FAIRSEA (ID 10046951)

"Fisheries in the AdriatIc Region - a Shared Ecosystem Approach"

D4.5.1 Fishing effort map distribution

Work Package:	WP4 - Implementation of a shared and integrated platform Activity 4.5 EFFORT – Effort distribution and fleet displacement
Type of Document	Assessment of the fishing effort distribution for both fishing vessels equipped with tracking devices (i.e. VMS or AIS) and non-equipped vessels (typically the fishing vessel smaller than 12 m).
Use	Internal
Responsible PP	PP6-CoNISMa: Carlucci R., Cipriano G., Ricci P., Capezzuto F., D'Onghia G., Maiorano P., Sion L., Tursi A.
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Version and date	28 January 2021

Deliverable 4.5.1

Fishing effort map distribution

FAIRSEA – Fisheries in the Adriatic Region – a shared Ecosystem Approach

FAIRSEA is financed by Interreg V-A IT-HR CBC Programme (Priority Axis 1 – Blue innovation)

Start date: 01 January 2019

End date: 28 February 2021 (extended to 31 August 2021)

Contents

List of Acronyms used

AIS	Automatic Identification System
GIS	Geographic Information System
CFP	Common Fisheries Policy
EAF	Ecosystem Approach to Fisheries
EAFM	Ecosystem Approach to Fisheries Management
FAIRSEA	Fisheries in the AdrIatic Region – a Shared Ecosystem Approach
GAM	Generalized Additive Models
GSA	FAO Geographical Sub Areas
GVC	Generalized Cross-Validation
IT	Italy
LL	Longline
LP	Lead Partner
LPUE	Landings Per Unit of Effort
OGS	Istituto Nazionale di Oceanografia e di Geofisica Sperimentale
OTB	Bottom Otter Trawl
PP	Project Partner
PS	Purse Seine
PTM	Mid-water Pair Trawl
TBB	Beam Trawl
VMS	Vessel Monitoring System
WP	Work packages

About FAIRSEA Project

The FAIRSEA is a European Territory Cooperation project financed under the priority 1 “Blue innovation”, Specific Objective 1.1 “Enhance the framework conditions for innovation in the relevant sectors of the blue economy within the cooperation area” of the INTERREG V-A Italy –Croatia Programme 2014-2020. The project focuses on the fisheries sector, key driver for the blue growth of the Adriatic communities, towards a sustainable co-management of resources and marine ecosystem protection. The transboundary nature of marine resources requires a cross-border cooperation and a shared “Vision” to properly tackle and address the different socio-economic and environmental challenges related to fisheries activities management. In this context, FAIRSEA Project aims at enhancing transnational capacity and cooperation in order to promote the sharing of knowledge and good practices between regional and transnational key actors in the sector of sustainable fisheries management in the Adriatic Sea as well as to implement innovative approaches adopting an ecosystem approach to fisheries (EAF). Coordinated by the OGS of Trieste (IT), the project involves a consortium of 12 strategic and operational partners from Italy and Croatia that will make to best use of their complementary expertise to address and support the application of the EAF ensuring a strong and interactive engagement of institutional, technical and socio-economic stakeholder in project activities.

The main result of the FAIRSEA Project will be the development of an integrated platform for a quantitative ecosystem approach to fisheries that goes across territorial boundaries and across several disciplines. The platform will integrate biological/ecological processes (i.e. considering water mass circulation, physical-chemical properties, plankton productivity, dynamics of resources including their interactions) and fisheries bio-economic dynamics (including fisheries displacement). This high technological and innovative platform will be used as a planning tool to implement demonstrative testing of applicable fisheries policies both at local (subareas) and Adriatic scales. It will provide a scientific basis for formulating and evaluating the shared management advice in the local and international participatory processes, involving management authorities, experts and stakeholders. The Project will also provide an answer to the need of reference points, best practices and guidelines for the optimisation between ecological and socio-economical sustainability of fisheries in the Adriatic Sea.

1 INTRODUCTION

The distribution of fishing effort and fleet displacement, called module EFFORT (Activity 4.5), is one of the cornerstone elements of the integrated platform designed in the WP4 of the FAIRSEA project.

The purpose of this activity was to provide an assessment of the fishing effort distribution (fishing hours per fleet segment in each quadrant) for both fishing vessels equipped with tracking devices (i.e. VMS or AIS) and non-equipped vessels (typically the fishing vessel smaller than 12 m). This task was pursued using a combined approach: (i) VMS/AIS data were analysed using the state-of-the-art VMSbase platform; (ii) the distribution of the small-scale fishing fleet was obtained through a methodology based on the identification of the most relevant factors which determine the spatial pattern of small-scale fishing. Small fishing vessels equipped with AIS allowed the calibration and validation of the approach. The individual behaviour of fishing vessels monitored by VMS/AIS was combined with the catch and landing data collected by on-board and on-dock observers from the different areas, a methodology developed within the FAO Adriamed region. Both Italian and Croatian fleets operating in the Adriatic Sea were considered. Namely, researchers belonging to the two countries collaborated to process the VMS and AIS data and share the corresponding results. Therefore, FAIRSEA D4.5.1 Fishing effort map distribution was required as a research product. i.e. a database and mapping of the spatial distribution of fishing effort by the main fishing segments and small-scale fishing activities obtained by integrating VMS/AIS data on vessel displacement with on-board observations of fishing operations in the Adriatic-Ionian region.

2 MATERIALS AND METHODS

2.1 Fishing effort

The estimation of the fishing footprint to the case study of Adriatic and Ionian seas within the FAIRSEA framework encompassed the marine surface enclosed by GSA 17, 18 and 19. The selected grid topology defines the physical boundaries of the case study, the spatial extension and its characteristics. The analyses were conducted constructing a reference grid, coherent with the Copernicus standards, dividing the GSA polygons in cells of size 5 x 5 km covering the area of interest (Figure 2.1.A). The dimension of the cells determines the minimum spatial resolution to which the following results will be related.

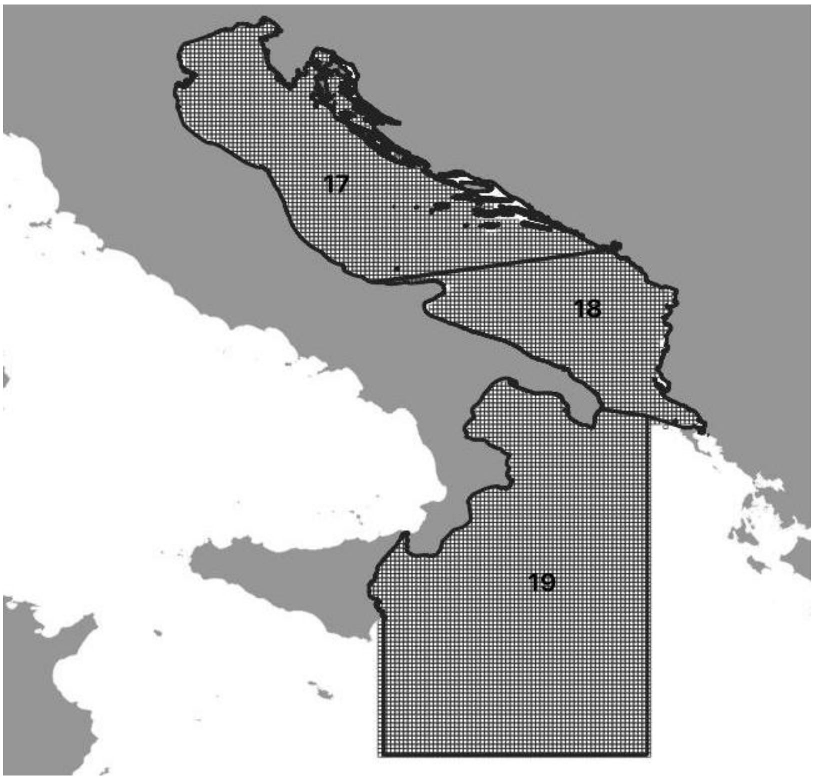


Figure 2.1.A - Representation of the5 x 5 Km square grid used to quantify the fishing footprint in the area of study.

The following section describe and summarize the procedure applied to estimate the fishing footprint for the Italian fleet operating in the area of study. In particular, different methods were applied for:

- Fleets equipped with VMS/AIS
- Fleets not-equipped with VMS/AIS

It is important to notice that, while the estimation of the fishing footprint for fleets not-equipped with VMS/AIS has been completed for all the involved countries, the corresponding VMS/AIS-based estimations were carried out only for the Italian fleet, whereas the analysis for the Croatian fleet is still ongoing.

2.1.1 Fleets equipped with VMS/AIS

The VMSbase platform (Russo et al., 2014; D'Andrea et al., 2020) was used to process the VMS and AIS datasets. The integration of VMS and AIS data were performed according to the procedure described in Russo et al., 2016. Then, the VMS/AIS-integrated dataset was submitted to a standard processing through the platform VMSbase (Russo et al., 2014, 2016).

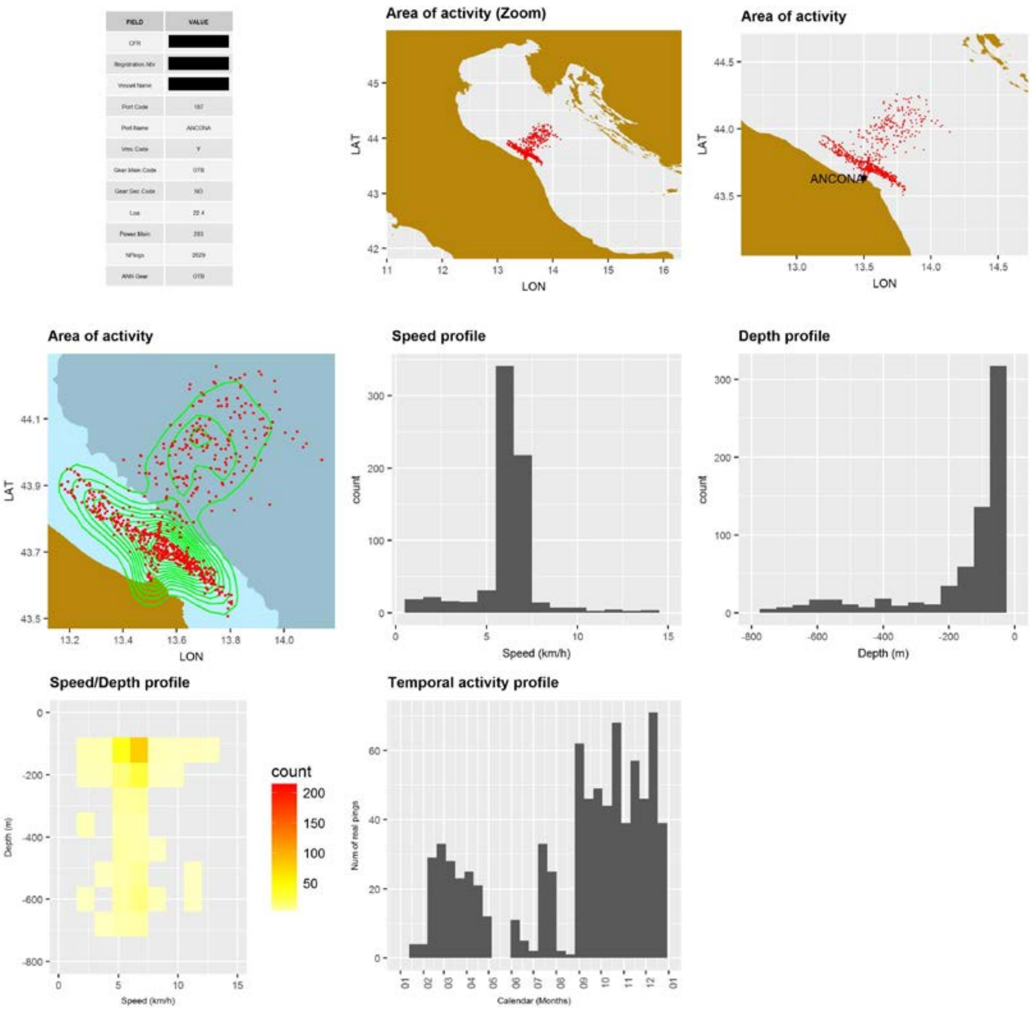
The details of this processing are extensively described and applied in different papers (Russo et al., 2011a, b, 2014, 2016).

A summary of the workflow could be itemized as follows:

- Data Cleaning: identification and flagging of duplicates and erroneous pings;
- Track Cutting: temporal sorting of pings for each single vessel, followed by the identification of in-harbour positions and then by the identification of "tracks", that is, series of temporally-ordered pings describing a single vessel trip, starting and ending in a given harbour;
- Track Interpolation: standardization of pings frequency (from native/variable pings rate to a fixed value of 5 minutes). This step also allows synchronizing the temporal coordinates of the pings for each area/case study;
- Assign bathymetry: Automatic download of the provided data by means of the NOAA (National Oceanic and Atmospheric Administration of the U.S. Department of Commerce) web servers and assignment of an estimated value of sea bottom depth to each ping in the databases. The NOAA bathymetric web servers will be accessed through the functionalities provided by the marmap R package (Pante et al. 2019).
- Fishing Points Identification: classification of interpolated pings as "Fishing" or "not fishing" (which corresponds to various activities, including steaming) on the basis of case study-

specific filter for speed and depth. This step allows identifying hauls within each track (fishing trip);

- Assignment of Fishing gear: this critical step was carried out using the output of the Artificial Neural Network described in Russo et al. (2011b). The public list of gear for which each vessel is authorized, and a visual screening of the activity that was based on the expert judgment of the researchers (an example of the vessel-specific information used for this kind of supervised inspection is represented in Figure 2.1.1.A).



FIELD	VALUE
CFR	[redacted]
Registration Nbr	[redacted]
Vessel Name	[redacted]
Port Code	187
Port Name	ANCONA
Vms Code	Y
Gear Main Code	OTB
Gear Sec Code	NO
Loa	22.4
Power Main	283
NPings	2029
ANN Gear	OTB

Figure 2.1.1.A - Representation of the thematic maps used to check the activity (and in particular the fishing gear) used by each vessel.

After gear identification and classification of fishing vessels concerning their gear groups, interpolated pings were classified with respect to the following classes: “in harbour”, “steaming”, and “fishing”. The last class comprises the fishing set positions, identified using gear-specific speed and depth filters. The final output of this analysis was represented by a set of maps representing the distribution of the monthly fishing effort for the mentioned above grid.

The bathymetry of the Adriatic and Ionian seas, downloaded from the ETOPO1 database (Amante & Eakins, 2009), was coupled with the grid assigning an average depth to each cell. The cells with a depth greater than 1000 m are then excluded from the subsequent analyses.

The fleet dataset integrates the fishing effort allocated to the area of interest and the general characteristics of each vessel (from the Fleet Register) monitored in the working fleet. The fleet included in the analyses is composed by all the Italian trawlers equipped either with VMS, AIS, or both systems. The smartR (D’Andrea et al., 2020) algorithm extracts the fishing effort data from one or more VMSbase databases. The native VMS/AIS pings were pre-processed using the VMSbase platform (Russo et al., 2014b) that have undergone through the standard steps including the track's interpolation (Russo et al., 2011b), bottom depth measurement for each interpolated ping, and metier classification (Russo et al., 2011a). The successive step of the estimation of the fishing effort consists in the identification of the fishing positions, aggregation of the fishing position into fishing hours, and overlay with the environmental grid (the number of fishing positions per cell divided by the number of points per hour). Thereafter, the spatially aggregated fishing effort is expressed in Fishing Hours.

The analysed time series included VMS/AIS data for the Italian fleet operating between January 2007 and December 2016. We classified the vessels by gears (OTB, PTM, PS, TBB, and LL) and another layer of subdivisions in fleet segments to distinguish each vessel by LOA classes: 12-18, 18-24, 24-40, and >40 m. Each fishing trip was associated with one of the gears listed in Table 2.1.1.a. Fishing set positions were identified, for each fishing trip, using a combined deep/speed filter, grouped by month and assigned to the cells of the 5 × 5 km square reference grid.

Table2.1.1.a - Table of the main technical details about the analysis of VMS/AIS data.

Temporal coverage	2007 – 2016 (monthly frequency)
Countries	ITA, HRV
Data sources	VMS, AIS
Gears	GN (Set Gillnet), OTB (Bottom Otter Trawl), LL (Longline), PS (Purse seine), PTM (Pelagic Pair Trawl), TBB (Beam Trawl)

2.1.2 Cascaded Multilayer perceptron network applied on environmental and fleet data for some component of the fleet without AIS/VMS

The estimation of the fishing footprint for the fleet components not covered by tracking devices (i.e. VMS and/or AIS) is a complex challenge. Nowadays, methods have been developed (Russo et al., 2019b) to infer the potential distribution of fishing effort on the basis of information about:

- Fleet structure (number and characteristics of vessels in terms of LOA/Engine power and operative range);
- Characteristics of the fishing grounds and, more in general, of the spatial domain in which fishing activity occurs;
- Data about the fishing behaviour of vessels with tracking devices.

In this project, a cascaded multilayer perceptron network (CMPN) combining environmental data and fleet structure was applied to predict the spatial distribution of fishing effort for the length class [12–15 m). This method was specifically developed for the Mediterranean basin and applied to the Adriatic Sea. The trained CMPN was applied for all the GSAs of the Mediterranean Sea. It is worth noting that the trawlers in the length class 12-15 m represent an important component of the Mediterranean fleets and, in particular, of the Italian and Croatian fleet (Russo et al., 2019b).

Input data required for model development were extracted for each GSA. Environmental characteristics were obtained by EUSeaMap2 Broad-Scale Predictive Habitat Map[1], while the fleet data of this deliverable, described in the section “Estimation of the activity index (Ac) - Data General Fisheries Commission for the Mediterranean - GFCM fleet register”, were used to defined the size (number of vessels) by country for the following length class: [12–15 m), [15–18), [18–24 m), and [24–40 m).

2.2 Estimation of the spatial productivities

The Landings Per Unit Effort (LPUE), at a monthly scale, was estimated for the subset of Italian fishing vessels operating with the Bottom Otter Trawl (OTB) system. LPUE were estimated by combining monthly landings (by vessel) with effort data using the procedure described in Russo et al., 2018, which is integrated in the R package smartR (D’Andrea et al., 2020). Monthly LPUE returned by the application of this procedure allows estimating the amount (kg) of landings by species and month as a function of: 1) the fishing footprint of a vessel, defined as pattern of fishing effort deployed in the cells of the reference grid; 2) size of the vessel, in terms of length-over-all (in meters).

The list of species for which this procedure was applied is provided in Table 2.2.a.

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[1] http://data.adriplan.eu/layers/geonode%3Aeunismedscale_4326

Table 2.2.a - List of species and related acronyms that were considered for the estimation of the LPUE.

Scientific Name	MEDITS CODE	FAO 3ALPHA
Aristaeomorpha foliacea	ARISFOL	ARS
Aristeus antennatus	ARITANT	ARA
Boops boops	BOOPBOO	BOG
Eledone cirrhosa	ELEDCIR	EOI
Engraulis encrasicolus	ENGRENC	ANE
Illex coindetii	ILLECOI	SQM
Lophius piscatorius	LOPHPISC	MON
Merluccius merluccius	MERLMER	HKE
Micromesistius poutassou	MICMPOU	WHB
Mullus barbatus	MULLBAR	MUT
Mullus surmuletus	MULLSUR	MUR
Nephrops norvegicus	NEPRNOR	NEP
Parapenaeus longirostris	PAPELON	DPS
Sardina pilchardus	SARDPIL	PIL
Trachurus trachurus	TRACTRA	HOM

3 RESULTS

3.1 Fishing effort: Fleets equipped with VMS/AIS

The mapping procedures yielded a series of maps (13 different panels with multiple maps within each panel) divided by gear and length class: OTB with 3 LOA classes (12-18, 18-24, 24-40); PS with 4 LOA classes (12-18, 18-24, 24-40, >40); PTM with 3 LOA classes (12-18, 18-24, 24-40); TBB with 3 LOA classes (12-18, 18-24, 24-40); LL with 2 LOA classes (12-18, 18-24). The spatial distribution of fishing effort is depicted with a scaled colour ramp where the effort values range from the dark blue to represent low effort hours and yellow for high values of effort hours. The hours of effort are monthly aggregated and arranged on a gear/LOA panel with a total of 12 maps in each panel.

The spatial pattern of effort of the OTB fleet, length class 12-18 m, is represented in Figure 3.1.A.

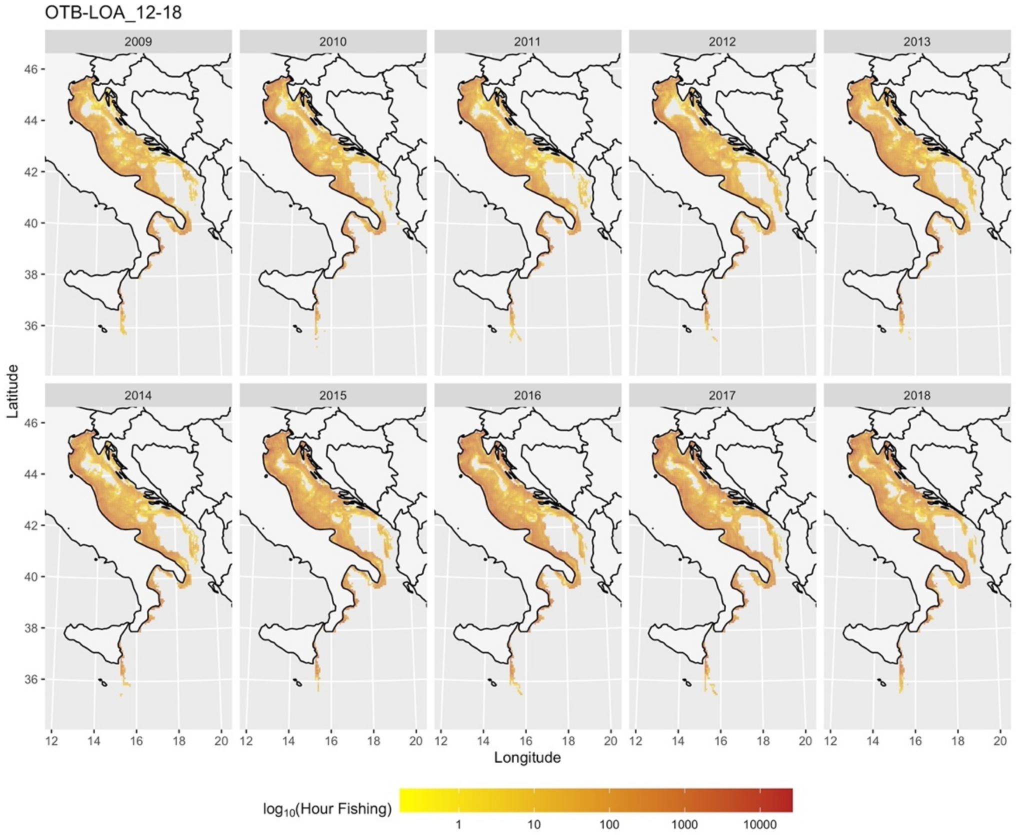


Figure 3.1.A – Total annual effort (hours fishing) deployed by trawlers in the length class 12-18 m.

The spatial pattern of effort of the OTB fleet, length class 18-24 m, is represented in Figure 3.1.B.

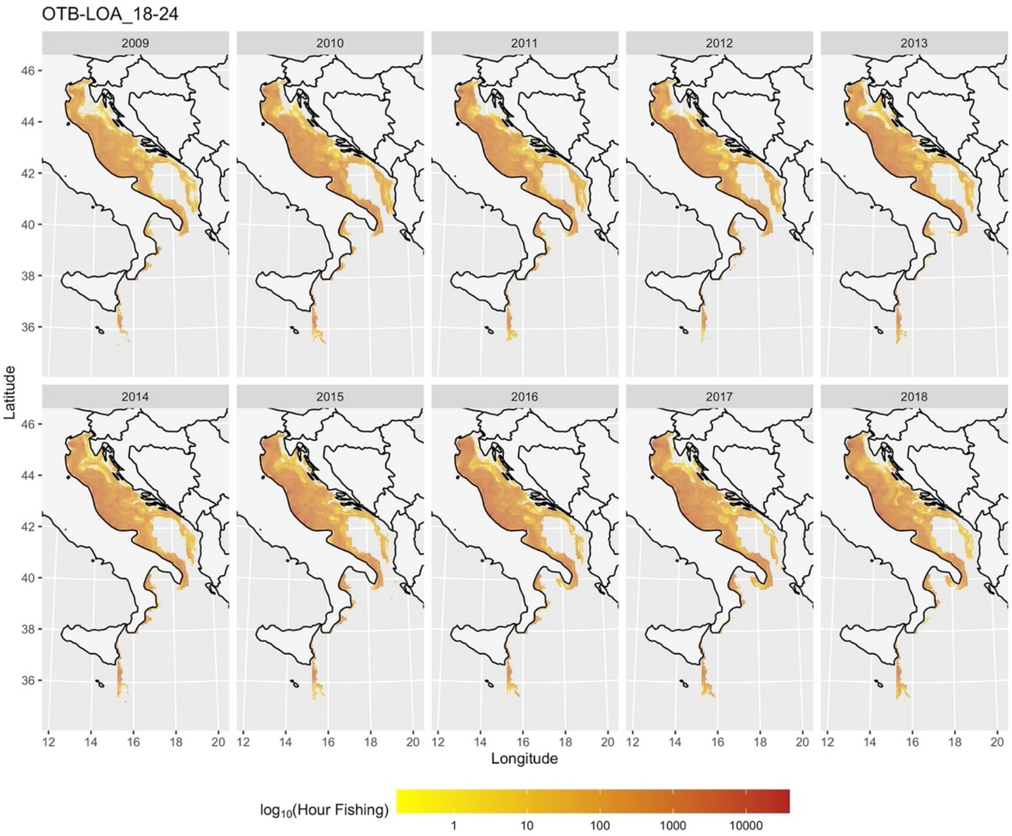


Figure 3.1.B - Total annual effort (hours fishing) deployed by trawlers in the length class 18-24 m.

The spatial pattern of effort of the OTB fleet, length class 24-40 m, is represented in Figure 3.1.C.

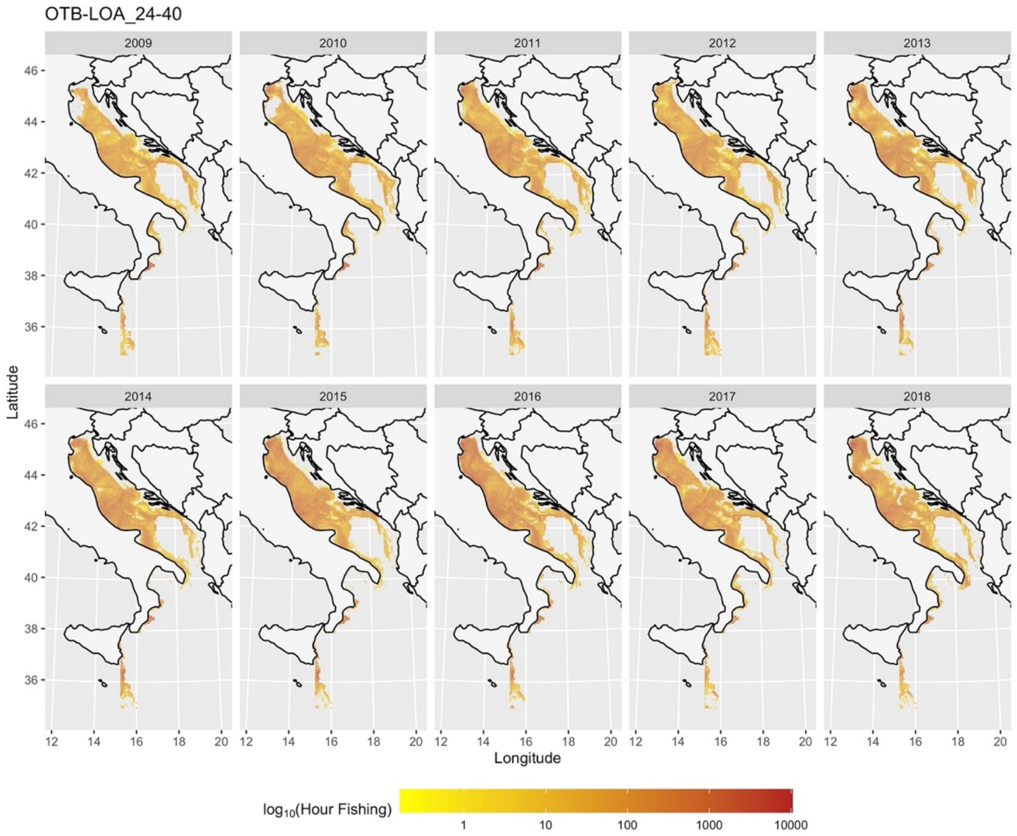


Figure 3.1.C - Total annual effort (hours fishing) deployed by trawlers in the length class 24-40 m.

The spatial pattern of effort of the LL fleet, length class 12-18 m, is represented in Figure 3.1.D.

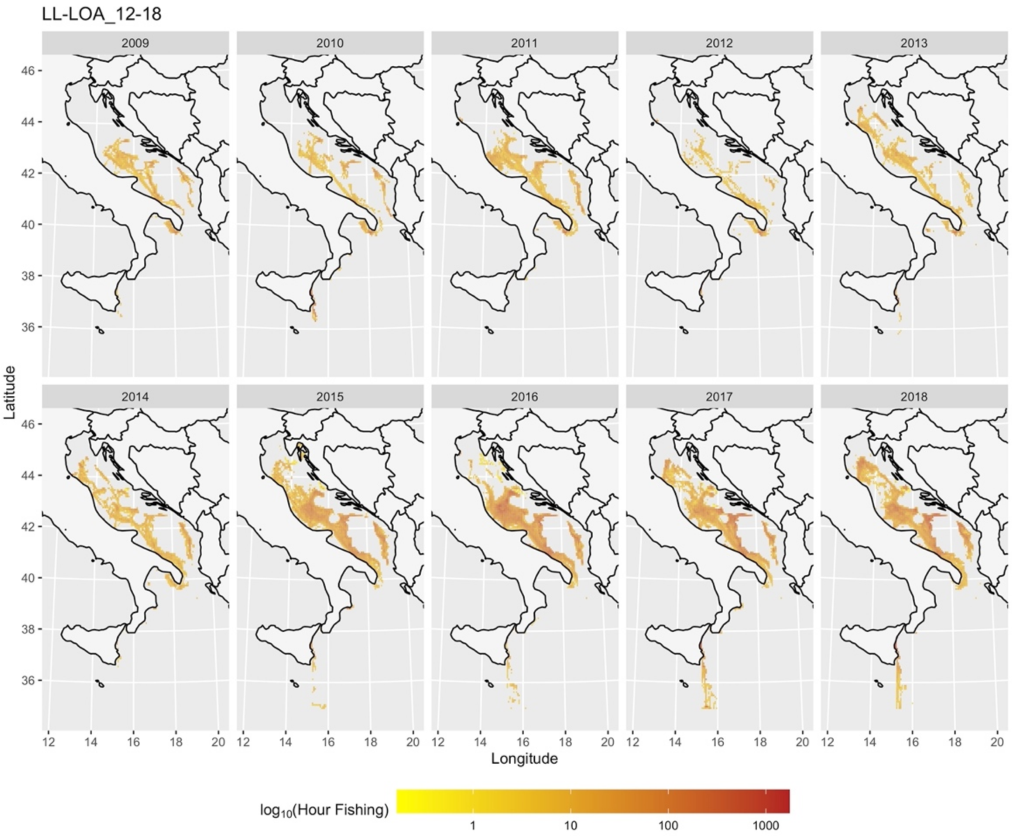


Figure 3.1.D - Total annual effort (hours fishing) deployed by longliners in the length class 12-18 m.

The spatial pattern of effort of the LL fleet, length class 18-24 m, is represented in Figure 3.1.E.

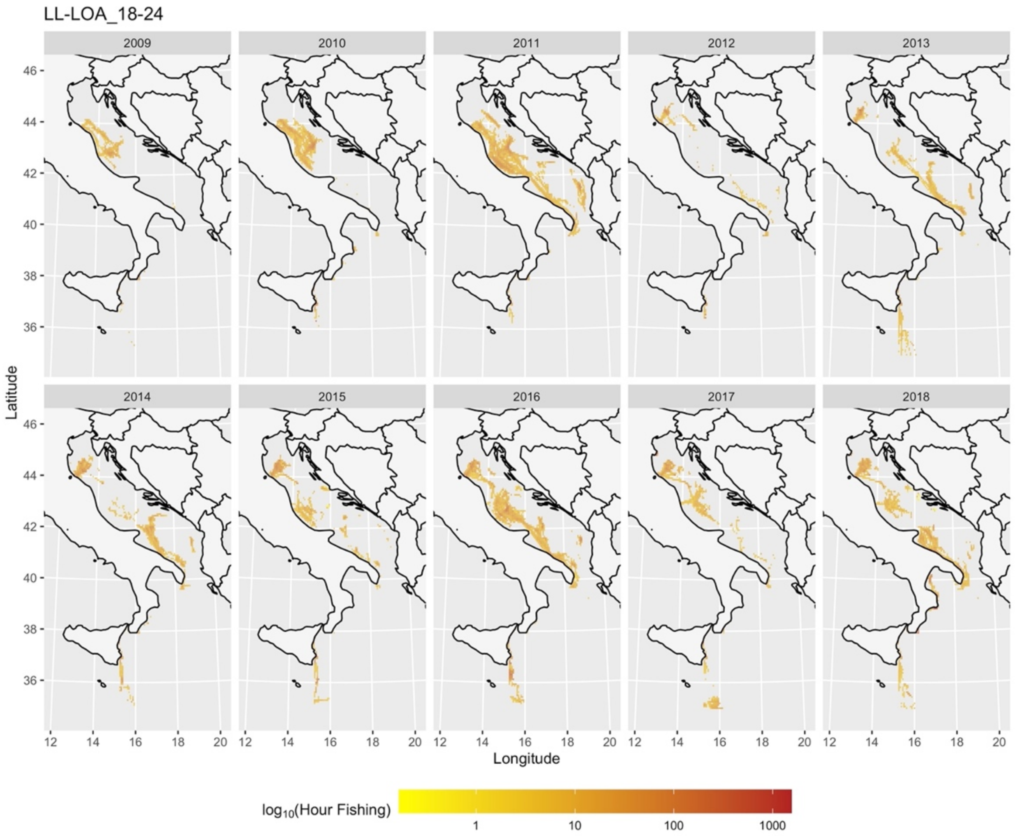


Figure 3.1.E - Total annual effort (hours fishing) deployed by longliners in the length class 18-24 m.

The spatial pattern of effort of the LL fleet, length class 24-40 m, is represented in Figure 3.1.F.

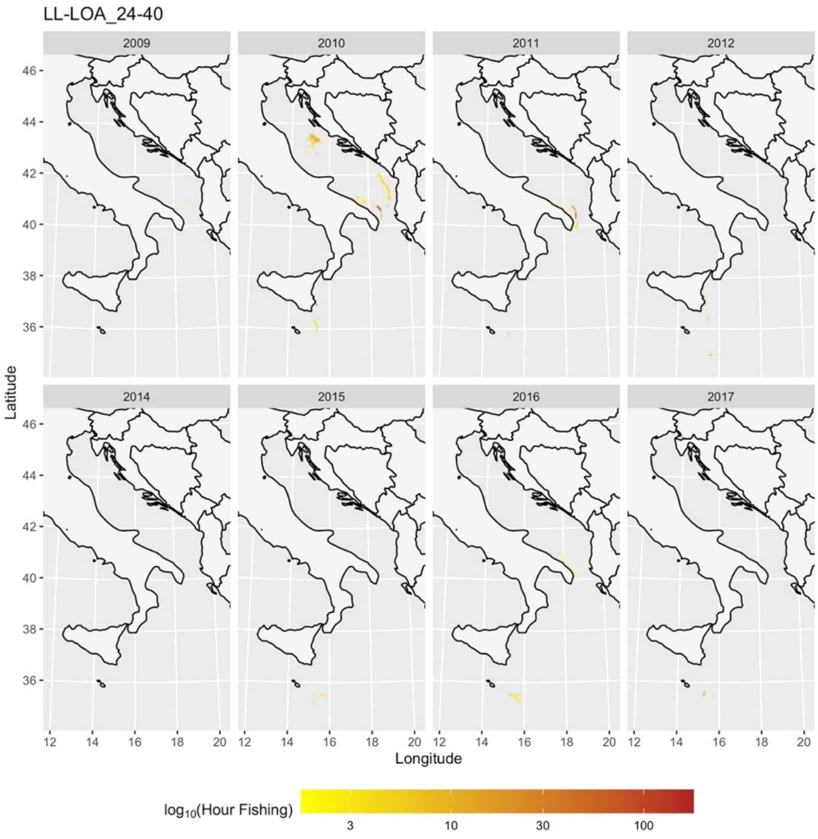


Figure 3.1.F - Total annual effort (hours fishing) deployed by longliners in the length class 24-40 m.

The spatial pattern of effort of the PS fleet, length class 12-18 m, is represented in Figure 3.1.G.

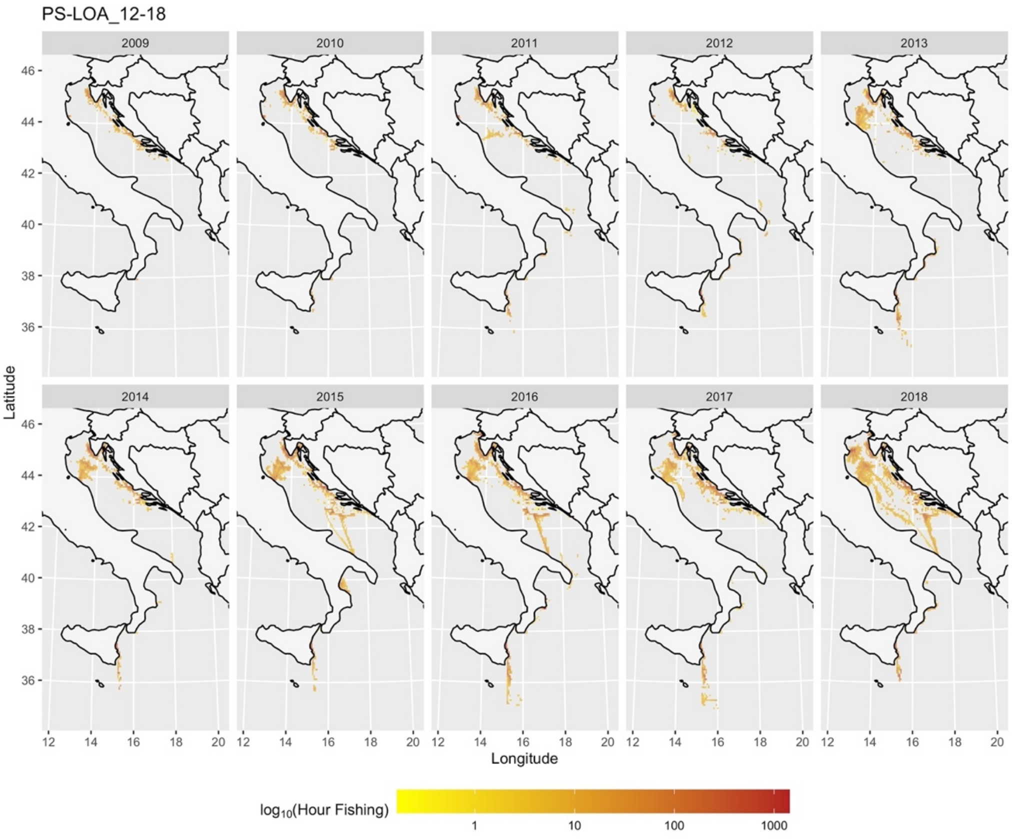


Figure 3.1.G - Total annual effort (hours fishing) deployed by purse seiners in the length class 12-18 m.

The spatial pattern of effort of the PS fleet, length class 18-24 m, is represented in Figure 3.1.H.

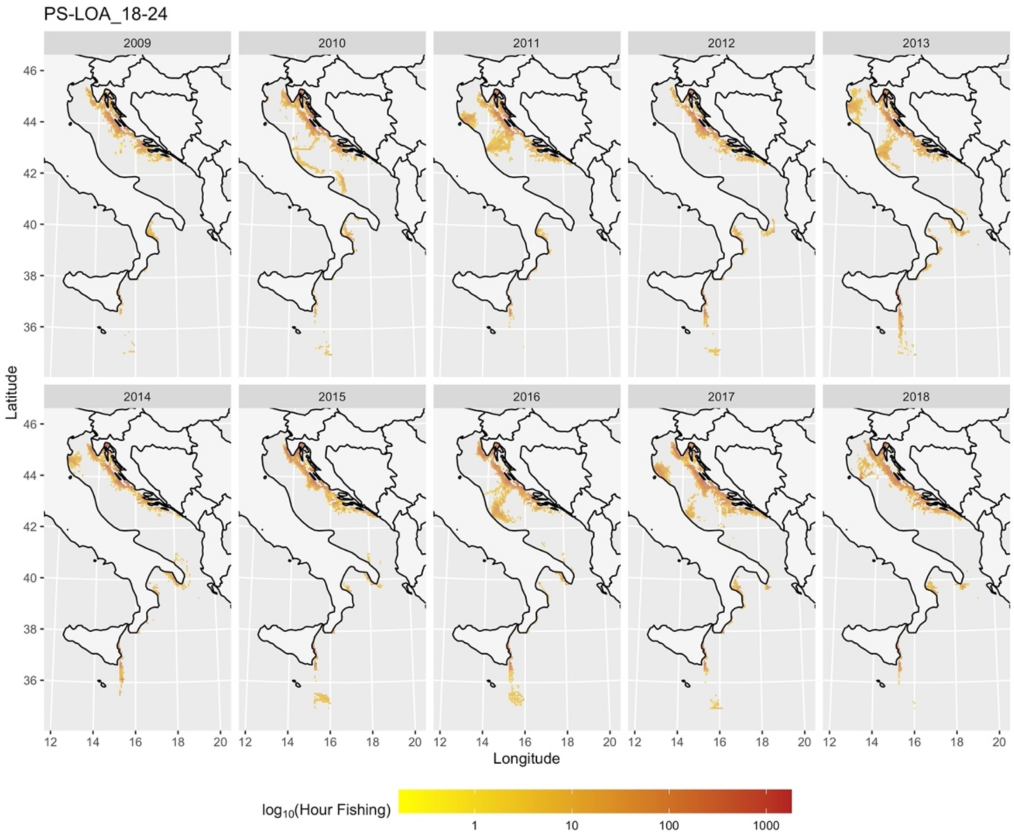


Figure 3.1.H - Total annual effort (hours fishing) deployed by purse seiners in the length class 18-24 m.

The spatial pattern of effort of the PS fleet, length class 24-40 m, is represented in Figure 3.1.I.

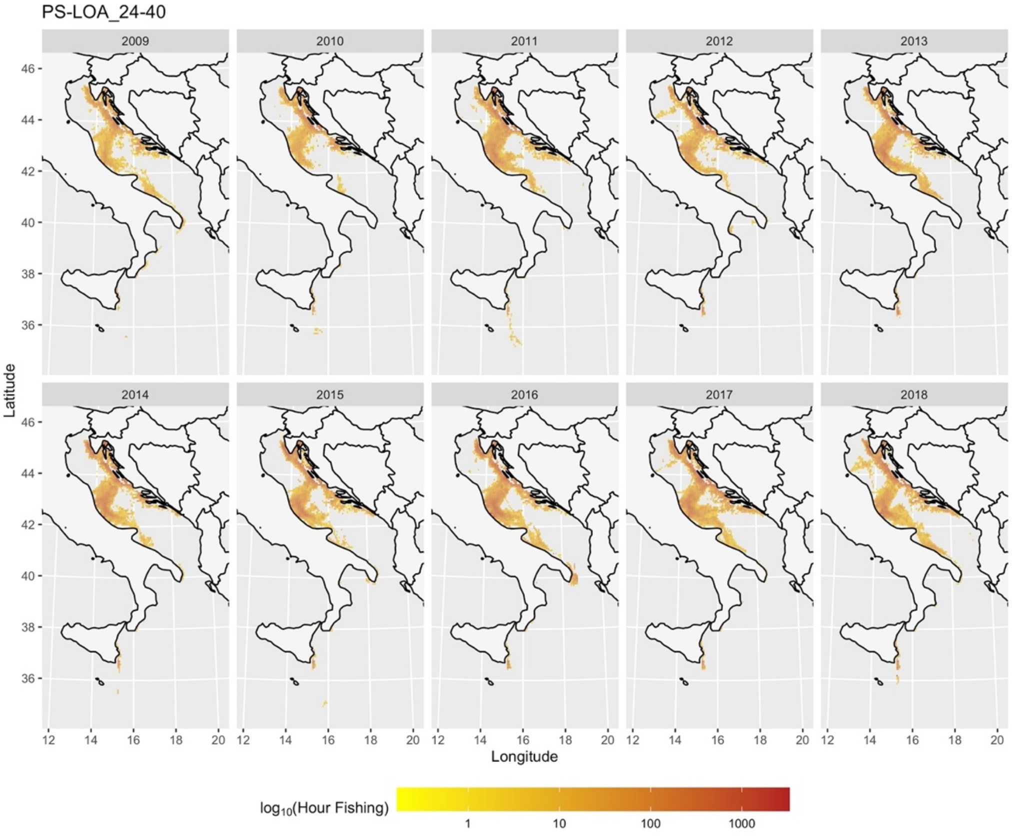


Figure 3.1.I - Total annual effort (hours fishing) deployed by purse seiners in the length class 24-40 m.

The spatial pattern of effort of the PS fleet, length class >40 m, is represented in Figure 3.1.J.

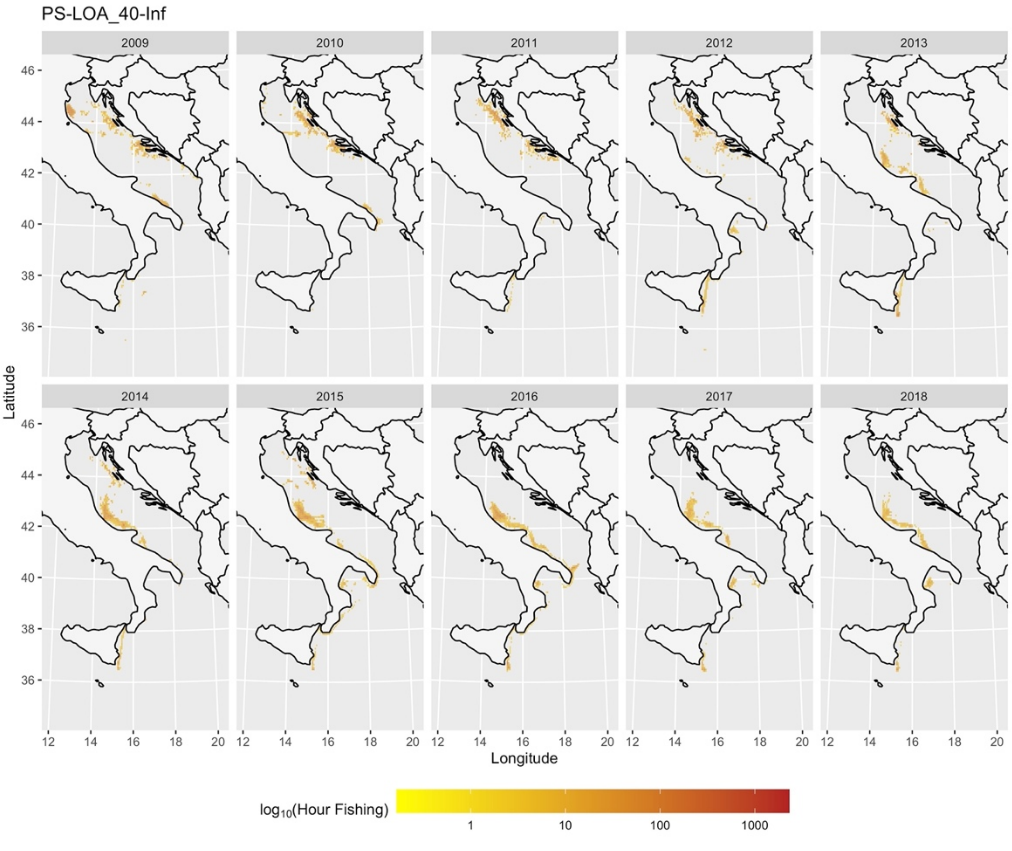


Figure 3.1.J - Total annual effort (hours fishing) deployed by purse seiners in the length class >40 m.

The spatial pattern of effort of the PTM fleet, length class 12-18 m, is represented in Figure 3.1.K.

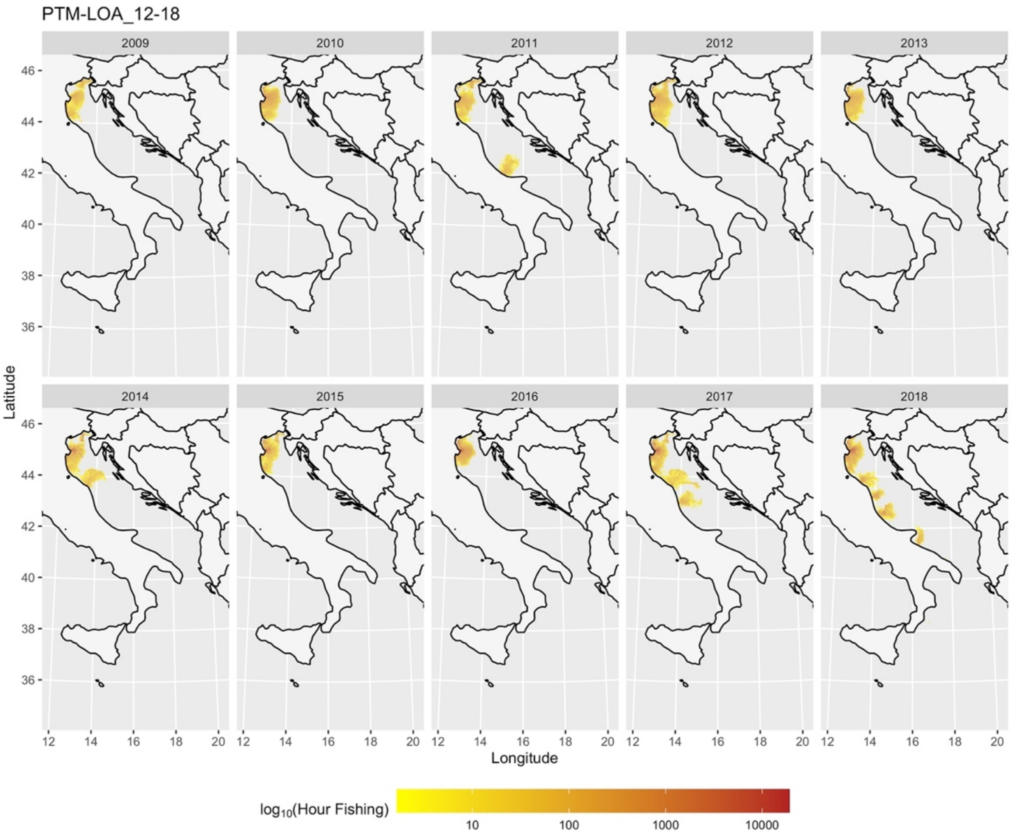


Figure 3.1.K4 - Total annual effort (hours fishing) deployed by pelagic trawlers in the length class 12-18 m.

The spatial pattern of effort of the PTM fleet, length class 18-24 m, is represented in Figure 3.1.L.

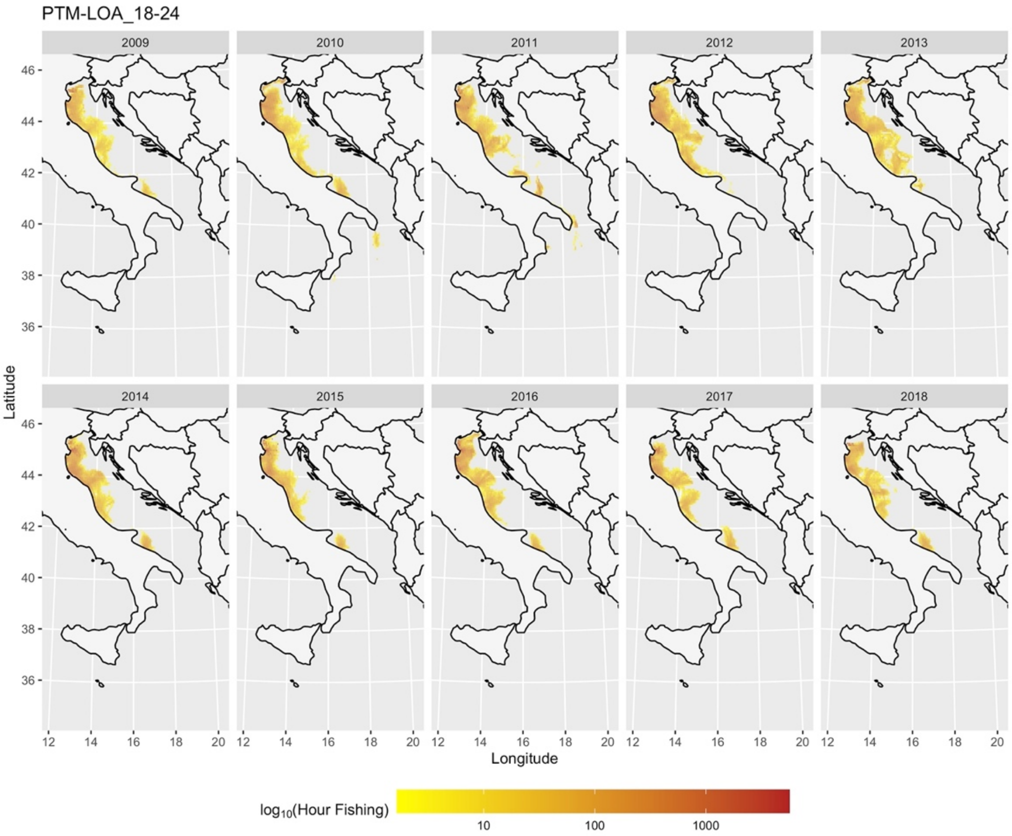


Figure 3.1.L5 - Total annual effort (hours fishing) deployed by pelagic trawlers in the length class 18-24 m.

The spatial pattern of effort of the PTM fleet, length class 24-40 m, is represented in Figure 3.1.M.

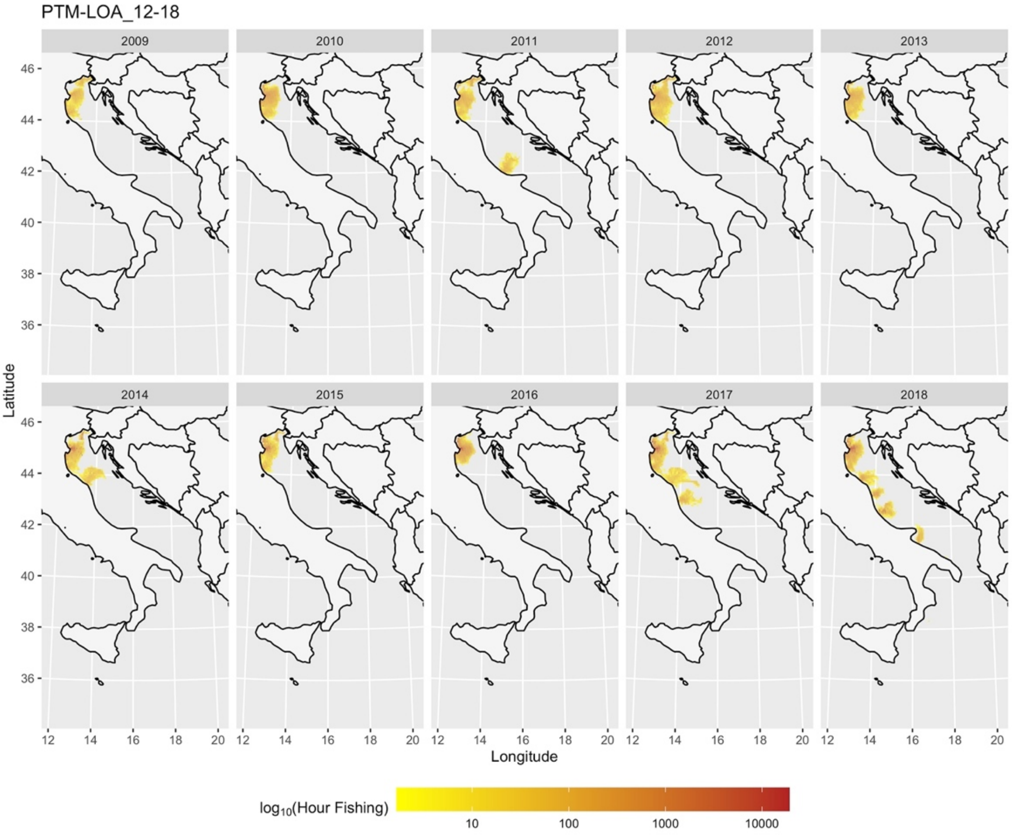


Figure 3.1.M -Total annual effort (hours fishing) deployed by pelagic trawlers in the length class 24-40 m.

The spatial pattern of effort of the TBB fleet, length class 12-18 m, is represented in Figure 3.1.N.

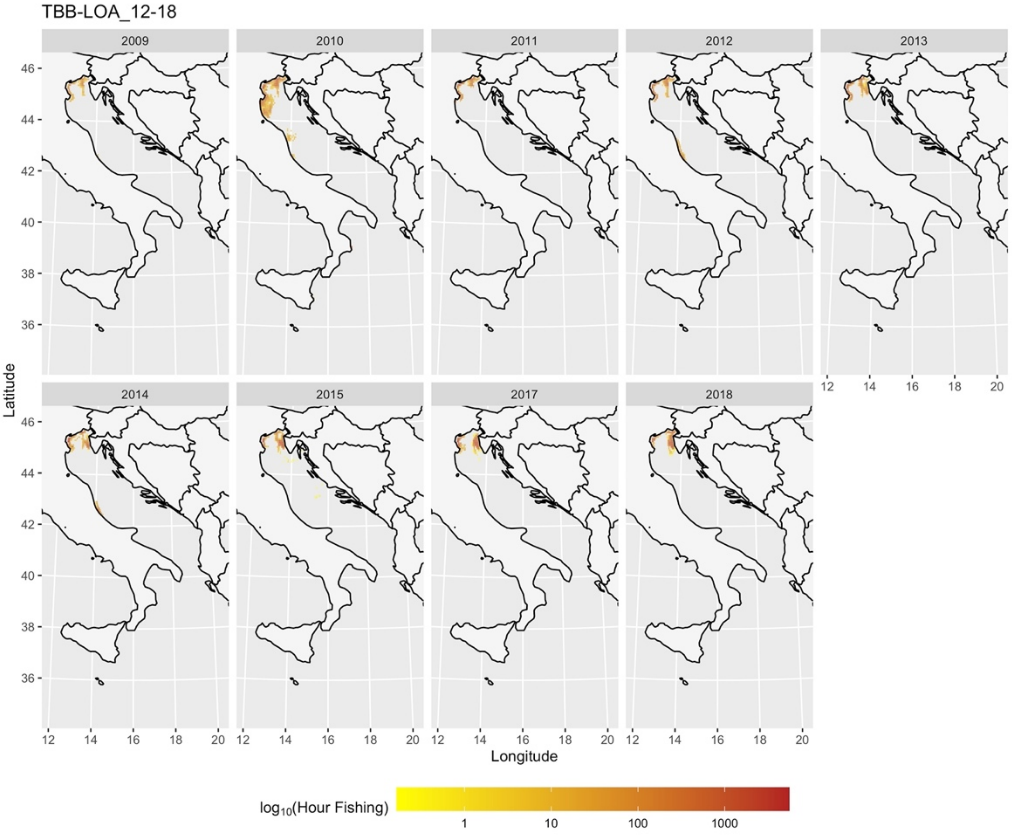


Figure 3.1.N6 - Total annual effort (hours fishing) deployed by beam trawlers in the length class 12-18 m.

The spatial pattern of effort of the TBB fleet, length class 18-24 m, is represented in Figure 3.1.O.

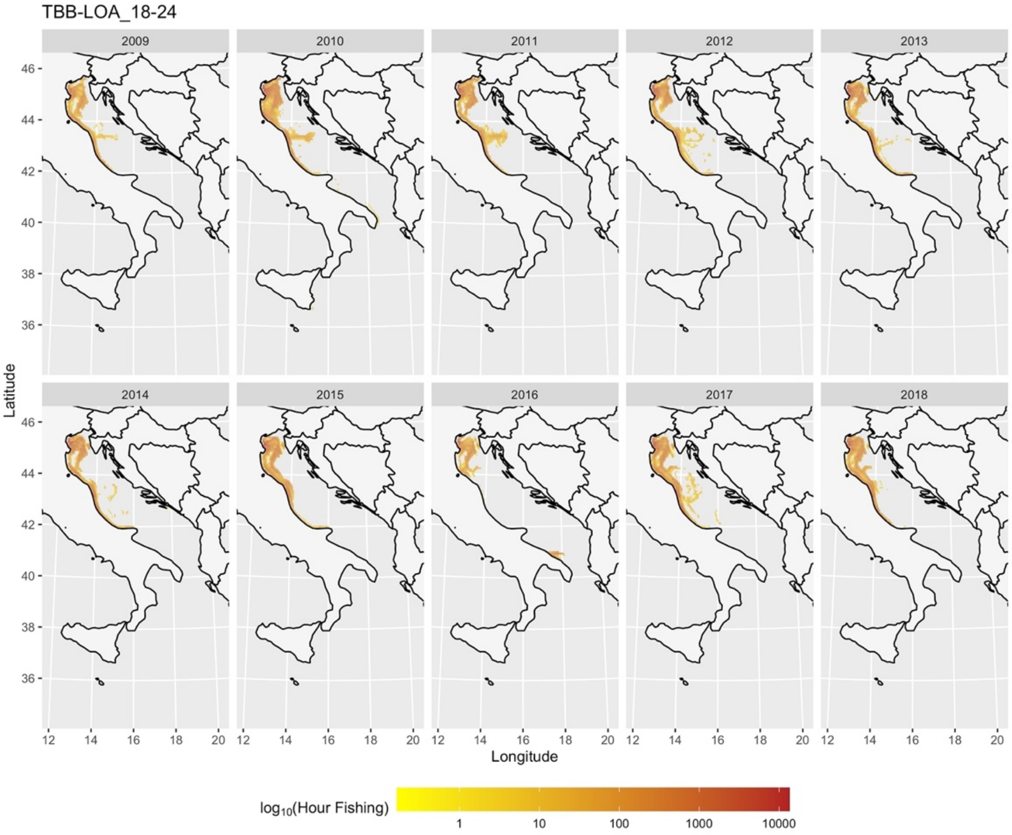


Figure 3.1.07 - Total annual effort (hours fishing) deployed by beam trawlers in the length class 18-24 m.

The spatial pattern of effort of the TBB fleet, length class 24-40 m, is represented in Figure 3.1.P.

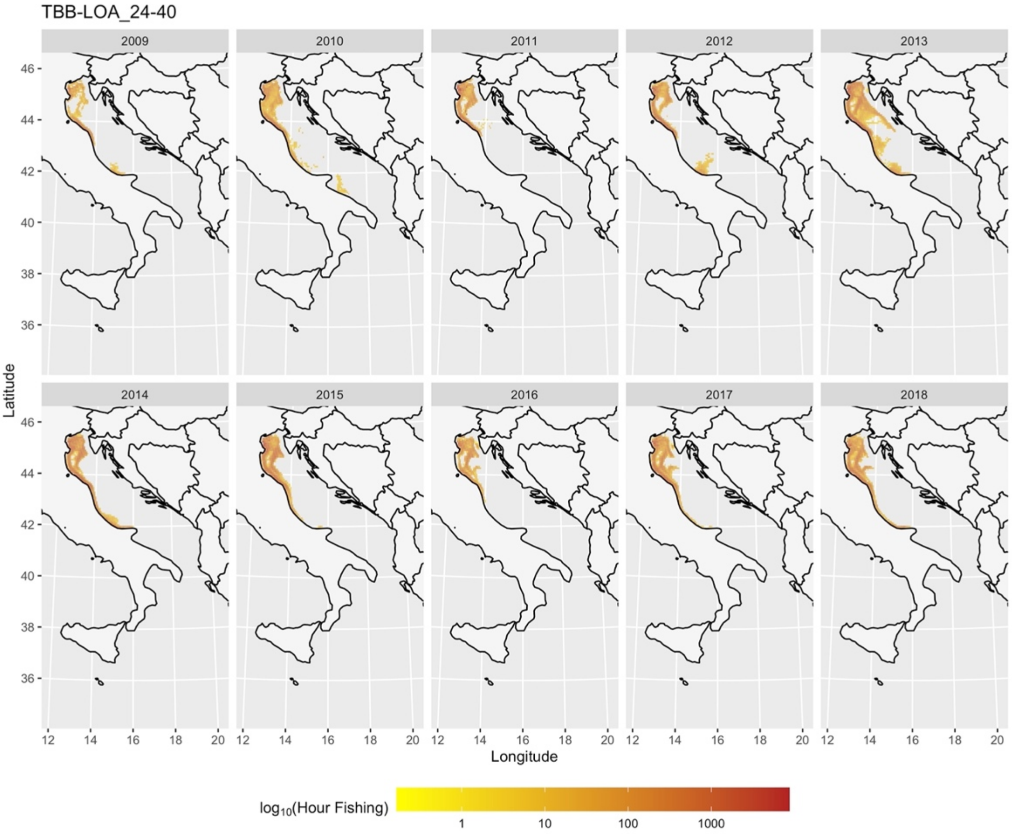


Figure 3.1.P8- Total annual effort (hours fishing) deployed by beam trawlers in the length class 24-40 m.

3.2 Fishing effort: Fleets without VMS/AIS

The application of the Cascaded Artificial Neural Network returned the estimation of the fishing effort represented in Figure 3.2.A. The spatial distribution of fishing effort is depicted with a scaled colour ramp where the effort values range from the dark blue to represent low effort hours and yellow for high values of effort hours. It is important stress that this analysis allowed to estimate an average total annual effort rather than monthly values.

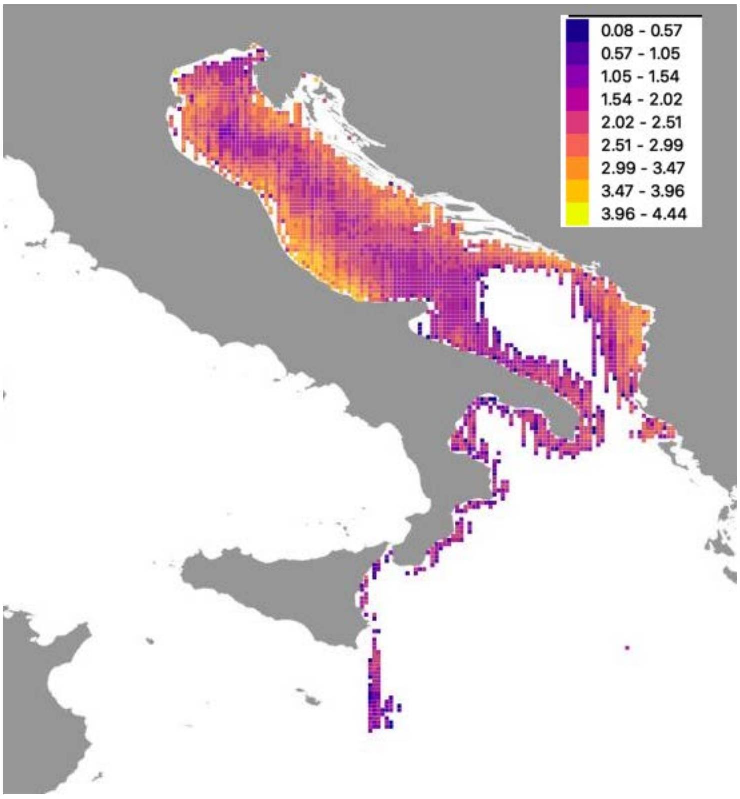


Figure 3.2.A9 - Total annual effort (hours fishing) deployed by trawlers in the length class 12-15 m.

3.3 Fishing effort: Main trends

The visual inspection of the trends of fishing effort (hours fishing) by gear and fleet segment (Figure 3.3.A) indicates that, overall, the annual effort is stably increasing, in the period analysed, in all cases excepting the beam trawling. The largest fluctuations occur for Longliners, and especially for the fleet segment 24-40m.

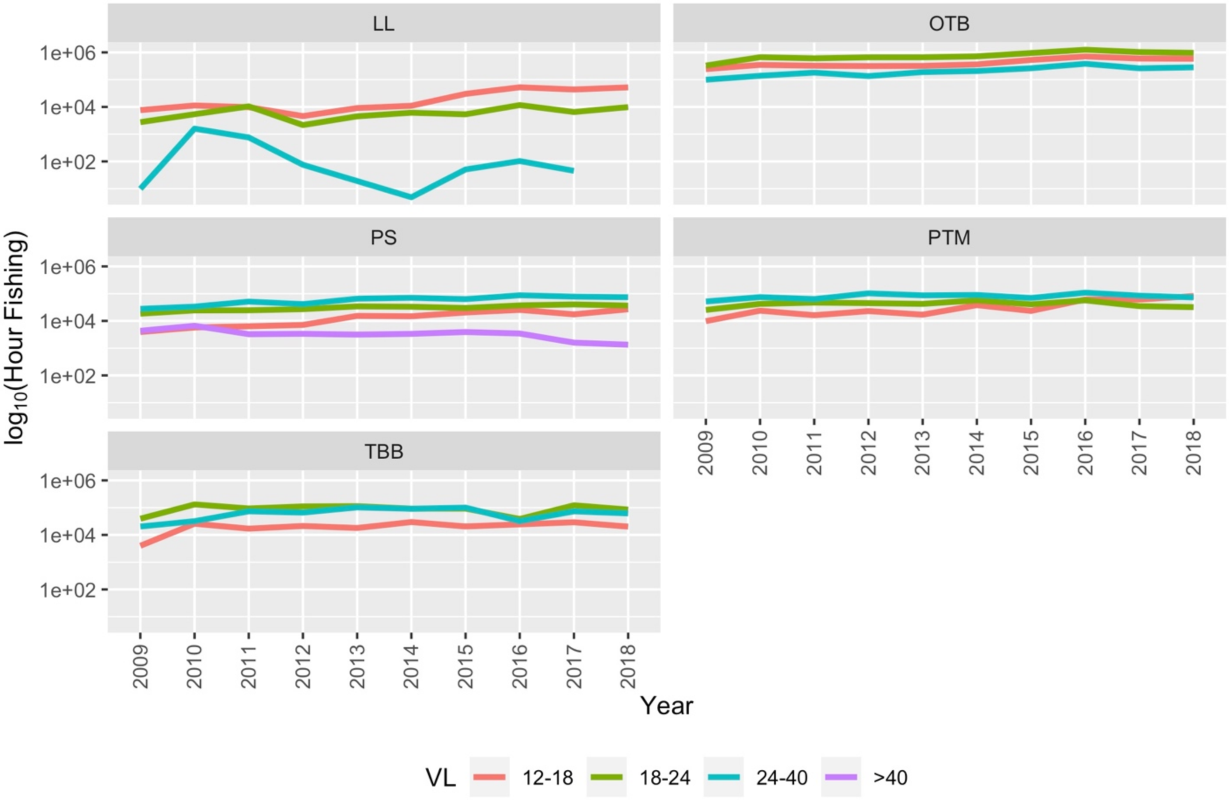
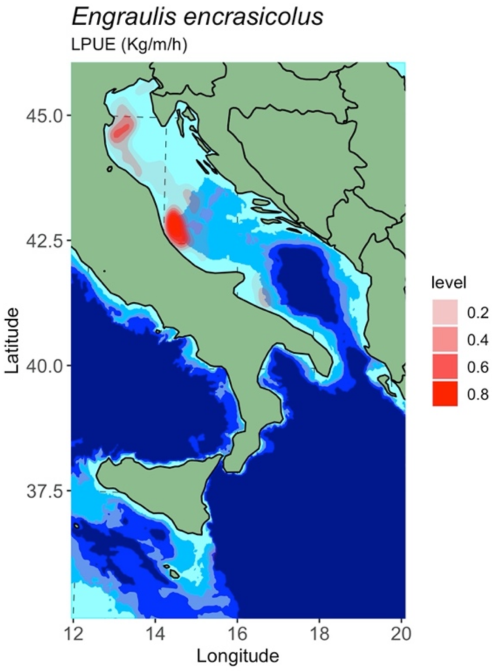


Figure 3.3.A10 – Trends of the total annual effort (hours fishing) by gear and fleet segment.

Looking at the spatial patterns, it is worth noting that there is a gradual increase of the trawling effort in the coastal fishing grounds.

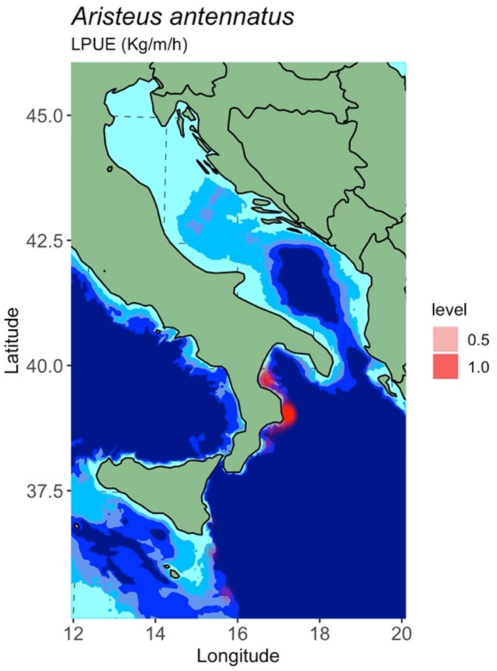
3.4 Estimation of the spatial productivities

The analysis returned a series of matrices containing the LPUE for each cell/month. In this section, a series of maps is used to represent the mean pattern by species. A smoothed surface is used, instead of the grid, to represent the spatial pattern of productivity and to identify areas with different ranges of LPUE, visualized as a colour scale from rose (low) to red (high).



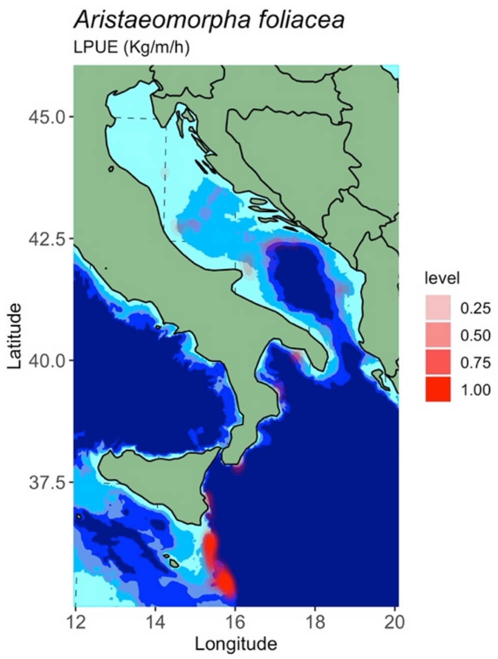
Engraulis encrasicolus

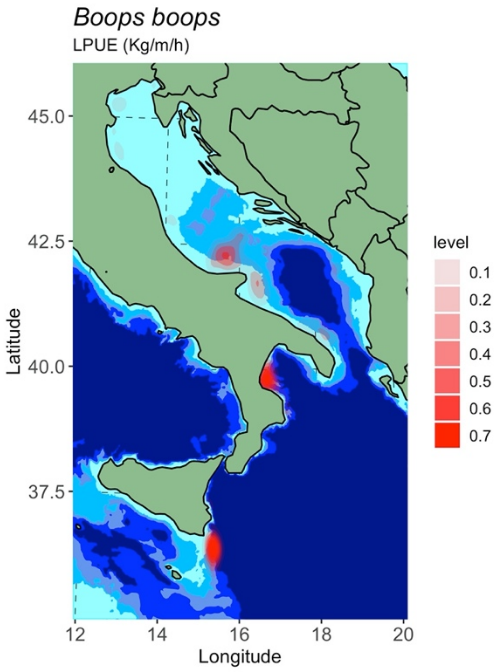
LPUE (Kg/m/h)

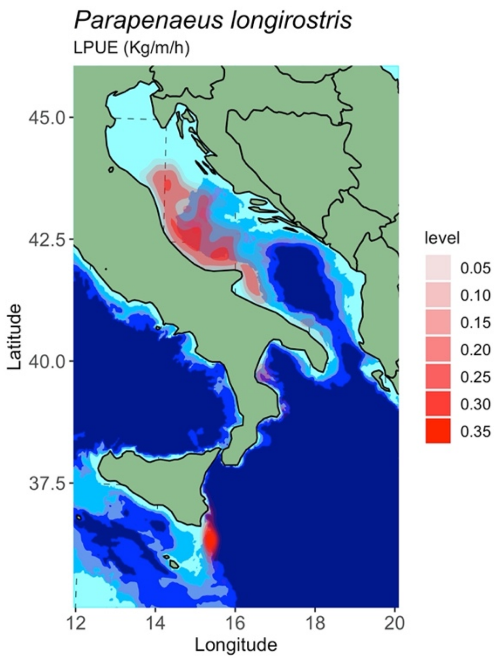


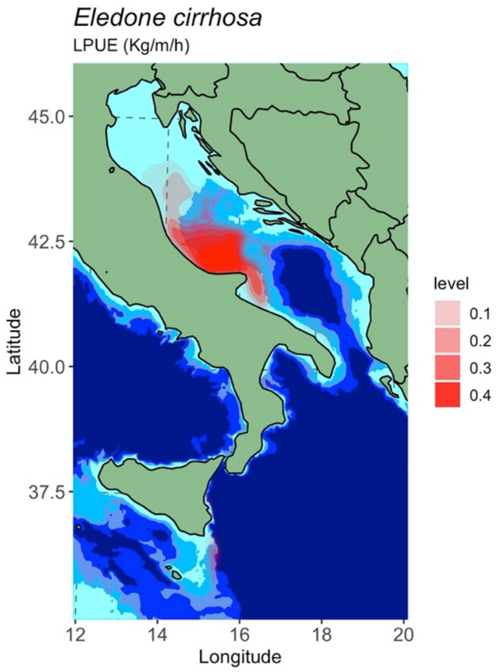
Aristeus antennatus

LPUE (Kg/m/h)


Aristaeomorpha foliacea
LPUE (Kg/m/h)
Latitude
45.0
42.5
40.0
37.5
12
14
16
18
20
Longitude
level
0.25
0.50
0.75
1.00


Boops boops
LPUE (Kg/m/h)
Latitude
45.0
42.5
40.0
37.5
12
14
16
18
20
Longitude
level
0.1
0.2
0.3
0.4
0.5
0.6
0.7


Parapenaeus longirostris
LPUE (Kg/m/h)
Latitude
45.0
42.5
40.0
37.5
12
14
16
18
20
Longitude
level
0.05
0.10
0.15
0.20
0.25
0.30
0.35


Eledone cirrhosa
LPUE (Kg/m/h)
Latitude
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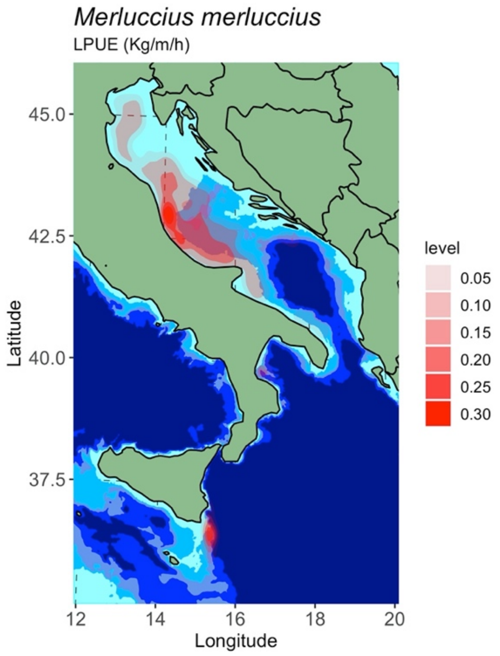
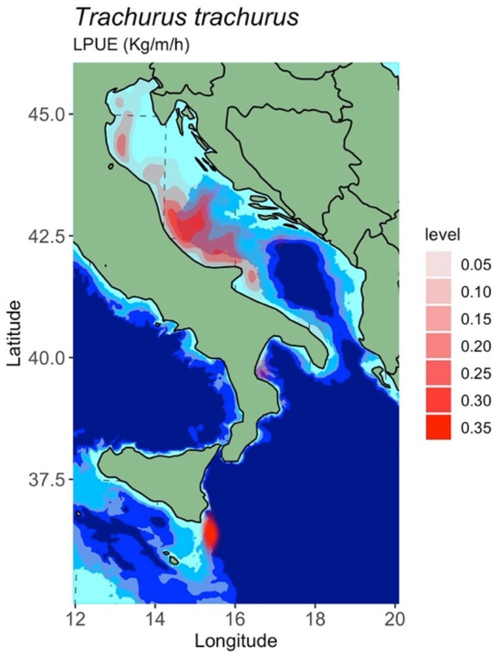
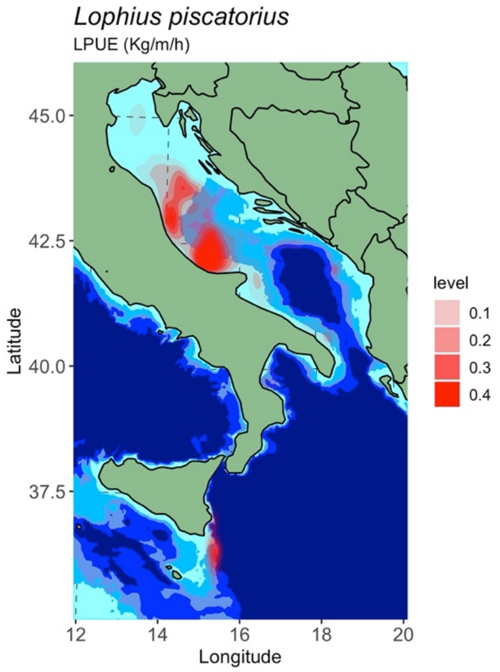
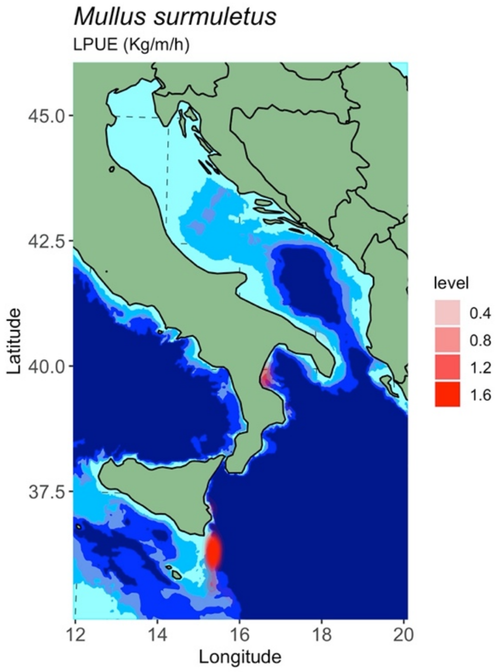
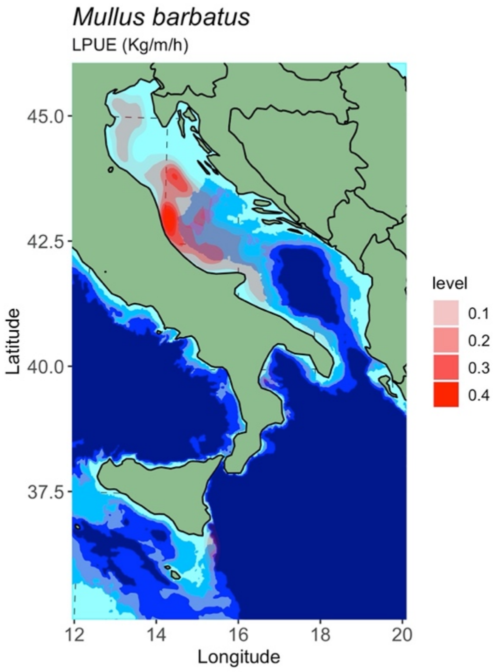
42.5
40.0
37.5
12
14
16
18
20
Longitude
level
0.1
0.2
0.3
0.4


Merluccius merluccius
LPUE (Kg/m/h)
45.0
42.5
40.0
37.5
Latitude
12
14
16
18
20
Longitude
level
0.05
0.10
0.15
0.20
0.25
0.30


Trachurus trachurus
LPUE (Kg/m/h)
45.0
42.5
40.0
37.5
Latitude
12
14
16
18
20
Longitude
level
0.05
0.10
0.15
0.20
0.25
0.30
0.35

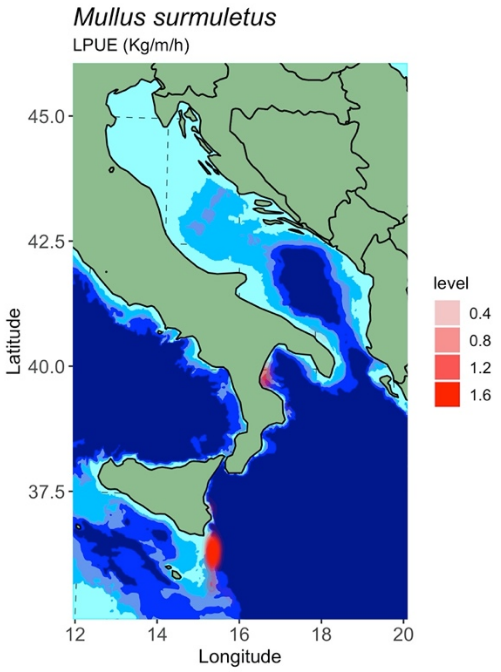

Lophius piscatorius
LPUE (Kg/m/h)
45.0
42.5
40.0
37.5
Latitude
12
14
16
18
20
Longitude
level
0.1
0.2
0.3
0.4


Mullus surmuletus
LPUE (Kg/m/h)
45.0
42.5
40.0
37.5
Latitude
12
14
16
18
20
Longitude
level
0.4
0.8
1.2
1.6



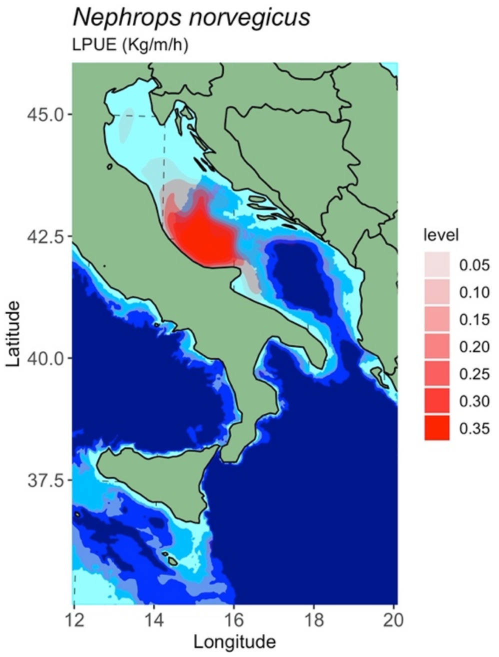
Mullus barbatus

LPUE (Kg/m/h)



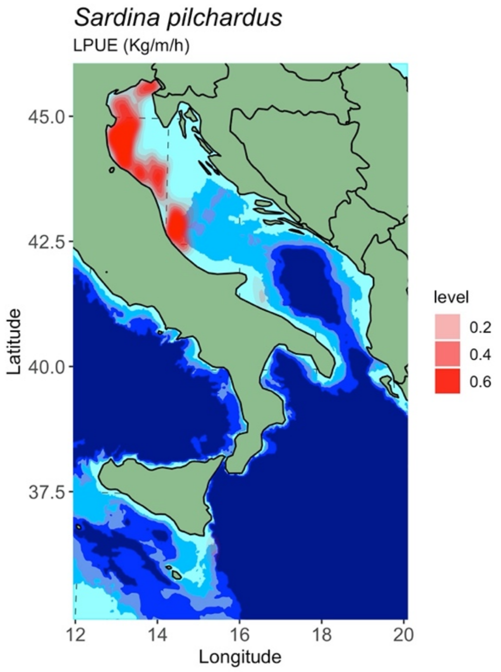
Mullus surmuletus

LPUE (Kg/m/h)



Nephrops norvegicus

LPUE (Kg/m/h)



Sardina pilchardus

LPUE (Kg/m/h)

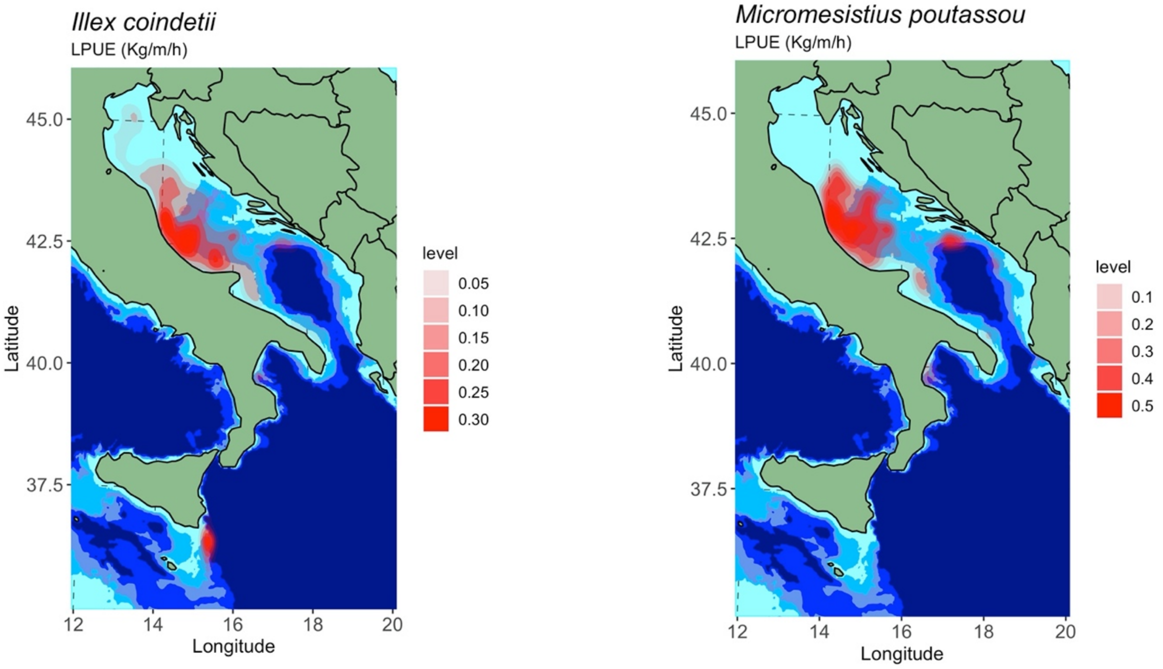


Figure 3.4.11 – Estimated LPUE areas for each species. A) E. encrasicolus; B) A. antennatus; C) A. foliacea; D) B. boops; E) P. longirostris; F) E. cirrhosa; G) M. merluccius; H) T. trachurus; I), L. piscatorius; J) M. surmuletus; K) M. barbatus; L) N. norvegicus; M) S. pilchardus; N) I. coindetii; O) M. poutassou

4 DISCUSSION

Fishing effort for all LOA classes of OTB gear (Fig. 3.1.A, 3.1.B, and 3.1.C) did not show significant changes over the years 2008-2018 from a spatial point of view. On the other hand, fishing activities close to the coast seemed to be intensified. In particular: the 12-18 length class has a minimum of intensity in the year 2008 and then a stable pattern; length class 18-24 shows a diffuse gradual increase of fishing hours in the years 2008-2010 combined with a regression toward the coast within the years 2014-2018; the length class 24-40 has a spatial distribution similar to the class 18-24 but more accentuated with maximum intensity in the years 2010-2011 and 2014-2016.

However, it is important to stress that the actual resolution of these analyses, based on a 5 × 5 Km square grid, does not allow to inspect the changes of fishing effort in the buffer 50m depth / 3 nautical miles, which represents an areas closed to trawl fishing.

Maps representing the part of LL (Fig. 3.1.D, 3.1.E, and 3.1.F) fleet showed a varying pattern of fishing effort over the years, particularly as concerns the spatial distribution. The Italian longliner fleet is mainly comprised within the 12-18 and 18-24 length classes, which shows a similar spatio-temporal pattern with the greater intensity deployed in the years 2015-2018 and an expansion of their activity northward. Instead, the maps of the length class 24-40 show few observations, indicating the low number of vessels engaged in this fishery observed by the AIS/VMS system.

PS fleet (Fig, 3.1.G, 3.1.H, 3.1.I, and 3.1.J) showed an increased effort activity for the lowest LOA (12-15m) over the time while all other classes showed a more stable pattern from both a spatial and intensity point of view. However, the length class 24-40 deploys the greater fishing intensity compared to the other length segment within the same metier.

The PTM fleet (Fig. 3.1.K, 3.1.L and 3.1.M) is characterised by a stable trend both temporally and spatially. Worth noting the distinct spatial footprint of the 12-18 length class, confined mostly only in the upper portion of the GSA 17 with sporadic southern activities. Instead, with a similar pattern, the length classes 18-24 and 24-40 are observed further south along all the Italian coasts of the GSA 17 and only a few vessels operating in the GSA 18.

TBB fishing effort showed instead an increasing pattern only for the LOA class of 24-40m (Fig. 3.1.N, 3.1.O and 3.1.P). The length classes distribution follows a similar trend as seen for the other metier, with the smaller vessels operating mostly in the upper region of the GSA 17, while only the larger ones reach the GSA 18.

Estimated values predicted by the CMNP model (Fig 3.2.A) showed that the effort for the 12-15m LOA vessels is intensified for the areas closest to the coast, particularly for the Italian and Croatian coasts of the GSA 17.

Estimated LPUE areas for *E. encrasicolus* (Fig. 3.4.A) are concentrated in the western part of the GSA 17*; A. antennatus* LPUE (Fig. 3.4.B) are centred in the Ionian Sea, particularly in the Gulf of Taranto. *A. foliacea* (Fig. 3.4.C) highest values of LPUE are present in the Strict of Sicily while both *B. boops* (Fig. 3.4.D) and *M. surmuletus* (Fig. 3.4.J) showed high values both for the Strict of Sicily and the Gulf of Taranto (GSA 19). LPUE estimated values for *P. longirostris* (Fig. 3.4E), *E. cirrhosa* (Fig. 3.4.F), *M. merluccius* (Fig. 3.4.G), *T. trachurus* (Fig. 3.4.H), *L. piscatorius* (Fig. 3.4I), *M. barbatus* (Fig. 3.4.K), *N. norvegicus* (Fig. 3.4.L), *I. coindetii* (Fig. 3.4I) and *M. poutassou* (Fig. 3.4O) are all concentrated in the south-western part of the GSA 17. *S. pilchardus* (Fig. 3.4.M) estimated LPUE showed instead the highest values in the northern part of the GSA17.

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