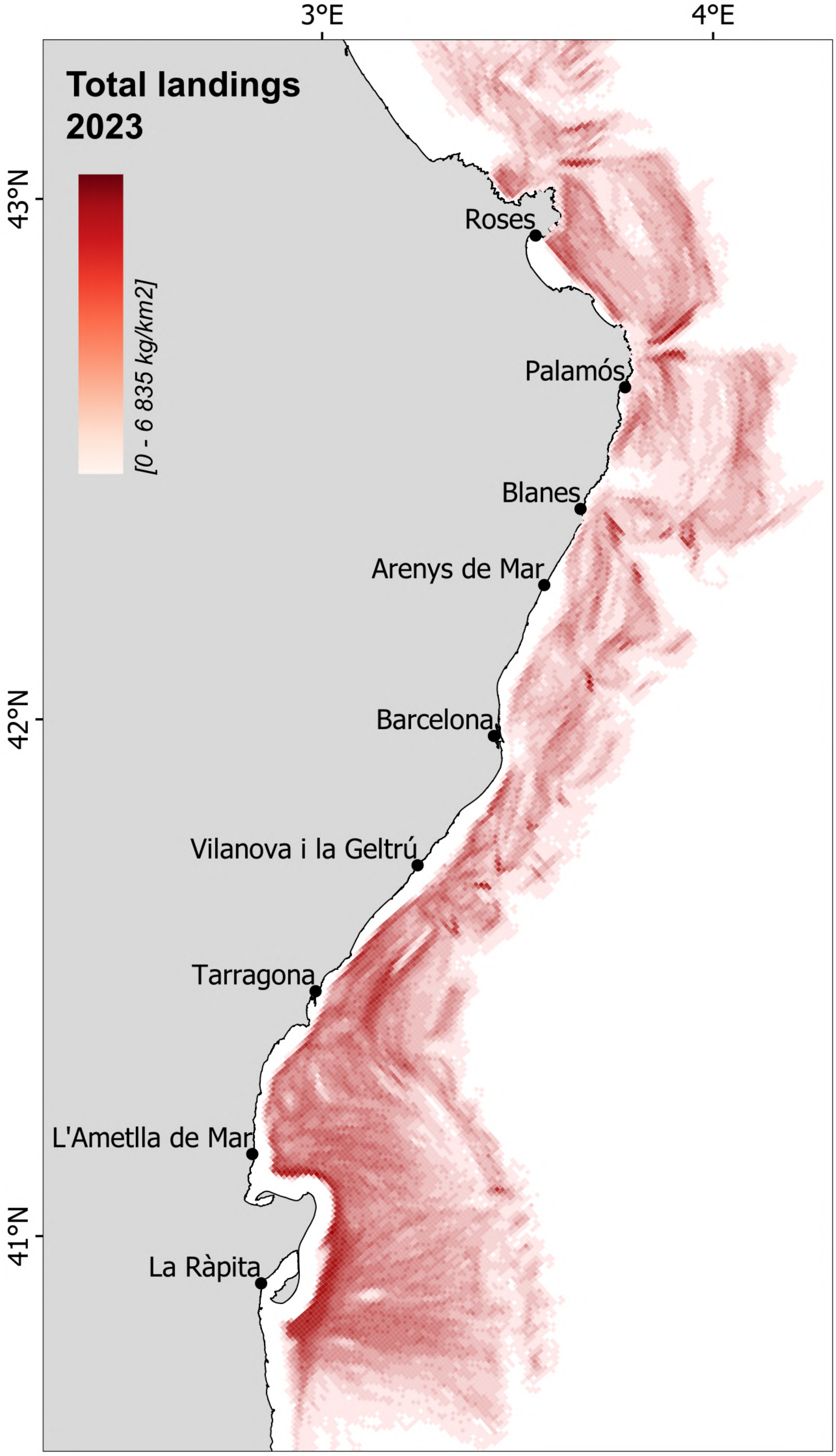


Figure 17. Spatial distribution of landings (kg) in the year analyzed.

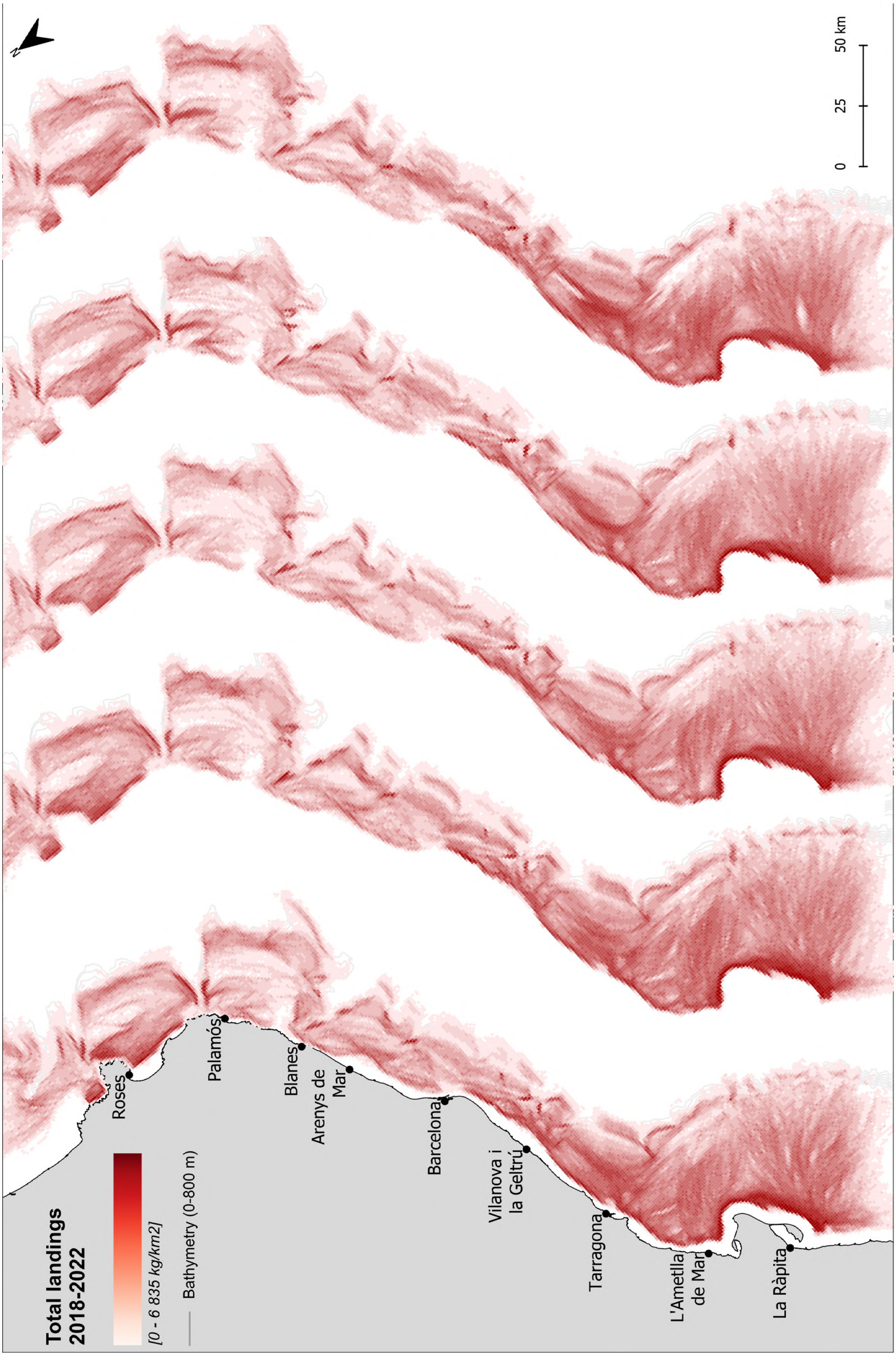


Figure 18. Spatial distribution of landings (kg) for the five years prior to the year analyzed.

Figure 19 and Figure 20 show the spatial representation of revenues per unit effort (€/h·km²) in 2023 and from 2018 to 2022, respectively. Revenue per unit effort is higher in the northernmost parts of the studied area, with similar values near the shelf break of the Ebre Delta as well. The maximum revenues per unit of effort in Catalonia for the bottom trawl fishery in 2023 was 11 6034 €/h·km².

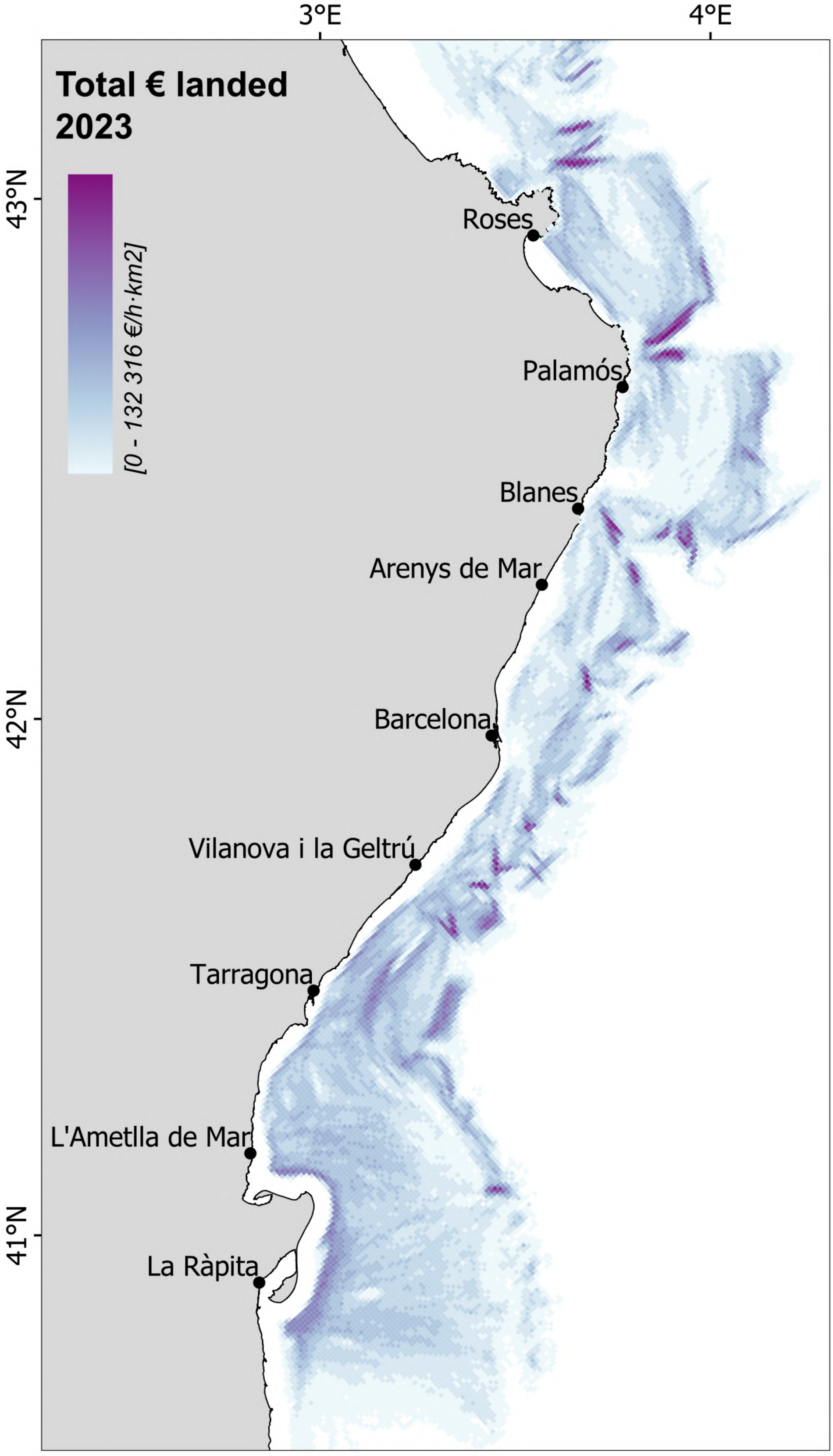


Figure 19. Spatial distribution of revenues per unit of effort (€/h*km²) in the year analyzed.

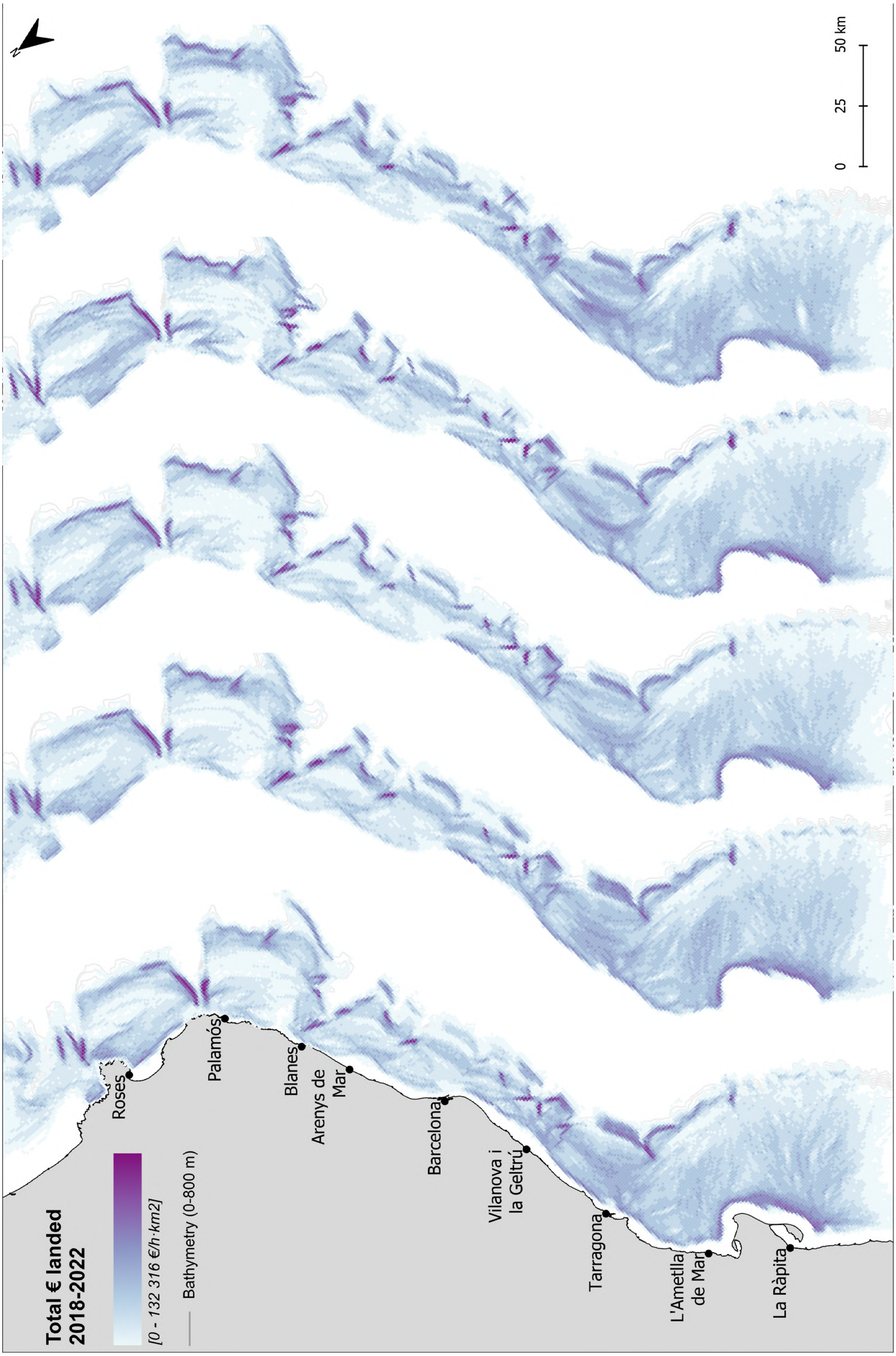


Figure 20. Spatial distribution of revenues per unit of effort (€/h*km²) for the five years prior to the year analyzed.

Hake (*Merluccius merluccius*) HKE

The total hake catch in Catalonia in 2023 was 577 t, of which approximately 93% were caught by bottom trawling and 7% by small-scale fisheries (ICATMAR, 24-03).

Figure 21 and Figure 22 show the spatial distribution of the species landings in 2023 and in the period 2018-2022 along the Catalan coast. A constant trend is observed over the years, with the highest annual maximum of 506 kg/km^2 in 2018. Landings decreased slightly but remained stable through the period analyzed. However, the lowest annual maximum was recorded in 2023 with 295 kg/km^2.

According to length-weight relationship parameters for both sexes combined, hake displayed an isometric growth (b=3) in 2023 (Table 2). When comparing the total weight with the eviscerated weight, no differences were found in the length-weight relationship, as well as when analyzing the two sexes separately, both showing isometric growth with similar *a* and r^2 values.

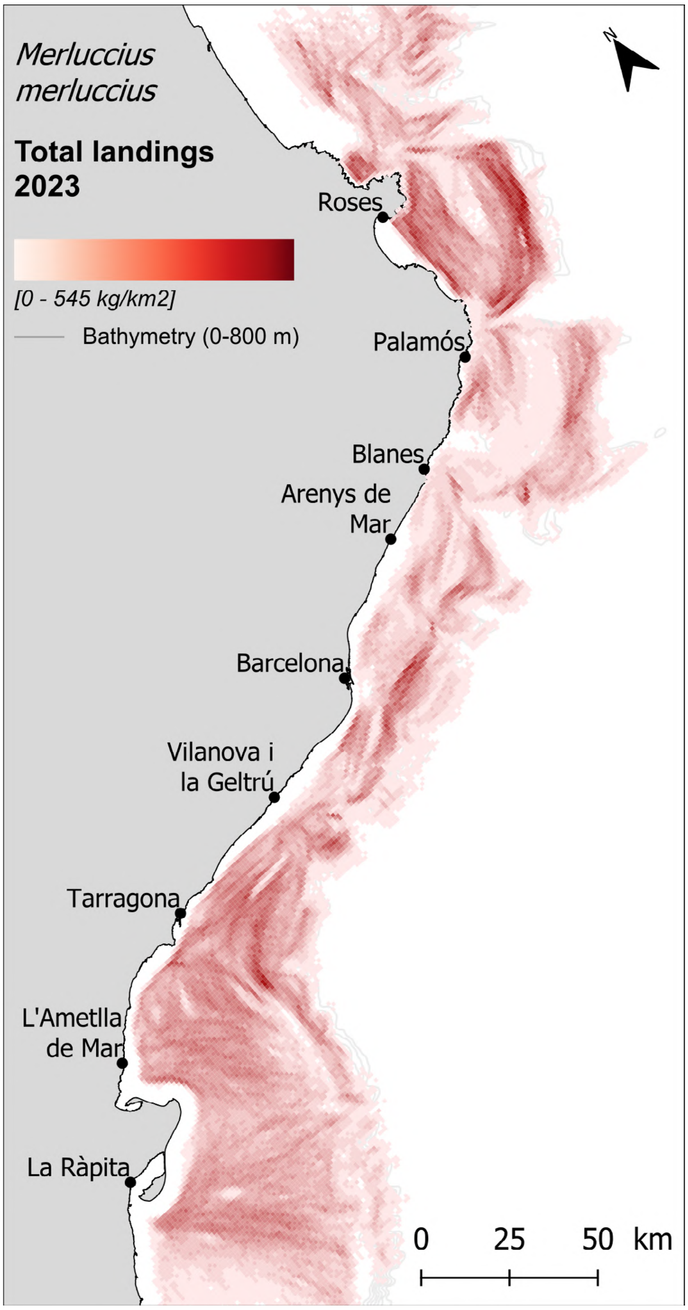


Figure 21. Spatial distribution of landings per unit of effort (LPUE) for hake in the Catalan fishing grounds (North GSA6) in the year analyzed.

Table 2. Hake length-weight relationship in the year analyzed.

Length – total weight relationship				
2023	a	b	r^2	n
Combined	0.0065	3.0234	0.99	2 579
Females	0.0068	3.0126	0.98	1 365
Males	0.0066	3.0207	0.98	1 067
Length – eviscerated weight relationship				
2023	a	b	r^2	n
Combined	0.0057	3.0426	0.99	2 579
Females	0.0062	3.0181	0.99	1 365
Males	0.0055	3.0547	0.98	1 067

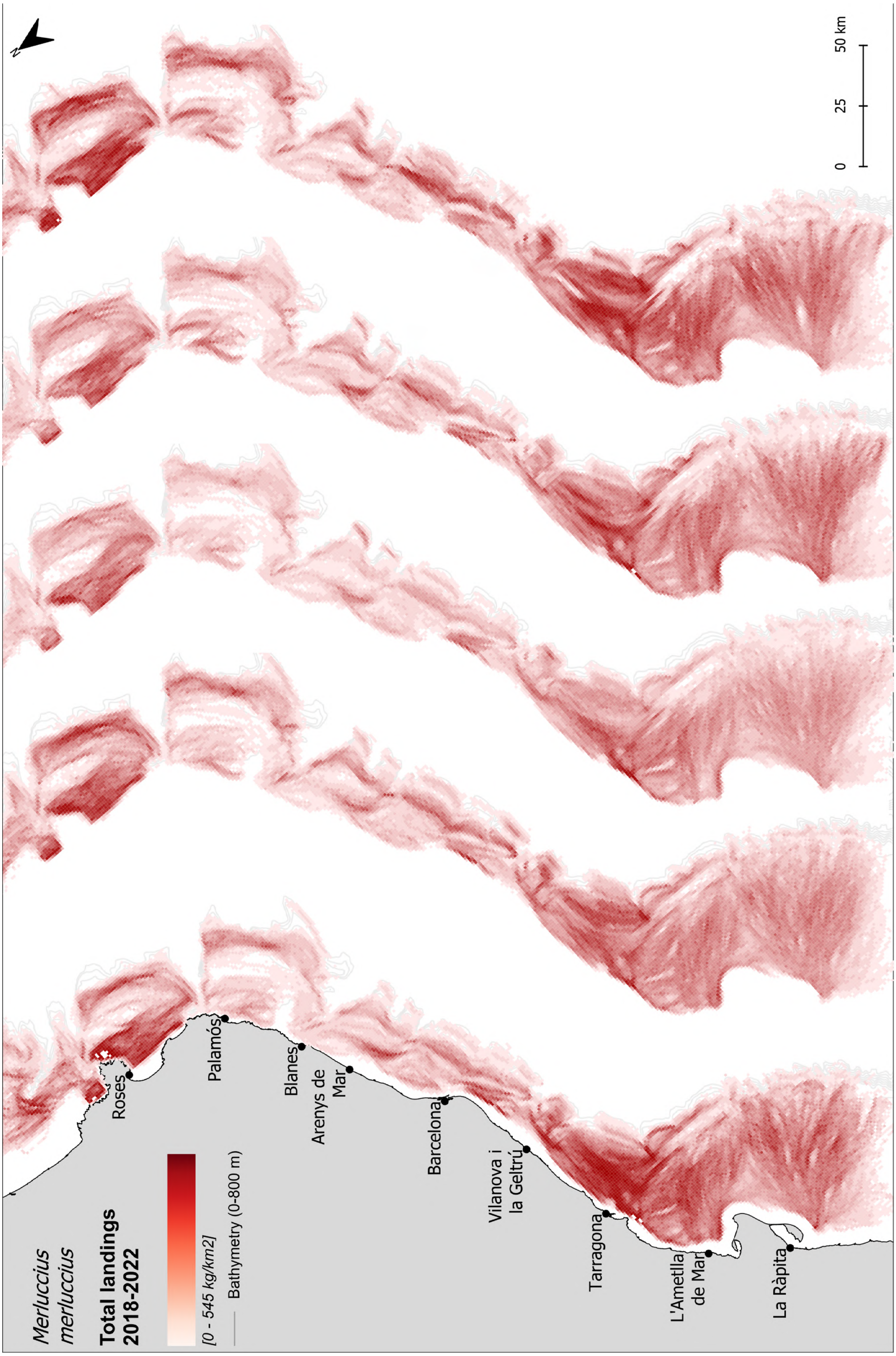


Figure 22. Spatial distribution of landings per unit of effort (LPUE) for hake in the Catalan fishing grounds (North GSA6) for the five years prior to the year analyzed.

Also, comparing hake length-weight relationships for both total weight and eviscerated weight, for both sexes combined and separately from 2019 to 2023 (Figure 23 and Figure 24), the results show similar trends with isometric growth in all cases.

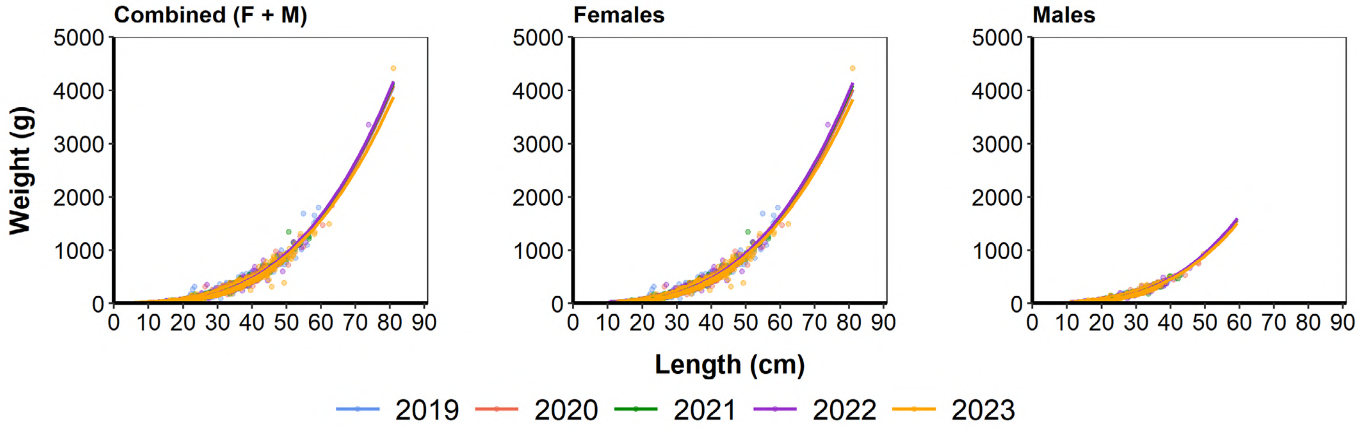


Figure 23. Hake length-weight relationship for the years sampled.

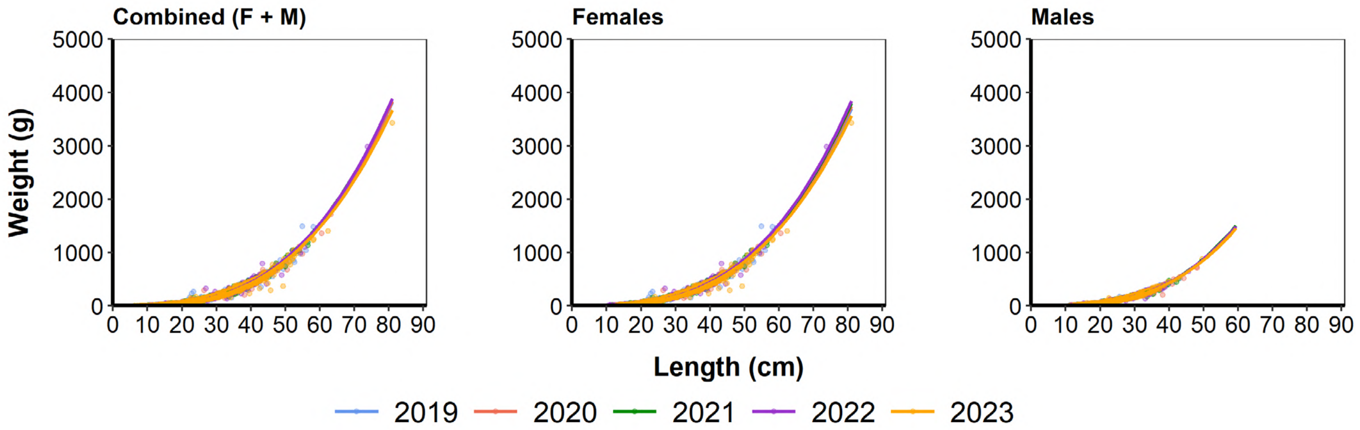


Figure 24. Hake length-eviscerated weight relationship for the years sampled.

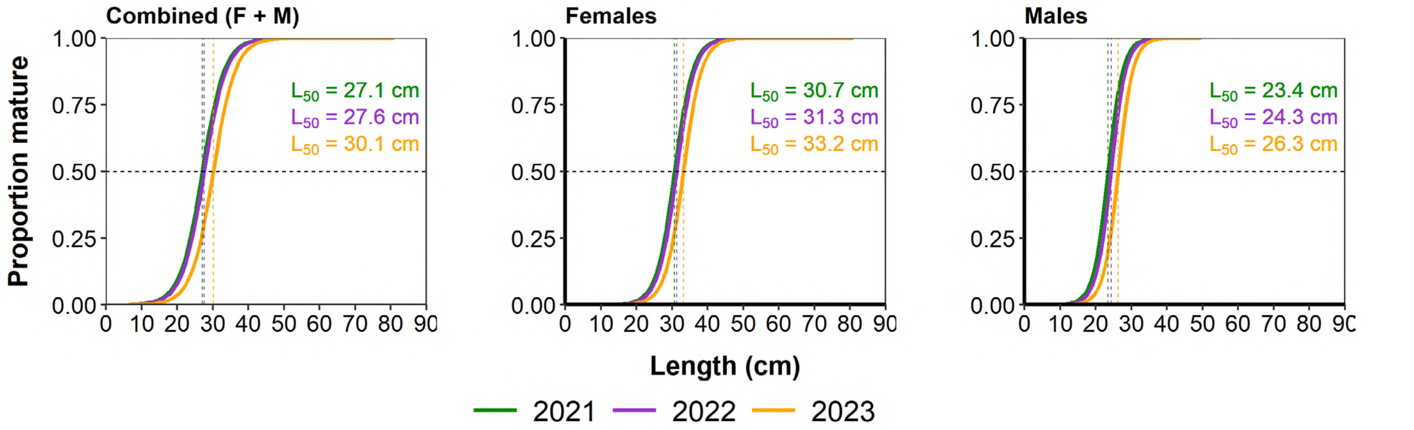


Figure 25. Hake size at first maturity (L_{50}) for all years sampled. Only data from 2021 onwards were considered due to a change in the criteria of maturity state classification.

The size at first maturity (L_{50}) for hake in 2023 was 30.1 cm of TL for both sexes combined, and 33.2 cm of TL and 26.3 cm of TL for females and males respectively, indicating that males mature earlier than females (Figure 25). When comparing between years, differences were observed between 2023 and the previous years, showing a higher L_{50} in 2023, of approximately 2 cm, for both combined and separated sexes.

In 2023, a total of 2 549 hake individuals were analyzed to calculate the L_{50}. Out of these, 1 666 individuals were classified as immature and 883 as mature (Table 3).

The number of mature and immature individuals of hake used to calculate all biological parameters are described in Table 3.

Table 3. Number of mature and immature individuals of hake included monthly in biological analyses.

Month	2019		2020		2021		2022		2023	
	Immature	Mature	Immature	Mature	Immature	Mature	Immature	Mature	Immature	Mature
January	96	87	32	57	113	23	66	17	178	116
February	36	148	52	53	40	14	137	71	107	48
March	21	211	35	48	180	80	72	49	212	78
April	120	299	0	0	138	42	151	36	71	33
May	60	149	0	0	127	46	125	65	159	100
June	35	89	157	84	80	12	81	50	163	50
July	56	125	118	77	143	63	174	48	160	41
August	59	132	92	70	171	55	127	124	79	43
September	47	86	102	70	160	63	166	99	178	122
October	86	142	39	45	93	108	142	75	0	0
November	60	75	187	139	0	0	148	199	337	246
December	102	75	121	64	179	197	91	124	22	6

The gonadal cycle of hake was analyzed monthly from 2019 to 2023 (Figure 26). The species, both males and females, showed a continuous reproductive activity as individuals in advanced maturity stages were present every month sampled throughout the years, confirming a continuous spawning period.

Females showed higher GSI values during autumn and winter months, coinciding with the maximum reproductive activity, but GSI values for males were relatively constant throughout the months.

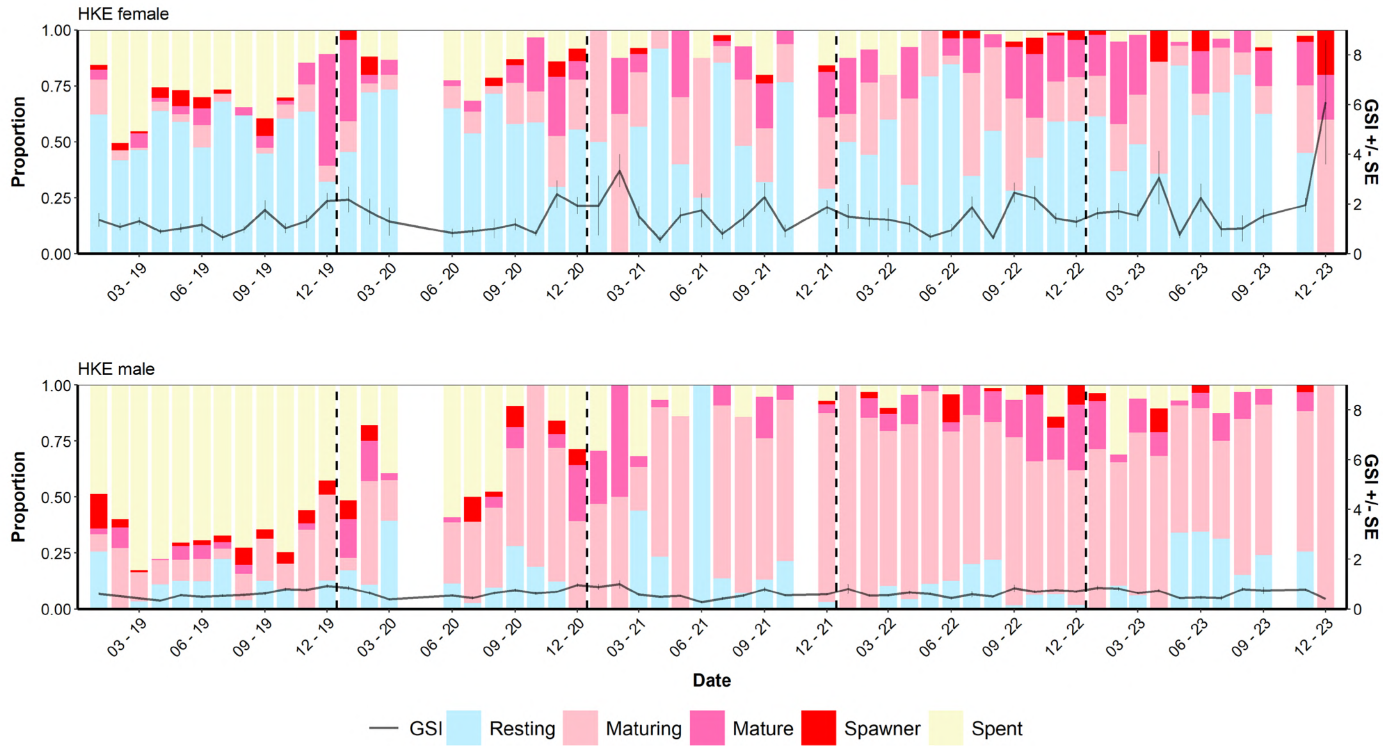


Figure 26. Hake monthly gonadal cycle for females (top) and males (bottom). Gonadosomatic index (GSI +/- SE (Standard Error)) and proportion of different maturity stages.

Plotting hake HSI and GSI together for all years sampled and for the two sexes separately shows that there is no clear relationship between these two parameters, as the reproductive activity of the species occurs throughout the year and is not restricted to a specific spawning season (Figure 27).

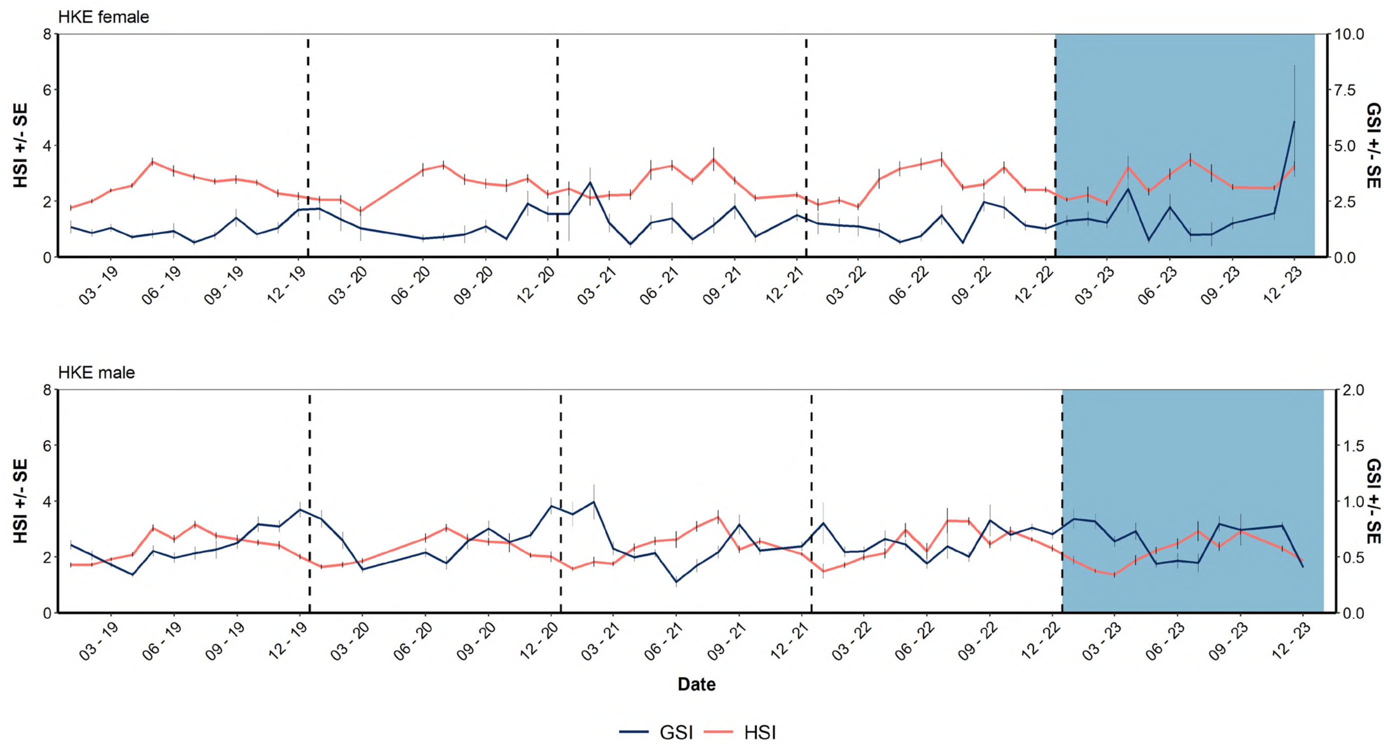


Figure 27. Hake monthly hepatosomatic index (HSI +/-SE (Standard Error)) and gonadosomatic index (GSI +/- SE) for females (top) and males (bottom). Blue shaded area indicates latest analyzed year.

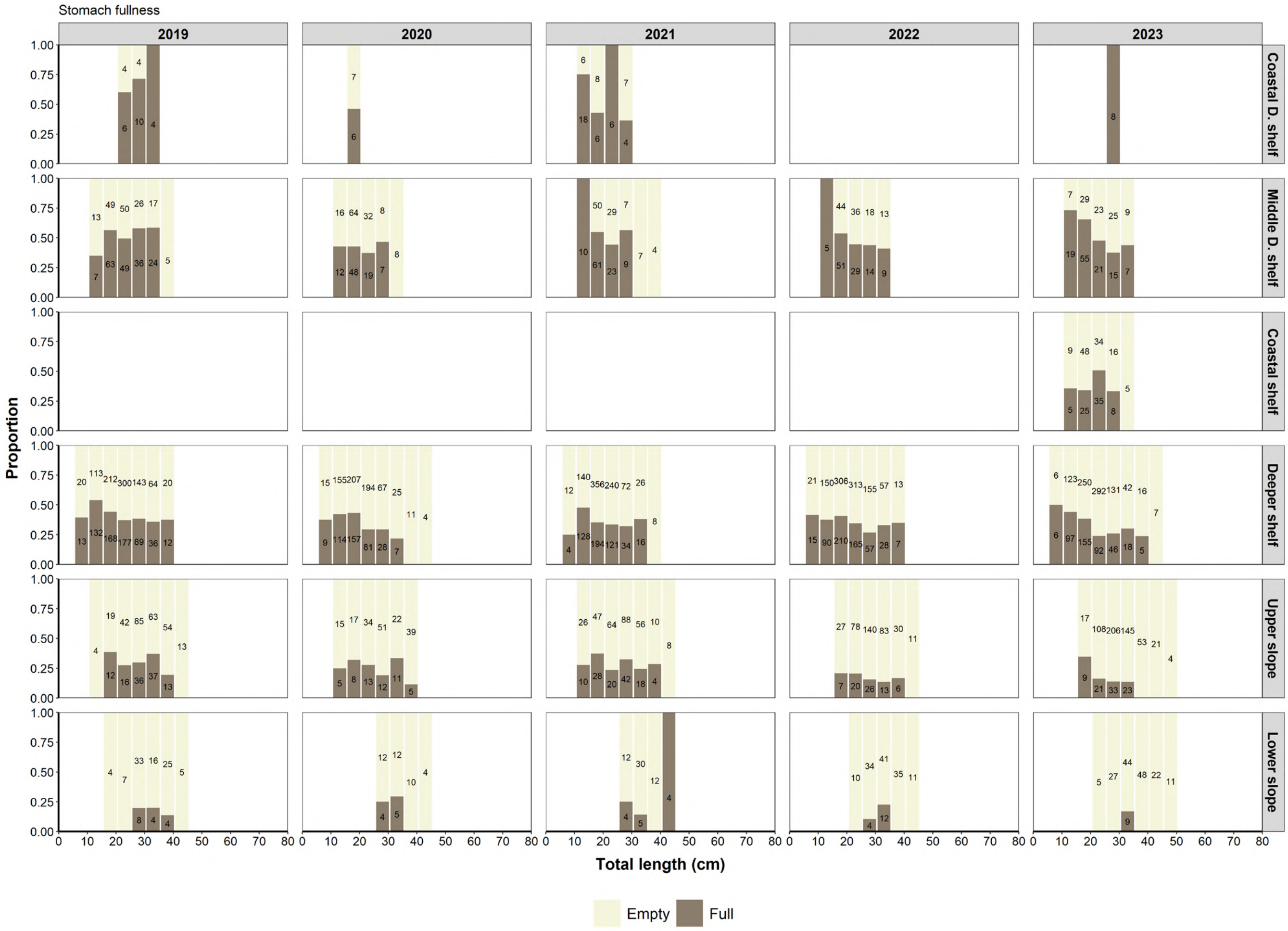


Figure 28. Proportion of stomach fullness of hake according to size range in different *métiers* (Coastal Delta Shelf, Middle Delta Shelf, Coastal Shelf, Deeper Shelf, Upper Slope and Lower Slope). Black numbers inside bars indicate the number of individuals sampled. Only lengths with more than 3 individuals sampled are shown.

Table 4. Number of hake individuals measured in the different fisheries along the zones sampled in each season (the values include all *métiers* sampled).

Fishery	Year	Zone	Winter	Spring	Summer	Autumn	N hauls
			Number individuals sampled				
Artisanal fisheries	2019	Center	1	0	0	0	1
Bottom trawl	2019	North	19	636	216	201	42
Bottom trawl	2019	Center	474	417	211	446	32
Bottom trawl	2019	South	525	181	305	218	31
Bottom trawl	2020	North	104	87	253	227	30
Bottom trawl	2020	Center	208	130	466	310	29
Bottom trawl	2020	South	56	197	370	328	19
Bottom trawl	2021	North	320	390	487	293	43
Bottom trawl	2021	Center	190	528	751	325	27
Bottom trawl	2021	South	141	56	641	441	20
Bottom trawl	2022	North	181	449	755	643	41
Bottom trawl	2022	Center	464	216	507	394	31
Bottom trawl	2022	South	92	165	353	306	18
Bottom trawl	2023	North	632	536	330	427	45
Bottom trawl	2023	Center	427	169	279	254	34
Bottom trawl	2023	South	19	152	289	164	20

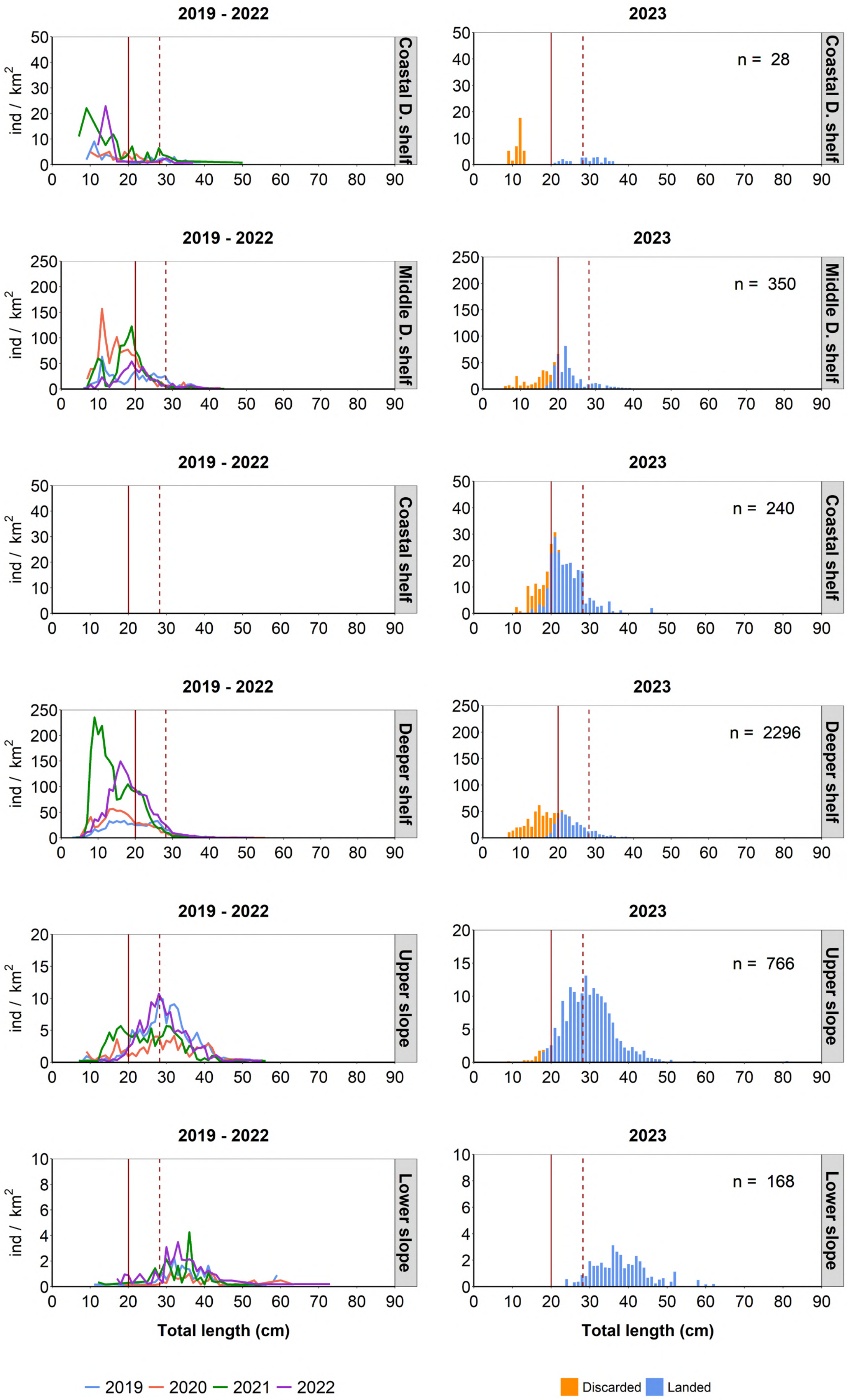


Figure 29. Annual length-frequency distribution of hake in different *métiers* (Coastal Delta Shelf, Middle Delta Shelf, Coastal Shelf, Deeper Shelf, Upper Slope and Lower Slope). Left: previous years sampled, right: year analyzed. (n) Total number of measured individuals. Red solid line: Minimum Conservation Reference Size (MCRS). Red dashed line: size at first maturity (L_{50}) calculated as the mean between the L50 values of 2021 to 2023.

The stomach fullness proportion of hake is represented from 2019 to 2023 and for the six *métier*s studied (Figure 28). Results indicate that the proportion of individuals with full stomachs was higher in the four *métier*s of the continental shelf, corresponding to juvenile individuals, and decreased progressively with increasing depth, being empty stomachs more abundant in the slopes where adult individuals are concentrated.

A higher proportion of full stomachs in small-sized individuals, i.e. recruits, in the *métier*s belonging to the continental shelf may be related to this stratum acting as a feeding ground for juveniles. Also, recruits have higher energy demands than adults and need to allocate the energy obtained from feeding on growth to improve their survival in early life stages.

The spatiotemporal length-frequency distribution of hake from 2019 to 2023 indicates that the species was more abundant on the deeper shelf for all years, despite being also present in the middle Delta shelf, the coastal shelf and the upper slope but with low levels of abundance (Figure 29). The coastal Delta shelf and the lower slope were the *métier*s with the lowest abundances of hake, corresponding to the shallowest and deepest depth strata respectively.

In terms of catch size, a significant proportion of individuals, especially in the coastal and deeper shelves, were caught below the minimum conservation reference size (MCRS) for the species, established at 20 cm of TL. Conversely, larger individuals were more predominant on both upper and lower slopes, corresponding to the adult population.

When comparing between years, maximum abundances of hake recruits (<10 cm) were found in the deeper shelf in 2021 and 2022, suggesting an acceptable recruitment for the species during the preceding years. In 2023, abundances of hake recruits in the deeper shelf were similar to the ones observed in 2019 and 2020, showing lower levels of abundance. The abundance of hake recruits varied with bathymetric distribution, decreasing with increasing depth. Thus, juvenile individuals were concentrated in both coastal and deeper shelves and progressively reduced in abundance in the slope. Young adults (30-40 cm) were present in all *métier*s, despite showing the highest abundances in the upper slope, while larger individuals (>50 cm) were exclusively found in the slopes.

For monthly length-frequency distribution of hake at different *métier*s in 2023 see Annex 13.

All parameters analyzed in this report for hake were calculated using only individuals obtained by bottom trawling sampling (Table 4).

Red mullet (*Mullus barbatus*) MUT

The total red mullet catch in Catalonia in 2023 was 677 t, of which approximately 89% were caught by bottom trawling and 11% by small-scale fisheries (ICATMAR, 24-03).

Figure 30 and Figure 31 show the spatial distribution of red mullet landings in 2023 and in the period 2018-2022 along the Catalan coast. It should be noted that the data correspond to the two species of red mullet present in the area combined, *Mullus barbatus* and *Mullus surmuletus*, as they are not easily distinguishable in the fish auction. Annual landings for these species typically range between 1 000 and 2 000 kg/km^2, with a maximum of 2 016 kg/km^2, reached in 2018. Maximum LPUE in 2023 were at the lower side of the range and were 1 299 kg/km^2.

Although red mullet was already listed as a target species in the previous report (ICATMAR, 23-07), this species began to be sampled biologically in 2023. For this reason, the analyses for red mullet, with the exception of the length-frequency distribution, only use data from 2023.

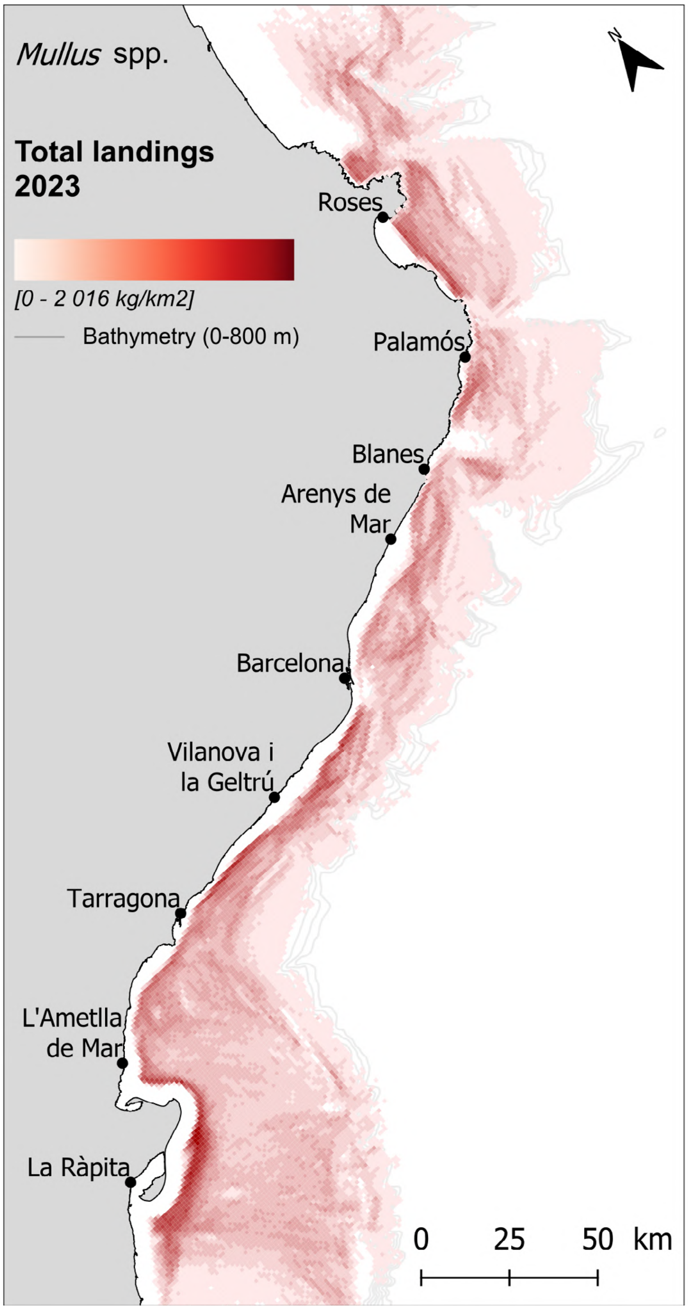


Figure 30. Spatial distribution of landings per unit of effort (LPUE) for red mullet (*Mullus spp.*) in the Catalan fishing grounds (North GSA6) in the year analyzed.

Table 5. Red mullet length-weight relationship in the year analyzed.

Length – total weight relationship				
2023	a	b	r^2	n
Combined	0.0092	3.0721	0.97	1 324
Females	0.0107	3.0225	0.97	874
Males	0.0143	2.8969	0.94	434
Length – eviscerated weight relationship				
2023	a	b	r^2	n
Combined	0.0108	2.9845	0.97	1 324
Females	0.0124	2.9388	0.97	874
Males	0.0134	2.8983	0.95	434

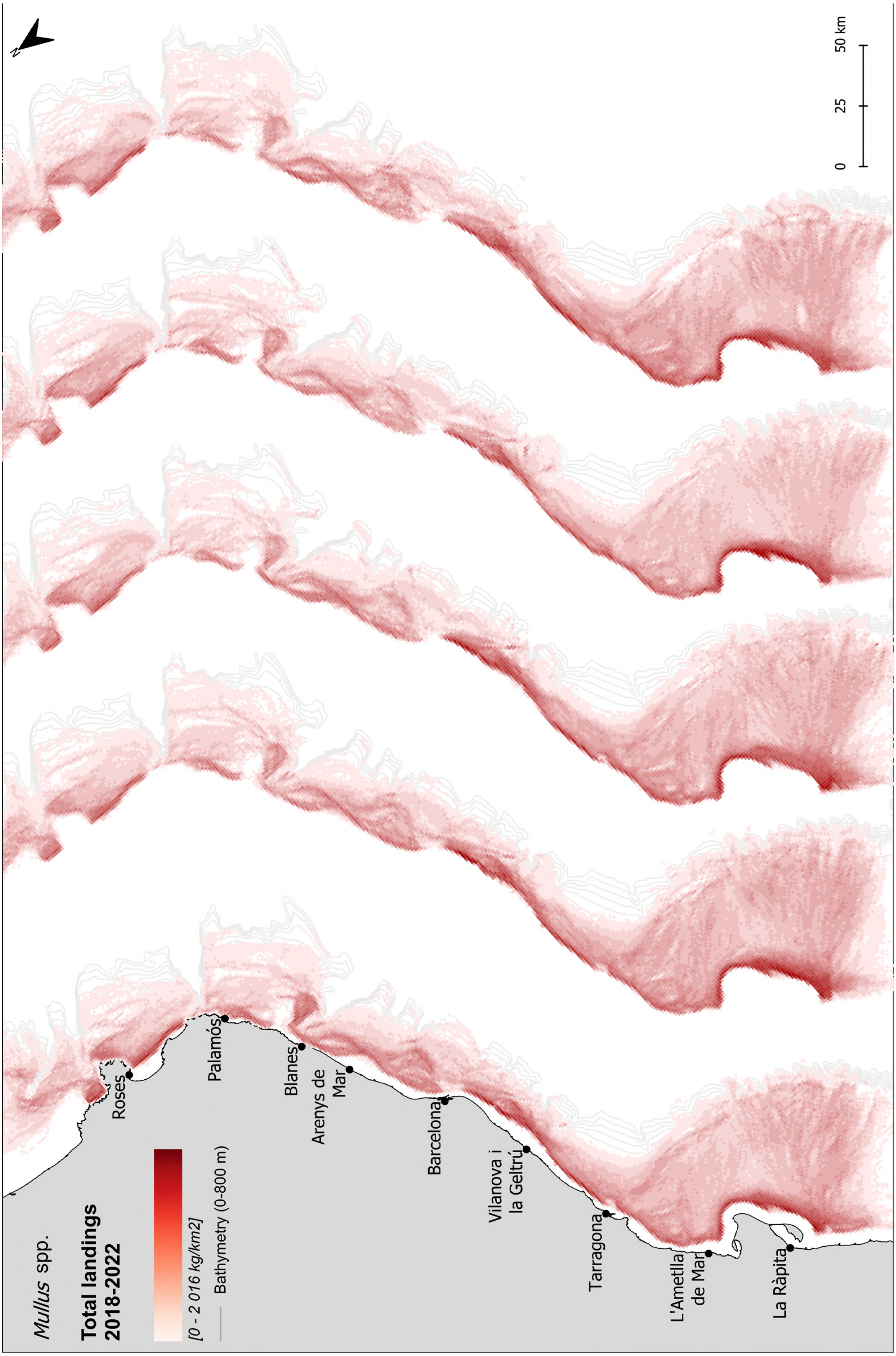


Figure 31. Spatial distribution landings per unit of effort (LPUE) for red mullet (*Mullus spp.*) in the Catalan fishing grounds (North GSA6) for the five years prior to the year analyzed.

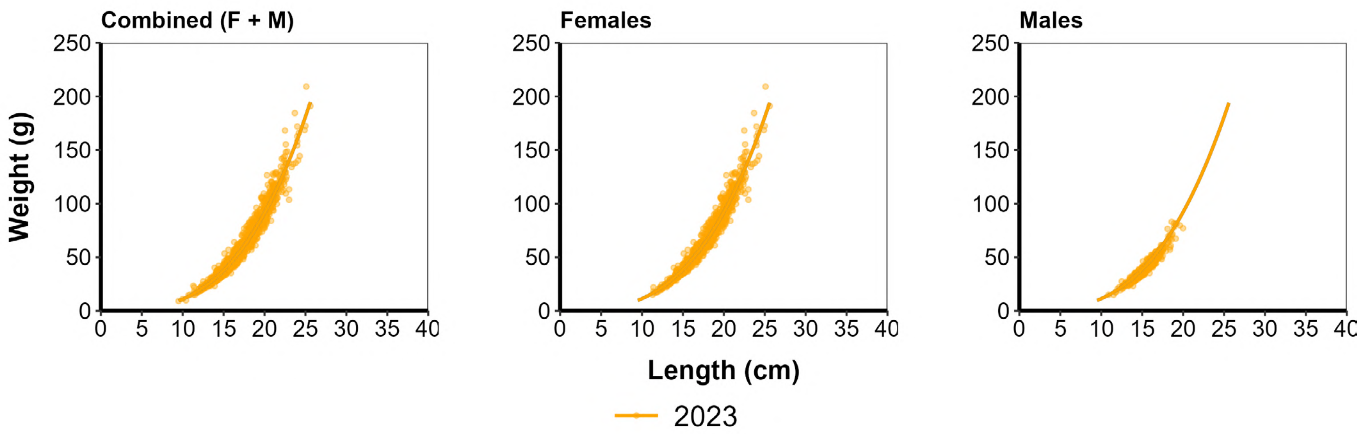


Figure 32. Red mullet length-weight relationship for the years sampled.

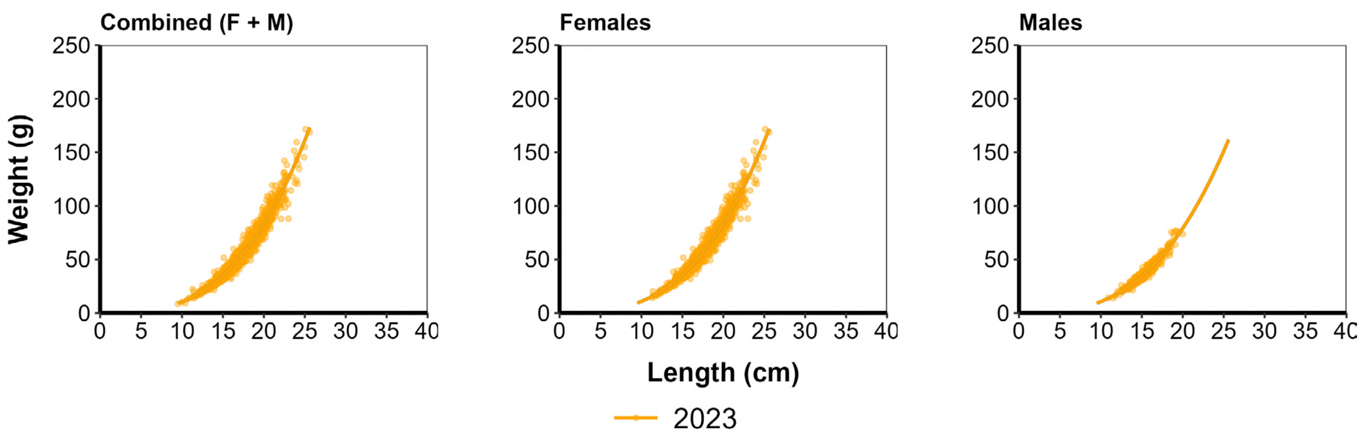


Figure 33. Red mullet length-eviscerated weight relationship for the years sampled.

According to length-weight relationship parameters for both sexes combined, red mullet displayed an isometric growth (b=3) in 2023 (Table 5). When comparing the total weight with the eviscerated weight, no differences were found in the length-weight relationship, as well as when analyzing the females separately, which show isometric growth with *b* values very close to 3 and similar *a* and r^2 values. In the case of males, *b* values are slightly lower for both total and eviscerated weight, which could indicate a tendency towards negative allometric growth. However, it should also be noted that the number of males sampled is almost 50% of the number of females. These length-weight relationships for both total and eviscerated weight in 2023 are shown graphically in Figure 23 and Figure 24.

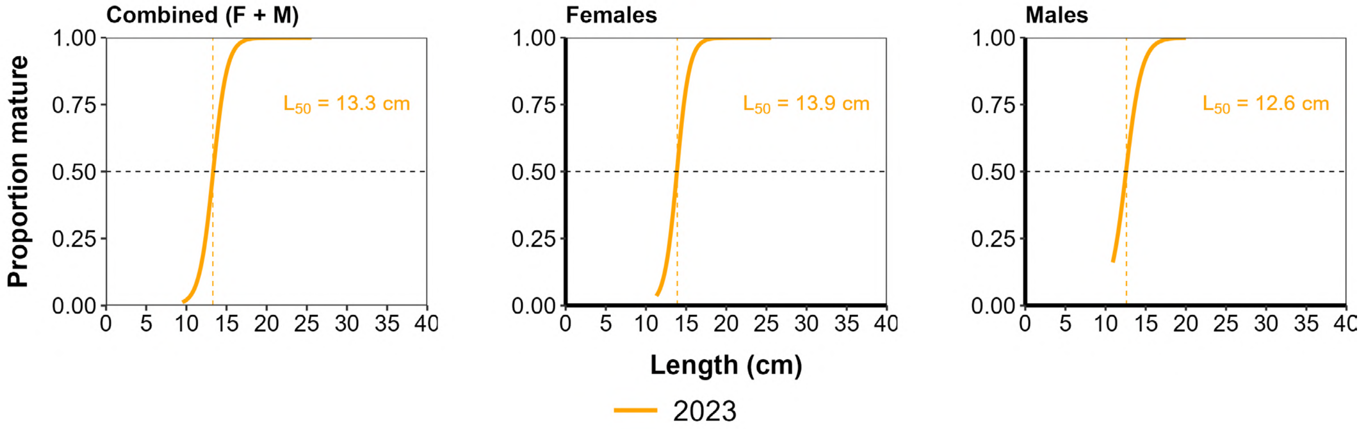


Figure 34. Red mullet size at first maturity (L_{50}) for the years sampled.

The size at first maturity (L_{50}) for red mullet in 2023 was 13.3 cm of TL for both sexes combined, 13.9 cm for females and 12.6 cm for males, indicating that males mature earlier than females (Figure 34).

In 2023, a total of 1 320 red mullet individuals were analyzed to calculate the L_{50} (Table 6). Out of these, 141 individuals were classified as immature and 1 179 as mature. It should be noted that the low number of immature individuals compared to the mature ones may bias the L_{50} towards larger sizes than it actually is.

Table 6. Number of mature and immature individuals of red mullet included monthly in biological analyses.

Month	2023	
	Immature	Mature
January	4	106
February	17	148
March	0	72
April	10	82
May	1	149
June	1	60
July	16	131
August	0	40
September	56	99
October	0	0
November	32	276
December	4	16

The gonadal cycle of red mullet was analyzed monthly for 2023 (Figure 35). Females of the species showed a markedly seasonal reproductive cycle with a peak during May when the highest proportion of mature and spawner individuals were present. For males, the reproductive cycle was more continuous although a slight peak was observed during the spring, with the highest proportion of spawning individuals in April.

Females showed higher GSI values during the spring, reaching the maximum in May, coinciding with the maximum reproductive activity. GSI values for males were more constant throughout the year, although they began to increase during the autumn months until reaching a maximum in May, coinciding with the highest GSI value for females. The reproductive cycle described here is consistent with that already known for the species from other studies in the Mediterranean Sea.

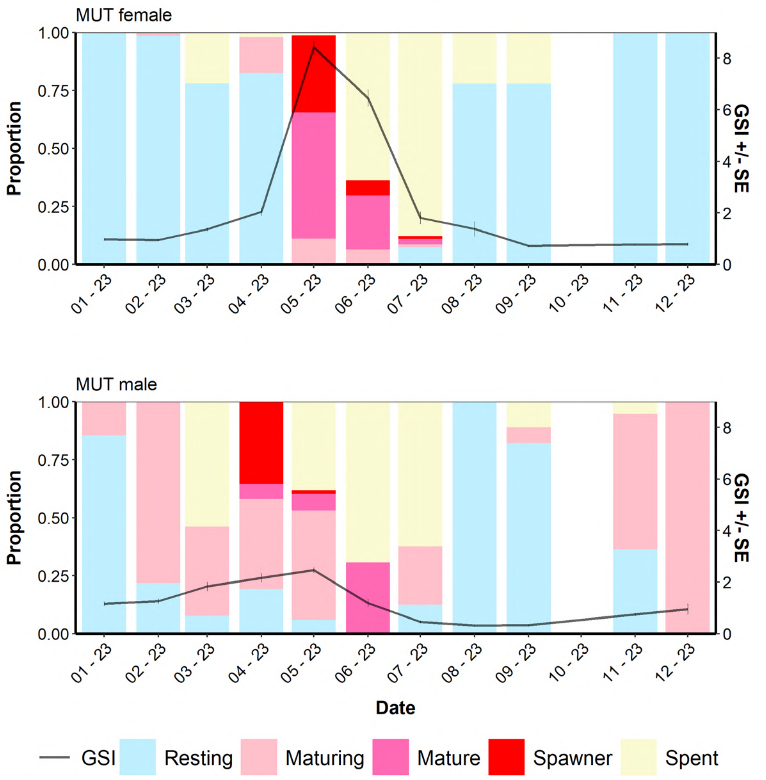


Figure 35. Red mullet monthly gonadal cycle for females (top) and males (bottom) for the years sampled. Gonadosomatic index (GSI +/- SE (Standard Error)) and proportion of different maturity stages.

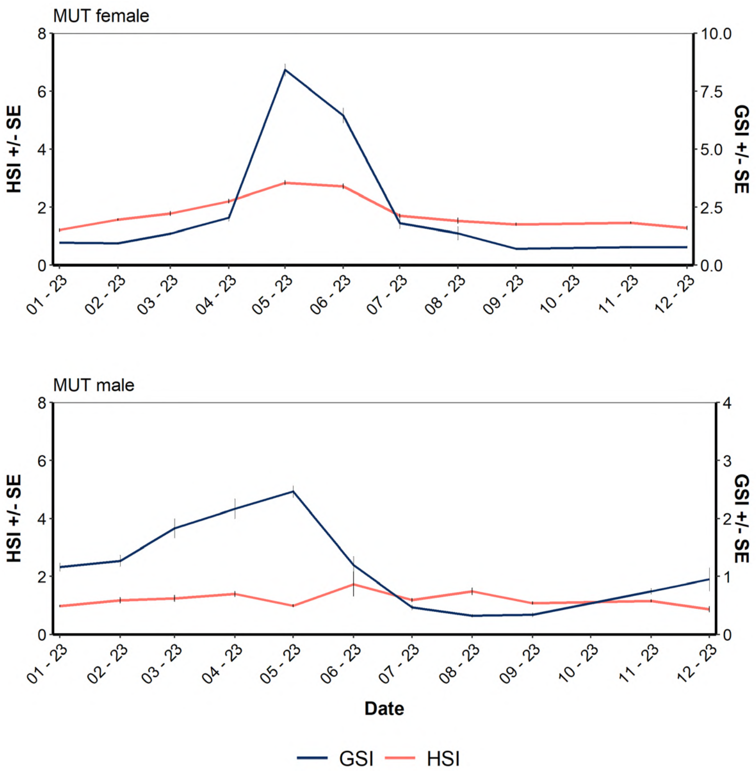


Figure 36. Red mullet monthly hepatosomatic index (HSI +/-SE (Standard Error)) and gonadosomatic index (GSI +/- SE) for females (top) and males (bottom) for the year analyzed. Blue shaded area indicates latest analyzed year.

Plotting red mullet HSI and GSI together for 2023 and for the two sexes separately shows that there is no clear relationship between these two parameters. HSI values for both sexes are constant throughout the year, especially for males. For females, although the increase is very slight, the highest HSI values coincide with the highest GSI values, during May and June (Figure 36).

Table 7. Number of red mullet individuals measured in the different fisheries along the zones sampled in each season (the values include all *métiers* sampled).

Fishery	Year	Zone	Winter	Spring	Summer	Autumn	N hauls
			Number individuals sampled				
Artisanal fisheries	2019	Center	0	3	0	0	1
Artisanal fisheries	2022	Center	0	2	0	0	1
Artisanal fisheries	2023	Center	23	0	0	0	1
Bottom trawl	2019	North	70	415	159	116	19
Bottom trawl	2019	Center	82	119	50	83	17
Bottom trawl	2019	South	301	217	206	391	25
Bottom trawl	2020	North	43	102	58	237	15
Bottom trawl	2020	Center	145	76	64	102	11
Bottom trawl	2020	South	114	67	264	142	18
Bottom trawl	2021	North	261	88	125	60	18
Bottom trawl	2021	Center	123	135	91	49	11
Bottom trawl	2021	South	33	46	221	211	20
Bottom trawl	2022	North	111	97	99	162	16
Bottom trawl	2022	Center	122	64	141	134	11
Bottom trawl	2022	South	88	188	272	359	21
Bottom trawl	2023	North	303	240	272	339	24
Bottom trawl	2023	Center	297	207	252	188	12
Bottom trawl	2023	South	297	141	285	122	20

The spatiotemporal length-frequency distribution of red mullet from 2019 to 2022 does not show a clear pattern across the sampled *métiers* (Figure 37, left). The highest abundances were found in the deeper shelf, followed by the shallowest *métier*, the coastal Delta shelf, and then the middle Delta shelf. The lowest abundance, with a sharp decline, was observed in the upper slope, the limit of the bathymetric range of the species. During this period (2019-2022), there is a gap in the coastal shelf as this *métier* started being sampled in 2023 in the ports of Blanes and Vilanova I la Geltrú; a métier which main target species is the red mullet. As Figure 37 (right) shows for 2023, the highest abundance was found in the coastal Delta shelf, which contrasts with the previous years sampled, followed by the coastal shelf, with abundances considerably higher than the rest of métiers. Abundance on the middle Delta shelf was lower than in previous years, which, considering the increase in abundance in the coastal Delta shelf, could be related to a shift of specimens of this *métier* to shallower depths in the Delta area in 2023. The upper slope showed pattern of abundance similar to previous years.

In terms of catch size, a slight increase in TL can be observed as the depth of the *métier* increases in all years sampled. The smallest individuals were caught in the coastal Delta shelf, with the largest proportion of individuals below the MCRS and the L_{50} set at 11 cm and 13.3 cm of TL respectively. When comparing between years, maximum abundances of red mullet recruits (<10 cm) were found in the coastal Delta shelf in 2020, 2022 and 2023, suggesting an acceptable recruitment for the species during these years.

For monthly length-frequency distribution of red mullet at different métiers in 2023 see Annex 14.

All parameters analyzed in this report for red mullet were calculated using only individuals obtained by bottom trawling sampling (Table 7). For the spatiotemporal length-frequency distribution, individuals obtained by artisanal fisheries sampling were also used.

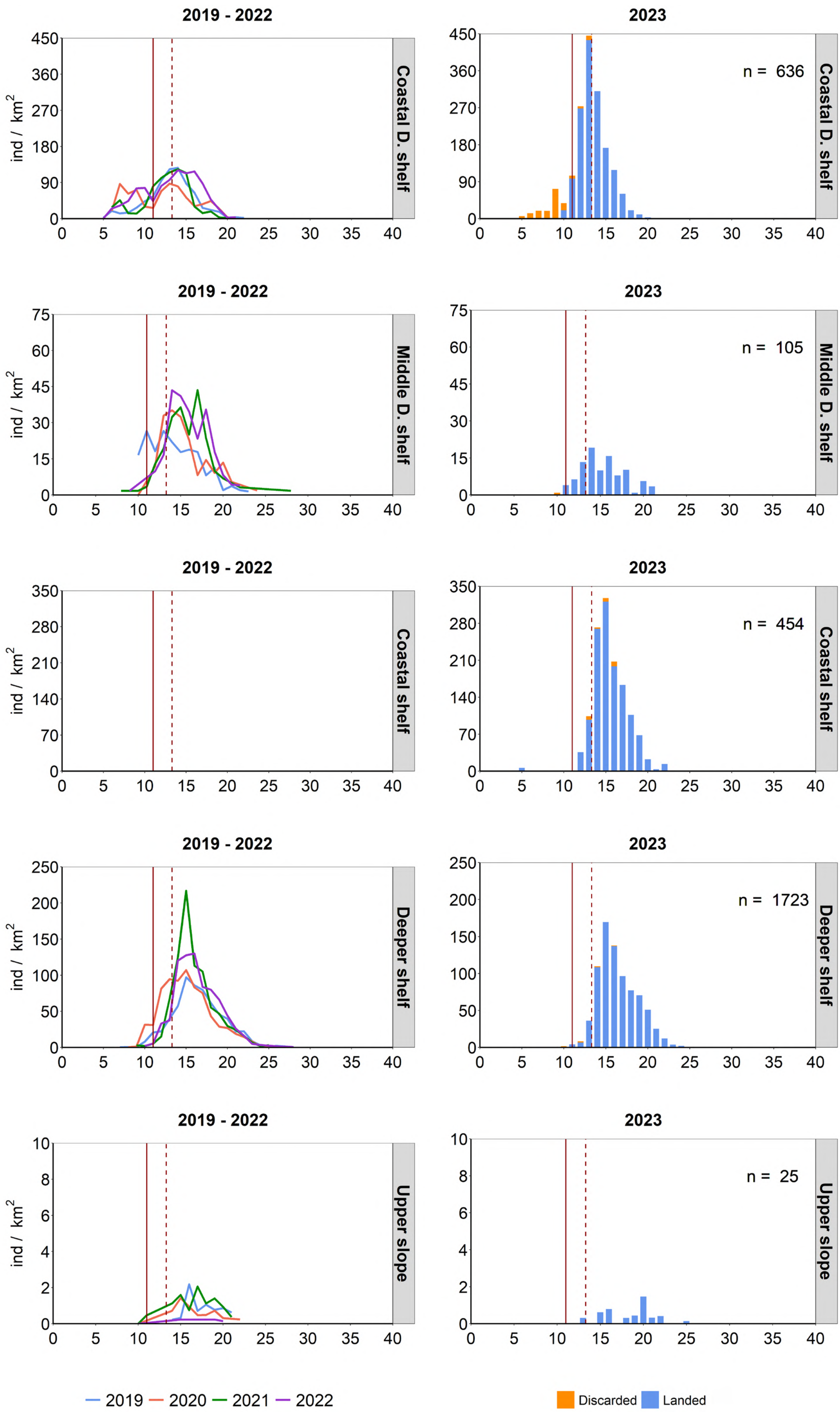


Figure 37. Annual length-frequency distribution of red mullet at different *métiers* (Coastal Delta Shelf, Middle Delta Shelf, Coastal Shelf, Deeper Shelf and Upper Slope). Left: four previous years sampled, right: year analyzed. (n) Total number of measured individuals. Red solid line: Minimum Conservation Reference Size (MCRS). Red dashed line: size at first maturity (L50) of 2023.

Norway lobster (*Nephrops norvegicus*) NEP

The total Norway lobster catch in Catalonia in 2023 was 142 t, 100% of which were caught by bottom trawling (ICATMAR, 24-03).

Figure 38 and Figure 39 show the spatial distribution of the species landings in 2023 and from 2018 to 2022 along the Catalan coast. A decreasing trend is observed over the years, from an annual maximum of 276 kg/km^2 in 2019 to 160 kg/km^2 in 2022, followed by a rebound in 2023 with 231 kg/km^2.

According to length-weight relationship parameters for both sexes combined, Norway lobster showed a positive allometric growth (b>3) in 2023 (Table 8). Likewise, when analyzing the growth curves separately for males and females, both exhibited positive allometric growth and similar a and r^2 values.

In 2023, there was a higher proportion of males which are larger in size and weight than females. Still, similar results can be observed over the years analyzed for both sexes combined and separately, with positive allometric growth in all cases (Figure 40).

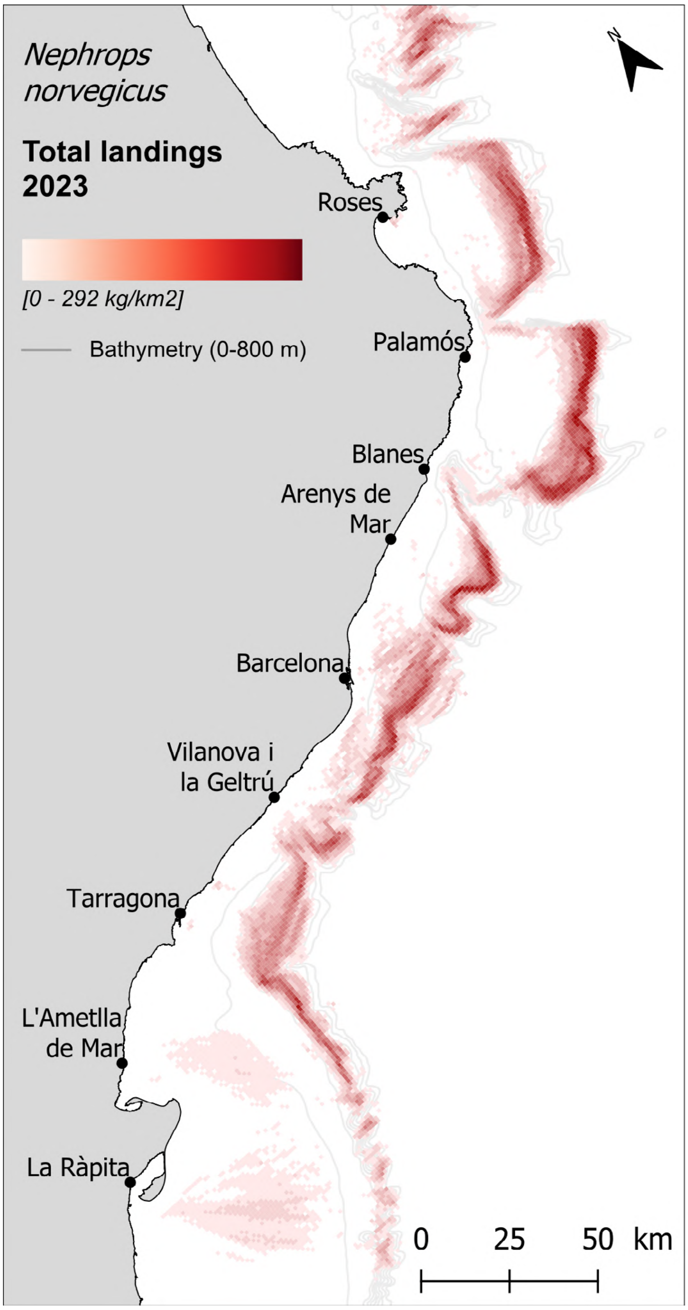


Figure 38. Spatial distribution of landings per unit of effort (LPUE) for Norway lobster in the Catalan fishing grounds (North GSA6) in the year analyzed.

Table 8. Norway lobster length-weight relationship in the year analyzed.

2023	L-W (a)	L-W (b)	L-W (r²)	n
Combined	0.0005	3.1313	0.96	2 496
Females	0.0003	3.2117	0.94	1 080
Males	0.0004	3.1581	0.96	1416

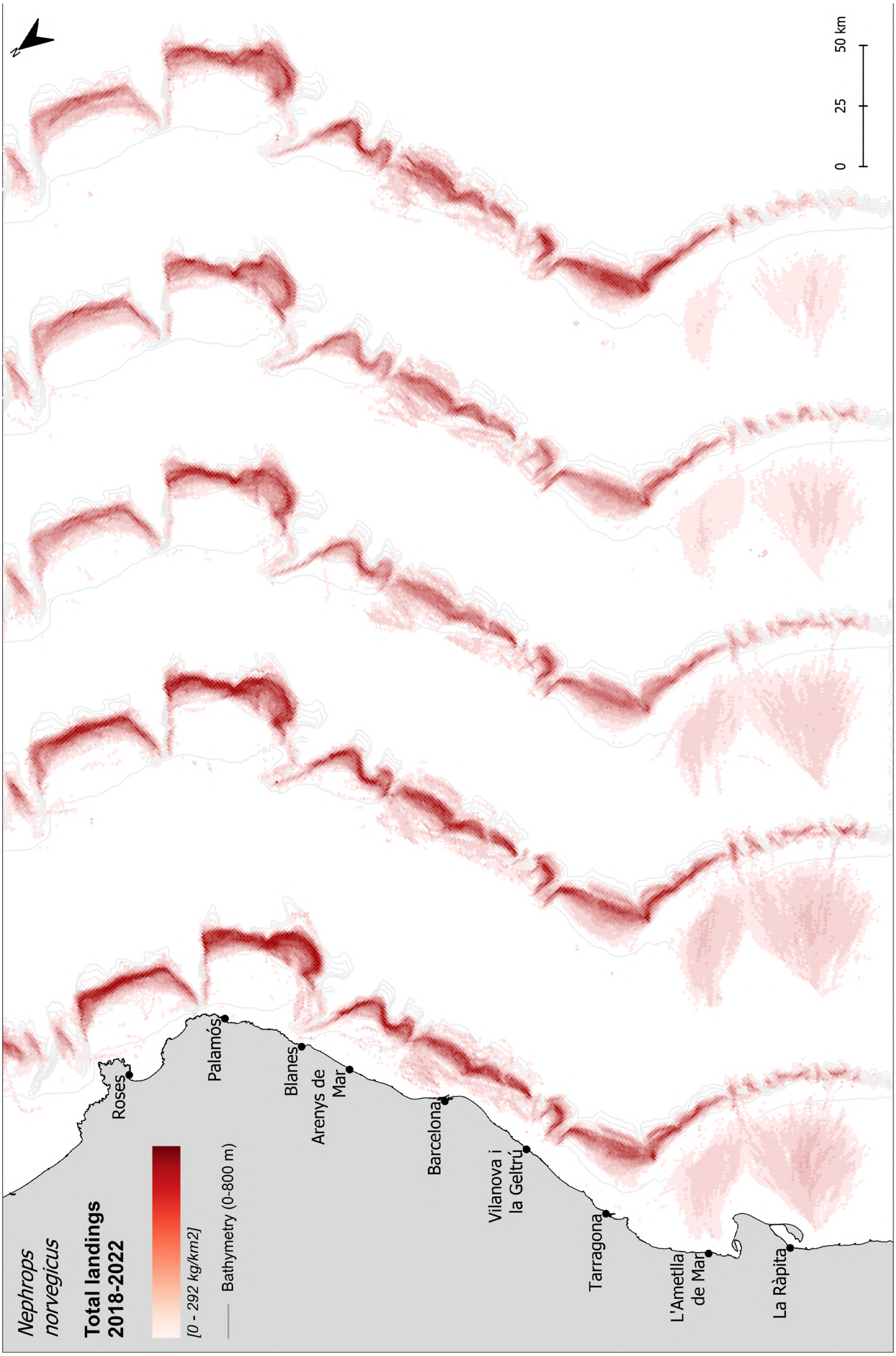


Figure 39. Spatial distribution of landings per unit of effort (LPUE) for Norway lobster in the Catalan fishing grounds (North GSA6) for the five years prior to the year analyzed.

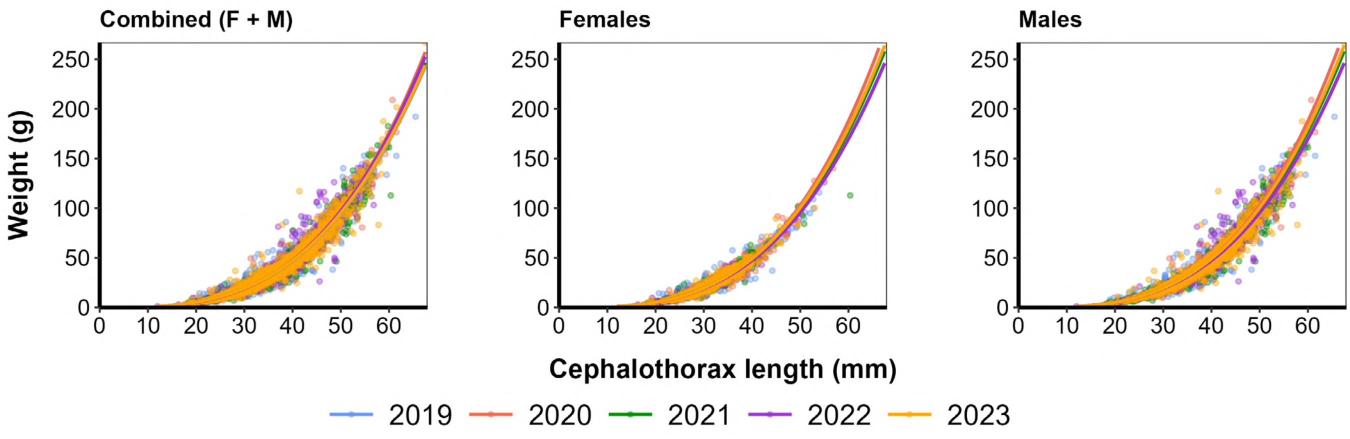


Figure 40. Norway lobster length-weight relationship for the previous four years sampled and the year analyzed.

The size at first maturity (L_{50}) for the Norway lobster in 2023 was 24.71 mm of CL (Figure 41). Comparing between years, 2021 had the lowest L_{50} and 2022 the highest.

In 2023, a total of 1 076 Norway lobster individuals were analyzed to calculate the L_{50}. Out of these, 121 individuals were classified as immature and 955 as mature (Table 9). It should be noted that the low number of immature individuals compared to the mature ones may bias the L_{50} towards larger sizes than it actually is.

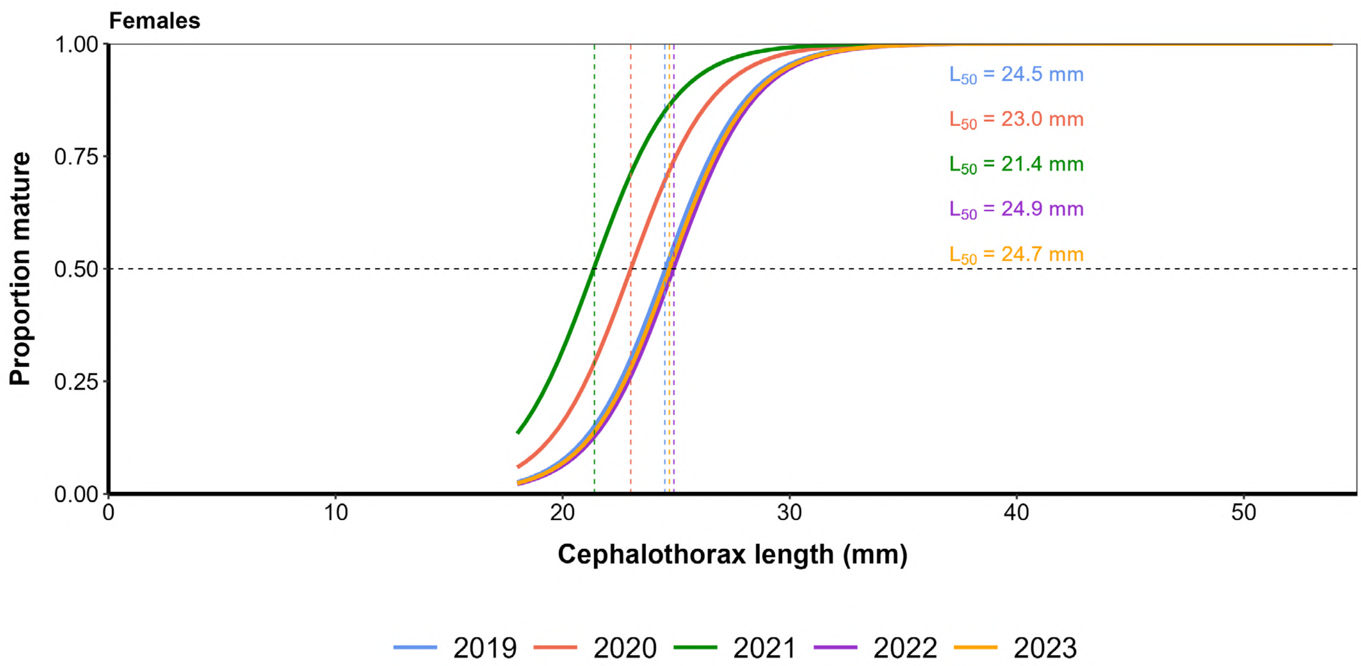


Figure 41. Norway lobster size at first maturity (L_{50}) for all years sampled.

Table 9. Number of mature and immature individuals of Norway lobster included monthly in biological analyses.

Month	2019		2020		2021		2022		2023	
	Immature	Mature	Immature	Mature	Immature	Mature	Immature	Mature	Immature	Mature
January	4	237	28	46	8	47	12	27	8	55
February	3	22	15	57		6	13	60	15	84
March	1	26	4	54	11	90	9	40	4	57
April	22	215				98	11	60	2	41
May	5	111			1	80	4	65	8	189
June		93	6	157		45	8	63	7	67
July	28	197	14	145	8	161	8	45	3	86
August	7	58	2	68	6	36	18	93	18	127
September	5	21	3	23	2	41	6	44	19	92
October	15	43	10	40	1	73	22	55		
November	4	95	11	52			19	75	33	138
December	5	59	6	31	12	57		44	4	19

The gonadal cycle of Norway lobster was analyzed monthly from 2019 to 2023 (Figure 42). The species showed a seasonal reproductive cycle with the highest abundance of mature females from May to September in all years sampled, except 2020, as there was no sampling neither in April nor May. In 2023, mature females were more abundant between May and September, showing a peak between June and August, which matches with the known reproductive season of the species, and coincides with the pattern observed in previous years.

According to the GSI in 2023, the reproductive activity reached a peak in August, when the proportion of mature females was the highest (Figure 42). The proportion of resting females increased after August, with most individuals in resting stage between November and December, coinciding with the minimum GSI values.

For Norway lobster, the proportion of ovigerous females over the years sampled is also represented in Figure 43. Females start to release the eggs right after the reproductive peak, in August, coinciding with the decrease of the GSI value (Figure 42). Thus, the highest proportion of eggs released in 2023 occurred between September and November, a trend that was also observed in all previous years. The eggs were graded according to their maturity stage by color: dark blue/dark green (eggs I, or recently released eggs), light green (eggs II, or developing eggs) and orange/brown (eggs III, or developed eggs). In 2023, ovigerous females with developing eggs (I) were found from September to January, while females with developed eggs (III) were only observed between January and February and in December (Figure 43).

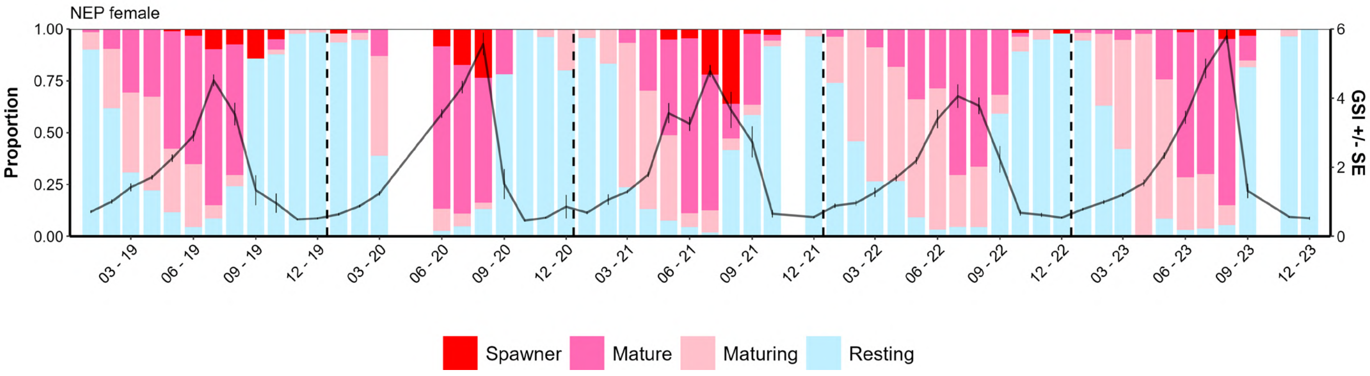


Figure 42. Norway lobster monthly gonadal cycle for females. Gonadosomatic index (GSI +/- SE (Standard Error)) and proportion of different maturity stages.

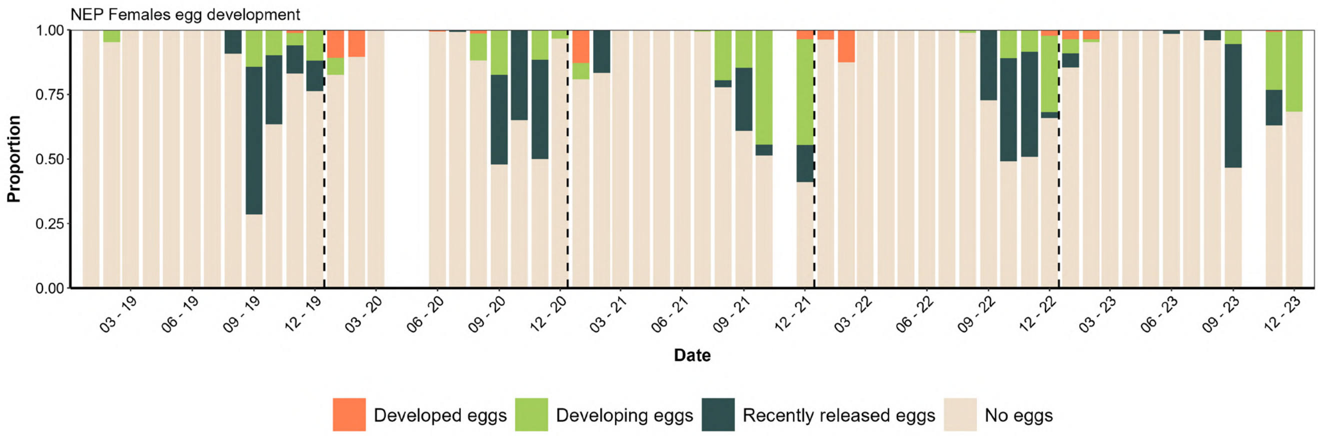


Figure 43. Norway lobster monthly proportion of different egg development stages.

Table 10. Number of Norway lobster individuals measured in the different fisheries along the zones sampled in each season (the values include all the *métier*s sampled).

Fishery	Year	Zone	Winter	Spring	Summer	Autumn	N hauls
			Number individuals sampled				
Bottom trawl	2019	North	16	1968	906	545	23
Bottom trawl	2019	Center	497	639	621	642	20
Bottom trawl	2019	South	183	23	187	6	12
Bottom trawl	2020	North	633	483	747	618	25
Bottom trawl	2020	Center	433	376	556	450	20
Bottom trawl	2020	South	75	1	12	2	9
Bottom trawl	2021	North	348	666	892	676	30
Bottom trawl	2021	Center	732	484	807	417	16
Bottom trawl	2021	South	15	1	6	2	8
Bottom trawl	2022	North	273	642	724	713	27
Bottom trawl	2022	Center	446	313	573	844	22
Bottom trawl	2022	South	1	1	2	0	4
Bottom trawl	2023	North	738	1017	1023	1044	27
Bottom trawl	2023	Center	414	803	662	450	24
Bottom trawl	2023	South	2	1	0	0	3

The spatiotemporal length-frequency distribution of Norway lobster from 2019 to 2023 indicates that the upper slope is the main habitat of the species, despite being also present in the lower slope, the deeper shelf and the middle Delta shelf (Figure 44). In 2023, the size-frequency distribution in the upper slope follows a Gaussian curve, being both tails represented and indicating that the whole community was sampled in this *métier*. Here, the highest abundance of individuals was around 300 ind/km^2 for lengths around 30 mm of CL. Individuals in the upper and lower slope showed a wider size distribution, ranging from 9 to almost 60 mm of CL. The lower slope presents a lower abundance when compared to the upper slope but the largest individuals were found in this *métier* with a CL of around 60 mm but abundances under 5 ind/km^2. In the deeper shelf and the middle Delta shelf only isolated individuals were caught during 2023, 17 and 1, respectively.

In terms of catch size and for all the *métier*s, the highest proportion of individuals were caught above the minimum conservation reference size (MCRS), established at 20 mm of CL (Figure 44). Accordingly, to the habitat preference, larger individuals were more predominant on the upper slope, but also appeared in the lower slope, corresponding to the adult population of the species. In these *métier*s the individuals below the MCRS of the species were mostly part of the discarded fraction of the catch. The L_{50} for 2023 was stablished at 23.7 mm (dashed red line). This is especially relevant in the upper slope, where 1/4 of the commercial size-frequency distribution is under the L_{50}. In 2023, Norway lobster discards are low, mostly from the upper and lower slope, and correspond to individuals under the MCRS and the L_{50}, however, a fraction of the catch under these two parameters is still commercialized. When comparing between years, maximum abundances of adult individuals were found in the upper and lower slope, suggesting a similar distribution for the species during the preceding years. Juvenile individuals were concentrated in the upper slope and decreased in the lower slope.

For monthly length-frequency distribution of Norway lobster at different *métier*s in 2023 see Annex 15.

All parameters analyzed in this report for the Norway lobster were calculated using only individuals obtained by bottom trawling sampling (Table 10).

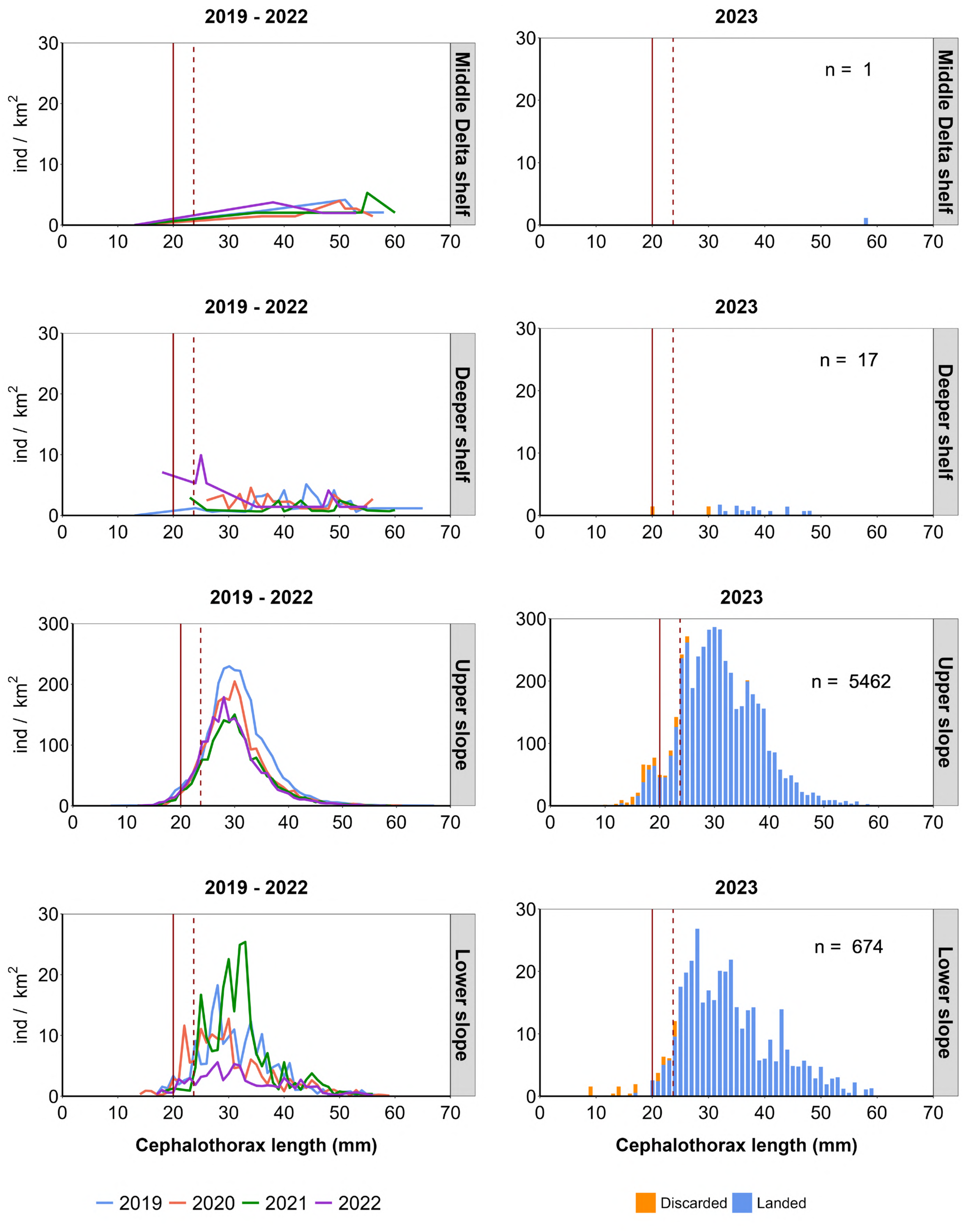


Figure 44. Annual length-frequency distribution of Norway lobster at different *métiers* (Middle Delta shelf; Deeper shelf; Upper slope; Lower slope). Left: previous years sampled, right: year analyzed. (n) Total number of measured individuals. Red solid line: Minimum Conservation Reference Size (MCRS) and red dashed line: size at first maturity (L_{50}) calculated as the mean between the L_{50} values of the previous four years sampled and the year analyzed.

Deep-water rose shrimp (*Parapenaeus longirostris*) DPS

The total deep-water rose shrimp catch in Catalonia in 2023 was 303 t, 100% of which were caught by bottom trawling (ICATMAR, 24-03).

Figure 45 and Figure 46 show the spatial distribution of the species landings in 2022 and the period 2018-2022 along the Catalan coast. An increasing trend is observed over the years with an annual maximum of 864 kg/km^2 in 2021. This peak was followed by a decreasing trend with a maximum of 472 kg/km^2 in 2023.

According to length-weight relationship parameters for both sexes combined and separately, deep-water rose shrimp displayed a negative allometric growth (b<3) in 2023 (Table 11). Despite not having samples from the entire year, there is a significant sample size, with 2768 individuals, and more than twice as many females as males. As with other crustacean species, there is a marked sexual dimorphism, with females being much larger than males.

Figure 47 shows deep-water rose shrimp length-weight relationship for 2022 and 2023. As with other species of the suborder Dendrobranchiata, there is clear sexual dimorphism within the species; females reach a larger size, and males do not grow much more than 30 mm in CL.

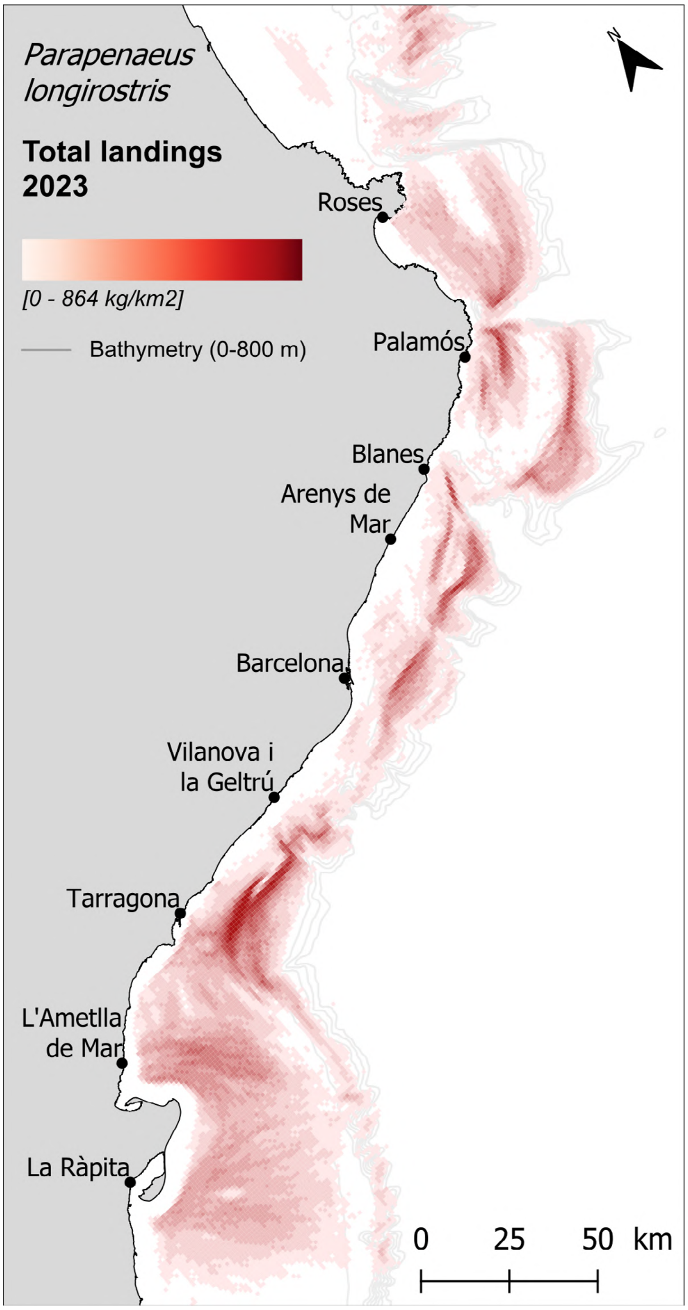


Figure 45. Spatial distribution of landings per unit of effort (LPUE) for deep-water rose shrimp in the Catalan fishing grounds (North GSA6) in the year analyzed.

Table 11 Deep-water rose shrimp length-weight relationship in the year analyzed.

Length – total weight relationship				
2023	a	b	r^2	n
Combined	0.0034	2.4578	0.94	2768
Females	0.0046	2.3775	0.94	1975
Males	0.0054	2.2986	0.87	790

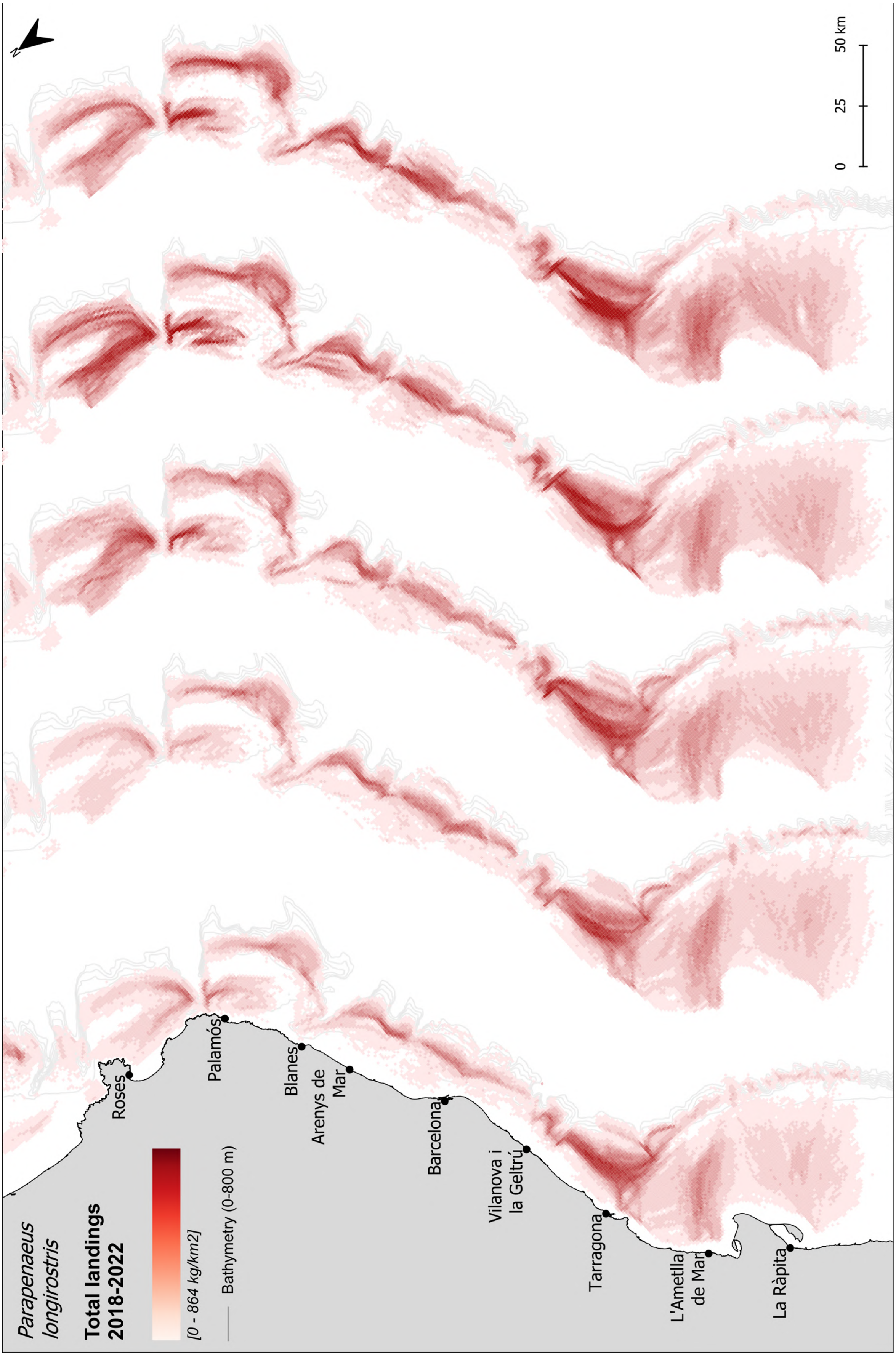


Figure 46. Spatial distribution of landings per unit of effort (LPUE) for deep-water rose shrimp in the Catalan fishing grounds (North GSA6) for the five years prior to the year analyzed.

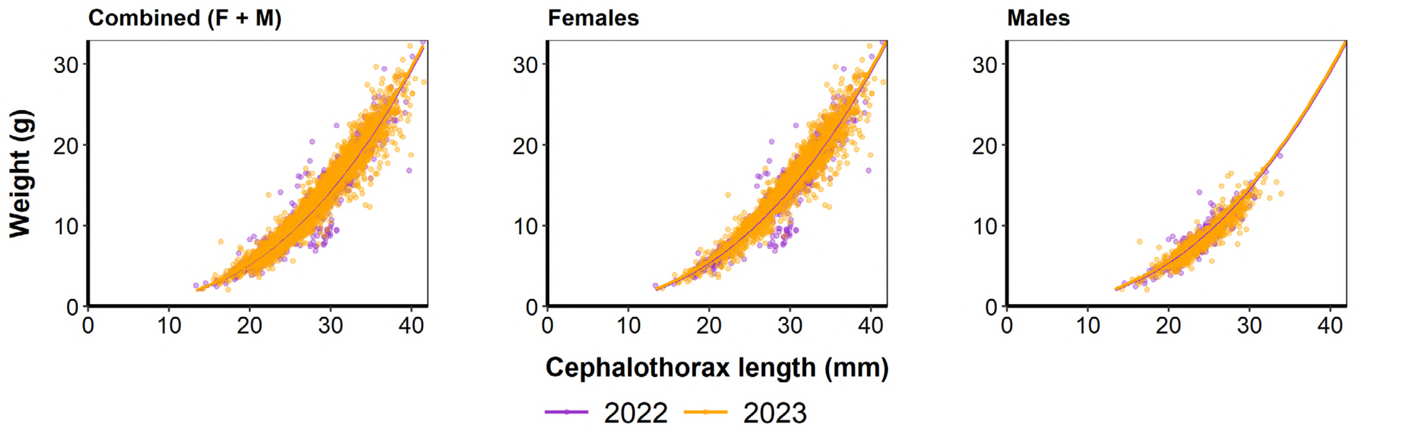


Figure 47 Deep-water rose shrimp length-weight relationship for the years sampled.

The L_{50} for deep-water rose shrimp in 2023 was 17.4 mm of CL, which is consistent with that obtained in previous studies (Figure 48). In 2022, sampling of this species began in August and, therefore, only females captured between August and December were used for the calculation of the L_{50} (Table 12). Given that this species has become an important fishing resource on the Catalan coast due to the considerable increase in its catches over the last decade, it will be interesting to see how its L50 evolves over time, as variations in this parameter are useful for assessing the level of exploitation of a species.

In 2023, a total of 2 112 deep-water rose shrimp individuals were analyzed to calculate the L_{50}. Out of these, 54 individuals were classified as immature and 2 058 as mature (Table 12). It should be noted that the low number of immature individuals compared to the mature ones may bias the L_{50} towards larger sizes than it actually is.

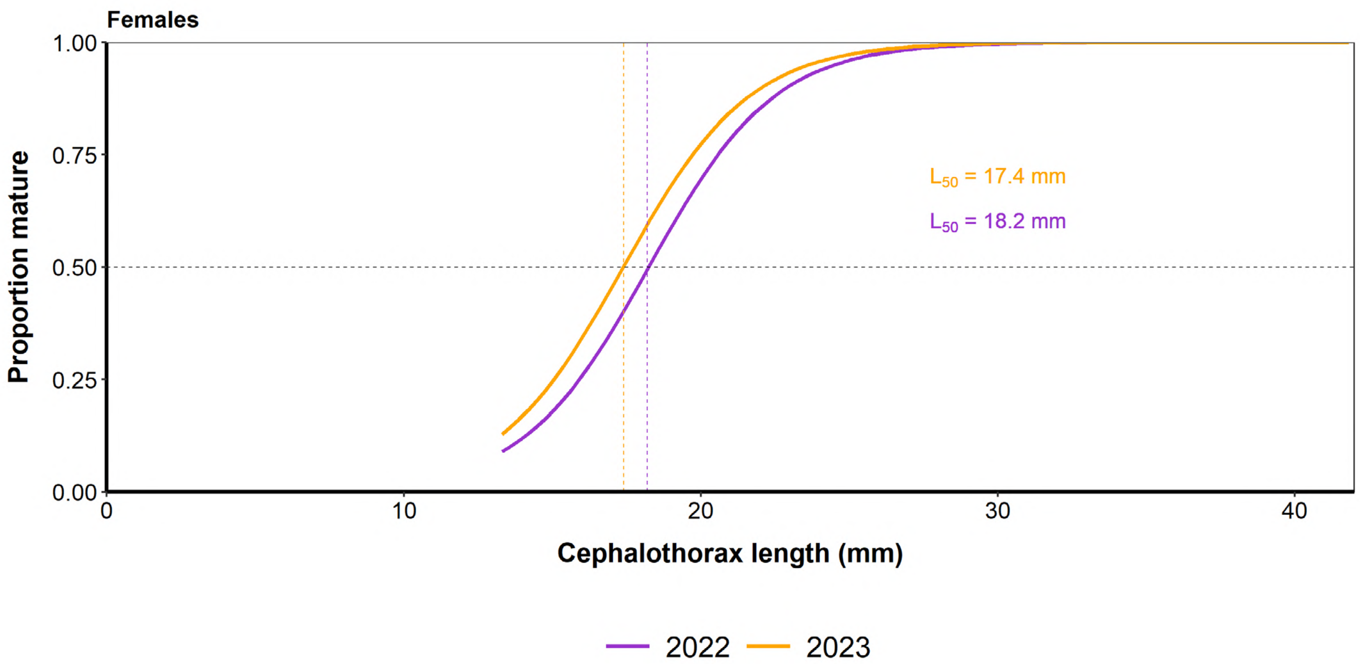


Figure 48 Deep-water rose shrimp size at first maturity (L_{50}) for all years sampled.

Table 12. Number of mature and immature individuals of deep-water rose shrimp included monthly in biological analyses.

Month	2022		2023	
	Immature	Mature	Immature	Mature
January			2	134
February			6	315
March			23	227
April			0	104
May			0	114
June			0	193
July			8	180
August	10	180	0	151
September	13	158	10	162
October	14	220	3	292
November	2	235	0	52
December	2	78	2	134

The gonadal cycle of deep-water rose shrimp was analyzed monthly from 2022 (sampling of this species started in August) to 2023 (Figure 49). The species showed a continuous reproductive cycle with females in all maturity states throughout the year. However, from February to April 2023 there was an increase in the proportion of resting females, coinciding with a decline of GSI values reaching their minimum. Existing literature indicates that, unlike other crustacean species of commercial interest, deep-water rose shrimp does not have a marked reproductive cycle, but presents individuals at different stages of maturity throughout the year, which could be related to the rapid expansion capacity of the species.

Figure 49 Deep-water rose shrimp monthly gonadal cycle for females (top) and males (bottom). Gonadosomatic index (GSI +/- SE (Standard Error)) and proportion of different maturity stages.

Table 13 Number of deep-water rose shrimp individuals measured in the different fisheries along the zones sampled in each season (the values include all *métiers* sampled).

Fishery	Year	Zone	Winter	Spring	Summer	Autumn	N hauls
			Number individuals sampled				
Bottom trawl	2019	North	206	459	212	328	30
Bottom trawl	2019	Center	204	263	157	553	21
Bottom trawl	2019	South	402	170	285	272	23
Bottom trawl	2020	North	206	236	405	532	24
Bottom trawl	2020	Center	292	308	364	425	23
Bottom trawl	2020	South	368	77	156	340	15
Bottom trawl	2021	North	518	676	818	591	34
Bottom trawl	2021	Center	402	404	387	214	19
Bottom trawl	2021	South	297	41	204	224	16
Bottom trawl	2022	North	397	419	931	983	32
Bottom trawl	2022	Center	311	239	1197	659	19
Bottom trawl	2022	South	186	242	380	753	13
Bottom trawl	2023	North	1245	880	1012	565	25
Bottom trawl	2023	Center	585	369	591	207	18
Bottom trawl	2023	South	895	517	449	311	14

The spatiotemporal length-frequency distribution of deep-water rose shrimp from 2019 to 2023 indicates that the species is present in all the *métiers* sampled, but shows the highest abundance in the upper slope, followed by the deeper shelf and the middle Delta shelf (Figure 50). In the case of the deep-water rose shrimp, the L_{50} is lower than the MCRS, which, theoretically, benefits the species by providing more time to reproduce. It should also be noted that in Ebre Delta area, the species inhabits shallower waters. According to the literature, the deep-water rose shrimp benefits from breeding and developing in areas with high temperature and salinity.

In terms of catch size, it can be observed that practically the entire available size range for the species was sampled, with the smallest individuals in the middle Delta shelf and the deeper shelf in all years samples (Figure 50). On the other hand, at greater depths, in the lower slope, all the specimens captured were adults, especially in 2023. Comparing between years, there seems to be an increase in abundance throughout the years, except in 2023, when abundances decreased slightly in all métiers but the coastal Delta shelf, where it increased.

For monthly length-frequency distribution of deep-water rose shrimp at different *métier*s in 2023 see Annex 16.

All parameters analyzed in this report for deep-water rose shrimp were calculated using only individuals obtained by bottom trawling sampling (Table 13).

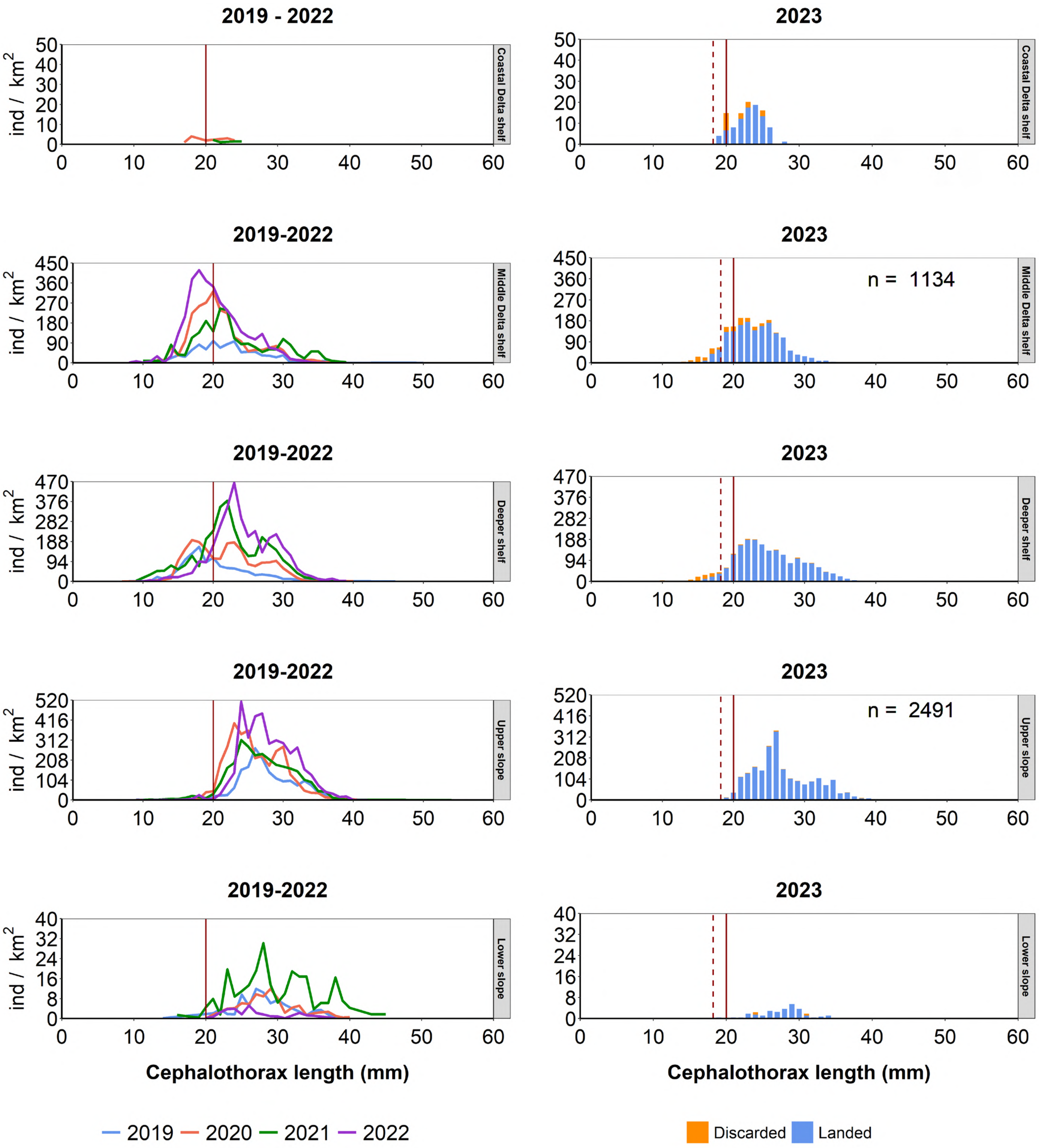


Figure 50 Annual length-frequency distribution of deep-water rose shrimp at different *métiers* (Coastal Delta Shelf, Middle Delta Shelf, Coastal Shelf, Deeper Shelf, Upper Slope and Lower Slope). Left: previous years sampled, right: year analyzed. (n) Total number of measured individuals. Red solid line: Minimum Conservation Reference Size (MCRS). Red dashed line: size at first maturity (L_{50}) calculated as the mean between the L50 values of 2022 and 2023.

Blue and red shrimp (*Aristeus antennatus*) ARA

The total blue and red shrimp catch in Catalonia in 2022 was 364 t, 100% of which were caught by bottom trawling (ICATMAR, 24-03).

Figure 51 and Figure 52 show the spatial distribution of the species landings in 2023 and in the period 2018-2022 along the Catalan coast, where he fishing effort is mainly concentrated around submarine canyons. A decreasing trend is observed over the years, with a maximum of 2 919 kg/km^2 in 2018 and a minimum of 1 190 kg/km^2 in 2022. In contrast, in 2023 there was a considerable increase with respect to 2022, reaching an annual maximum of 2 853 kg/km^2.

According to length-weight relationship parameters for both sexes combined and separately, blue and red shrimp displayed a negative allometric growth (b<3) in 2023 (Table 14).

Comparing the growth curves between the years sampled for both sexes combined and separately, similar results can be observed over the years with negative allometric growth in all cases (Figure 53). As shown in the length-weight relationship separated by sexes, females reach larger sizes than males.

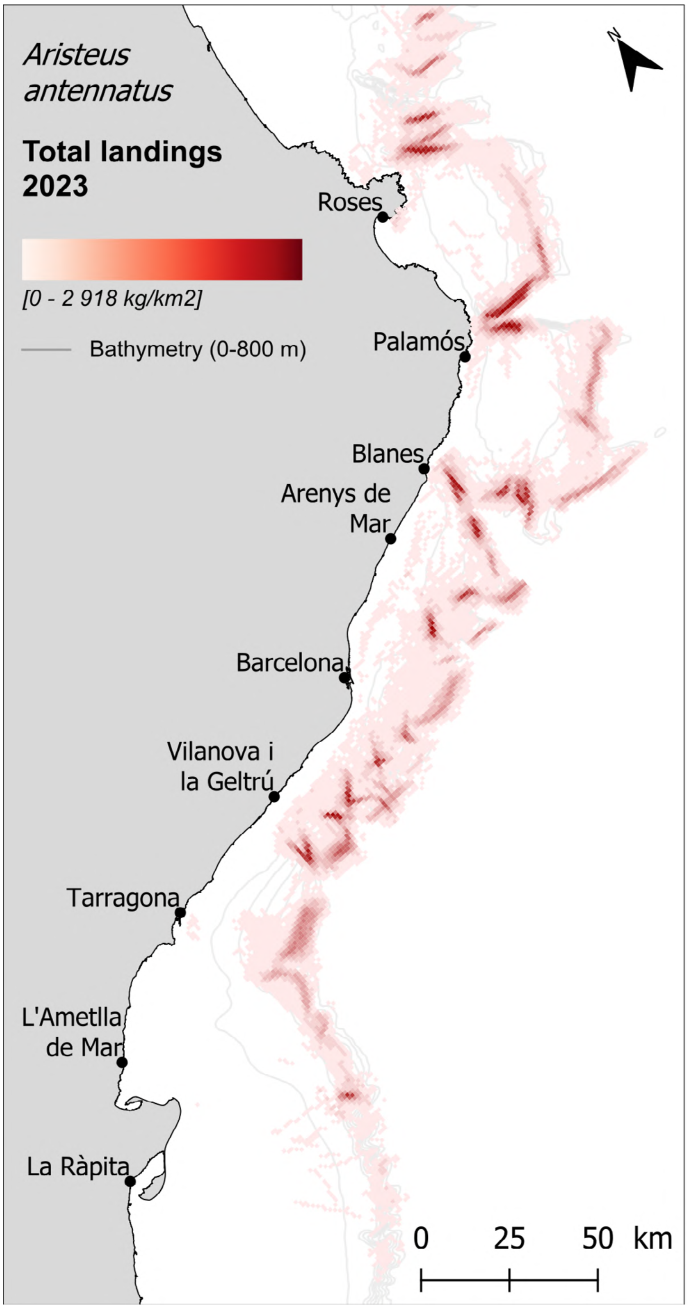


Figure 51. Spatial distribution of landings per unit of effort (LPUE) for blue and red shrimp in the Catalan fishing grounds (North GSA6) in the year analyzed.

Table 14. Blue and red shrimp length-weight relationship in the year analyzed.

2023	L-W (a)	L-W (b)	L-W (r^2)	n
Combined	0.0029	2.4615	0.98	1928
Females	0.003	2.4568	0.98	1827
Males	0.0053	2.2734	0.94	101

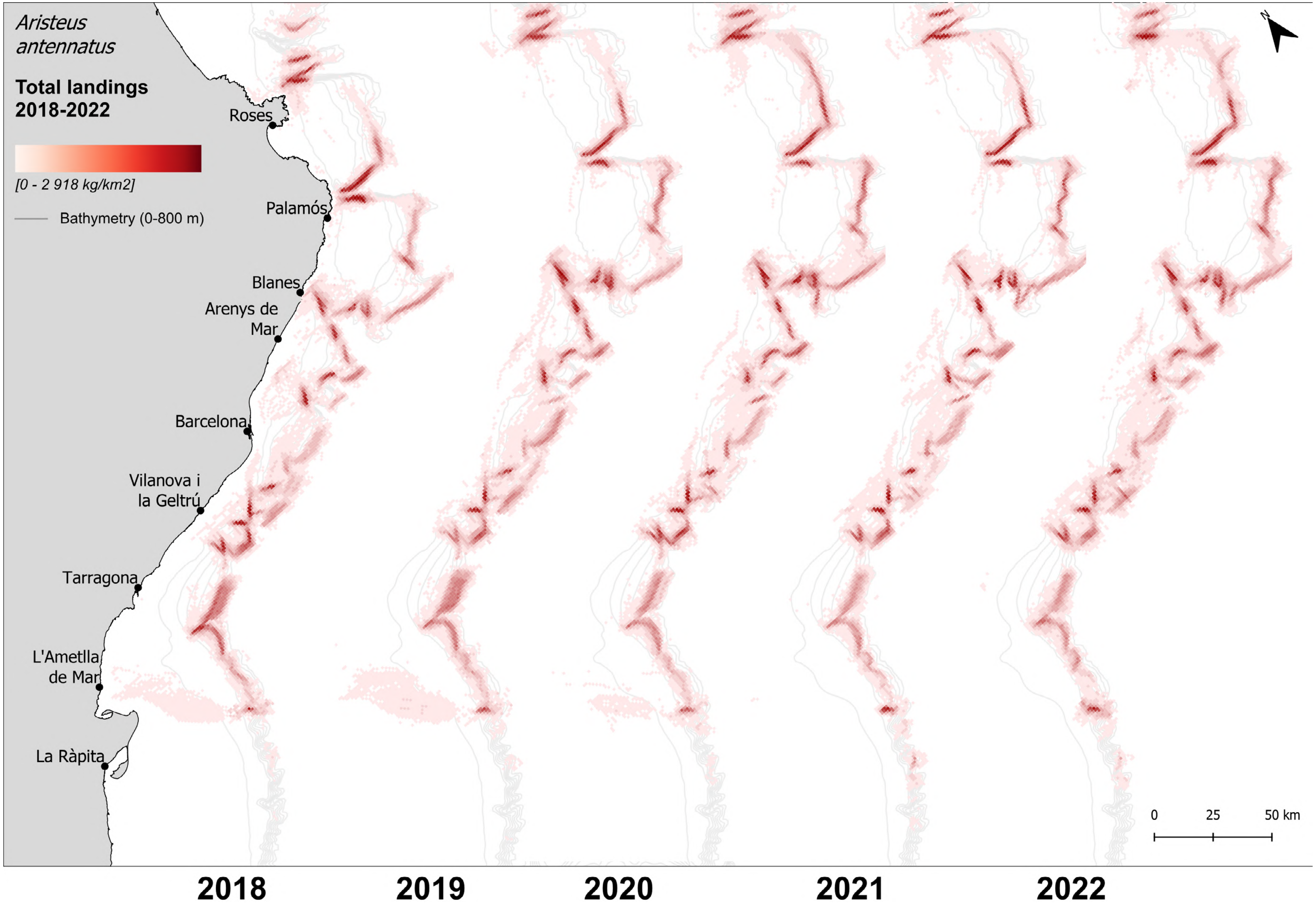


Figure 52. Spatial distribution of landings per unit of effort (LPUE) for blue and red shrimp in the Catalan fishing grounds (North GSA6) for the five years prior to the year analyzed.

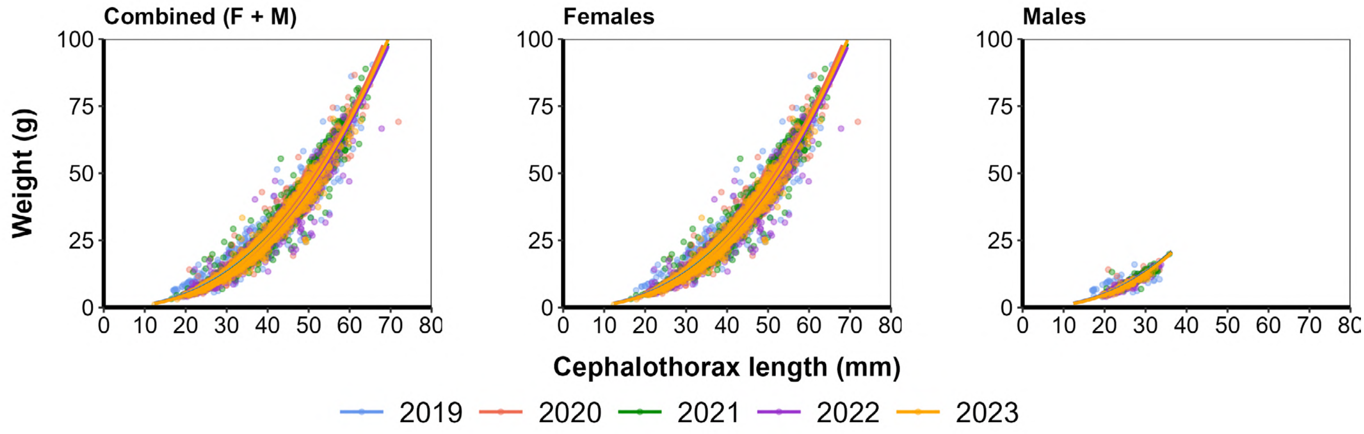


Figure 53. Blue and red shrimp length-weight relationship for the previous four years sampled and the year analyzed.

The L_{50} for blue and red shrimp in 2023 was 24.2 mm of CL (Figure 54). Comparing between years, a decreasing trend from 2019 to 2021 can be observed, especially in 2021, when the L_{50} decreased by almost 1 mm. However, in the following two years it increased by 1 mm per year.

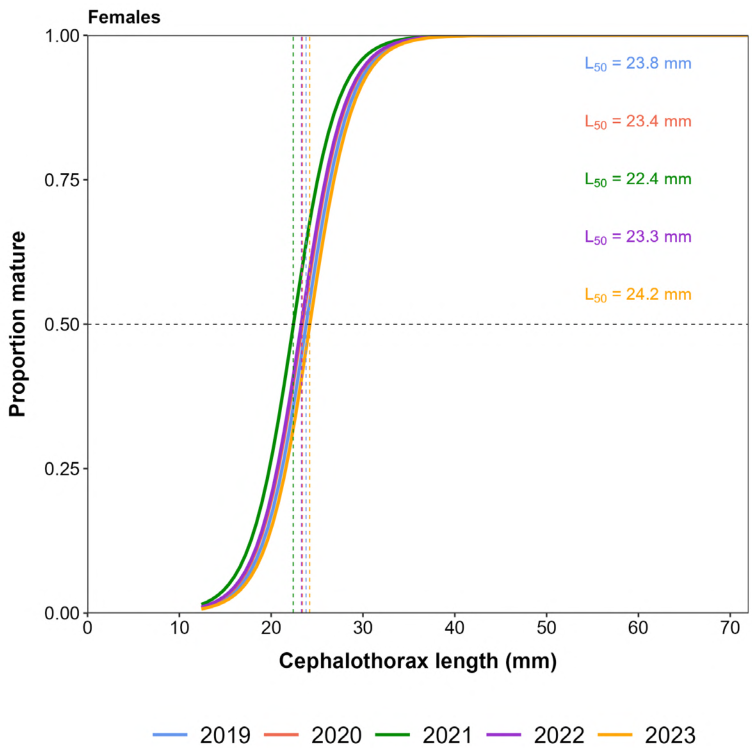


Figure 54. Blue and red shrimp size at first maturity (L_{50}) for all years sampled.

Table 15. Number of mature and immature individuals of blue and red shrimp included monthly in biological analyses.

Month	2019		2020		2021		2022		2023	
	Immature	Mature	Immature	Mature	Immature	Mature	Immature	Mature	Immature	Mature
January	26	264	18	136	7	246	38	162	6	116
February	3	75	4	195	0	0	13	158	24	62
March	0	72	2	158	0	321	5	158	0	156
April	5	283	0	0	0	256	10	71	0	68
May	1	235	0	0	0	187	0	131	0	158
June	0	140	0	345	6	102	0	162	1	191
July	4	335	0	274	0	268	0	119	0	90
August	3	335	5	301	0	131	0	240	2	144
September	1	95	0	85	0	175	0	181	8	274
October	44	160	7	195	13	230	4	106	0	0
November	30	426	39	318	0	0	0	163	54	384
December	2	148	8	93	32	177	9	126	0	85

In 2023, a total of 1 823 blue and red shrimp female individuals were analyzed to calculate the L_{50} (Table 15). Out of these, 95 individuals were classified as immature and 1 728 as mature. It should be noted that the low number of immature individuals compared to the mature ones may bias the L_{50} towards larger sizes than it actually is. However, the capture of a reduced number of immature individuals in the samples is a good indication of improved sustainability of the fishery. In fact, a possible management measure is to improve the selectivity of the trawl gear to reduce the catch of immature individuals.

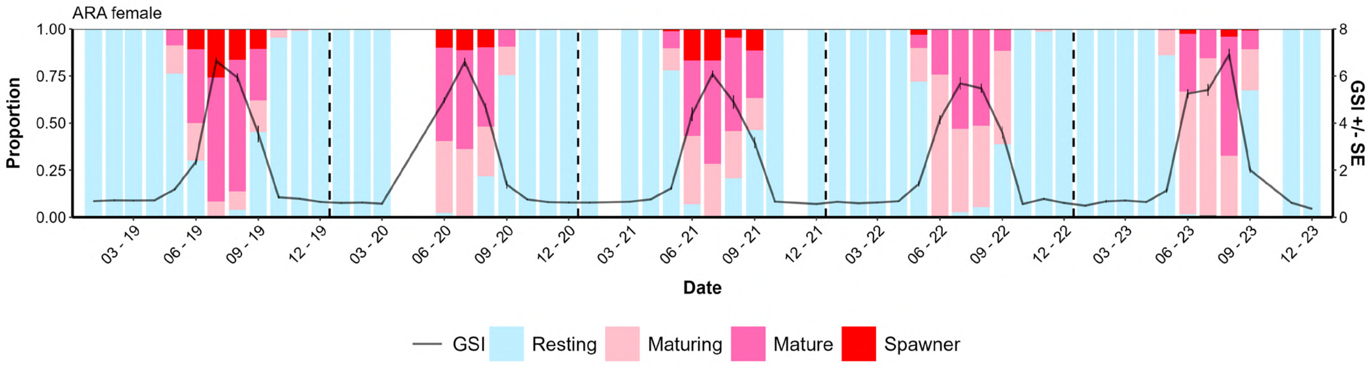


Figure 55. Blue and red shrimp monthly gonadal cycle for females from 2019 to 2023. Gonadosomatic index (GSI +/-SE (Standard Error)) and proportion of different maturity stages.

The gonadal cycle of blue and red shrimp was analyzed monthly from 2019 to 2023 (Figure 55). The species showed a highly seasonal reproductive cycle with a peak in its reproductive activity during the spring and summer months, co-inciding with the highest GSI values. In contrast, females were in resting state during most of the autumn and winter months for all years.

Throughout their life cycle, blue and red shrimp females store the spermatophore deposited by a male in their telycum. The presence or absence of spermatophore is related to the sexual maturity of females. Figure 56 shows the monthly spermatophore occurrence by size in blue and red shrimp females over the years sampled. It can be observed that 100% of females showed presence of spermatophore during the spring and summer months, coinciding with the species reproductive season (Figure 55). In contrast, during the autumn and winter months, the proportion of females with presence of spermatophore was lower.

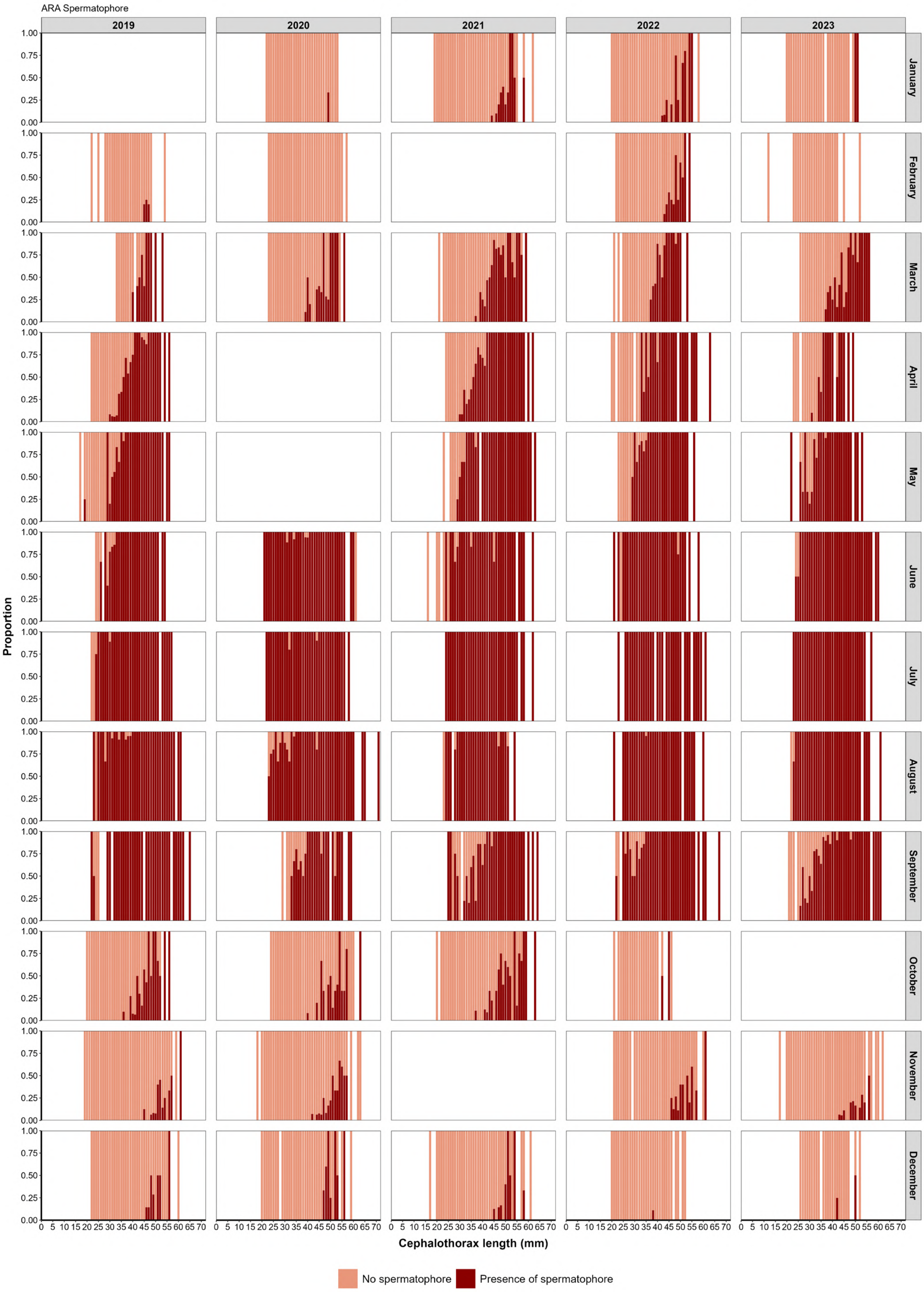


Figure 56. Monthly proportion of females with attached spermatophore of blue and red shrimp at different lengths.

Table 16. Number of blue and red shrimp individuals measured in bottom trawl fishery along the zones sampled in each season (the values include all métiers sampled). Blue and red shrimp sampling in the South zone ceased from 2021.

Fishery	Year	Zone	Winter	Spring	Summer	Autumn	N hauls
			Number individuals sampled				
Bottom trawl	2019	North	181	1796	1102	900	17
Bottom trawl	2019	Center	1005	848	483	1049	12
Bottom trawl	2019	South	490	0	898	433	5
Bottom trawl	2020	North	697	502	1040	1055	16
Bottom trawl	2020	Center	467	655	894	991	10
Bottom trawl	2020	South	537	0	477	335	3
Bottom trawl	2021	North	1053	979	1146	1100	16
Bottom trawl	2021	Center	1067	974	552	465	12
Bottom trawl	2022	North	889	921	934	746	15
Bottom trawl	2022	Center	835	532	663	431	11
Bottom trawl	2023	North	651	629	921	721	13
Bottom trawl	2023	Center	587	757	816	772	13

In terms of size, larger individuals had more presence of spermatophore compared to smaller ones. Furthermore, larger individuals can maintain the spermatophore throughout the year regardless of their sexual maturity stage (Sardà and Demestre, 1987). The presence of spermatophore throughout the year could be related to the fact that larger individuals undergo less molting processes than smaller ones and therefore do not lose their spermatophore. On the contrary, the proportion of smaller individuals with spermatophore presence increased from spring onwards and decreased after summer, as they undergo multiple molting processes throughout the year. When comparing between years, the results are similar for all years sampled.

The spatiotemporal length-frequency distribution of blue and red shrimp from 2019 to 2023 is only shown for the upper and lower slopes *métiers*, as these are the ones that correspond to the strata where the species inhabits (Figure 57). The highest abundances were found in the lower slope in all years sampled. When comparing between years, 2022 showed the highest abundance in both *métiers*. The abundance of larger sizes in the lower slope, decreased from 2019 to 2022.

In 2023, sizes ranged between 15.5 and 60 mm of CL, with the mode locate at 33 mm of CL in the lower slope, higher than in 2022. Furthermore, in 2023 there was a lower proportion of individuals caught below the MCRS established at 25 mm CL, reflecting an improvement in the selectivity of this species. No individuals were caught in the upper slope during the 2023 sampling, as was the case in 2021.

The MCRS for Blue and red shrimp (25 mm of CL) was not established until December 2023, so all catches of this species could be commercialized and there were hardly any discarded individuals. Even so, a considerable proportion of the individuals sampled were below the L_{50} and the MCRS.

For monthly length-frequency distribution of blue and red shrimp at different *métiers* in 2023 see Annex 17.

All parameters analyzed in this report for blue and red shrimp were calculated using only individuals obtained by bottom trawling sampling (Table 16).

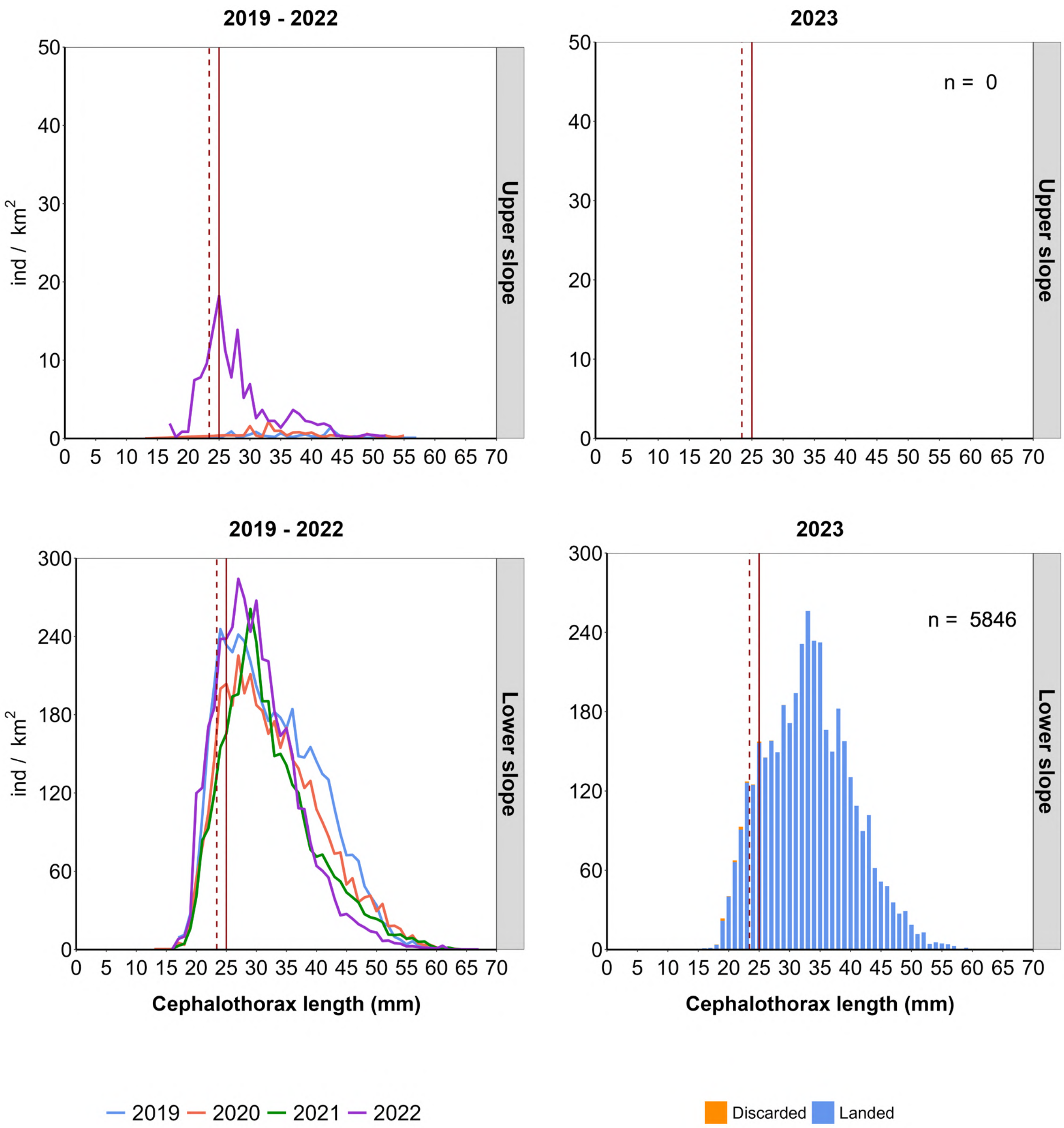


Figure 57. Annual length-frequency distribution of blue and red shrimp at different *métiers* (US; Upper Slope and LS; Lower Slope). Left: previous years sampled, right: year analyzed. (n) Total number of measured individuals. Red solid line: Minimum Conservation Reference Size (MCRS). Red dashed line: size at first maturity (L_{50}) calculated as the mean between the L_{50} values of the previous four years sampled and the year analyzed.

Horned octopus (*Eledone cirrhosa*) EOI

The total horned octopus catch in Catalonia in 2023 was 318 t, 100% of which were caught by bottom trawling (ICATMAR, 24-03).

Figure 58 and Figure 59 show the spatial distribution of horned octopus landings in 2023 and from 2018 to 2022 along the Catalan coast. Maximum annual landings were reached in 2018 with 588 kg/km^2, mainly off Roses and Tarragona, and remained stable in the following years at around 400 kg/km^2. In 2023, the trend remained stable as annual maximum landings per unit of effort were 358 kg/km^2.

According to length-weight relationship parameters for both sexes combined and separately, horned octopus displayed a negative allometric growth ($b < 3$). Likewise, when applying the growth curves separately for males and females, both sexes exhibited negative allometric growth. (Figure 60). Previous years showed similar growth trends when analyzing both sexes. However, growth trend seems to be slightly lower in 2019 when females and males are compared separately.

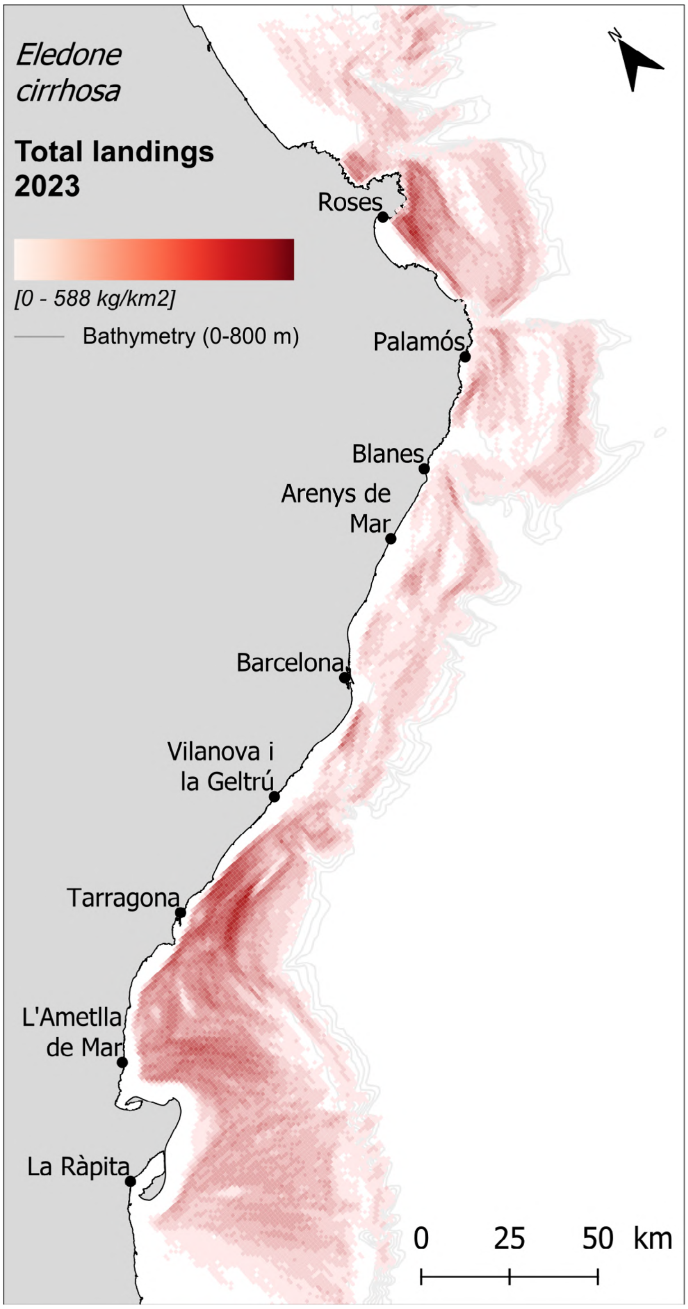


Figure 58. Spatial distribution of landings per unit of effort (LPUE) for horned octopus in the Catalan fishing grounds (North GSA6) in the year analyzed.

Table 17. Horned octopus length-weight relationship in the year analyzed.

Length – total weight relationship				
2023	a	b	r^2	n
Combined	0.6777	2.6277	0.84	603
Females	1.1661	2.3978	0.8	322
Males	0.6685	2.6244	0.76	277

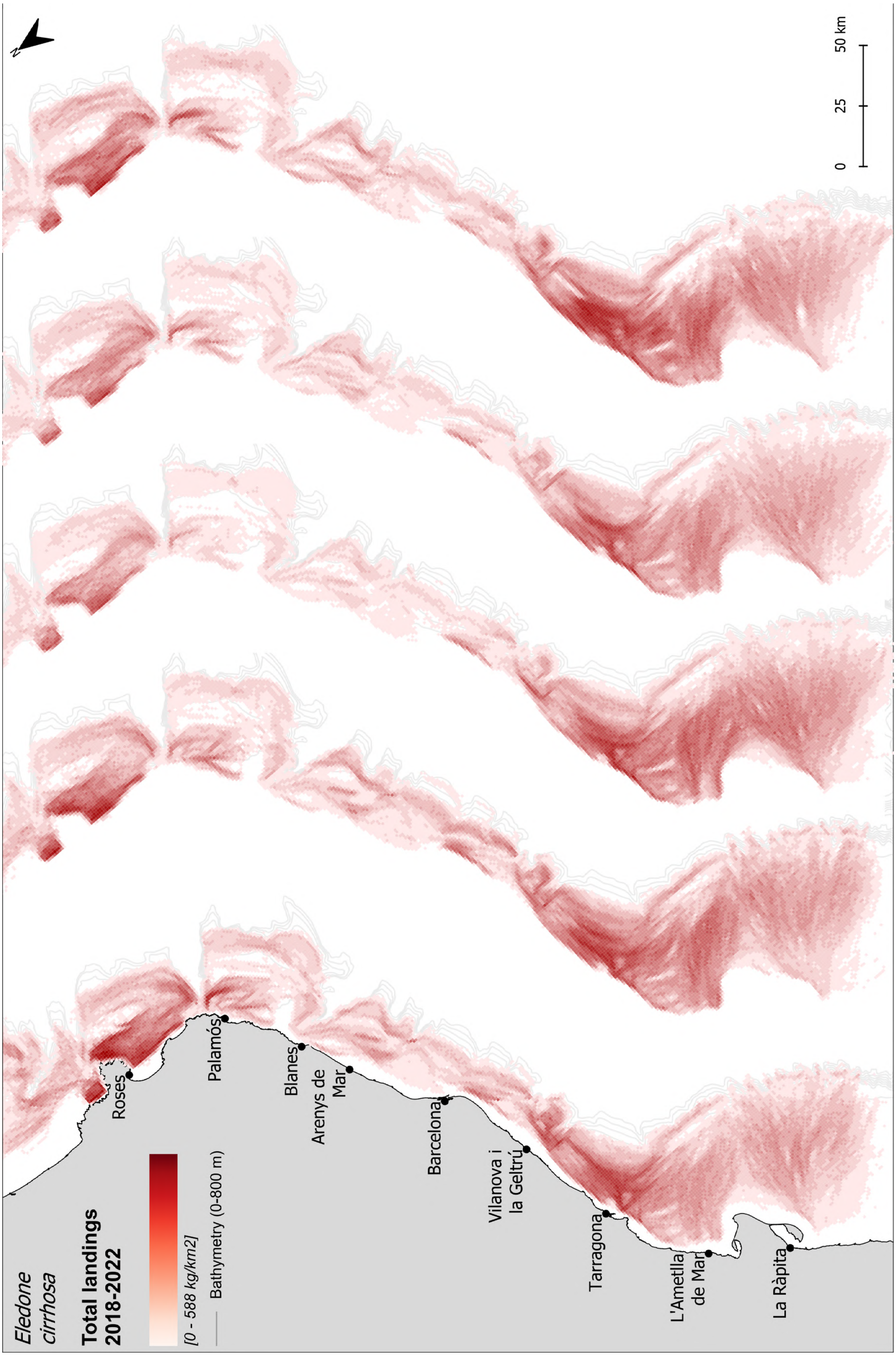


Figure 59. Spatial distribution of landings per unit of effort (LPUE) for horned octopus in the Catalan fishing grounds (North GSA6) for the five years prior to the year analyzed.

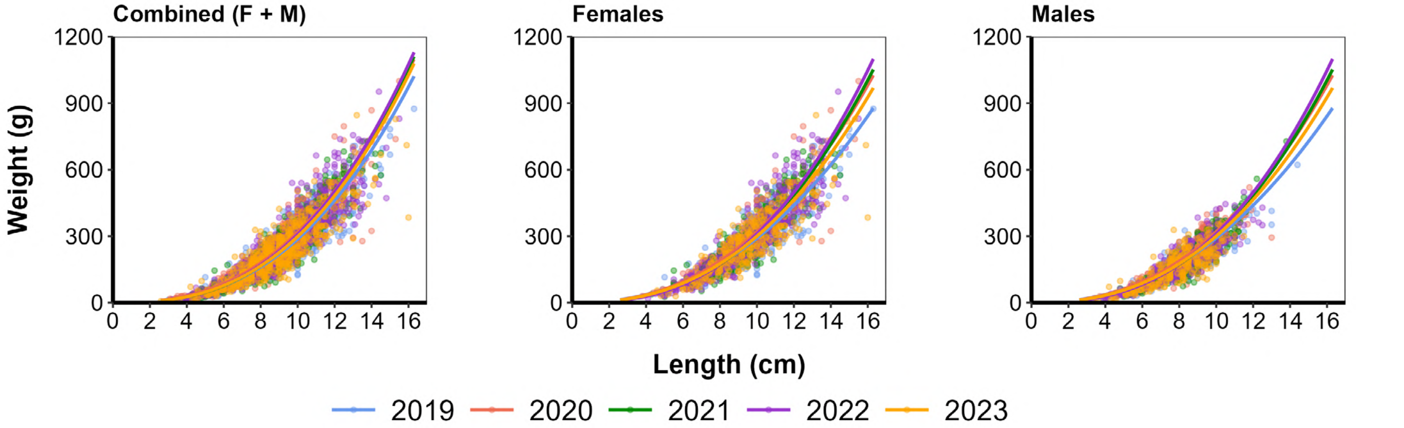


Figure 60. Horned octopus length-weight relationship for the previous four years sampled and the year analyzed.

Regarding the L_{50}, 50% of horned octopus specimens attained sexual maturity at 6.3 cm of ML in 2023 (Figure 61). Males showed an earlier maturation as their L_{50} was 6.1 cm of ML, which is lower than the L_{50} of females (7.2 cm of ML). When comparing between years, 2019 showed the lowest L_{50} of all. However, the differences between years were despicable.

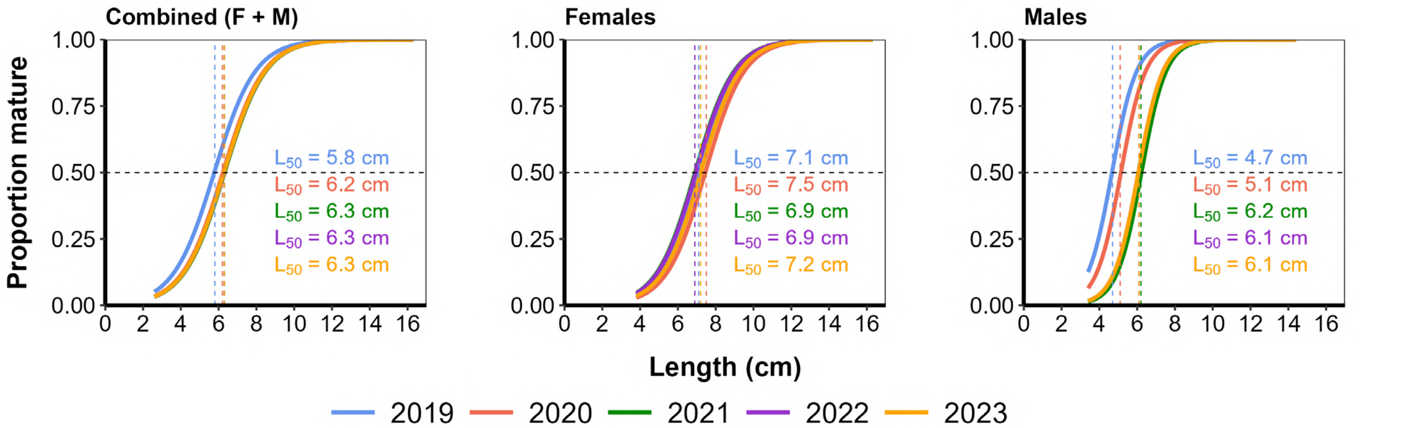


Figure 61. Horned octopus size at first maturity (L_{50}) for all years sampled.

Table 18. Number of mature and immature individuals of horned octopus included monthly in biological analyses.

Month	2019		2020		2021		2022		2023	
	Immature	Mature	Immature	Mature	Immature	Mature	Immature	Mature	Immature	Mature
January	0	23	1	67	0	50	0	43	12	87
February	0	49	3	94	2	37	1	75	0	72
March	2	53	0	10	4	103	3	56	0	87
April	4	128	0	0	0	22	0	20	0	9
May	1	74	0	0	2	59	6	53	2	125
June	2	73	11	74	2	18	31	69	8	42
July	26	56	27	18	10	25	14	25	4	12
August	7	61	42	42	24	16	28	24	1	3
September	24	18	13	48	24	35	20	42	40	16
October	2	96	1	8	1	19	8	62	0	0
November	5	49	22	104	0	0	12	74	28	45
December	17	61	8	35	17	103	10	56	3	6

In 2023, a total of 602 horned octopus individuals were analyzed to calculate the L_{50} (Table 18). Out of these, 98 individuals were classified as immature and 504 as mature. It should be noted that the low number of immature individuals compared to the mature ones may bias the L_{50} towards larger sizes than it actually is.

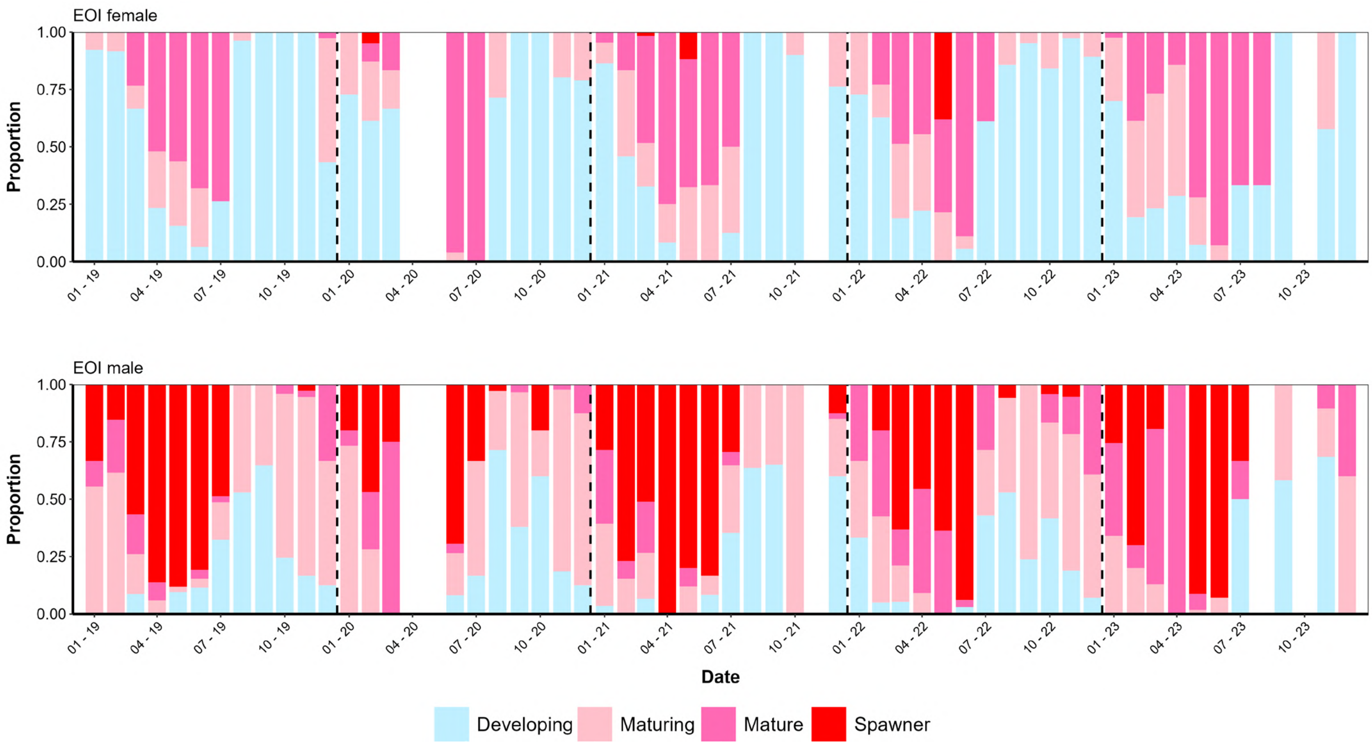


Figure 62. Horned octopus monthly gonadal cycle for females (top) and males (bottom). Proportion of different maturity stages.

The gonadal cycle of horned octopus was analyzed monthly from 2019 to 2023 (Figure 62). The species showed a seasonal reproductive cycle with the highest proportion of mature individuals (also spawners in the case of males) between March and July. When comparing between years, the reproductive peak in 2022 and 2023 occurred in June instead of July as in previous years. It should be noted that, although spawning females were almost absent, their monthly reproductive pattern was consistent with that of males.

Table 19. Number of horned octopus individuals measured in the bottom trawl fishery along the zones sampled in each season (the values include all *métiers* sampled).

Fishery	Year	Zone	Winter	Spring	Summer	Autumn	N hauls
			Number individuals sampled				
Artisanal fisheries	2019	Center	1	0	0	0	1
Bottom trawl	2019	North	19	182	24	107	26
Bottom trawl	2019	Center	32	81	37	99	23
Bottom trawl	2019	South	98	27	135	69	19
Bottom trawl	2020	North	20	46	13	57	21
Bottom trawl	2020	Center	119	19	104	40	22
Bottom trawl	2020	South	55	24	117	82	15
Bottom trawl	2021	North	117	86	46	67	30
Bottom trawl	2021	Center	64	28	30	30	21
Bottom trawl	2021	South	62	5	61	51	14
Bottom trawl	2022	North	85	93	82	112	36
Bottom trawl	2022	Center	72	70	50	44	25
Bottom trawl	2022	South	25	24	53	94	15
Bottom trawl	2023	North	182	145	26	33	33
Bottom trawl	2023	Center	72	58	9	36	24
Bottom trawl	2023	South	45	12	43	16	16

The spatiotemporal length-frequency distribution of horned octopus in 2023 indicates that the species was more abundant in the deeper shelf and the upper slope, while presence in the coastal Delta shelf and the lower slope was despicable (Figure 63). In the coastal shelf, only sampled in 2023, sizes ranged from 4 to 14 cm of ML with a mode at 8 cm of ML. Regarding deeper shelf, sizes range was larger from 2.5 to 16 com of ML with a higher mode at 8.5 cm of ML in all years sampled. Finally, in the upper slope, individuals of smaller sizes were rare and the mode was located at 9.5 cm of ML, similar to the mode observed in 2019.

All parameters analyzed in this report for horned octopus were calculated using only individuals obtained by bottom trawling sampling (Table 19). For the spatiotemporal length-frequency distribution, individuals obtained by artisanal fisheries sampling was also used.

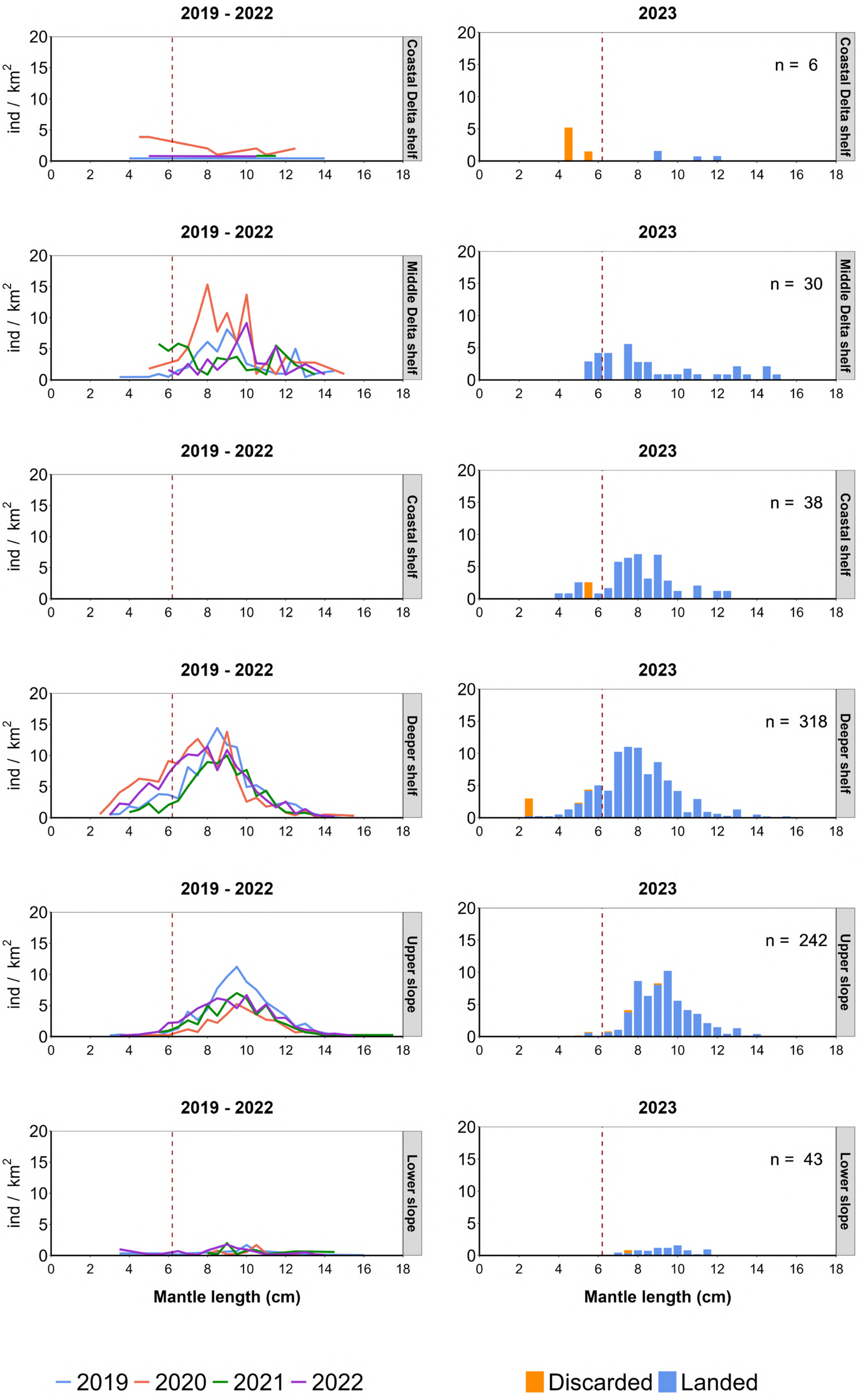


Figure 63. Annual length-frequency distribution of horned octopus at different *métiers* (Coastal Delta Shelf, Middle Delta Shelf, Coastal Shelf, Deeper Shelf, Upper Slope and Lower Slope). Left: previous years sampled, right: year analyzed. (n) Total number of measured individuals. Red dashed line: size at first maturity (L_{50}) calculated as the mean between the L_{50} values of the previous four years sampled and the year analyzed.

Spottail mantis squillid (*Squilla mantis*) MTS

The total spottail mantis squillid catch in Catalonia in 2023 was 330 t, 94% of which were caught by bottom trawling and 5% by artisanal fisheries (ICATMAR, 24-03).

Figure 64 and Figure 65 show the spatial distribution of the species landings in 2023 and from 2018 to 2022 along the Catalan coast, centered around the Ebre Delta area. A stable trend is observed from 2018 to 2022 with an annual maximum of 1 325 kg/km². However, in 2018 landings per unit of effort (LPUE) decreased to an annual maximum of 885 kg/km².

According to length-weight relationship parameters for both sexes combined and separately, the species showed a negative allometric growth (b<3) in 2023 but with significant weight variations at equal size (Table 20). Therefore, its length-weight relationship is not well adjusted, which could be related to the short life cycle of the species.

When comparing growth curves for both sexes combined and separately from 2019 to 2023 (Figure 66), the results show a similar trend from 2020 to 2022. However, in 2019 and especially 2023 the growth trend was lower.

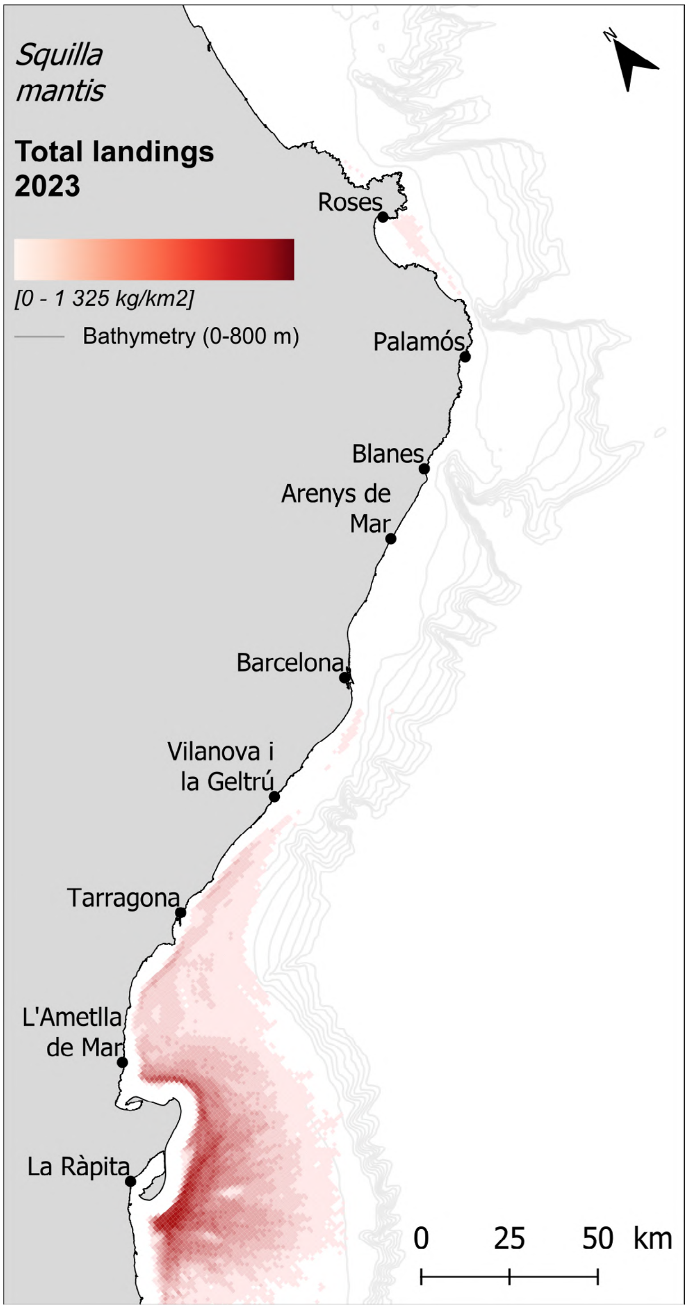


Figure 64. Spatial distribution of landings per unit of effort (LPUE) for spottail mantis squillid in the Catalan fishing grounds (North GSA6) in the year analyzed.

Table 20. Spottail mantis squillid length-weight relationship and size at first maturity (L_{50}) in the year analyzed.

Length – total weight relationship				
2023	**a**	**b**	**r²**	**n**
Combined	0.0125	2.3763	0.73	529
Females	0.0194	2.2416	0.72	286
Males	0.0066	2.5730	0.75	243

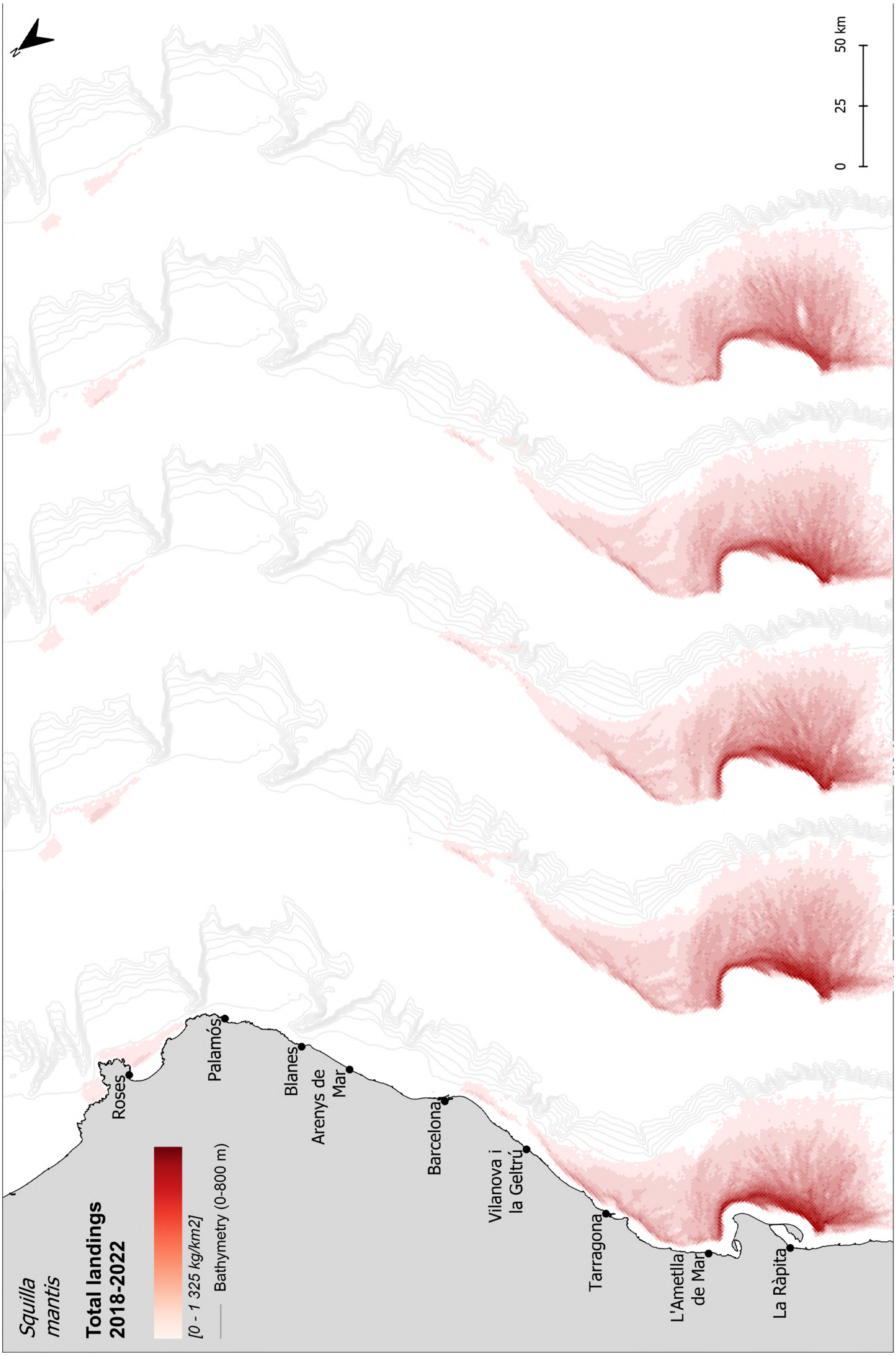


Figure 65. Spatial distribution of landings per unit of effort (LPUE) for spottail mantis squillid in the Catalan fishing grounds (North GSA6) for the five years prior to the year analyzed.

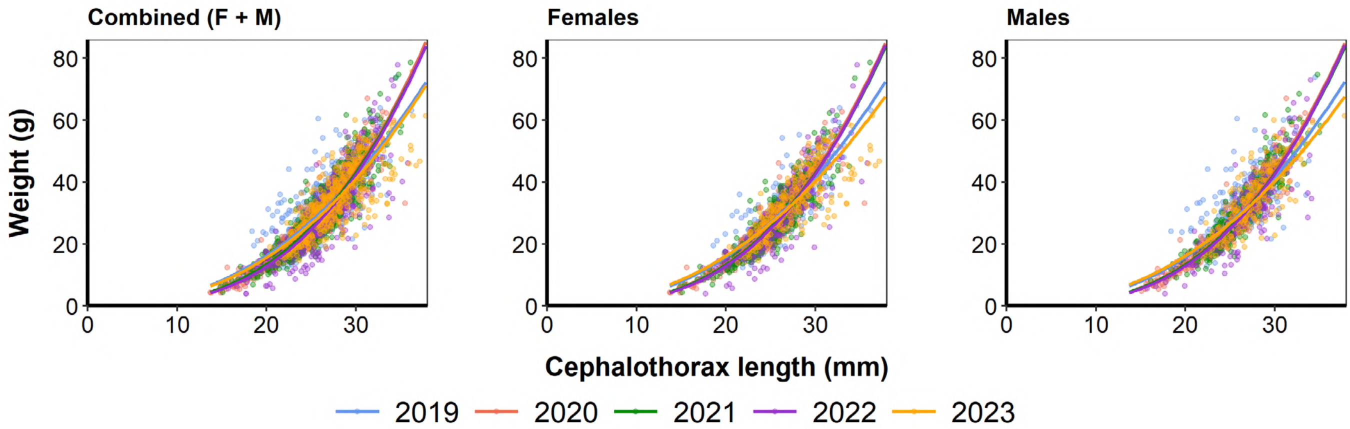


Figure 66. Spottail mantis squillid length-weight relationship for the previous four years sampled and the year analyzed.

The gonadal cycle of spottail mantis squillid was analyzed monthly from 2019 to 2023 (Figure 67). The species showed a marked reproductive cycle with maturing and mature individuals during winter and spring, which is consistent with its described reproductive cycle. The spottail mantis squillid is a species with a short life cycle, in which adults die after spawning and, for this reason, only immature individuals were found after the reproductive peak during summer and autumn. This characteristic, together with a rapid growth, makes this species able to withstand the fishing pressure to which it is subjected.

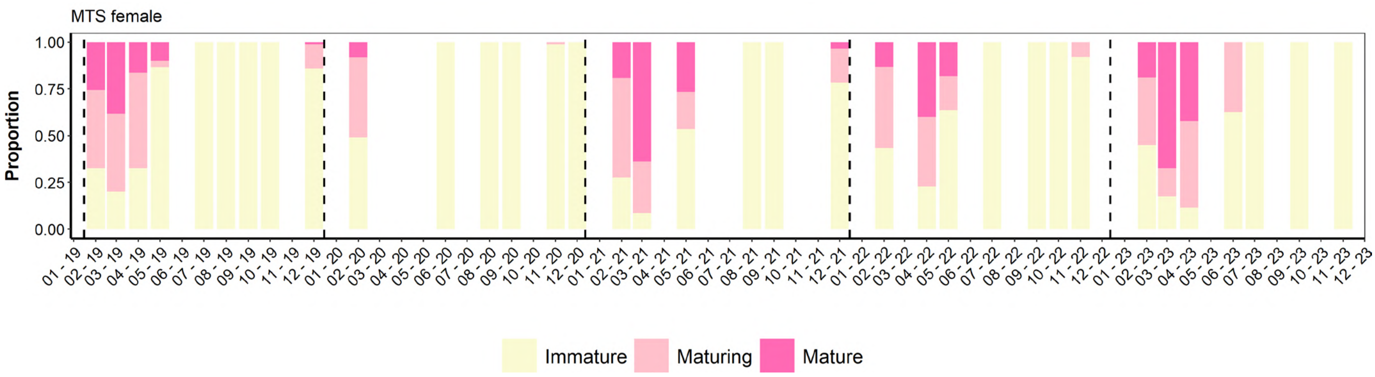


Figure 67. Spottail mantis squillid monthly gonadal cycle for females (top) and males (bottom).

The spatiotemporal length-frequency distribution of spottail mantis squillid from 2019 to 2023 shows that most of the population size ranges were caught during the sampling (Figure 68). Comparing between years, it can be observed that the size range and mode are practically the same across all years. 2021 was the year with the highest abundance in both métiers, while in 2023 abundance was higher than 2022, especially in the coastal Delta shelf. For smaller size ranges (below 20 mm of CL), almost all individuals were discarded.

For monthly length-frequency distribution of spottail mantis squillid at different *métiers* in 2023 see (Annex 18).

All parameters analyzed in this report for spottail mantis squillid were calculated using only individuals obtained by bottom trawling sampling (Table 21)

Table 21 Number of Spottail mantis squillid individuals measured in the different fisheries along the zones sampled in each season (the values include all *métiers* sampled).

Fishery	Year	Zone	Winter	Spring	Summer	Autumn	N hauls
			Number individuals sampled				
Bottom trawl	2019	North	0	1	0	8	2
Bottom trawl	2019	Center	0	1	1	0	2
Bottom trawl	2019	South	693	420	960	402	27
Bottom trawl	2020	North	0	0	1	5	2
Bottom trawl	2020	Center	0	0	4	0	2
Bottom trawl	2020	South	265	78	577	347	18
Bottom trawl	2021	Center	1	1	0	0	2
Bottom trawl	2021	South	573	85	647	613	21
Bottom trawl	2022	Center	1	0	0	0	1
Bottom trawl	2022	South	259	195	306	506	20
Bottom trawl	2023	Center	0	0	1	0	1
Bottom trawl	2023	South	585	221	289	69	19

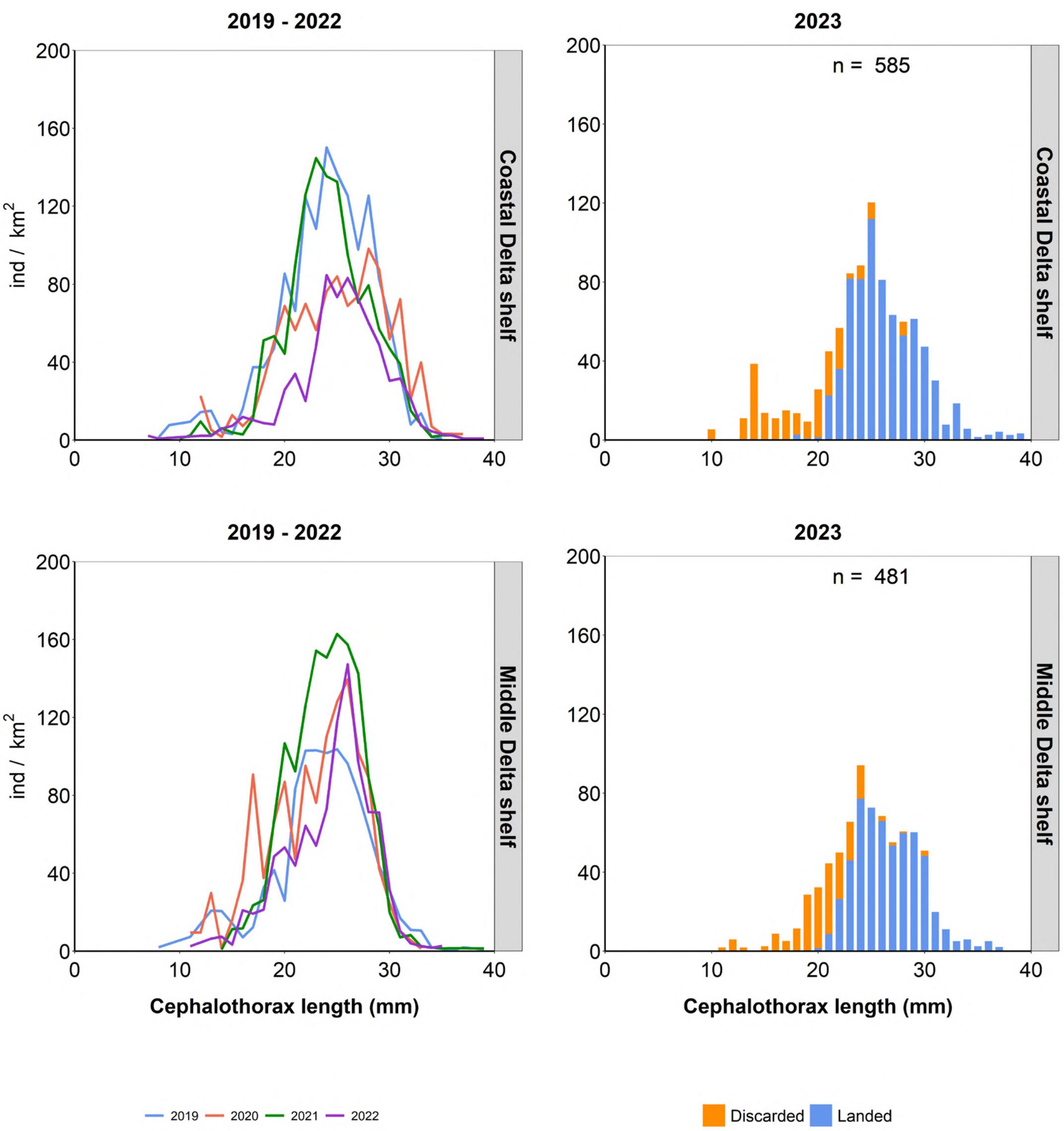


Figure 68 Annual length-frequency distribution of Spottail mantis squillid at different *métiers* (Coastal Delta Shelf and Middle Delta Shelf). Left: previous years sampled, right: the year analyzed. (n) Total number of measured individuals.

Caramote prawn (*Penaeus kerathurus*) TGS

The total caramote prawn catch in Catalonia in 2023 was 75 t, 31% of which were caught by bottom trawling and 68% by artisanal fisheries (ICATMAR, 24-03).

Figure 69 and Figure 70 show the spatial distribution of the species landings in 2023 and from 2018 to 2022 along the Catalan coast. A stable trend is observed over the years, with similar maximum annual landings. However, most of caramote prawn landings are obtained by artisanal fisheries and, therefore, not shown in these maps. In 2023 the maximum landings per area trawled were 188 kg/km^2.

According to length-weight relationship parameters for both sexes combined and separately, the caramote prawn showed a negative allometric growth ($b < 3$) in 2023 (Table 22). The sample size (n) is limited in this case due to the species not being sampled across its entire range and the low number of captures. Despite this limitation, the combined data show a very high correlation (r^2 = 0.90), with females exhibiting an even higher correlation (r^2 = 0.93). In contrast, males display a lower correlation (r^2 = 0.64).

When comparing the growth curves between the years sampled for both sexes combined and separately (Figure 71), it is evident that this species exhibits a pronounced sexual dimorphism, with females being larger and heavier than males. The the sampling *métier* for this species, the coastal Delta shelf, is located at a depth of less than 40 m; a depth stratum in which the specimens captured are adults.

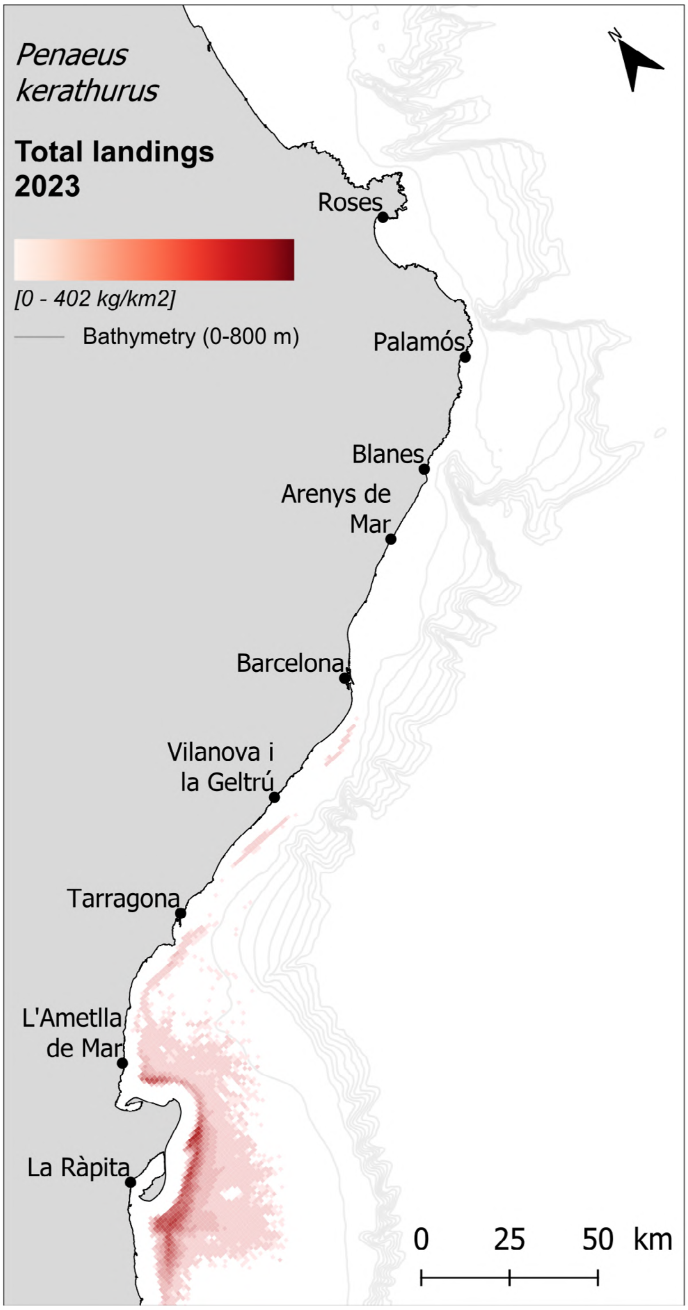


Figure 69. Spatial distribution of landings per unit of effort (LPUE) for caramote prawn in the Catalan fishing grounds (North GSA6) in the year analyzed.

Table 22. Caramote prawn length-weight relationship in the year analyzed.

2023	a	b	r^2	n
Combined	0.0043	2.4259	0.90	161
Females	0.0026	2.5657	0.93	88
Males	0.0092	2.2089	0.64	73

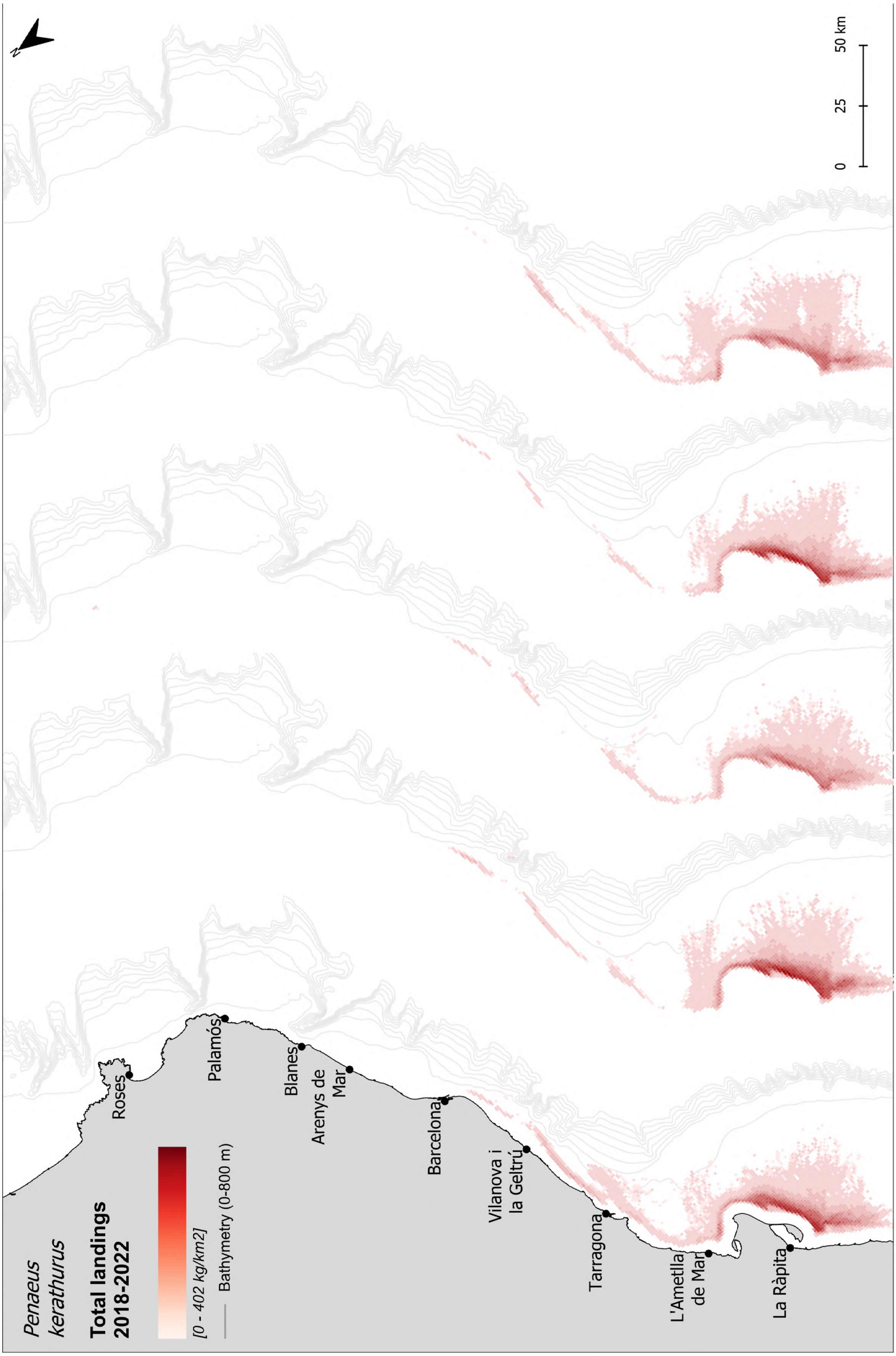


Figure 70. Spatial distribution of landings per unit of effort (LPUE) for caramote prawn in the Catalan fishing grounds (North GSA6) for the five years prior to the year analyzed.

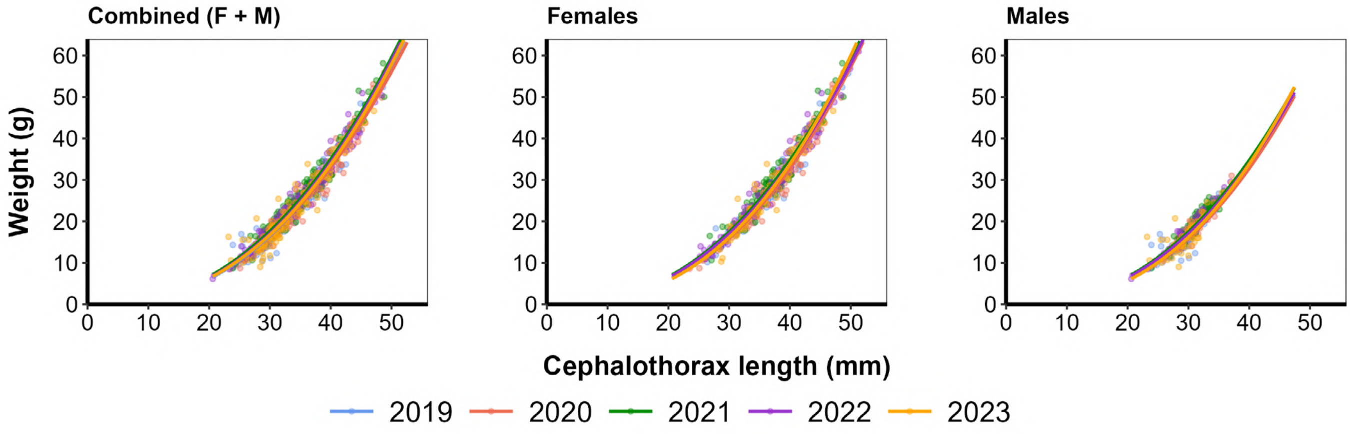


Figure 71. Caramote prawn length-weight relationship for the years sampled.

Table 23 shows the number of immature and mature caramote prawn individuals obtained for the years sampled. As can be observed, the low number of individuals sampled, 0 immatures in 2023, makes it impossible to calculate the L_{50} for this species.

Month	2019		2020		2021		2022		2023	
	Immature	Mature	Immature	Mature	Immature	Mature	Immature	Mature	Immature	Mature
January	0	0	0	0	0	0	0	0	0	0
February	0	11	0	0	0	20	3	14	0	21
March	1	6	0	0	0	1	0	0	0	0
April	0	1	0	0	0	0	0	1	0	19
May	0	0	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	0	0	0
July	0	0	0	0	0	0	0	13	0	17
August	0	3	0	31	0	14	0	0	0	0
September	0	31	0	28	4	11	7	33	6	21
October	0	16	0	0	0	0	0	22	0	0
November	0	0	0	5	0	0	0	36	0	4
December	0	23	0	23	0	42	0	0	0	0

The reproductive cycle of caramote prawn was not analyzed because mature individuals move to shallower depths prior to spawning (from April to August) to a bathymetry not covered by this sampling design. This seasonal migration hinders the collection of comprehensive data on the species' distribution.

Table 24. Number of caramote prawn individuals measured in the different fisheries along the zones sampled in each season (the values include all métiers sampled).

Fishery	Year	Zone	Winter	Spring	Summer	Autumn	N hauls/fishing trips
			Number individuals sampled				
Bottom trawl	2019	Center	0	0	1	0	1
Bottom trawl	2019	South	95	1	264	248	10
Bottom trawl	2020	South	1	0	155	179	7
Bottom trawl	2021	South	45	0	143	120	6
Bottom trawl	2022	South	39	2	121	361	6
Bottom trawl	2023	North	0	0	0	1	1
Bottom trawl	2023	South	122	53	168	11	5

The spatiotemporal length-frequency distribution of caramote prawn from 2019 to 2023 is shown only for the Coastal Delta shelf, as this is the primary habitat of the species (Figure 72). The size range of the species extended from 20 to 50 mm of CL in all years sampled, with the mode located at around 30 mm of CL. In 2023, the sizes ranged from 23.2 to 49.2 mm of CL, with a mean size of 33.7 mm of CL, higher than in 2022. At the sampling depths of the coastal Delta shelf *métier*, which range from 20 to 40 meters, only the adult population of the species is captured, while smaller specimens, found near the river mouth at shallower depths, are not included in the sampling.

For monthly length-frequency distribution of caramote prawn at Coastal Deltal shelf *métier* in 2023 see Annex 17.

All parameters analyzed in this report for caramote prawn were calculated using only individuals obtained by the bottom trawling sampling (Table 24).

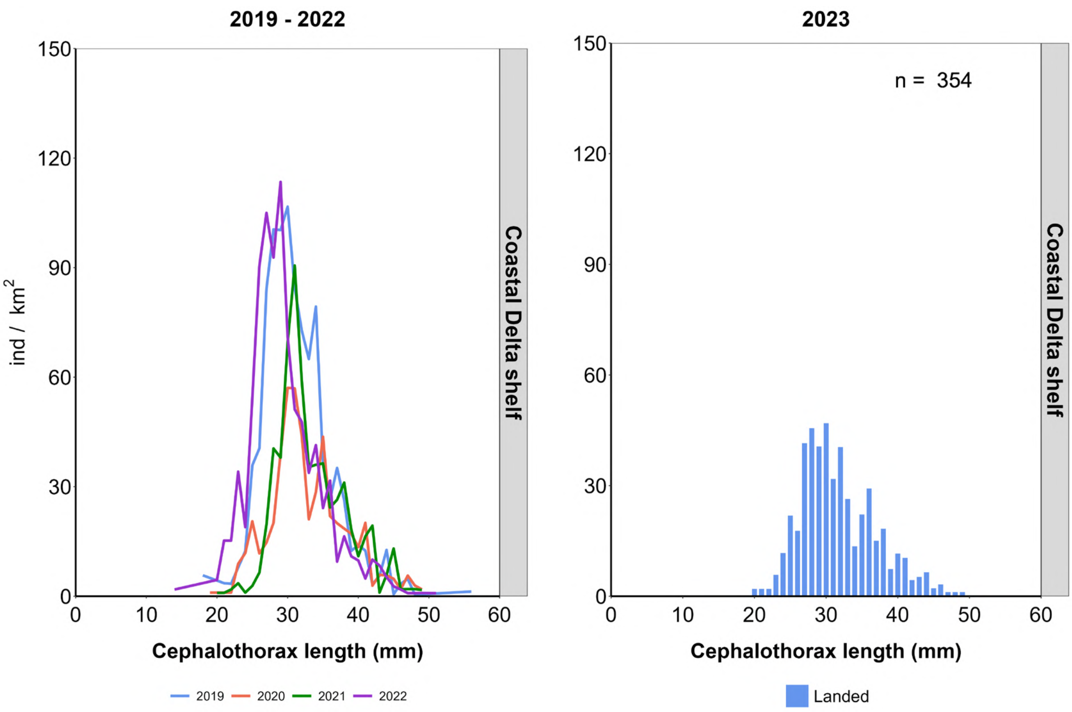


Figure 72. Annual length-frequency distribution of caramote prawn at the Coastal Delta shelf *métier*. Left: previous years sampled, right: year analyzed. (n) Total number of measured individuals.

Bottom trawling by port

In this section, the sampling hauls carried out in 2023 are shown for each zone. In addition, within each zone, the catch composition, landed species with higher biomass, discarded species with higher biomass, categories of natural debris with higher biomass and categories of marine litter with higher mass are shown for each *métier* in the ports where bottom trawling samplings were conducted in the period 2019-2022 and in 2023.

North Zone

North zone: Figure 73.

Roses: Figure 74, Figure 75, Figure 76, Figure 77, Figure 78.

Palamós: Figure 79, Figure 80, Figure 81, Figure 82, Figure 83.

Blanes: Figure 84, Figure 85, Figure 86, Figure 87, Figure 88.

Arenys de Mar: Figure 89, Figure 90, Figure 91, Figure 92, Figure 93.

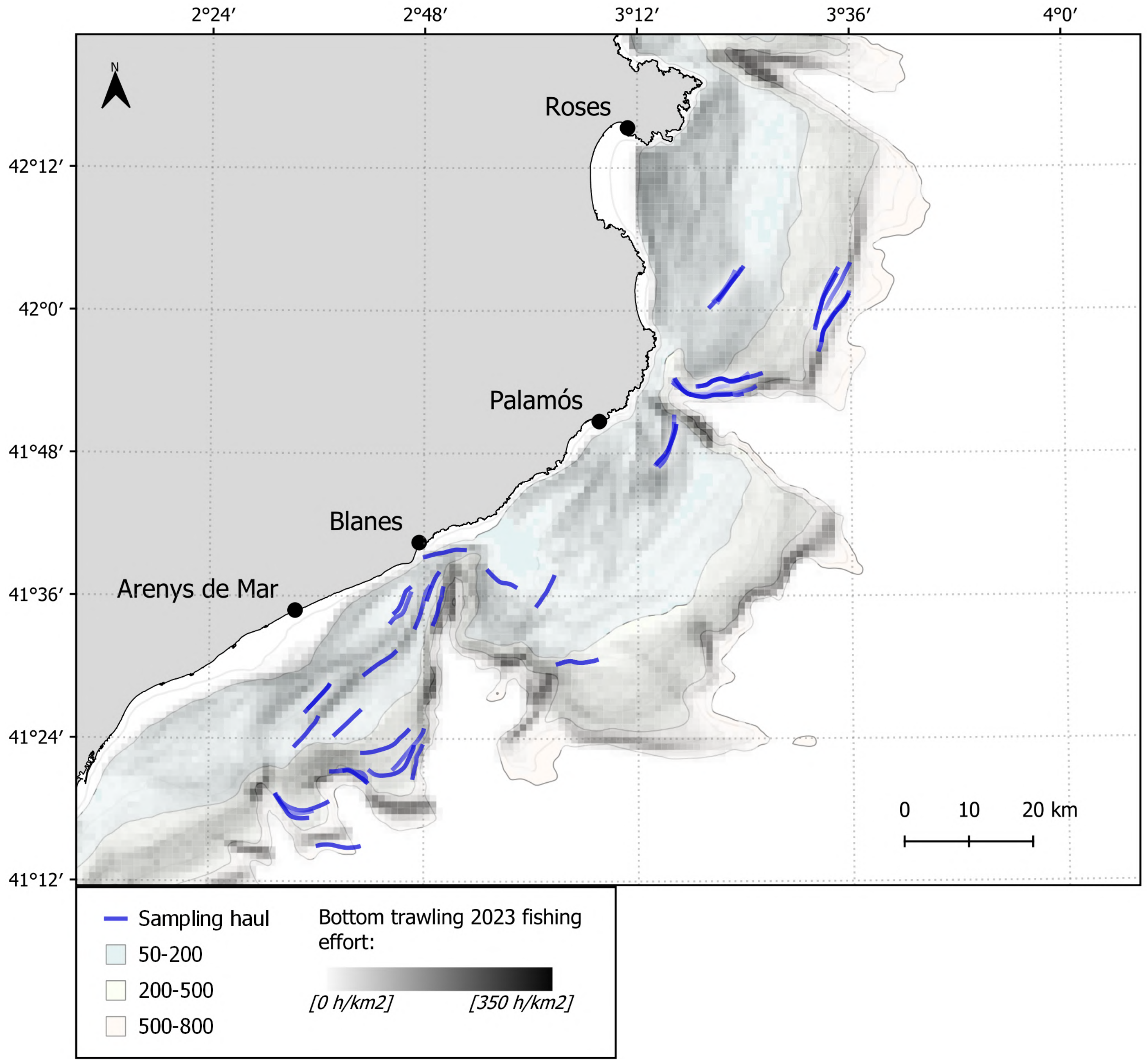


Figure 73. North zone sampling trawls in 2023.

Roses

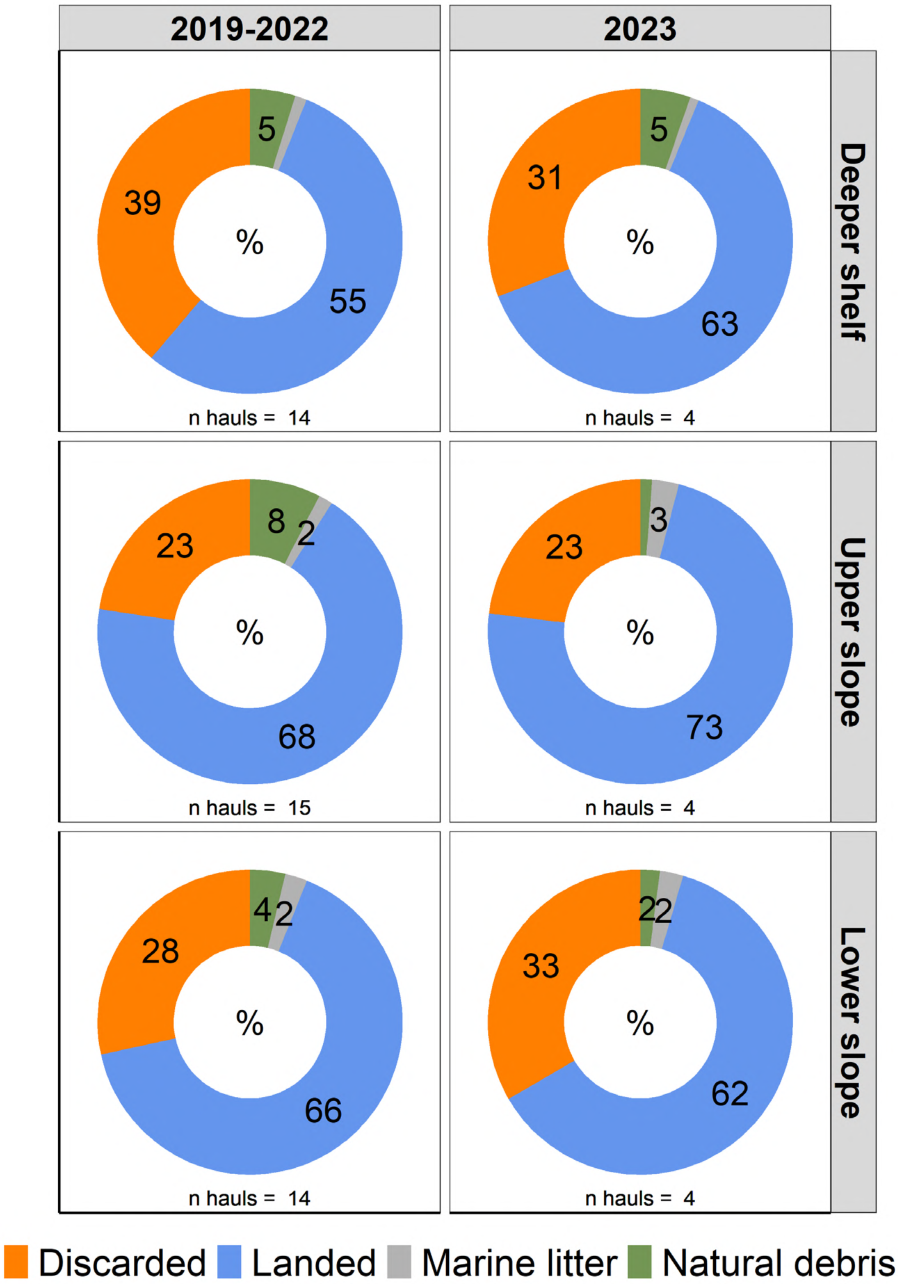


Figure 74. Roses catch composition. Percentage by weight of landings, discarded, natural debris and marine litter fraction including all hauls within each period and *métier*.

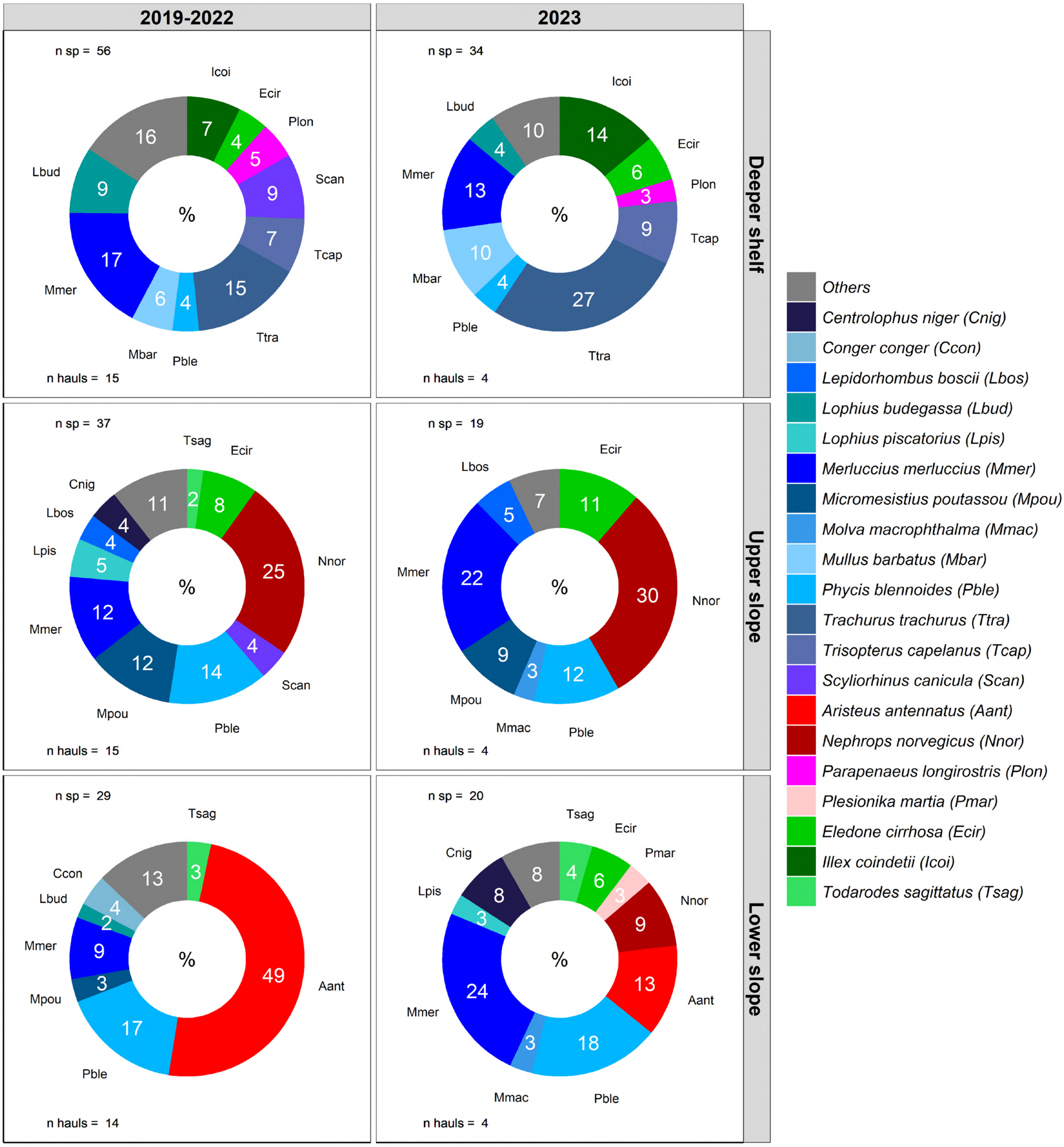


Figure 75. Roses landed species with most biomass. Percentage in weight including all hauls within each period and *métier*.

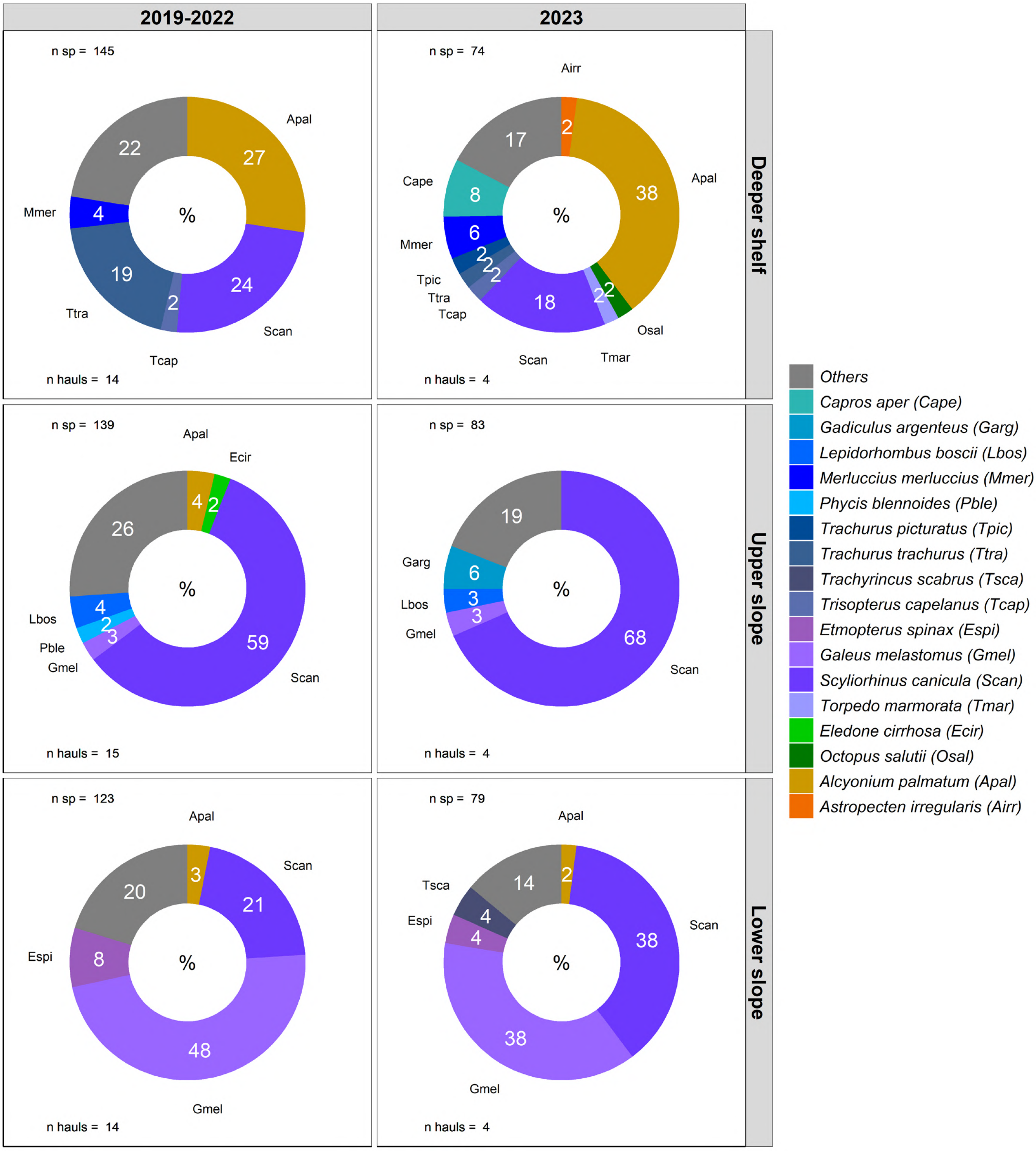


Figure 76. Roses discarded species with most biomass. Percentage in weight including all hauls within each period and *métier*.

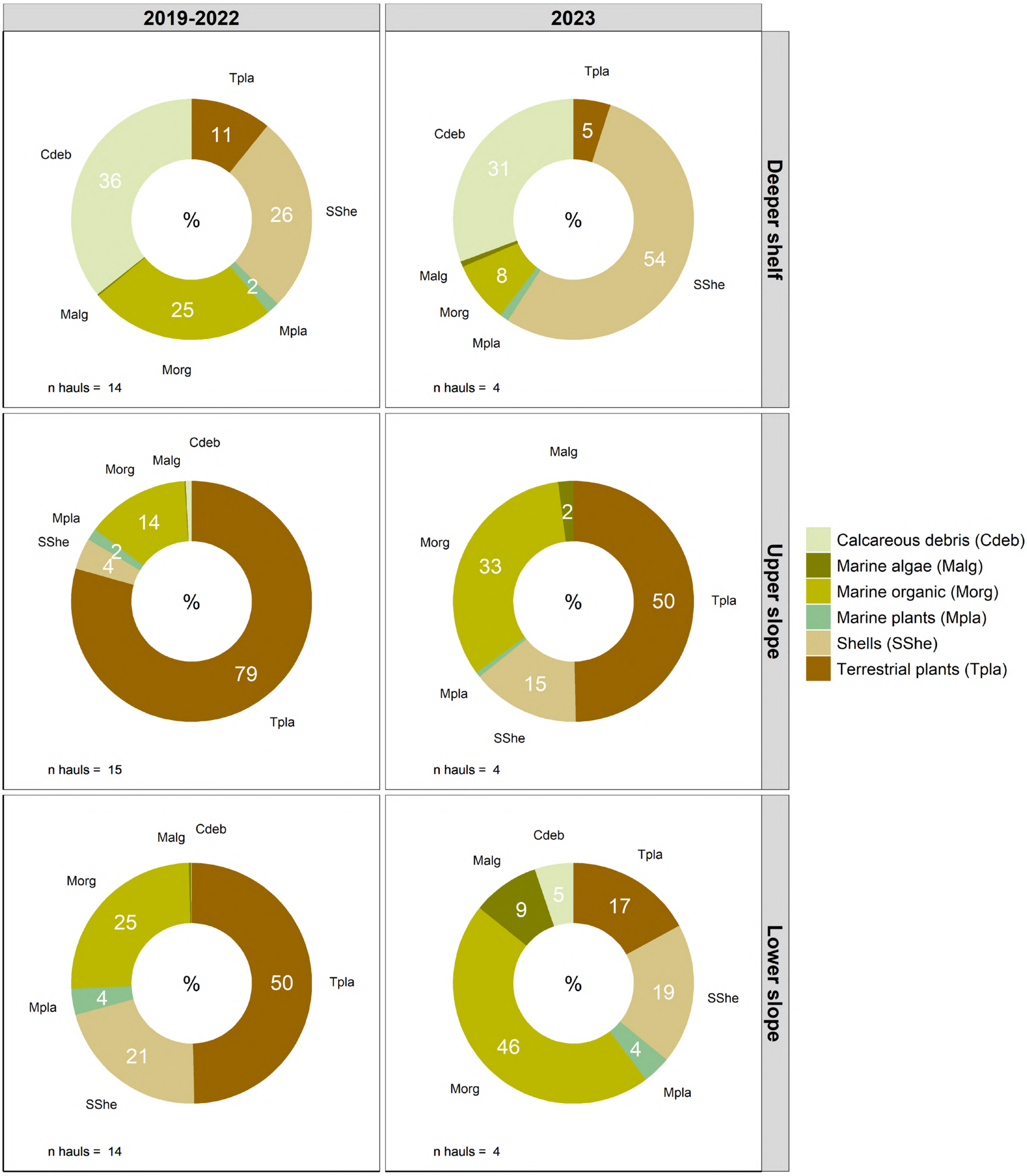


Figure 77. Roses categories of natural debris with higher biomass. Percentage in weight including all hauls within each period and *métier*.

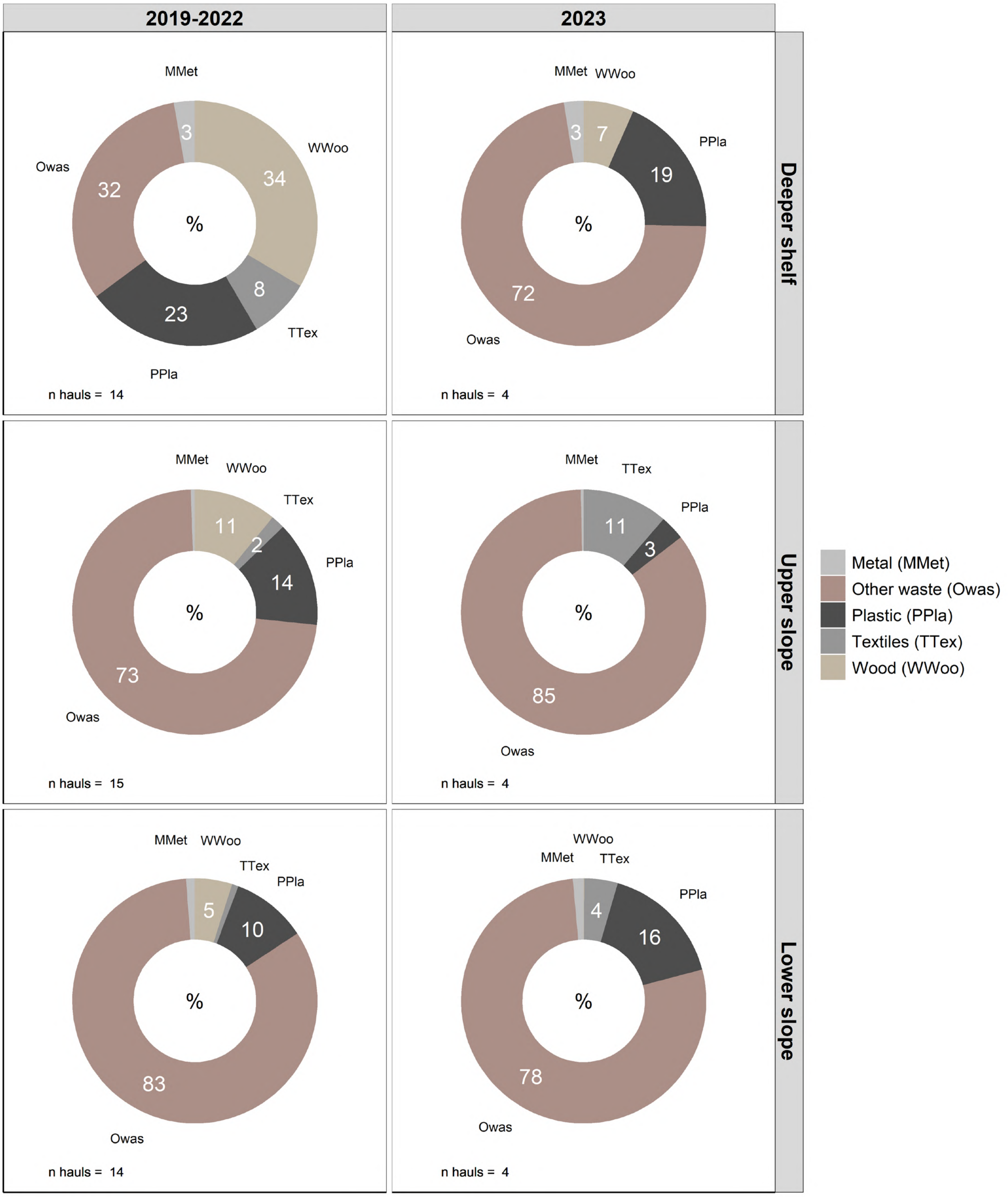


Figure 78. Roses categories of marine litter with higher mass. Percentage in weight including all hauls within each period and *métier*.

Palamós

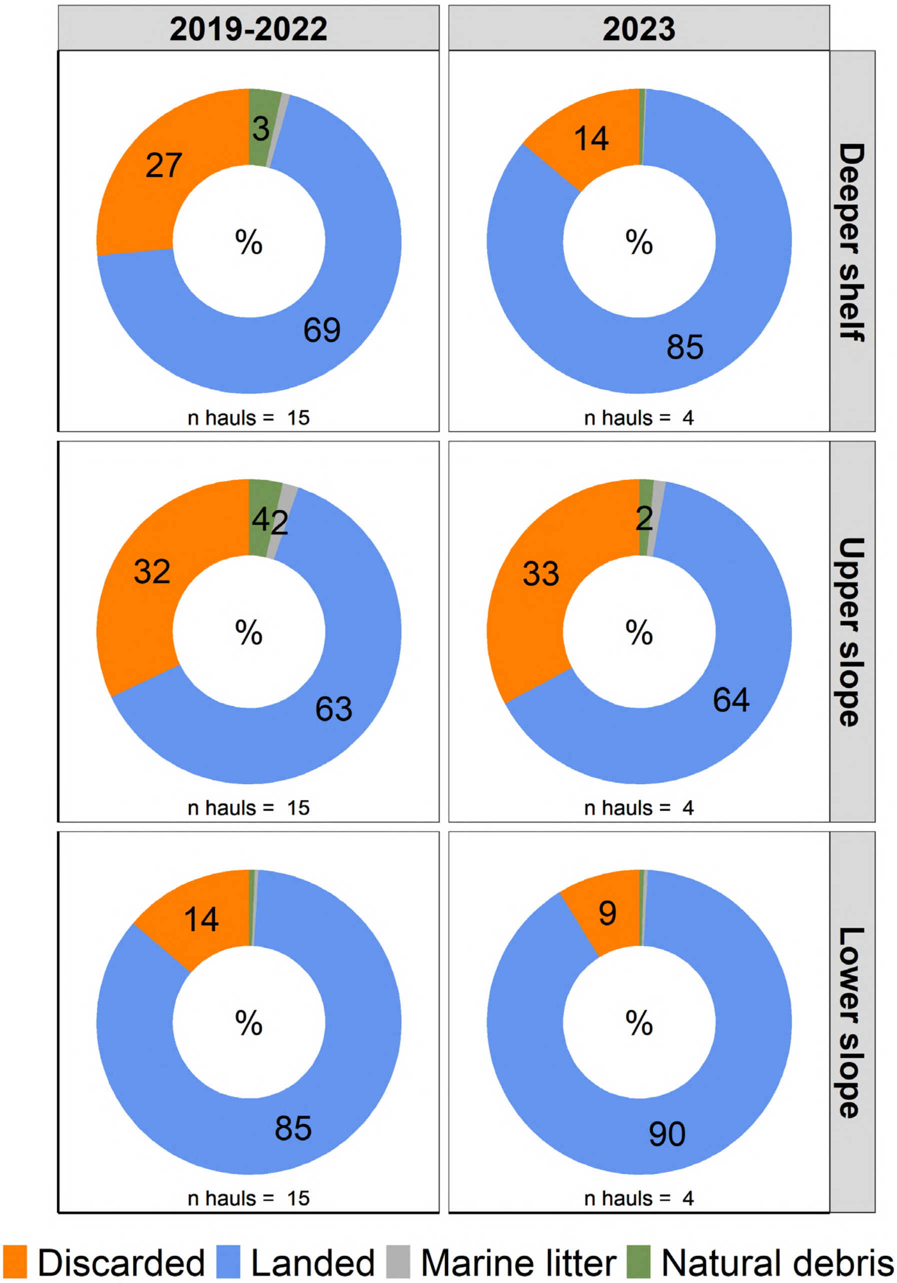


Figure 79. Palamós catch composition. Percentage by weight of landings, discarded, natural debris and marine litter fraction including all hauls within each period and *métier*.

Figure 80. Palamós landed species with most biomass. Percentage in weight including all hauls within each period and *métier*.

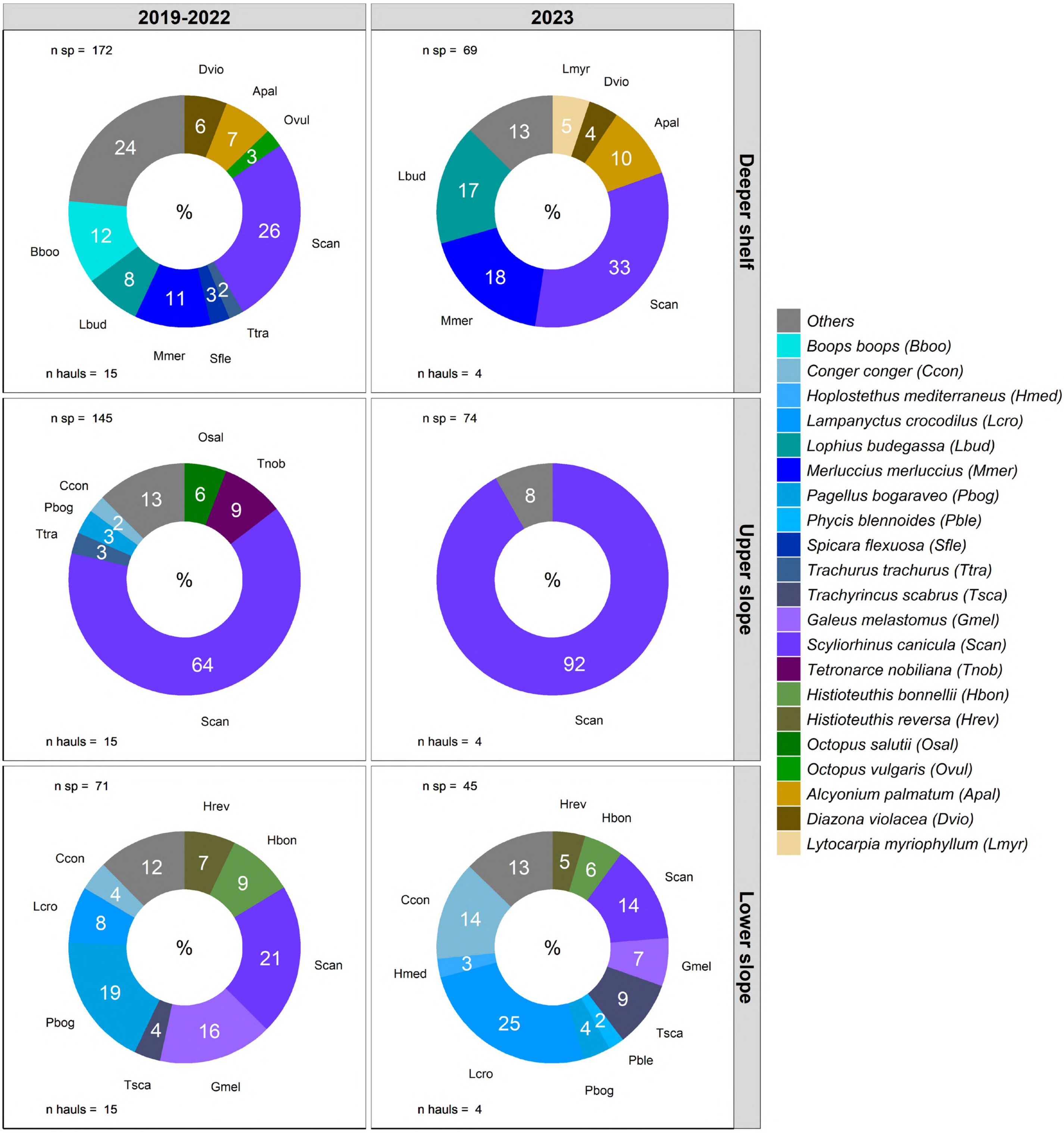


Figure 81. Palamós discarded species with most biomass. Percentage in weight including all hauls within each period and *métier*.

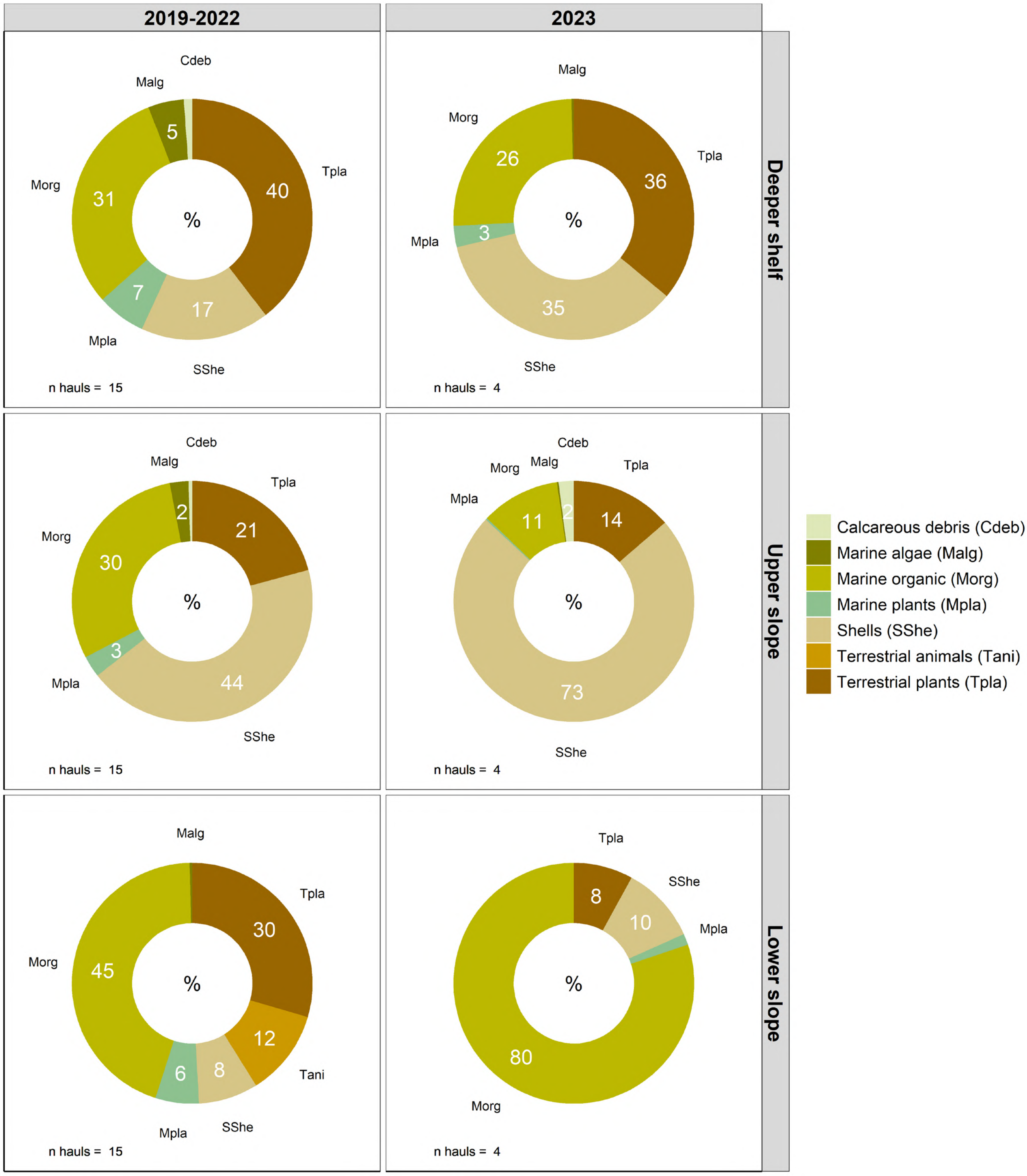


Figure 82. Palamós Categories with higher biomass natural debris. Percentage in weight including all hauls within each period and *métier*.

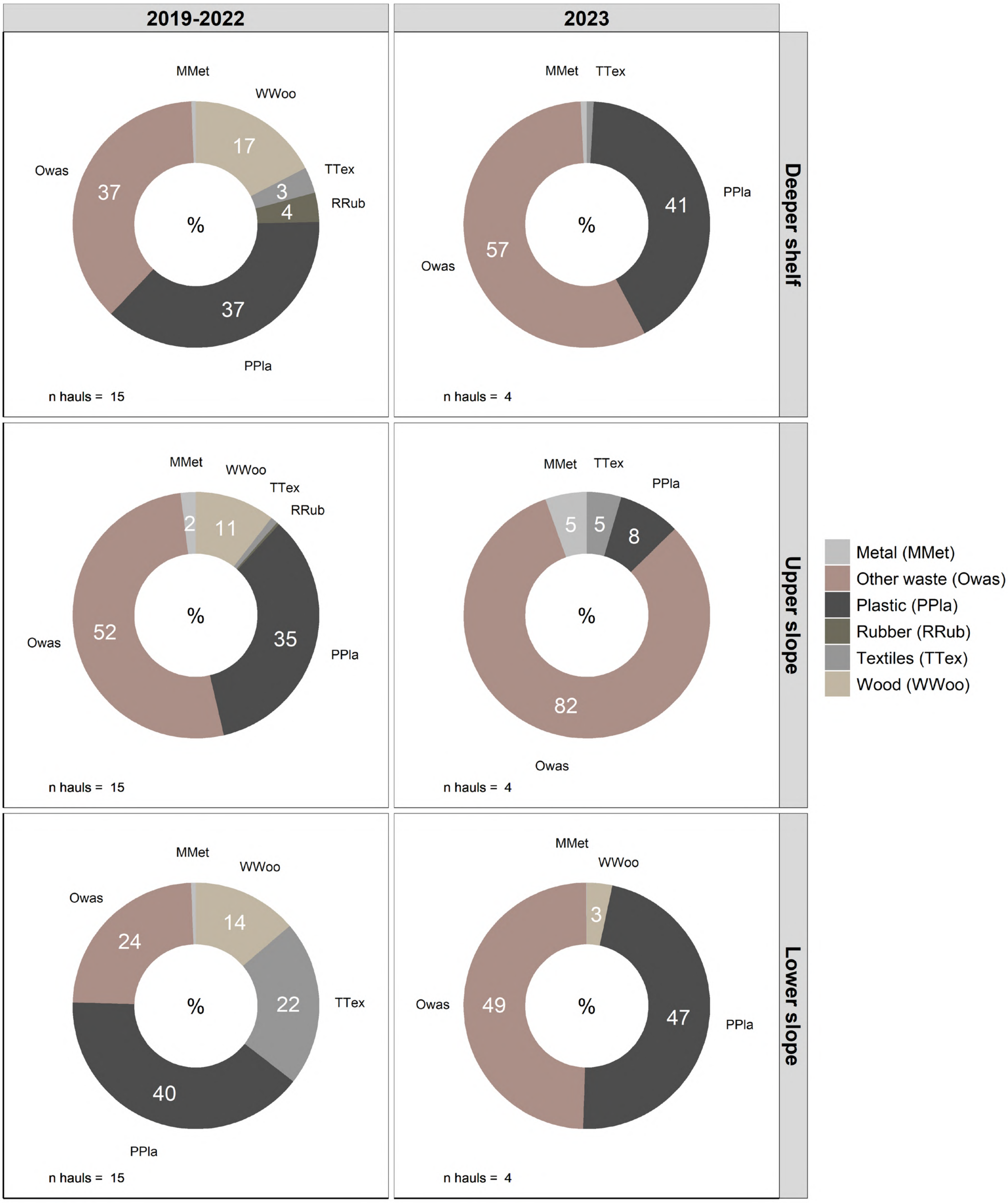


Figure 83. Palamós Categories with higher mass marine litter. Percentage in weight including all hauls within each period and *métier*.

Blanes

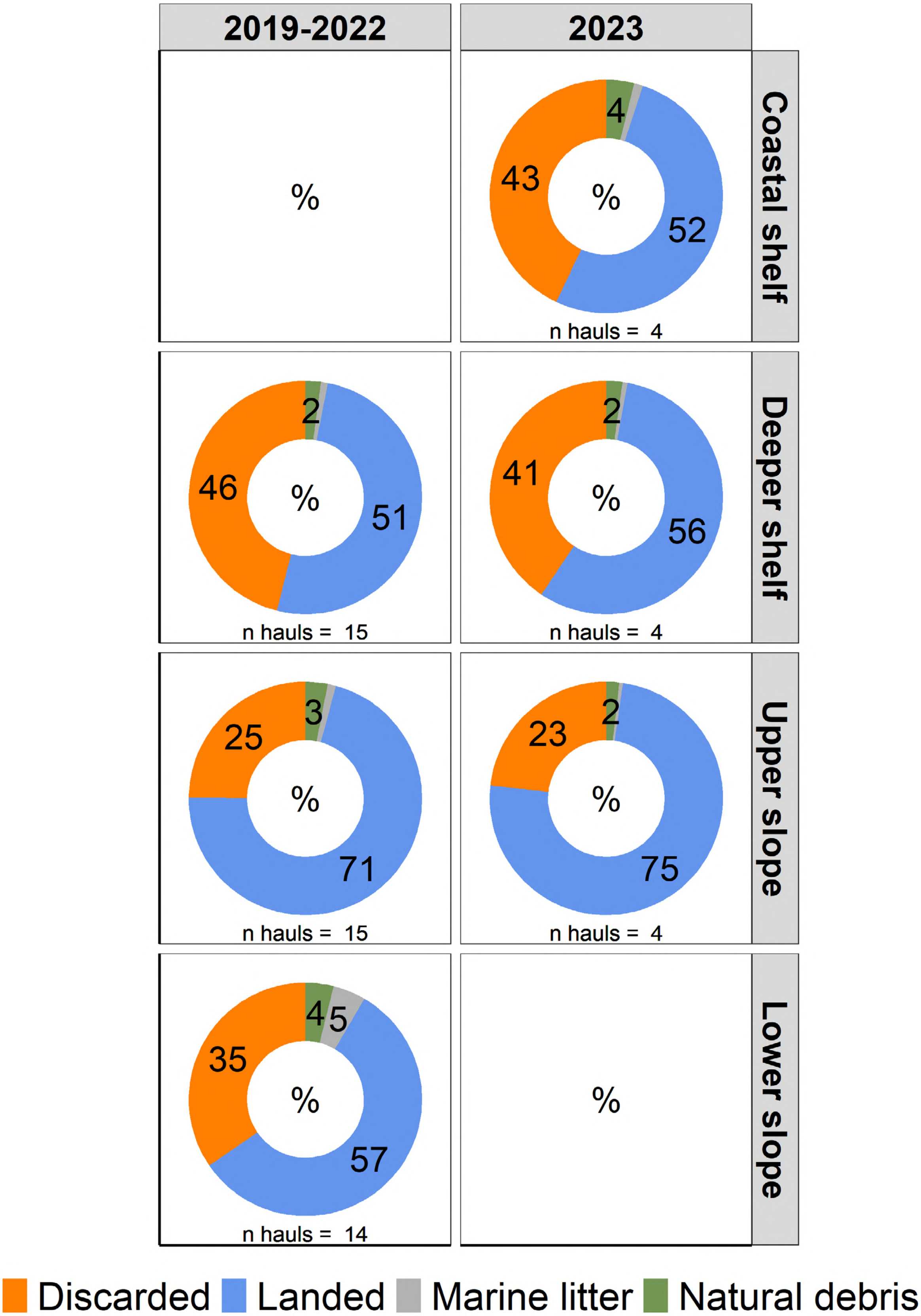


Figure 84. Blanes catch composition. Percentage by weight of landings, discarded, natural debris and marine litter fraction including all hauls within each period and *métier*.

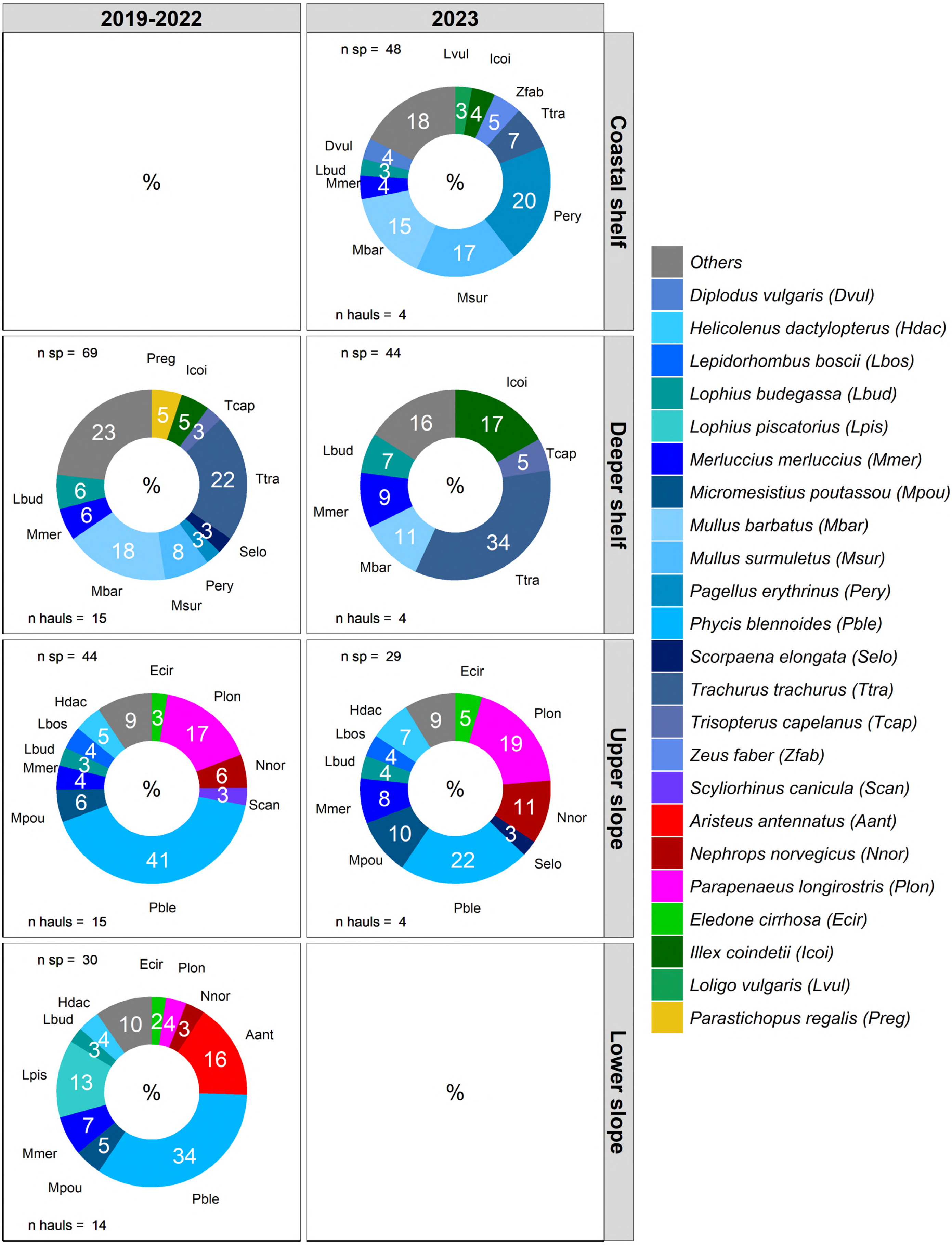


Figure 85. Blanes landed species with most biomass. Percentage in weight including all hauls within each period and *métier*.

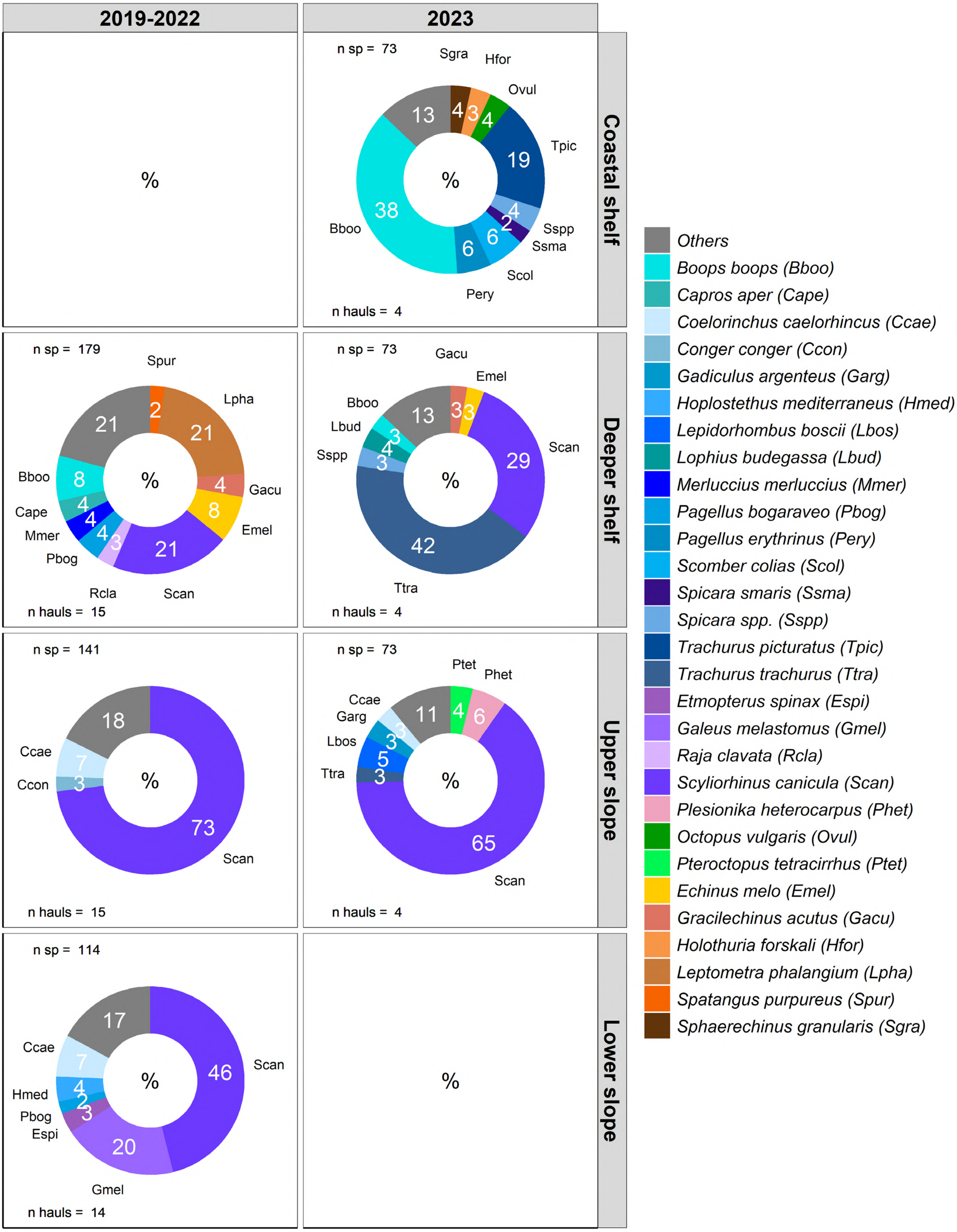


Figure 86. Blanes discarded species with most biomass. Percentage in weight including all hauls within each period and *métier*.

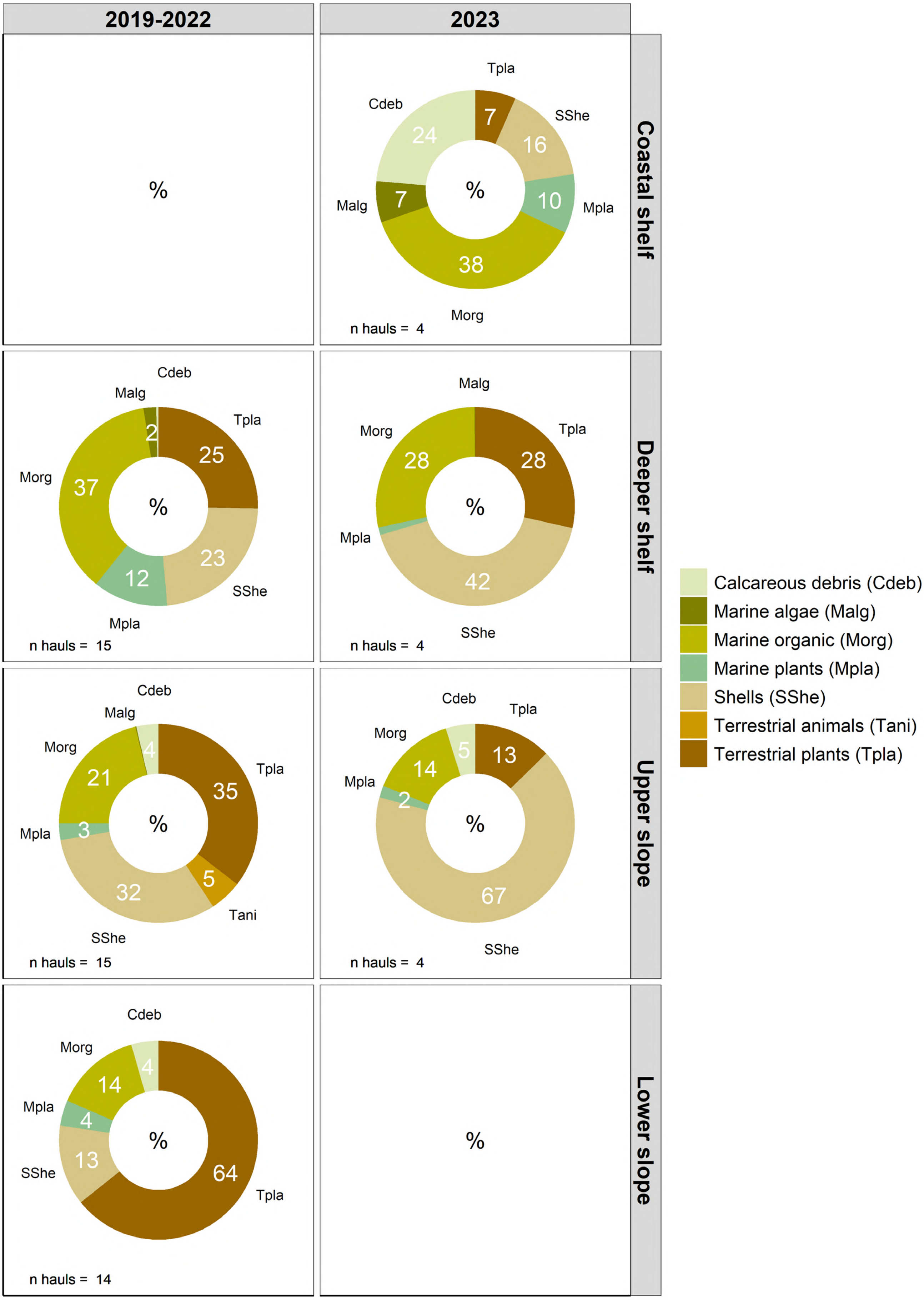


Figure 87. Blanes Categories with higher biomass natural debris. Percentage in weight including all hauls within each period and *métier*.

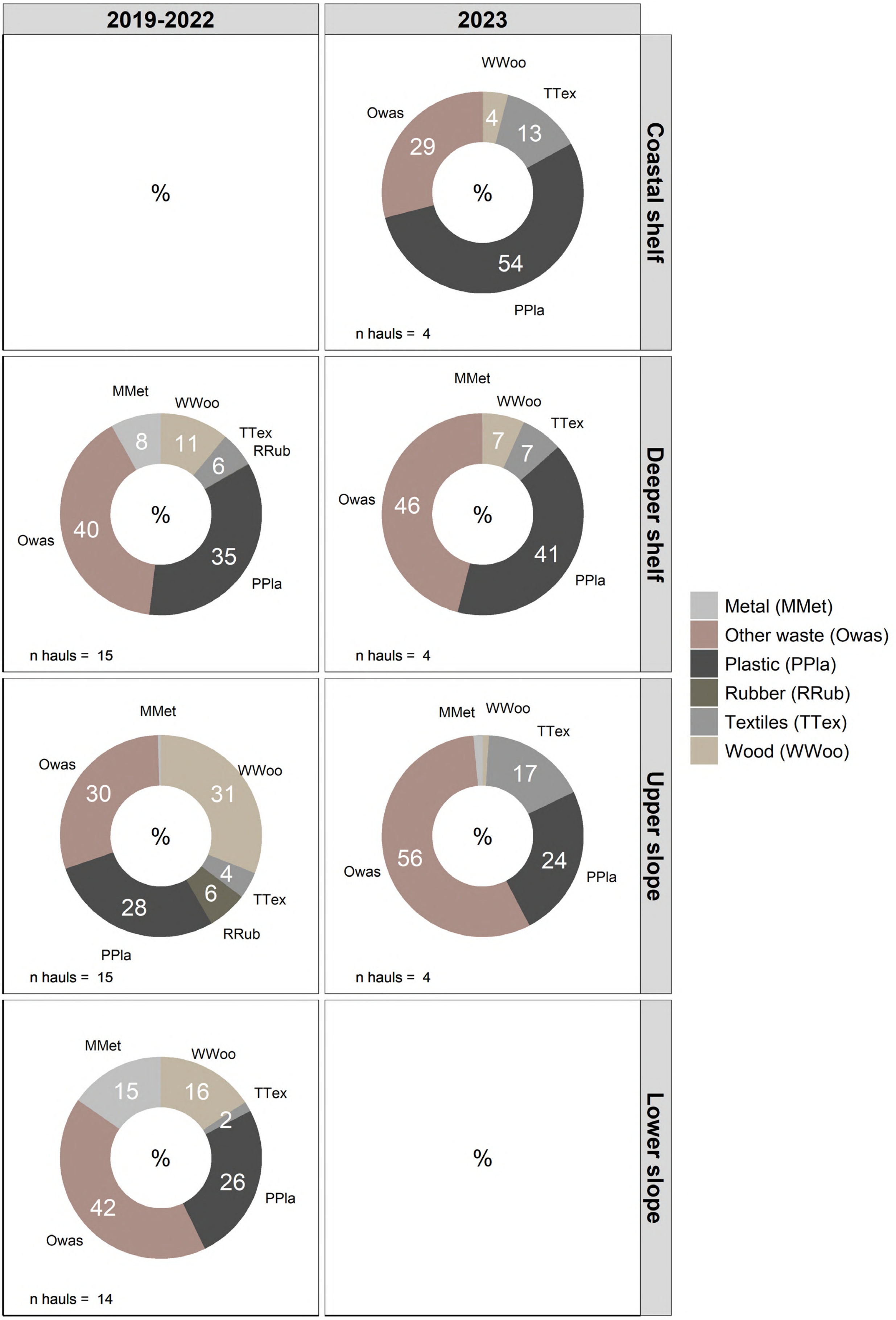


Figure 88. Blanes Categories with higher mass marine litter. Percentage in weight including all hauls within each period and *métier*.

Arenys de Mar

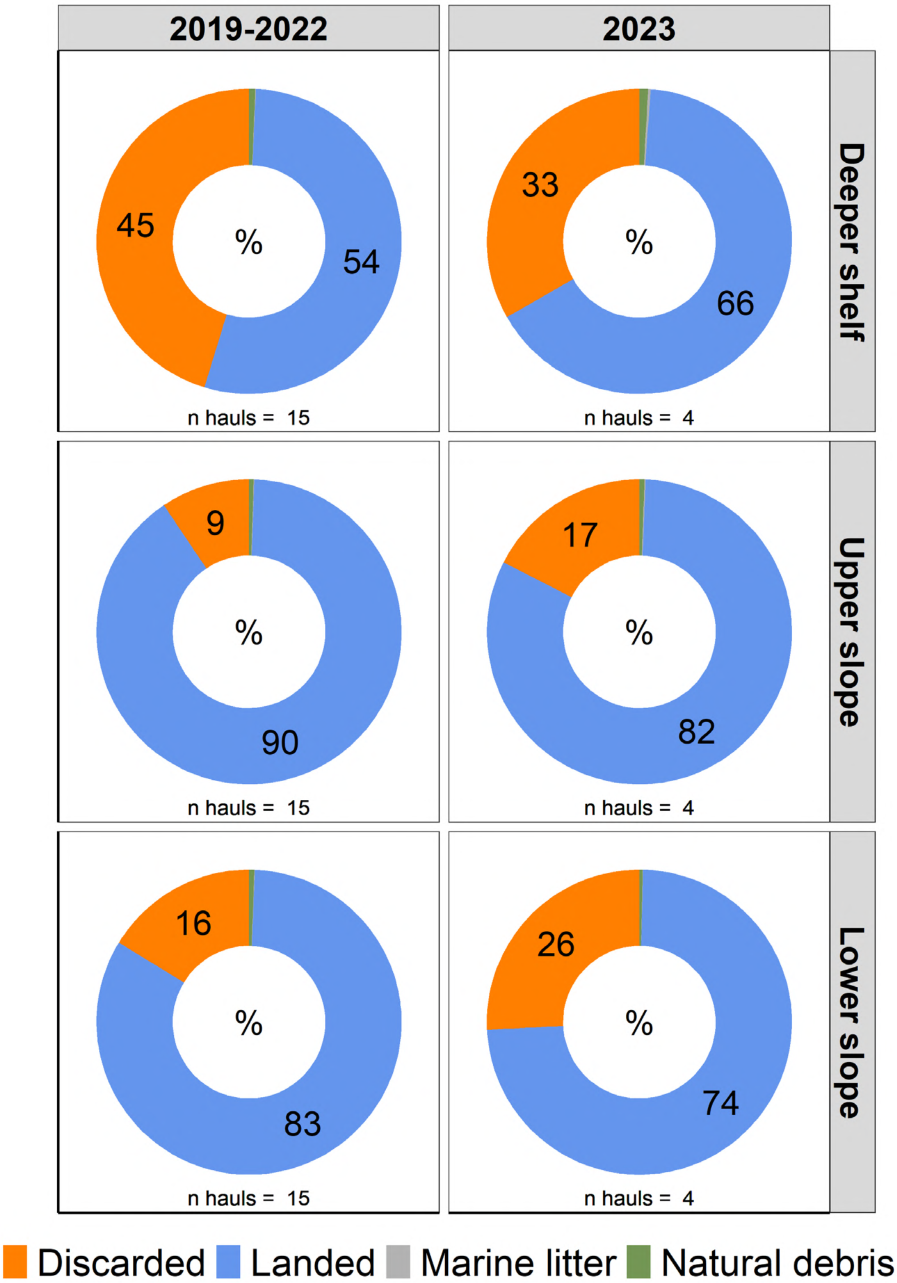


Figure 89. Arenys de Mar catch composition. Percentage by weight of landings, discarded, natural debris and marine litter fraction including all hauls within each period and *métier*.

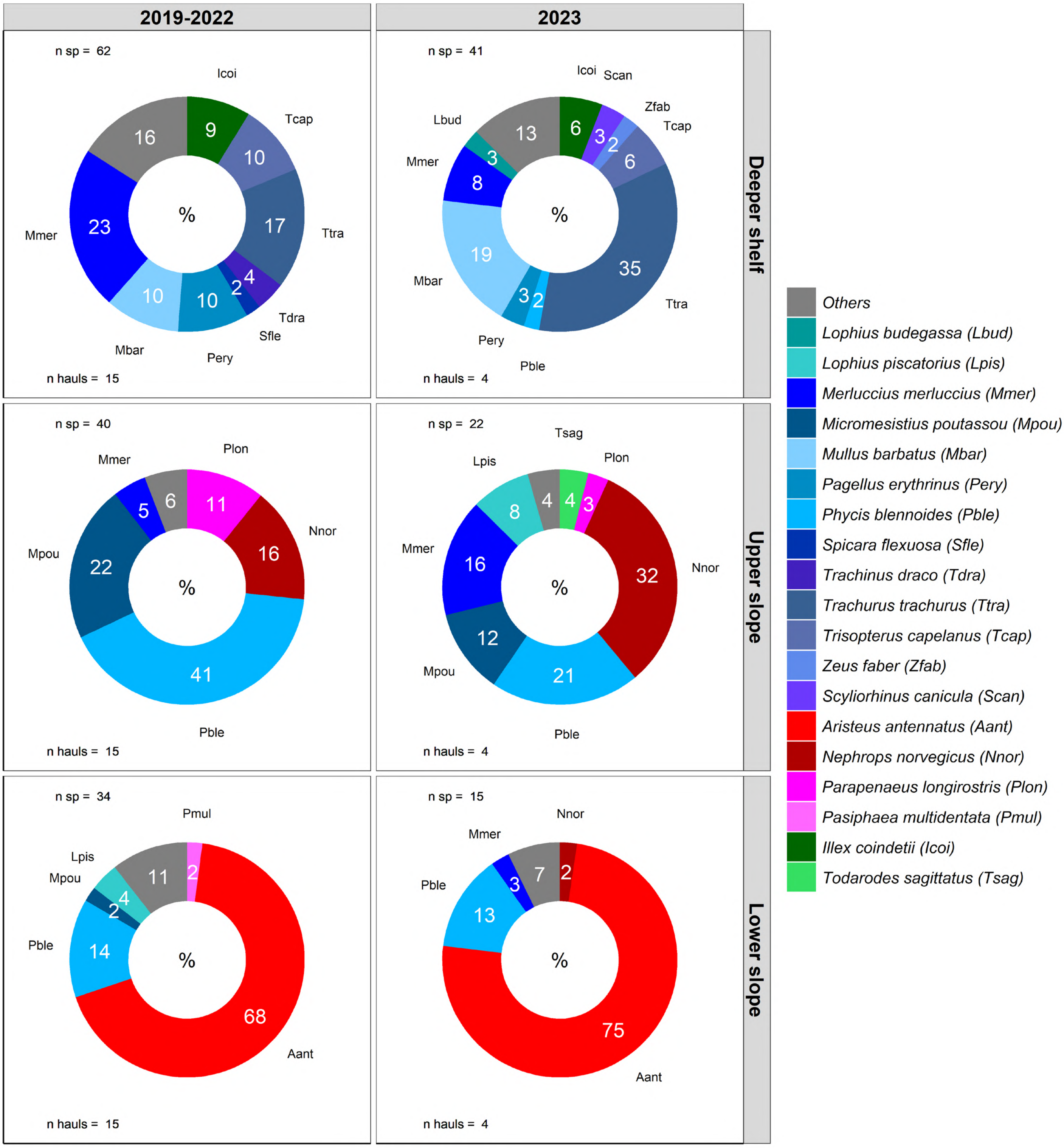


Figure 90. Arenys de Mar landed species with most biomass. Percentage in weight including all hauls within each period and *métier*.

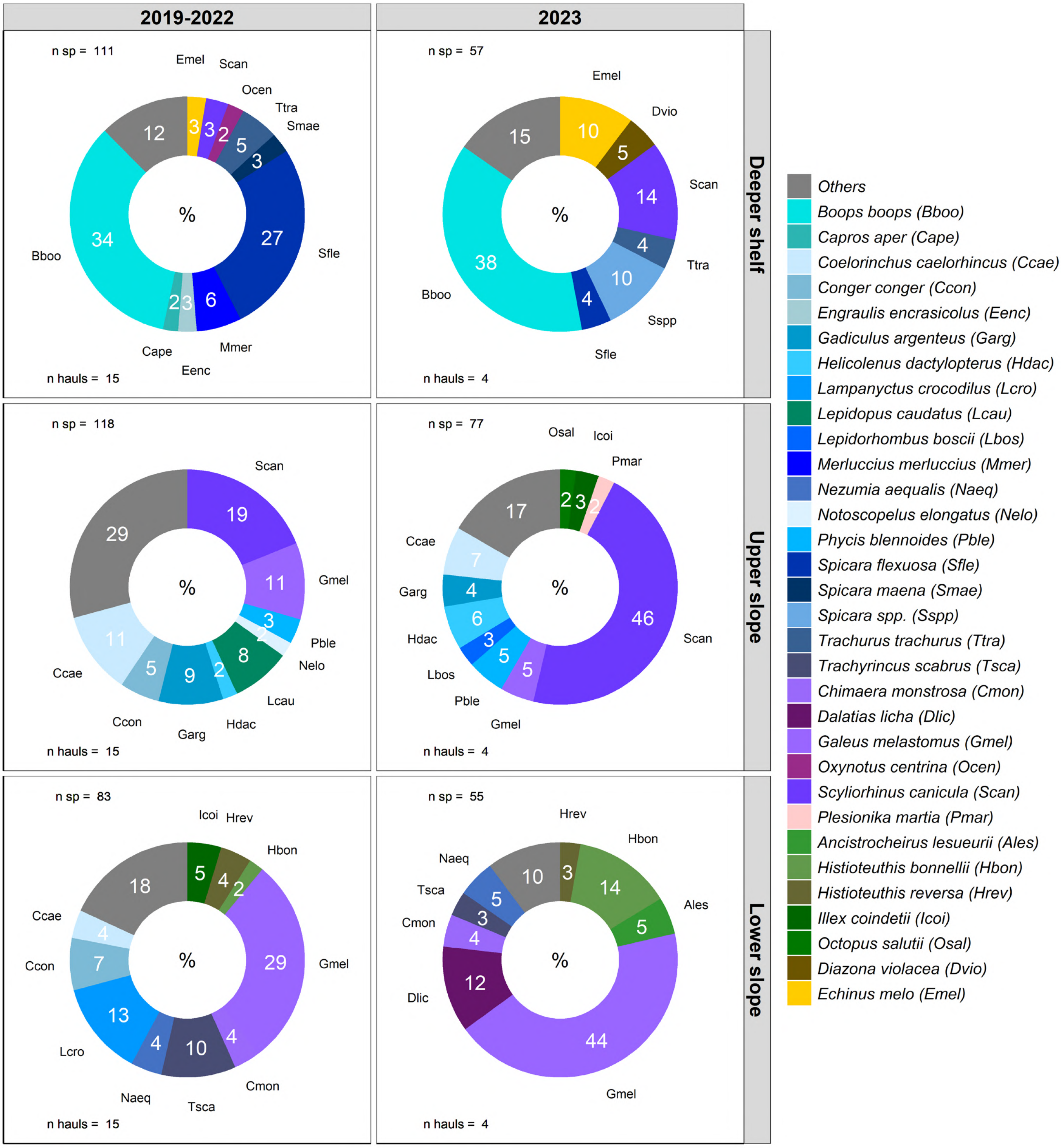


Figure 91. Arenys de Mar discarded species with most biomass. Percentage in weight including all hauls within each period and *métier*.

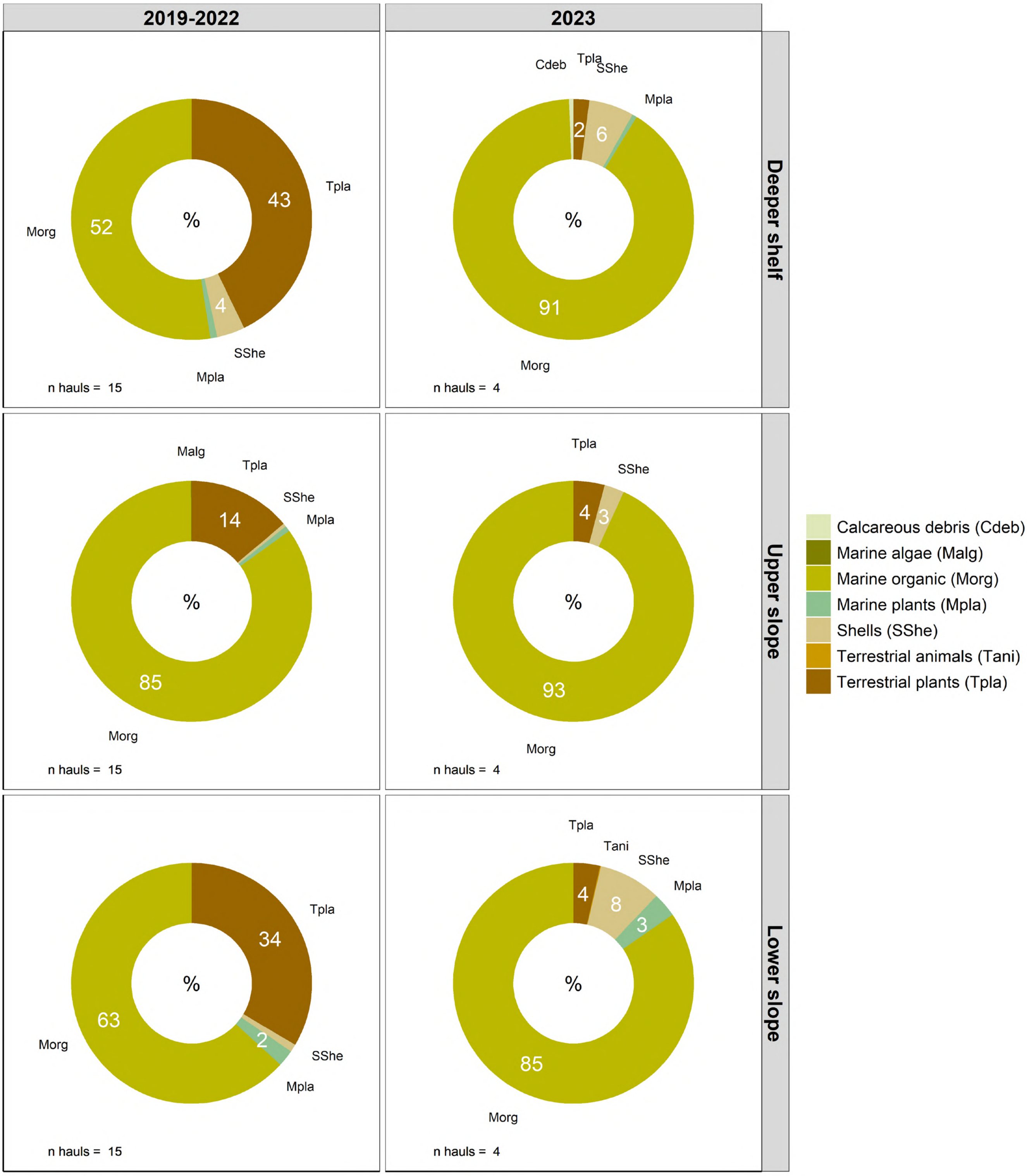


Figure 92. Arenys de Mar Categories with higher biomass natural debris. Percentage in weight including all hauls within each period and *métier*.

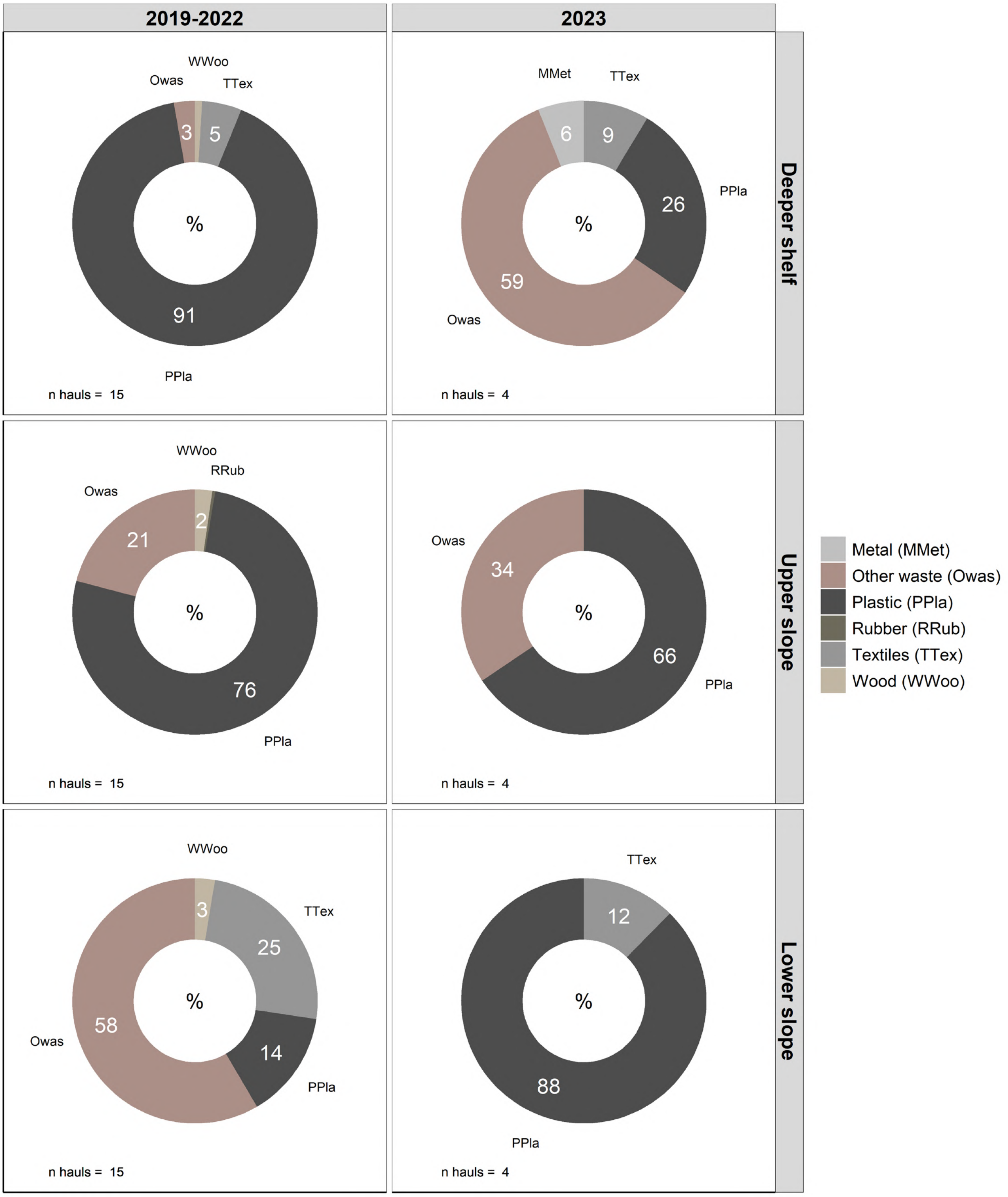


Figure 93. Arenys de Mar Categories with higher mass marine litter. Percentage in weight including all hauls within each period and *métier*.

Center Zone

Center zone: Figure 94.

Barcelona: Figure 95, Figure 96, Figure 97, Figure 98, Figure 99.

Vilanova i la Geltrú: Figure 100, Figure 101, Figure 102, Figure 103, Figure 104.

Tarragona: Figure 105, Figure 106, Figure 107, Figure 108, Figure 109.

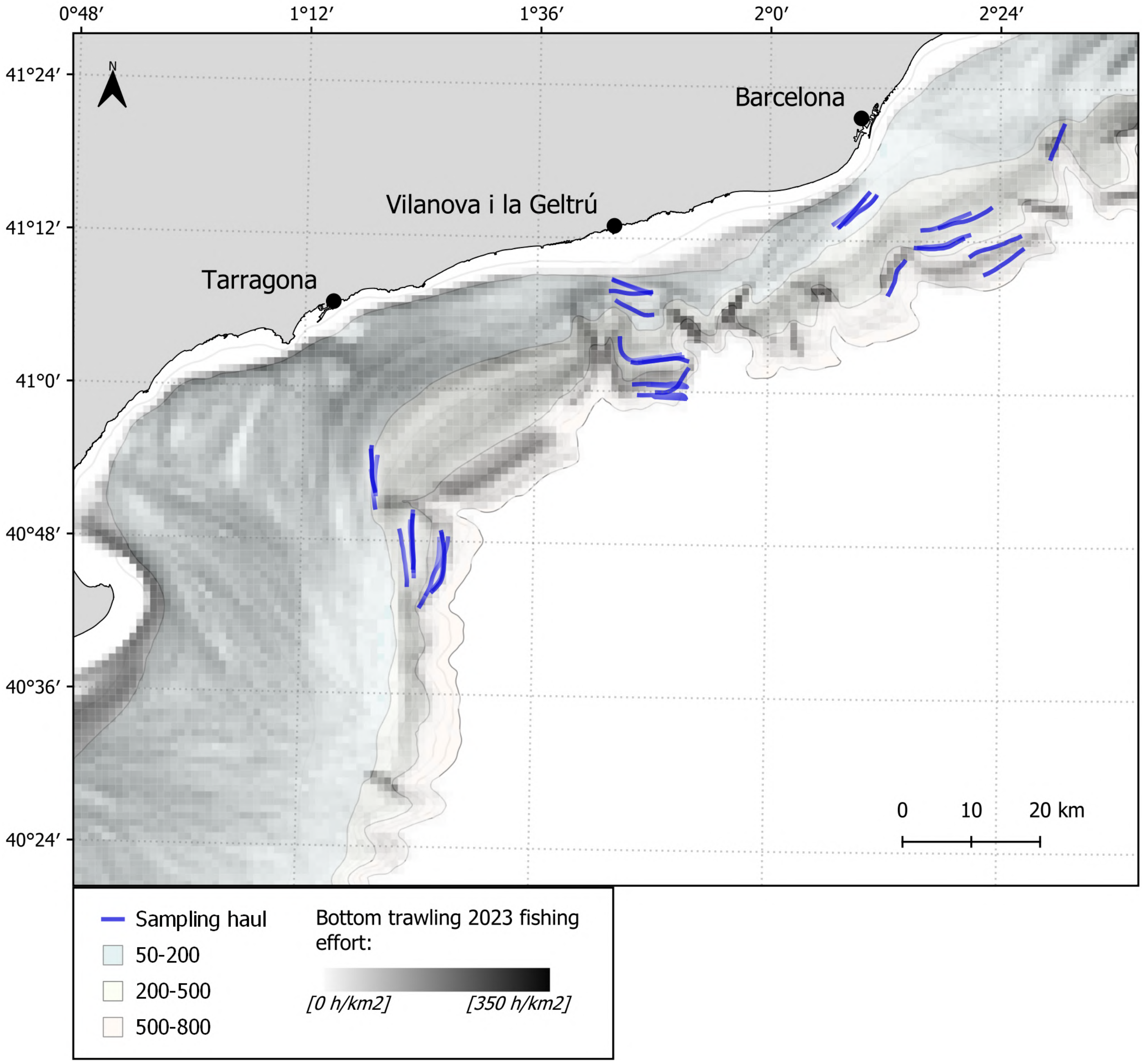


Figure 94. Center zone sampling trawls in 2023.

Barcelona

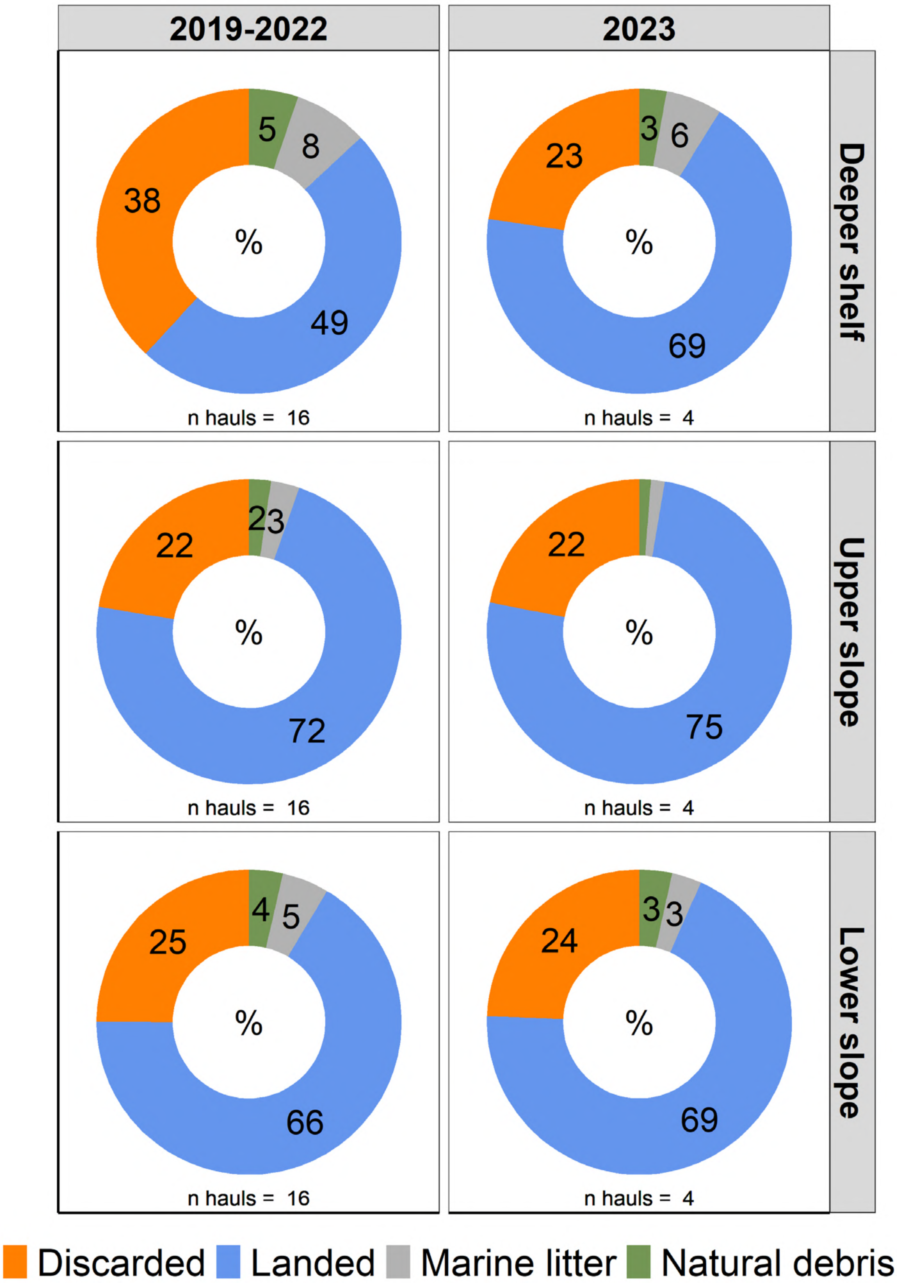


Figure 95. Barcelona catch composition. Percentage by weight of landings, discarded, natural debris and marine litter fraction including all hauls within each period and *métier*.

Figure 96. Barcelona landed species with most biomass. Percentage in weight including all hauls within each period and *métier*.

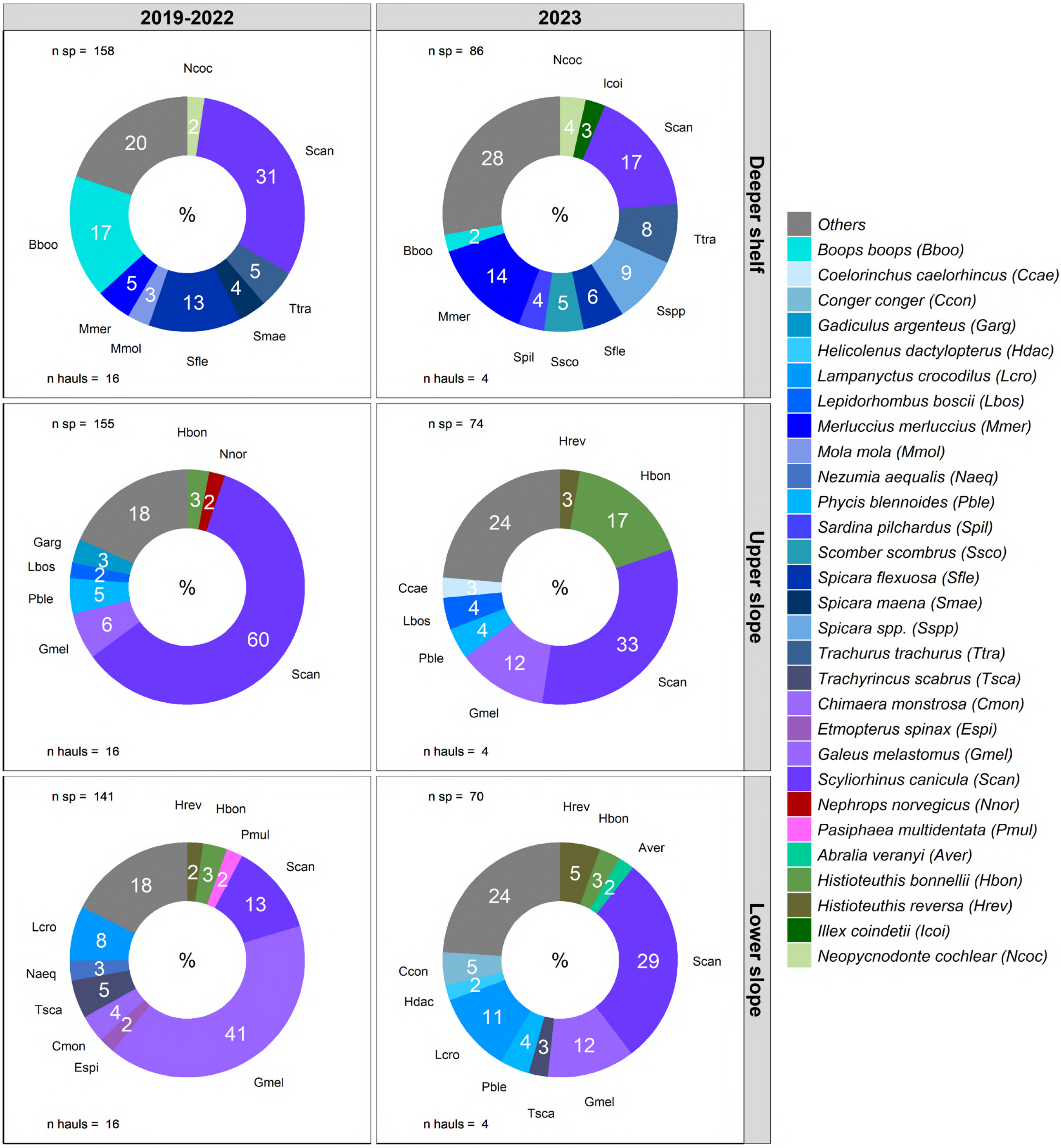


Figure 97. Barcelona discarded species with most biomass. Percentage in weight including all hauls within each period and *métier*.

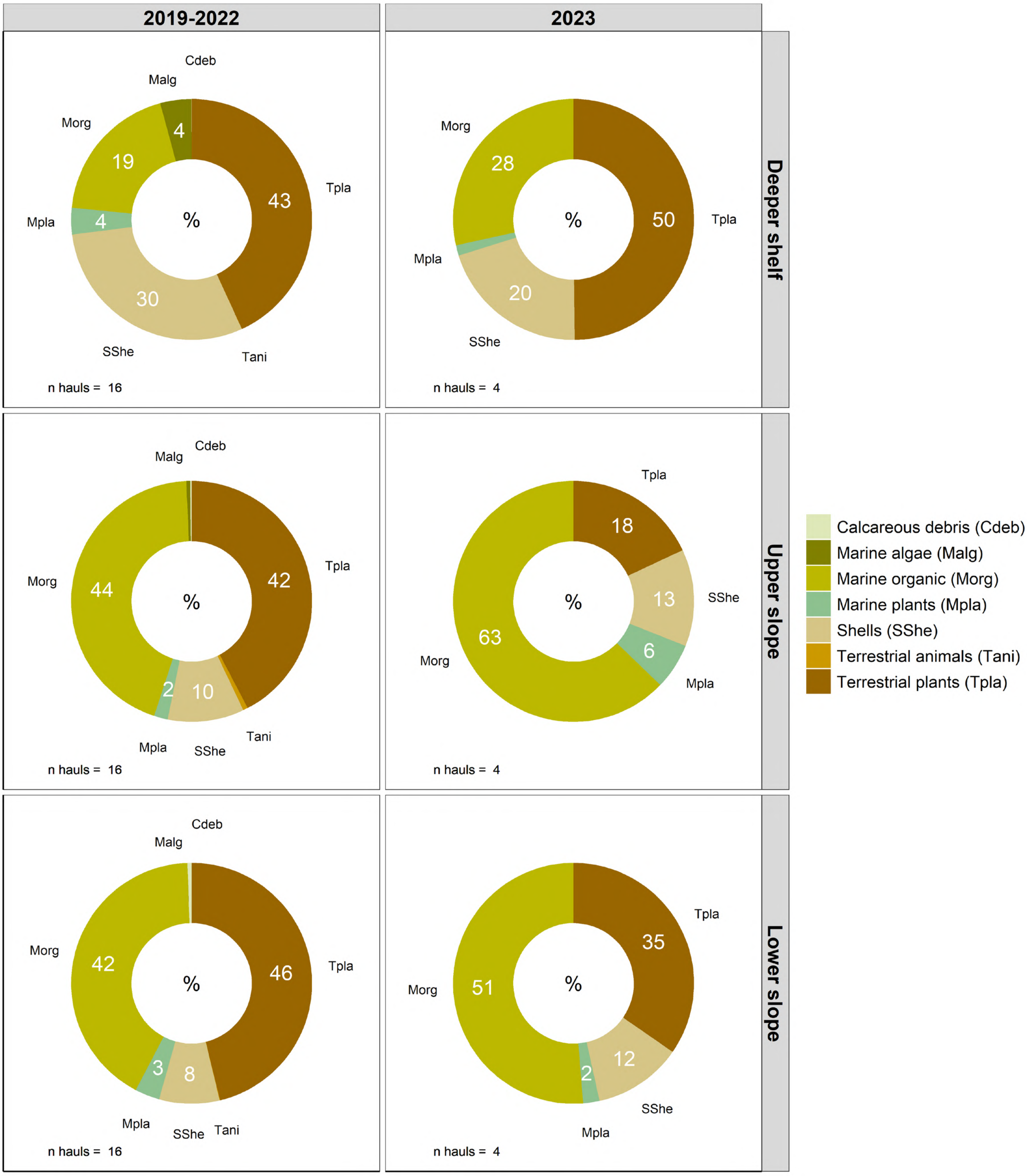


Figure 98. Barcelona Categories with higher biomass natural debris. Percentage in weight including all hauls within each period and *métier*.

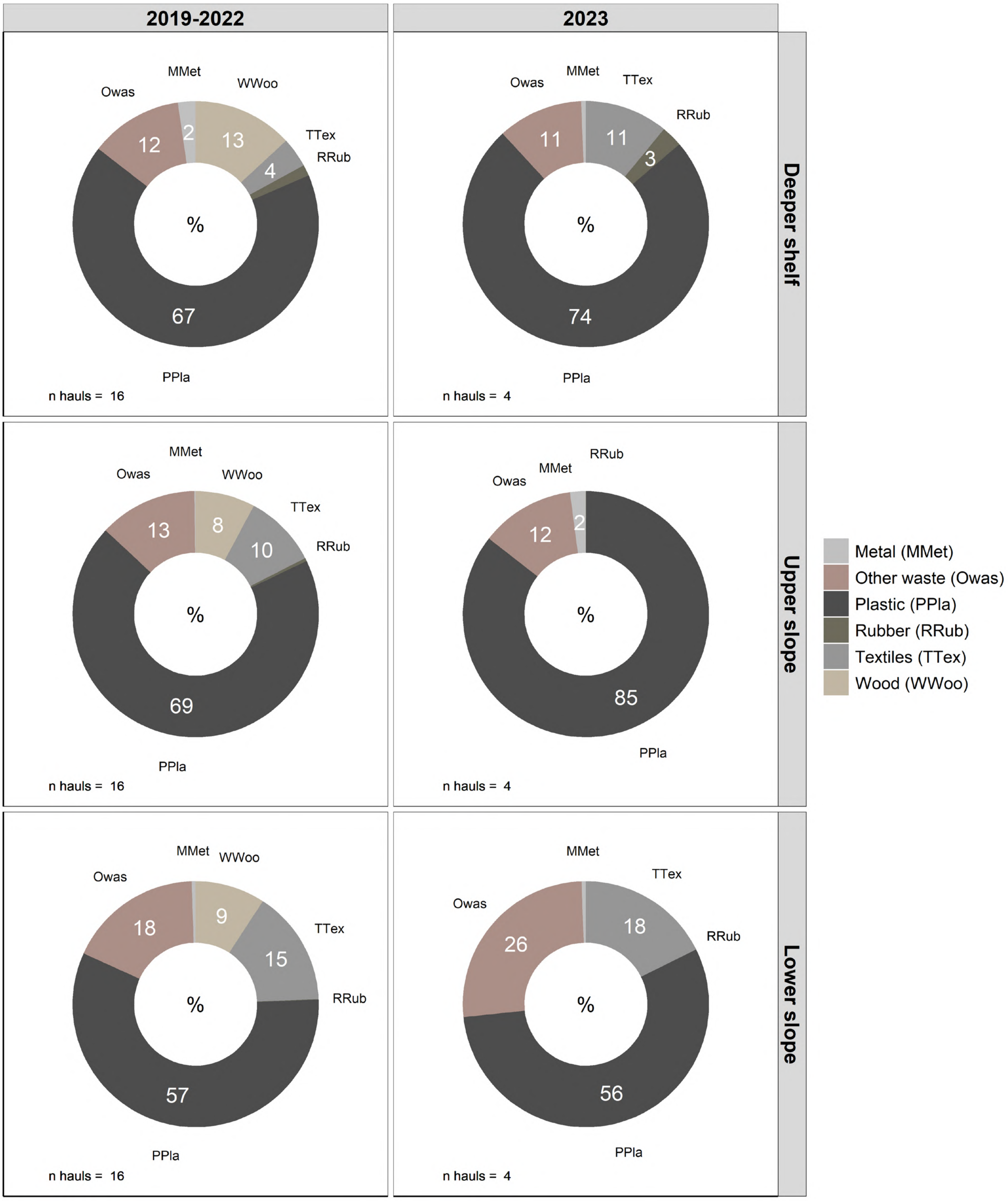


Figure 99. Barcelona Categories with higher mass marine litter. Percentage in weight including all hauls within each period and *métier*.

Vilanova i la Geltrú

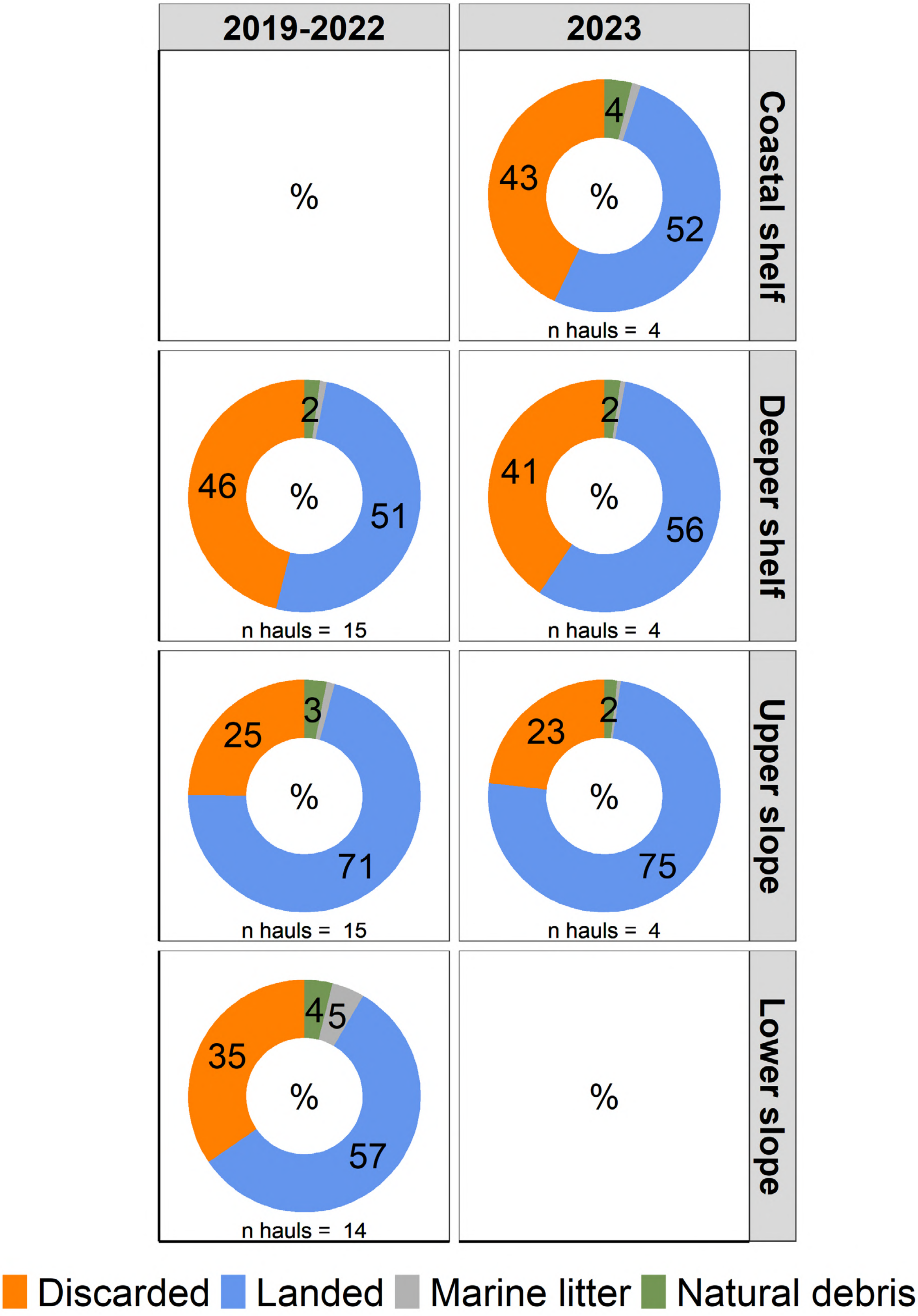


Figure 100. Vilanova i la Geltrú catch composition. Percentage by weight of landings, discarded, natural debris and marine litter fraction including all hauls within each period and *métier*.

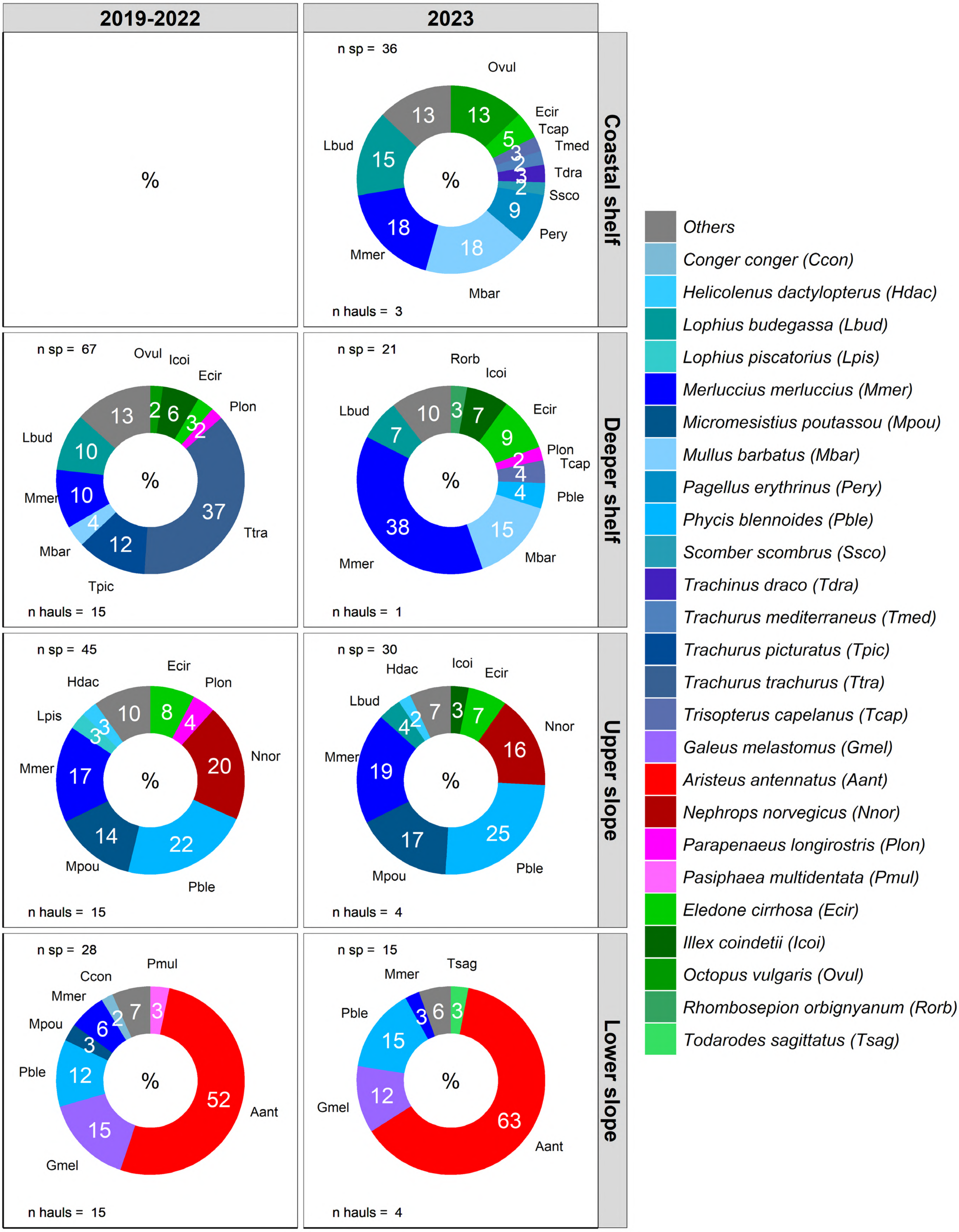


Figure 101. Vilanova i la Geltrú landed species with most biomass. Percentage in weight including all hauls within each period and *métier*.

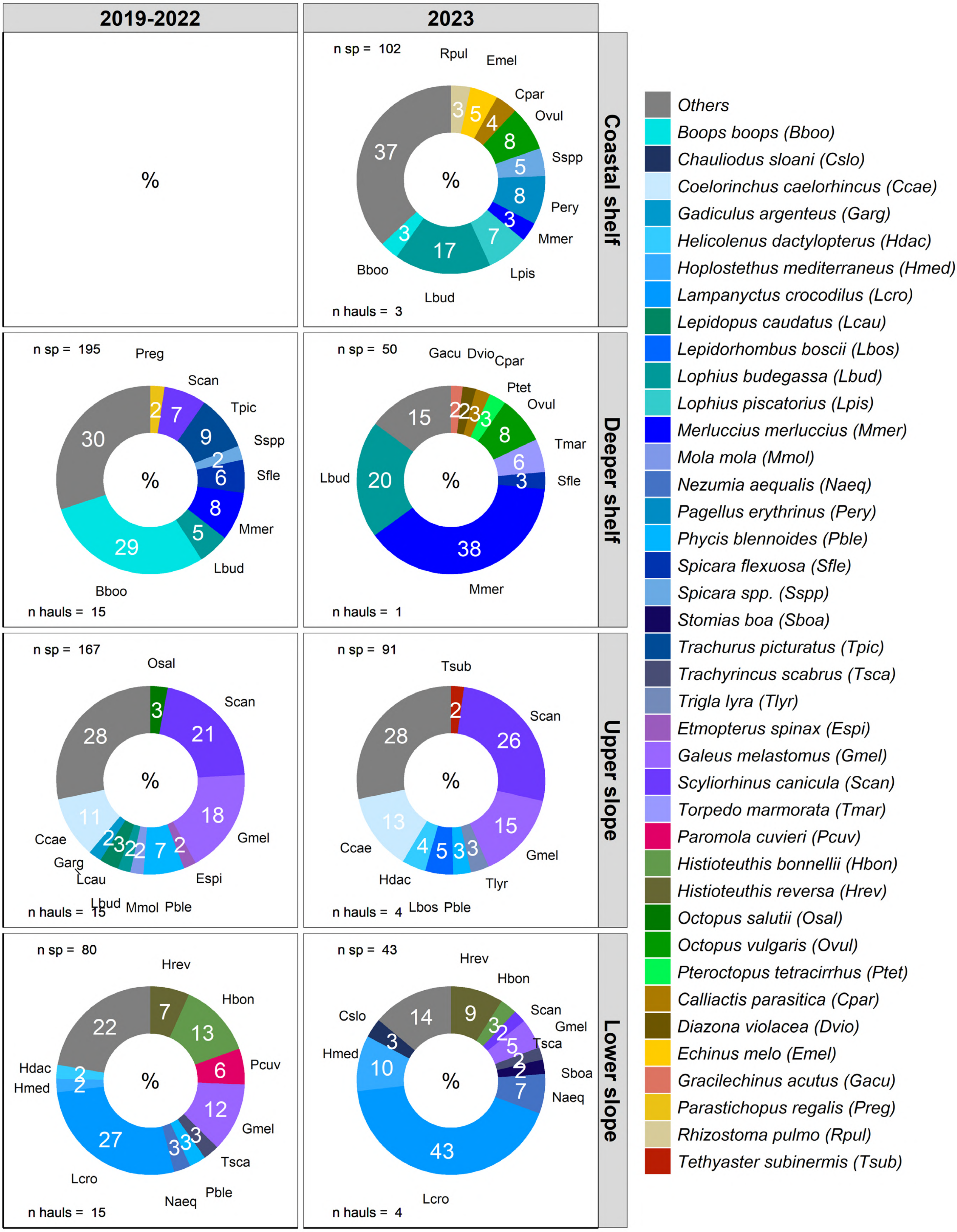


Figure 102. Vilanova i la Geltrú discarded species with most biomass. Percentage in weight including all hauls within each period and *métier*.

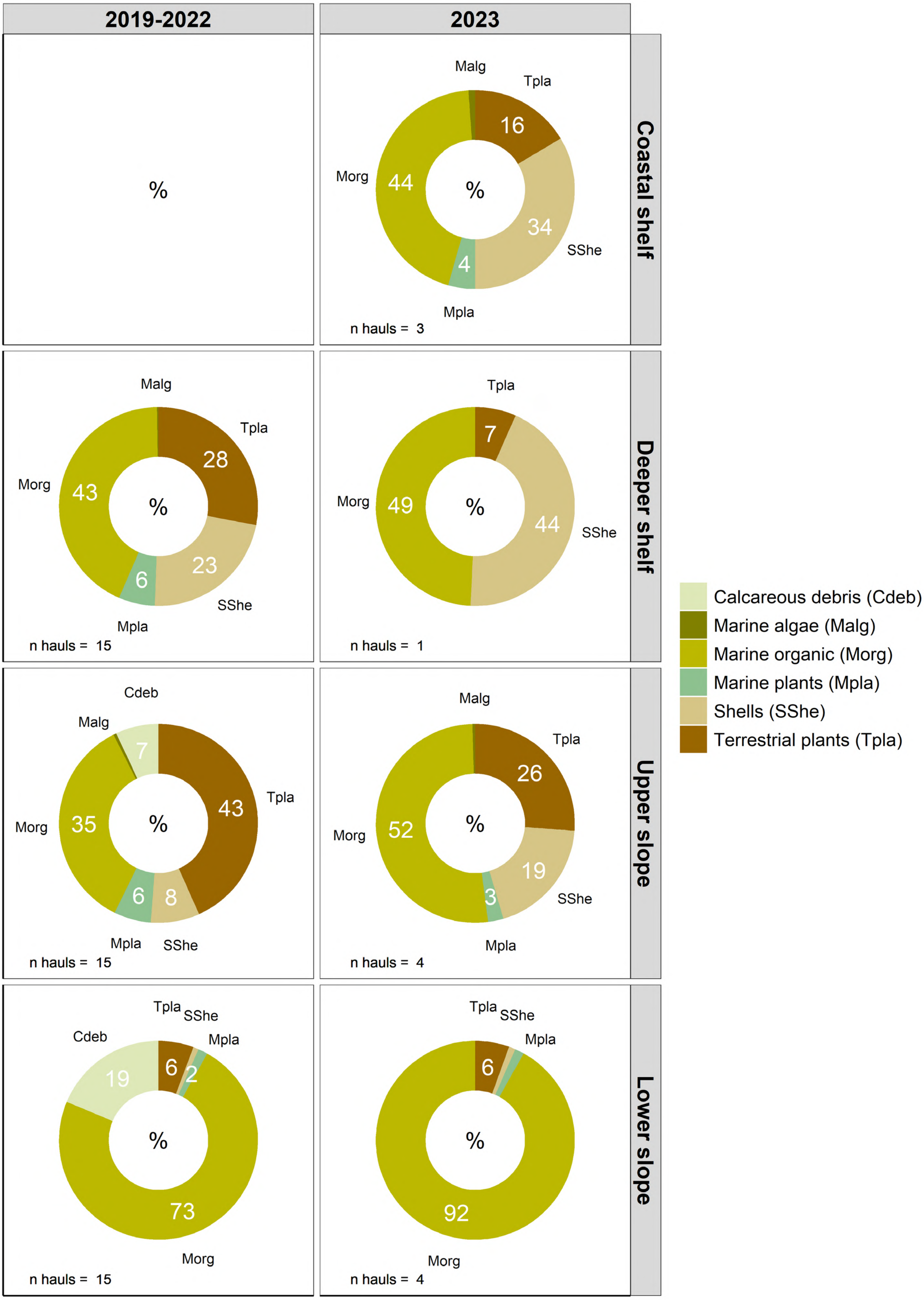


Figure 103. Vilanova i la Geltrú Categories with higher biomass natural debris. Percentage in weight including all hauls within each period and *métier*.

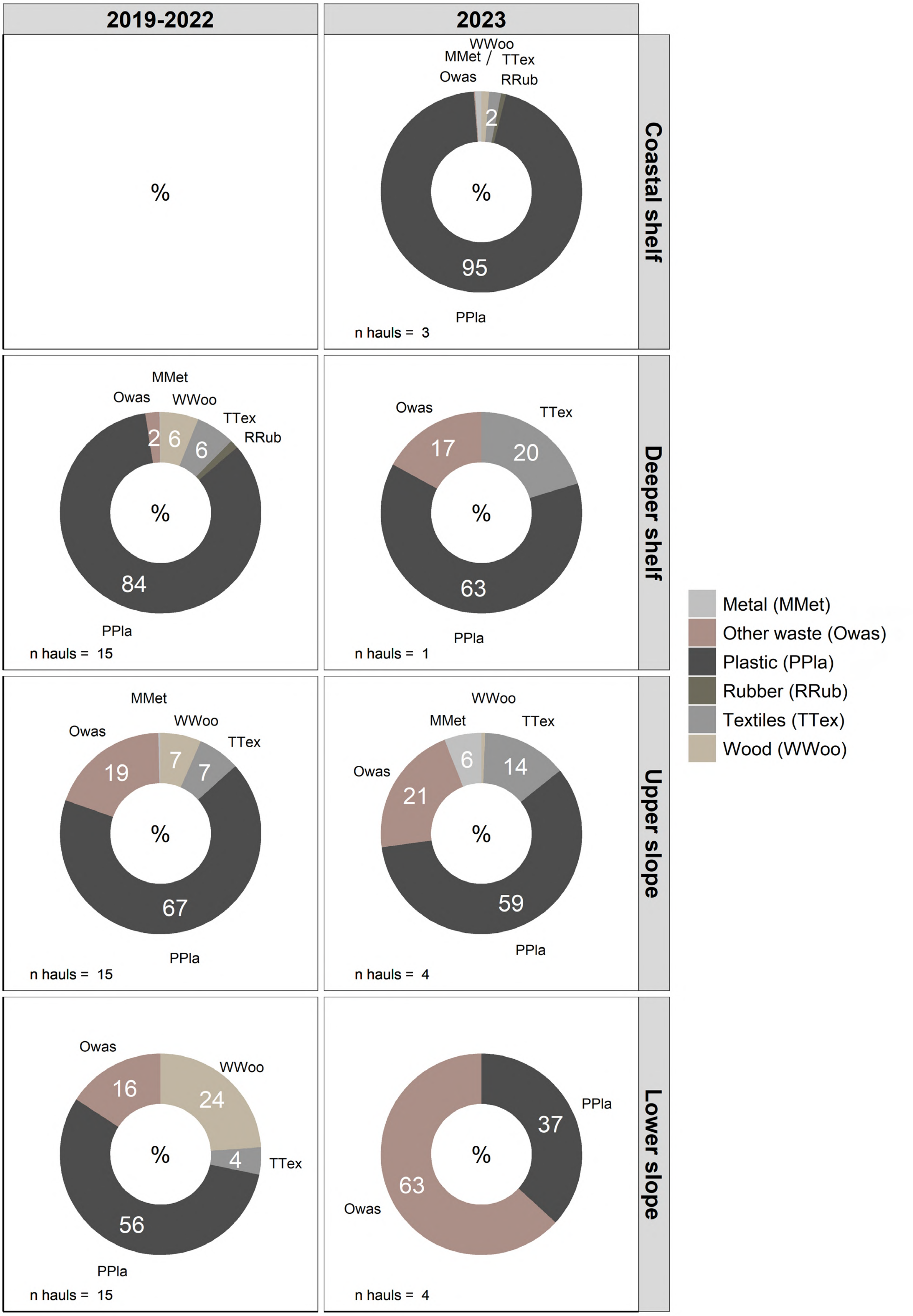


Figure 104. Vilanova i la Geltrú Categories with higher mass marine litter. Percentage in weight including all hauls within each period and *métier*.

Tarragona

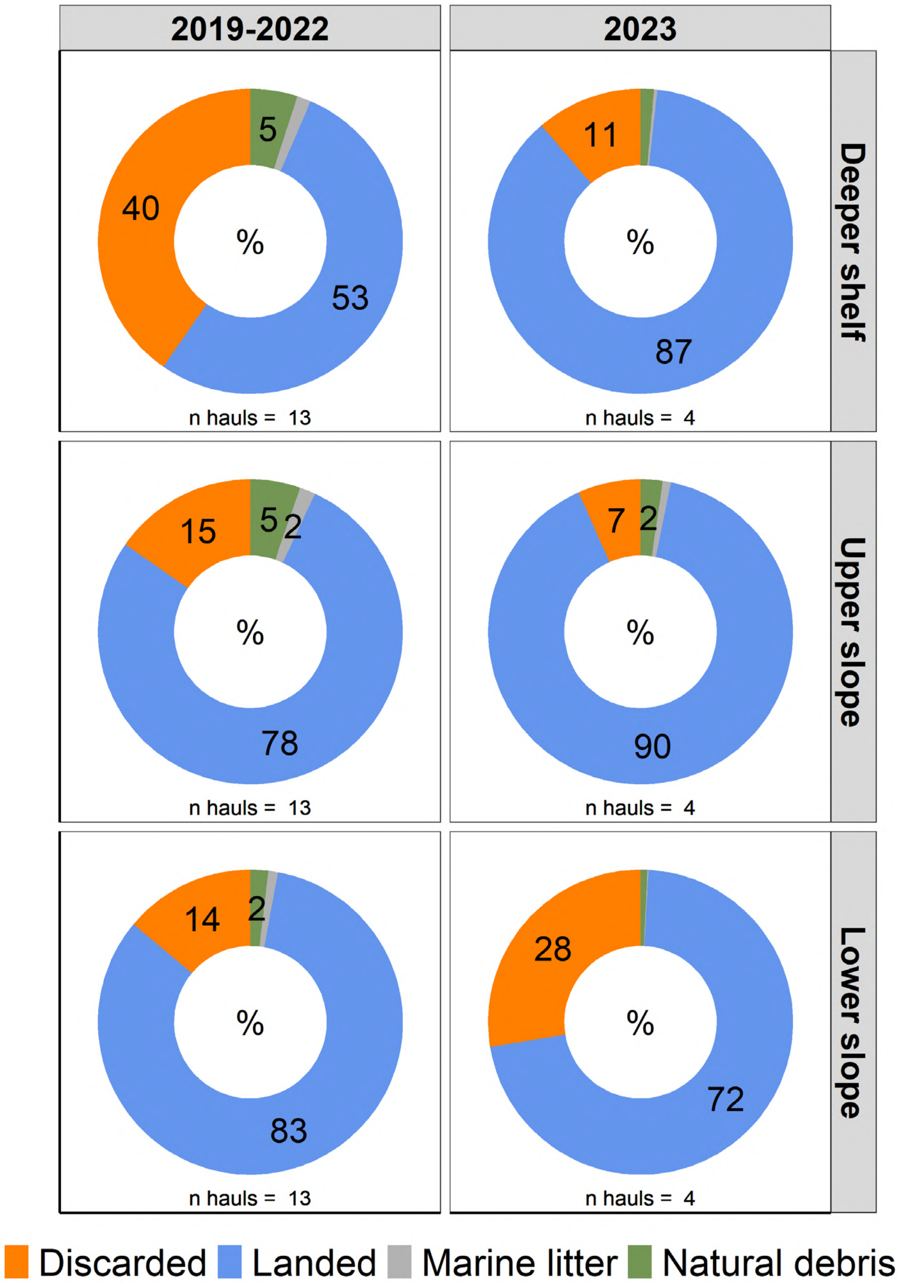


Figure 105. Tarragona catch composition. Percentage by weight of landings, discarded, natural debris and marine litter fraction including all hauls within each period and *métier*.

Figure 106. Tarragona landed species with most biomass. Percentage in weight including all hauls within each period and *métier*.

Figure 107. Tarragona discarded species with most biomass. Percentage in weight including all hauls within each period and *métier*.

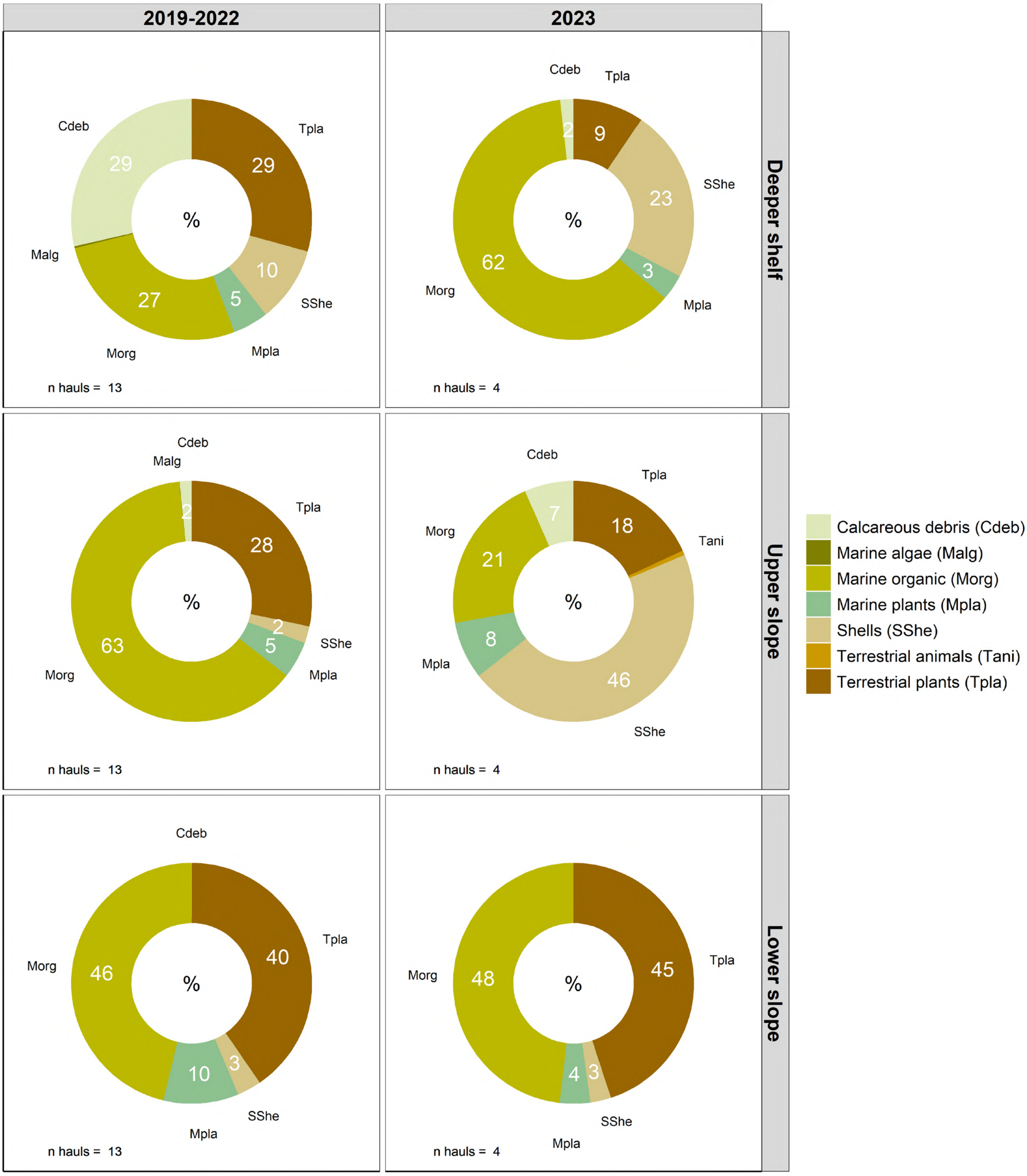


Figure 108. Tarragona Categories with higher biomass natural debris. Percentage in weight including all hauls within each period and *métier*.

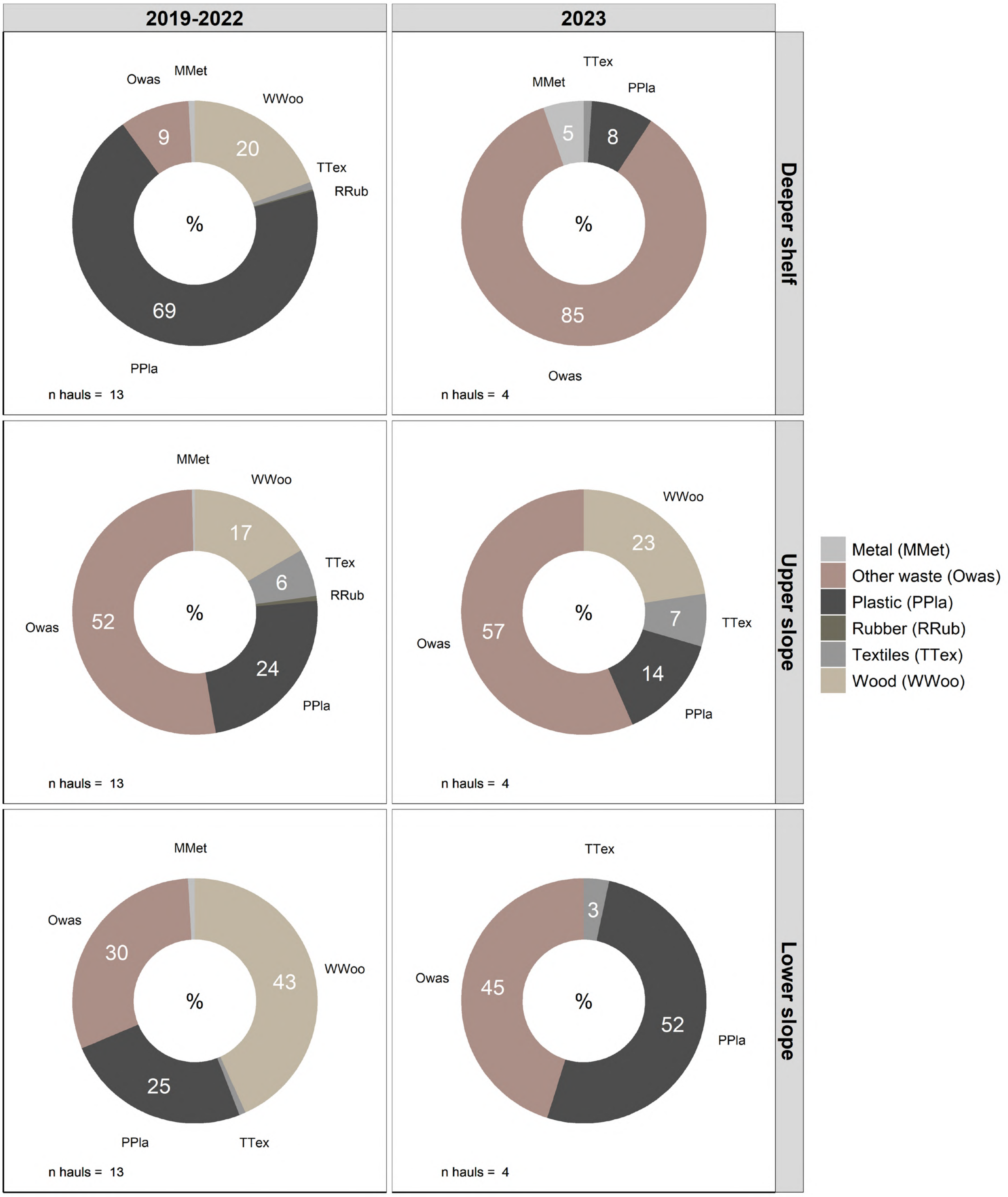


Figure 109. Tarragona Categories with higher mass marine litter. Percentage in weight including all hauls within each period and *métier*.

South Zone

South zone: Figure 110.

L'Ametlla de Mar: Figure 111, Figure 112, Figure 113, Figure 114, Figure 115.

La Ràpita: Figure 116, Figure 117, Figure 118, Figure 119, Figure 120.

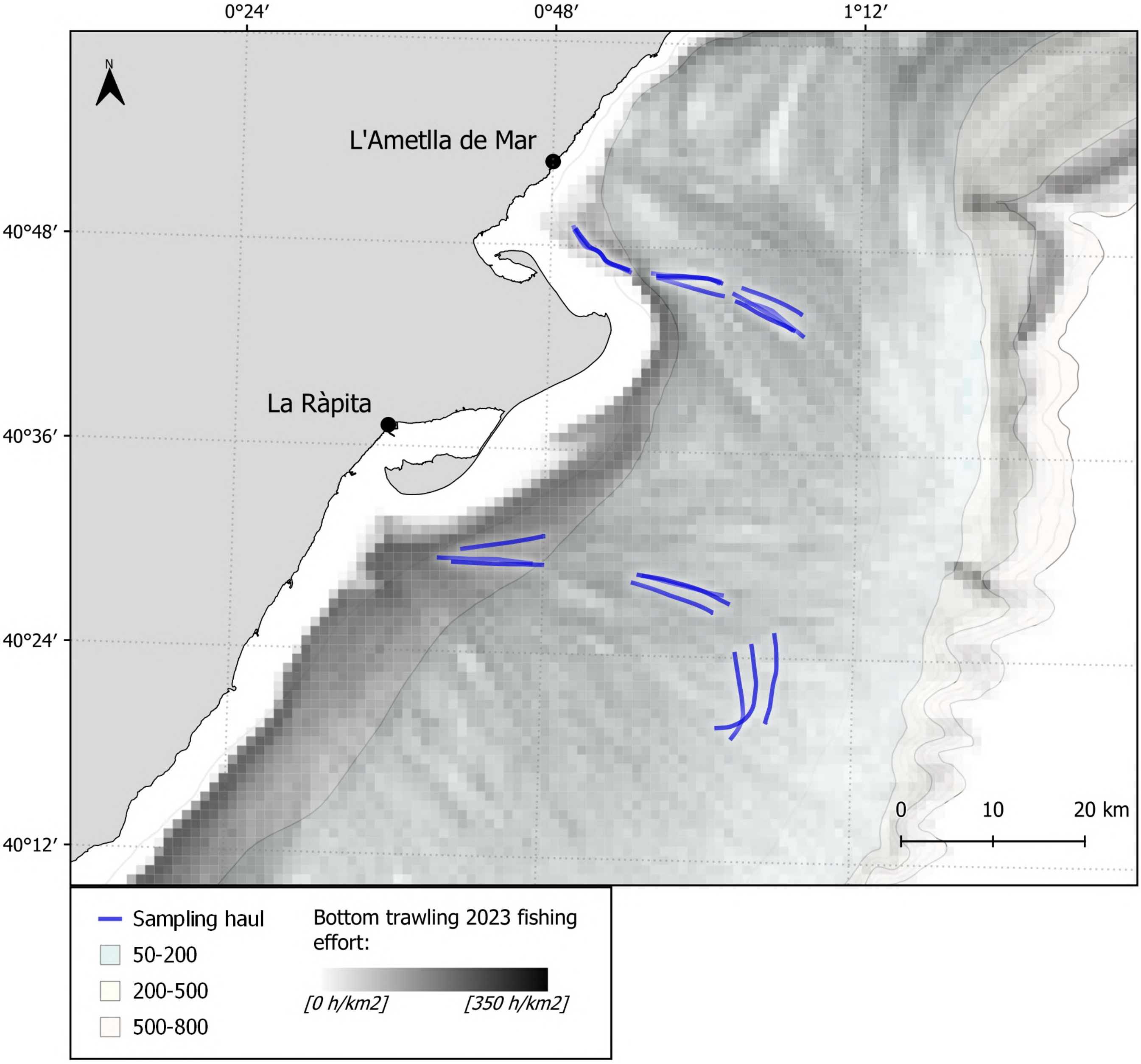


Figure 110. South zone sampling trawls in 2023.

L'Ametlla de Mar

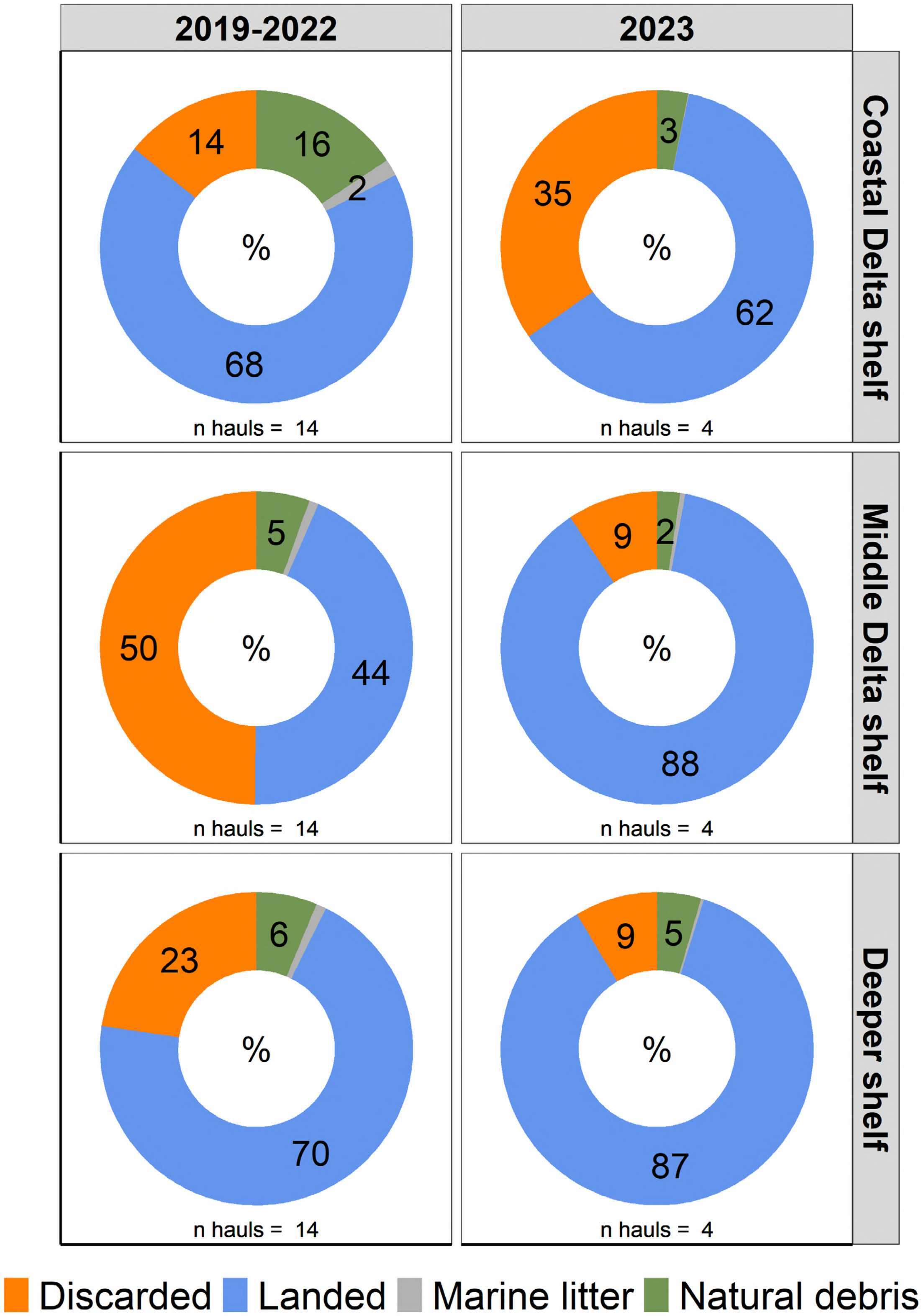


Figure 111. L'Ametlla de Mar catch composition. Percentage by weight of landings, discarded, natural debris and marine litter fraction including all hauls within each period and *métier*.

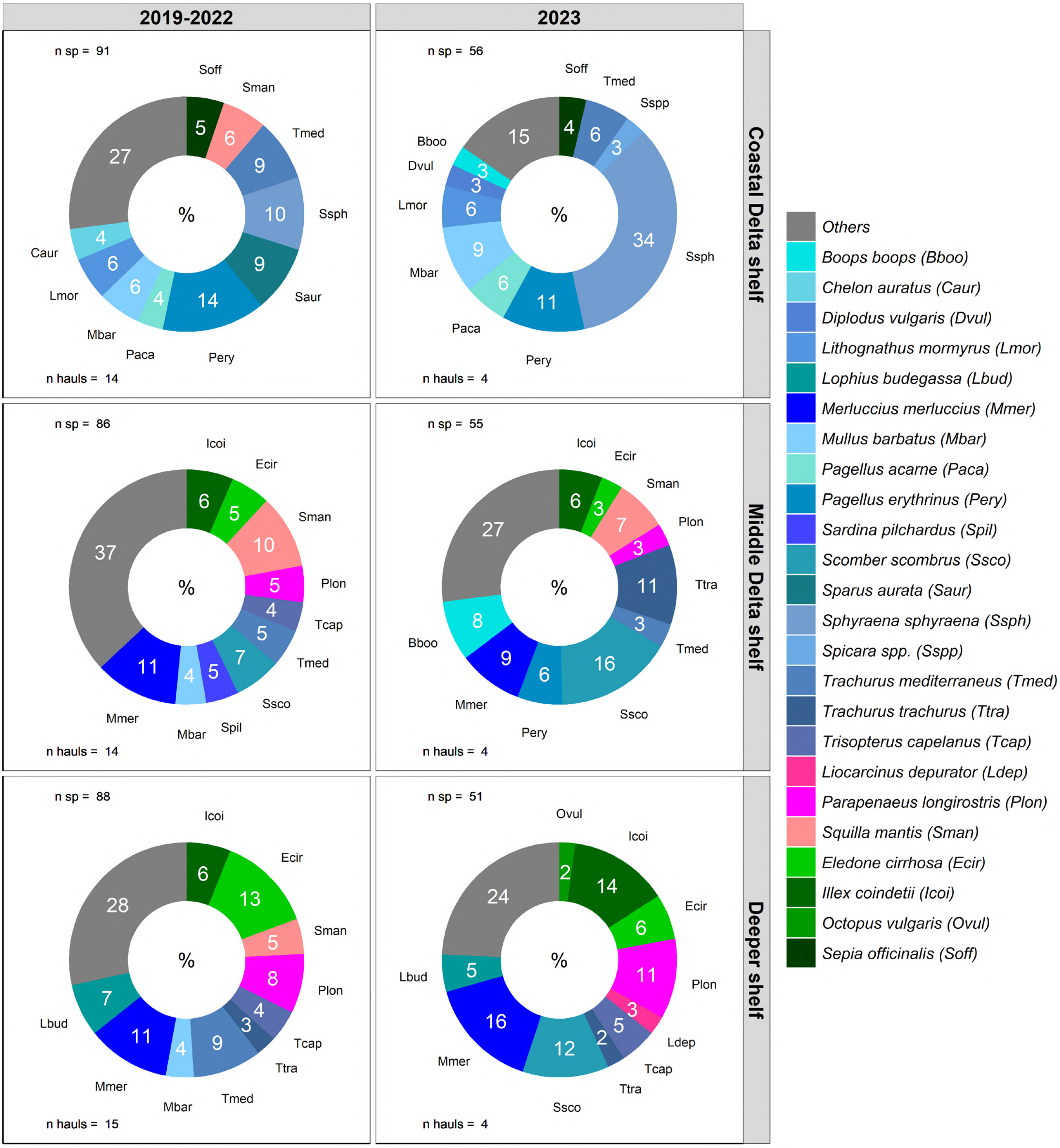


Figure 112. L'Ametlla de Mar landed species with most biomass. Percentage in weight including all hauls within each period and *métier*.

Figure 113. L'Ametlla de Mar discarded species with most biomass. Percentage in weight including all hauls within each period and *métier*.

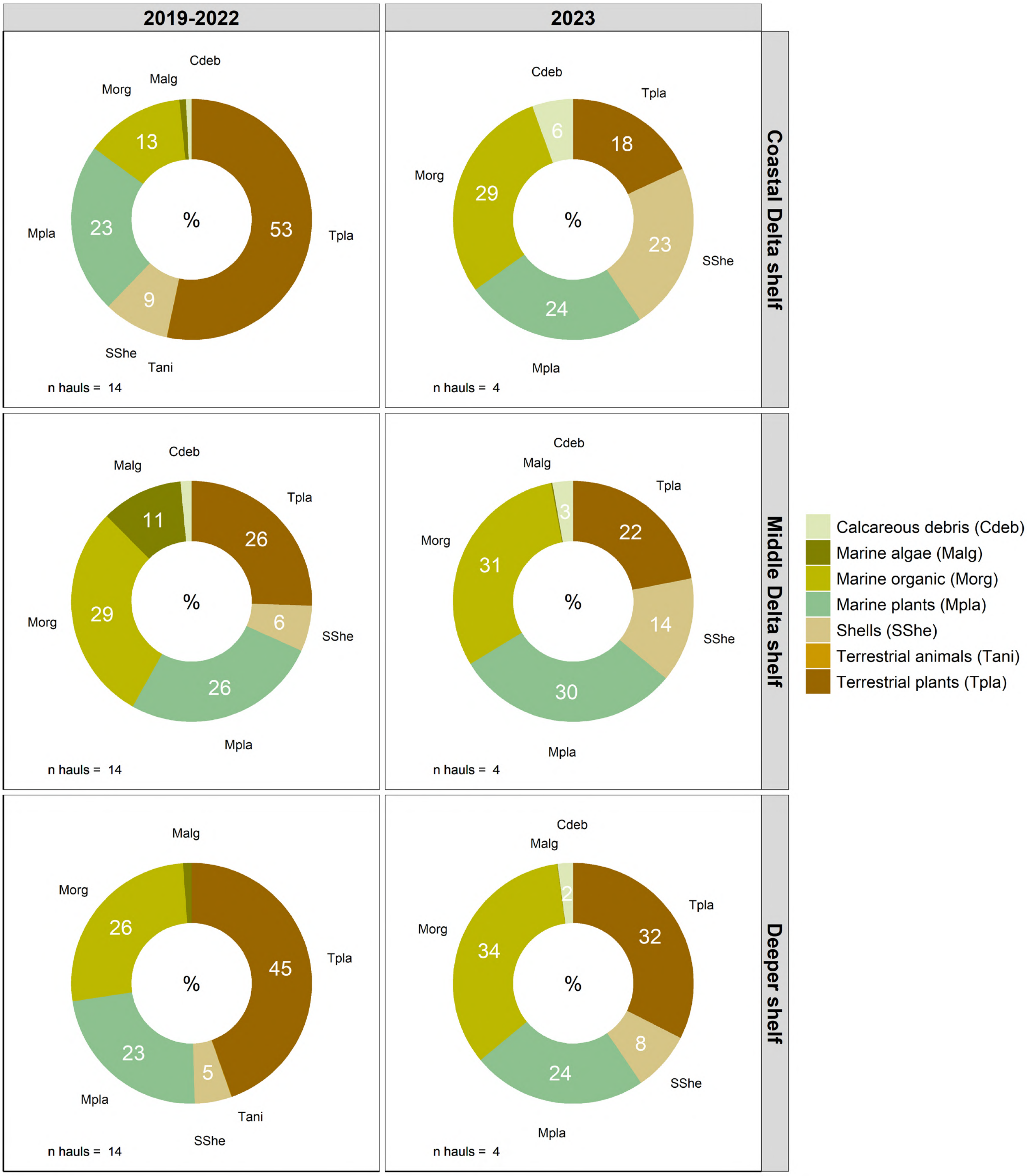


Figure 114. L'Ametlla de Mar Categories with higher biomass natural debris. Percentage in weight including all hauls within each period and *métier*.

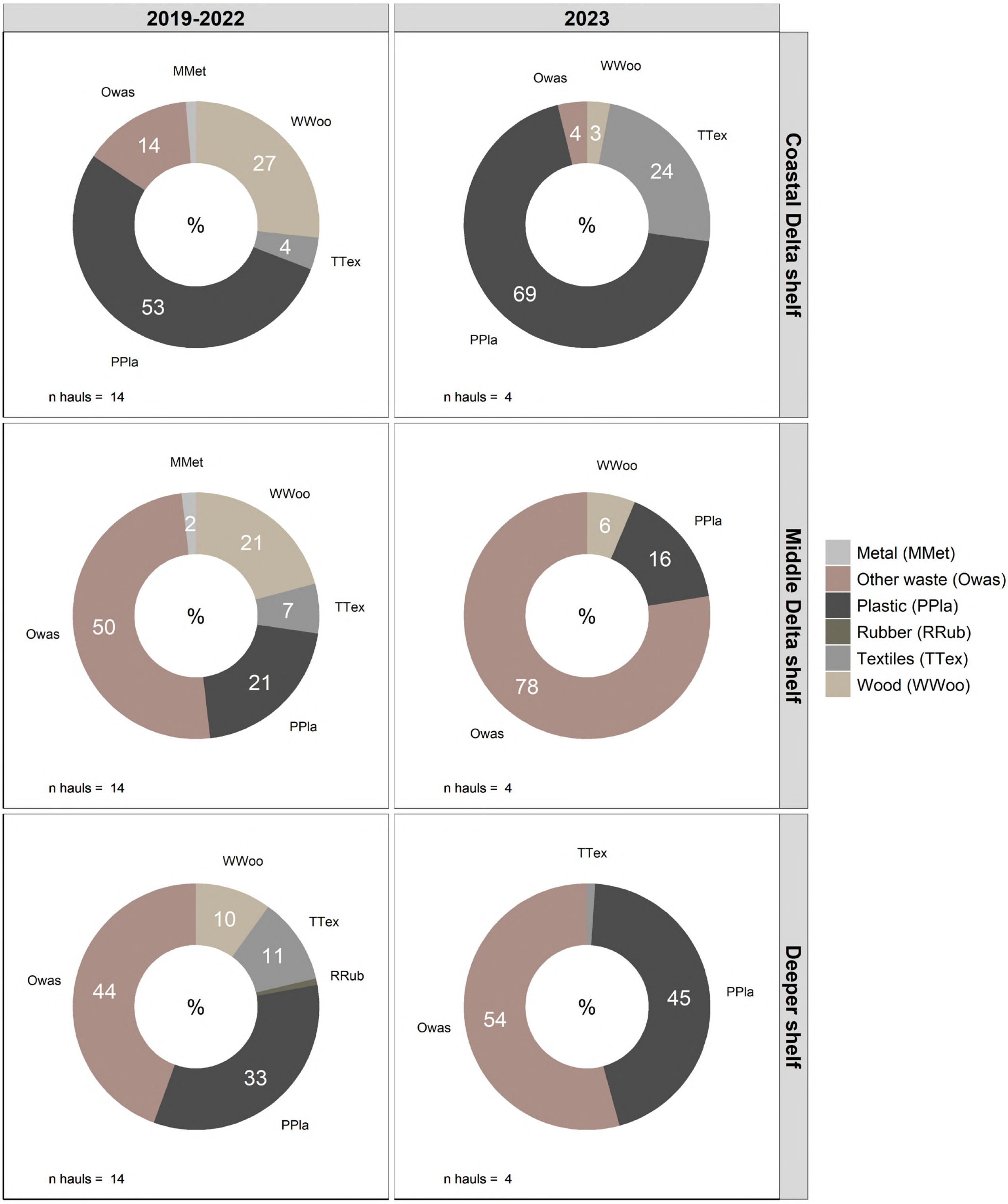


Figure 115. L'Ametlla de Mar Categories with higher mass marine litter. Percentage in weight including all hauls within each period and *métier*.

La Ràpita

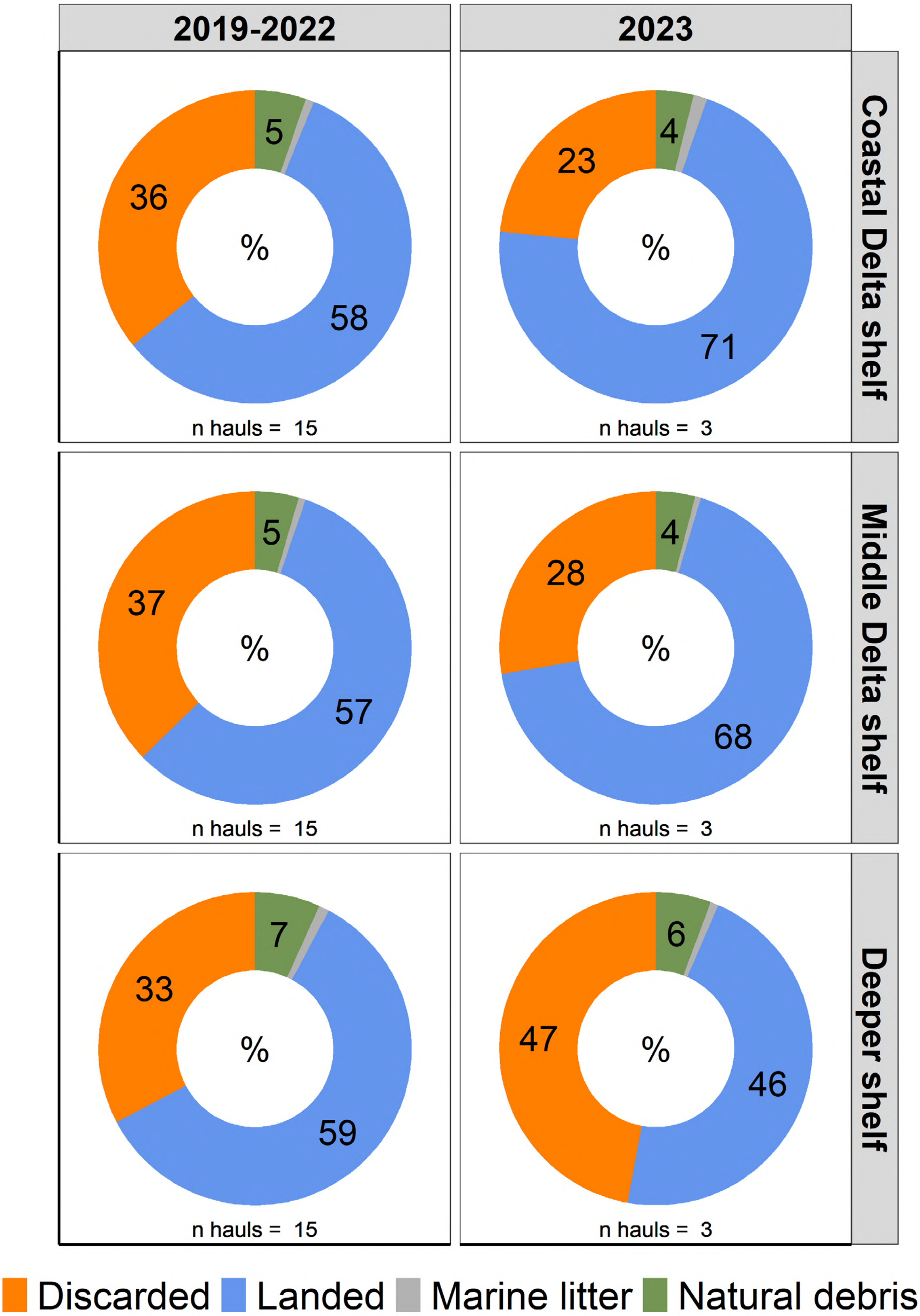


Figure 116. La Ràpita catch composition. Percentage by weight of landings, discarded, natural debris and marine litter fraction including all hauls within each period and *métier*.

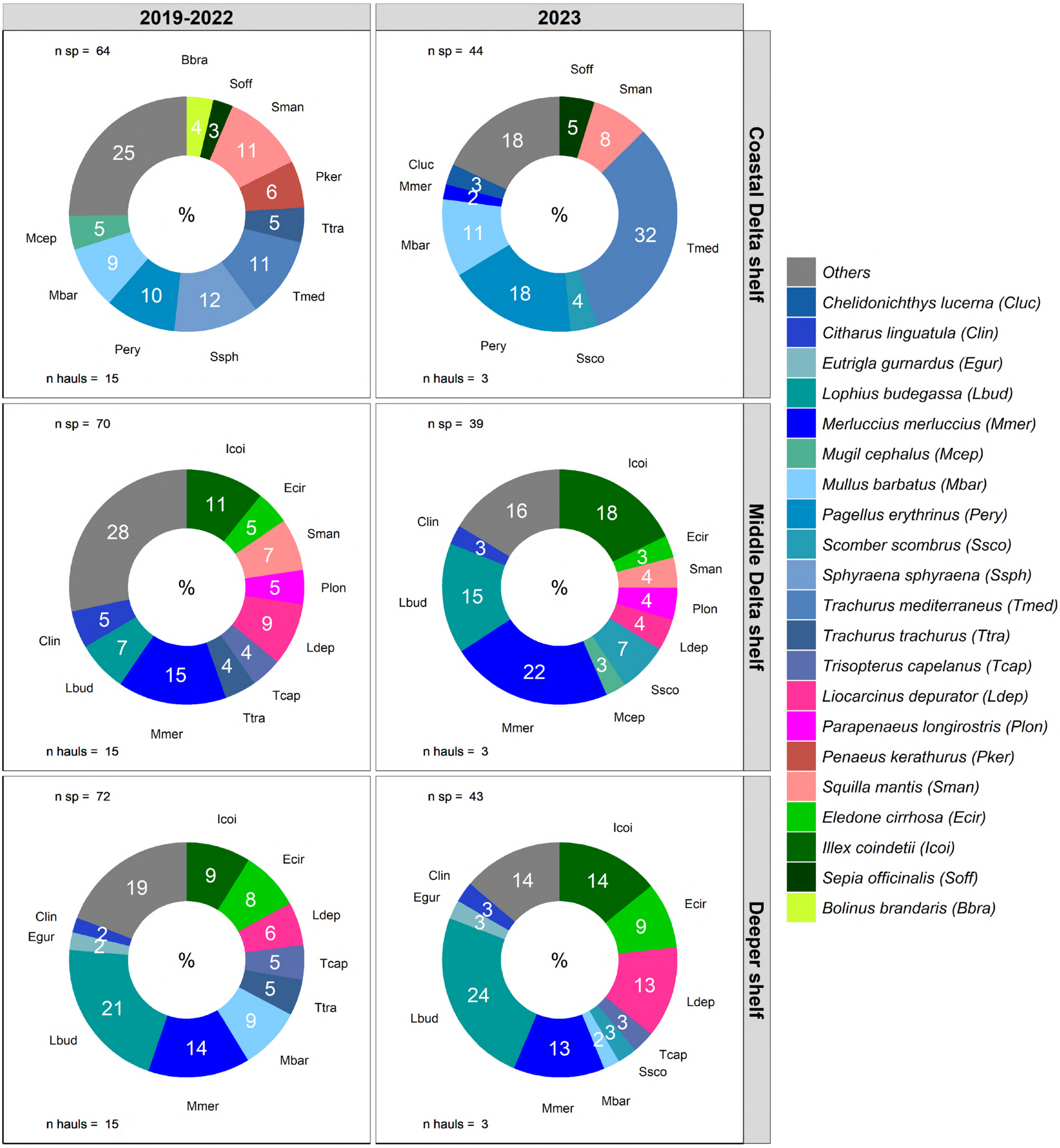


Figure 117. La Ràpita landed species with most biomass. Percentage in weight including all hauls within each period and *métier*.

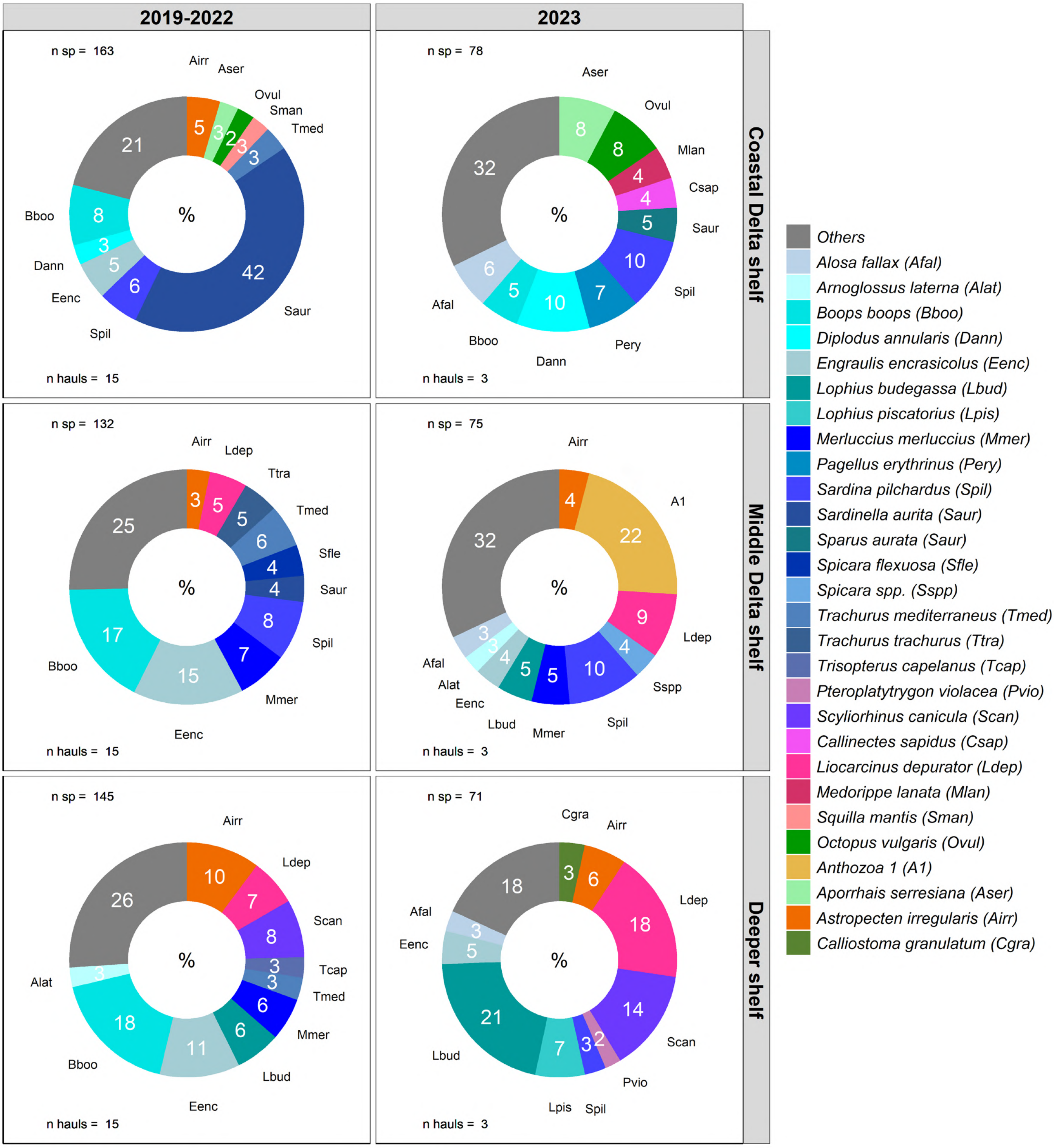


Figure 118. La Ràpita discarded species with most biomass. Percentage in weight including all hauls within each period and *métier*.

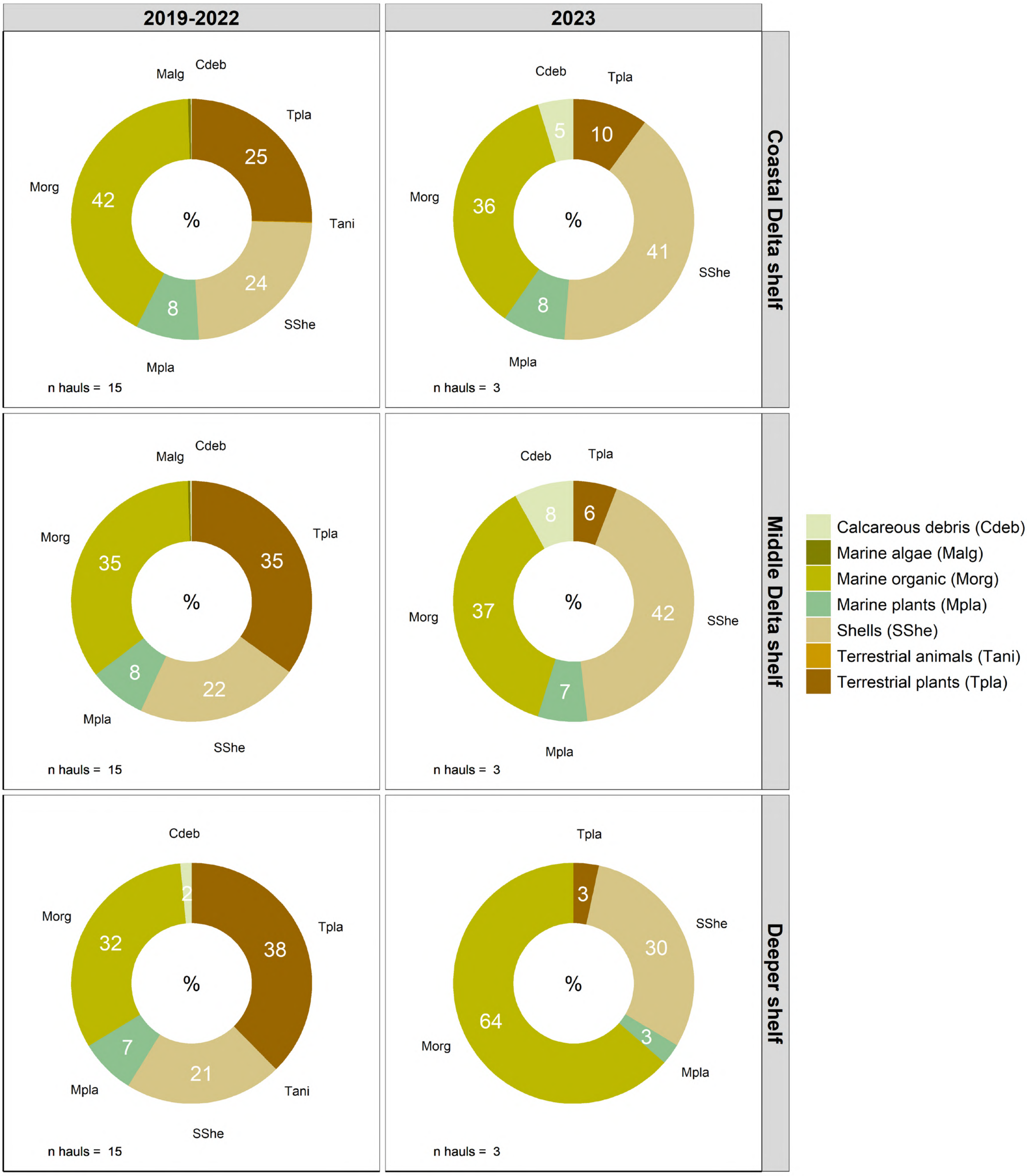


Figure 119. La Ràpita Categories with higher biomass natural debris. Percentage in weight including all hauls within each period and *métier*.

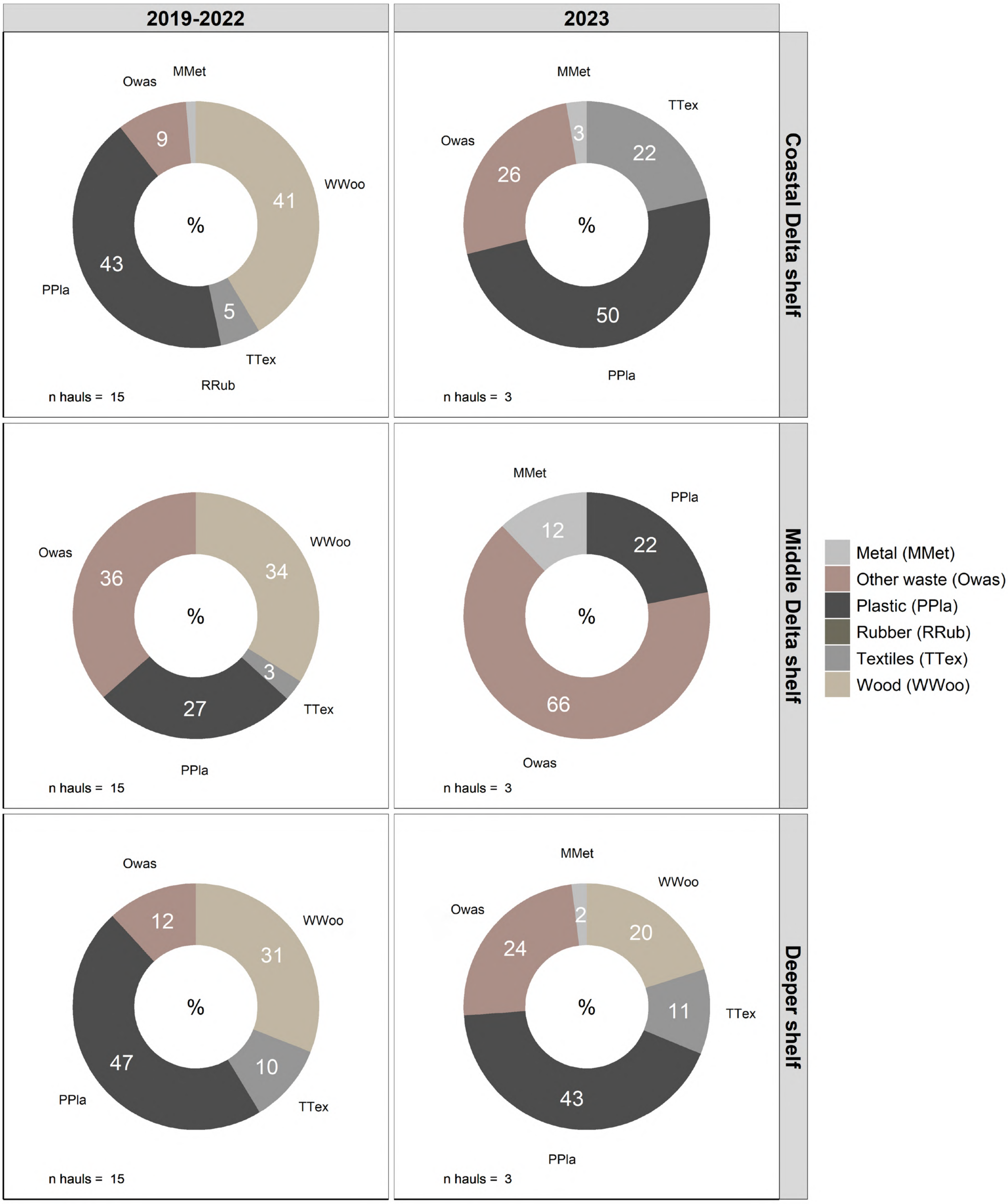


Figure 120. La Ràpita Categories with higher mass marine litter. Percentage in weight including all hauls within each period and *métier*.

SECTION 3
Purse seine fishing

Fishery monitoring of purse seine fishing in Catalonia

Purse seine fishery in Catalonia

A total of 374 purse seine fishery samplings were carried out in the period 2019-2023, 292 were fish market samplings, through the purchase of batches, and 71 were onboard samplings (Table 25). In 2023 25 onboard and 45 fish market samplings were carried out (Figure 121).

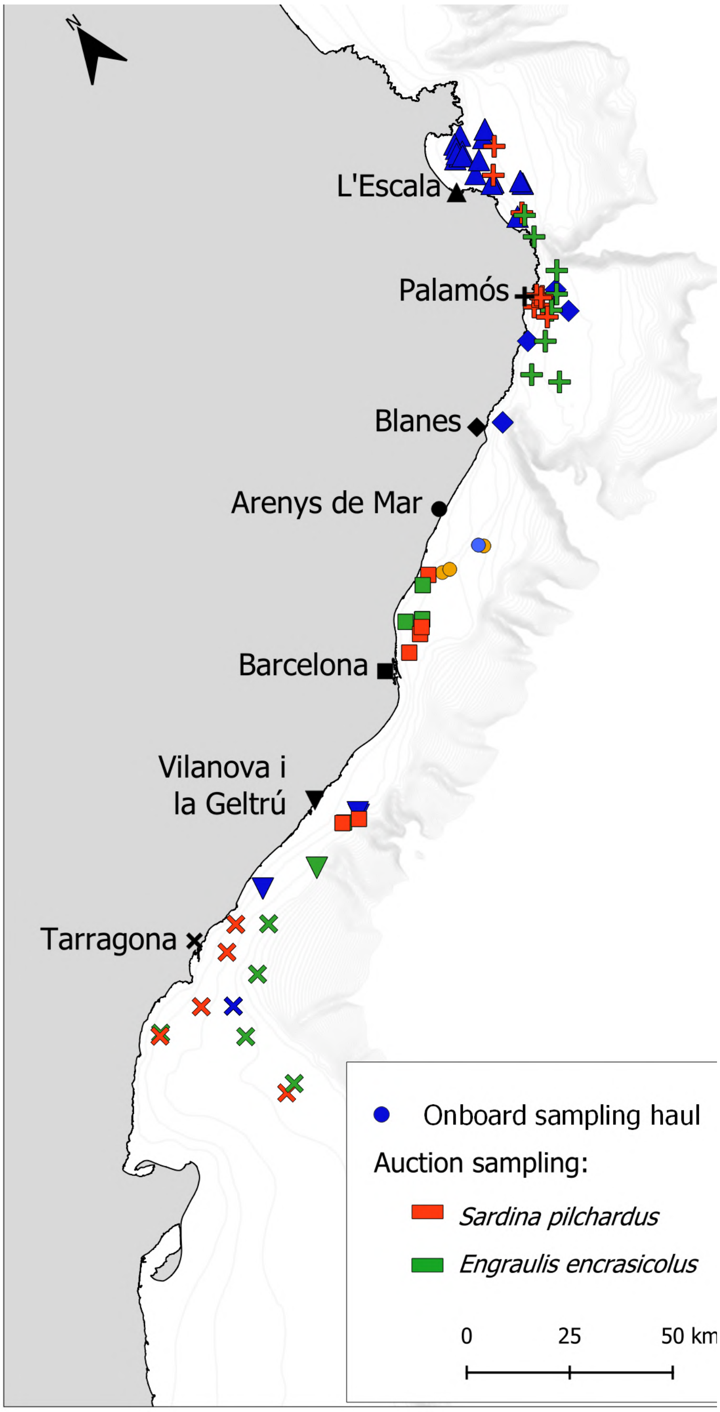


Figure 121. Purse seine sampling conducted in Catalonia in the year analyzed.

Table 25. Number of purse seine samplings. Fish market (samples obtained from the fish market) and onboard sampling (samples obtained on board commercial fishing vessels).

Fishery	Year	Zone	Winter	Spring	Summer	Autumn
			Number of samplings			
Purse seine (fish market)	2019	North	9	13	11	6
Purse seine (fish market)	2019	Center	8	8	9	7
Purse seine (fish market)	2020	North	6	6	10	8
Purse seine (fish market)	2020	Center	3	5	8	9
Purse seine (fish market)	2021	North	8	8	9	4
Purse seine (fish market)	2021	Center	8	7	10	8
Purse seine (fish market)	2022	North	6	9	8	6
Purse seine (fish market)	2022	Center	6	9	9	6
Purse seine (fish market)	2023	North	6	6	6	3
Purse seine (fish market)	2023	Center	7	7	6	4
Purse seine (on board sampling)	2020	North	5	0	0	0
Purse seine (on board sampling)	2020	Center	1	0	0	0
Purse seine (on board sampling)	2021	North	0	0	0	5
Purse seine (on board sampling)	2021	Center	0	0	1	1
Purse seine (on board sampling)	2022	North	7	4	9	4
Purse seine (on board sampling)	2022	Center	2	3	2	2
Purse seine (on board sampling)	2023	North	3	6	7	3
Purse seine (on board sampling)	2023	Center	0	3	0	0
Purse seine (on board sampling)	2023	South	0	0	1	2
Total number of samplings per season			**85**	**94**	**106**	**89**
Total number of samplings in the studied period						**374**

The catch composition, in terms of biomass, of the purse seine fishery in the onboard sampling in 2023 consisted of 90% target species (either European sardine or anchovy), 3% other commercial species (by-catch) and 7% discards (species not commercialized) (Figure 122).

Regarding the catch composition of target species in terms of biomass from onboard sampling in 2023, anchovy accounted for 71%, an increase from the 58% it accounted for in 2022. European sardine increased to 29% in 2023, up from 42% in 2022 (Figure 123).

Seven species were identified within the by-catch fraction of the onboard purse seine fishery sampling in 2023 (Figure 124). The non-target commercial species with higher biomasses were *Sardinella aurita* (69%) and *Euthynnus alletteratus* (21%), followed by *Xiphias gladius* (5%). For both years sampled *Sardinella aurita* was the most important species within the by-catch.

From the discarded fraction of the onboard purse seine fishery sampling in 2023, 27 species were identified (Figure 125). Of these, the species that accounted for the highest biomasses were *Auxis rochei* (24%) and *Boops boops* (18%).

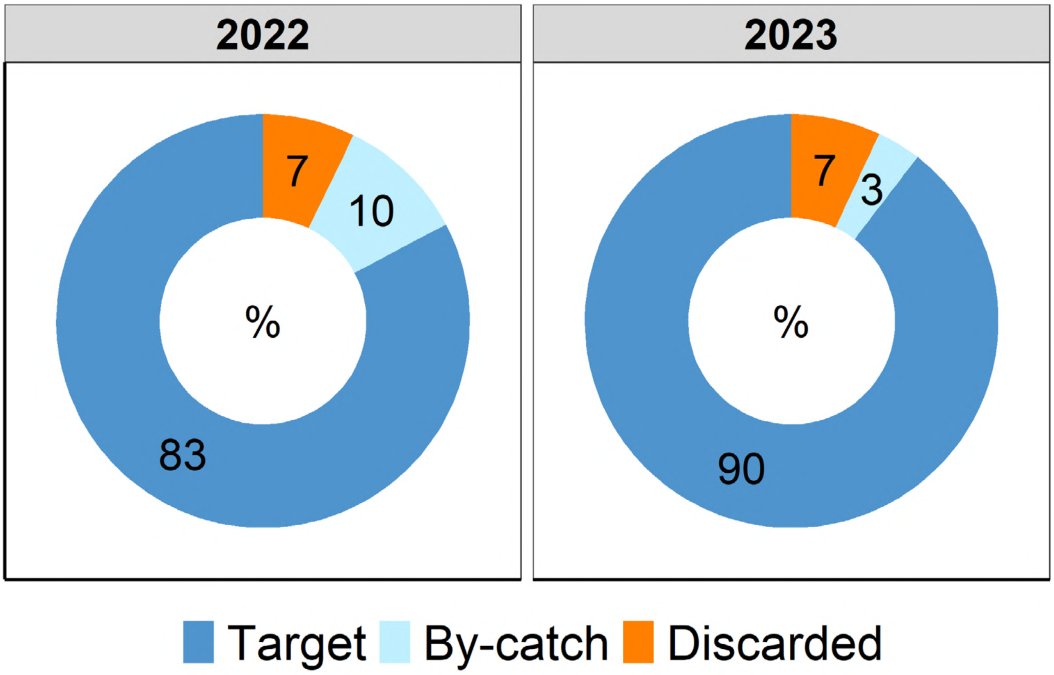


Figure 122. Purse seine fishery catch composition. Percentage by weight of target species (European sardine and anchovy), by-catch (other species commercialized) and discarded catch (species not commercialized).

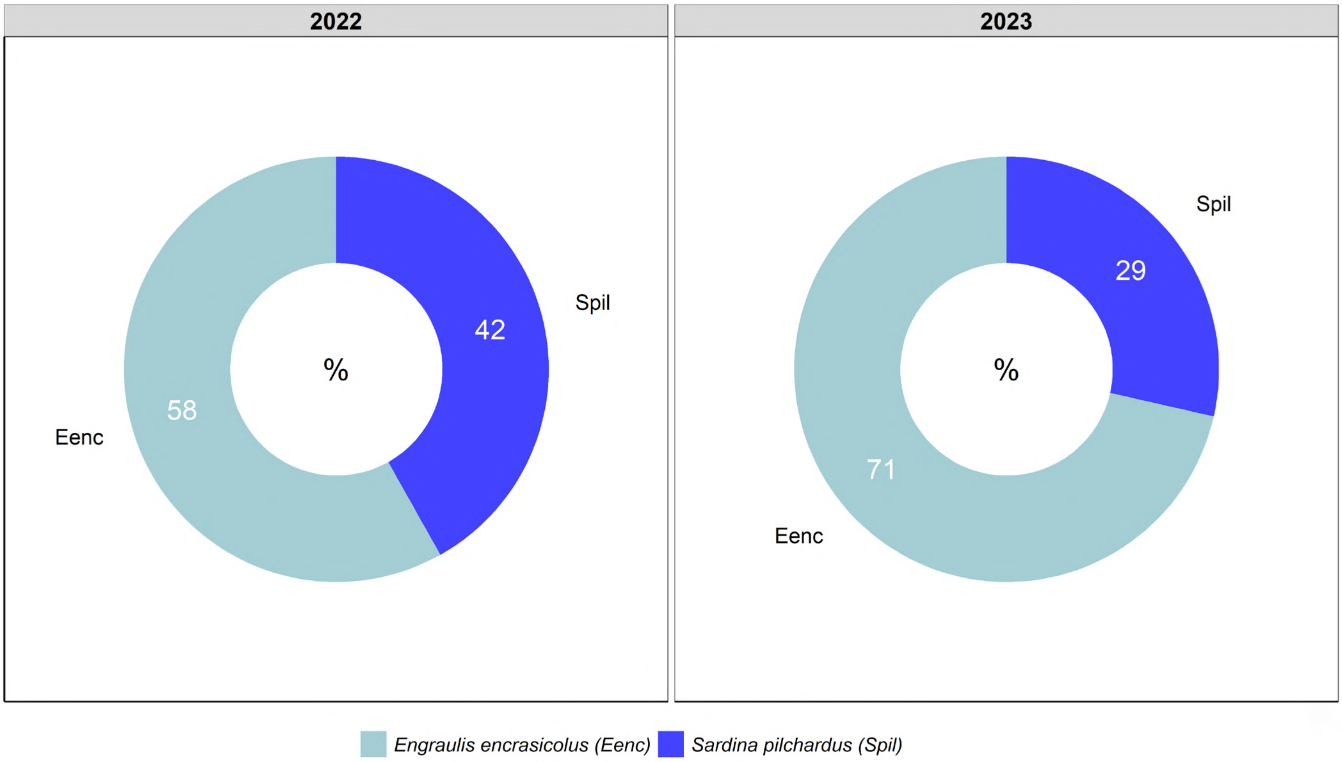


Figure 123. Purse seine fishery target species composition. Percentage by weight of each target species.

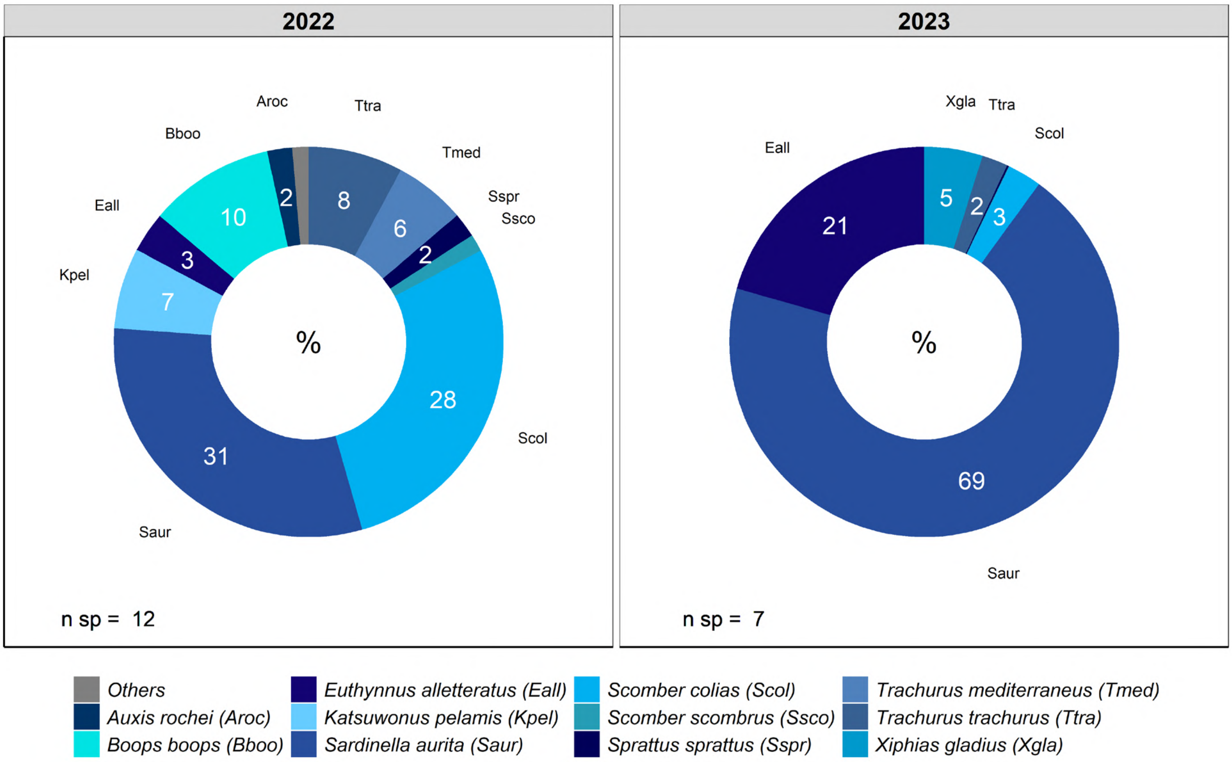


Figure 124. Purse seine fishery by-catch species composition. Percentage by weight of each by-catch species.

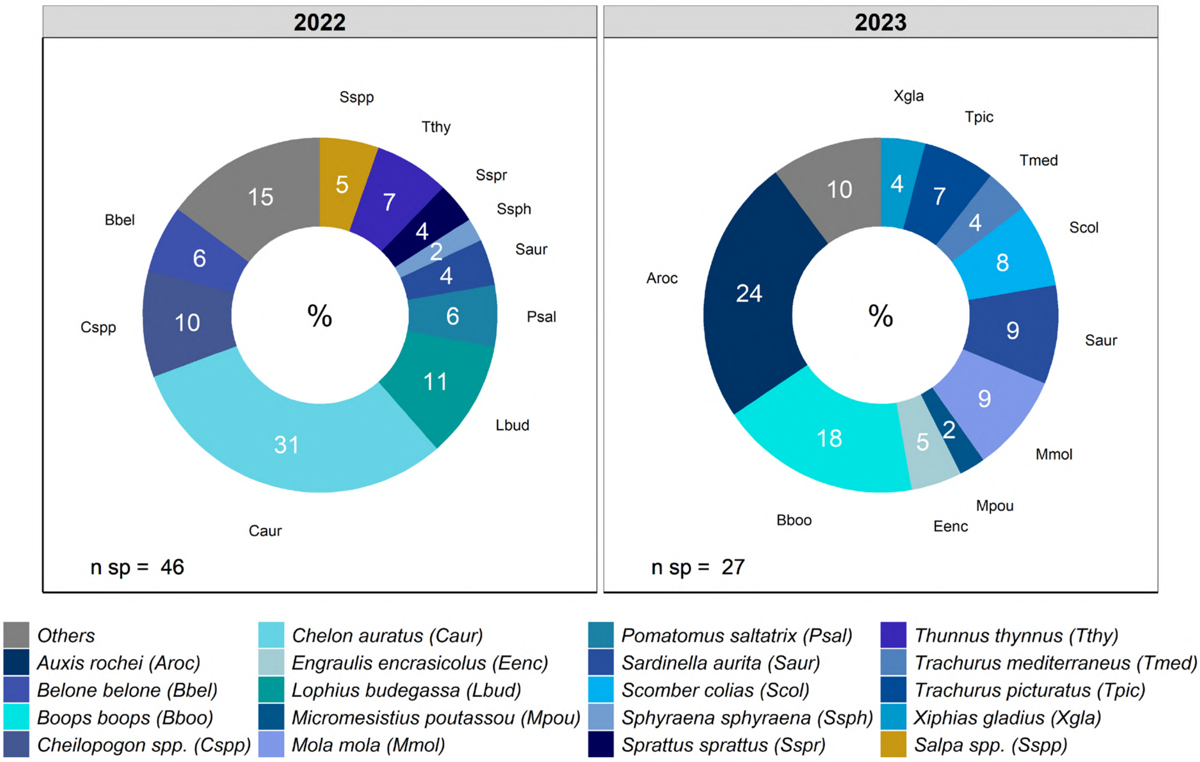


Figure 125. Purse seine fishery discarded species. Percentage by weight of species with most biomass discarded.

European sardine (*Sardina pilchardus*) PIL

The total European sardine catch in Catalonia in 2023 was 2 265 t, 99% of which were caught by purse seine (ICATMAR, 24-03).

Figure 126 and Figure 127 show the spatial distribution of the species landings in 2023 and from 2018 to 2022 along the Catalan coast. The annual maximum was reached in 2020 with 41 393 kg/km^2, followed by 2022 with 35 625 kg/km^2. In 2023, the maximum landings per area were 11 668 kg/km^2.

According to length-weight relationship parameters for both sexes combined and separately, European sardine displayed a positive allometric growth (b>3) in 2023 (Table 26). Comparing the growth curves between the years sampled for both sexes combined and separately, similar results can be observed over the years with positive allometric growth in all cases (Figure 128).

The size at first maturity (L_{50}) for European sardine in 2023 was 10.3 cm of TL for both sexes combined (Figure 129). Females showed earlier maturation than males in 2023, with a L_{50} of 10.6 and 10.1 cm of TL respectively, a trend also observed in previous years sampled. Comparing between years for both sexes combined, 2020 had the lowest L_{50} and 2021 the highest.

In 2023, a total of 1 357 European sardine individuals were analyzed to calculate the L_{50} (Table 27). Out of these, 250 individuals were classified as immature and 1 107 as mature. It should be noted that the low number of immature individuals compared to the mature ones, as most of the sampled individuals come from the fish market through the purchase of batches and are therefore above the MCRS of the species, may bias the L_{50} towards larger sizes than it actually is.

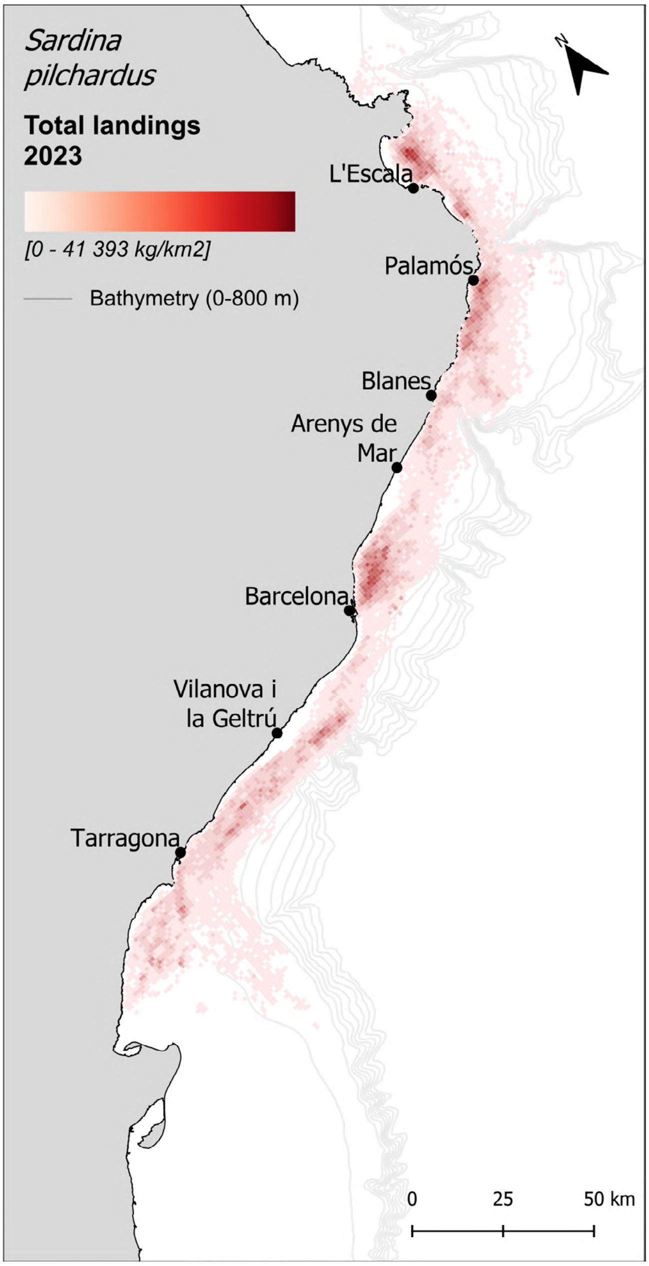


Figure 126. Spatial distribution of landings per unit of effort (LPUE) for European sardine in the Catalan fishing grounds (North GSA6) in the year analyzed.

Table 26. European sardine length-weight relationship in the year analyzed.

2023	L-W (a)	L-W (b)	L-W (r²)	n
Combined	0.003	3.314	0.98	1375
Females	0.003	3.402	0.97	723
Males	0.003	3.432	0.95	550

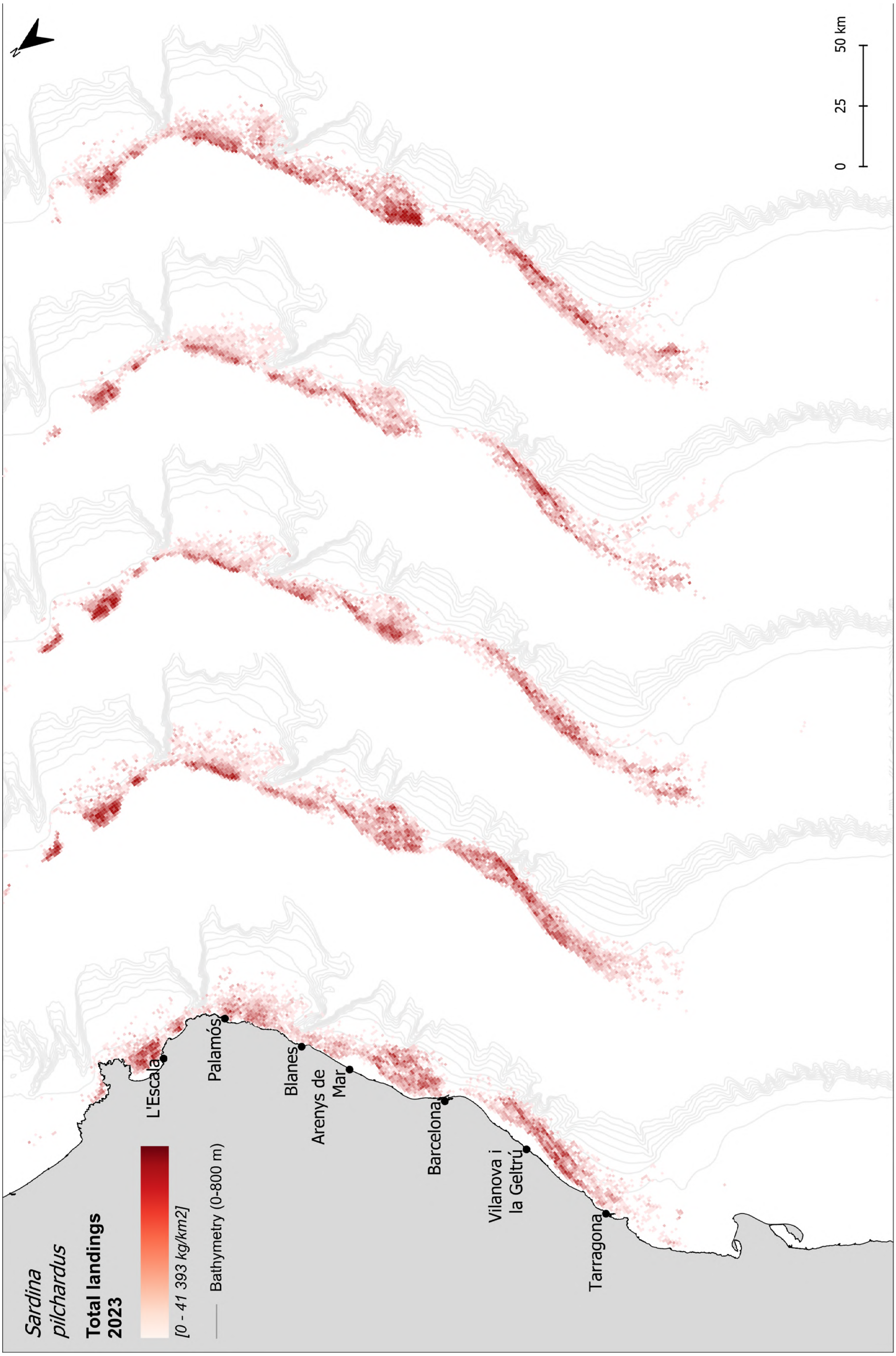


Figure 127. Spatial distribution of landings per unit of effort (LPUE) for European sardine in the Catalan fishing grounds (North GSA6) for the five years prior to the year analyzed.

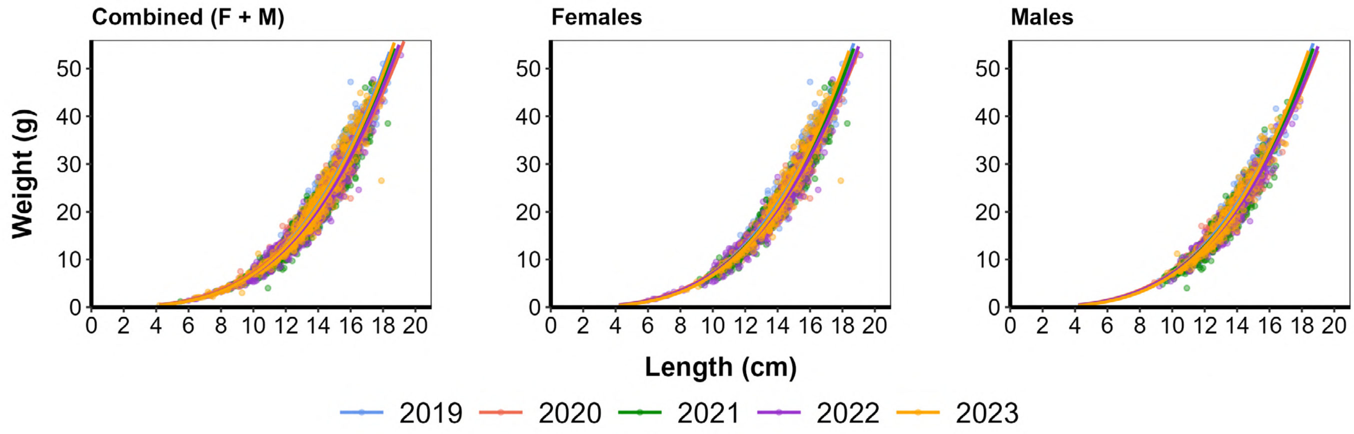


Figure 128. European sardine length-weight relationship for the years sampled.

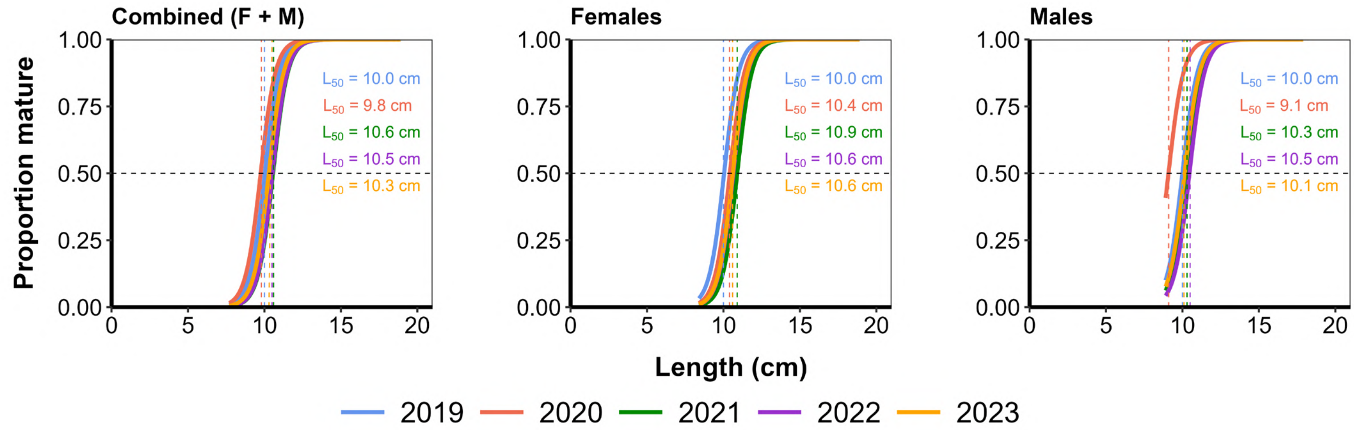


Figure 129. European sardine size at first maturity (L_{50}) for all years sampled.

Table 27. Number of mature and immature individuals of European sardine included monthly in biological analyses.

Month	2019		2020		2021		2022		2023	
	Immature	Mature	Immature	Mature	Immature	Mature	Immature	Mature	Immature	Mature
January	0	120	0	40	0	80	0	67	5	100
February	0	120	4	145	1	159	11	150	6	157
March	0	120	0	78	3	157	13	112	0	149
April	4	194	-	-	0	119	35	128	15	119
May	0	119	-	-	8	152	31	142	0	86
June	2	158	36	200	16	60	60	131	78	132
July	0	159	39	118	2	157	0	180	46	86
August	0	118	21	98	64	171	5	136	30	36
September	19	137	33	124	70	94	10	141	43	119
October	2	118	27	93	33	95	5	87	20	70
November	13	107	3	117	51	68	3	65	7	53
December	2	118	0	160	12	97	0	60	-	-

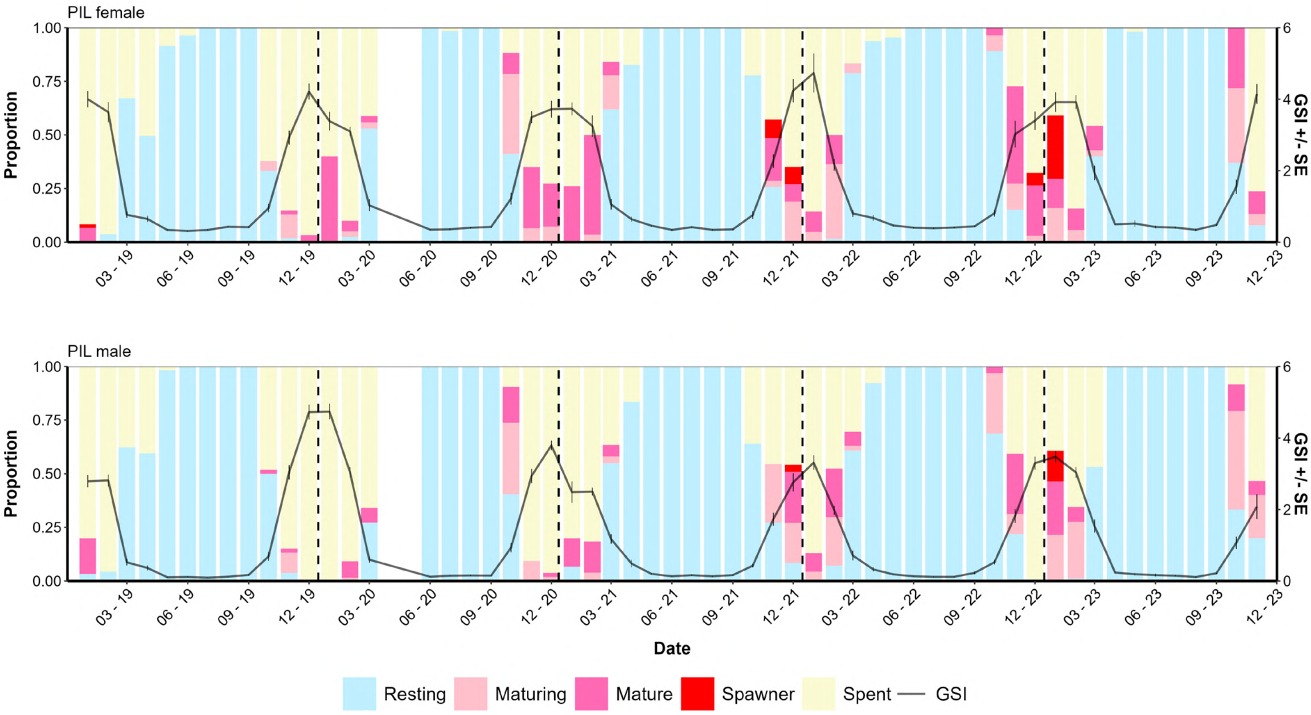


Figure 130. European sardine monthly gonadal cycle for females (top) and males (bottom). Gonadosomatic index (GSI +/- SE (Standard Error)) and proportion of different maturity stages.

The gonadal cycle of European sardine was analyzed monthly from 2019 to 2023 (Figure 130). The species, both males and females, showed a seasonal reproductive cycle as individuals in advanced maturity stages were present from November to February, which is consistent with the reproductive cycle described for the species in the study area in Palomera et al., (2007). On the other hand, the highest proportion of resting individuals was observed from April to September. The highest GSI values for both males and females were also found between November and February, coinciding with the reproductive peak of the species.

The annual cycle of mesenteric fat content of European sardine was analyzed monthly from 2019 to 2023 (Figure 131). As shown, females and males followed the same pattern, with the highest proportion of individuals with medium and high fat content from April to October. Notably, GSI followed an opposite pattern, with the lowest values during spring and summer, confirming that European sardine stores fat before the reproductive season as described by Zorica et al., (2019).

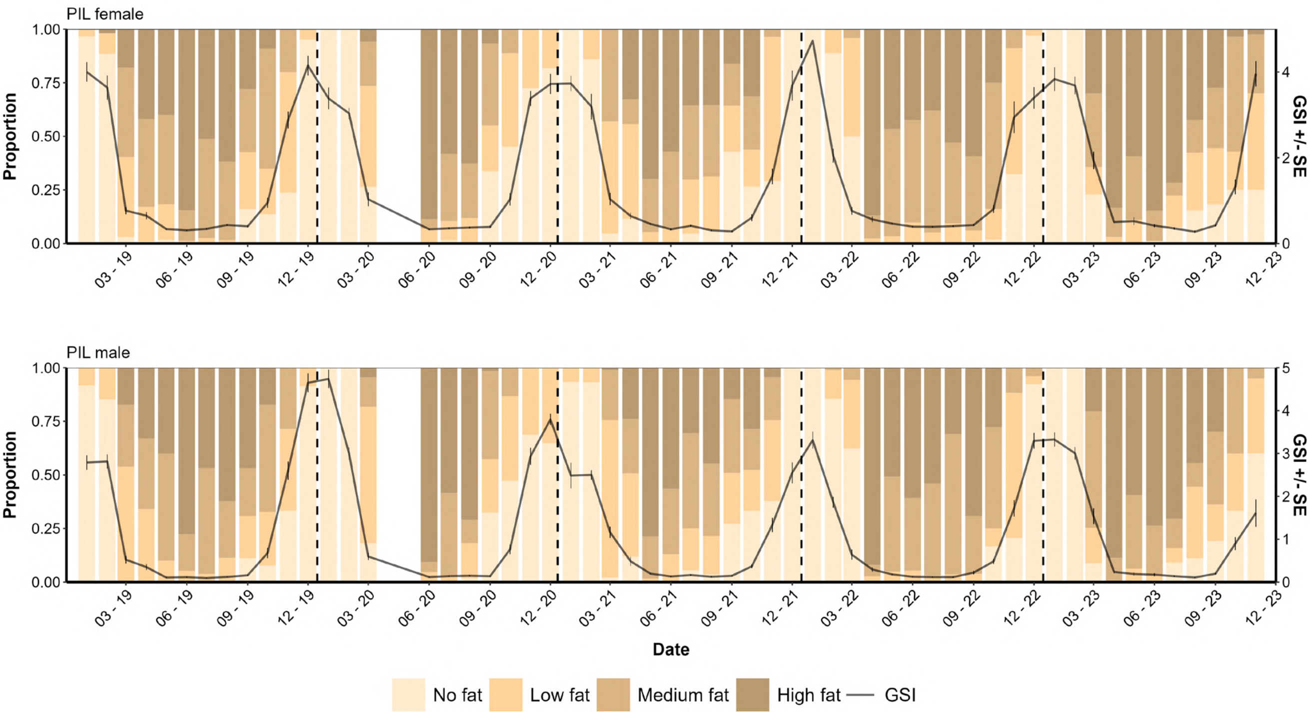


Figure 131. European sardine annual cycle for mesenteric fat content for females (top) and males (bottom). Gonadosomatic index (GSI +/- SE (Standard Error)) and monthly proportion of different mesenteric fat content.

Table 28. Number of European sardine individuals measured in the different fisheries along the zones sampled in each season.

Fishery	Year	Zone	Winter	Spring	Summer	Autumn	N sampling
			Number individuals sampled				
Artisanal fisheries	2019	North	0	0	1	0	1
Artisanal fisheries	2019	Center	32	3	0	0	2
Artisanal fisheries	2021	North	1	0	0	0	1
Bottom trawl	2019	South	38	122	404	53	18
Bottom trawl	2020	North	0	0	3	1	2
Bottom trawl	2020	Center	0	0	30	1	2
Bottom trawl	2020	South	7	96	132	94	14
Bottom trawl	2021	North	4	0	4	0	4
Bottom trawl	2021	Center	9	1	15	11	6
Bottom trawl	2021	South	16	85	352	191	17
Bottom trawl	2022	North	0	5	2	1	4
Bottom trawl	2022	Center	4	0	0	38	2
Bottom trawl	2022	South	0	31	182	166	12
Bottom trawl	2023	North	0	8	2	3	3
Bottom trawl	2023	Center	0	70	31	0	2
Bottom trawl	2023	South	7	247	294	29	18
Purse seine (fish market)	2019	North	826	990	724	610	22
Purse seine (fish market)	2019	Center	800	861	725	690	19
Purse seine (fish market)	2020	North	722	393	936	681	18
Purse seine (fish market)	2020	Center	354	465	817	836	15
Purse seine (fish market)	2021	North	867	878	925	557	21
Purse seine (fish market)	2021	Center	623	370	921	526	17
Purse seine (fish market)	2022	North	979	785	500	407	17
Purse seine (fish market)	2022	Center	699	905	663	561	19
Purse seine (fish market)	2023	North	470	394	485	130	10
Purse seine (fish market)	2023	Center	570	463	598	431	15
Purse seine (on board)	2022	North	581	497	750	11	17
Purse seine (on board)	2022	Center	0	267	193	0	4
Purse seine (on board)	2023	North	1058	780	970	144	22
Purse seine (on board)	2023	Center	78	332	0	0	4
Purse seine (on board)	2023	South	0	0	1	0	1

The annual length-frequency distribution of European sardine from 2019 to 2023 shows a clear mode at around 13 cm of TL in all years sampled and both types of sampling (Figure 132). In 2023, most of the fish market samples were above the MRCS of the species (12 cm of TL). In the case of the onboard sampling, around half of the distribution was below the MRCS, with the smallest individuals measuring 7 cm compared to 10 cm of TL in the fish market sampling.

For monthly length-frequency distribution of European sardine at different depth strata in 2023 see Annex 21.

All parameters analyzed in this report for European sardine were calculated using individuals obtained by purse seine sampling (Table 28). Some of the sampled individuals were also caught by bottom trawling, especially in the southern part of the sampling area, and by artisanal fisheries, although their numbers were considerably low and were only used for the spatiotemporal length-frequency distributions.

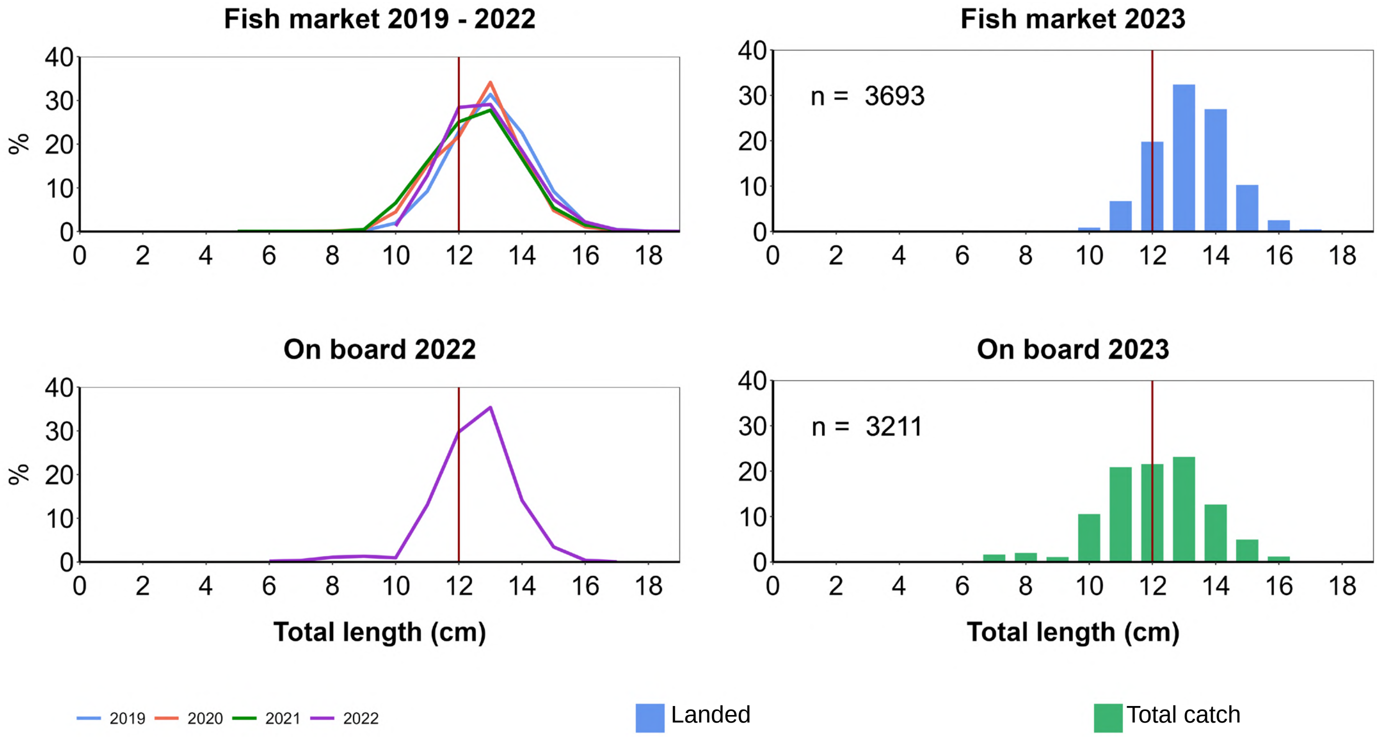


Figure 132. Annual length-frequency distribution of European sardine. Left: previous years sampled, right: year analyzed. Top: fish market samples. Bottom: on board samples. (n) Total number of measured individuals. Red solid line: Minimum Conservation Reference Size (MCRS).

Anchovy (*Engraulis encrasicolus*) ANE

The total anchovy catch in Catalonia in 2023 was 4 063 t, 99% of which were caught by purse seine (ICATMAR, 24-03).

Figure 133 and Figure 134 show the spatial distribution of the species landings in 2023 and from 2018 to 2022 along the Catalan coast. A decreasing trend is observed over the years, especially in landings south of Barcelona. In 2023, the maximum landings per area were 12 852 kg/km^2.

According to length-weight relationship parameters for both sexes combined and separately, anchovy displayed a positive allometric growth (b>3) in 2023 (Table 29). Comparing the growth curves between the years sampled for both sexes combined and separately, similar trends are observed (Figure 135).

The size at first maturity (L_{50}) for anchovy in 2023 was 8.2 cm of TL for both sexes combined (Figure 136). Females showed earlier maturation than males in 2023, with L_{50} of 8.6 and 8.9 cm of TL respectively, as opposed to what was observed in 2022 and 2021 when males' L_{50} was lower than females'. Comparing between years for both sexes combined, 2023 had the lowest L_{50} and 2021 the highest.

In 2023, a total of 1 209 anchovy individuals were analyzed to calculate the L_{50} (Table 30). Out of these, 98 individuals were classified as immature and 1 111 as mature. It should be noted that the low number of immature individuals compared to the mature ones, as most of the sampled individuals come from the fish market through the purchase of batches and are therefore above the MCRS of the species, may bias the L_{50} towards larger sizes than it actually is.

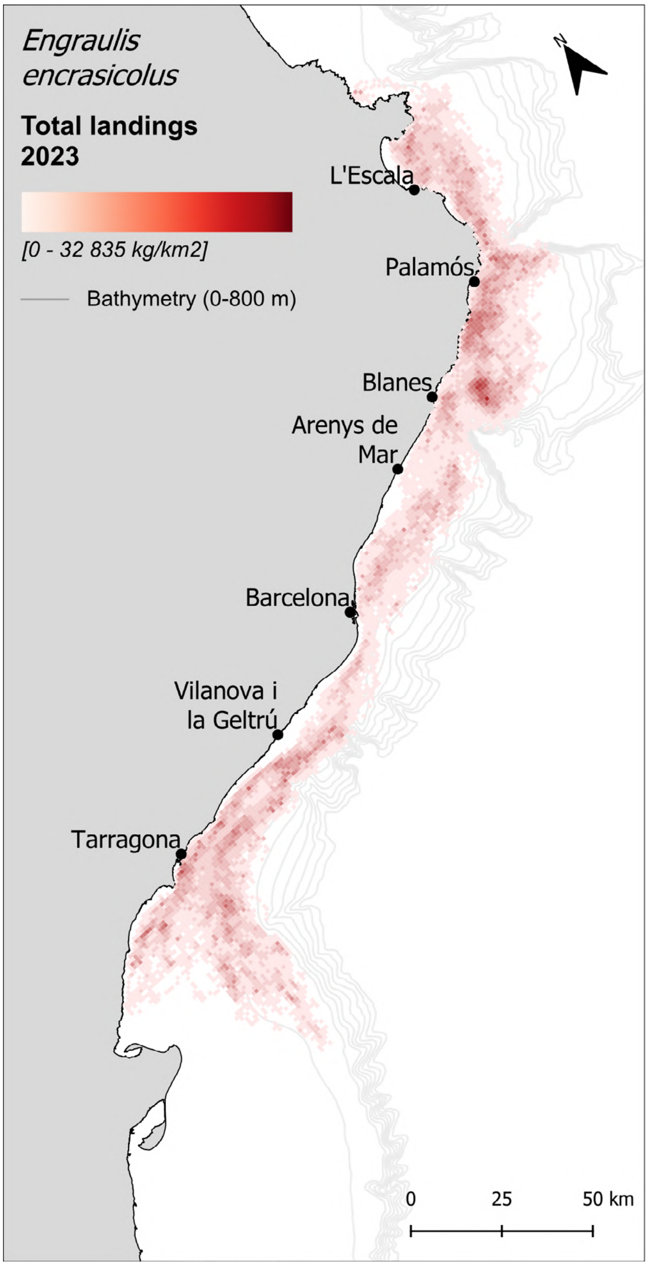


Figure 133. Spatial distribution of landings per unit of effort (LPUE) for anchovy in the Catalan fishing grounds (North GSA6) in the year analyzed.

Table 29. Anchovy length-weight relationship in the year analyzed.

2023	L-W (a)	L-W (b)	L-W (r^2)	n
Combined	0.0031	3.284	0.99	1288
Females	0.0030	3.288	0.97	658
Males	0.0046	3.127	0.96	522

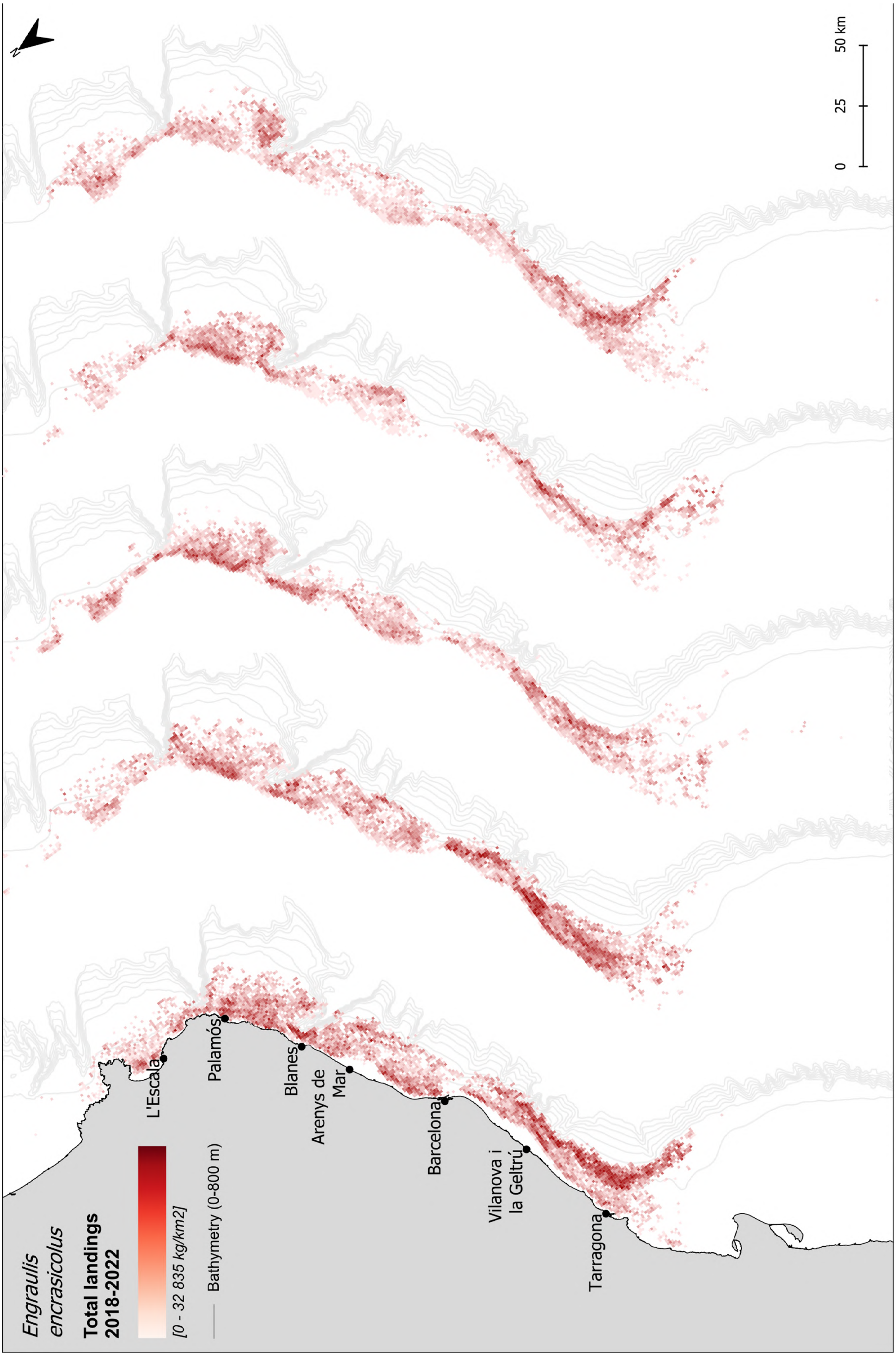


Figure 134. Spatial distribution of landings per unit of effort (LPUE) for anchovy in the Catalan fishing grounds (North GSA6) for the five years prior to the year analyzed.

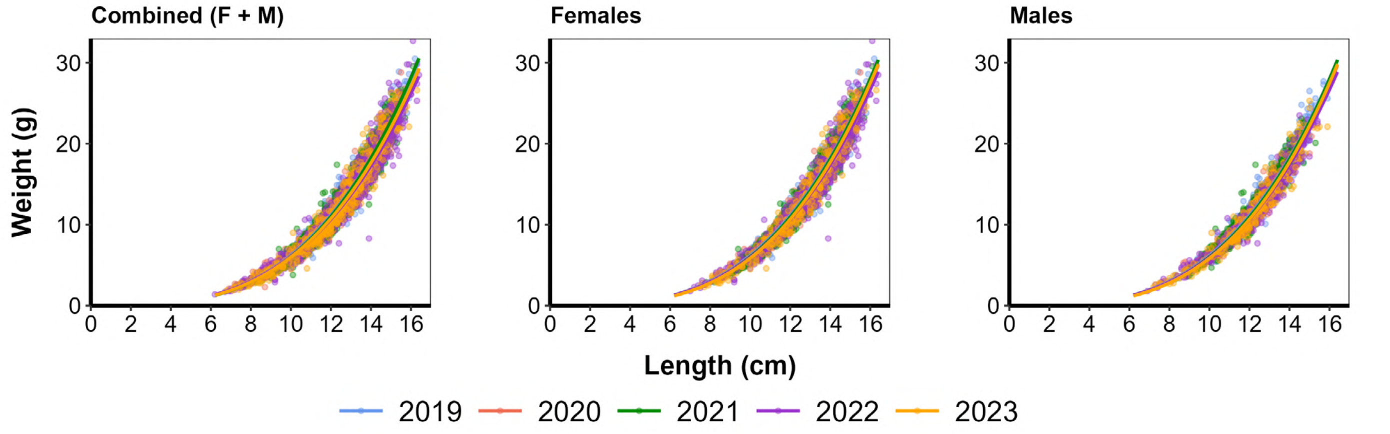


Figure 135. Anchovy length-weight relationship for the years sampled.

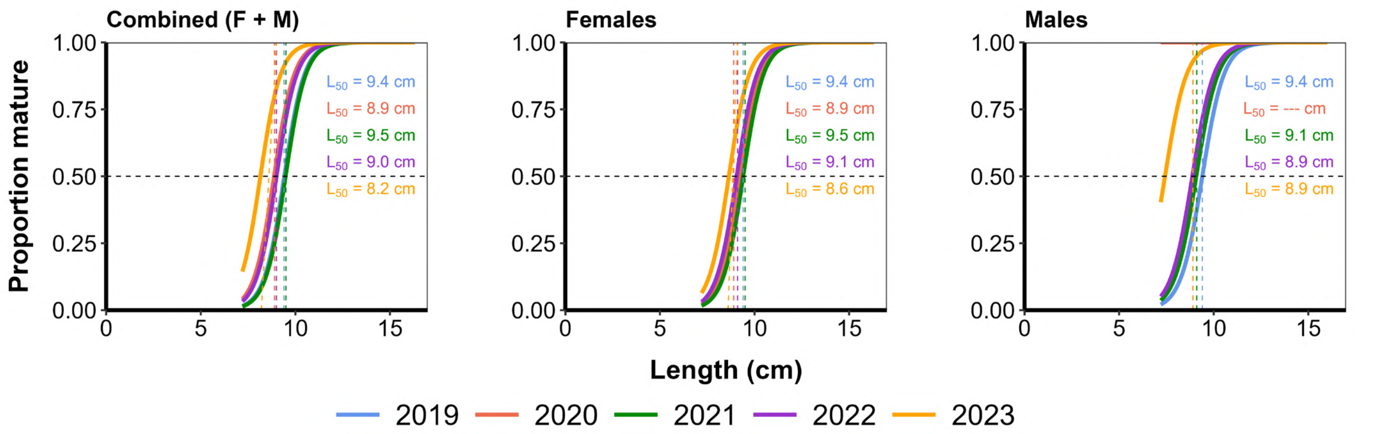


Figure 136. Anchovy size at first maturity (L_{50}) for all years sampled.

Table 30. Number of mature and immature individuals of anchovy included monthly in biological analyses.

Month	2019		2020		2021		2022		2023	
	Immature	Mature	Immature	Mature	Immature	Mature	Immature	Mature	Immature	Mature
January	0	75	31	9	34	44	8	22	8	82
February	3	108	9	145	21	136	29	126	64	120
March	11	109	2	73	19	140	3	184	5	115
April	19	175	-	-	7	112	14	136	0	90
May	6	114	-	-	10	150	5	145	0	120
June	0	160	0	240	0	120	0	149	5	115
July	0	160	1	116	0	120	0	151	0	150
August	1	119	2	78	11	186	1	142	3	72
September	19	101	9	148	8	110	25	136	8	97
October	7	112	2	38	12	30	21	53	4	59
November	33	47	25	95	19	63	9	84	1	91
December	30	45	51	106	39	67	37	49	-	-

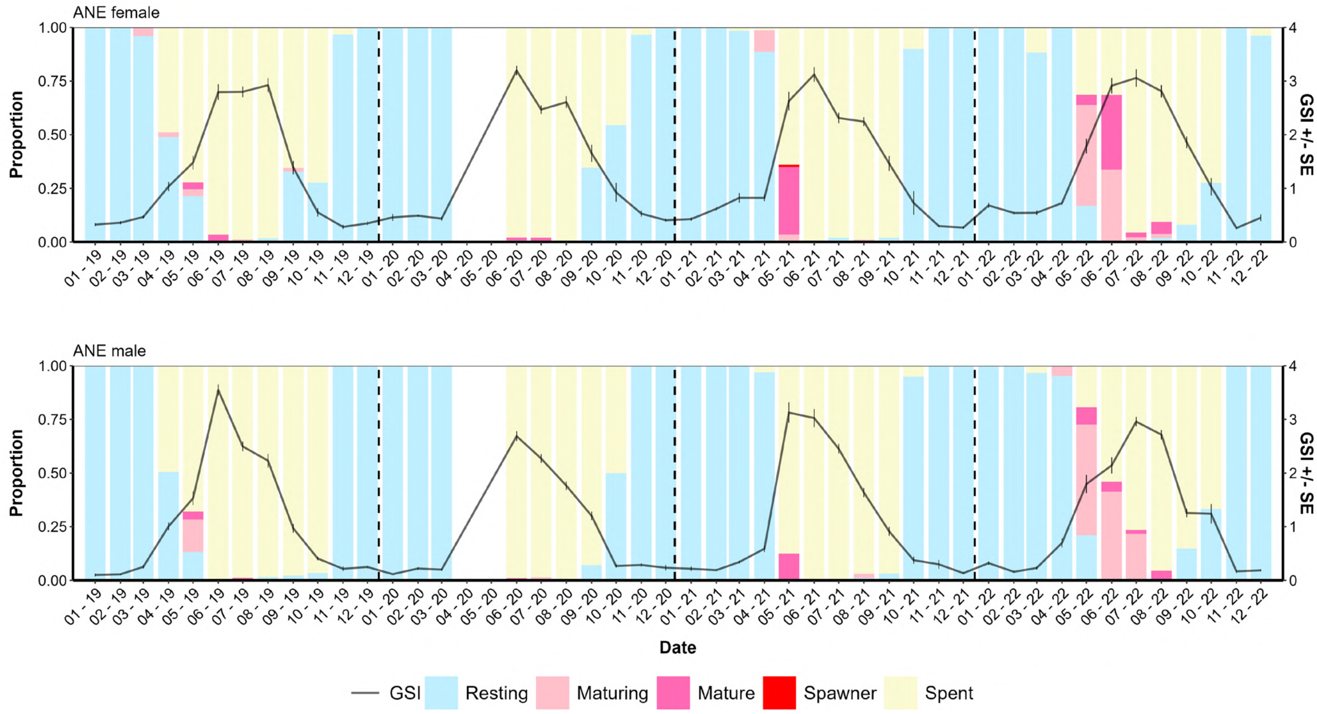


Figure 137. Anchovy monthly gonadal cycle for females (top) and males (bottom). Gonadosomatic index (GSI +/- SE (Standard Error)) and proportion of different maturity stages.

The gonadal cycle of anchovy was analyzed monthly from 2019 to 2023 (Figure 137). The species, both males and females, showed a seasonal reproductive cycle as individuals in advanced maturity stages were present from May to September, which is consistent with the reproductive cycle described for the species in the study area in Palomera et al., (2007). On the other hand, the highest proportion of resting individuals was found from November to April. The highest GSI values for both males and females were also found between May and September, coinciding with the reproductive peak of the species.

The annual cycle of mesenteric fat content of anchovy was analyzed monthly from 2019 to 2023 (Figure 138). It can be observed that females and males followed the same pattern, with the highest proportion of individuals with medium and high fat content from October to April/May. Notably, GSI followed an opposite pattern, with the lowest values during autumn and winter.

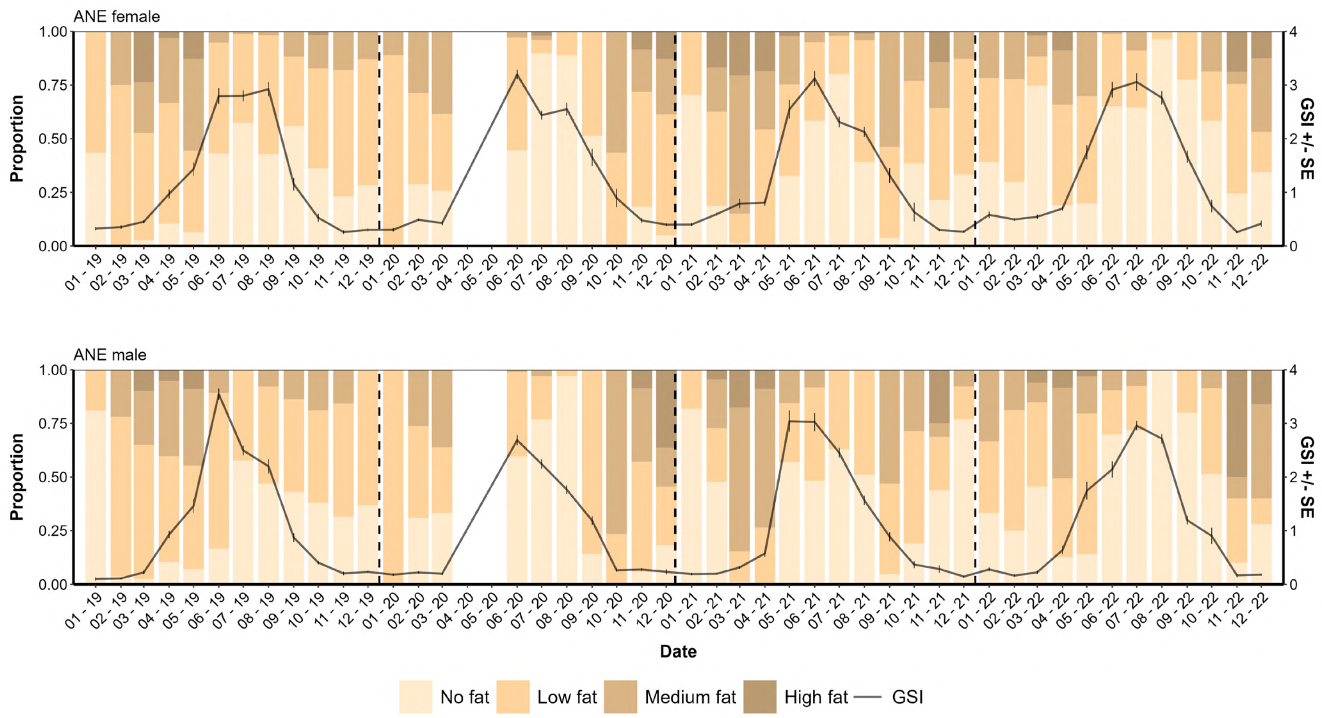


Figure 138. Anchovy annual cycle for mesenteric fat content for females (top) and males (bottom). Gonadosomatic index (GSI +/- SE (Standard Error)) and monthly proportion of different mesenteric fat content.

Table 31. Number of anchovy individuals measured in the different fisheries along the zones sampled in each season.

Fishery	Year	Zone	Winter	Spring	Summer	Autumn	N sampling
			Number individuals sampled				
Artisanal fisheries	2019	Center	0	1	0	0	1
Artisanal fisheries	2020	North	0	0	0	19	1
Artisanal fisheries	2021	North	0	3	0	1	2
Artisanal fisheries	2021	Center	105	0	0	0	3
Artisanal fisheries	2022	Center	0	13	0	0	1
Artisanal fisheries	2023	North	0	0	0	30	1
Artisanal fisheries	2023	Center	39	0	0	0	1
Bottom trawl	2019	North	0	2	81	0	3
Bottom trawl	2019	Center	1	0	163	25	4
Bottom trawl	2019	South	428	372	582	238	27
Bottom trawl	2020	North	0	0	5	0	3
Bottom trawl	2020	Center	0	1	1	51	3
Bottom trawl	2020	South	10	273	266	177	14
Bottom trawl	2021	North	3	52	5	0	8
Bottom trawl	2021	Center	56	6	30	47	4
Bottom trawl	2021	South	72	143	192	297	19
Bottom trawl	2022	North	3	40	91	0	4
Bottom trawl	2022	Center	0	13	0	0	1
Bottom trawl	2022	South	8	259	155	180	17
Bottom trawl	2023	North	0	2	1	0	2
Bottom trawl	2023	Center	0	31	0	0	1
Bottom trawl	2023	South	60	277	109	1	17
Purse seine (fish market)	2019	North	1052	1729	1282	929	20
Purse seine (fish market)	2019	Center	929	1278	944	1078	17
Purse seine (fish market)	2020	North	1333	649	1562	1129	17
Purse seine (fish market)	2020	Center	1008	496	677	854	13
Purse seine (fish market)	2021	North	1307	1100	1416	565	19
Purse seine (fish market)	2021	Center	778	1037	1302	968	19
Purse seine (fish market)	2022	North	576	1637	867	752	16
Purse seine (fish market)	2022	Center	710	1337	1135	399	16
Purse seine (fish market)	2023	North	986	551	697	387	12
Purse seine (fish market)	2023	Center	907	1327	384	269	13
Purse seine (on board)	2022	North	1755	153	939	573	15
Purse seine (on board)	2022	Center	430	383	471	834	9
Purse seine (on board)	2023	North	967	185	887	525	13
Purse seine (on board)	2023	Center	254	193	0	0	2
Purse seine (on board)	2023	South	0	0	221	398	3

The annual length-frequency distribution of anchovy from 2019 to 2023 shows a mode between 11 and 12 cm of TL in all years sampled (Figure 139). In the case of 2023, both fish market samples and onboard sampling showed a mode at 12 cm of TL. Most of the individuals measured in both types of sampling were above the MRCS of the species (10 cm of TL) in 2023.

For monthly length-frequency distribution of anchovy at different depth strata in 2023 see Annex 22.

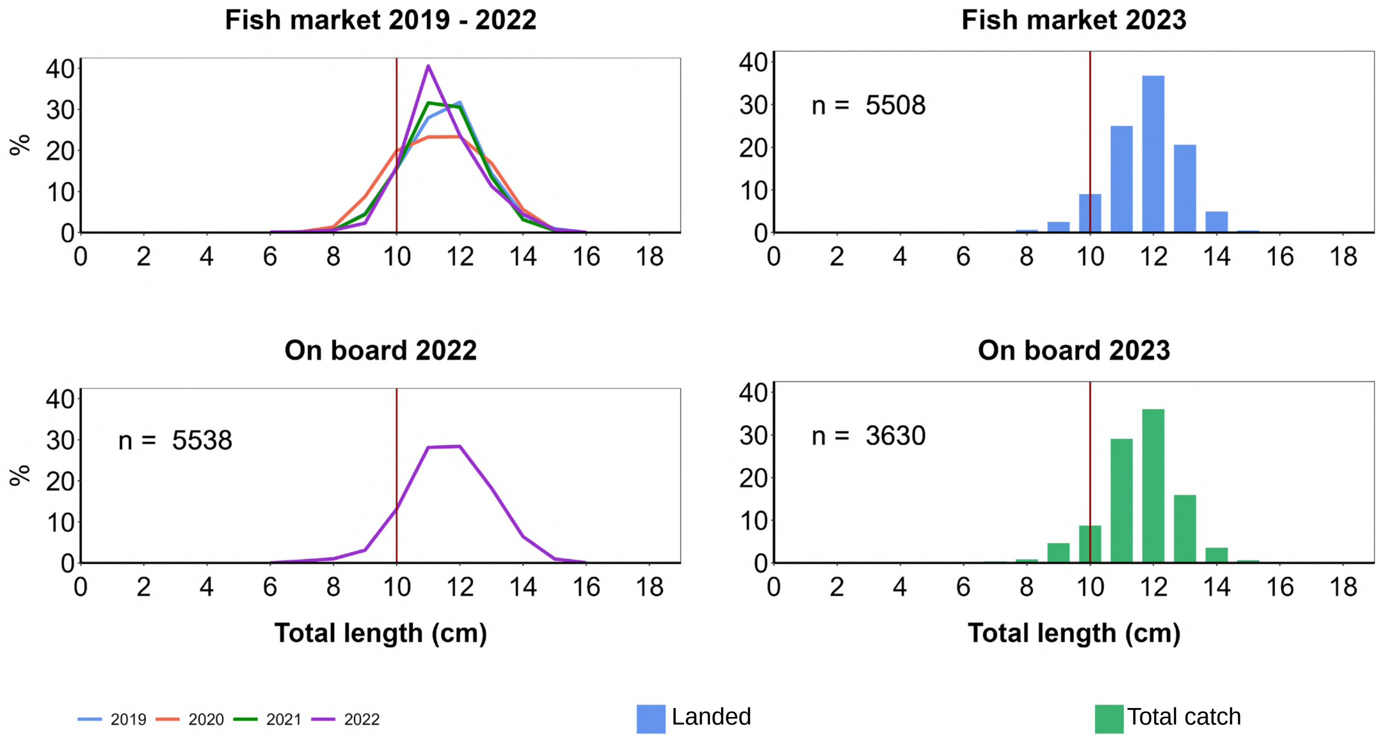


Figure 139. Annual length-frequency distribution of anchovy. Left: from previous years sampled, right: year analyzed. Top: fish market samples. Bottom: on board samples. (n) Total number of measured individuals. Red solid line: Minimum Conservation Reference Size (MCRS).

All parameters analyzed in this report for anchovy were calculated using individuals obtained by purse seine sampling (Table 31). Some of the sampled individuals were also caught by bottom trawling, especially in the northern part of the sampling area, and by artisanal fisheries, although their numbers were considerably low and were only used for the spatiotemporal length-frequency distributions.

SECTION 4
Small-scale fisheries

Monitoring of sandeel, common octopus and blue crab fisheries in Catalonia

The monitoring of small-scale fisheries consists of the the sandeel fishery – including Mediterranean sandeel (*Gymnammodytes cicerelus*), smooth sandeel (*Gymnammodytes semisquamatus*), and transparent goby (*Aphia minuta*) –, the common octopus (*Octopus vulgaris*) fishery and the blue crab (*Callinectes sapidus*) fishery. The sandeel fishery is the subject of a co-management plan since 2014, the common octopus fishery is co-managed in two different areas of the territory (Central Catalonia and the Ebre Delta) and the blue crab fishery is also co-managed in the Ebre Delta area.

Table 32. Number of onboard samplings of small-scale fisheries monitored (sandeel and common octopus fisheries). In this table samplings of blue crab were not included (see Table 43).

Fishery	Type	Year	Zone	Winter	Spring	Summer	Autumn
				Number of samplings			
Artisanal fisheries	Sandeel seiner	2019	North	6	7	10	7
Artisanal fisheries	Sandeel seiner	2019	Center	1	1	0	0
Artisanal fisheries	Sandeel seiner	2020	North	3	2	6	12
Artisanal fisheries	Sandeel seiner	2020	Center	2	0	0	0
Artisanal fisheries	Sandeel seiner	2021	North	3	6	6	2
Artisanal fisheries	Sandeel seiner	2021	Center	3	0	0	0
Artisanal fisheries	Sandeel seiner	2022	North	5	6	10	7
Artisanal fisheries	Sandeel seiner	2022	Center	0	1	0	0
Artisanal fisheries	Sandeel seiner	2023	North	6	7	9	8
Artisanal fisheries	Sandeel seiner	2023	Center	1	0	0	0
Artisanal fisheries	Pots	2019	Center	6	7	8	5
Artisanal fisheries	Pots	2020	Center	5	8	7	6
Artisanal fisheries	Pots	2020	South	0	0	2	7
Artisanal fisheries	Pots	2021	Center	9	10	6	18
Artisanal fisheries	Pots	2021	South	5	6	6	4
Artisanal fisheries	Pots	2022	Center	12	8	8	18
Artisanal fisheries	Pots	2022	South	4	1	6	11
Artisanal fisheries	Pots	2023	Center	17	8	2	15
Artisanal fisheries	Pots	2023	South	4	6	4	7
Artisanal fisheries	Traps	2019	Center	6	6	11	0
Artisanal fisheries	Traps	2020	Center	16	9	10	7
Artisanal fisheries	Traps	2021	Center	7	6	12	11
Artisanal fisheries	Traps	2022	Center	9	11	12	13
Artisanal fisheries	Traps	2022	South	2	6	0	0
Artisanal fisheries	Traps	2023	Center	14	13	2	8
Artisanal fisheries	Traps	2023	South	5	6	0	0
Total number of samplings per season				**151**	**141**	**137**	**166**
Total number of samplings in the studied period							**595**

Sandeel fishery in Catalonia

In Catalonia, the main target species of the boat seines "sonsera" are *Gymnammodytes cicerelus*, *Gymnammodytes semisquamatus*, and *Aphia minuta*. The two species of the genus *Gymnammodytes* are coastal species found on the continental shelf on shallow waters, on sand, shells and fine gravel bottoms, inhabiting burrows dug on sandy substrates and living in large groups.

The sandeel fishery is regulated by quotas and fishing effort limitations (number of vessels and fishing days per vessel). Fishing has a regulated closure during the spawning season, from December 15th to March 1st. On the other hand, the transparent goby is only allowed to be fished during the closed fishing period for the sandeels.

The total sandeel catch in Catalonia in 2023 was 117 t, all of it caught by boat seines "*sonsera*" within the co-management plan (ICATMAR, 24-03).

A total of 31 sandeel fishery samplings were carried out in 2023 (Table 32 and Figure 140). Catch composition shows that 99% of the were target species and 1% were discards (Figure 141). The most important target species of the fishery was Mediterranean sandeel (70% in the period 2019-2022 and 64% in 2023), with transparent goby (*Aphia minuta*) accounting for 10% in 2023 and less than 2% in the period 2019-2022 (Figure 142). The most abundant species in sandeel discards was *Coryphaena hippurus* for the period 2019-2022 and *Mullus barbatus* in 2023 (Figure 143).

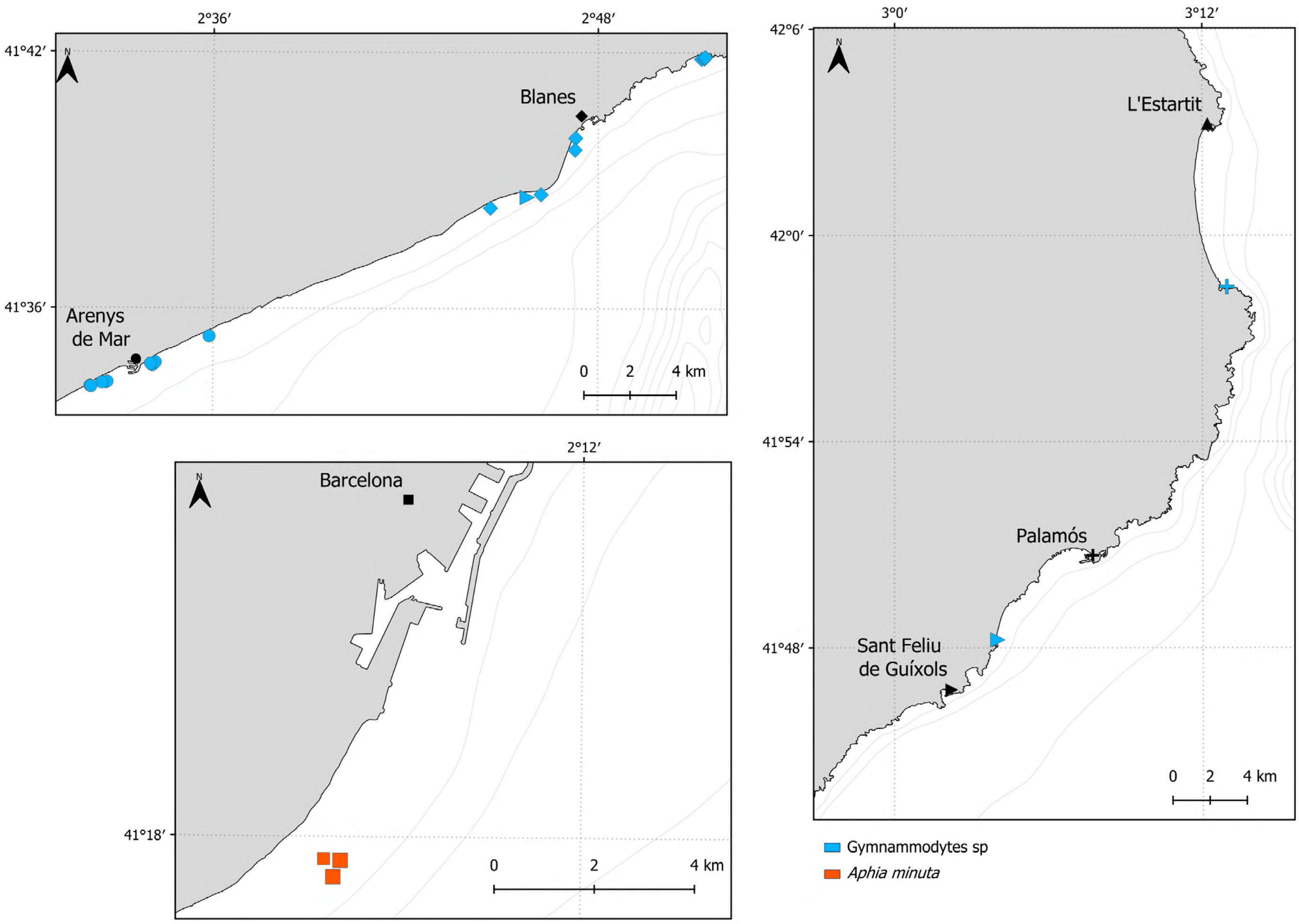


Figure 140. Sandeel samplings in the year analyzed.

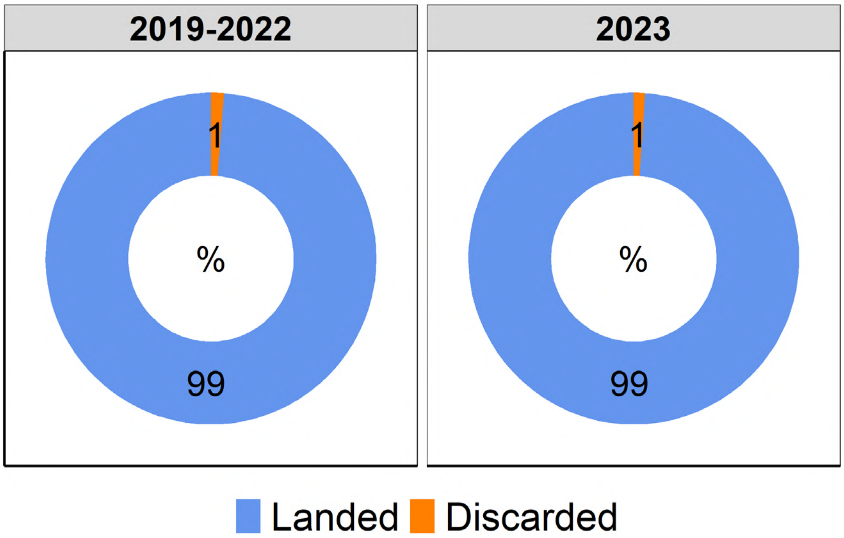


Figure 141. Sandeel fishery catch composition. Percentage by weight of landed and discarded catch.

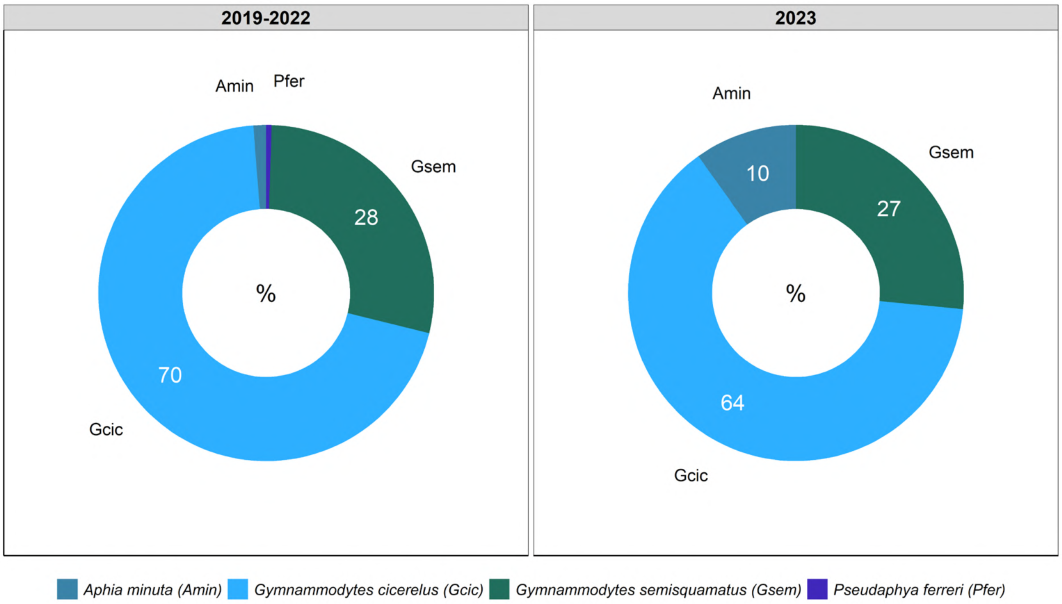


Figure 142. Sandeel target species composition. Percentage by weight of each target species.

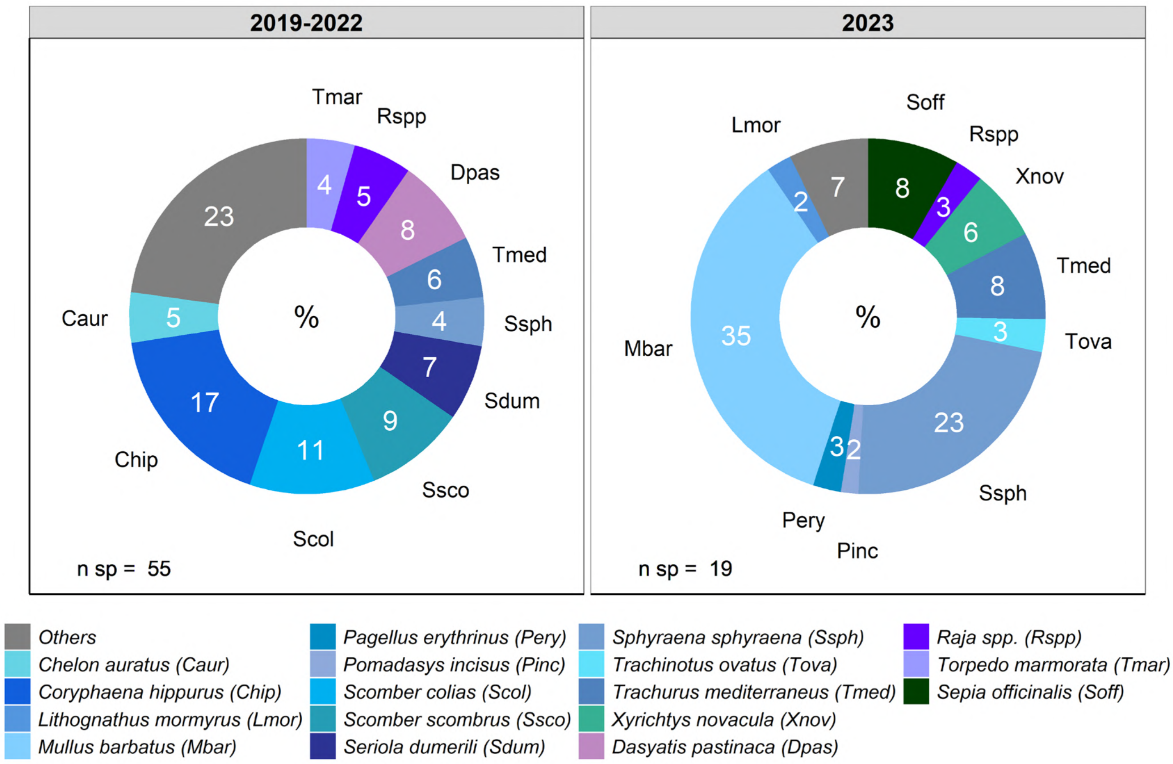


Figure 143. Sandeel discarded species composition. Percentage by weight of each discarded species.

Mediterranean sandeel (*Gymnammodytes cicerelus*) ZGC

According to length-weight relationship parameters for both sexes combined Mediterranean sandeel displayed a slightly positive allometric growth ($b>3$) in 2023, while males and females separately showed an isometric growth ($b=3$) (Table 33). Also, when comparing length-weight relationships for both sexes combined and separately from 2019 to 2023, results show similar trends for all years sampled (Figure 144).

Table 33. Mediterranean sandeel length-weight relationship in the year analyzed.

2023	L-W (a)	L-W (b)	L-W (r^2)	n
Combined	0.0019	3.1331	0.97	1002
Females	0.0025	3.0101	0.93	225
Males	0.0025	3.0211	0.96	56

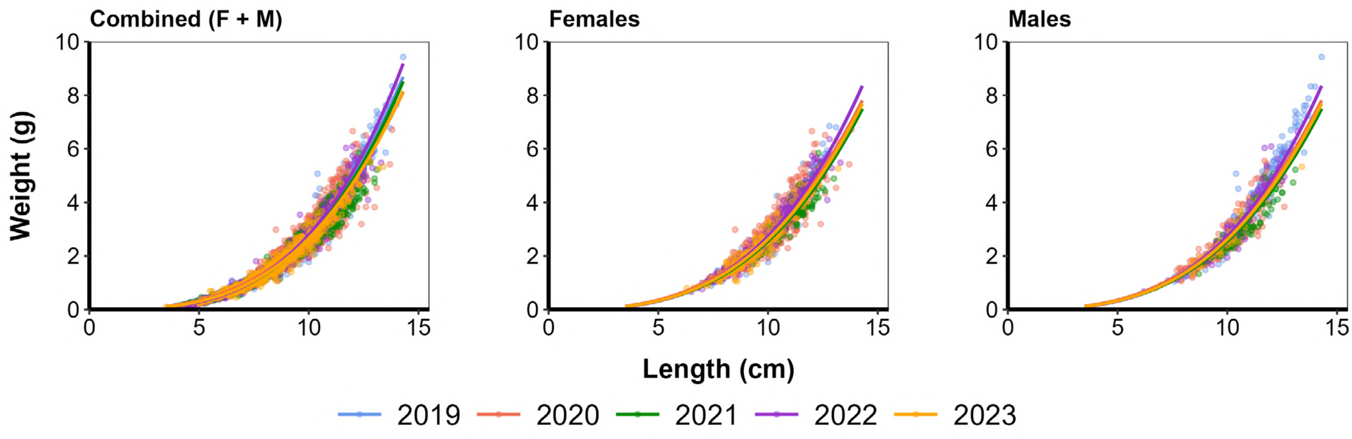


Figure 144. Mediterranean sandeel length-weight relationship for all years sampled.

The size at first maturity (L_{50}) for Mediterranean sandeel in 2023 was 9.2 cm of TL for both sexes combined (Figure 145). When comparing between years, the L_{50} in 2023 is within the range of the five years sampled (7.9 to 10 cm of TL).

In 2023, a total of 1 016 Mediterranean sandeel individuals were analyzed to calculate the L_{50} (Table 34). Out of these, 708 individuals were classified as immature and 308 as mature.

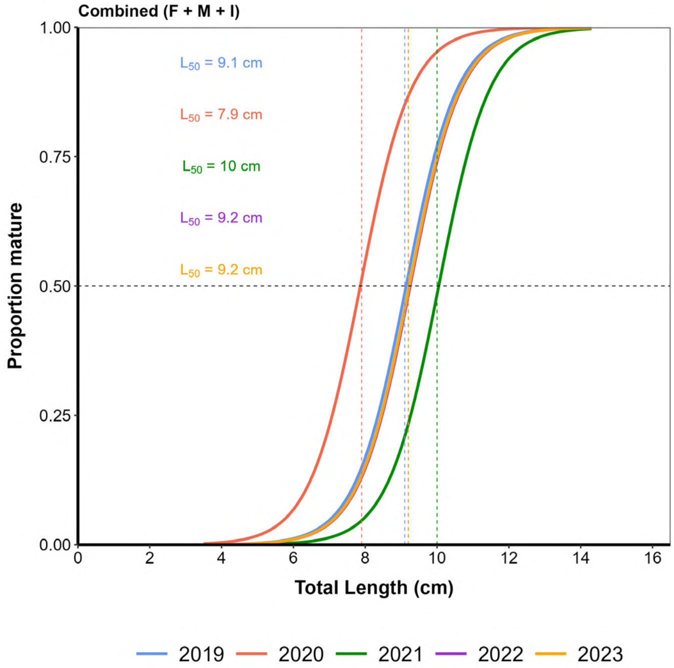


Figure 145. Mediterranean sandeel size at first maturity (L_{50}) for all years sampled.

Table 34. Number of mature and immature individuals of Mediterranean sandeel included in the biological analyses in each month.

Month	2019		2020		2021		2022		2023	
	Immature	Mature	Immature	Mature	Immature	Mature	Immature	Mature	Immature	Mature
January	0	50	0	50	0	50	0	50	0	76
February	0	50	3	47	0	50	56	0	99	1
March	5	95	13	37	20	29	15	0	98	2
April	5	50			50	51	18	1	83	0
May	18	4			21	0	50	0	100	0
June	62	15	13	63	4	0	81	18	76	0
July	80	0	77	23	48	0	71	29	78	19
August	97	0	18	61	39	0	37	52	56	0
September	76	24	0	62	55	7	7	93	0	53
October	31	67	8	79	7	3	0	50	19	80
November	10	90	4	96	2	48	0	50	0	76
December	1	49	5	94	0	50	56	0	99	1

The gonadal cycle of Mediterranean sandeel was analyzed monthly from 2019 to 2023 (Figure 146). The species showed a seasonal reproductive cycle with spawning females present from November to March, with a peak in January. In the period 2022-2023, spawning females were found from November to March, but no samples were obtained during January. In this period, the highest GSI values, both for females and males, were found from November 2022 to February 2023, reaching the maximum in December 2022 and February 2023.

The annual length-frequency distribution of Mediterranean sandeel from 2019 to 2023 ranged between 3.5 and 13 cm of TL (Figure 147). As opposed to previous years sampled, no individuals above 13 cm of TL were caught. As can be observed, distribution modes varied over the four years sampled.

Monthly size frequency distributions of Mediterranean sandeel in 2023 showed an evolution of sizes throughout the year (Annex 23). The largest individuals were caught in February and the smallest ones in May and June.

All parameters analyzed in this report for Mediterranean sandeel were calculated using individuals obtained by artisanal fisheries sampling (Table 35).

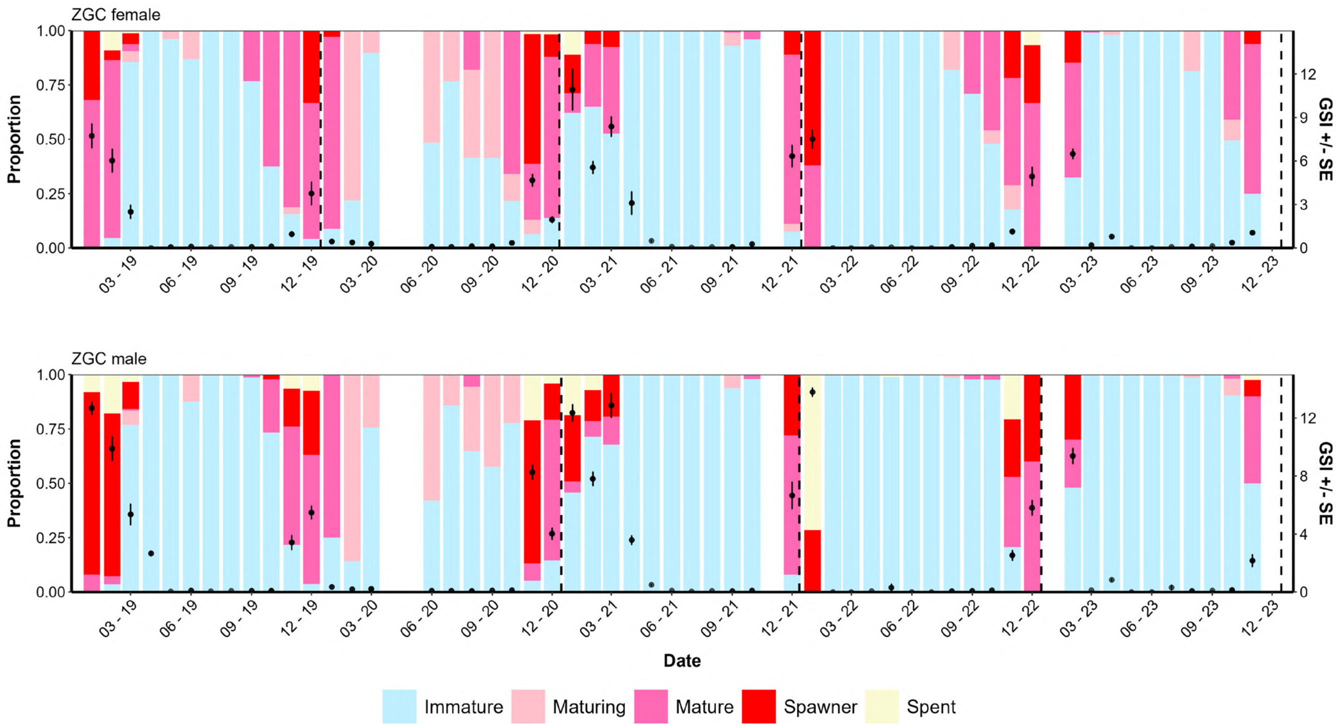


Figure 146. Mediterranean sandeel monthly gonadal cycle for females (top) and males (bottom). Gonadosomatic index (GSI +/- SE (Standard Error)) and proportion of different maturity stages.

Table 35. Number of Mediterranean sandeel individuals measured along the zones sampled in each season.

Fishery	Year	Zone	Winter	Spring	Summer	Autumn	N on board sampling
			Number individuals sampled				
Artisanal fisheries	2019	North	727	2358	1775	1041	20
Artisanal fisheries	2020	North	1038	562	1427	1122	17
Artisanal fisheries	2021	North	723	1935	1335	301	17
Artisanal fisheries	2022	North	749	1884	1418	999	21
Artisanal fisheries	2023	North	809	1909	1852	1200	20

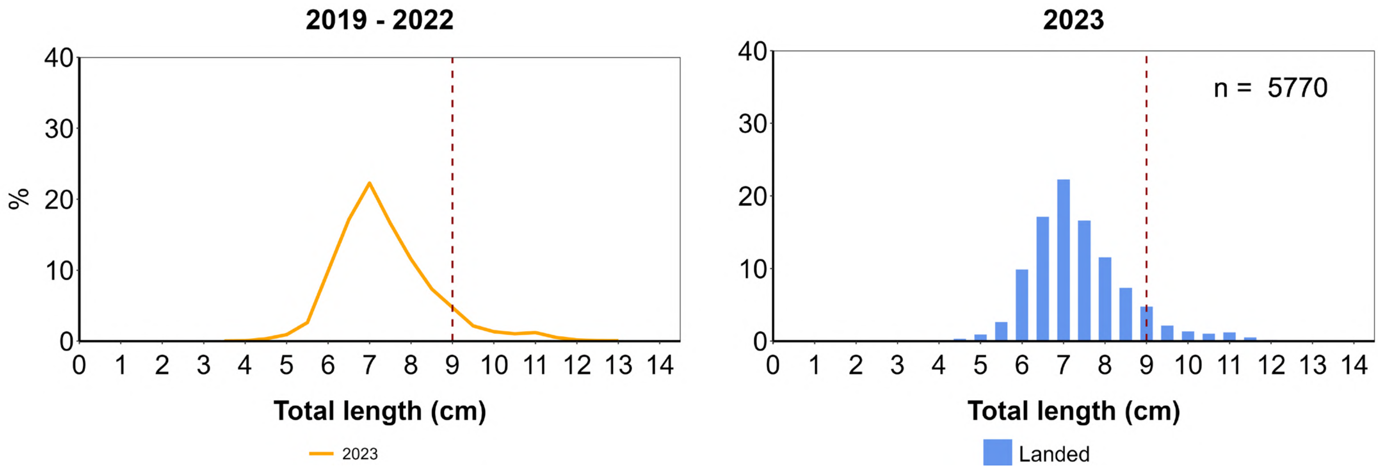


Figure 147. Annual length-frequency distribution of Mediterranean sandeel. Left: previous years sampled, right: year analyzed. (n) Total number of measured individuals. Red dashed line: size at first maturity (L_{50}) calculated as the mean between the L_{50} values of the previous four years sampled and the year analyzed.

Smooth sandeel (*Gymnammodytes semisquamatus*) ZGS

According to length-weight relationship parameters for both sexes combined and males, smooth sandeel displayed a positive allometric growth (*b*>3), while females shows a negative allometric growth in 2023 (Table 36). Also, when comparing length-weight relationships for both sexes combined and separately from 2019 to 2023, results show similar trends for all years sampled (Figure 148).

Table 36. Smooth sandeel length-weight relationship in the year analyzed.

2023	L-W (a)	L-W (b)	L-W (r^2)	n
Combined	0.0019	3.0705	0.97	57
Females	0.0038	2.7984	0.9	21
Males	0.0014	3.1871	0.83	30

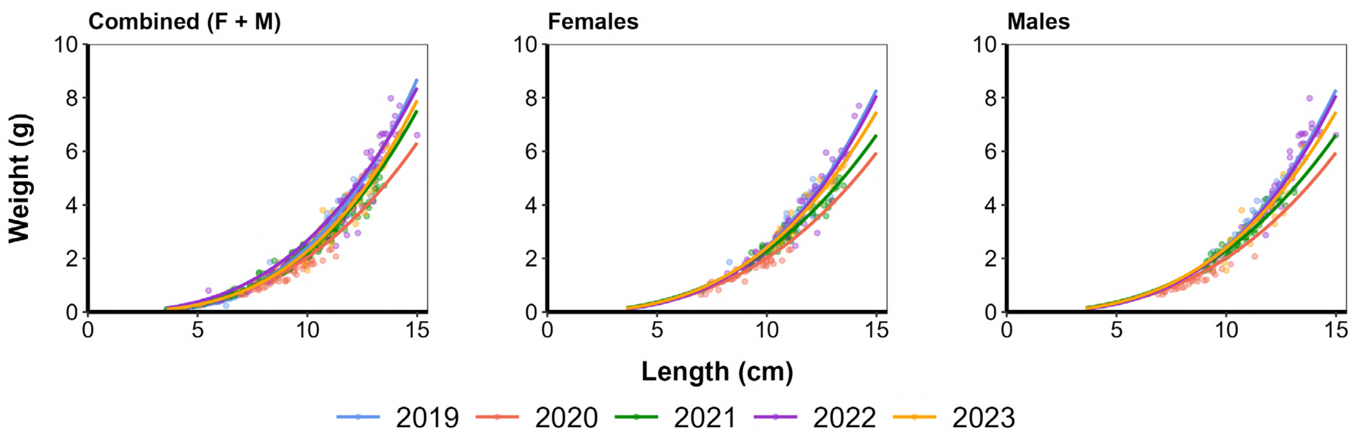


Figure 148. Smooth sandeel length-weight relationship for all years sampled.

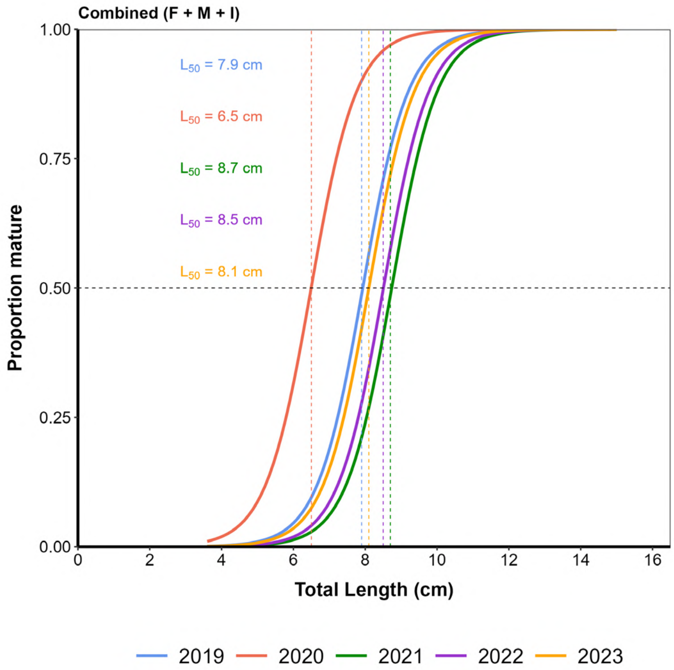


Figure 149. Smooth sandeel size at first maturity (L_{50}) for all years sampled.

The size at first maturity (L_{50}) for smooth sandeel in 2023 was 8.1 cm of TL for both sexes combined (Figure 139). When comparing between years, the L_{50} in 2023 is within the range of the five years sampled (7.9 to 8.7 cm of TL).

In 2023, a total of 57 smooth sandeel individuals were analyzed to calculate the L_{50} (Table 37). Out of these, 6 individuals were classified as immature and 51 as mature.

Table 37. Number of mature and immature individuals of smooth sandeel included in the biological analyses in each month.

Month	2019		2020		2021		2022		2023	
	Immature	Mature	Immature	Mature	Immature	Mature	Immature	Mature	Immature	Mature
January	0	0	0	0	1	49	0	15	0	0
February	0	0	0	5	0	11	2	48	0	51
March	5	5	0	27	0	0	0	0	2	0
April	5	3			22	11	0	0	0	0
May	0	1			18	0	15	4	2	0
June	1	1	2	0	0	0	0	0	2	0
July	1	2	0	0	5	0	0	0	0	0
August	2	0	0	1	2	0	0	0	0	0
September	0	0	0	4	7	0	0	0	0	0
October	0	0	3	4	2	0	0	0	0	0
November	9	2	0	0	0	0	4	46	0	0
December	1	0	0	50	5	45	0	0	0	0

The gonadal cycle of smooth sandeel was analyzed monthly from 2019 to 2023 (Figure 150). The species showed a seasonal reproductive cycle with spawning females present from December to April, with a peak in January. In the period 2022-2023, spawning females were found from November to February, but no samples were obtained neither in December nor January. In this period, the highest GSI values, both for females and males, were found in February 2023, when the only significant sample of smooth sandeel was obtained.

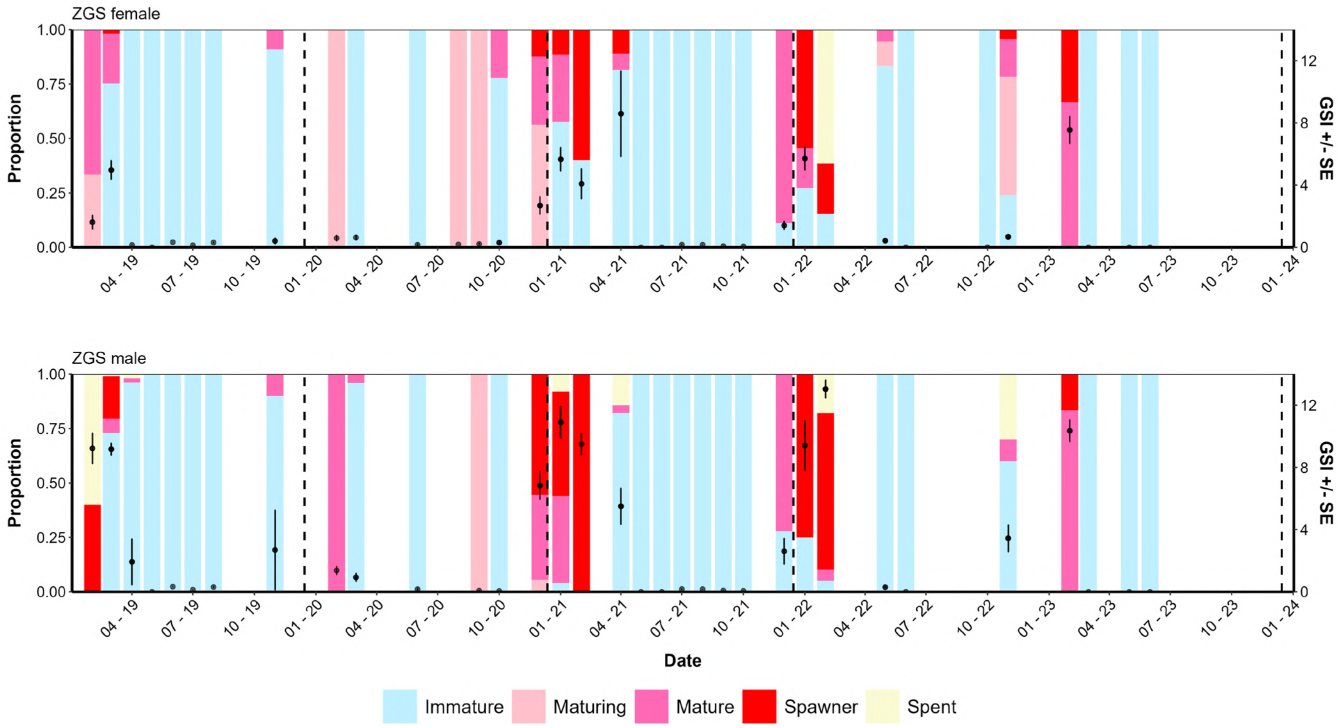


Figure 150. Smooth sandeel monthly gonadal cycle for females (top) and males (bottom). Gonadosomatic index (GSI +/- SE (Standard Error)) and proportion of different maturity stages.

Table 38. Number of smooth sandeel individuals measured along the zones sampled in each season.

Fishery	Year	Zone	Winter	Spring	Summer	Autumn	N on board sampling
			Number individuals sampled				
Artisanal fisheries	2019	North	343	170	3	12	10
Artisanal fisheries	2020	North	32	2	5	122	8
Artisanal fisheries	2021	North	251	27	16	122	11
Artisanal fisheries	2022	North	129	25	0	164	7
Artisanal fisheries	2023	North	138	4	0	0	5

The annual length-frequency distribution of smooth sandeel from 2019 to 2022 ranged between 4.5 and 13.5 cm of TL, but most individuals samples ranged between 9.5 and 13.5 cm of TL (Figure 151). As can be observed, distribution modes varied over the four years sampled.

Monthly size frequency distributions of Smooth sandeel in 2023 do not show clear changes throughout the year due to low number of individuals obtained during the sampling (Annex 23).

All parameters analyzed in this report for smooth sandeel were calculated using individuals obtained by artisanal fisheries sampling (Table 38).

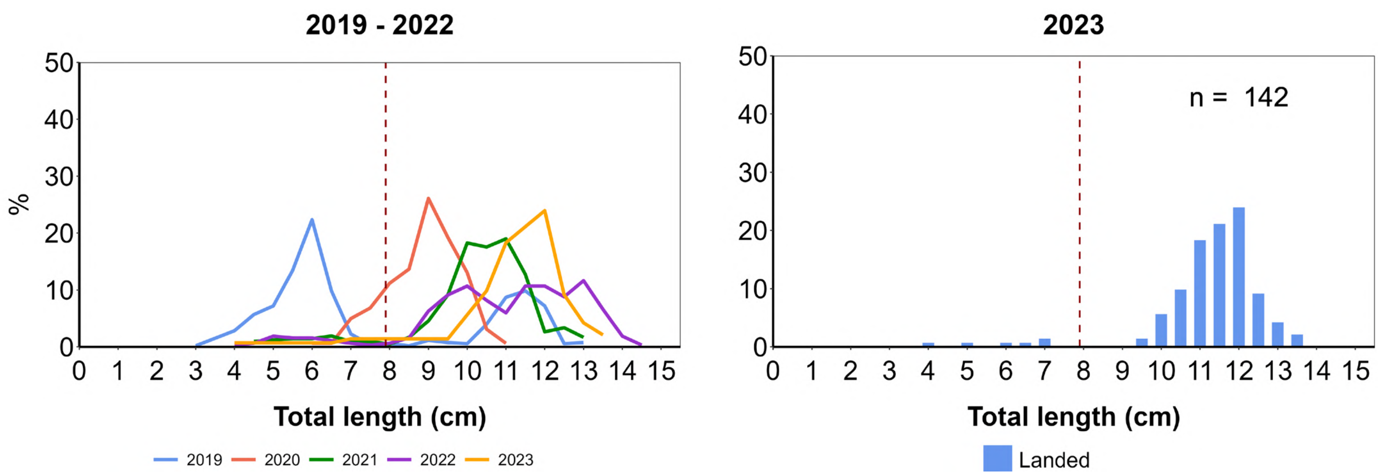


Figure 151. Annual length-frequency distribution of smooth sandeel. Left: previous years sampled, right: year analyzed. (n) Total number of measured individuals.

Transparent goby (*Aphia minuta*) FIM

According to length-weight relationship parameters for both sexes combined, transparent goby displayed a positive allometric growth (b>3) in 2023 (Table 39). Also, when comparing length-weight relationships from 2019 to 2023, results show similar trends for all years sampled (Figure 152).

Table 39. Transparent goby length-weight relationship in the year analyzed.

2023	L-W (a)	L-W (b)	L-W (r^2)	n
Combined	0.0034	3.3271	0.88	150

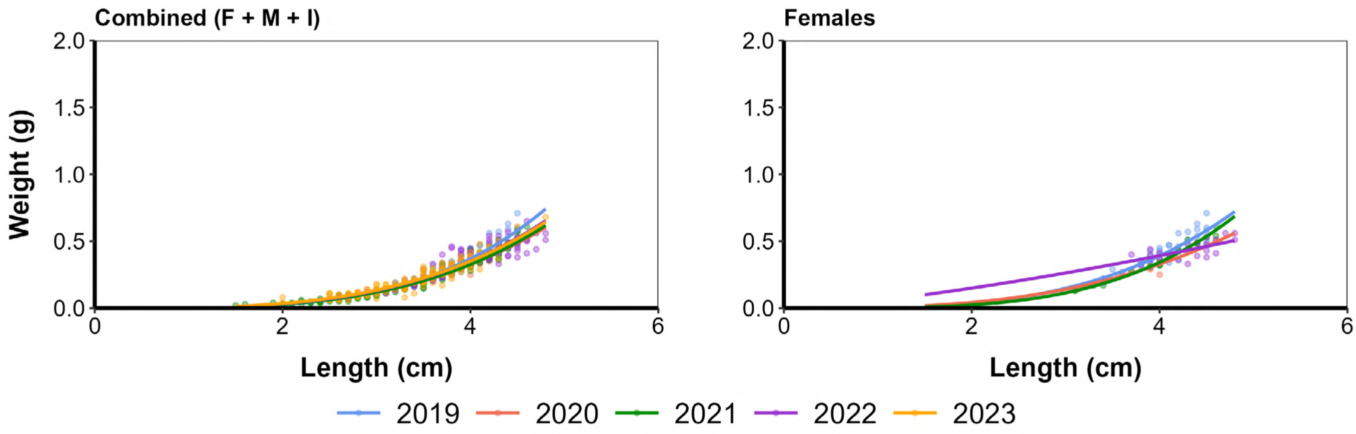


Figure 152. Transparent goby length-weight relationship for all years sampled.

Table 40. Number of transparent goby individuals measured along the zones sampled in each season.

Fishery	Year	Zone	Winter	Spring	Summer	Autumn	N on board sampling
			Number individuals sampled				
Artisanal fisheries	2019	Center	114	220	0	0	2
Artisanal fisheries	2020	Center	325	0	0	0	1
Artisanal fisheries	2021	Center	777	0	0	0	3
Artisanal fisheries	2022	North	117	0	0	0	1
Artisanal fisheries	2022	Center	0	86	0	0	1
Artisanal fisheries	2023	North	413	0	0	0	2
Artisanal fisheries	2023	Center	184	0	0	0	1

The annual length-frequency distribution of transparent goby in 2023 ranged between 2 and 4.5 cm of TL, but most individuals samples ranged between 2.5 and 4 cm of TL (Figure 153). From 2019 to 2022, sizes ranged between 1.5 and 4.5 of TL, with similar distribution trends across all years sampled

For monthly length-frequency distribution of transparent goby in 2023 see Annex 23. This species can only be fished during the sandeel closure period, so the months not shown in the graph were not sampled.

All parameters analyzed in this report for transparent goby were calculated using individuals obtained by artisanal fisheries sampling (Table 40).

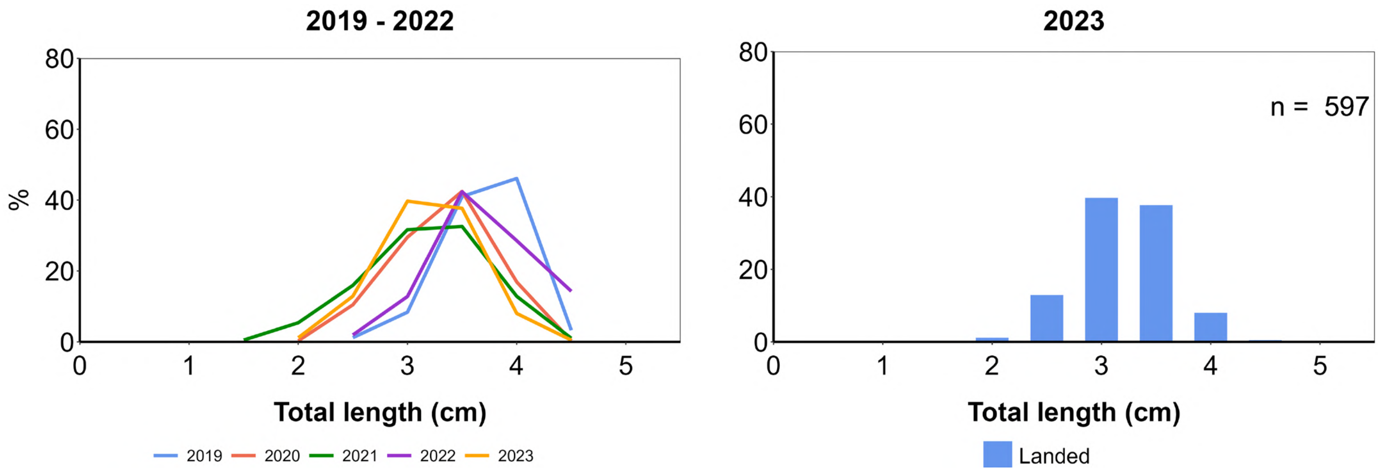


Figure 153. Annual length-frequency distribution of transparent goby. Left: previous years sampled, right: year analyzed. (n) Total number of measured individuals.

Common octopus fishery in Catalonia

A total of 99 artisanal fisheries sampling hauls were carried out for the common octopus fishery in 2023 (pots and traps), within the co-management areas of Central Catalonia and Ebre Delta (Table 32 and Figure 154). Individuals below 1 kg weight were measured on-board but not sold in auction, as explained by the current regulation (ARP/222/2020).

The total common octopus catch in Catalonia in 2023 was 274 t, approximately 61% of which were caught by small-scale fisheries, 29% by bottom trawling and 0.5% by shellfishers (ICATMAR, 24-03).

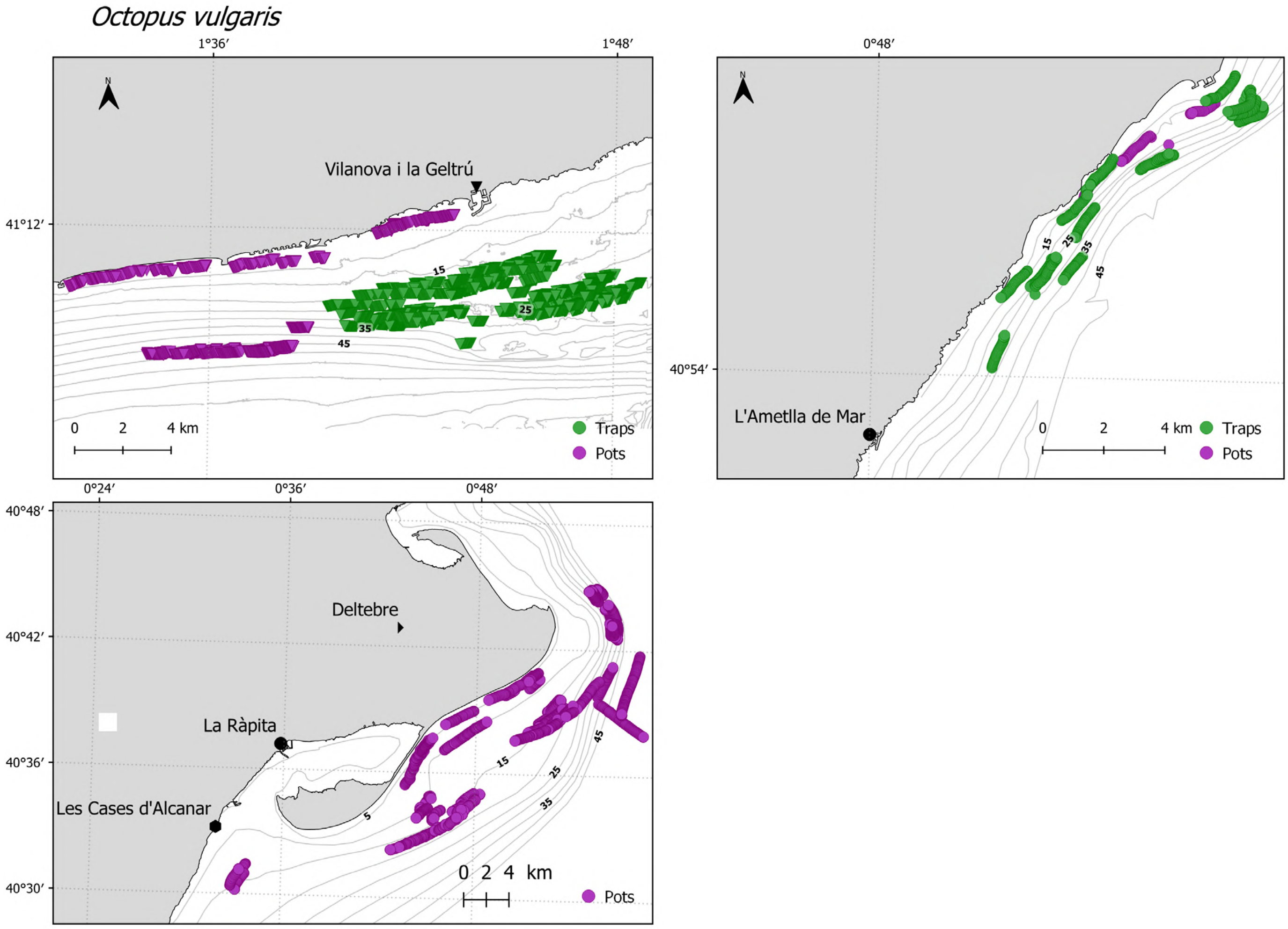


Figure 154. Common octopus sampling in the year analyzed. Central Catalonia (top-left), Ebre Delta (top-right and bottom-felt).

Common octopus (*Octopus vulgaris*) OCC

Individuals with missing arms were excluded from the calculations of length-weight parameters of common octopus in 2023.

According to length-weight relationship parameters for both sexes combined and separately, common octopus displayed a negative allometric growth (b<3) in 2023 (Table 41). Also, when comparing length-weight relationships for both sexes combined and separately from 2019 to 2023, results show similar trends for all years sampled with negative allometric growth in all cases (Figure 155).

All parameters analyzed in this report for common octopus were calculated using only individuals obtained by artisanal fisheries sampling, mainly by traps and pots, although a few measured individuals were caught by bottom trawling sampling (Table 42). Most of the variations between the Ebre Delta and Central Catalonia areas were due to differences in sampling effort, being greater in the latter.

Table 41. Common octopus length-weight relationship in the year analyzed. Only individuals with all arms were included in the analysis.

Length – weight relationship				
2023	a	b	r^2	n
Combined	4.5582	2.1433	0.68	1200
Females	5.4698	2.0701	0.71	532
Males	3.6533	2.2302	0.66	668

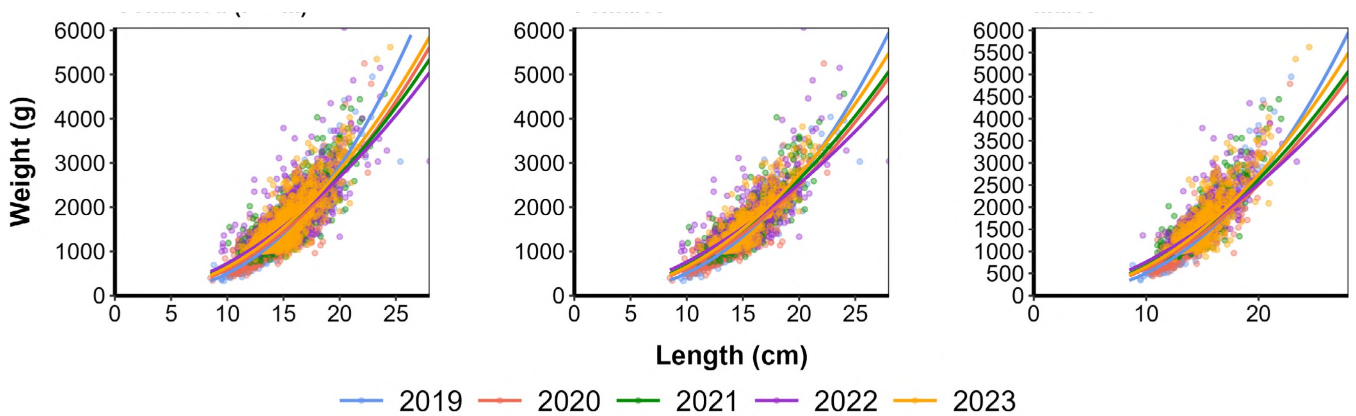


Figure 155. Common octopus length-weight relationship. Only individuals with all arms were included in the analysis.

Table 42. Number of common octopus individuals measured in the different fisheries along the zones sampled in each season.

Fishery	Fishing gear	Year	Zone	Winter	Spring	Summer	Autumn	N on board sampling
				Number individuals sampled				
Artisanal fisheries	Pots	2019	Center	87	144	48	19	26
Artisanal fisheries	Sandeel seiner	2019	North	0	0	3	0	3
Artisanal fisheries	Traps	2019	Center	111	180	113	0	23
Artisanal fisheries	Pots	2020	Center	24	175	99	161	26
Artisanal fisheries	Pots	2020	South	0	0	18	141	9
Artisanal fisheries	Sandeel seiner	2020	North	0	0	0	1	1
Artisanal fisheries	Traps	2020	Center	133	195	128	135	42
Artisanal fisheries	Pots	2021	Center	93	85	91	155	42
Artisanal fisheries	Pots	2021	South	96	77	207	104	21
Artisanal fisheries	Sandeel seiner	2021	North	0	0	1	0	1
Artisanal fisheries	Traps	2021	Center	81	169	159	64	36
Artisanal fisheries	Pots	2021	Center	10	0	0	0	1
Artisanal fisheries	Pots	2022	Center	74	102	112	95	46
Artisanal fisheries	Pots	2022	South	115	19	83	330	22
Artisanal fisheries	Traps	2022	Center	112	202	218	57	45
Artisanal fisheries	Traps	2022	South	5	61	0	0	8
Artisanal fisheries	Pots	2023	Center	120	200	47	238	40
Artisanal fisheries	Pots	2023	South	90	45	75	113	17
Artisanal fisheries	Traps	2023	Center	140	308	51	93	35
Artisanal fisheries	Traps	2023	South	8	37	0	0	7
Bottom trawl		2019	North	0	36	10	3	11
Bottom trawl		2019	Center	8	5	0	1	5
Bottom trawl		2019	South	5	1	12	13	12
Bottom trawl		2020	North	1	6	4	0	7
Bottom trawl		2020	Center	0	1	0	3	3
Bottom trawl		2020	South	0	0	27	7	7
Bottom trawl		2021	North	8	1	2	0	7
Bottom trawl		2021	Center	2	2	4	6	8
Bottom trawl		2021	South	5	0	16	15	9
Bottom trawl		2022	North	2	1	2	1	6
Bottom trawl		2022	Center	11	0	1	10	7
Bottom trawl		2022	South	3	3	8	5	8
Bottom trawl		2023	North	0	7	3	27	12
Bottom trawl		2023	Center	4	6	6	20	6
Bottom trawl		2023	South	3	9	11	1	9

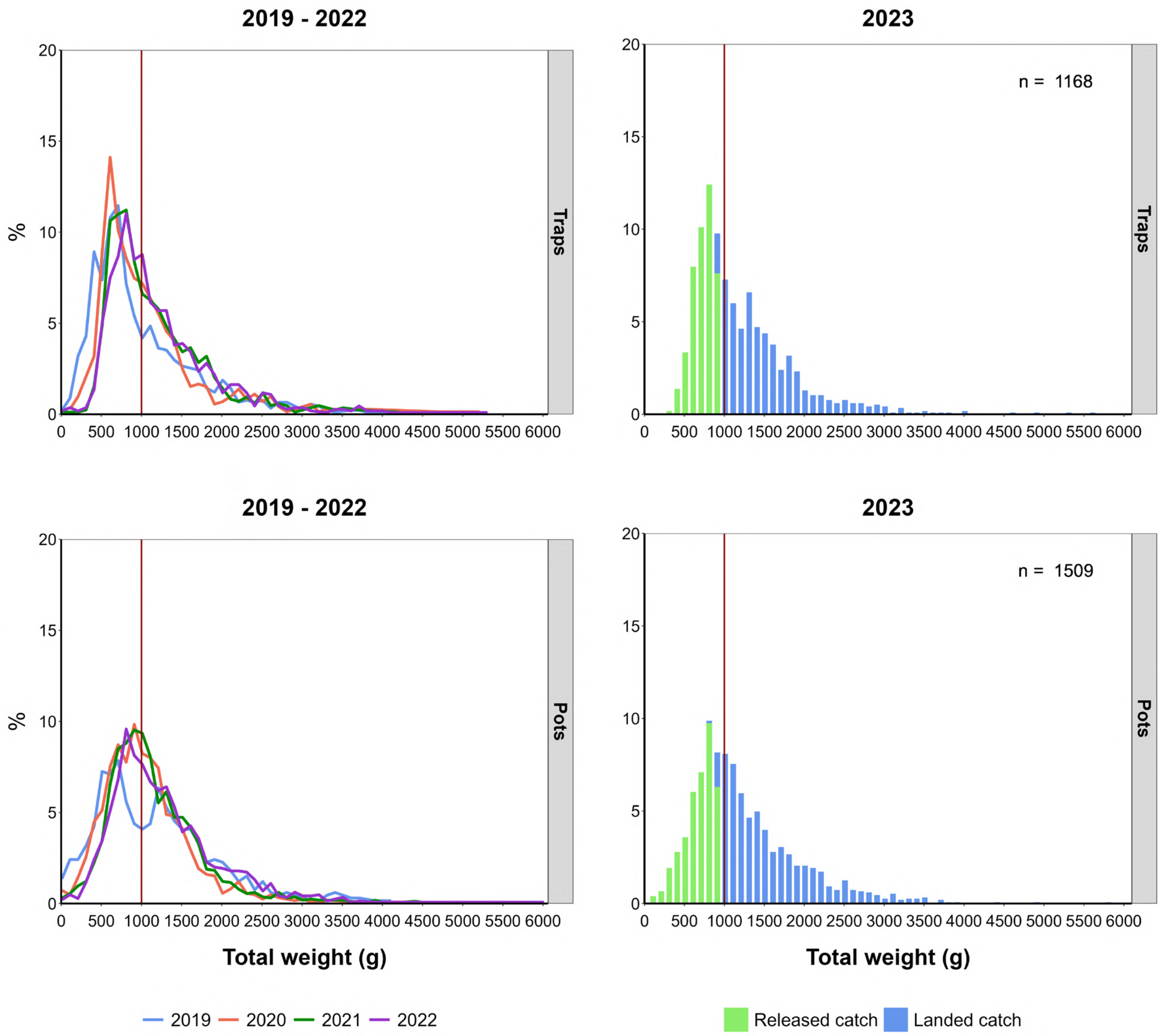


Figure 156. Annual weight-frequency distribution of common octopus at different fishing gear (Traps and Pots). Left: previous years sampled, right: year analyzed. (n) Total number of measured individuals. Red line: Minimum Conservation Reference Weight (MCRW).

The annual weight-frequency distribution of common octopus from 2019 to 2023 show that the highest weight frequencies were below the MCRW, although most of these individuals are released back to the sea alive (Figure 156). The temporal distributions (2019-2022) show, in the case of traps, an increase in abundances near the MCRW and, in the case of pots, a similar trend over the years. It should be noted that in 2019 only the Central Catalonia area was sampled, so the number of individuals sampled is lower. Comparing between gears, in 2023, traps showed the mode around 800 g, below the MRCW. In the case of pots, a similar trend is observed, with the mode at 800 g, but with lower frequencies.

The gonadal cycle of common octopus was analyzed monthly from 2019 to 2023 (Figure 157). Both sexes show a spawning period during late spring and summer, with the highest presence of mature and spawning individuals from May to September. However, sexual differences were observed. The reproductive cycle of females showed a marked seasonality, with the spawning period in late spring and summer. On the contrary, males showed a continuous reproductive cycle, as mature and spawning individuals occurred all year-round. The lower presence of spawning and spent females may be caused by a faster senescence process after spawning than in males which leads to an earlier death.

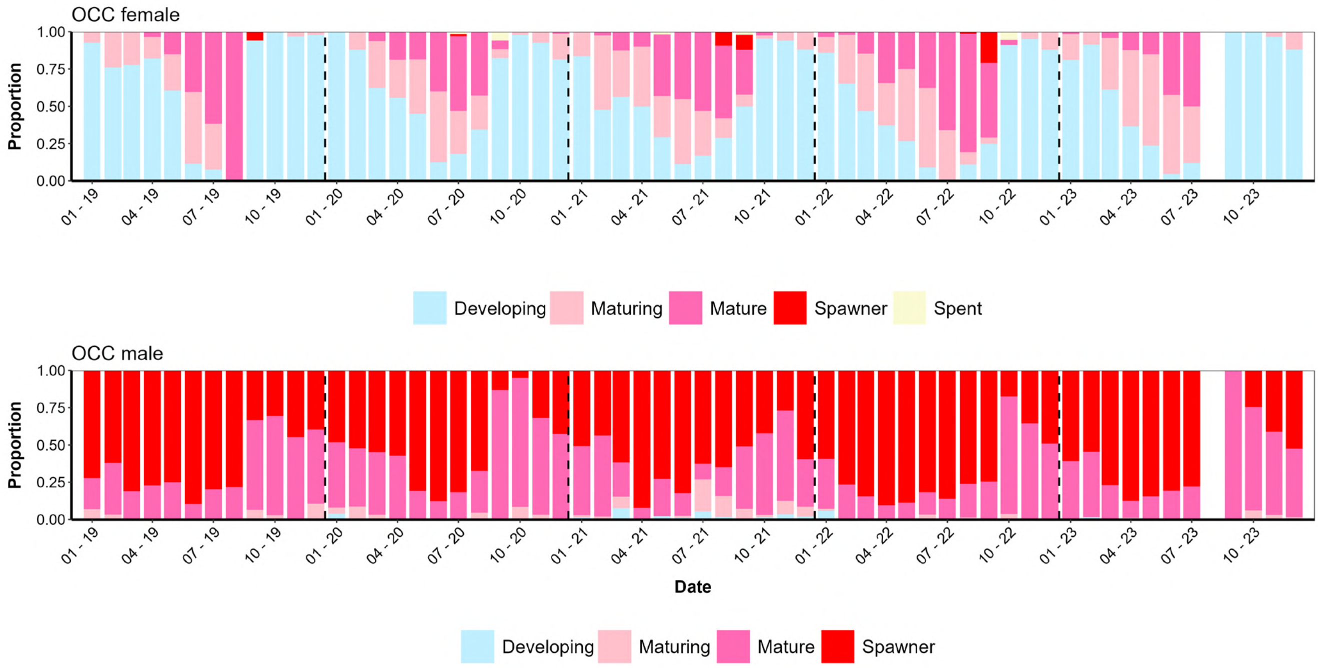


Figure 157. Common octopus monthly gonadal cycle for females and males.

Common octopus females can accumulate sperm from several males in their spermathecae for a period of time before fertilizing their eggs. In this way, they increase the genetic variability of their offspring. Thus, they can mate and store sperm while they are still developing, and use it when they mature.

Figure 158 shows, as in Figure 157, that this species has a marked reproductive cycle. Although mating occurs all year-round, the period with the highest proportion of mated females with sperm stored in their spermathecae coincided with the reproductive period over the years.

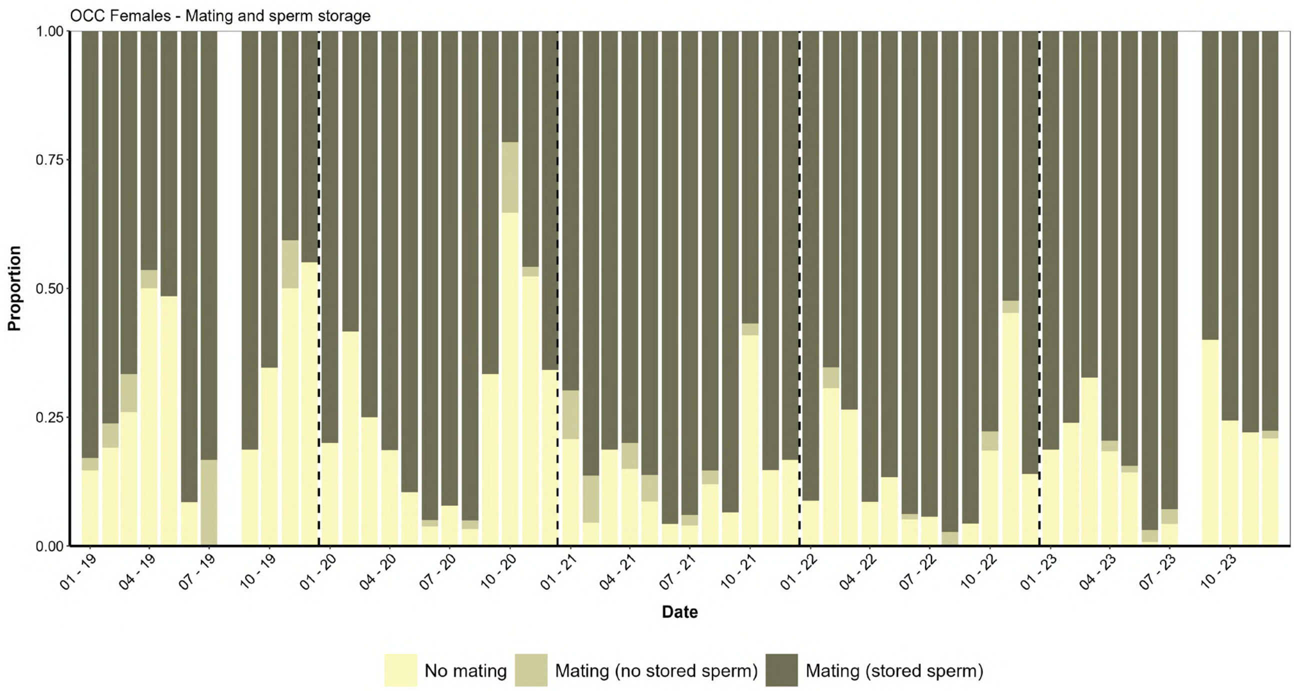


Figure 158. Common octopus monthly mating cycle for females.

Common octopus fishery in Central Catalonia

The annual weight-frequency distribution of common octopus in Central Catalonia in 2023 shows similar values among fishing gears, except for individuals under 500g, which were found in greater abundance with pots (Figure 159). In the case of traps, lower abundances of individuals weighing less than 2500g were found, compared with pots. In both cases a normal distribution with a marked mode was clearly visible. The highest frequencies were concentrated between 1000-1500g, above and below the MCRW, especially in the case of traps where the frequency of released individuals reached higher values.

For monthly weight-frequency distribution of Central Catalonia common octopus in 2023 see Annex 24.

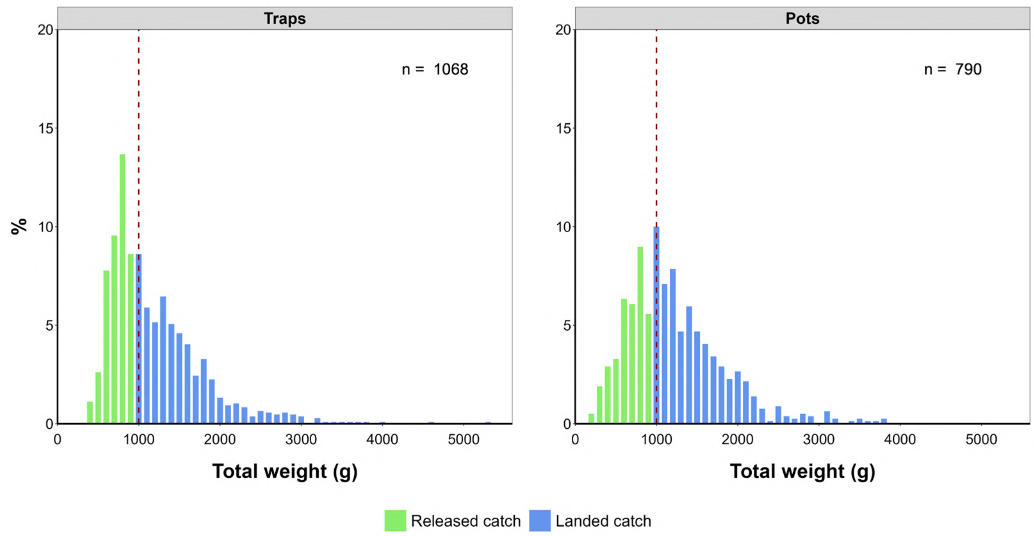


Figure 159. Annual weight-frequency distribution of common octopus at different fishing gear (Traps and Pots) in Central Catalonia in 2023. Red line: Minimum Conservation Reference Weight (MCRW).

The gonadal cycle of common octopus in Central Catalonia was analyzed monthly from 2019 to 2023 (Figure 160). Both sexes showed a spawning period during late spring and summer, with the highest presence of mature and spawning individuals from May to September. However, sexual differences were observed: the reproductive cycle of females showed a marked seasonality, with the spawning period in late spring and summer, while males showed a continuous reproductive cycle with presence of mature individuals throughout the year.

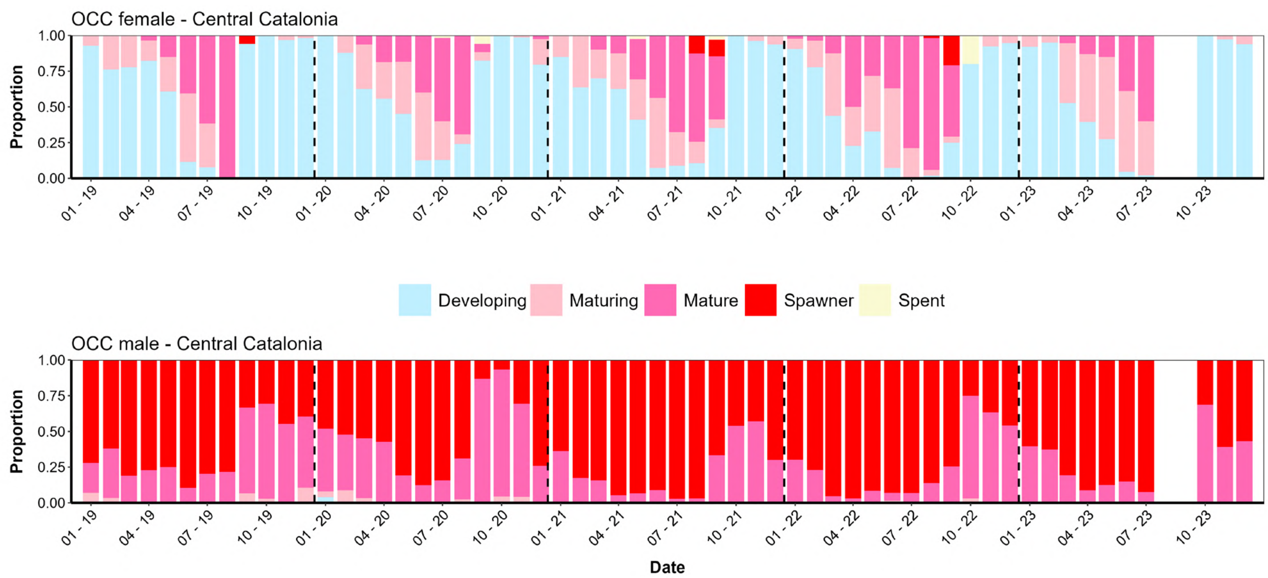


Figure 160. Common octopus monthly gonadal cycle for females and males in Central Catalonia.

Common octopus fishery in the Ebre Delta

The annual weight-frequency distribution of common octopus in the Ebre Delta in 2023 shows different values among fishing gears in terms of abundance and distribution (Figure 161). In the case of traps, no clear normal distribution with a mode was observed, which could be related to the low number of sampled individuals. On the other hand, in the case of pots, a normal distribution was observed similar to that of pots from Central Catalonia. In both fishing gears, highest abundances were found above and below the MCRW.

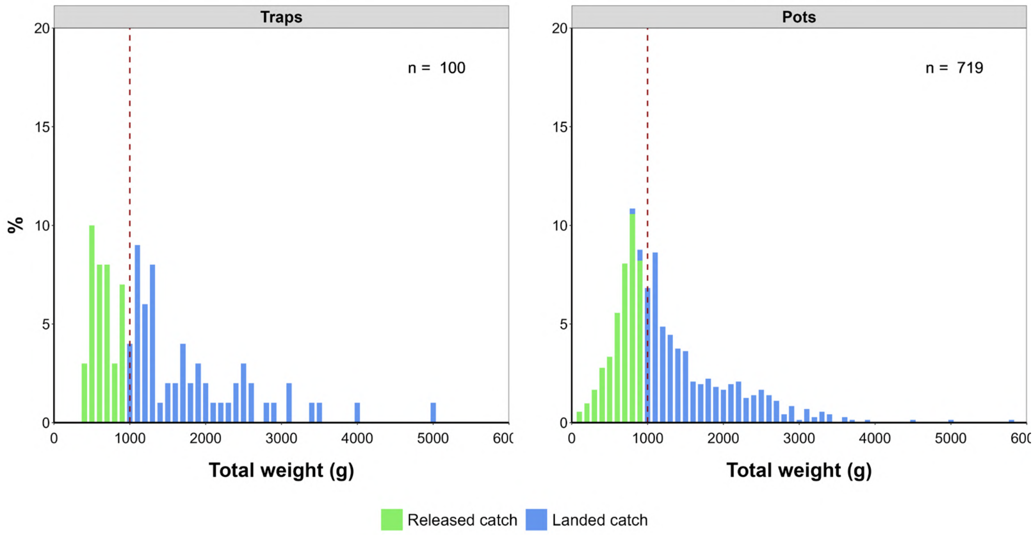


Figure 161. Annual weight-frequency distribution of common octopus at different fishing gear (Traps and Pots) in South Catalonia in 2023. Red line: Minimum Conservation Reference Weight (MCRW).

The gonadal cycle of common octopus in South Catalonia was analyzed monthly from mid-2020 to 2023 (Figure 162). Both sexes show a spawning period during late spring and summer, with the greatest presence of mature and spawner individuals from May to August. The cycle was not as marked as in Central Catalonia, probably due to the lower number of individuals sampled. However, sexual differences were also observed: the reproductive cycle of females showed a marked seasonality, with the spawning period in late spring and summer, while males showed a continuous reproductive cycle with presence of mature individuals all year-round. It is worth mentioning that there are some significant months for the reproductive cycle in which data are missing due to gaps in sampling, either because of the closed season or for other reasons.

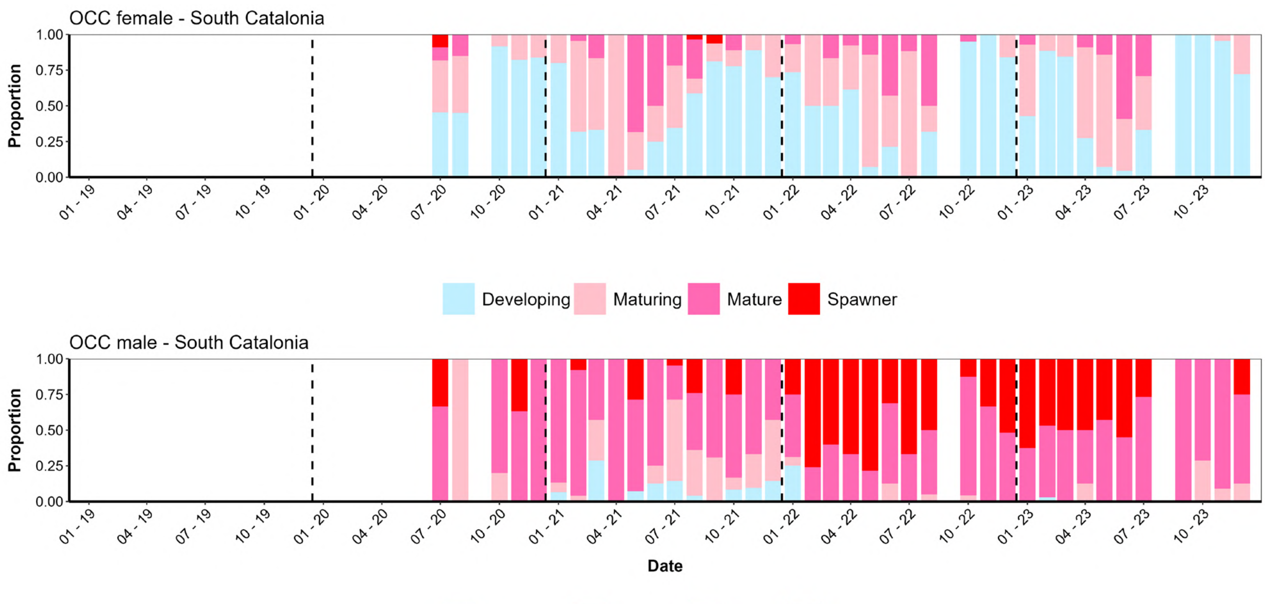


Figure 162. Common octopus monthly gonadal cycle for females and males in South Catalonia.

Blue crab fishery in Catalonia

It should be noted that the results obtained for the sampling of the blue crab fishery are still preliminary and therefore different from those of the other species analyzed in this report.

The blue crab fishery sampling is exclusively carried out in the Ebre Delta zone, where it is a non-indigenous species. It was first detected in 2012 and has become into a new fishing resource since 2016, with an average price of 3.46 €/kg during 2023 (ICATMAR, 24-03). It is fished with bottom trawling, dredge ("rastell"), trammel nets and a specific kind of traps used in La Ràpita ("monetes"). The sampling strata are defined both by location inside or outside Alfacs Bay and by depth (Figure 163):

Inside the bay: deep bay (DB, starting at 5 m depth), shallow bay North (SBN, up to 5 m depth), and shallow bay South (SBS, up to 5 m depth).

Outside the bay: open water (OW).

Transition zone between the bay and the open water: channel (CH).

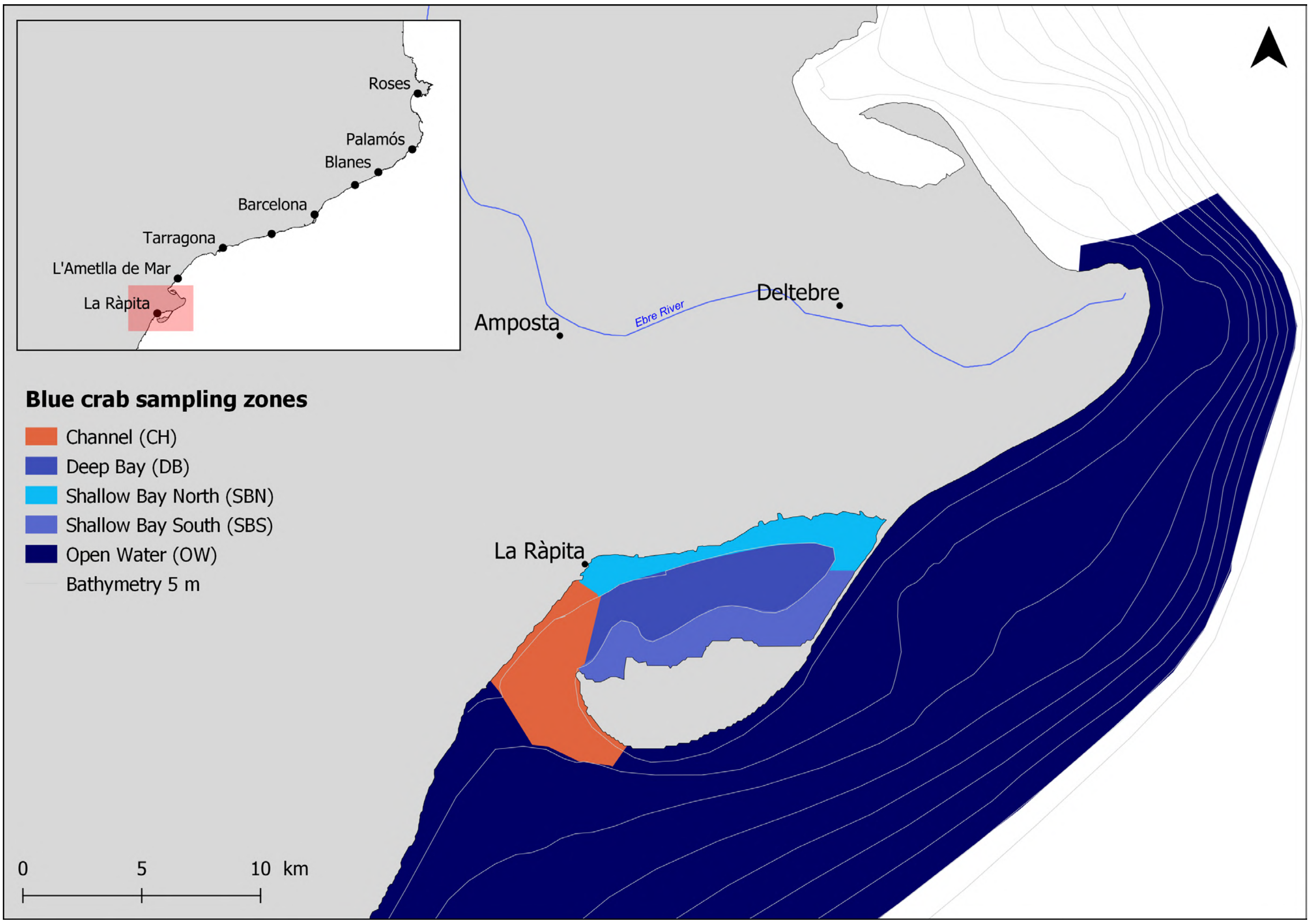


Figure 163. Map of the sampling zones of blue crab.

Most of the individuals sampled from the bay (shallow and deep waters) came from artisanal fisheries, such as traps and trammel nets (Table 43). Individuals sampled from the channel, connecting the bay and the open sea, were captured with trammel nets (all years), while individuals sampled in the open sea came from dredges, bottom trawls and, to a lesser extent, trammel nets and longlines. In the case of shellfish gatherers, most of the individuals sampled came from the shallow bay waters with traps. The most sampled area over the years is the shallow bay North (SBN), as this is where the species is most abundant and, therefore, where fishing is concentrated.

Table 43. Number of blue crab samplings by season and strata according to fishery and zone.

Fishery	Type	Year	SBN				SBS				DB				CH				OW			
			W	Sp	Su	A	W	Sp	Su	A	W	Sp	Su	A	W	Sp	Su	A	W	Sp	Su	A
Artisanal fisheries	Traps	2019		2	4	10				1			1	3								
Artisanal fisheries	Trammel net	2019		1				1				1	1				1			2	2	2
Artisanal fisheries	Longline	2019										1						1		1		2
Artisanal fisheries	Dredge	2019																		1	3	5
Shellfish gatherer	Traps	2019		2	6	2															2	16
Bottom trawl		2019																				
Artisanal fisheries	Traps	2020	6	6	7	6	2				2		1									
Artisanal fisheries	Trammel net	2020			1	1			1	2					1	1	1		2	3	1	2
Artisanal fisheries	Longline	2020																				
Artisanal fisheries	Dredge	2020																		7	5	3
Shellfish gatherer	Traps	2020	5	2	6	2																
Bottom trawl		2020																	2		1	
Artisanal fisheries	Traps	2021	7	7	5	8	1				2	1		2								
Artisanal fisheries	Trammel net	2021			1			1								1			5			1
Artisanal fisheries	Longline	2021																				
Artisanal fisheries	Dredge	2021																		2	3	5
Shellfish gatherer	Traps	2021	3	6	4	2								1								
Bottom trawl		2021																				
Artisanal fisheries	Traps	2022	5	7	8	9	2	1		1	2	1	1	2								
Artisanal fisheries	Trammel net	2022	1	2			1						2		1				1			
Artisanal fisheries	Longline	2022																				
Artisanal fisheries	Dredge	2022																			2	1
Shellfish gatherer	Traps	2022	2	2	3						1											
Bottom trawl		2022																				
Artisanal fisheries	Traps	2023	4	7	10	7		1			2		5									
Artisanal fisheries	Trammel net	2023	2							2	1							1				1

Blue crab (*Callinectes sapidus*) CRB

The total blue crab catch in Catalonia in 2023 was 402 t, approximately 86% of which were caught by small-scale fisheries, 14% by shellfish and less than 0.3% by bottom trawling (ICATMAR, 24-03).

Almost all of the individuals sampled were caught by artisanal fisheries during the five years sampled (Table 44). In the case of bottom trawling, dredges and longline, blue crab was a by-catch. Similar trends are observed over the five years for individuals measured in all seasons, although a slight seasonality is observed, with a lower number of individuals sampled particularly during the winter, compared to the rest of seasons.

Table 44. Number of blue crab individuals measured in the different fisheries along the zone sampled in each season (the values include all strata sampled).

Fishery	Fishing gear	Year	Zone	Winter	Spring	Summer	Autumn	N samplings
				Number individuals sampled				
Artisanal fisheries	Dredge	2019	South	0	2	30	35	9
Artisanal fisheries	Longline	2019	South	0	11	0	38	4
Artisanal fisheries	Traps	2019	South	0	89	394	854	19
Artisanal fisheries	Trammel net	2019	South	0	99	151	105	11
Shellfishers	Traps	2019	South	0	93	321	122	10
Bottom trawling		2019	South	0	0	33	64	18
Artisanal fisheries	Dredge	2020	South	0	79	61	15	15
Artisanal fisheries	Traps	2020	South	350	321	429	364	27
Artisanal fisheries	Trammel net	2020	South	67	85	94	82	15
Shellfishers	Traps	2020	South	239	125	315	137	15
Bottom trawling		2020	South	2	0	9	0	3
Artisanal fisheries	Dredge	2021	South	0	23	41	66	10
Artisanal fisheries	Traps	2021	South	510	475	450	604	31
Artisanal fisheries	Trammel net	2021	South	84	58	32	3	9
Shellfishers	Traps	2021	South	184	376	243	83	16
Artisanal fisheries	Dredge	2022	South	0	0	32	1	3
Artisanal fisheries	Traps	2022	South	483	466	602	670	33
Artisanal fisheries	Trammel net	2022	South	174	81	39	0	8
Shellfishers	Traps	2022	South	109	90	159	0	8
Artisanal fisheries	Dredge	2023	South	0	0	0	11	4
Artisanal fisheries	Traps	2023	South	144	745	871	585	32
Artisanal fisheries	Trammel net	2023	South	150	8	0	46	7
Shellfishers	Traps	2023	South	44	50	0	101	4
Shellfishers	Trammel net	2023	South	9	22	0	0	2
Bottom trawling		2023	South	0	0	50	0	1

The L_{50} for blue crab females in 2023 was 109 mm of CW, the lowest of the series (Figure 164). However, when comparing between sampled years, it is observed that the L_{50} values show little variation over the years.

In 2023, a total of 981 blue crab females were analyzed to calculate the L_{50} (Table 45). Out of these, 54 individuals were classified as juvenile and 927 as adults. It should be noted that the low number of juvenile individuals compared to the adult ones, may bias the L_{50} towards larger sizes than it actually is.

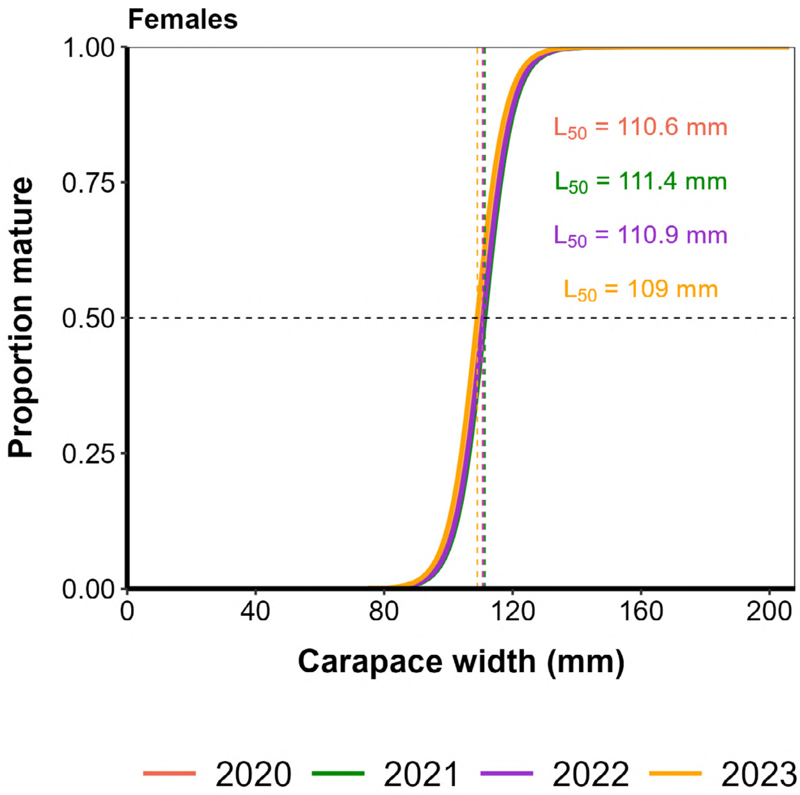


Figure 164. Blue crab size at first maturity (L_{50}) for all years sampled.

Table 45. Number of juvenile and adult individuals of blue crab (only females) included monthly in biological analysis (the values include all strata sampled).

Month	2019		2020		2021		2022		2023	
	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult
January			2	115	5	246	1	191	8	21
February			4	150	14	60	10	127		79
March					12	96	9	47	2	62
April							4	15	21	39
May		25		61	11	187		47		86
June	2	34	1	120	4	137	1	41		82
July	5	34		12					2	1
August	4	11	21	40	14	5	8	52	6	3
September	7	105	17	116	4	94	8	49		58
October	2	208	2	91		139	1	141	1	85
November	3	236	1	124	12	134		78	9	170
December	2	190	4	138	15	156	3	154	5	241

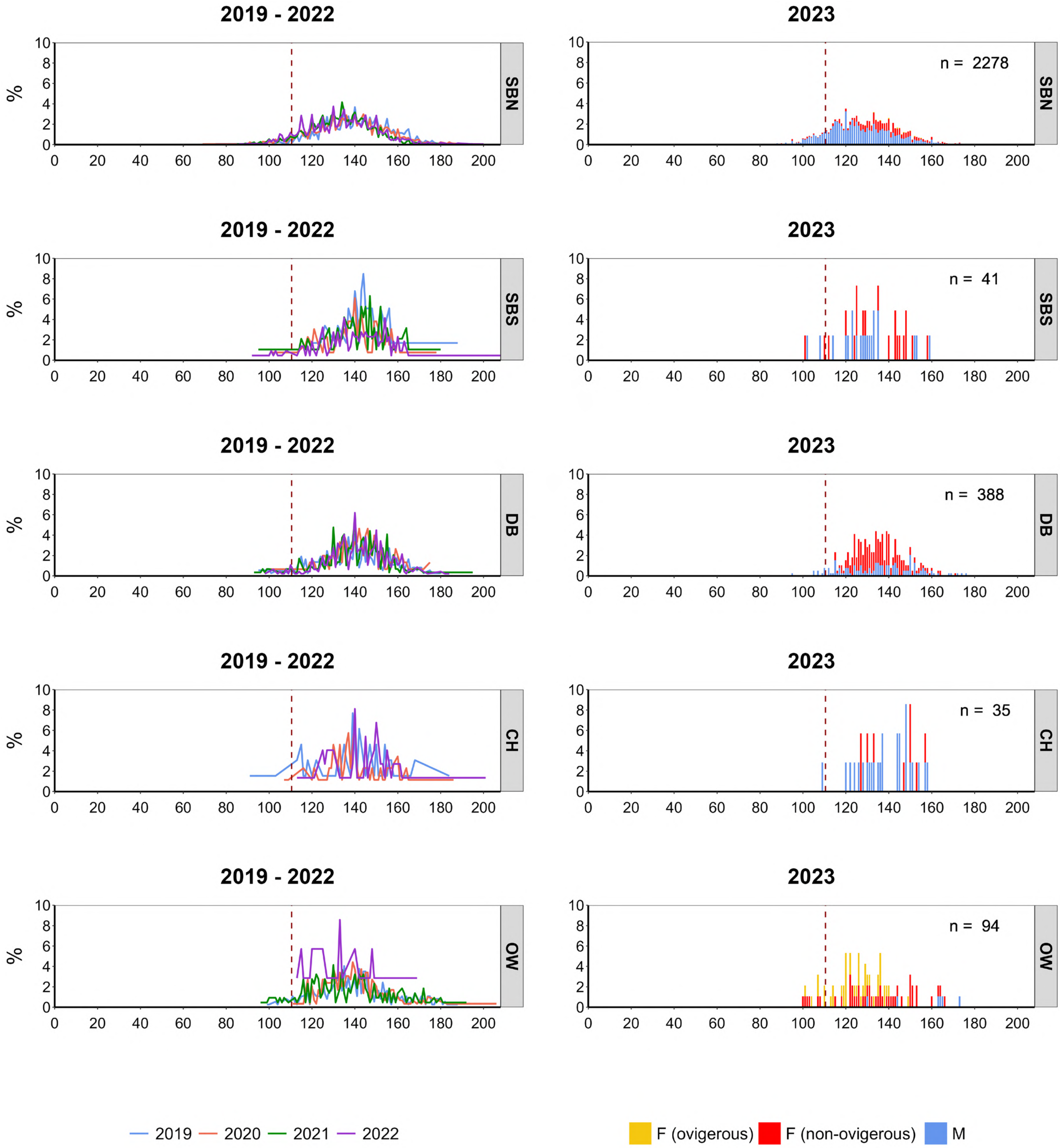


Figure 165. Annual length-frequency distribution of Blue crab at different depth strata (SBN; Shallow Bay North, SBS; Shallow Bay South, BD; Deep Bay, CH; Channel and OW; Open Water). Left: previous years sampled, right: year analyzed. (n) Total number of measured individuals. Red dashed line: size at first maturity (L_{50}) calculated as the mean between the L50 values from 2020 to 2023.

The annual length-frequency distribution of blue crab from 2019 to 2022 showed a similar trend over the years for all strata sampled (Figure 165). The highest number of individuals were caught in shallow and deep waters inside the bay (SBN, SBS and DB), while lower abundances were found in the channel linking the bay and in the open waters (CH and OW).

In 2023, the highest number of individuals was caught in SBN and DB strata, while in SBS, CH and OW, few specimens were captured. Notably, the species showed a differential distribution by sex, with males mainly found within the bay, especially in shallow waters (SBN and SBS), and in the channel. In contrast, non-ovigerous females predominated in deep areas within the bay (DB) or in the open sea (OW), while ovigerous females were present in open water. Most of the individuals measured over the years were above the size at first maturity (L50).

For monthly weight-frequency distribution of blue crab at different depth strata in 2023 see Annex 25.

Figure 166 shows the proportion of blue crab females with eggs and their developmental stages from 2019 to 2023. The species did not show a clear reproductive pattern in the first two years of sampling. In contrast, from 2021 to 2023, two clear reproductive peaks were observed, one during spring and the other in late summer.

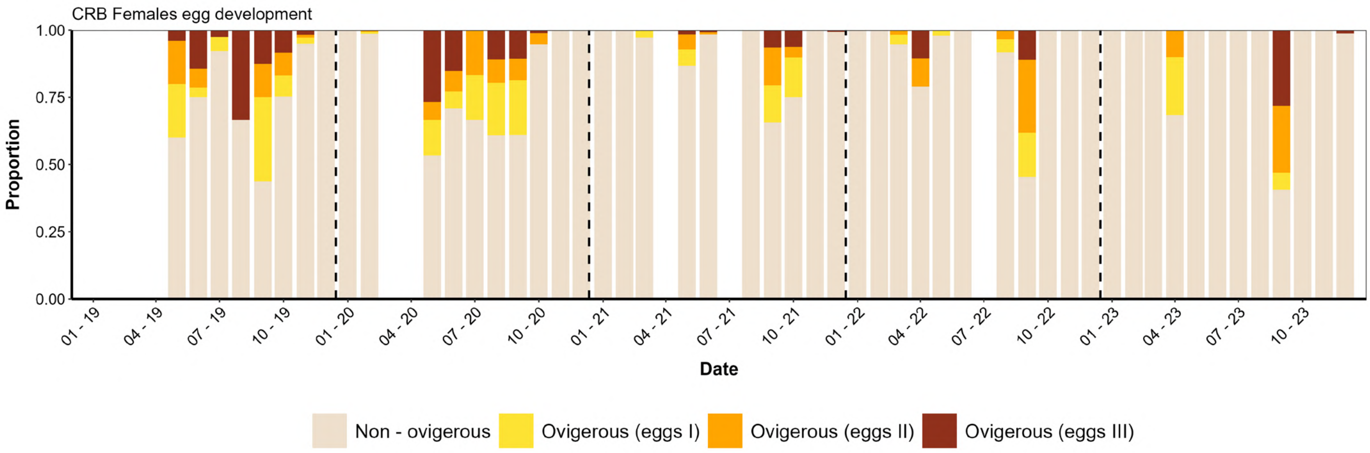


Figure 166. Blue crab monthly proportion of different egg development stages.

References

References

Balcells, M., Blanco, M., Colmenero, A.I., Barría, C., Santos-Bethencourt, R., Nos, D., López-Pérez, C., Ribera-Altimir, J., Sala-Coromina, J., Garriga-Panisello, M., Rojas, A., Galimany, E., 2023. Fishing for litter, accidental catch in bottom trawl nets along the Catalan coast, Northwestern Mediterranean. Waste Manag. 166, 360–367. https://doi.org/10.1016/j.wasman.2023.05.021

Blanco, M., Nos, D., Lombarte, A., Recasens, L., Company, J.B., Galimany, E., 2022. Characterization of discards along a wide bathymetric range from a trawl fishery in the NW Mediterranean. Fish. Res. 258, 106552. https://doi.org/10.1016/j.fishres.2022.106552

Clavel-Henry, M., Solé, J., Bahamon, N., Carretón, M., Company, J.B., 2021. Larval transport of Aristeus antennatus shrimp (Crustacea: Decapoda: Dendrobranchiata: Aristeidae) near the Palamós submarine canyon (NW Mediterranean Sea) linked to the North Balearic Front. Prog. Oceanogr. 192. https://doi.org/10.1016/j.pocean.2021.102515

ICATMAR, 19-01. Institut Català de Recerca per a la Governança del Mar (ICATMAR). Estat de les Pesqueres a Catalunya 2019. Part 1: Mètodes i Resultats. 310 pp, Barcelona.

ICATMAR, 21-02. Institut Català de Recerca per a la Governança del Mar (ICATMAR). State of Fisheries in Catalonia 2020. Part 1: Methods and Results. 519 pp, Barcelona. DOI: https://doi.org/10.2436/10.8080.05.11

ICATMAR, 22-04. Institut Català de Recerca per a la Governança del Mar (ICATMAR). State of fisheries in Catalonia 2021, Part 1: report on the monitoring of the commercial fishing fleet. 202 pp, Barcelona. DOI: 10.2436/10.8080.05.14

ICATMAR, 22-05. Institut Català de Recerca per a la Governança del Mar (ICATMAR). State of fisheries in Catalonia 2021, Part 2: stock assessment. 110 pp, Barcelona. DOI: 10.2436/10.8080.05.15

ICATMAR, 22-06. Institut Català de Recerca per a la Governança del Mar (ICATMAR). Fisheries advisory report for the Northern GSA6 2021. 41 pp., Barcelona. DOI: 10.2436/10.8080.05.16

ICATMAR, 23-03. Institut Català de Recerca per a la Governança del Mar (ICATMAR). Evolució de les Captures i els Preus de Venda del Sector Pesquer a Catalunya: Comparativa 2021-2022. 184 pp, Barcelona. DOI: 10.57645/10.8080.05.3

ICATMAR, 23-07. Institut Català de Recerca per a la Governança del Mar (ICATMAR). State of fisheries in Catalonia 2022, Part 1: report on the monitoring of the commercial fishing fleet. 199 pp, Barcelona. DOI: 10.57645/10.8080.05.7

ICATMAR, 24-03. Institut Català de Recerca per a la Governança del Mar (ICATMAR). Evolució econòmica de les captures del sector pesquer a Catalunya: Comparativa 2022-2023. 198 pp, Barcelona. DOI: https://doi.org/10.20350/digitalCSIC/16242

Margalef, R., 1989. On diversity and connectivity, as historical expressions of ecosystems. Coenoses 4, 121–126.

Palomera, I., Olivar, M.P., Salat, J., Sabatés, A., Coll, M., García, A., Morales-Nin, B., 2007. Progress in Oceanography Small pelagic fish in the NW Mediterranean Sea : An ecological review. Prog. Oceanogr. 74, 377–396. https://doi.org/10.1016/j.pocean.2007.04.012

Ribera-Altimir, J., Llorach-Tó, G., Sala-Coromina, J., Company, J.B., Galimany, E. Fisheries data management systems in the NW Mediterranean: From data collection to web visualization. Database (2023) Vol. 2023: article ID baad067; DOI:https://doi.org/10.1093/database/baad067.

Sardà, F., Demestre, M., 1987. Estudio biológico de la gamba *Aristeus antennatus* (Risso, 1816) en el Mar Catalán (NE de España). Investig. Pesq. 51, 213–232.

Zorica, B., An, I., Vanja, Č., 2019. Sardine (*Sardina pilchardus*) spawning in the light of fat content analysis. Sci. Mar. 83, 207–213.

Annexes

Annex 1. Landed species with higher biomass for previous period. SE: standard error.

2019-2022 Landed Biomass (kg/km^2)		Coastal Delta shelf		Middle Delta shelf		Deeper shelf		Upper slope		Lower slope	
Class	Species	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Actinopterygii	*Merluccius merluccius*	4.27	1.10	39.98	4.96	51.22	4.06	21.67	1.96	8.00	1.32
	Phycis blennoides	0.00	0.00	0.07	0.04	5.87	1.00	86.05	14.95	31.13	3.60
	Trachurus trachurus	7.93	4.67	10.22	2.31	79.30	13.90	2.10	1.06	0.04	0.03
	Mullus barbatus	22.70	4.40	10.03	1.56	39.71	4.28	0.35	0.13	0.00	0.00
	Lophius budegassa	0.09	0.06	14.74	3.70	40.56	3.95	8.23	1.55	1.83	0.70
	Pagellus erythrinus	38.81	10.31	7.11	1.88	4.74	1.04	0.03	0.03	0.05	0.03
	Trachurus mediterraneus	30.82	7.81	7.35	3.49	5.87	3.16	0.00	0.00	0.01	0.01
	Micromesistius poutassou	0.00	0.00	0.00	0.00	1.52	0.93	33.27	5.79	5.07	1.24
	Sphyraena sphyraena	34.10	12.09	1.39	1.02	0.03	0.03	0.00	0.00	0.00	0.00
	Trisopterus capelanus	1.37	0.74	12.16	2.47	18.11	1.88	0.05	0.02	0.02	0.01
	Lophius piscatorius	0.02	0.02	1.63	1.17	2.85	1.13	6.28	1.88	8.24	3.86
	Scomber scombrus	3.29	1.40	12.09	2.92	2.80	1.02	0.02	0.01	0.00	0.00
	Citharus linguatula	1.32	0.26	12.28	1.81	3.69	0.43	0.02	0.01	0.00	0.00
	Sparus aurata	16.13	8.43	0.44	0.22	0.00	0.00	0.00	0.00	0.00	0.00
	Boops boops	6.34	2.70	7.64	2.86	1.90	0.75	0.00	0.00	0.00	0.00
	Helicolenus dactylopterus	0.00	0.00	0.00	0.00	3.28	0.90	10.48	1.61	2.00	0.54
	Mullus surmuletus	2.00	0.55	3.67	1.26	6.90	1.70	0.99	0.46	0.16	0.15
	Lepidorhombus boscii	0.00	0.00	0.00	0.00	3.60	0.59	7.28	0.76	0.81	0.18
	Lithognathus mormyrus	10.37	5.42	0.23	0.23	0.00	0.00	0.00	0.00	0.00	0.00
	Diplodus annularis	8.80	2.05	0.61	0.22	0.01	0.00	0.00	0.00	0.00	0.00
	Pagellus acarne	6.55	3.15	2.16	1.35	0.24	0.11	0.00	0.00	0.00	0.00
	Chelon auratus	8.18	5.74	0.12	0.12	0.12	0.12	0.00	0.00	0.00	0.00
	Mugil cephalus	7.08	4.11	0.77	0.77	0.00	0.00	0.00	0.00	0.00	0.00
	Chelidonichthys lucerna	3.26	1.14	3.53	0.93	1.06	0.18	0.00	0.00	0.00	0.00
	Scomber colias	2.29	0.97	4.57	2.47	0.75	0.44	0.01	0.01	0.00	0.00
	Conger conger	1.16	0.33	0.50	0.19	0.66	0.20	2.03	0.35	2.00	0.38
	Sardina pilchardus	0.01	0.01	5.26	2.58	0.51	0.30	0.00	0.00	0.00	0.00
	Trachinus draco	0.46	0.17	2.11	0.45	3.19	0.50	0.01	0.01	0.00	0.00
Elasmobranchii	*Scyliorhinus canicula*	0.00	0.00	0.00	0.00	6.91	3.53	11.64	3.30	1.45	0.63
	Galeus melastomus	0.00	0.00	0.00	0.00	0.00	0.00	0.83	0.40	10.51	2.61
Malacostraca	*Aristeus antennatus*	0.00	0.00	0.00	0.00	0.00	0.00	0.57	0.43	71.88	5.13
	Parapenaeus longirostris	0.02	0.02	14.25	2.15	18.99	3.48	35.13	4.74	1.60	0.63
	Squilla mantis	26.73	3.56	24.67	3.32	2.16	0.54	0.00	0.00	0.00	0.00
	Nephrops norvegicus	0.00	0.00	0.52	0.18	0.36	0.11	45.83	3.96	2.50	0.58
	Liocarcinus depurator	0.27	0.12	15.94	4.90	4.04	1.12	0.19	0.12	0.00	0.00
	Penaeus kerathurus	13.17	2.93	0.05	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Cephalopoda	*Illex coindetii*	2.14	1.59	26.71	7.34	31.15	3.51	4.29	0.85	0.59	0.20
	Eledone cirrhosa	0.84	0.56	14.68	2.67	20.02	1.77	15.32	2.12	1.65	0.36
	Octopus vulgaris	5.41	2.45	4.46	1.77	3.89	0.79	0.09	0.07	0.09	0.09
	Sepia officinalis	12.90	2.42	0.01	0.01	0.49	0.23	0.00	0.00	0.00	0.00
	Alloteuthis spp.	3.63	0.83	4.43	0.74	1.43	0.35	0.00	0.00	0.02	0.02
	Todarodes sagittatus	0.00	0.00	0.00	0.00	0.05	0.03	3.36	0.50	2.35	0.39
Gastropoda	*Bolinus brandaris*	6.71	1.54	1.60	0.28	0.16	0.11	0.00	0.00	0.00	0.00

Annex 2. Landed species with higher biomass for year analyzed. SE: standard error.

2023 Landed Biomass (kg/km^2)		Coastal Delta shelf		Middle Delta shelf		Coastal shelf		Deeper shelf		Upper slope		Lower
Class	Species	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean
Actinopterygii	*Trachurus trachurus*	0.00	0.00	20.08	14.31	22.63	14.30	209.59	97.55	2.61	2.20	0.12
	Merluccius merluccius	5.40	4.42	50.90	22.05	28.08	8.34	43.86	4.89	36.99	6.48	16.58
	Mullus barbatus	49.35	21.45	4.69	1.50	62.35	22.54	43.54	7.46	0.40	0.26	0.00
	Pagellus erythrinus	70.72	34.68	13.59	5.76	69.30	30.74	3.57	1.52	0.00	0.00	0.00
	Phycis blennoides	0.00	0.00	0.00	0.00	0.00	0.00	7.42	1.82	73.88	13.82	25.99
	Sphyraena sphyraena	97.64	83.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Trachurus mediterraneus	87.90	44.26	5.40	2.85	2.28	1.92	0.08	0.05	0.00	0.00	0.00
	Lophius budegassa	0.70	0.70	28.72	14.04	21.89	4.75	26.02	5.56	10.11	2.62	0.81
	Mullus surmuletus	3.07	1.42	1.43	0.32	52.50	22.13	2.37	0.72	1.26	0.53	0.41
	Scomber scombrus	8.45	6.98	38.03	17.32	2.06	1.48	5.61	2.62	0.00	0.00	0.00
	Trisopterus capelanus	1.42	0.62	6.59	1.95	6.77	3.79	20.63	3.36	0.02	0.02	0.00
	Micromesistius poutassou	0.00	0.00	0.00	0.00	0.00	0.00	3.29	3.09	27.28	6.47	3.07
	Pagellus acarne	17.72	7.84	3.28	1.84	7.15	4.57	0.12	0.09	0.08	0.08	0.00
	Boops boops	7.69	4.77	13.88	11.35	0.00	0.00	1.02	0.48	0.00	0.00	0.00
	Helicolenus dactylopterus	0.00	0.00	0.00	0.00	0.04	0.04	4.09	1.63	14.60	5.47	1.90
	Spicara spp.	7.85	6.75	4.70	1.76	0.00	0.00	7.71	5.66	0.00	0.00	0.00
	Diplodus vulgaris	9.08	7.03	0.06	0.06	10.76	5.61	0.00	0.00	0.00	0.00	0.00
	Lophius piscatorius	0.48	0.48	2.01	1.07	2.38	1.84	1.60	0.70	8.64	3.95	3.62
	Zeus faber	0.12	0.12	0.17	0.17	14.92	12.15	2.08	0.95	0.00	0.00	0.00
	Lithognathus mormyrus	15.83	14.83	0.44	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Chelidonichthys lucerna	7.05	3.93	4.53	3.83	1.18	0.70	1.76	0.46	0.00	0.00	0.00
	Lepidorhombus boscii	0.00	0.00	0.00	0.00	0.06	0.06	4.18	0.87	8.94	2.60	0.58
	Citharus linguatula	0.81	0.40	6.37	1.57	1.60	0.93	2.36	0.72	0.07	0.05	0.00
	Gobius niger	4.26	2.75	4.73	1.80	0.26	0.26	0.47	0.21	0.00	0.00	0.00
	Mugil cephalus	4.36	4.36	4.60	4.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Conger conger	4.25	2.71	0.00	0.00	0.26	0.26	0.56	0.25	1.89	0.45	1.42
	Serranus cabrilla	0.02	0.02	0.04	0.03	7.60	4.25	0.19	0.12	0.00	0.00	0.00
	Trigla lyra	0.00	0.00	0.00	0.00	0.71	0.60	2.64	0.85	4.36	2.02	0.05
	Diplodus annularis	5.89	4.06	1.00	0.59	0.07	0.07	0.07	0.05	0.00	0.00	0.00
	Trachinus draco	0.45	0.28	1.04	0.56	3.58	1.21	1.86	0.61	0.00	0.00	0.00
Elasmobranchii	*Galeus melastomus*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.30	11.06
Malacostraca	*Aristeus antennatus*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	74.13
	Parapenaeus longirostris	0.73	0.73	12.31	3.44	0.00	0.00	19.56	6.06	25.62	11.83	0.34
	Nephrops norvegicus	0.00	0.00	0.22	0.22	0.00	0.00	0.14	0.07	51.71	8.54	4.83
	Squilla mantis	23.30	8.57	18.85	7.96	0.02	0.02	0.50	0.31	0.00	0.00	0.00
	Liocarcinus depurator	0.10	0.07	7.73	3.10	0.00	0.00	5.09	3.01	0.07	0.06	0.00
	Penaeus kerathurus	7.90	3.13	0.00	0.00	0.06	0.06	0.00	0.00	0.00	0.00	0.00
Cephalopoda	*Illex coindetii*	0.66	0.33	38.71	15.38	13.57	9.96	67.69	28.23	3.46	1.25	0.13
	Eledone cirrhosa	1.03	0.75	9.93	3.67	8.64	3.23	15.88	3.27	15.56	4.21	2.34
	Octopus vulgaris	10.76	6.71	3.45	2.95	14.77	8.42	0.72	0.53	0.13	0.13	0.00
	Sepia officinalis	20.71	10.04	0.35	0.35	1.73	1.73	0.00	0.00	0.00	0.00	0.00
	Loligo vulgaris	0.78	0.45	0.39	0.17	8.41	8.22	0.36	0.21	0.00	0.00	0.00
	Alloteuthis spp.	2.19	1.11	4.69	1.41	0.20	0.20	0.67	0.31	0.00	0.00	0.00

Annex 3. Landed species with higher abundance for previous period. SE: standard error.

2019-2022 Landed Abundance (N. Ind./km^2)		Coastal Delta shelf		Middle Delta shelf		Deeper shelf		Upper slope		Lower slope	
Class	Species	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Actinopterygii	*Merluccius merluccius*	4.27	1.10	39.98	4.96	51.22	4.06	99.32	11.56	20.80	3.43
	Phycis blennoides	0.00	0.00	0.07	0.04	5.87	1.00	906.58	100.68	246.76	29.54
	Trachurus trachurus	7.93	4.67	10.22	2.31	79.30	13.90	12.21	4.46	0.27	0.19
	Mullus barbatus	22.70	4.40	10.03	1.56	39.71	4.28	5.50	1.97	0.00	0.00
	Lophius budegassa	0.09	0.06	14.74	3.70	40.56	3.95	15.11	2.62	1.68	0.43
	Pagellus erythrinus	38.81	10.31	7.11	1.88	4.74	1.04	0.33	0.28	0.26	0.17
	Trachurus mediterraneus	30.82	7.81	7.35	3.49	5.87	3.16	0.00	0.00	0.05	0.05
	Micromesistius poutassou	0.00	0.00	0.00	0.00	1.52	0.93	337.33	56.66	49.63	14.70
	Sphyraena sphyraena	34.10	12.09	1.39	1.02	0.03	0.03	0.00	0.00	0.00	0.00
	Trisopterus capelanus	1.37	0.74	12.16	2.47	18.11	1.88	0.79	0.32	0.47	0.32
	Lophius piscatorius	0.02	0.02	1.63	1.17	2.85	1.13	1.67	0.62	1.24	0.42
	Scomber scombrus	3.29	1.40	12.09	2.92	2.80	1.02	0.10	0.07	0.00	0.00
	Citharus linguatula	1.32	0.26	12.28	1.81	3.69	0.43	0.42	0.19	0.09	0.06
	Sparus aurata	16.13	8.43	0.44	0.22	0.00	0.00	0.00	0.00	0.00	0.00
	Boops boops	6.34	2.70	7.64	2.86	1.90	0.75	0.00	0.00	0.00	0.00
	Helicolenus dactylopterus	0.00	0.00	0.00	0.00	3.28	0.90	139.36	21.42	20.29	6.05
	Mullus surmuletus	2.00	0.55	3.67	1.26	6.90	1.70	5.02	2.24	0.86	0.78
	Lepidorhombus boscii	0.00	0.00	0.00	0.00	3.60	0.59	179.77	25.86	14.17	3.13
	Lithognathus mormyrus	10.37	5.42	0.23	0.23	0.00	0.00	0.00	0.00	0.00	0.00
	Diplodus annularis	8.80	2.05	0.61	0.22	0.01	0.00	0.00	0.00	0.00	0.00
	Pagellus acarne	6.55	3.15	2.16	1.35	0.24	0.11	0.00	0.00	0.00	0.00
	Chelon auratus	8.18	5.74	0.12	0.12	0.12	0.12	0.00	0.00	0.00	0.00
	Mugil cephalus	7.08	4.11	0.77	0.77	0.00	0.00	0.00	0.00	0.00	0.00
	Chelidonichthys lucerna	3.26	1.14	3.53	0.93	1.06	0.18	0.00	0.00	0.00	0.00
	Scomber colias	2.29	0.97	4.57	2.47	0.75	0.44	0.10	0.10	0.00	0.00
	Conger conger	1.16	0.33	0.50	0.19	0.66	0.20	5.65	0.79	5.91	1.20
	Sardina pilchardus	0.01	0.01	5.26	2.58	0.51	0.30	0.00	0.00	0.00	0.00
	Trachinus draco	0.46	0.17	2.11	0.45	3.19	0.50	0.09	0.07	0.00	0.00
Elasmobranchii	*Scyliorhinus canicula*	0.00	0.00	0.00	0.00	6.91	3.53	63.80	18.53	7.17	3.18
	Galeus melastomus	0.00	0.00	0.00	0.00	0.00	0.00	3.17	1.65	29.23	7.23
Malacostraca	*Aristeus antennatus*	0.00	0.00	0.00	0.00	0.00	0.00	40.18	34.29	3983.95	259.41
	Parapenaeus longirostris	0.02	0.02	14.25	2.15	18.99	3.48	2834.15	398.66	104.07	35.05
	Squilla mantis	26.73	3.56	24.67	3.32	2.16	0.54	0.00	0.00	0.00	0.00
	Nephrops norvegicus	0.00	0.00	0.52	0.18	0.36	0.11	2036.42	181.63	94.10	24.22
	Liocarcinus depurator	0.27	0.12	15.94	4.90	4.04	1.12	20.26	13.99	0.13	0.10
	Penaeus kerathurus	13.17	2.93	0.05	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Cephalopoda	*Illex coindetii*	2.14	1.59	26.71	7.34	31.15	3.51	68.07	14.70	7.45	2.13
	Eledone cirrhosa	0.84	0.56	14.68	2.67	20.02	1.77	54.84	7.06	5.43	1.26
	Octopus vulgaris	5.41	2.45	4.46	1.77	3.89	0.79	0.14	0.10	0.02	0.02
	Sepia officinalis	12.90	2.42	0.01	0.01	0.49	0.23	0.00	0.00	0.00	0.00
	Alloteuthis spp.	3.63	0.83	4.43	0.74	1.43	0.35	0.04	0.04	0.05	0.05
	Todarodes sagittatus	0.00	0.00	0.00	0.00	0.05	0.03	7.81	1.09	6.96	1.18
Gastropoda	*Bolinus brandaris*	6.71	1.54	1.60	0.28	0.16	0.11	0.00	0.00	0.00	0.00

Annex 4. Landed species with higher abundance for year analyzed. SE: standard error.

2023 Landed Abundance (N. Ind./km^2)		Coastal Delta shelf		Middle Delta shelf		Coastal shelf		Deeper shelf		Upper slope		Lower slope	
Class	Species	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Actinopterygii	***Trachurus trachurus***	0.00	0.00	409.53	298.13	368.82	215.93	3800.23	1587.62	24.93	23.22	0.73	0.73
	Mullus barbatus	1519.75	763.69	96.64	32.16	1308.91	460.91	803.66	141.58	4.82	3.34	0.00	0.00
	Pagellus erythrinus	830.05	403.50	144.68	55.63	690.06	223.65	37.10	15.43	0.00	0.00	0.00	0.00
	Trachurus mediterraneus	1141.88	486.62	87.18	46.76	25.39	21.50	1.13	0.78	0.00	0.00	0.00	0.00
	Merluccius merluccius	25.38	20.99	414.51	182.82	222.81	76.16	381.78	51.31	170.29	38.14	39.62	10.90
	Phycis blennoides	0.00	0.00	0.00	0.00	0.00	0.00	110.42	29.60	799.88	116.60	155.09	18.22
	Trisopterus capelanus	39.30	17.00	202.12	56.09	189.60	101.84	625.29	96.69	0.29	0.20	0.00	0.00
	Mullus surmuletus	60.16	27.95	14.64	3.04	638.44	316.35	22.44	7.37	5.09	2.15	1.98	1.84
	Scomber scombrus	161.06	142.00	385.79	189.66	31.96	26.14	50.64	21.15	0.00	0.00	0.00	0.00
	Helicolenus dactylopterus	0.00	0.00	0.00	0.00	1.57	1.57	195.45	91.52	265.92	99.79	20.58	10.64
	Boops boops	171.57	102.51	274.05	226.07	0.00	0.00	17.33	7.99	0.00	0.00	0.00	0.00
	Spicara spp.	171.86	140.09	106.60	46.41	0.00	0.00	144.21	104.26	0.00	0.00	0.00	0.00
	Micromesistius poutassou	0.00	0.00	0.00	0.00	0.00	0.00	116.14	112.24	282.84	68.39	21.51	6.45
	Pagellus acarne	256.55	118.39	51.92	31.10	73.35	52.68	0.65	0.49	1.15	1.15	0.00	0.00
	Citharus linguatula	27.47	13.22	209.93	46.76	51.63	27.62	71.39	24.52	1.39	1.15	0.00	0.00
	Lepidorhombus boscii	0.00	0.00	0.00	0.00	1.71	1.71	93.89	22.38	256.88	89.51	7.22	3.78
	Lepidotrigla cavillone	0.00	0.00	68.13	31.06	172.40	80.84	52.01	21.36	0.00	0.00	0.00	0.00
	Diplodus vulgaris	192.88	163.50	0.85	0.85	97.24	52.20	0.00	0.00	0.00	0.00	0.00	0.00
	Trigla lyra	0.00	0.00	0.00	0.00	6.42	4.73	127.77	46.56	117.46	38.72	0.47	0.47
	Chelidonichthys lucerna	153.49	87.81	68.16	54.30	6.71	4.10	11.48	3.48	0.00	0.00	0.00	0.00
	Chelidonichthys cuculus	0.00	0.00	0.00	0.00	214.54	117.46	24.62	9.78	0.17	0.17	0.00	0.00
	Eutrigla gurnardus	3.37	2.59	100.73	63.55	2.40	1.65	101.69	40.96	0.11	0.11	0.00	0.00
	Lithognathus mormyrus	197.95	177.93	4.45	2.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Lophius budegassa	2.30	2.30	58.62	25.16	38.26	8.42	80.93	20.19	19.71	5.57	1.21	0.62
	Arnoglossus laterna	8.98	5.35	96.63	39.21	16.46	10.41	56.82	23.49	0.00	0.00	0.00	0.00
	Lepidotrigla dieuzeidei	4.03	4.03	73.00	47.43	0.00	0.00	67.70	27.40	0.00	0.00	0.00	0.00
	Sphyraena sphyraena	138.20	118.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Serranus cabrilla	0.79	0.79	2.38	1.60	126.37	61.60	4.25	2.53	0.00	0.00	0.00	0.00
Malacostraca	***Parapenaeus longirostris***	89.96	89.96	1593.87	425.57	0.00	0.00	1886.40	560.81	2111.45	1115.27	27.19	27.19
	Aristeus antennatus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3995.08	706.89
	Nephrops norvegicus	0.00	0.00	1.49	1.49	0.00	0.00	3.25	1.58	2189.71	357.45	147.75	51.02
	Plesionika heterocarpus	0.00	0.00	0.00	0.00	0.00	0.00	1417.12	941.18	15.16	10.62	0.73	0.73
	Squilla mantis	721.03	297.34	571.76	235.40	0.85	0.85	14.17	8.52	0.00	0.00	0.00	0.00
	Liocarcinus depurator	8.53	5.76	623.01	272.79	0.00	0.00	341.46	194.93	8.01	7.16	0.21	0.21
	Plesionika martia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	131.53	113.47	717.54	153.84
	Pasiphaea multidentata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.06	9.06	594.36	176.24
	Penaeus kerathurus	348.97	167.63	0.00	0.00	1.26	1.26	0.00	0.00	0.00	0.00	0.00	0.00
Cephalopoda	***Illex coindetii***	6.27	2.42	776.76	229.38	204.48	158.16	2008.21	796.23	69.20	20.38	1.33	0.55
	Eledone cirrhosa	3.09	2.36	35.38	19.47	44.35	14.94	83.26	19.59	58.29	17.49	8.33	5.85
	Alloteuthis spp.	57.41	24.51	140.97	40.04	5.12	5.12	24.03	12.05	0.00	0.00	0.00	0.00
	Sepia officinalis	191.27	126.57	1.75	1.75	8.30	8.30	0.00	0.00	0.00	0.00	0.00	0.00
	Loligo vulgaris	6.11	3.37	4.45	1.65	117.32	112.52	4.16	2.64	0.00	0.00	0.00	0.00
	Bolinus brandaris	138.92	63.71	20.00	8.57	0.00	0.00	3.43	1.79	0.00	0.00	0.00	0.00

Annex 5. Discarded species with higher biomass for previous period. SE: standard error.

2019-2022 Discards Biomass (kg/km^2)		Coastal Delta shelf		Middle Delta shelf		Deeper shelf		Upper slope		Lower slope	
Class	Species	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Actinopterygii	*Engraulis encrasicolus*	5.63	2.30	81.01	37.38	7.61	2.20	0.01	0.01	0.00	0.00
	Boops boops	8.66	3.57	22.20	9.43	29.66	6.06	0.08	0.04	0.04	0.03
	Sardina pilchardus	6.69	2.14	45.79	28.43	1.50	0.42	0.00	0.00	0.01	0.01
	Sardinella aurita	40.24	15.24	10.51	5.60	0.20	0.15	0.00	0.00	0.00	0.00
	Merluccius merluccius	0.67	0.30	10.18	3.16	20.14	5.17	0.34	0.15	0.11	0.04
	Trachurus trachurus	0.66	0.50	9.13	4.13	12.36	4.97	1.13	0.36	0.11	0.05
	Spicara flexuosa	0.78	0.33	6.64	2.72	12.42	2.13	0.14	0.06	0.01	0.00
	Trachurus mediterraneus	5.57	1.57	7.21	4.17	1.82	0.86	0.00	0.00	0.00	0.00
	Pagellus acarne	9.43	5.34	2.18	1.10	0.09	0.03	0.00	0.00	0.00	0.00
	Lophius budegassa	0.13	0.08	3.14	1.80	6.94	1.20	0.58	0.11	0.08	0.05
	Spicara maena	0.30	0.17	3.82	1.36	2.71	1.12	0.09	0.04	0.00	0.00
	Capros aper	0.00	0.00	0.05	0.03	6.13	2.26	0.68	0.22	0.02	0.01
	Arnoglossus laterna	1.69	0.51	2.96	0.61	1.19	0.22	0.02	0.01	0.00	0.00
	Pagellus bogaraveo	0.00	0.00	0.16	0.11	3.17	1.12	1.25	0.38	0.93	0.50
	Coelorinchus caelorhincus	0.00	0.00	0.00	0.00	0.03	0.02	3.59	0.79	1.77	0.56
	Diplodus annularis	5.18	2.01	0.07	0.05	0.01	0.01	0.00	0.00	0.00	0.00
	Trisopterus capelanus	0.15	0.06	2.01	0.76	2.51	0.60	0.02	0.01	0.00	0.00
	Macroramphosus scolopax	0.00	0.00	0.00	0.00	4.46	3.30	0.01	0.00	0.00	0.00
	Pagellus erythrinus	3.43	0.81	0.29	0.17	0.59	0.21	0.03	0.01	0.00	0.00
	Lampanyctus crocodilus	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.18	3.12	0.63
	Phycis blennoides	0.00	0.00	0.00	0.00	0.96	0.48	1.71	0.27	0.53	0.08
	Conger conger	0.00	0.00	0.00	0.00	0.20	0.09	1.71	0.46	0.95	0.22
	Mola mola	0.00	0.00	0.00	0.00	1.49	1.21	0.08	0.08	1.08	1.08
	Citharus linguatula	0.39	0.14	1.45	0.38	0.57	0.11	0.01	0.01	0.00	0.00
	Gadiculus argenteus	0.00	0.00	0.00	0.00	0.10	0.04	2.05	0.44	0.07	0.02
Elasmobranchii	*Scyliorhinus canicula*	0.00	0.00	0.07	0.07	43.54	7.43	55.58	8.46	14.03	3.58
	Galeus melastomus	0.00	0.00	0.00	0.00	0.04	0.02	3.42	0.60	15.43	2.83
	Tetronarce nobiliana	0.00	0.00	0.00	0.00	0.00	0.00	2.28	2.28	0.00	0.00
Malacostraca	*Liocarcinus depurator*	0.83	0.27	6.24	2.19	2.26	0.86	0.03	0.01	0.01	0.00
	Squilla mantis	3.14	0.72	4.05	1.11	0.55	0.21	0.00	0.00	0.00	0.00
	Plesionika heterocarpus	0.00	0.00	0.00	0.00	4.53	3.97	0.30	0.07	0.01	0.00
	Parapenaeus longirostris	0.01	0.00	1.17	0.32	1.04	0.20	0.44	0.06	0.08	0.04
	Dardanus arrosor	0.47	0.12	0.39	0.13	1.02	0.22	0.51	0.10	0.28	0.12
Cephalopoda	*Octopus vulgaris*	4.25	1.28	0.80	0.48	1.38	0.34	0.10	0.05	0.00	0.00
	Illex coindetii	0.29	0.12	0.54	0.19	2.12	0.40	0.58	0.11	0.45	0.10
	Octopus salutii	0.00	0.00	0.08	0.08	0.27	0.13	2.31	0.72	0.28	0.15
Gastropoda	*Aporrhais serresiana*	2.29	0.92	0.65	0.26	0.03	0.01	0.00	0.00	0.00	0.00
Crinoidea	*Leptometra phalangium*	0.00	0.00	0.00	0.00	27.41	16.07	0.01	0.01	0.00	0.00
Asteroidea	*Astropecten irregularis*	4.92	1.35	4.56	1.03	4.04	0.92	0.11	0.02	0.03	0.01
Echinoidea	*Echinus melo*	0.00	0.00	0.00	0.00	7.35	2.66	0.00	0.00	0.37	0.34
	Gracilechinus acutus	0.00	0.00	0.00	0.00	2.84	1.63	0.00	0.00	0.02	0.02
Anthozoa	*Alcyonium palmatum*	0.35	0.10	0.47	0.11	10.54	2.82	0.64	0.28	0.29	0.14
Ascidiacea	*Diazona violacea*	0.00	0.00	0.01	0.01	2.27	0.60	0.04	0.02	0.01	0.01

Annex 6. Discarded species with higher biomass for year analyzed. SE: standard error.

2023 Discards Biomass (kg/km^2)		Coastal Delta shelf		Middle Delta shelf		Coastal shelf		Deeper shelf		Upper slope		Lower slope	
Class	Species	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Actinopterygii	*Boops boops*	20.73	11.39	1.89	0.71	96.93	75.70	9.96	6.56	0.05	0.04	0.00	0.00
	Pagellus erythrinus	42.11	22.40	2.32	1.26	19.82	5.77	0.73	0.33	0.04	0.03	0.00	0.00
	Trachurus picturatus	0.00	0.00	0.00	0.00	47.49	47.49	1.38	0.85	0.09	0.09	0.00	0.00
	Trachurus trachurus	0.10	0.10	0.49	0.16	4.77	3.16	32.29	27.44	1.13	0.78	0.00	0.00
	Spicara spp.	14.25	14.16	2.53	1.89	13.43	5.58	6.11	2.44	0.10	0.09	0.06	0.06
	Lophius budegassa	0.37	0.25	4.56	1.58	10.44	5.62	13.91	4.15	0.94	0.31	0.02	0.01
	Lithognathus mormyrus	24.88	24.80	0.10	0.10	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00
	Trachurus mediterraneus	15.51	12.07	1.73	1.30	2.33	2.09	0.08	0.05	0.00	0.00	0.00	0.00
	Sardina pilchardus	7.86	5.79	9.08	4.30	0.99	0.80	1.70	1.01	0.00	0.00	0.00	0.00
	Merluccius merluccius	0.40	0.20	4.76	2.41	2.09	1.20	9.65	2.23	0.12	0.11	0.00	0.00
	Scomber colias	0.00	0.00	0.00	0.00	15.85	15.85	0.47	0.42	0.00	0.00	0.00	0.00
	Sardinella aurita	11.90	11.25	0.36	0.35	0.22	0.18	0.01	0.01	0.00	0.00	0.00	0.00
	Spicara maena	10.36	10.34	0.00	0.00	0.00	0.00	0.08	0.08	0.00	0.00	0.00	0.00
	Sparus aurata	9.88	5.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Engraulis encrasicolus	2.87	2.21	3.23	1.24	0.00	0.00	2.47	1.25	0.00	0.00	0.00	0.00
	Diplodus annularis	7.28	5.24	0.08	0.08	0.69	0.45	0.01	0.01	0.00	0.00	0.00	0.00
	Alosa fallax	4.68	4.68	2.13	2.13	0.00	0.00	0.99	0.99	0.00	0.00	0.00	0.00
	Lophius piscatorius	0.00	0.00	0.37	0.29	4.50	2.58	2.88	2.39	0.03	0.02	0.00	0.00
	Pagellus acarne	3.38	3.38	2.37	1.43	1.67	0.80	0.01	0.01	0.01	0.01	0.00	0.00
	Spicara smaris	0.00	0.00	0.00	0.00	6.13	5.40	0.00	0.00	0.00	0.00	0.00	0.00
	Spicara flexuosa	0.02	0.02	0.39	0.27	3.56	2.38	1.93	0.96	0.00	0.00	0.00	0.00
	Lampanyctus crocodilus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.16	4.85	1.98
	Capros aper	0.00	0.00	0.00	0.00	0.00	0.00	4.74	1.86	0.18	0.08	0.19	0.19
Elasmobranchii	*Scyliorhinus canicula*	0.00	0.00	0.00	0.00	0.81	0.81	40.22	16.69	58.91	16.58	11.00	3.74
	Galeus melastomus	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.07	3.73	1.25	17.46	6.04
	Pteroplatytrygon violacea	4.32	4.32	0.00	0.00	0.00	0.00	0.77	0.77	0.00	0.00	0.00	0.00
Malacostraca	*Liocarcinus depurator*	1.03	0.92	5.93	3.48	0.03	0.03	6.41	4.78	0.01	0.01	0.04	0.03
	Plesionika heterocarpus	0.00	0.00	0.00	0.00	0.00	0.00	5.03	3.80	1.92	1.38	0.03	0.03
	Squilla mantis	2.41	0.71	2.73	0.78	0.00	0.00	0.09	0.06	0.00	0.00	0.00	0.00
	Medorippe lanata	3.26	2.09	0.71	0.39	0.03	0.03	0.21	0.13	0.00	0.00	0.00	0.00
Cephalopoda	*Octopus vulgaris*	5.63	5.34	0.14	0.14	14.23	4.52	1.57	0.54	0.17	0.17	0.00	0.00
	Illex coindetii	2.18	1.51	0.72	0.37	0.67	0.37	2.16	0.54	0.58	0.18	0.20	0.09
Gastropoda	*Aporrhais serresiana*	5.71	5.34	1.29	0.95	0.00	0.00	0.05	0.05	0.01	0.01	0.00	0.00
Crinoidea	*Leptometra phalangium*	0.00	0.00	0.00	0.00	0.00	0.00	4.55	3.16	0.00	0.00	0.00	0.00
Asteroidea	*Astropecten irregularis*	4.36	2.07	3.54	1.41	0.14	0.13	3.20	1.28	0.12	0.04	0.03	0.01
Holothuroidea	*Holothuria forskali*	0.00	0.00	0.02	0.02	8.65	5.71	0.06	0.04	0.14	0.14	0.00	0.00
Echinoidea	*Sphaerechinus granularis*	0.00	0.00	0.00	0.00	8.70	8.70	0.00	0.00	0.00	0.00	0.00	0.00
	Echinus melo	0.00	0.00	0.00	0.00	3.53	1.88	4.02	2.17	0.00	0.00	0.02	0.02
	Gracilechinus acutus	0.00	0.00	0.00	0.00	3.96	3.96	1.93	1.89	0.00	0.00	0.00	0.00
Anthozoa	*Anthozoa 1*	0.30	0.23	14.70	10.68	0.00	0.00	0.08	0.06	0.00	0.00	0.00	0.00
	Alcyonium palmatum	0.16	0.06	0.19	0.06	0.70	0.37	12.79	5.97	0.22	0.09	0.34	0.25
	Calliactis parasitica	0.00	0.00	0.02	0.02	3.56	1.11	0.43	0.18	0.05	0.02	0.01	0.01
Scyphozoa	*Pelagia noctiluca*	2.72	2.72	1.69	1.62	0.09	0.09	0.03	0.03	0.00	0.00	0.08	0.05

Annex 7. Discarded species with higher abundance for previous period. SE: standard error.

2019-2022 Discards Abundance (N.Ind./km^2)		Coastal Delta shelf		Middle Delta shelf		Deeper shelf		Upper slope		Lower slope	
Class	Species	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Actinopterygii	*Engraulis encrasicolus*	1465.23	645.13	16479.37	8900.05	1083.17	417.53	0.40	0.35	0.13	0.11
	Sardina pilchardus	803.89	263.24	5649.80	4153.37	130.78	45.91	0.05	0.05	0.31	0.31
	Trachurus trachurus	68.95	60.84	1146.13	583.56	885.68	471.43	31.21	9.70	1.87	0.87
	Sardinella aurita	1045.95	403.36	864.13	729.13	4.04	3.09	0.00	0.00	0.00	0.00
	Capros aper	1.04	1.04	25.09	20.58	1405.35	808.69	50.09	15.73	2.04	1.08
	Merluccius merluccius	32.95	12.94	424.14	123.63	949.47	278.01	10.25	3.84	1.24	0.48
	Boops boops	215.38	76.08	563.99	184.12	494.36	97.14	0.81	0.37	0.45	0.34
	Trachurus mediterraneus	444.82	112.41	676.82	425.34	90.32	47.82	0.06	0.06	0.00	0.00
	Arnoglossus laterna	190.29	50.55	381.87	74.14	189.00	34.37	2.11	0.82	0.67	0.33
	Macroramphosus scolopax	0.00	0.00	0.00	0.00	718.40	562.46	1.39	0.48	0.41	0.26
	Spicara flexuosa	27.23	10.15	191.81	76.25	337.90	59.60	3.43	1.30	0.15	0.11
	Pagellus acarne	359.23	213.01	65.60	35.04	2.25	0.83	0.00	0.00	0.00	0.00
	Trisopterus capelanus	6.64	2.63	166.61	63.40	180.71	47.50	1.00	0.48	0.00	0.00
	Sprattus sprattus	65.32	36.73	265.48	219.72	0.69	0.69	0.00	0.00	0.00	0.00
	Coelorinchus caelorhincus	0.00	0.00	0.00	0.00	1.37	0.79	230.32	42.91	56.23	19.13
	Lampanyctus crocodilus	0.00	0.00	0.00	0.00	0.12	0.12	29.22	13.86	226.78	41.07
	Spicara maena	25.16	19.83	139.09	51.93	69.96	23.47	2.15	0.96	0.13	0.13
	Citharus linguatula	37.37	16.95	142.72	38.27	42.89	7.64	1.19	0.60	0.04	0.04
	Phycis blennoides	0.00	0.00	0.00	0.00	60.89	36.46	110.38	16.97	30.27	4.91
	Mullus barbatus	177.83	66.01	2.49	2.10	16.28	6.14	0.06	0.06	0.00	0.00
	Lophius budegassa	5.34	3.11	50.23	25.23	120.41	24.10	16.02	3.05	1.51	0.46
	Gadiculus argenteus	0.00	0.00	0.00	0.00	24.19	11.84	160.60	34.88	5.38	1.42
Elasmobranchii	*Scyliorhinus canicula*	0.22	0.22	0.68	0.68	343.74	65.02	347.29	51.07	78.61	26.96
	Galeus melastomus	0.00	0.00	0.00	0.00	1.78	1.07	150.00	31.25	71.96	11.21
	Raja spp. eggs	56.92	16.62	93.76	19.88	41.23	10.38	4.47	1.70	1.27	0.39
Malacostraca	*Plesionika heterocarpus*	0.00	0.00	0.00	0.00	2242.07	1962.27	70.89	16.60	1.65	0.89
	Liocarcinus depurator	106.97	31.74	1219.71	421.71	282.69	79.01	4.10	1.52	1.19	0.60
	Parapenaeus longirostris	1.00	0.83	316.30	87.32	262.49	59.44	58.88	8.33	8.24	3.85
	Squilla mantis	279.80	64.04	305.38	67.12	44.64	17.04	0.12	0.08	0.00	0.00
	Pasiphaea sivado	0.00	0.00	0.00	0.00	2.25	2.21	507.65	209.90	8.64	2.90
	Goneplax rhomboides	157.67	46.87	143.16	35.51	17.53	3.69	6.73	1.03	0.88	0.22
	Macropodia tenuirostris	14.28	5.90	117.69	35.76	142.21	38.93	11.02	4.94	1.77	0.89
	Medorippe lanata	155.48	32.13	52.04	17.67	12.56	2.89	3.59	0.96	0.55	0.40
	Dardanus arrosor	41.95	8.10	34.14	9.49	79.02	15.87	42.03	9.63	19.91	8.13
Cephalopoda	*Illex coindetii*	16.34	6.40	58.15	23.05	150.56	21.05	28.67	4.61	11.82	2.67
Gastropoda	*Aporrhais serresiana*	343.70	135.80	89.82	35.93	3.53	1.68	0.39	0.33	0.39	0.39
	Calliostoma granulatum	53.76	13.10	71.05	13.13	94.57	23.27	0.12	0.09	0.18	0.18
Crinoidea	*Leptometra phalangium*	0.00	0.00	3.65	3.65	6698.90	3006.22	17.68	15.43	0.14	0.14
Asteroidea	*Astropecten irregularis*	2077.74	561.57	1733.69	368.32	2167.58	538.82	42.99	7.28	8.07	2.92
Anthozoa	*Alcyonium palmatum*	49.86	12.13	84.88	20.16	1226.38	284.84	96.15	39.69	39.19	17.54
	Anthozoa 1	119.89	46.78	442.17	146.87	8.17	3.45	0.21	0.17	0.04	0.04
	Pennatula phosphorea	7.26	2.68	46.46	13.45	251.92	79.10	1.48	0.49	0.33	0.16
Ascidiacea	*Ascidiella spp.*	0.27	0.27	52.50	15.54	344.30	99.82	0.27	0.14	0.04	0.04

Annex 8. Discarded species with higher abundance for year analyzed. SE: standard error.

2023 Discards Abundance (N. Ind./km^2)		Coastal Delta shelf		Middle Delta shelf		Coastal shelf		Deeper shelf		Upper slope		Lower slope	
Class	**Species**	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Actinopterygii	***Sardina pilchardus***	1296.45	889.32	1594.10	787.90	86.33	78.66	423.06	270.85	0.00	0.00	0.00	0.00
	Boops boops	757.38	387.33	36.21	11.80	2155.34	1708.00	201.50	141.76	1.40	0.98	0.00	0.00
	Pagellus erythrinus	1529.57	836.36	60.92	35.08	533.99	166.26	15.78	7.24	0.90	0.67	0.00	0.00
	Trachurus trachurus	7.48	7.48	48.67	29.36	195.30	96.96	1529.75	1340.02	52.26	41.67	0.00	0.00
	Spicara spp.	1073.71	1057.55	59.27	37.00	436.87	215.15	167.39	74.06	3.83	3.36	1.33	1.33
	Engraulis encrasicolus	651.41	513.87	506.99	185.00	0.00	0.00	343.54	194.64	0.00	0.00	0.00	0.00
	Trachurus mediterraneus	1136.93	799.70	166.61	129.20	111.93	90.68	11.63	9.52	0.28	0.28	0.00	0.00
	Trachurus picturatus	0.00	0.00	0.00	0.00	1191.45	1191.45	24.90	13.90	0.62	0.62	0.00	0.00
	Spicara maena	1161.62	1159.88	0.00	0.00	0.00	0.00	1.06	1.06	0.00	0.00	0.00	0.00
	Sardinella aurita	719.38	707.30	22.38	17.73	5.99	3.92	0.38	0.38	0.00	0.00	0.00	0.00
	Lophius budegassa	22.85	16.09	204.53	108.48	153.83	73.67	258.36	73.57	65.18	29.01	3.32	2.91
	Merluccius merluccius	36.57	18.07	194.75	71.19	56.40	28.01	404.83	100.01	3.90	3.76	0.00	0.00
	Capros aper	0.00	0.00	0.00	0.00	0.00	0.00	605.12	204.52	13.72	5.75	11.32	11.01
	Arnoglossus laterna	96.22	47.57	223.11	102.91	102.03	50.02	116.80	44.89	0.00	0.00	0.40	0.40
	Lithognathus mormyrus	470.78	469.04	8.77	8.77	0.00	0.00	0.38	0.38	0.00	0.00	0.00	0.00
	Scomber colias	0.00	0.00	0.00	0.00	379.88	379.88	11.40	10.00	0.00	0.00	0.00	0.00
	Lepidorhombus boscii	2.99	2.99	0.00	0.00	0.00	0.00	55.03	23.62	258.11	71.30	39.11	13.96
	Trisopterus capelanus	17.64	11.64	152.14	73.86	23.34	13.09	132.65	56.87	2.62	2.24	0.00	0.00
	Pagellus acarne	185.54	185.54	65.04	36.64	39.02	18.78	0.38	0.26	0.28	0.28	0.00	0.00
	Spicara smaris	0.00	0.00	0.00	0.00	283.55	245.63	0.00	0.00	0.00	0.00	0.00	0.00
	Lampanyctus crocodilus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	23.66	13.63	249.76	96.86
	Sparus aurata	273.05	161.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Elasmobranchii	***Scyliorhinus canicula***	0.00	0.00	0.00	0.00	3.42	3.42	293.79	142.86	374.00	108.02	62.99	24.65
	Raja spp. eggs	86.63	30.54	155.72	41.13	60.68	29.72	32.74	16.06	0.80	0.45	0.96	0.56
	Galeus melastomus	0.00	0.00	0.00	0.00	0.00	0.00	12.50	5.43	178.48	61.03	132.38	54.40
Malacostraca	***Plesionika heterocarpus***	0.00	0.00	0.00	0.00	0.00	0.00	2089.47	1535.89	230.17	134.11	8.08	8.08
	Liocarcinus depurator	179.75	152.76	1006.85	620.11	4.89	4.89	1057.17	701.20	1.63	0.99	8.06	5.13
	Squilla mantis	206.85	94.23	200.53	54.72	0.00	0.00	5.95	3.68	0.00	0.00	0.00	0.00
	Dardanus arrosor	45.09	29.90	26.88	11.47	232.49	71.35	44.85	15.81	12.23	3.88	5.52	2.50
	Parapenaeus longirostris	16.26	11.23	210.55	99.44	0.00	0.00	98.53	45.46	22.53	6.68	1.64	1.47
	Medorippe lanata	258.79	159.05	57.32	31.11	2.56	2.56	25.75	11.96	0.43	0.43	0.00	0.00
	Goneplax rhomboides	68.65	31.20	186.26	117.07	2.56	2.56	44.16	26.89	8.85	2.69	1.75	0.68
Cephalopoda	***Illex coindetii***	147.00	96.07	73.48	48.27	55.50	43.21	170.86	42.65	33.07	8.71	10.84	5.51
Gastropoda	***Aporrhais serresiana***	745.32	691.22	174.11	124.85	0.00	0.00	6.55	5.84	2.47	2.47	0.00	0.00
	Calliostoma granulatum	144.25	76.10	96.88	37.55	9.08	6.68	249.13	144.02	0.00	0.00	0.00	0.00
Bivalvia	***Venus nux***	53.85	46.23	187.12	88.15	0.00	0.00	121.55	70.76	0.00	0.00	0.00	0.00
Crinoidea	***Leptometra phalangium***	26.85	26.85	0.00	0.00	0.00	0.00	5306.10	4247.11	0.00	0.00	0.00	0.00
	Antedon mediterranea	0.00	0.00	0.90	0.90	12.22	12.22	1276.33	1245.34	0.30	0.30	0.00	0.00
Asteroidea	***Astropecten irregularis***	1300.77	513.28	1052.45	439.79	24.93	19.34	1840.91	736.90	67.65	32.78	14.50	6.41
Anthozoa	***Anthozoa 1***	192.85	149.87	4711.82	3937.56	0.00	0.00	43.17	32.12	0.00	0.00	0.00	0.00
	Alcyonium palmatum	53.83	23.14	39.67	13.68	118.33	61.25	1753.55	953.05	32.13	13.69	39.42	27.45
	Calliactis parasitica	0.00	0.00	1.82	1.82	379.79	97.92	50.66	23.57	5.73	2.63	0.87	0.60
Ascidiacea	***Ascidiella spp.***	0.00	0.00	81.51	70.39	6.11	6.11	287.56	204.55	0.00	0.00	0.00	0.00

Annex 9. Naturall debris mass, previous years. SE: standard error.

2019-2022 Natural debris Mass (kg/km²)	Coastal Delta shelf		Middle Delta shelf		Deeper shelf		Upper slope		Lower slope	
Type	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Terrestrial plants	24.70	17.95	8.64	2.05	9.97	1.54	6.33	1.72	3.05	1.12
Marine organic	10.74	1.80	9.20	1.69	8.62	1.01	4.71	1.02	1.77	0.22
Shells	6.58	1.16	3.97	0.91	6.23	0.68	2.76	0.62	0.69	0.18
Marine plants	10.31	4.61	4.95	1.04	2.14	0.37	0.44	0.07	0.25	0.06
Calcareous debris	0.32	0.19	0.24	0.21	2.79	1.35	0.29	0.14	0.15	0.08
Marine algae	0.40	0.24	1.66	1.35	0.47	0.19	0.10	0.05	0.00	0.00
Terrestrial animals	0.03	0.02	0.00	0.00	0.00	0.00	0.18	0.17	0.01	0.01

Annex 10. Naturall debris mass, year analyzed. SE: standard error.

2023 Natural debris Mass (kg/km²)	Coastal Delta shelf		Middle Delta shelf		Coastal shelf		Deeper shelf		Upper slope		Lower slope	
Type	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Marine organic	8.49	2.83	4.97	1.69	13.39	4.61	7.94	1.99	1.64	0.23	1.87	0.51
Shells	8.18	2.19	4.73	2.23	7.37	3.68	7.25	2.10	3.08	1.27	0.43	0.21
Terrestrial plants	3.81	1.40	1.54	0.36	3.33	0.88	3.37	0.70	1.14	0.26	0.91	0.52
Marine plants	4.53	1.37	2.00	0.33	2.63	1.61	0.76	0.18	0.17	0.05	0.10	0.04
Calcareous debris	1.37	0.90	0.90	0.48	5.23	3.92	1.77	1.59	0.20	0.12	0.05	0.05
Marine algae	0.00	0.00	0.01	0.01	1.61	0.91	0.05	0.03	0.02	0.01	0.09	0.08
Terrestrial animals	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00

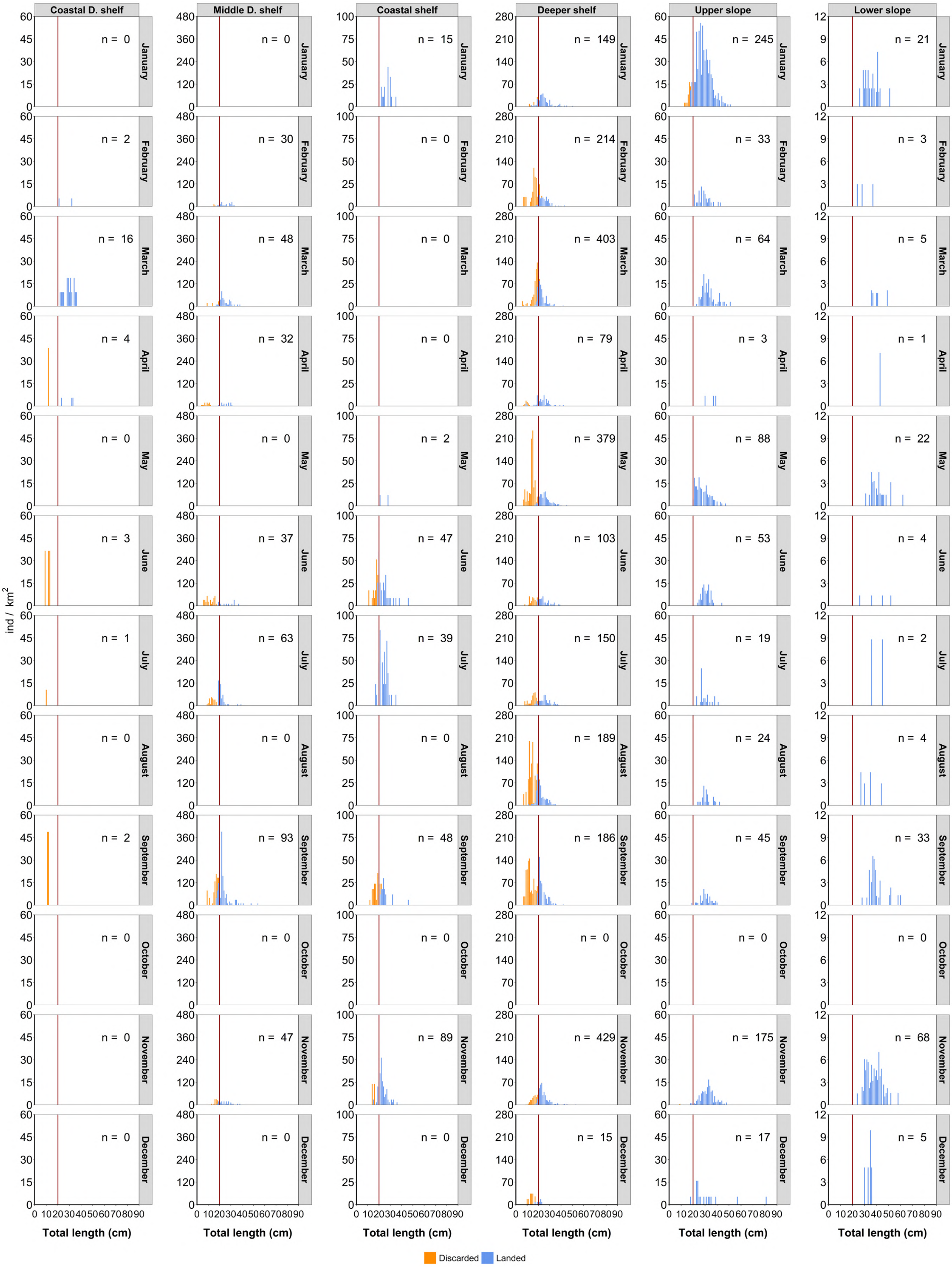
Annex 11. Marine litter mass, previous years. SE: standard error.

2019-2022 Marine litter Mass (kg/km^2)	Coastal Delta shelf		Middle Delta shelf		Deeper shelf		Upper slope		Lower slope	
Type	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Plastic	3.31	1.49	1.14	0.33	10.24	2.19	3.31	0.50	2.33	0.51
Other waste	0.84	0.36	2.10	0.86	2.76	0.52	2.45	0.34	2.27	0.76
Wood	2.07	0.82	1.30	0.43	2.59	0.52	0.97	0.28	0.81	0.34
Textiles	0.30	0.10	0.23	0.08	0.79	0.26	0.39	0.10	0.42	0.23
Metal	0.09	0.05	0.05	0.04	0.38	0.17	0.05	0.02	0.45	0.42
Rubber	0.00	0.00	0.00	0.00	0.20	0.11	0.10	0.08	0.00	0.00

Annex 12. Marine litter mass, year analyzed. SE: standard error.

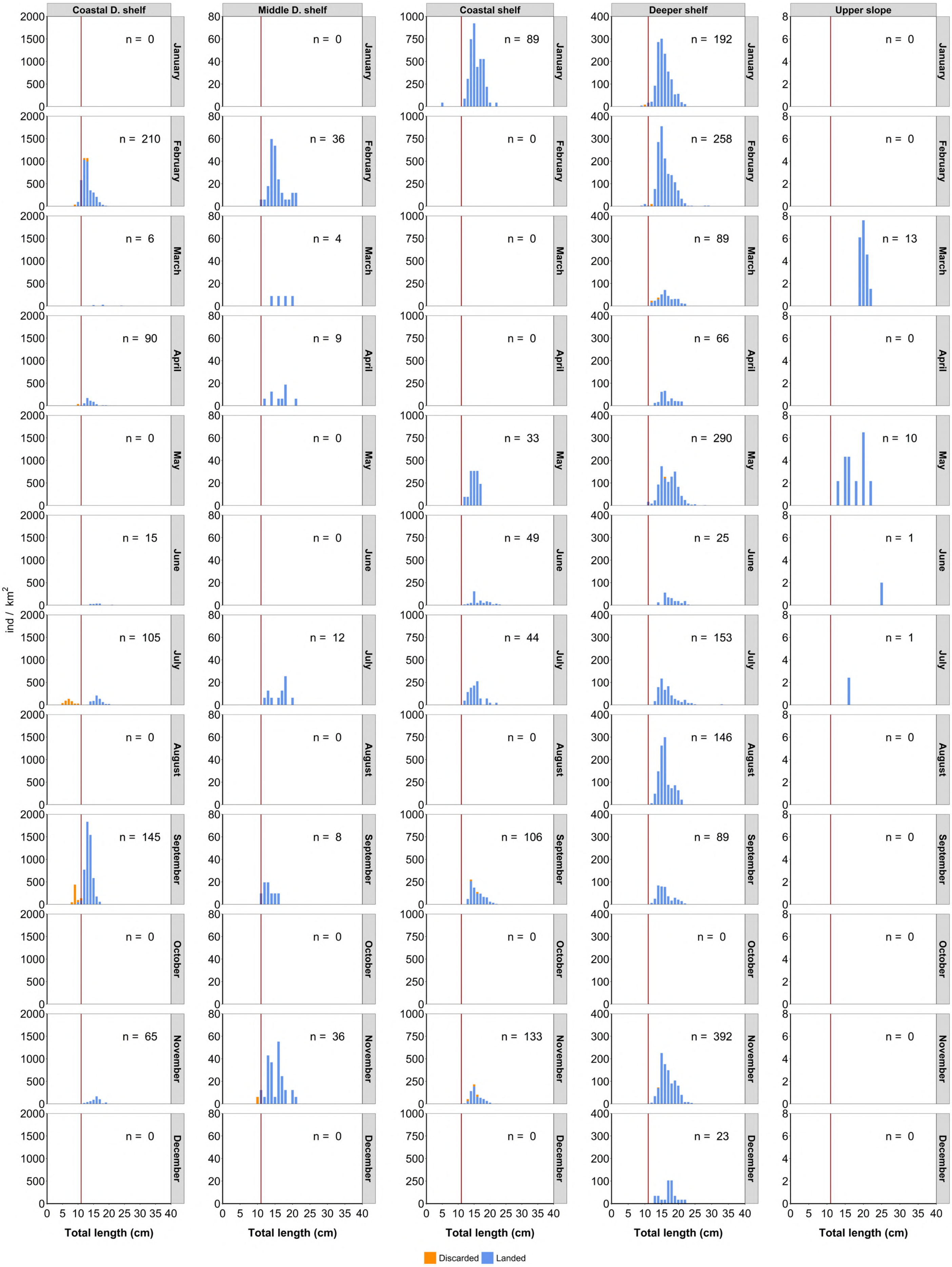
2023 Marine litter Mass (kg/km^2)	Coastal Delta shelf		Middle Delta shelf		Coastal shelf		Deeper shelf		Upper slope		Lower slope	
Type	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Plastic	2.35	1.60	0.47	0.15	7.96	3.36	4.18	1.82	1.12	0.29	1.24	0.72
Other waste	1.16	1.15	1.72	0.80	2.11	1.34	2.82	0.82	2.75	0.78	1.50	0.75
Textiles	1.01	0.94	0.00	0.00	1.02	0.64	0.63	0.26	0.40	0.19	0.36	0.25
Wood	0.01	0.01	0.07	0.07	0.35	0.28	0.28	0.16	0.09	0.08	0.00	0.00
Metal	0.12	0.12	0.17	0.11	0.04	0.04	0.12	0.05	0.11	0.06	0.03	0.02
Rubber	0.00	0.00	0.00	0.00	0.03	0.03	0.11	0.11	0.00	0.00	0.00	0.00

Hake (*Merluccius merluccius*) HKE



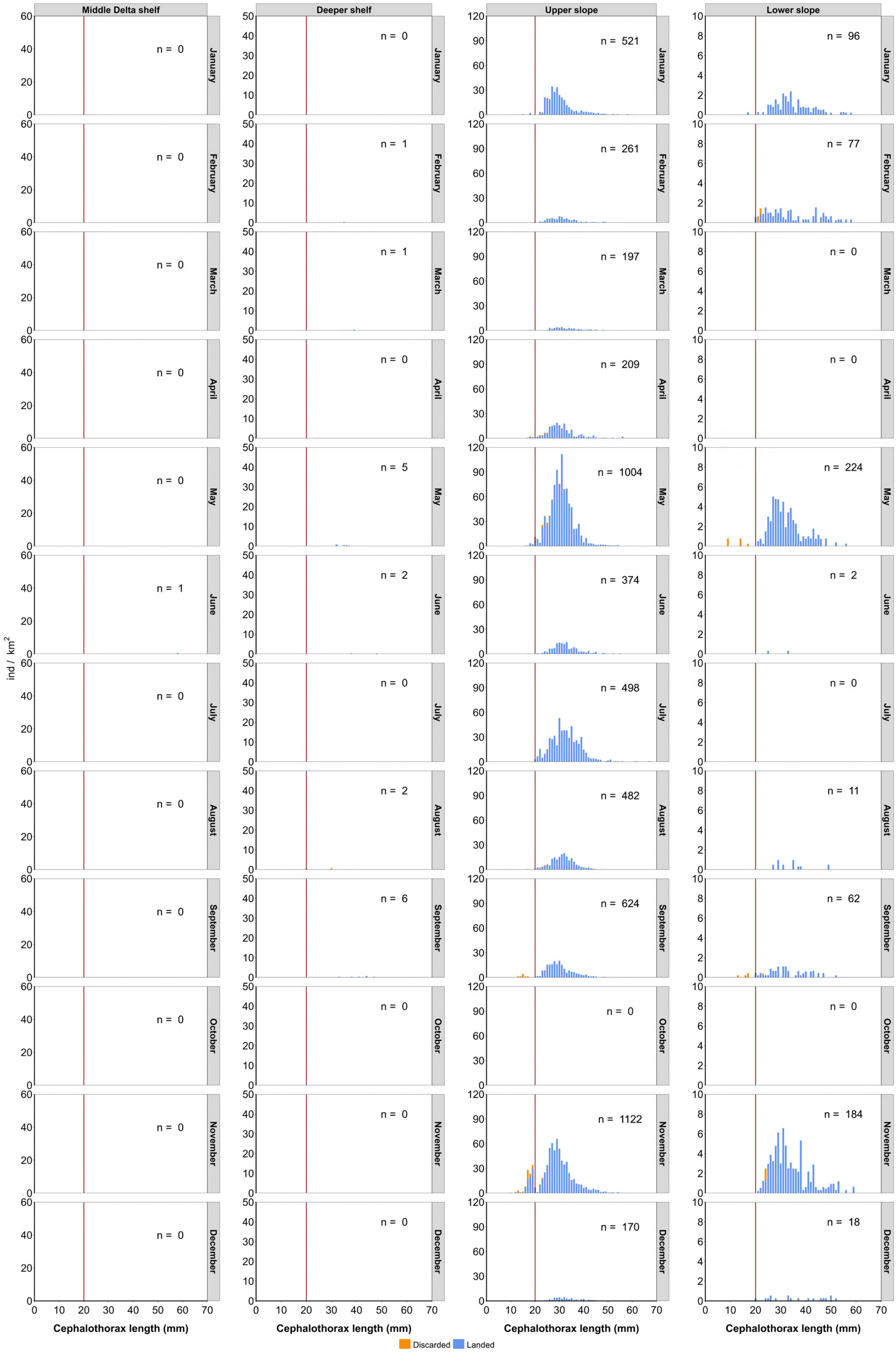
Annex 13. Monthly length-frequency distribution of hake in 2023 at different *métiers* (Coastal Delta Shelf, Middle Delta Shelf, Coastal Shelf, Deeper Shelf, Upper Slope and Lower Slope) in 2023. (n) Total number of measured individuals. Red solid line: Minimum Conservation Reference Size (MCRS).

Red Mullet (*Mullus barbatus*) MUT



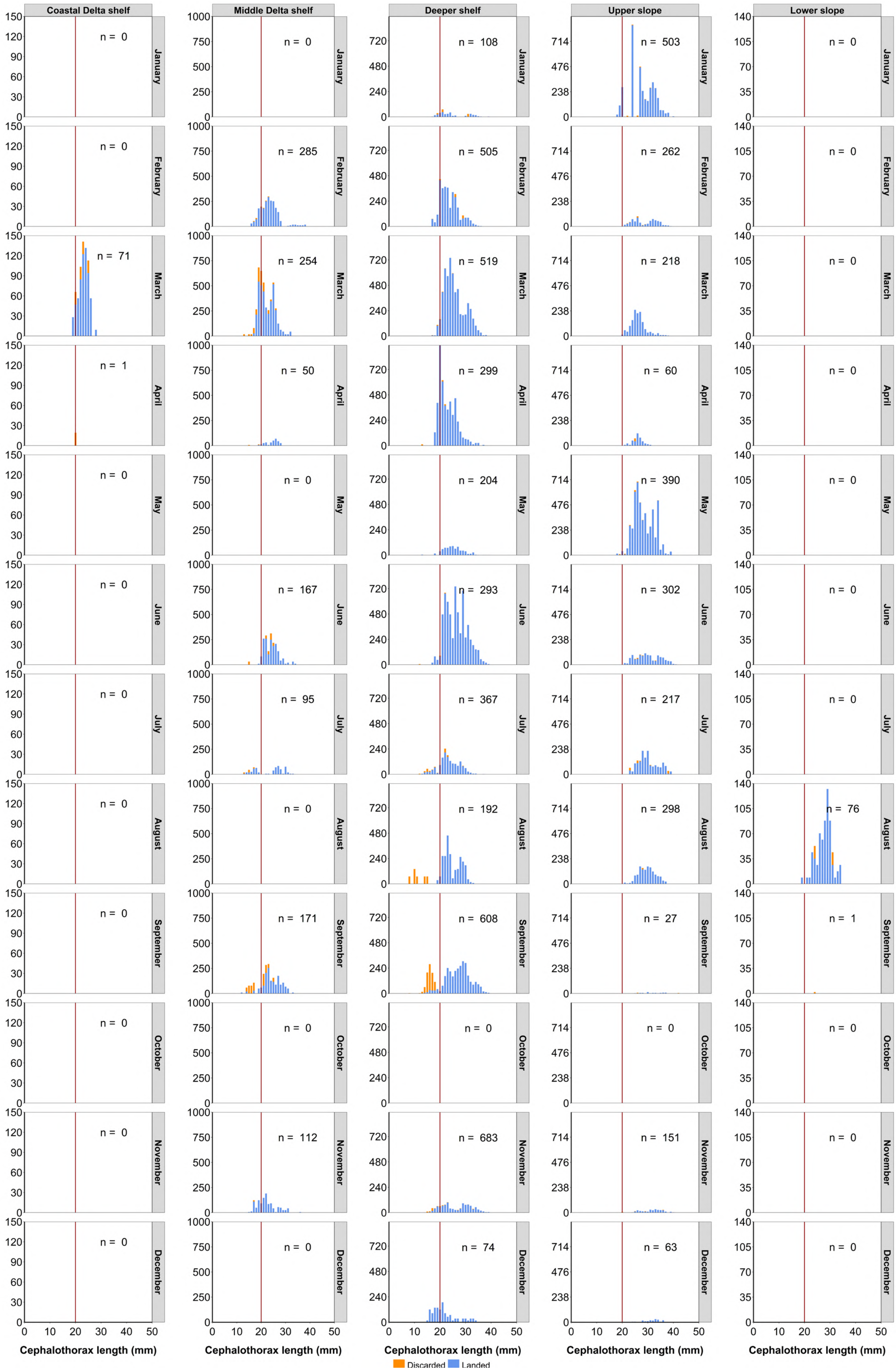
Annex 14. Monthly length-frequency distribution of red mullet in 2023 at different *métiers* (Coastal Delta Shelf, Middle Delta Shelf, Coastal Shelf, Deeper Shelf, Upper Slope and Lower Slope) in 2023. (n) Total number of measured individuals. Red solid line: Minimum Conservation Reference Size (MCRS).

Norway lobster (*Nephrops norvegicus*) NEP



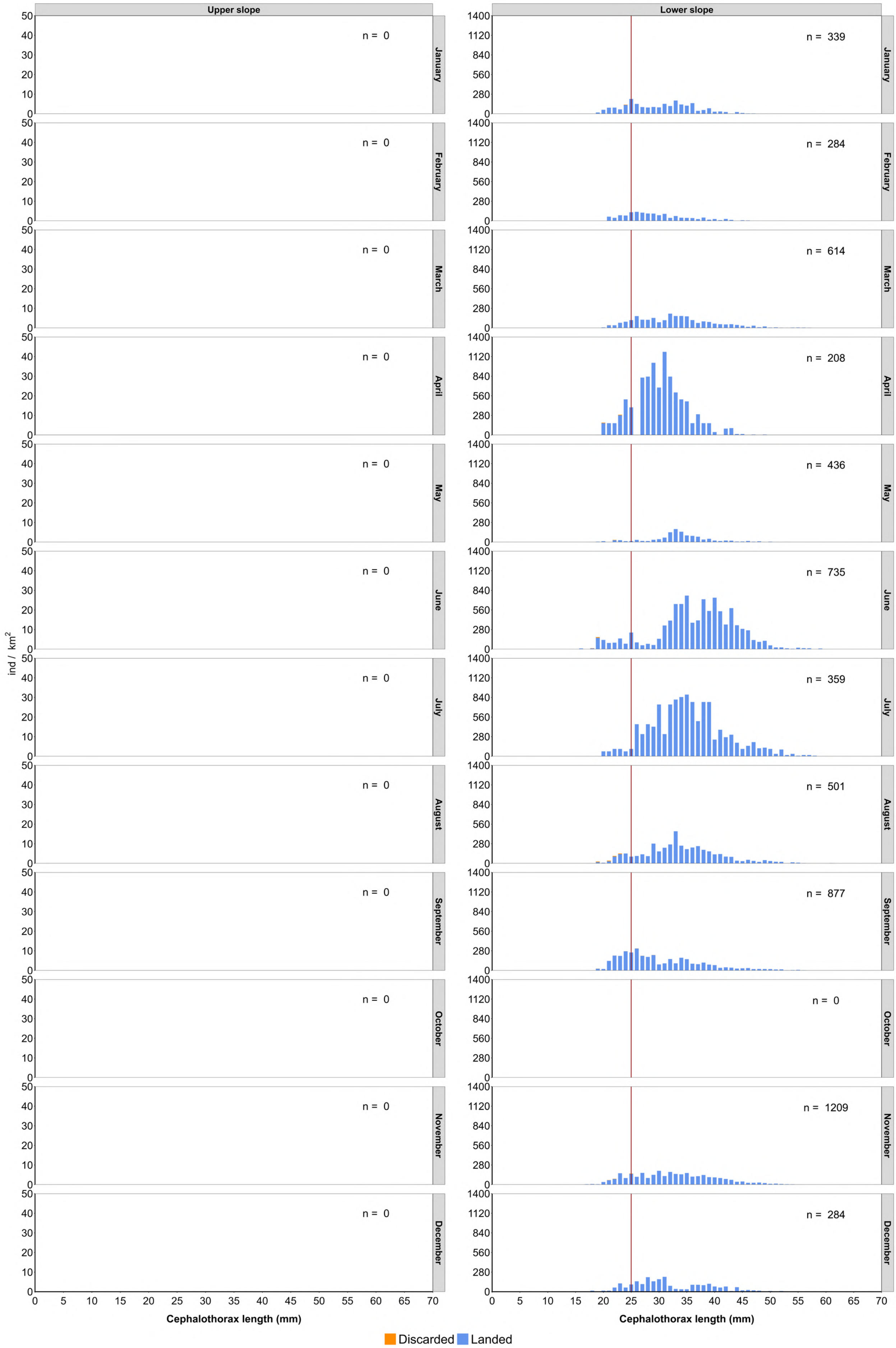
Annex 15. Monthly length-frequency distribution of Norway lobster in 2023 at different *métiers* (Middle Delta shelf; Deeper shelf; Upper slope; Lower slope) in the year analyzed. (n) Total number of measured individuals. Red solid line: Minimum Conservation Reference Size (MCRS).

Deep-water rose shrimp (*Parapenaeus longirostris*) DPS



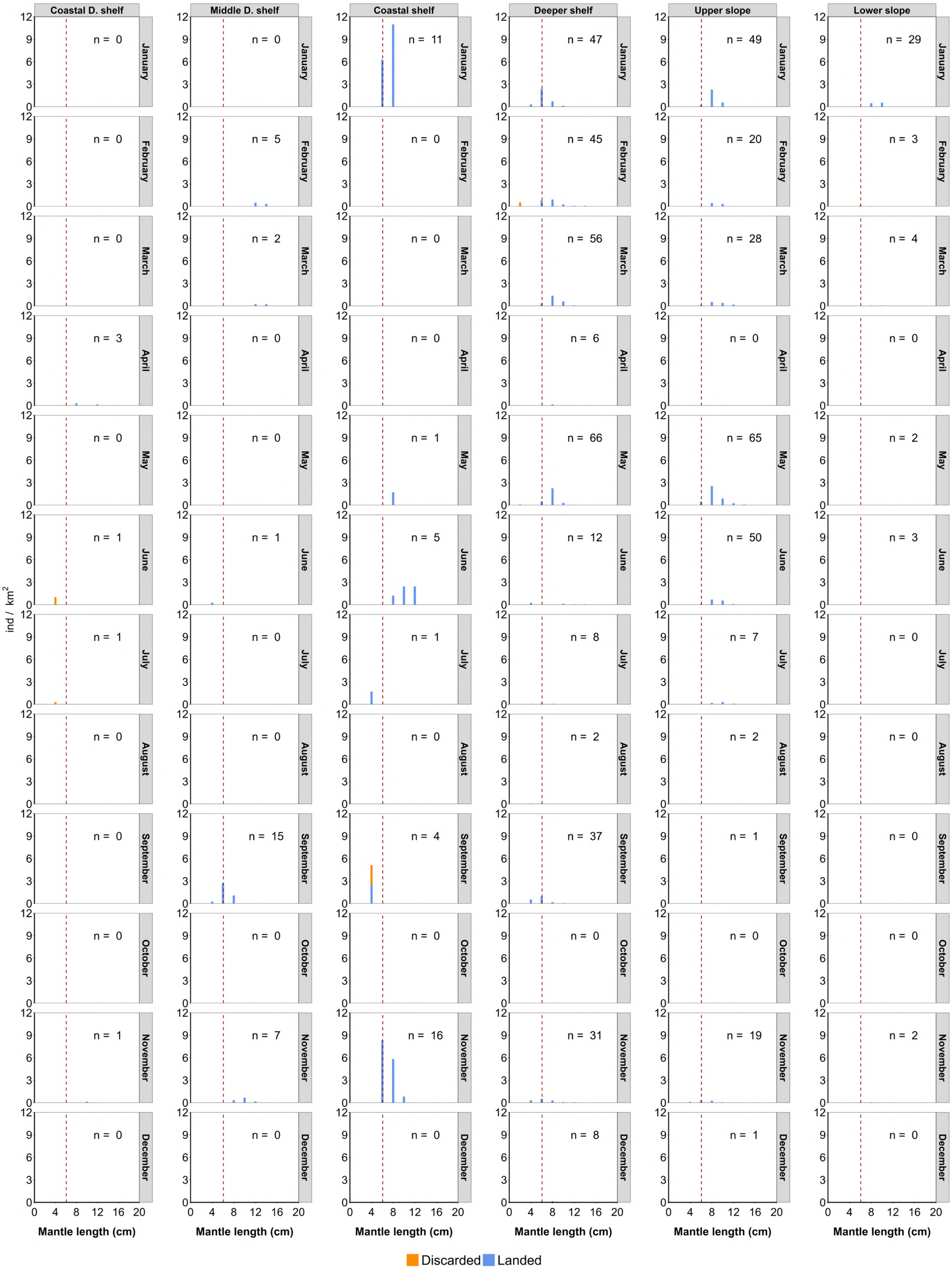
Annex 16. Monthly length-frequency distribution of deep-water rose shrimp in 2023 at different *métiers* (Coastal Delta Shelf, Middle Delta Shelf, Coastal Shelf, Deeper Shelf, Upper Slope and Lower Slope) in 2023. (n) Total number of measured individuals. Red solid line: Minimum Conservation Reference Size (MCRS).

Blue and red shrimp (*Aristeus antennatus*) ARA



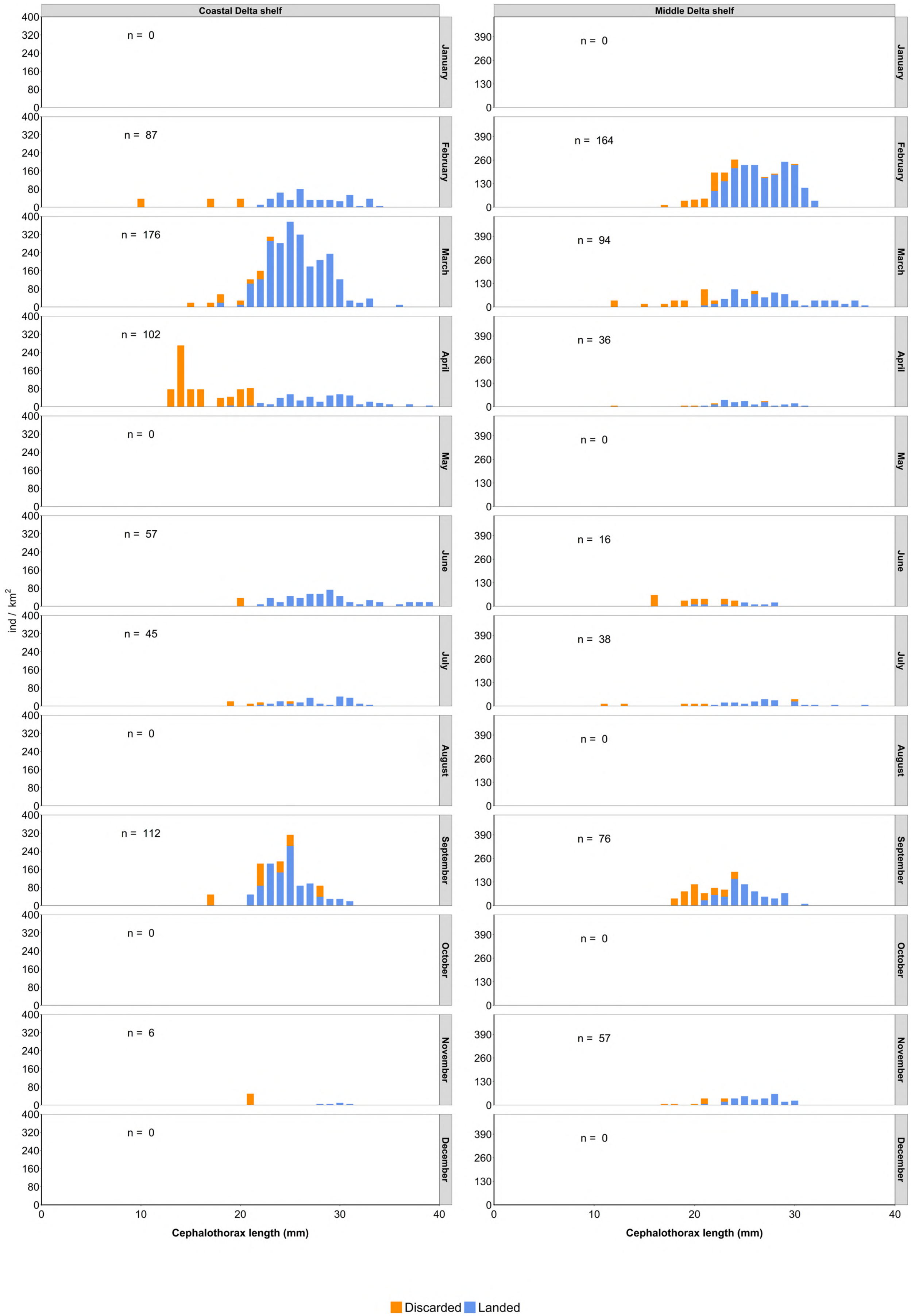
Annex 17. Monthly length-frequency distribution of blue and red shrimp in 2023 at different métier (US; Upper Slope and LS; Lower Slope) in the year analyzed. (n) Total number of measured individuals. Red line: Minimum Conservation Reference Size (MCRS).

Horned octopus (*Eledone cirrhosa*) EOI



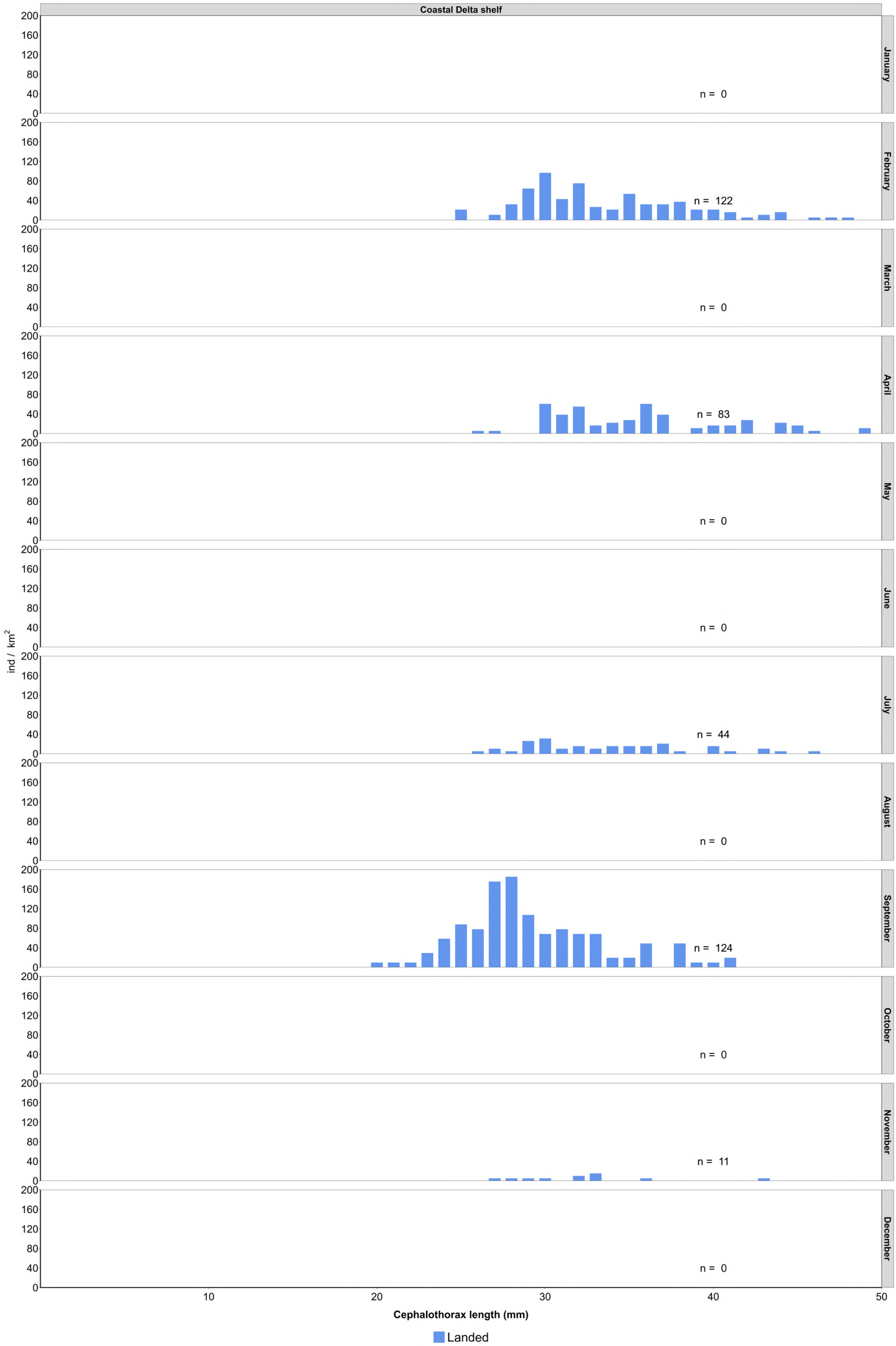
Annex 18. Monthly length-frequency distribution of horned octopus in 2023 at different *métiers* (Coastal Delta Shelf, Middle Delta Shelf, Coastal Shelf, Deeper Shelf, Upper Slope and Lower Slope) in 2023. (n) Total number of measured individuals. Red dashed line: Annual mean size at first maturity (L_{50}) considering the mean of the years analyzed.

Spottail mantis shrimp (*Squilla mantis*) MTS



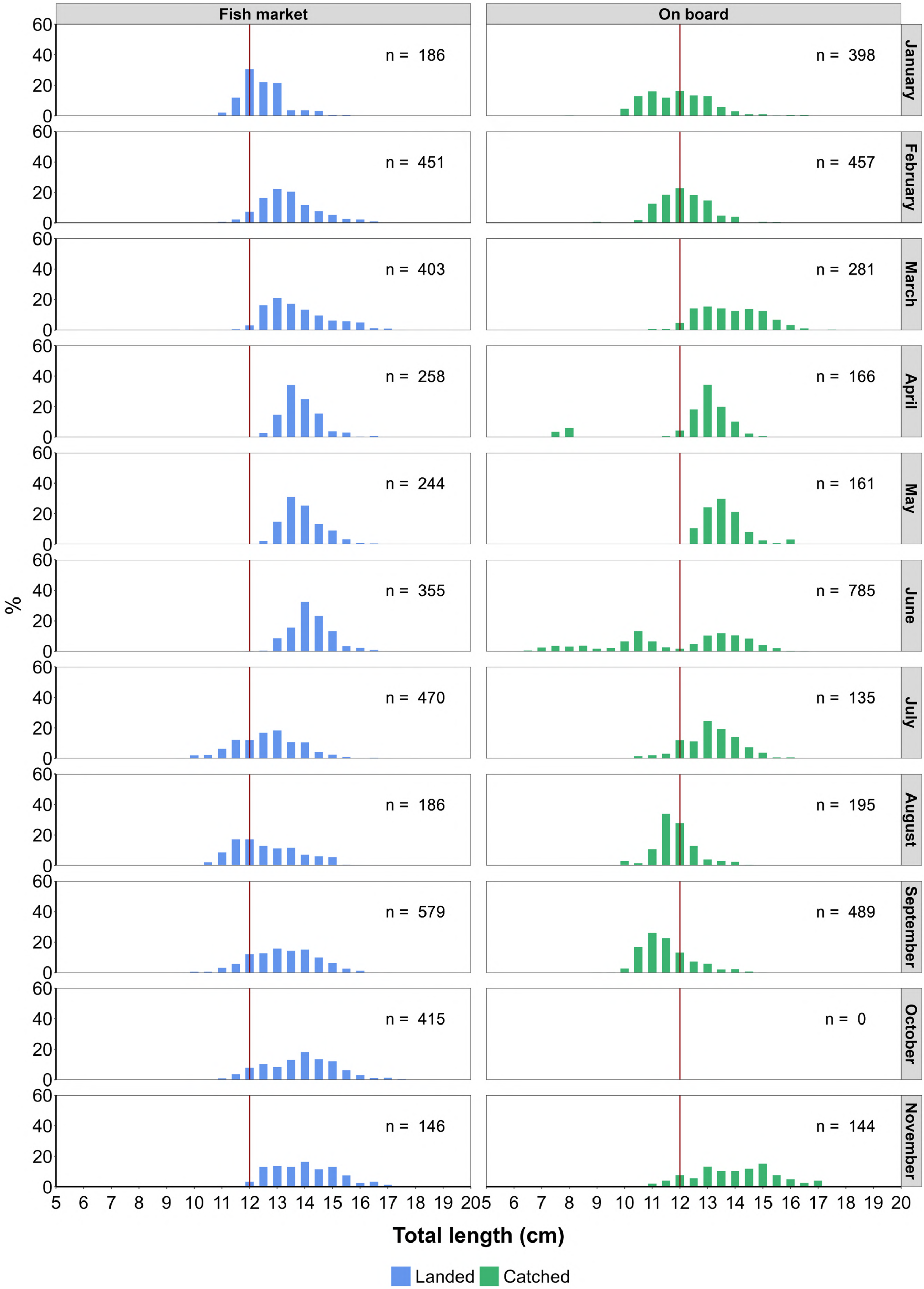
Annex 19. Monthly length-frequency distribution of Spottail mantis squillid in 2023 at different métiers (Coastal Delta Shelf, Middle Delta Shelf, Coastal Shelf, Deeper Shelf, Upper Slope and Lower Slope) in 2023. (n) Total number of measured individuals.

Caramote prawn (Penaeus kerathurus) TGS



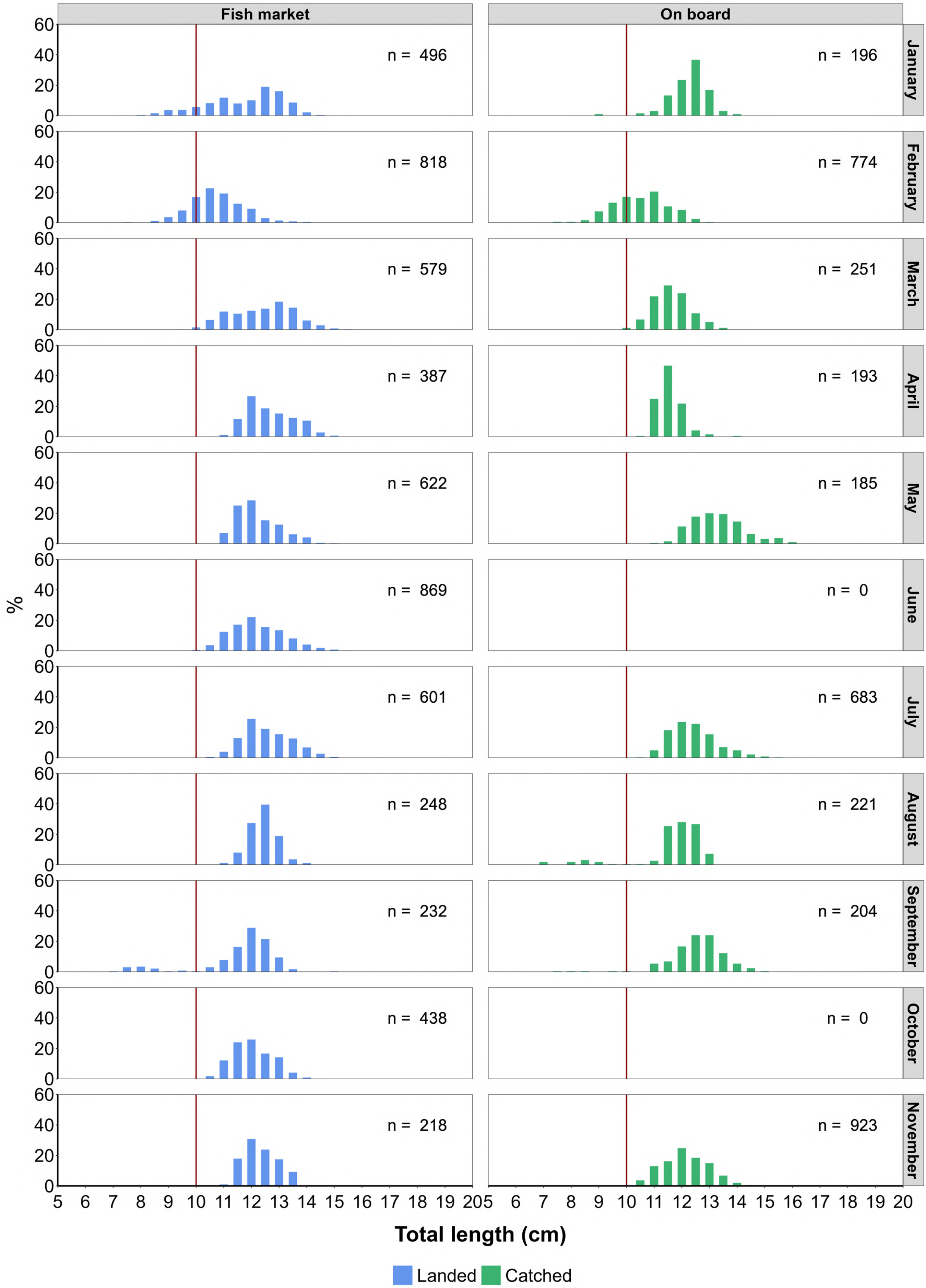
Annex 20. Monthly length-frequency distribution of caramote prawn in 2023 at CDS; Coastal Deltal shelf métier in the year analyzed. (n) Total number of measured individuals.

European sardine (*Sardina pilchardus*) PIL



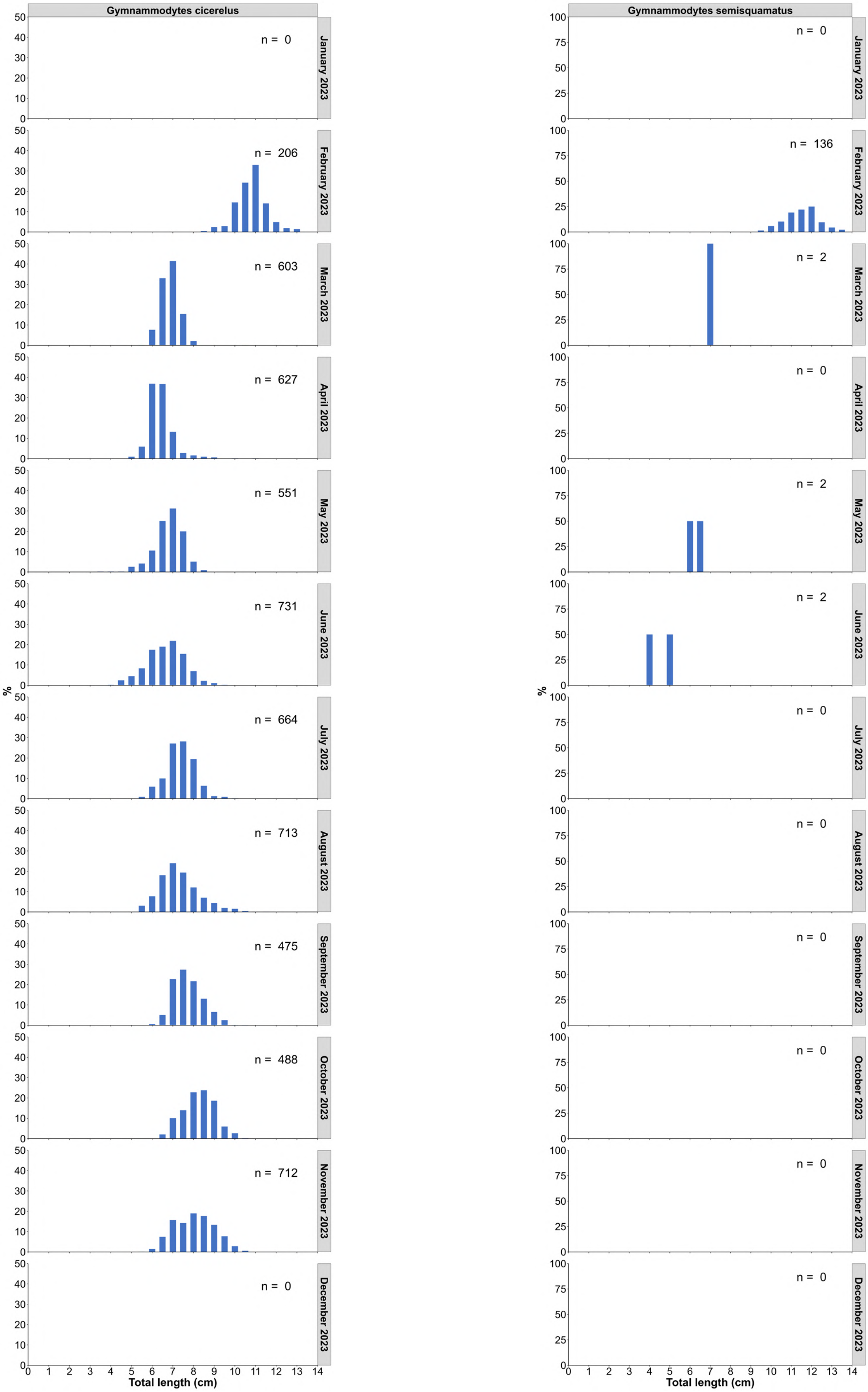
Annex 21. Monthly length-frequency distribution of European sardine in 2023, left: fish market sampling and right: on-board sampling. (n) Total number of measured individuals. Red dashed line: Minimum Conservation Reference Size (MCRS).

Anchovy (*Engraulis encrasicolus*) ANE



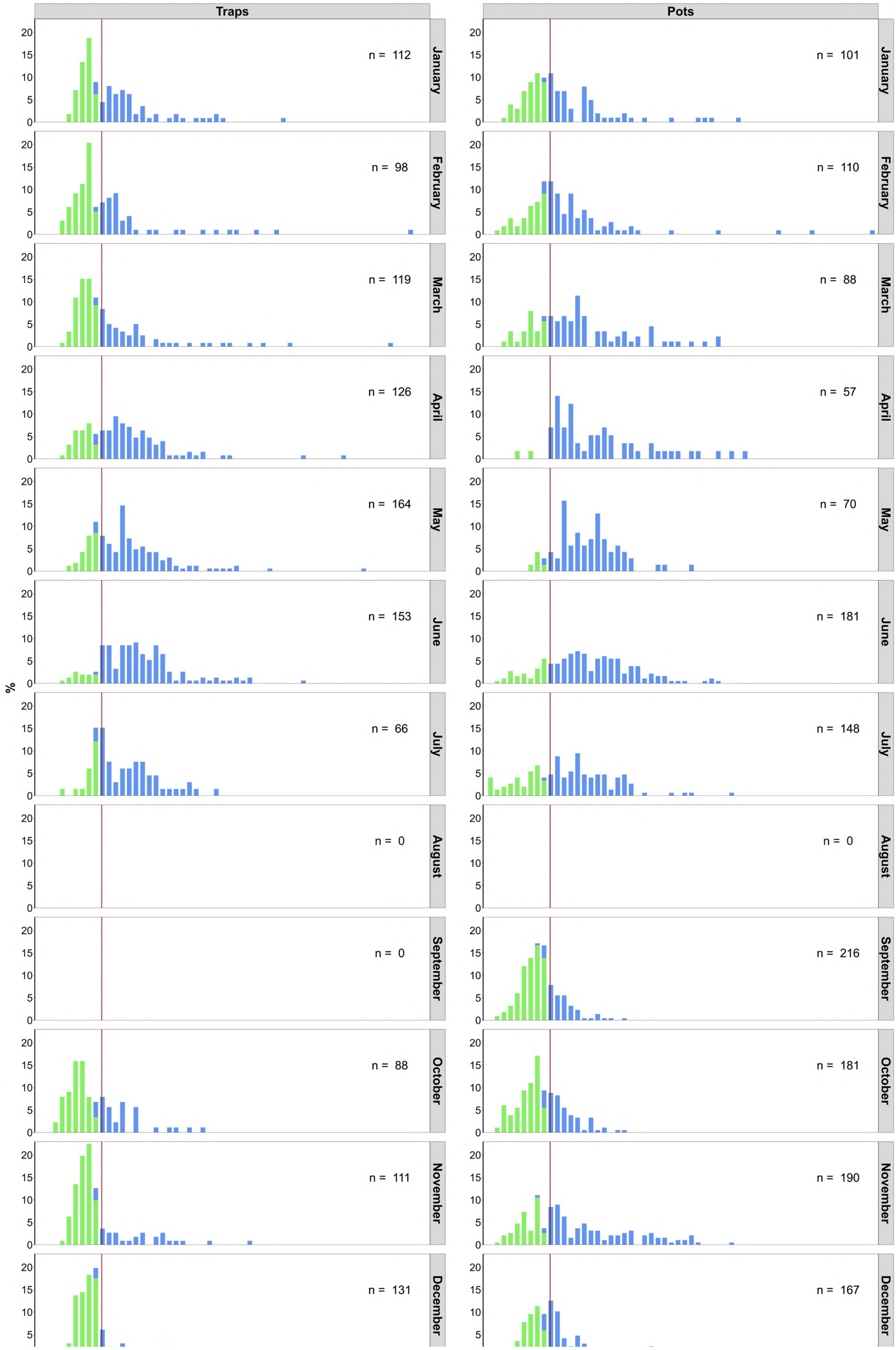
Annex 22. Monthly length-frequency distribution of Anchovy in 2023, left: fish market sampling and right: on-board sampling. (n) Total number of measured individuals. Red dashed line: Minimum Conservation Reference Size (MCRS).

Target species in Sand eel fishery (ZGC, ZGS)



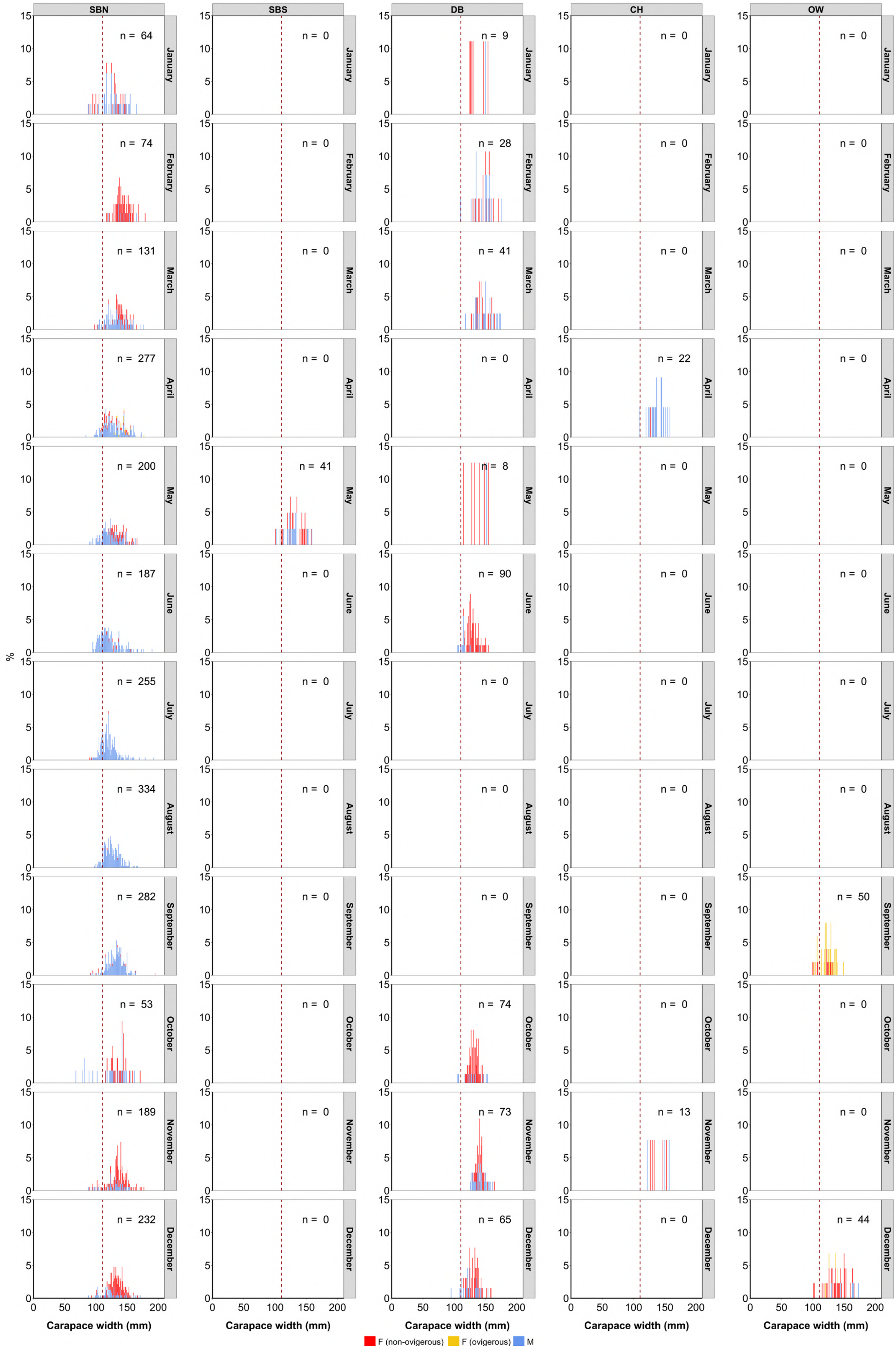
Annex 23. Monthly length-frequency distribution of the main target species of the sandeel fishery in 2023. (n) Total number of measured individuals.

Common octopus (*Octopus vulgaris*) OCC



Annex 24. Monthly weight-frequency distribution of common octopus at different fishing gear (Traps and Pots) in Central Catalonia in 2023. Red line: Minimum Conservation Reference Weight (MCRW).

Blue crab (*Callinectes sapidus*) CRB



Annex 25. Monthly length-frequency distribution of Blue crab at different depth strata (SBN; Shallow Bay North, SBS; Shallow Bay South, BD; Deep Bay, CH; Channel and OW; Open Water). Left: previous years sampled, right: year analyzed. (n) Total number of measured individuals. Red dashed line: Size at first sexual maturity (L_{50}).

icatmar
Institut Català de Recerca per a la Governança del Mar

www.icatmar.cat

Co-funded by the European Union

Generalitat de Catalunya
Departament d'Acció Climàtica, Alimentació i Agenda Rural

CSIC
Consejo Superior de Investigaciones Científicas

ICM
Institut de Ciències del Mar