Database of environmental conditions relevant for the habitat suitability of target organisms

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Summary

1. Abstract

This report describes the database of environmental data and target species data relevant for the habitat suitability modelling. All data layers have been gathered, prepared and shared through Google Drive and are available to all project partners.

2. Introduction

One of the aims of the project is to collect data on environmental conditions that may affect the soundscape profiles. This includes data on commercial shipping in the study area from the AIS and VMS tracking systems. Moreover, data on recreational boating will be collected from land- based observations using a theodolite and based on the assessment of the over-night stays of recreational boats in local marinas and harbours, in collaboration with Harbour authorities. Furthermore, the sensitivity to environmental parameters including chlorophyll, bathymetry, temperature, salinity, currents and sea floor sediment type will be assessed based on the existing literature and data available in order to evaluate the habitat quality.

3. Database description

3.1 Environmental database

Summaries of the collected database to develop the habitat model, including the relevant information (i.e. year, spatial and temporal resolution) were shown in Table 1 and 2. Detailed information are available if the data are from satellite or calculated by numerical models. Each variable was transformed into GeoTIFF format. For data from numerical models, the yearly average was calculated and successively the first layer or the vertical average from 0 to 300 m was extracted.

Table 1: Description of data in the environmental database

								Temporal resolution	Horizontal resolution	Vertical Layers	Vertical Range	
Sediment distribution	Distribution of sediment grainsize as mean diameter (d50) using phi	D50, phi	-	-	tiff	Adriatic	Adriatic	static	0.02 x 0.02 m	1	1	ISMAR
	Monthly Multi-sensor and multi water-type Chlorophyll a concentration											
	Multi-sensor and multi water-type Standard Deviation Of Monthly	CHL_error	milligram m^-	-	nc	Med	Adriatic	monthly [12 rec]	2 km	-	-	copernicus
	Multi-sensor and multi water-type Number Of Observations Of	CHL count	1	-	nc	Med	Adriatic	monthly [12 rec]	3 km	-	-	copernicus
	OLCI Monthly Sentinel-3A multi water-type Chlorophyll a concentration	CHL	milligram m^-	-	nc	Med	Adriatic	monthly [12 rec]	4 km	-	-	copernicus
	OLCI Sentinel-3A multi water-type Standard Deviation Of Monthly	CHL_error	milligram m^-	-	nc	Med	Adriatic	monthly [12 rec]	5 km	-	-	copernicus
	OLCI Sentinel-3A multi water-type Number Of Observations Of	CHL count	1	-	nc	Med	Adriatic	monthly [12 rec]	6 km	-	-	copernicus
dissolved O2	Mole concentration of Dissolved Molecular Oxygen in sea water	O2	mmol m^-3	Jan-Dec 2019	nc	Med	Adriatic	monthly mean	1/24 degree	-	-	copernicus
net primary production	Net primary production of biomass expressed as carbon per unit volume in sea water	nppv	mg m^-3 day-1	Jan-Dec 2019	nc	Med	Adriatic	monthly mean	1/24 degree	-	-	copernicus
dissolved O2	Mole concentration of Dissolved Molecular Oxygen in sea water	O2	mmol m^-3	Jan 2019 - Jan 2020	nc	Global	Global	monthly mean	1/4 degree	50	0-5700 m	copernicus
Chlorophyll	Mass concentration of chlorophyll in sea water	CHL	mg m^-3	Jan 2019 - Jan 2020	nc	Global	Global	monthly mean	1/4 degree	50	0-5700 m	copernicus
Phytoplankton	Mole concentration of phytoplankton expressed as carbon in sea water	phyc	mmol m^-3	Jan 2019 - Jan 2020	nc	Global	Global	monthly mean	1/4 degree	50	0-5700 m	copernicus
Phytoplankton	Sea water ph reported on total scale	Ph	1	Jan 2019 - Jan 2020	nc	Global	Global	monthly mean	1/4 degree	50	0-5700 m	copernicus
net primary production	Net primary production of biomass expressed as carbon per unit volume in sea water	nppv	mg m^-3 day-1	Jan 2019 - Jan 2020	nc	Global	Global	monthly mean	1/4 degree	50	0-5700 m	copernicus
Salinity	Sea water salinity	so	0.001	Jan 2019 - Jan 2020	nc	Med	Adriatic	monthly	1/24 degree	141	unevenly spaced	copernicus
Temperature	Sea water potential temperature	thetao	degrees C	Jan 2019 - Jan 2020	nc	Med	Adriatic	monthly	1/24 degree	141	unevenly spaced	copernicus
Temperature at sea floor	Sea water potential temperature at sea floor	bottom	degrees C	Jan 2019 - Jan 2020	nc	Med	Adriatic	monthly	1/24 degree	141	unevenly spaced	copernicus
	Estimated error standard deviation of analysed SST	short analysis error	kelvin	2019	nc	Med	Adriatic	daily	0.0625 x 0.0625 deg	-	-	copernicus
Sea surface temperature	Analysed sea surface temperature	short analysed sst	kelvin	2019	nc	Med	Adriatic	daily	0.0625 x 0.0625 deg	-	-	copernicus
Sound Scape Study Area	Polygon of study area	-	-	-	shp	Adriatic	Adriatic	-	-	-	-	ADRIPLAN Portal

The second table shows the list of presence data that were adopted to develop the model. After the initial run of the model, all the data that were found useful in the model development will also be collected for the year 2020.

Table 2. Data of presence of target species from BWI

Data	Data Description	Variable	Unit	Data Year	File Type	Scale	Area	Temporal resolution	Horizontal resolution	Source
Loggerhead sea turtle	Presence of loggerhead sea turtle	-	-	2019-2020	shp	Adriatic	Adriatic	Jul, Aug 2019 & Feb-Apr 2020 (possible	1x1 km	BWI
Bottom Trawler	Encounter rates of bottom trawler	-	-	2019-2020	shp	Adriatic	Adriatic	Jul, Aug 2019 & Feb-Apr 2020 (possible winter and summer season)	1x1 km	BWI
Research Effort	Survey lines of boat surveys by BWI			2019-2020	shp	Adriatic	Adriatic	Jul, Aug 2019 & Feb-Apr 2020 (possible winter and summer season)	-	BWI
Sea Turtles	Loggerhead sea turtle presence from application	-	-	2019-2020	shp	Adriatic	Adriatic	Jul, Aug 2019 & Feb-Apr 2020 (possible winter and summer season)	point layer	BWI
Trawler	Presence of bottom trawler	-	-	2019-2020	shp	Adriatic	Adriatic	Jul, Aug 2019 & Feb-Apr 2020 (possible winter and summer season)	point layer	BWI
Common Bottlenose Dolphin	Presence of Common Bottlenose Dolphins	-	-	2019-2020	shp	Adriatic	Adriatic	Jul, Aug 2019 & Feb-Apr 2020 (possible winter and summer season)	1x1 km	BWI

3.2 Environmental data

According to literature research, the following environmental factors are relevant for habitat suitability models for the target species considered in the SOUNDSCAPE project: 1) Density anomaly, 2) Gradient of density anomaly, 3) Oxygen saturation, 4) Mean water temperature, 5) Depth, 6) Distance from the coast, 7) Habitat area of prey and 8) Sediment type (Bearzi et al., 2008; Ingram and Rogan, 2002; La Manna et al., 2016; Bonizzoni et al., 2019).

The density anomaly and gradient of density can be calculated or directly considered by the temperature and salinity distribution. The oxygen saturation represents a proxy for primary production, together with chlorophyll A and phytoplankton distribution. These layers are proxy for habitat areas of prey of the target species. Moreover, we considered the bathymetry as an indicator of target species (dolphin and turtle), assuming that they are generally concentrated within the100 m isobath and not deeper than 200m. The sediment type is considered because of the preference of target species to fine sand. The distance from the coast has to be calculated on the basis of presence data.

Once available, the maps of underwater noise simulated around the most sensitive frequency for the target species (250 Hz and 4000 Hz) will be also be included in the model. Finally, the distribution of small-scale fishery and trawling activity as additional relevant information will also be considered in the model.

3.2.1 Bathymetric data

The bathymetry data for the Adriatic Sea was downloaded from the EMODNET repository (https://www.emodnet-bathymetry.eu/data-products). The latest bathymetric data was published in mid-September 2018 with high resolution of 1/16 x 1/16 arc minutes. In the EMODNET website, Adriatic Sea was composed of three DTM tiles namely E5, E6, and F5. These tiles were mosaiced into one DTM image as shown in Figure 1. Depths in the Northern Adriatic are relatively lower (< -50 m) compared to the southern part of the basin. Shallower depths were observed along the Italian coast, especially from Rimini to Trieste, in contrast to the Croatian coastal areas. In the southern area of the Adriatic, deeper depths of more than -100m were common off the coast (50-100 km from the coast) of Italy and along the coast of Croatia.

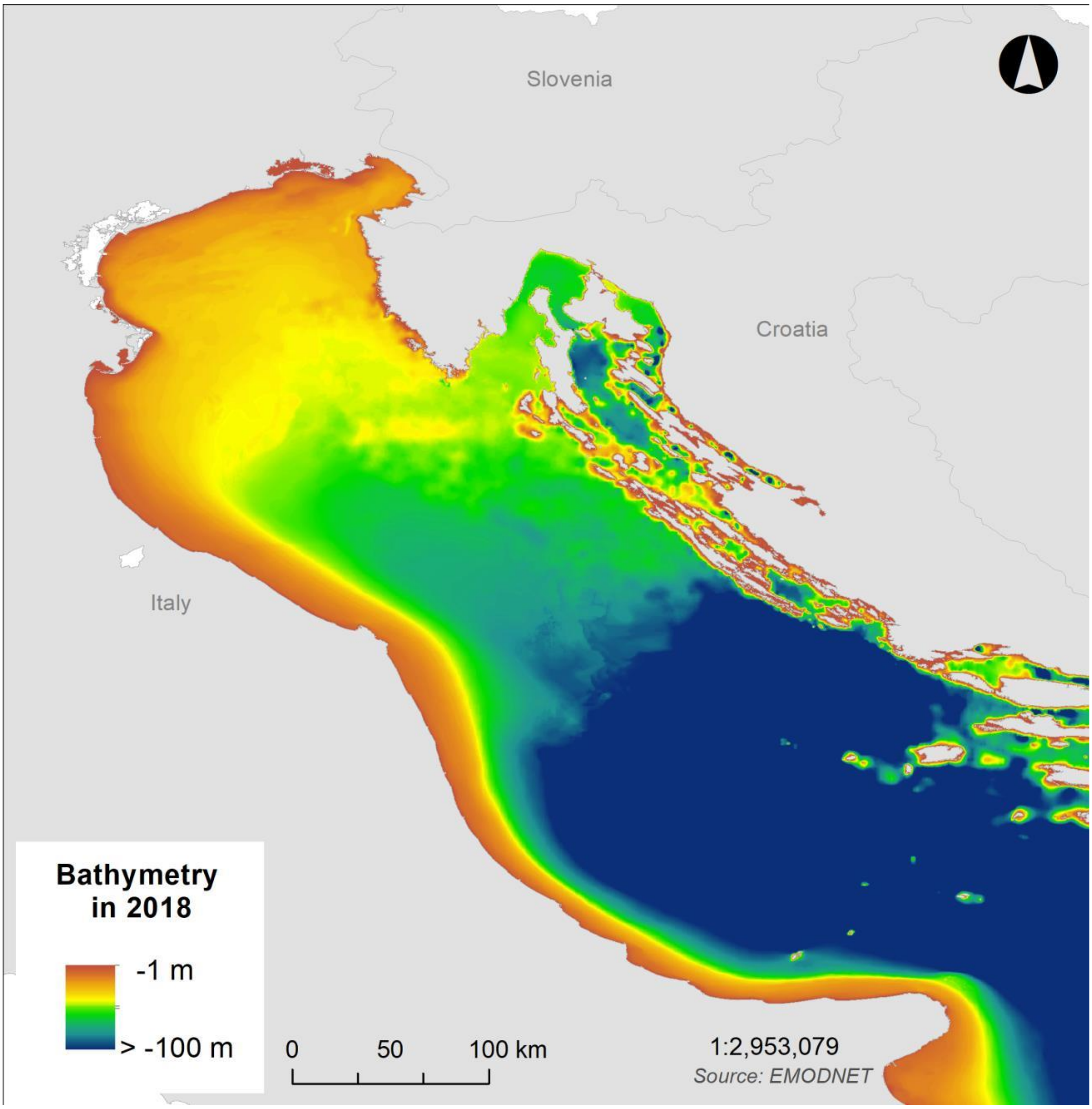


Figure 1. Bathymetric data of Northern Adriatic in 2018. Data downloaded from EMODNET.

3.2.2 Sediment Grainsize Distribution

Distribution of sediment grainsize as mean diameter (d50) using phi is shown in Fig. 2. The map of sediment distribution was from the integration of the latest data acquired in the Adriatic by ISMAR with a d50 database for the basin. The recent data and d50 database were interpolated using the ArcGIS Geostatistical Analyst tool, Kriging (simple). The processing of data was done in collaboration with researchers of INSTARR (Institute for Arctic and Alpine Research) Colorado, University of Colorado at Boulder European projects EURODELTA, and EUROSTRATAFORM PROMESS1 and PALICLAS. The data was downloaded from the EMODNET-Geology (https://www.emodnet-geology.eu/map-viewer/?p=seabed_substrate).

Finer sediments characterized the Italian seafloor, where mean grainsize of 4-8 phi (very fine sand to very-fine silt) were dominant. The finest sediment was distributed in the more western portion of the basin where the river Po delta and Apennine rivers pile up their sediment input. In the deep basins, Meso-Adriatic Depression, and the south Adriatic basin the surface sediments are predominantly fine. In contrast, the sediment composition in the Croatian seafloor was dominated by very coarse sand to fine sand. The axial shallow northern and central shelf is mainly characterized by fine sands to sands with more coarse material around the eastern coast of the basin.

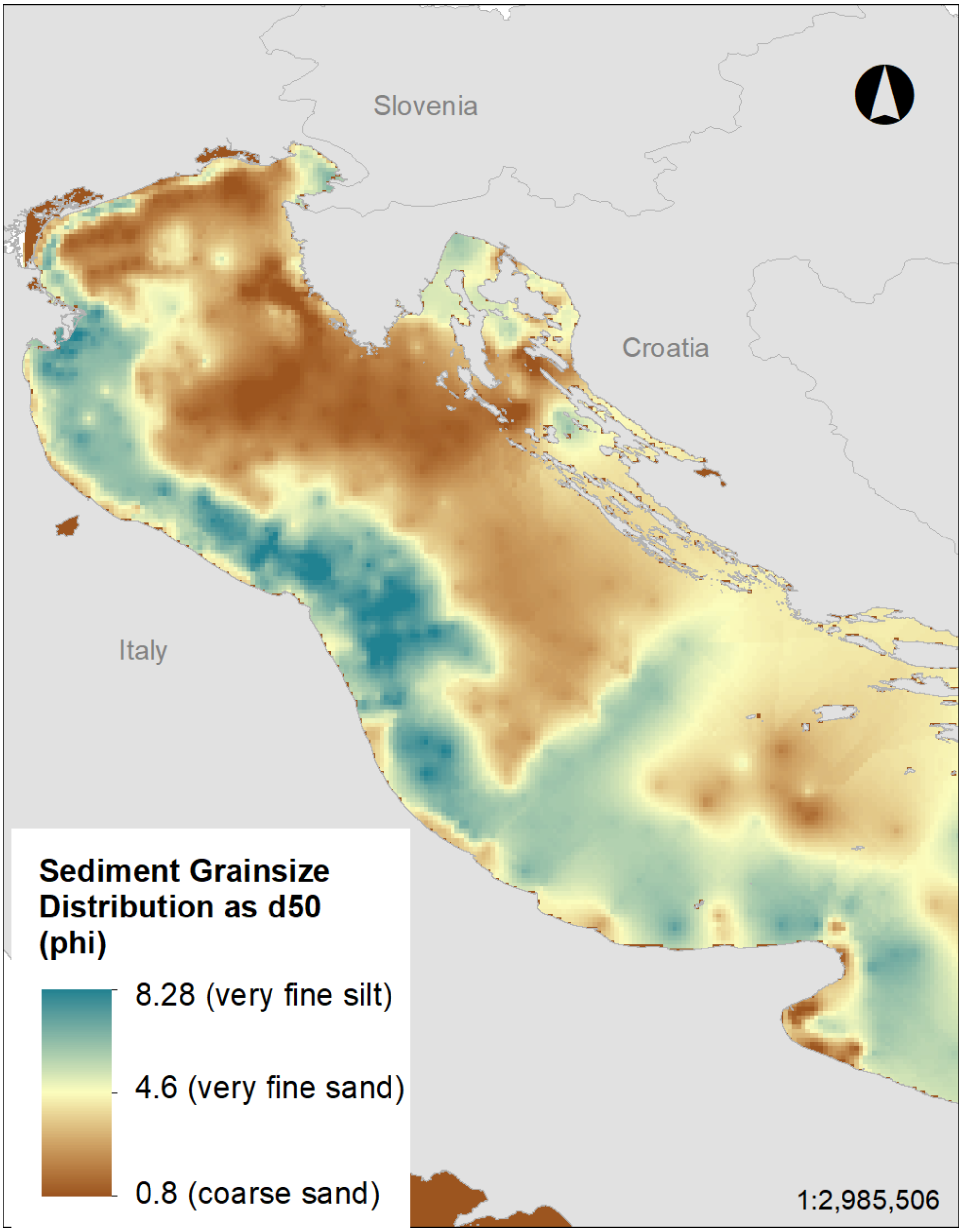


Figure 2. Sediment grainsize distribution in Northern Adriatic presented by mean grainsize (d50). Data was downloaded from EMODNET-Geology: https://www.emodnet-geology.eu/map-viewer/?p=seabed_substrate.

3.2.3 Temperature

Sea surface temperature of the Northern Adriatic in 2019 were derived from hydrodynamic numerical models that were retrieved from E.U. Copernicus Marine Services Information. One of our aims is to evaluate two habitat suitability models. The first one will be derived from the surface layer of the model, and the second will be constructed using the vertical average of the first 300 m of the model data. The vertically averaged layer will provide information on the influence of temperature of the deeper layer on the surficial assessment. We have observed a difference in SST values between the surface and vertically average data (Fig. 3). Sea surface temperature from the first layer of the model have lower values than the vertically averaged data. This indicate that when using the vertically averaged values of the model, temperature in the Northern Adriatic is warmer, which can influence the result of the habitat suitability model.

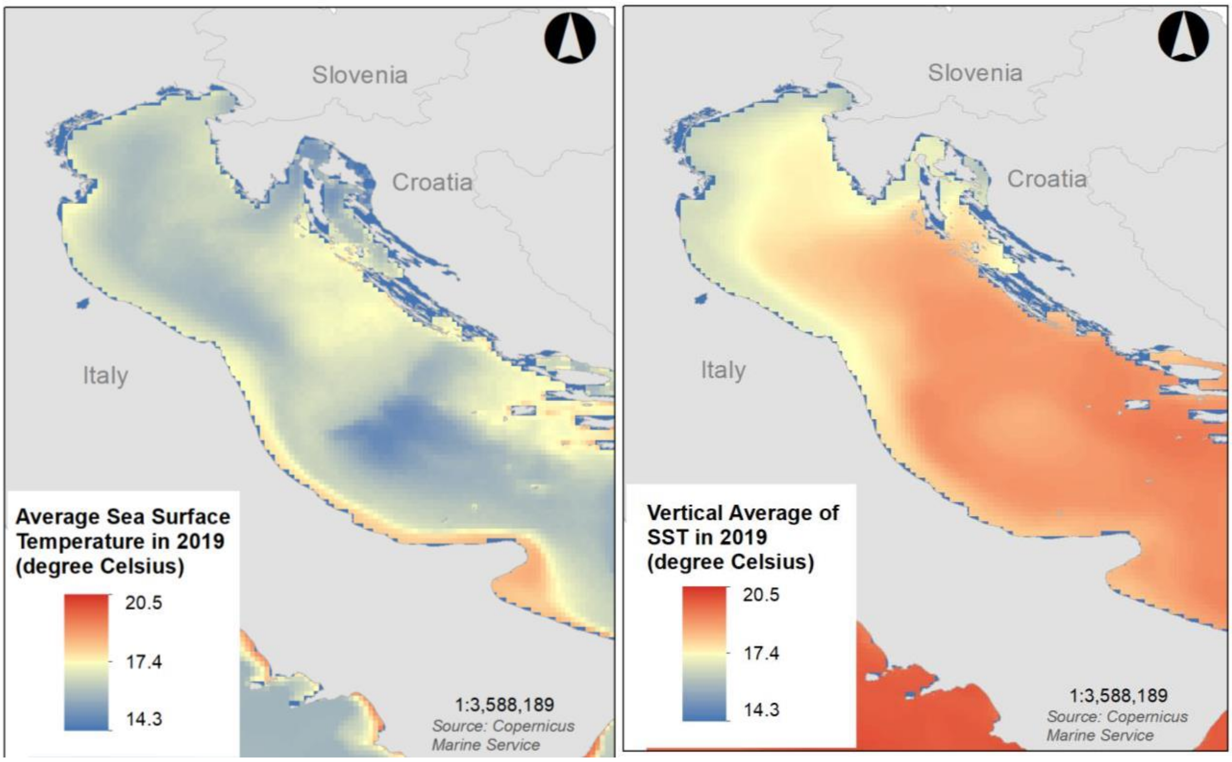


Figure 3. (left) Average sea surface temperature in 2019 derived from the first layer data of the model; (right) vertical average (0.300m) of the data from the numerical model.

We included also in the database the remotely sensed Sea Surface Temperature products by COPERNICUS service. The data are developed with high resolution in the Mediterranean area based on the night times images. The comparison between yearly average satellite temperature and the data provided as first layer temperature by the numerical model indicates that the distributions and values are comparable.

3.2.4 Salinity

Dolphin presence was found to be abundant in areas with brackish water (Ingram and Rogan, 2002), therefore the influence of salinity values should be considered in the habitat suitability models. In this regard, we obtained the seawater salinity data from the numerical models developed for the Mediterranean Forecasting System (Med-Currents). The data was generated by the E.U. Copernicus Marine Service Information. It is a coupled hydrodynamic-wave model implemented over the whole Mediterranean Basin with a horizontal grid resolution of 1/24˚ (ca. 4 km) and has 141 unevenly spaced vertical levels. The model solutions are corrected by a variational data assimilation scheme (3DVAR) of temperature and salinity vertical profiles and along track satellite Sea Level Anomaly observations (Clementi et al., 2019).

We observed a slight difference between the values of the first layer of the model and the vertically average values from the first 300 m (Fig. 4). Seawater salinity have decreased along the Italian coast in the vertically average values. However, salinity levels are lower along the Italian coasts than the Croatian coasts because of the influence of river discharge.

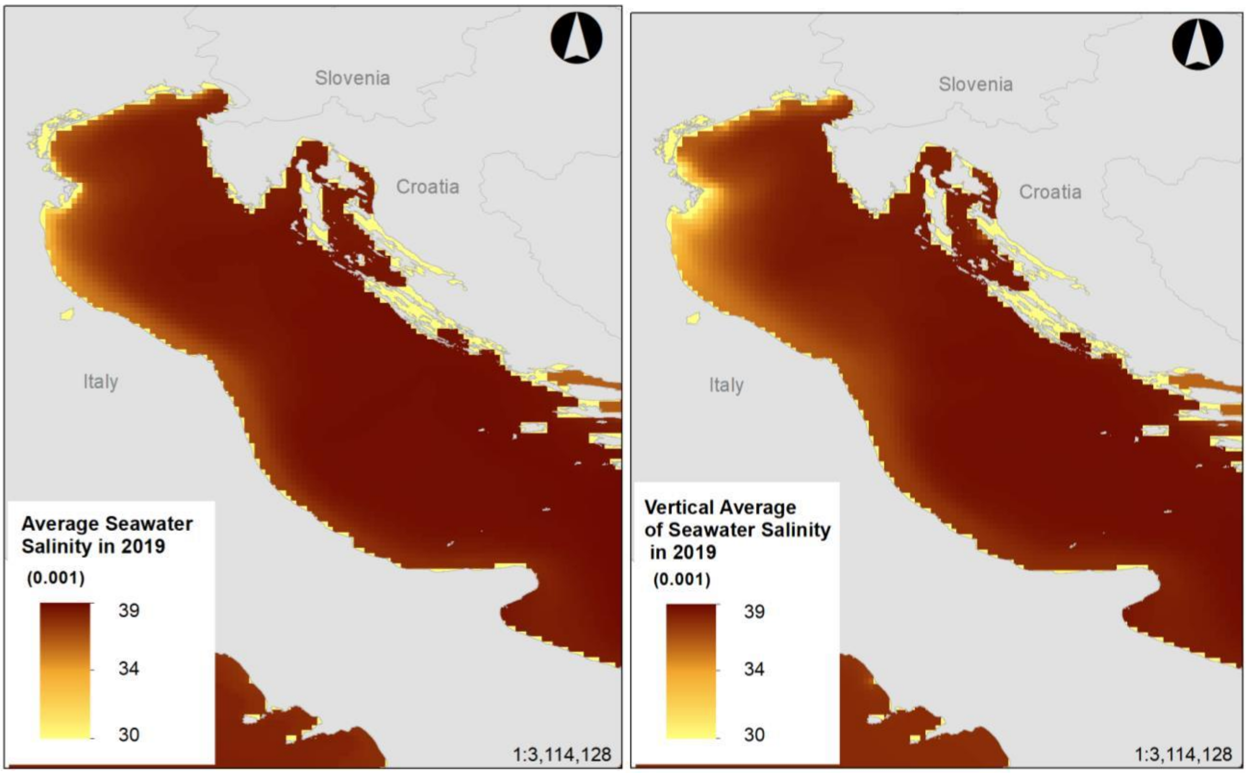


Figure 4. (left) Average values of salinity in 2019; (right) vertical (0.300m) average of data from numerical model.

3.2.5 Dissolved Oxygen

Dolphin presence in the northern Adriatic Sea was found to have direct correlation with peaks of oxygen saturation, especially during the summer season (Bearzi et al. 2008). Our data of mole concentration of dissolved molecular oxygen in sea water is derived from the numerical model from the E.U. Copernicus Marine Service Information. We have noticed that the oxygen values of the vertically averaged data are higher than the surface layer (Fig. 4). Oxygen concentration values have increased in the northern Italian coast when we averaged the first 300 m of the data from the model. Generally, oxygen concentrations were higher in the Italian coast, where there are rivers, than in the Croatian coastline. Low oxygen concentrations were observed in middle of the basin.

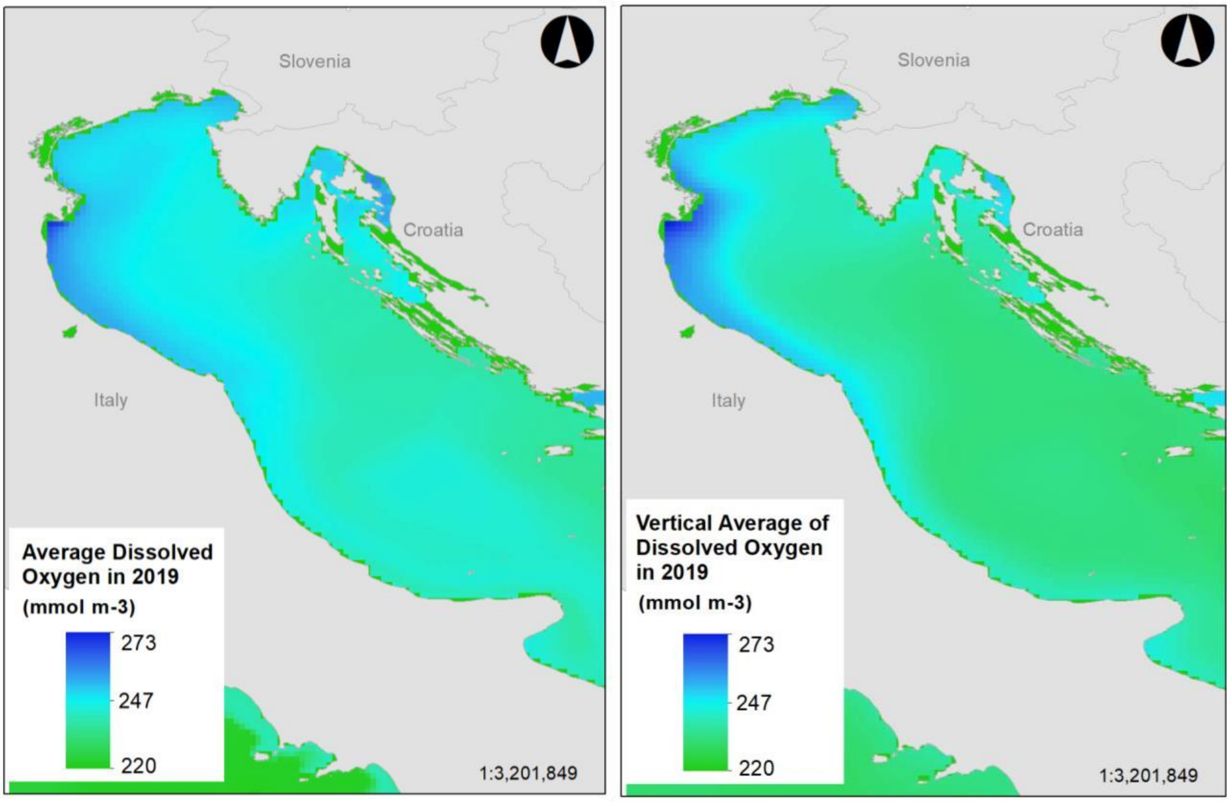


Figure 5. (left) average values of dissolved oxygen in 2019; (right) vertical average (0.300 m) of the data from numerical model.

3.2.6 Chlorophyll a

Chl-a was found to be an important predictor of likelihood of dolphin presence and as an indicator of its preferred habitat (La Manna et al., 2016; Bonizzoni et al., 2019).Moreover, primary production can be represented by coupling oxygen saturation, chlorophyll a, and phytoplankton distribution data. In this regard, we collected numerical model of mass concentration of Chl-ain seawater from the E.U. Copernicus Marine Service Information. The model was developed for the Mediterranean Sea at 1/24 degree and are produced by means of the MedBFM model system (i.e. the physical-biogeochemical OGSTM-BFM model coupled with the 3DVarBio assimilation scheme). MedBFM model is run by OGS and uses as physical forcing the outputs of the NEMO-OceanVar model system (Med-PHY managed by CMCC).Seven days of analysis are weekly produced on Tuesday, with the assimilation of surface chlorophyll concentration from satellite observations (provided by the CMEMS-OCTAC) and chlorophyll plus nitrate from Biogeochemical Argo floats (provided by CORIOLIS and LOV). One day of hindcasts and ten days of forecast are produced daily (Bolzon et al., 2020, Salon et al., 2019).

The calculated vertical averaged of the first 300m of the model appears to have higher values of Chl-a concentration along the Italian coast, compared to the data from the first layer of the model (Fig. 6). Low Chl-a concentration was observed along the coastal areas of the Northern Adriatic, and it increases toward mid-basin.

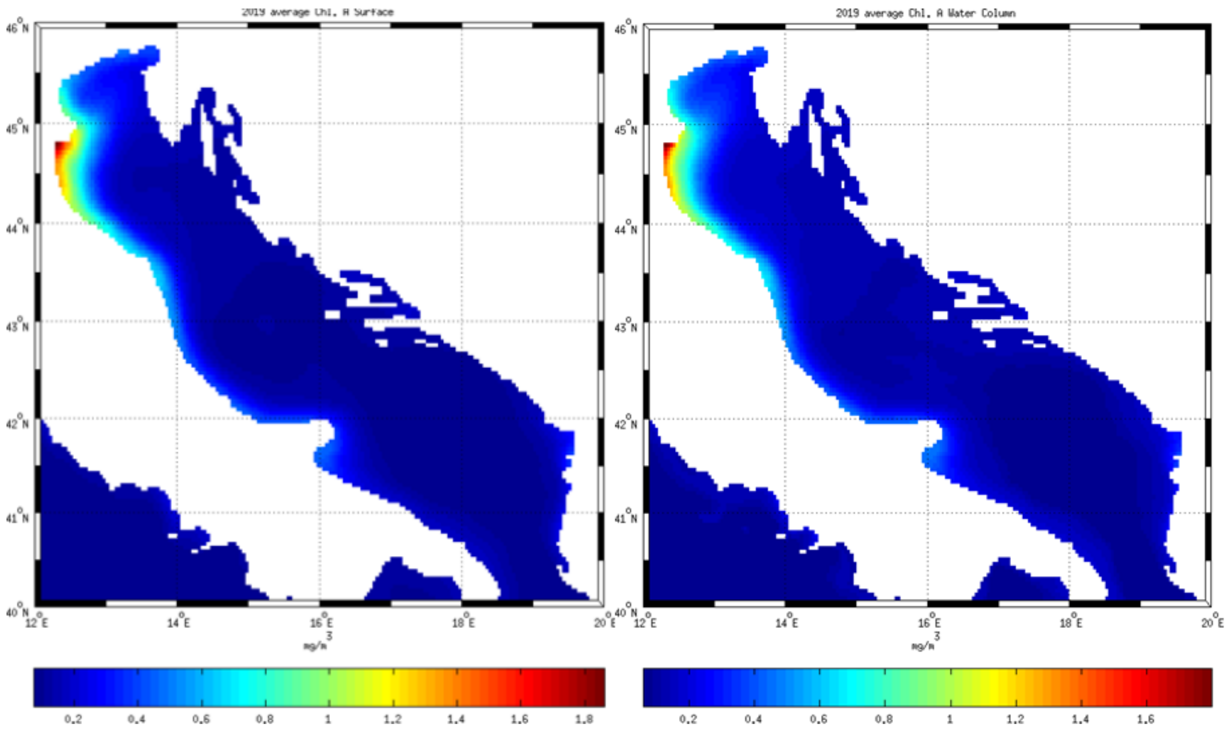


Figure 6. (left) average values of chlorophyll-a in 2019; (right) vertical average of the chlorophyll-a data for the first 300 m of the model.

3.2.7 Phytoplankton Distribution

Phytoplankton distribution will be combined with oxygen saturation and Chl-a concentration to be used as proxy of primary production. Our data of mole concentration of phytoplankton expressed as carbon in sea water were obtained from the numerical model for the Mediterranean, which was generated by E.U. Copernicus Marine Service Information. Similar to Chl-a and dissolved oxygen models, phytoplankton model has a resolution of 1/24 degree and are produced by means of the MedBFM model system (i.e. the physical-biogeochemical OGSTM- BFM model coupled with the 3DVarBio assimilation scheme; Bolzon et al., 2020, Salon et al., 2019). Phytoplankton concentration was observed the highest along the Italian coast

(Fig. 7). We observed that the values of phytoplankton concentration have slightly increased in northern Italy when the values of the first 300 m of the data were averaged.

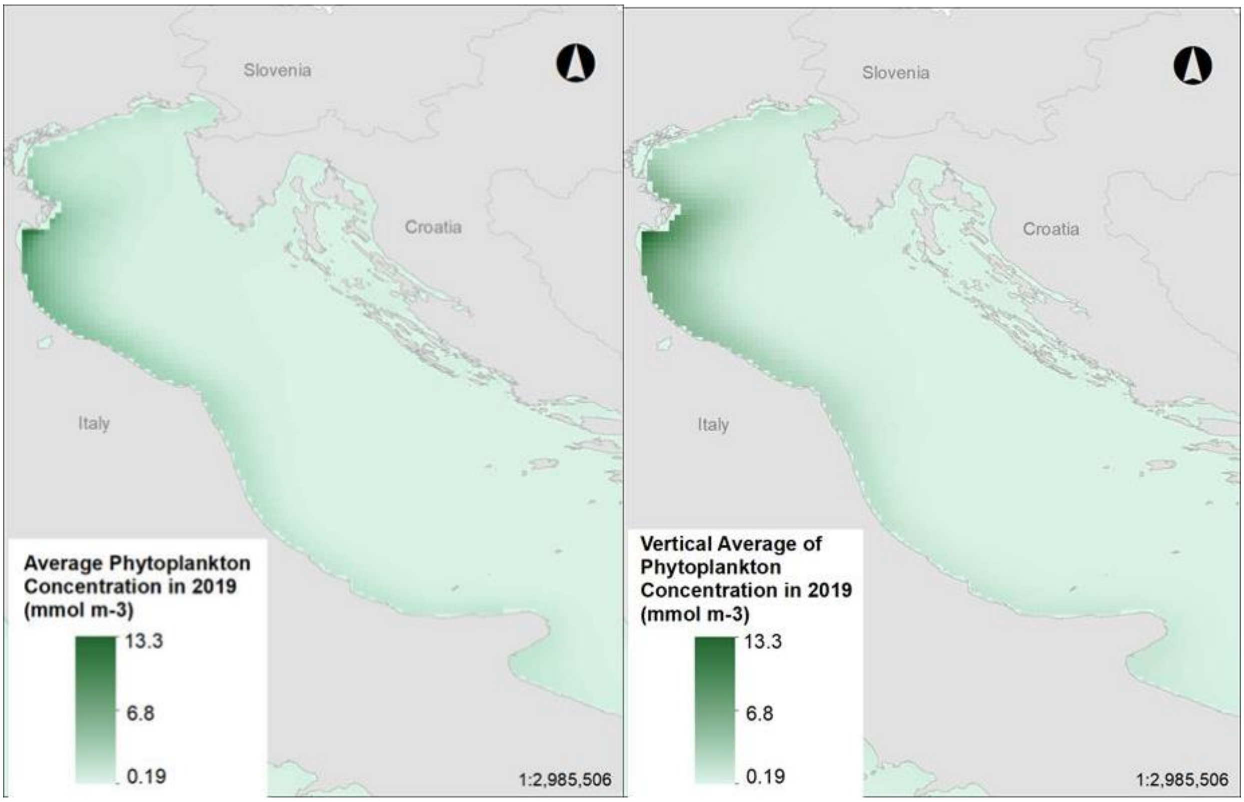


Figure 7. (left) annual average of phytoplankton concentration in 2019; (right) vertically average values of phytoplankton concentration from the first 300 m of the model.

3.3 Target species data

The Blue World Institute for Marine Research and Conservation is undertaking survey on target species in the period from January to September 2020. The first report on target species contains the data collected from July-September 2019 and January-April 2020 in northern Adriatic. The research effort includes area from the middle part of the island Cres to the Lim channel on the north, that includes two Natura 2000 sites- the Cres-Lošinj Archipelago (HR3000161) and Western Istria (HR5000032), and on the south to the northern part of Dugi otok (Fig. 8).

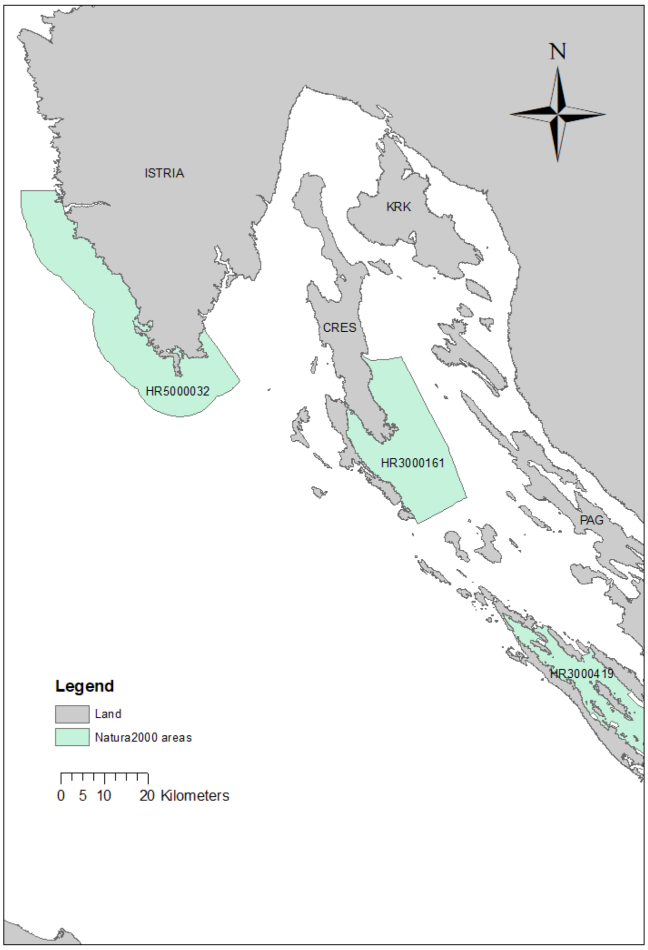


Figure 8. Study area

Guidelines to access the target species distribution maps:

The data was calculated into the European Environment Agency reference grid (https://www.eea.europa.eu/data-and-maps/data/eea-reference-grids-2).

Properties of the shapefiles are:

- Geometry Type – Polygon
- Projected Coordinate System – ETRS_1989_LAEA
- Projection – Lambert_Azimuthal_Equal_Area
- Geographic Coordinate System – GCS_ETRS_1989
- Datum – D_ETRS_1989

3.3.1 Research effort

During the period from July-September 2019 and January-April 2020 the analysis of navigation data shows that the research vessel covered the area from the middle part of the island Cres to the Lim channel in the north, that includes two Natura 2000 sites- the Cres-Lošinj Archipelago (HR3000161)and Western Istria (HR5000032), and in the south to the northern part of Dugi otok. In total, 41 field trips were made during which researchers spent 205 hours at sea and covered the overall distance of 1773,01 NM. Distance covered in search for dolphins was 1138,21 NM during 92 hours (Fig. 9).

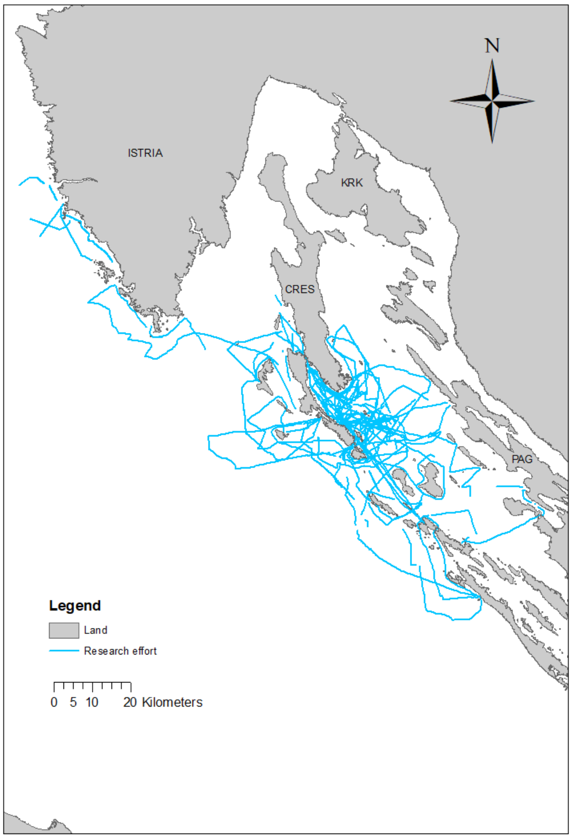


Figure 9. Research effort

3.3.2 Bottlenose dolphin

Bottlenose dolphins were encountered 72 times (Figure 10, left). Encounter rate was calculated in two ways. First way (ER1)-calculated as the ratio of the total number of sightings and total distance covered in positive search effort with a rate of 0.03. Second way (ER2)- was calculated using a polygon mesh size of 1x1 km with a rate of 0.03 (Figure 10, right). Time spent with the dolphins was 48 hours and distance covered was 136,44 NM. Group size varied from 1 to 30 individuals, and the average group size consisted of 8 individuals.

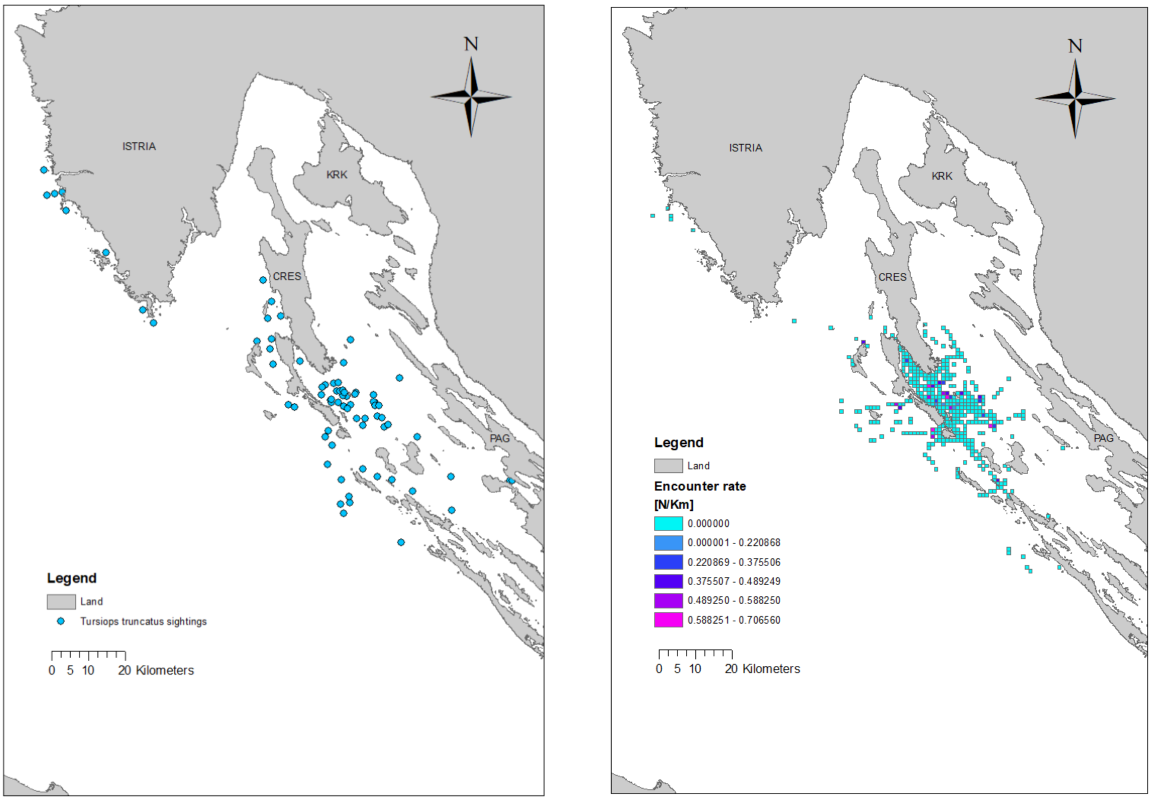
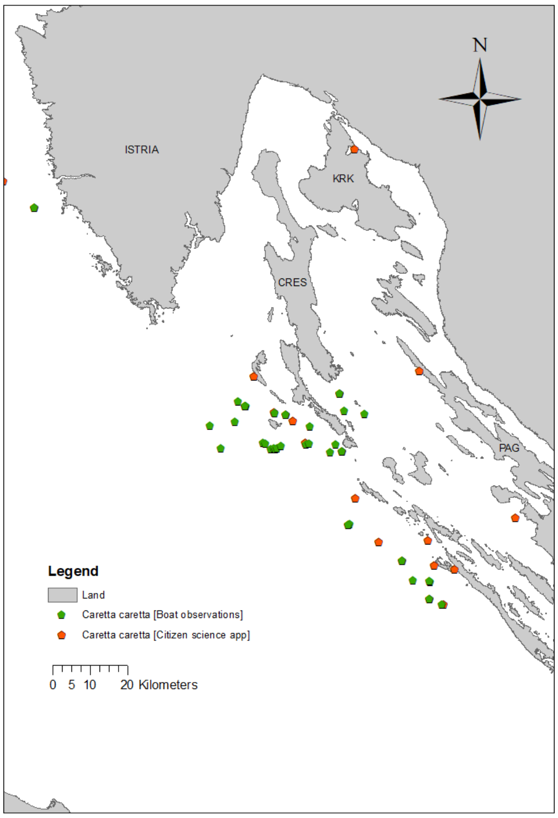


Figure 10. (left) Bottlenose dolphin encounters; (right) Encounter rate [ER2]

3.3.3 Loggerhead sea turtle

During the boat-based survey, using the Navilog application, 35 loggerhead sea turtles were recorded. Sightings locations can be found on Figure 11 (left). The locations of loggerhead sea turtle sightings were also collected through the BWI citizen science app. Through the citizen science app 21 individuals were reported. Encounter rate of loggerhead sea turtle, using a polygon mesh size of 1x1 km, is shown on Figure 11 (right). Most of the individuals were observed along the western side of the island of Lošinj, near the islands of Susak and Dugi otok.



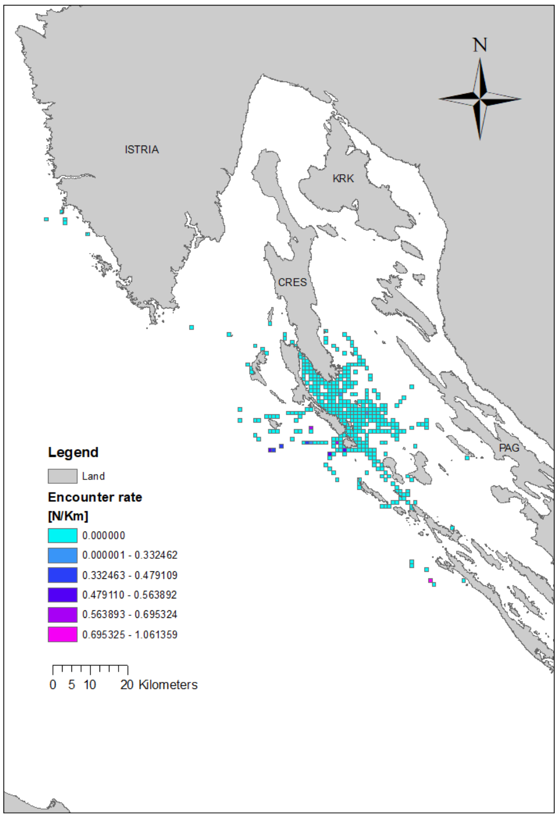


Figure 11. (left) Encounter of loggerhead sea turtles trough boat survey and citizen science app entrances; (right) Encounter rate of loggerhead sea turtles.

3.3.4 Bottom Trawler

During the monitoring period, 37 trawling boats were recorded and on 16 occasions, bottlenose dolphins were observed while feeding behind the recorded trawlers (Figure 12, left). Encounter rate of bottom-trawlers and research effort, using a polygon mesh size of 1x1 km, is shown in Figure 12 (right).

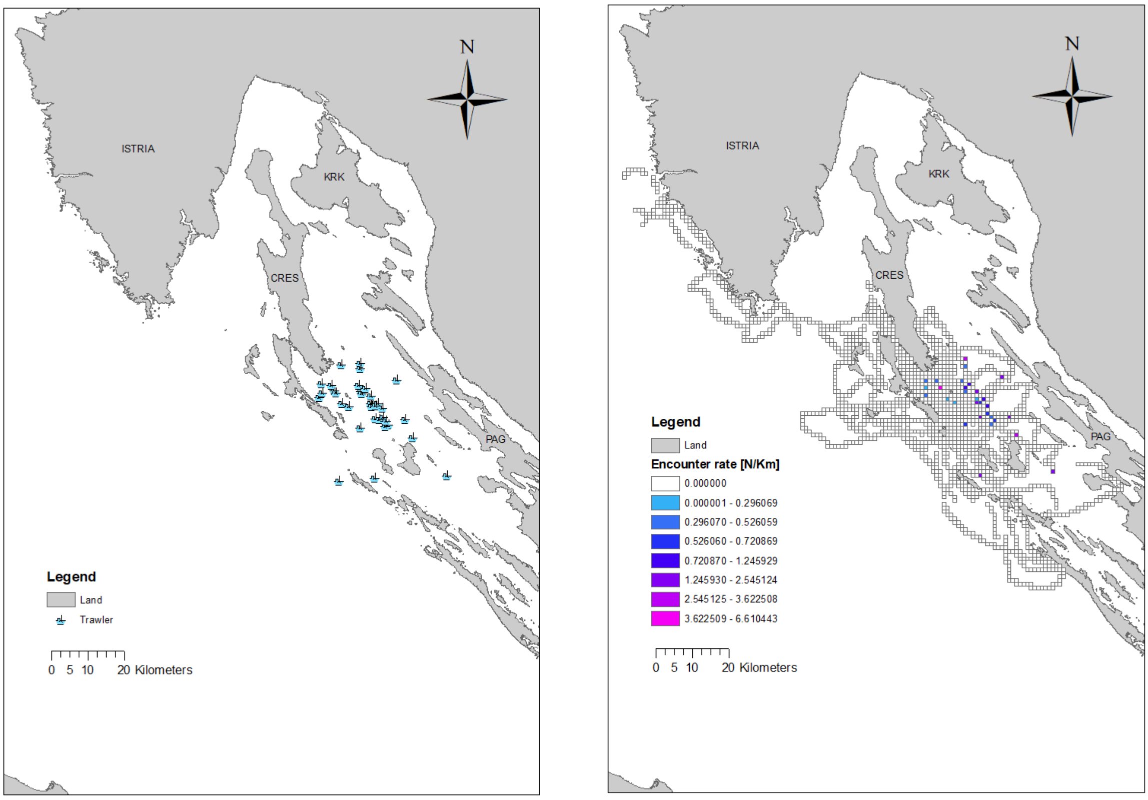


Figure 12. (left) Observations of bottom-trawlers; (right) Encounter rate and research effort

4. Conclusion

This database of environmental data and target species data relevant for the habitat suitability modelling will be updated along the modelling process. All data layers have been gathered, prepared and shared temporarily through Google Drive and are available to all project partners (https://drive.google.com/drive/folders/15xIOsFgDSUllhj5jHJxeSOnZz8dN7eR-). All data will be moved onto a server from CNR or BWI in the future.

5. Reference

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