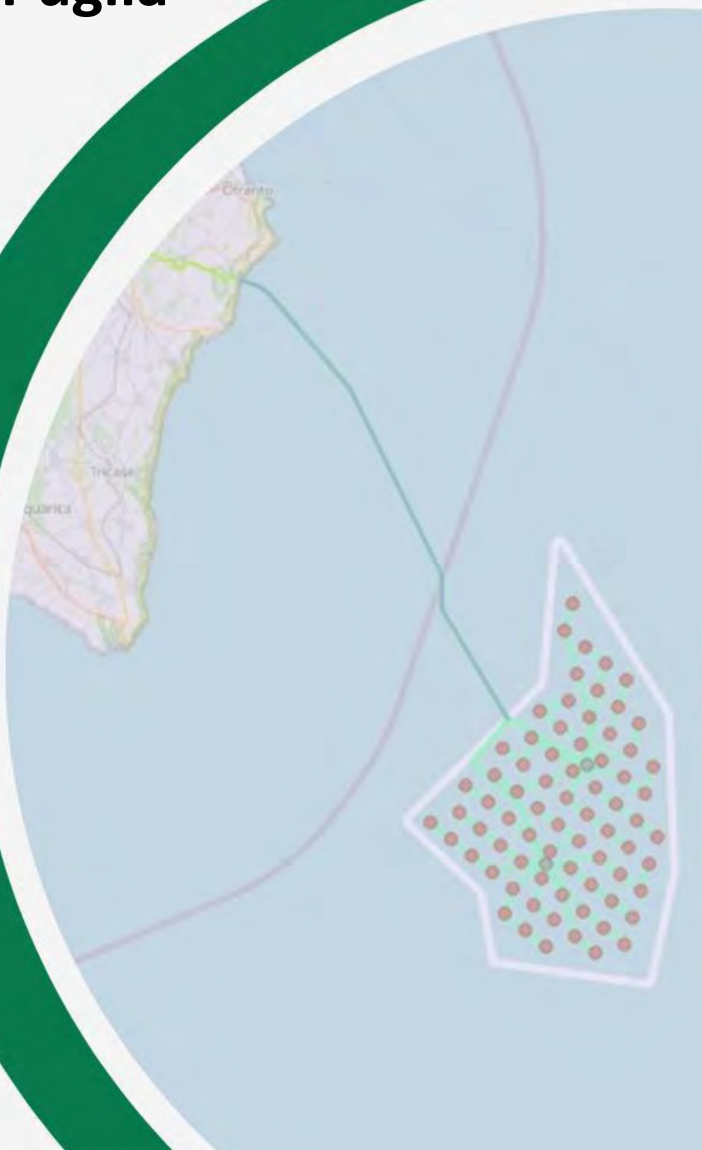
Technical and economic feasibility study for the 1,314 MW Messapia floating offshore wind farm in the Ionian Sea off the coast of Puglia



Environmental Impact Study

Volume 2

messapia

Review

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Abbreviations and symbols

Abbreviations	
AAE-1	Asia-Africa-Europe 1
AIS	Atlantic-Ionian Current
AOT	Accumulated Ozone exposure over a Threshold of 40ppb
AW	Atlantic waters
AW-a	Annual surface circulation of modified waters of Atlantic origin
AW-s	Seasonal surface circulation of modified waters of Atlantic origin
CDS	Conventional Distance Sampling
CGPM	General Fisheries Commission for the Mediterranean
CR	Seriously threatened
CTD	Conductivity. Temperatures, depth
Ministerial	Ministerial Decree
dB	DeciBel
dB(A)	DeciBel expressed with A weighting
ECC	Export Cable Corridor
ECVs	Essential Climate Variables
eDNA	Environmental DNA
EMDW	Deep waters of the eastern Mediterranean
EN	Endangered
EQB	Biological Quality Elements
FOSS	Floating Offshore Sub-Stations
GCOS	Global Climate Observing System
HAB	Harmful Algal Bloom
IAC	Inter-array cables
IBA	Important Bird Area
ICBP	International Council for Bird Protection
IPA	Polycyclic aromatic hydrocarbons
IUCN	International Union for Conservation of Nature
JTB	Joint Transition Bay
km/km2	Kilometres/Square kilometres
kW	Kilowatt
LC	Carapace length
Leq	Equivalent continuous level
LIW	Levantine intermediate waters
LOQ	Limit of quantification
LT	Total length
m	Metres
MASE	Ministry of the Environment and Protection of Land and Sea

Abbreviations	
MAW	Modified Atlantic Water
MBES	Multi-beam echo sounder
MMO	Marine Mammal Observers
MW	Megawatt
NADW	North Atlantic Deep Water
nm	nautical miles
NT	Almost at risk
SS	Onshore electrical substation
OWF	Offshore Wind
PAM	Passive Acoustic Monitoring
PCB	Polychlorinated biphenyls
PPTR	Regional Landscape Plan
PRQA	Regional Air Quality Plan
PTHA	Probabilistic Tsunami Hazard Analysis
RF	High-frequency electromagnetic waves
RMN	National Tide Gauge Network
ROV	Remote Operated Vehicle
RQE	Ecological Quality Ratio
RRQA	Air Quality Monitoring Network
SBP	Sub-Bottom Profiler
SE	Electrics Station
SIC	Sites of Community Interest
SPK	Sparker Profiler
TOC	Total organic carbon
TPL	Local public transport
VIA	Environmental Impact Assessment
VOC	Volatile organic compounds
VU	Vulnerable
EEZ	Exclusive Economic Zone
SPA	Special Protection Zones
ZSC	Special Conservation Areas

5 Description of the current state of the environment

5.1 General overview and introduction

As mentioned in the introduction, the Project concerns the construction of the Floating Offshore Wind Farm called "Messapia", located in the waters of the Ionian Sea, at a depth of between -550 and -850 m. The offshore wind farm will be located at a minimum distance of approximately 28 km south-east of the coast of Puglia, in the waters between Tricase and the marine area south-east of Capo Santa Maria di Leuca, in the Province of Lecce. The related connection works will affect the municipalities of Otranto, Minervino di Lecce, Giuggianello, Sanarica, Muro Leccese, Maglie, Melpignano, Corigliano d'Otranto, Soleto, Sternatia, Lequile and Copertino, in the province of Lecce in Puglia (**Error! Reference source not found.)**.

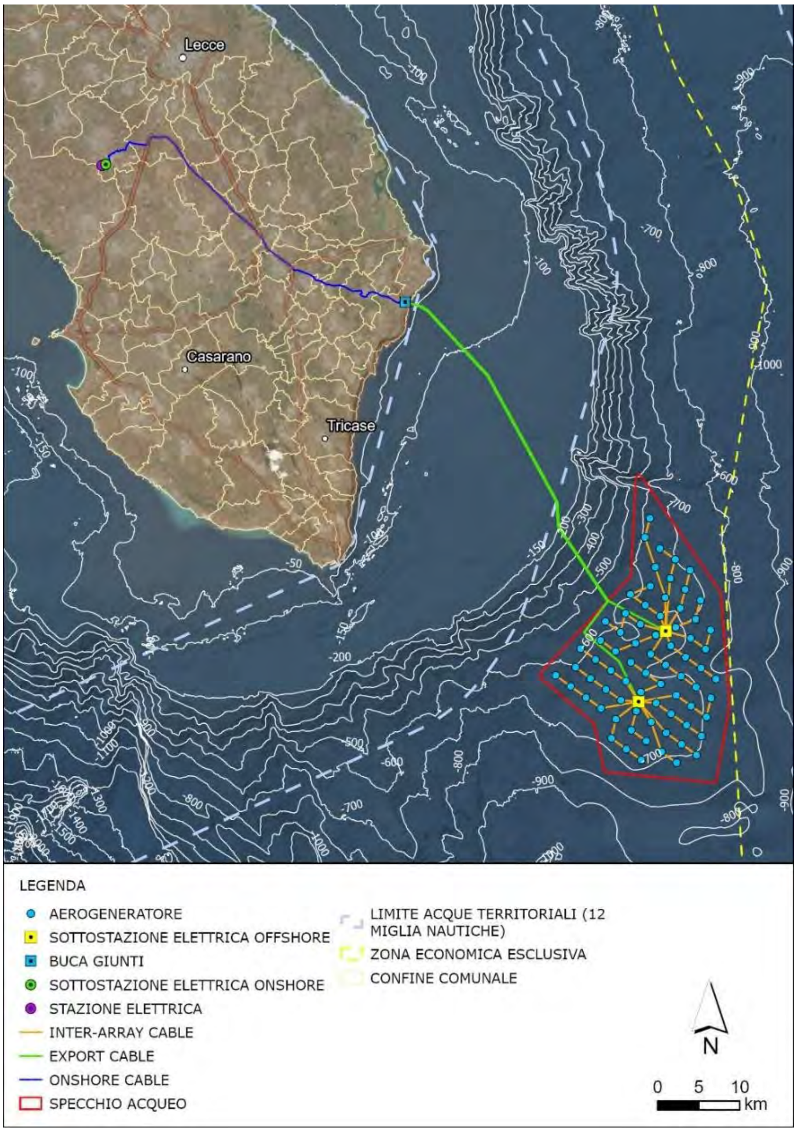
Within the offshore area, 73 floating wind turbines with a capacity of 18 MW each are to be installed, for a total capacity of 1,314 MW. The wind farm will be connected to the onshore electricity grid through a series of submarine cables (inter-array cables) connecting the floating turbines to two floating offshore substations (Floating Offshore SubStations, FOSS).

Starting from 2 FOSS, 4 submarine cables will be laid to transport electricity (EC - export cables) to the landing area in the municipality of Santa Cesarea Terme (LE), approximately 500 m south of the small port of Porto Badisco, where the joint pit will be built.

The main components of the wind farm will be divided into:

- **Offshore components:** wind turbines including floating foundations, floating offshore substations (FOSS), mooring and anchoring systems, marine connection ducts between the offshore FOSS and the landing area, and inter-array cables (IAC) necessary to connect the turbines to the FOSS.
- **Landfall:** area at the onshore/offshore interface where the offshore cables are brought ashore to be converted into land cable ducts. This junction requires the construction of a joint transition bay (JTB).
- **Onshore components:** land cables from the landing area and joint transition bays, necessary to connect the wind farm to the connection point at the onshore substation (Onshore Substation – OSS) and to the national grid via the newly built Electrical Substation (SE).

Figure 5-1 General overview of the Messapia offshore wind farm



Source: ERM processing, 2024 based on Messapia Floating Wind Srl project layout, 2024

The following paragraphs analyse the characteristics and current quality levels of the environmental matrices potentially affected by the Project. The environmental components analysed in the following paragraphs are as follows:

- meteorological and climatic conditions;
- air quality;
- geology and geomorphology;
- hydrology (marine and terrestrial environment);
- biodiversity (protected areas, regional ecological network, marine and terrestrial biodiversity);

- fishing;
- maritime traffic;
- landscape system, cultural and archaeological heritage;
- population and public health;
- activities, facilities and infrastructure in the area.

5.2 Identification of the Project Area

The offshore Project Area covers an area of approximately 476 km^2, extending for a length of approximately 10 km parallel to the coastline and approximately 26 km across the coastline.

The offshore cable system (export cables) lands in the municipality of Santa Cesarea Terme (LE) south of Porto Badisco and proceeds towards the user substation near the delivery point in the municipality of Copertino (LE). To connect to the Terna delivery point, an underground cable duct will be built along the existing road network, and a user substation will be built near the delivery point.

The unique nature of the Project, which in the different phases of its life cycle (construction, operation, decommissioning) affects various environmental and social matrices relating to offshore and onshore components, makes it difficult to define the reference area unambiguously.

Legislative Decree 152/2006 and subsequent amendments require a description of the baseline status of the pipeline components for the geographical areas potentially affected by the effects of the Project. In this study, two areas have been considered, a Project Area and a Wider Area, defined in accordance with SNPA Technical Standards (SNPA, 2020). In light of the above, the following definitions have been introduced:

- Project Area, which corresponds to the area where the offshore wind farm will be installed (including the offshore area characterised by the presence of wind turbines, FOSS, related marine connection cables and the land portion of the design elements);
- Wide Area, which is defined according to the expected magnitude of the impacts generated and the sensitivity of the environmental components involved.

In general, the Wider Area includes the Project Area and the study corridor of the related linear works.
to the Project (corridor of approximately 1-2 km on each side). Exceptions are:

- the landscape component, for which the Area Vasta extends to a radius of approximately 20 km centred on the Project Area for onshore components and approximately 50 km - 60 km for offshore components due to the potential visibility of the turbines from the coast and the hills behind it;
- the maritime traffic component and the socio-economic component, for which the wider area extends to the provincial-regional scale and the Strait of Otranto and the area in front of Capo Santa Maria di Leuca.

In the Offshore Section, the Project Area is identified with the footprint of all the offshore structures of the Project (wind farm and marine cables). A buffer varying from a few hundred metres to a few kilometres has generally been applied to this footprint, depending on the environmental component under consideration within the Italian Exclusive Economic Zone (EEZ).

As regards the Onshore Section, the Project Area corresponds to the onshore Project footprint (landing point, land cable duct and user stations), to which a buffer zone ranging from a few metres to several kilometres has generally been added, depending on the environmental component under consideration.

The extent of the wider area, for both the Offshore and Onshore Sections, also varies depending on the specific component and generally extends to a few kilometres around the Project Area.

As regards social components, in defining the Project Area and the Wider Area, reference was made to the administrative subdivisions provided for by Italian law, as these are the units for which statistical data are usually collected and made available. An effort was made to use data at the most detailed level possible, i.e. municipal data and, where not available, provincial or regional data. Where possible, an attempt was also made to compare data at different administrative levels in order to highlight similarities and differences in the dynamics at work in the wider area covered by the Project.

The extent of the Project Area and the Wider Area, varying component by component, is indicated at the beginning of the discussion of each environmental and social component.

5.3 Weather and climate conditions

The data reported in this section provide an overview of the weather and climate conditions in the Project Area.

To represent the temperature and rainfall data for the Onshore Section, based on information contained in the national system for the collection, processing and dissemination of climate data of environmental interest (National System for the Collection, Processing and Dissemination of Climate Data of Environmental Interest, ISPRA), the weather station closest to the Project Area is Santa Maria di Leuca (Station Code 163600), located at approximately 112 m above sea level, within the town of Santa Maria di Leuca, at a distance of approximately 30 km from the wind farm and approximately 32 km from the cable landing point.

As regards air and water temperatures in the Offshore Section, the monitoring station closest to the Project Area is located at the port of Otranto and is equipped with altimeter benchmarks. For reference, the water and air temperature data for the last year analysed, 2022, are included.

The preliminary assessment of wind and wave data, on the other hand, is based on data available for the Otranto tide gauge station, the Monopoli wave gauge station and data processed for the offshore Project Area available on Wind Atlas[1].

5.3.1 Temperatures

Climate change is now a priority issue involving science, society and politics.

Scientific evidence has become increasingly solid in recent years and, at the same time, awareness has grown of the need to take action, both to reduce climate-changing gas emissions and to mitigate the effects of rising temperatures and adopt adaptation strategies.

Due to its geographical conformation and location, Italy is particularly sensitive to the effects of climate change.

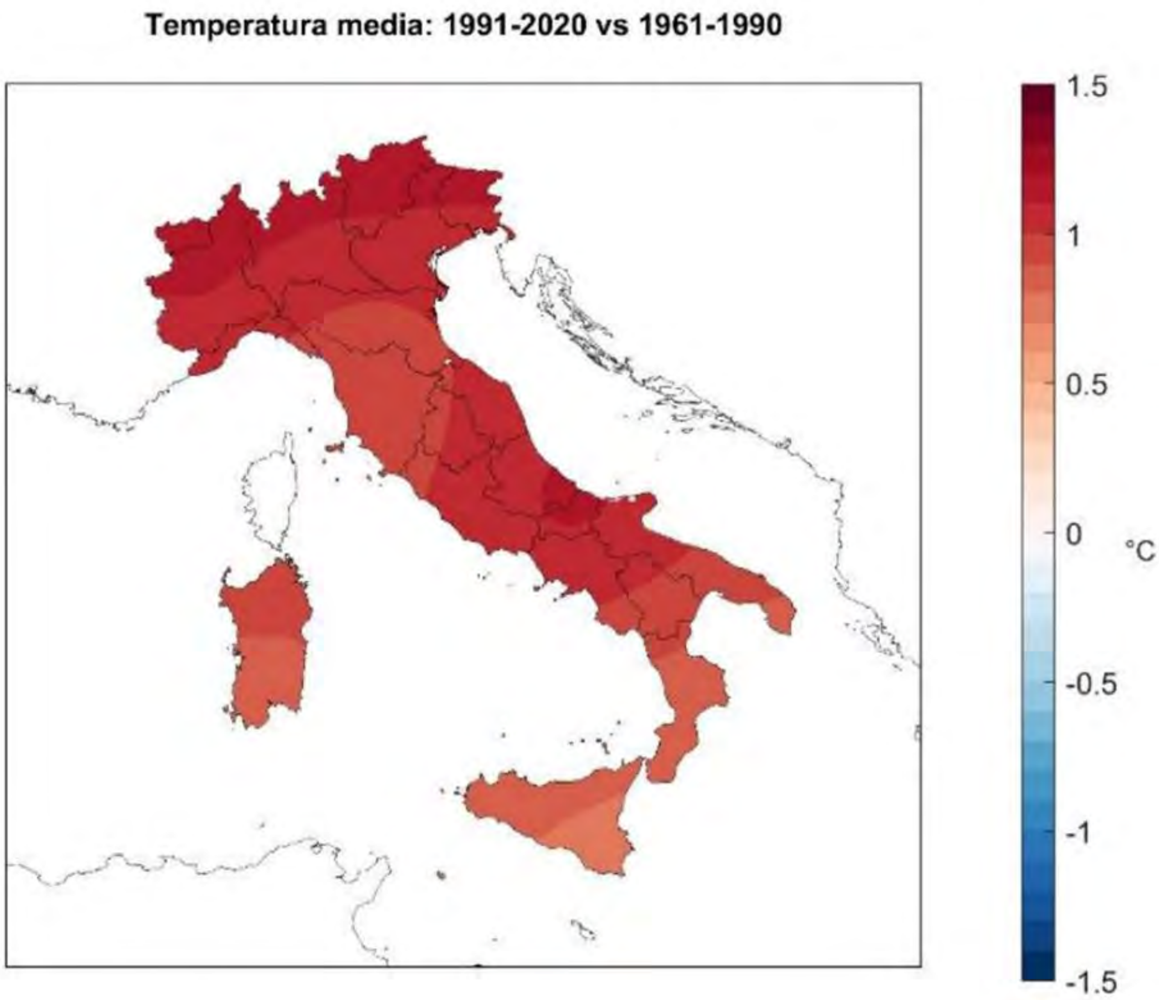
The average temperature in Italy has risen over the last 100 years: estimates of the rate of warming are in the order of +1 °C/century over the last 100 years and 2 °C/century over the last 50 years; the rate of change has been even more consistent and stable over the last 30 years. The increase in temperature is more noticeable in summer and spring. The upward trend is confirmed by the trend in extreme temperature indicators (MATTM, 2014).

In Puglia, the available data confirm the trend towards an increase in minimum, average and maximum temperatures recorded.

From the thirty-year period 1901-1930 to the period 1991-2020, average minimum temperatures rose from 10.6 °C to 11.7 °C; similarly, the average maximum temperature recorded in the same time periods increased from approximately 19.5 °C to 20.3 °C. Average annual temperatures have increased by about 1 °C, from 15.05 °C to 15.95 °C. Figure 5-2 shows a map of the differences between the normal annual average temperatures between the periods 1991-2020 and 1961-1990 at national level. In Puglia, the variation ranges from 1 °C in the northernmost areas to 0.8 °C towards the Project Area.

[1] https://globalwindatlas.info/en(2024)

Figure 5-2 Map of differences between normal annual average temperature values



Source: ISPRA, 2022

Currently, the climate of Puglia is classified as Mediterranean according to the Koppen-Geiger classification, characterised by hot, dry summers and mild, moderately rainy winters, with abundant rainfall during the autumn season. Average temperatures are around 15 °C-16 °C, with higher average values in the Ionian-Salento area and lower values in the Sub-Appennine Dauno and Gargano areas (Beck *et al.,* 2018).

Summers have average temperatures between 25 °C and 30 °C and peaks of over 40 °C on the hottest days. Winters are relatively mild and the temperature rarely drops below 0 °C. In most of the region, the average winter temperature is not lower than 5 °C (Cotecchia V. *et al.*, 2014).

Time series for various climate indicators are available for three stations in the Area Vasta.
meteorological stations: Otranto, Santa Maria di Leuca and Lecce (Table 5.1).

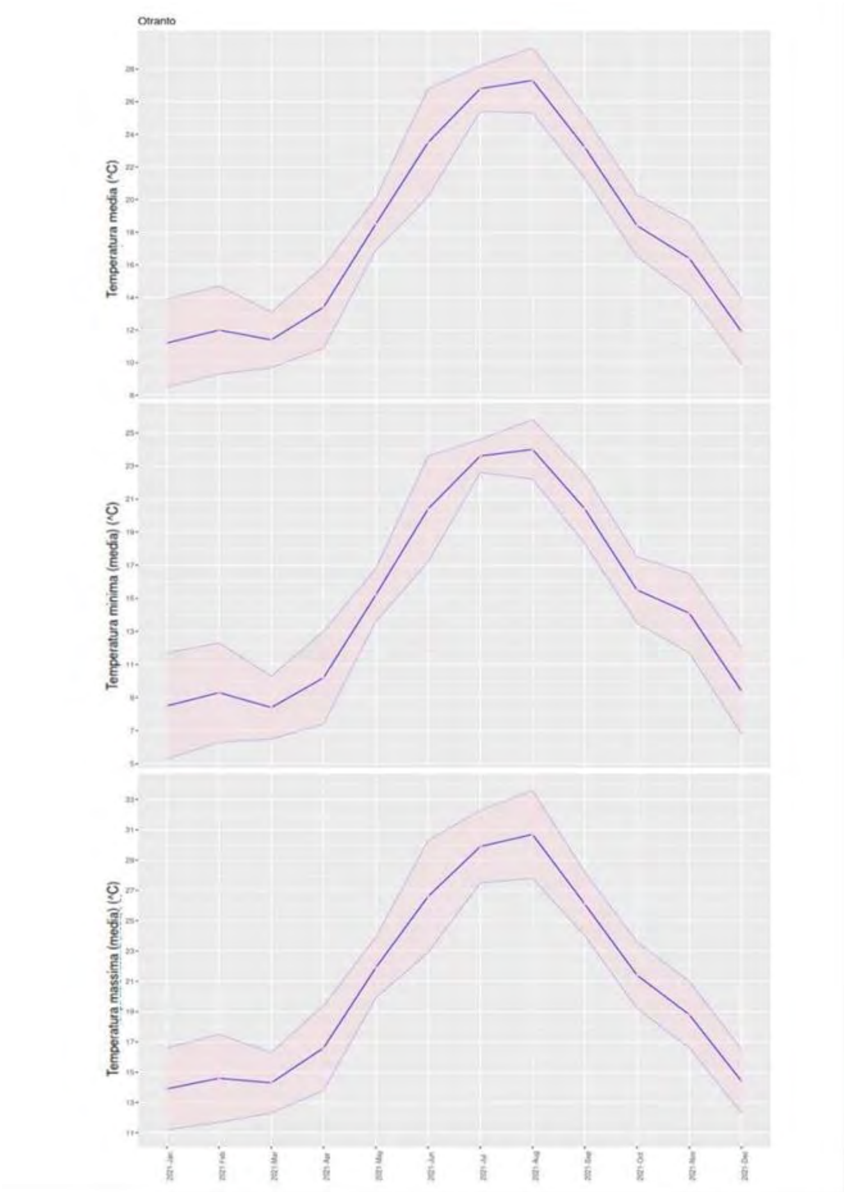
Table 5.1 Type and location of weather stations included in the temperature data analysis

Station name	Type	Latitude	Longitude
Otranto	Tide gauge	40° 08' 49.74"N	18° 29' 49.52"E
Santa Maria di Leuca	Synoptic	39°48'41.57	18°20'32.43
Lecce	Synoptic	40°21’32.72”	18°10’05.31”E

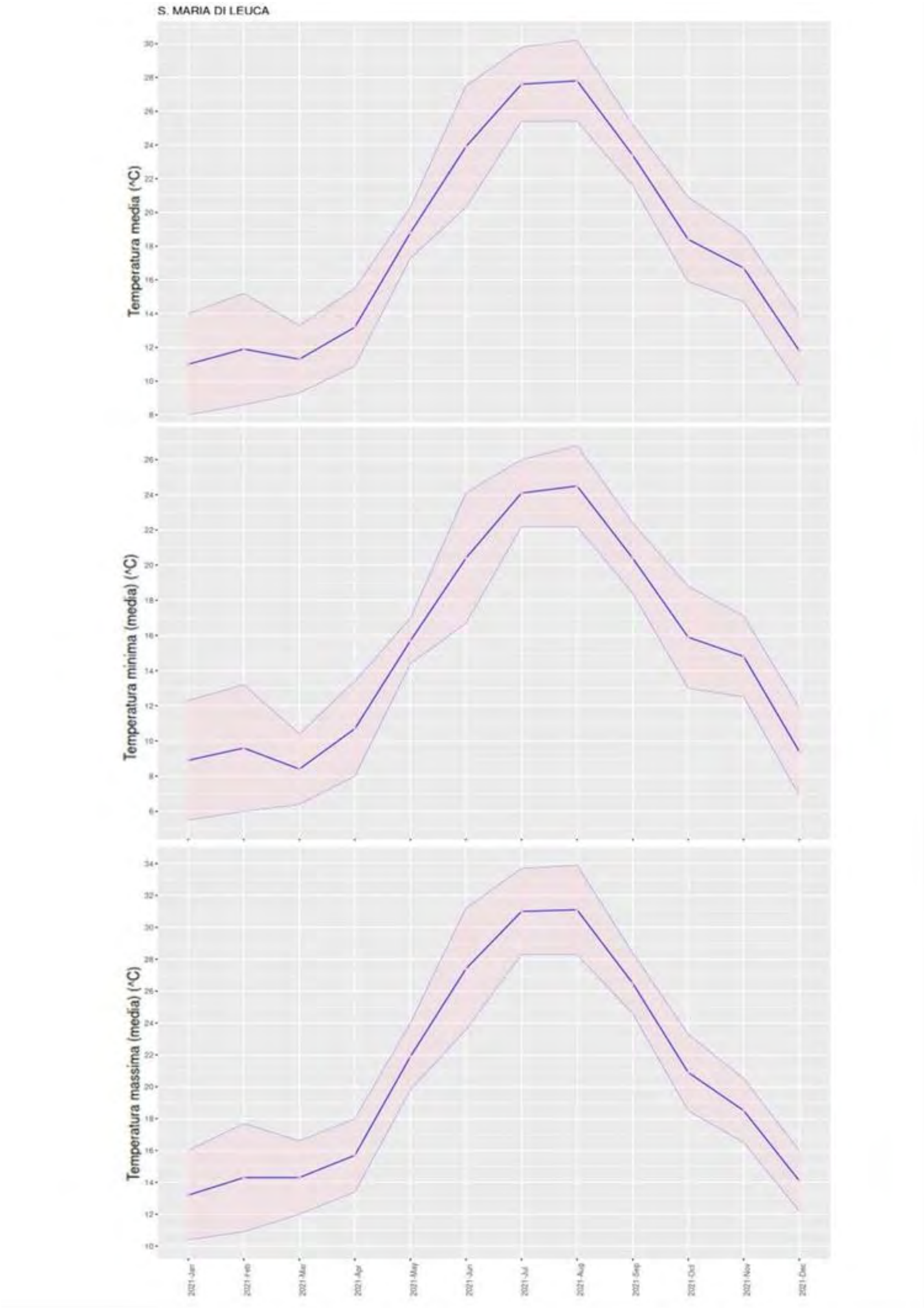
Source: SCIA, 2021

Figure 5-3 shows the average, maximum and minimum monthly temperatures recorded at the synoptic weather station in Santa Maria di Leuca, according to the latest updates available for 2021. The average temperatures range between 8 °C and 26 °C, with lower values at the Lecce station and higher values at the Santa Maria di Leuca station. Temperatures rarely fall below 5 °C in winter.

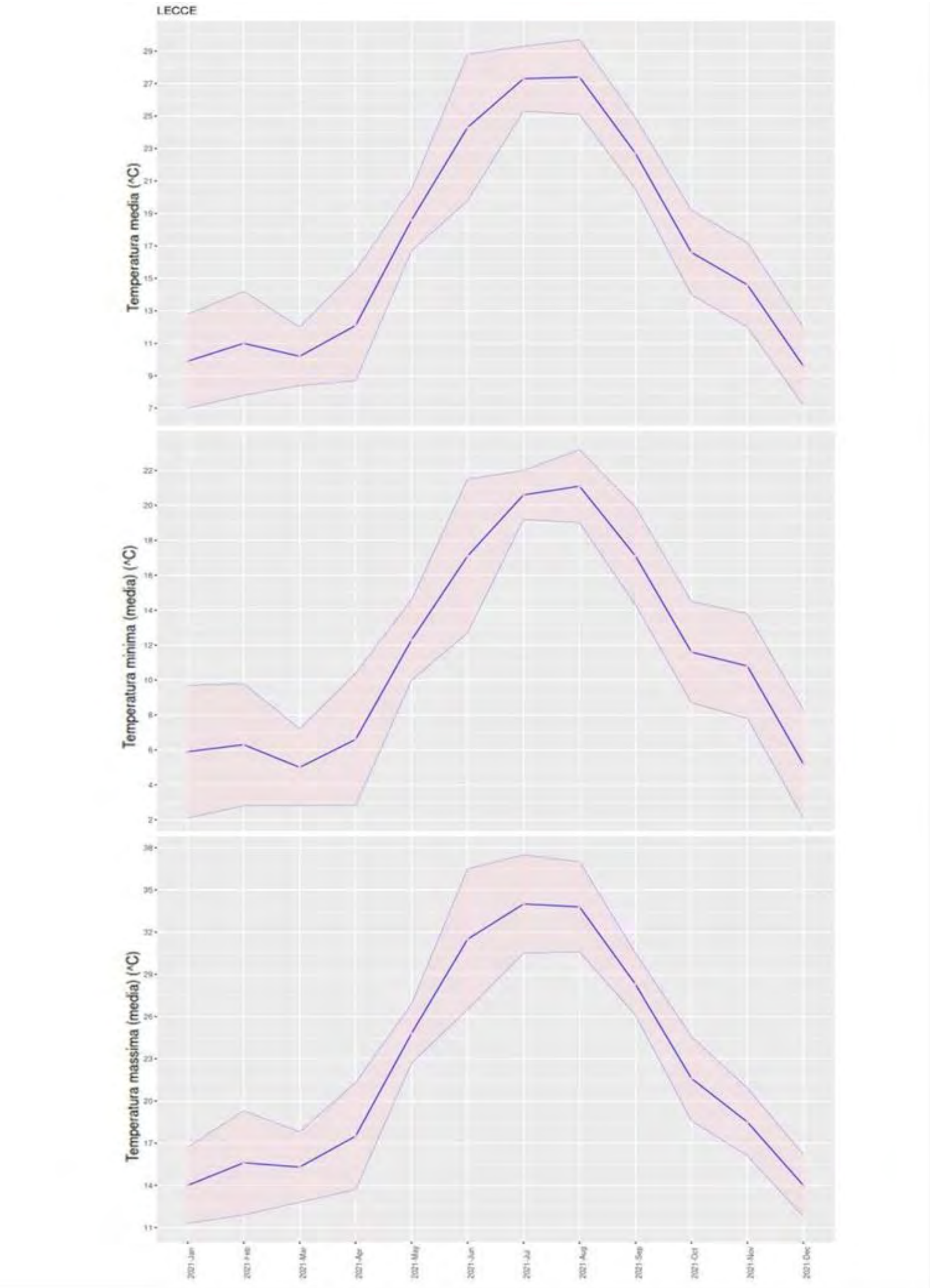
Figure 5-3 Average, minimum and maximum temperatures in 2021 at the stations of Otranto (a), Santa Maria di Leuca (b) and Lecce (c)



(a)


S. MARIA DI LEUCA
Temperatura media (°C)
Temperatura minima (media) (°C)
Temperatura massima (media) (°C)

(b)



(c)

Source: SCIA2 ,data 2024

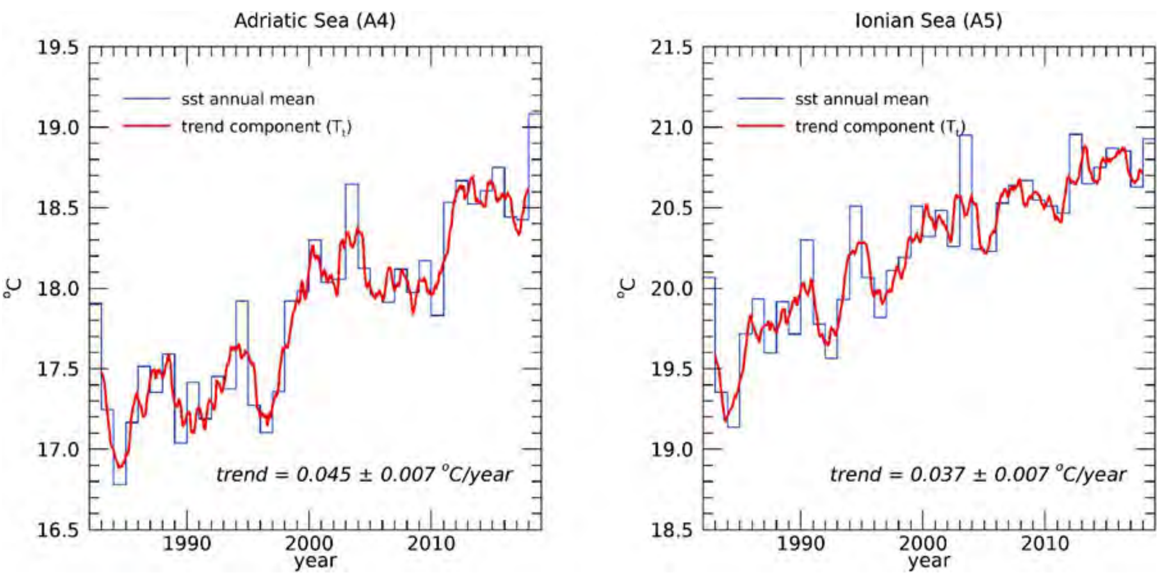
2 https://scia.isprambiente.it/dati-e-indicatori/ (2024)

As regards the marine environment, ocean surface temperature is one of the Essential Climate Variables (ECVs) defined by the Global Climate Observing System (GCOS), as it contributes to modulating heat exchange between the ocean and the atmosphere, as well as being an indicator of changes in ocean thermohaline circulation (Pisano *et al.* 2020).

Solar forcing causes seasonal fluctuations in water temperature, especially in the surface layer.

On longer time scales, i.e. annual or multi-year, sea surface temperatures are subject to both natural variability (solar forcing, wind conditions, cloud cover and water-atmosphere interactions) and climate change induced by human activity. Looking at historical trends, the data show that, similar to air temperature, the surface temperature of the Mediterranean Sea is increasing, although not uniformly across the entire area. The study by Pisano *et al. (*2020) calculates that in the Adriatic and Ionian sectors, the average sea surface temperature would increase by 0.045±0.007 °C/year and 0.037±0.007 °C/year (Figure 5-4).

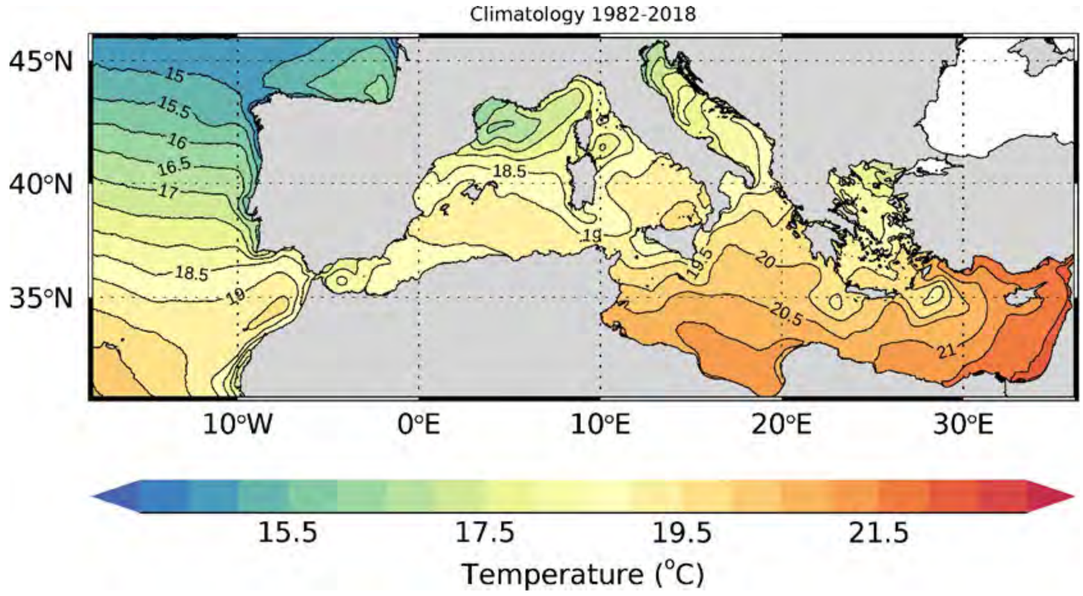
Figure 5-4 Average sea surface temperature (°C) between 1982 and 2018 in the Adriatic (left) and Ionian (right) sectors



Source: Pisano et al., 2020

The average sea surface temperature in the Mediterranean basin between 1982 and 2018 is shown in Figure 5-5, with values in the Offshore Section ranging between 18 °C and 19 °C.

Figure 5-5 Average sea surface temperature (°C) between 1982 and 2018 in the Mediterranean basin and the north-east Atlantic

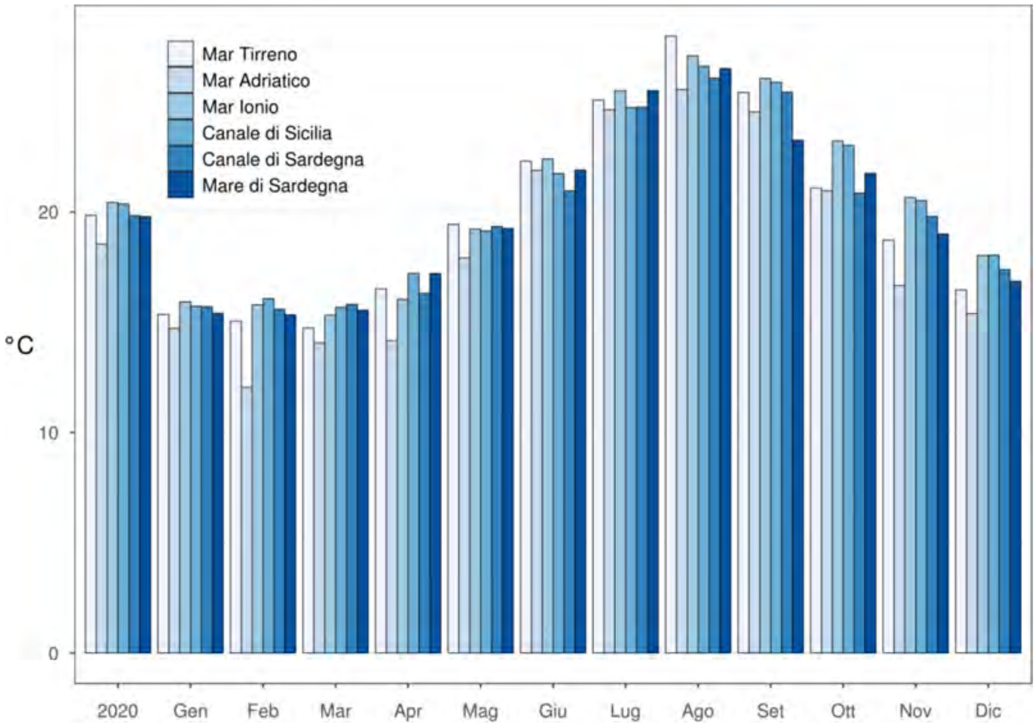


Source: Pisano et al., 2020

As regards the current situation, according to the ISPRA report on 'Climate indicators in Italy in 2020', the average anomalies for Italian seas in 2020 were positive in all months and intensified during the year until August. The positive deviations from normal values were highest in August (+1.7 °C) and May (+1.4 °C), while the smallest deviation occurred in October (+0.3 °C) (ISPRA, 2021).

Figure 5-6 shows the average sea surface temperature in Italy in 2020 (annual and monthly values) in detail.

Figure 5-6 Average sea surface temperature in Italy in 2020 (annual and monthly)



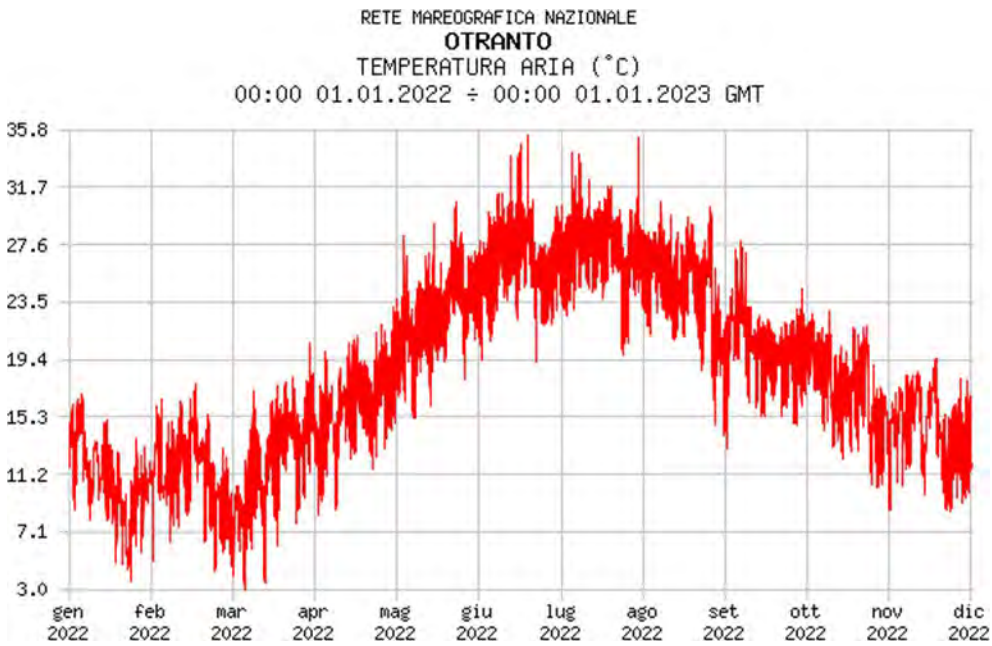
Source: ISPRA analysis of NOAA data, 2023

The following figures show the water and air temperature trends in the sea area measured by the Otranto station over a period from January 2022 to January 2023 (**Error! Reference source not found.** Figure 5-8).

Figure 5-7 Water temperature trends (°C) recorded by the Otranto station during the observation period

Source: ISPRA, 2024

Figure 5-8 Air temperature (°C) trends recorded by the Otranto station during the observation period



Source: ISPRA, 2024

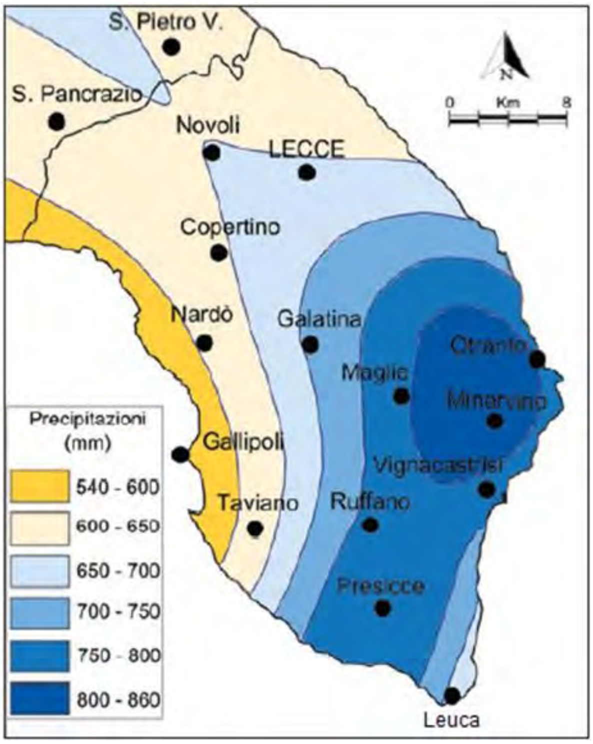
5.3.2 Rainfall data

At national level, long-term average annual precipitation is decreasing slightly (by around 1% per decade). However, the sign and level of significance of the trends vary greatly depending on the time interval, the geoclimatic area and the season. In the long term, there has also been a significant decrease in the number of low-intensity events. Precipitation intensity and frequency trends are not clear-cut when considering shorter and more recent time windows and when looking at specific regions of Italy (MATTM, 2014).

In the Apulia region, total annual rainfall for the period 1901-1930 was 585 mm, compared to 623 mm for the period 1991-2020. With reference to historical trends, total rainfall is therefore slightly increasing; however, observations show a sharp decrease in precipitation in the winter quarters, which coincides with the most important period for the replenishment of regional aquifers. Summer precipitation, on the other hand, has increased overall (Cotecchia *et al.,* 2014).

Within the region itself, there are two sub-regions with different characteristics: the Ionian side, with higher annual temperatures and lower rainfall, and the Adriatic side, which has the opposite characteristics. Figure 5-9 shows the distribution of average annual rainfall in the Lecce area of Salento for the period 1931-1996, calculated on the basis of the 19 stations shown in Figure 5-9 (Gianfreda *et al.,* 2022).

Figure 5-9 Distribution of average annual rainfall in the Lecce area of Salento for the period 1931-1996



Source: Geologi e Territorio, 2022

The trends shown below were obtained by considering the data series available for the stations of Otranto – Punta Palascia, Santa Maria di Leuca and Lecce (Table 5.2).

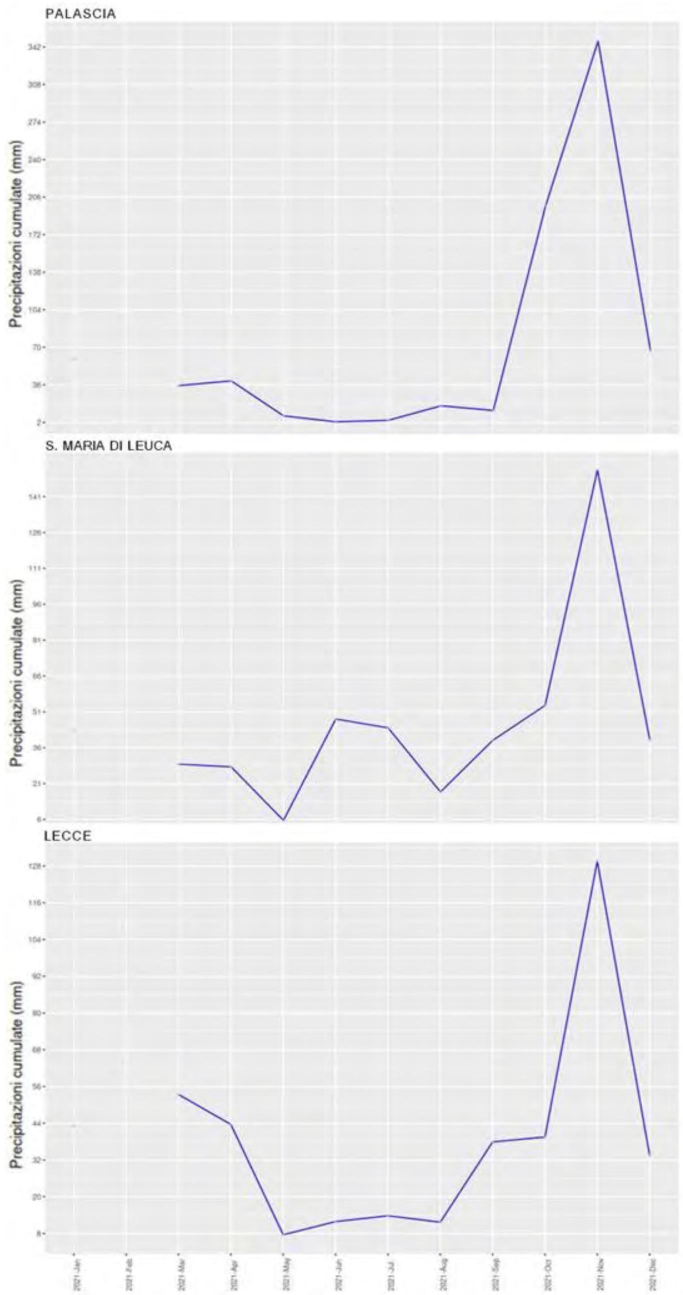
Table 5.2 Type and location of weather stations included in the rainfall data analysis

Station name	Type	Latitude	Longitude
Otranto – Punta Palascia	Synoptic	40°06'37.26	18°30'49.49"
Santa Maria di Leuca	Synoptic	39°48'41.57	18°20'32.43"
Lecce	Synoptic	40°21'32.72"	18°10'05.31"E

Source: SCIA, 2021

The graph (Figure 5-10 P) identifies a rainy season in the period November-January and a drier season coinciding with the summer period June-August.

Figure 5-10 Cumulative precipitation at the stations of Otranto (tide gauge), Santa Maria di Leuca (synoptic) and Lecce (synoptic), 2021



Source: SCIA[3] ,data 2024

3 https://scia.isprambiente.it/dati-e-indicatori/ (2024)

With reference to the year 2021, the cumulative precipitation values for the three stations considered are summarised in Table 5.3.

Table 5.3 Type and location of weather stations included in the rainfall data analysis

Station name	Cumulative precipitation (2021)
Otranto – Punta Palascia	823.5
Santa Maria di Leuca	519.4
Lecce	457.6

Source: SCIA, 2024

5.3.3 Anemometric data

A fairly accurate knowledge of the wind field can be obtained through continuous observations over time and in locations that are not excessively affected by wind-surface interactions. These measurements are obtained using anemometers, generally installed at a height of 10 m above ground level, which provide the direction and intensity of the winds, representative of a relatively large area.

Currently, there are several organisations in Italy that deal with systematic wind measurement, although the most reliable data, in terms of acquisition standards and the size of the historical series available, are those collected by the Italian Air Force Meteorological Service.

The anemometric sensors currently in use at AM stations are Pitot tube type and provide wind intensity and direction; many sensors have been replaced in the last decade. They take readings every three hours, at 0:00, 3:00, 6:00, 9:00, 12:00, 15:00, 18:00 and 21:00 (the value of each reading is obtained as the average of the values recorded in the 10 minutes prior to the synoptic hour).

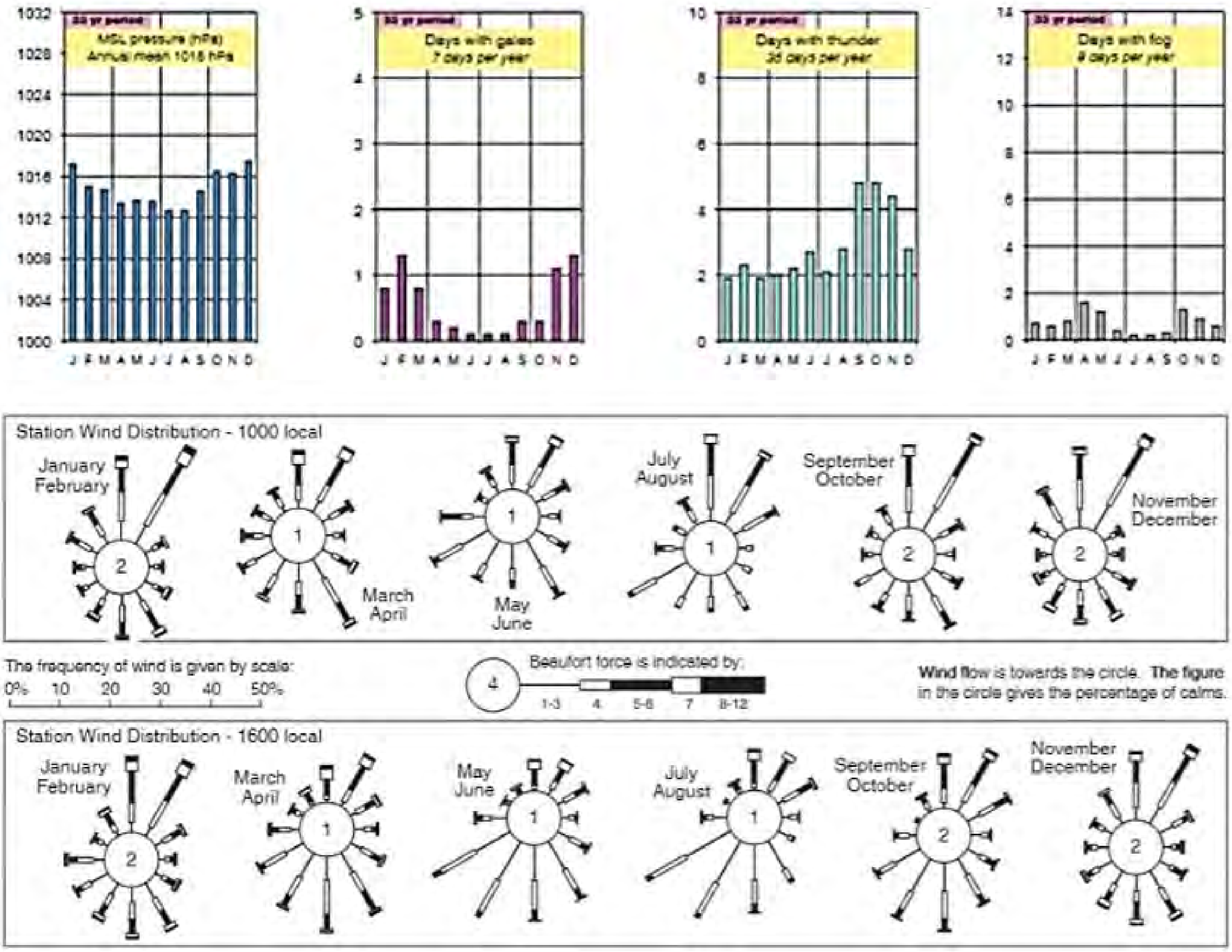
The reference anemometer stations for the project in question are those of Santa Maria di Leuca, approximately 30 km from the Project Area, and Otranto, approximately 40 km from the nearest Project turbines.

As regards Santa Maria di Leuca, the meteorological station has a series of data for the period 1984-2016.

Figure 5-11 highlights some particularly significant conditions: storms and fog occur
a few days a year, 7 and 9 respectively.

The strongest winds in this area come from the north and north-east, with Beaufort wind force of 8-12 on some occasions, but mainly force 4-6. There is a significant diurnal change in wind direction between 1000 and 1600 observations, with a higher frequency of south to south-westerly winds during the day.

Figure 5-11 Graphs referring to the Santa Maria di Leuca weather station: atmospheric pressure, stormy days, days with lightning, days with fog (annual and monthly data); wind rose with percentage distribution of wind direction and relative intensity (monthly data). The number in the centre of each circle gives the percentage of calms winds.



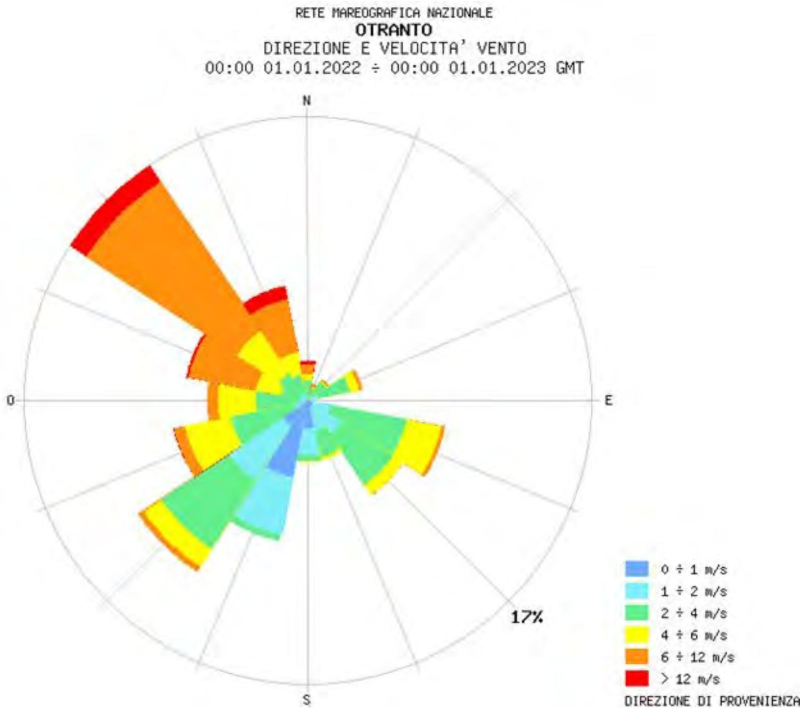
Source: Admiralty Sailing Directions, 2023

For the Otranto station, Figure 5-12 shows the annual wind rose recorded at the tide gauge station during the period 2022-2023 (Puglia Region and Politecnico di Bari, 2007).

The graphs show that wind distribution tends to concentrate in the north and north-west sectors for the historical series, with a prevalence of north-west winds on an annual basis.

It shows that, on an annual basis, wind distribution tends to concentrate in the west and north-west sectors. In terms of speed, it is worth noting the high presence of weak winds (less than 4 m/s), which probably indicate that the circulation due to mesoscale conditions is disturbed by breezes caused by local thermal conditions. The west direction is associated with higher intensity phenomena, with maximum values recorded above 12 m/s.

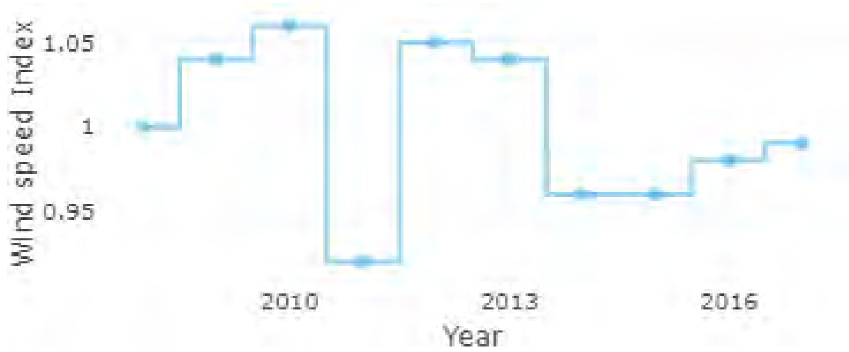
Figure 5-12 Wind rose, Otranto tide gauge station, 2022



Source: ISPRA, 2023

For the Offshore Section, Global Wind Atlas data are available, which have been processed for wind speed variability over the period 2007-2017 at the centre of the wind farm at a height of 150 m (Figure 5-13).

Figure 5-13 Wind speed variability in the offshore wind farm area during the period under review



Source: Global Wind Atlas, 2024

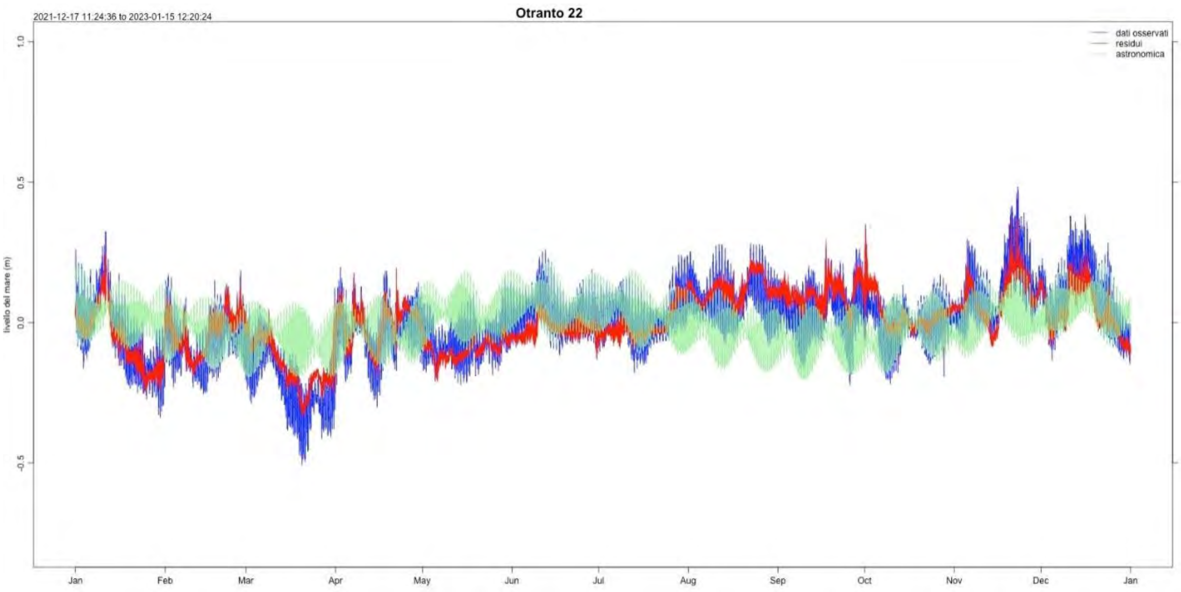
Power density is min = 529.5 W/m², max = 552 W/m² and average = 539.4 W/m² within the perimeter of the farm, again at an estimated hub height of 150 m.

5.3.4 Wave data

Astronomical tides are an excellent indicator for accurately characterising normal sea level fluctuations, allowing for geographical comparison on a national scale and monitoring over time of any variations caused by short- or long-term physical phenomena. The data are acquired by the tide gauge stations of the National Tide Gauge Network (RMN), which guarantees spatial coverage throughout the country, hourly sampling and multi-year historical series.

Figure 5-14Figure 5-14 A shows the expected astronomical tide (in green) compared with the observed data (in blue) at the Otranto tide gauge station. The red series highlights the difference between the two values. It is clear that in the months between August and January, the observed sea level is generally higher than the expected value for the astronomical tide. However, the variations in level are generally limited, with magnitudes of less than one metre.

Figure 5-14 Astronomical tide height and sea level observed at the Otranto tide gauge station (reference year: 2022)



Source: ISPRA, 2022

There can be many reasons for the discrepancy between the expected astronomical tide level and the observed level.

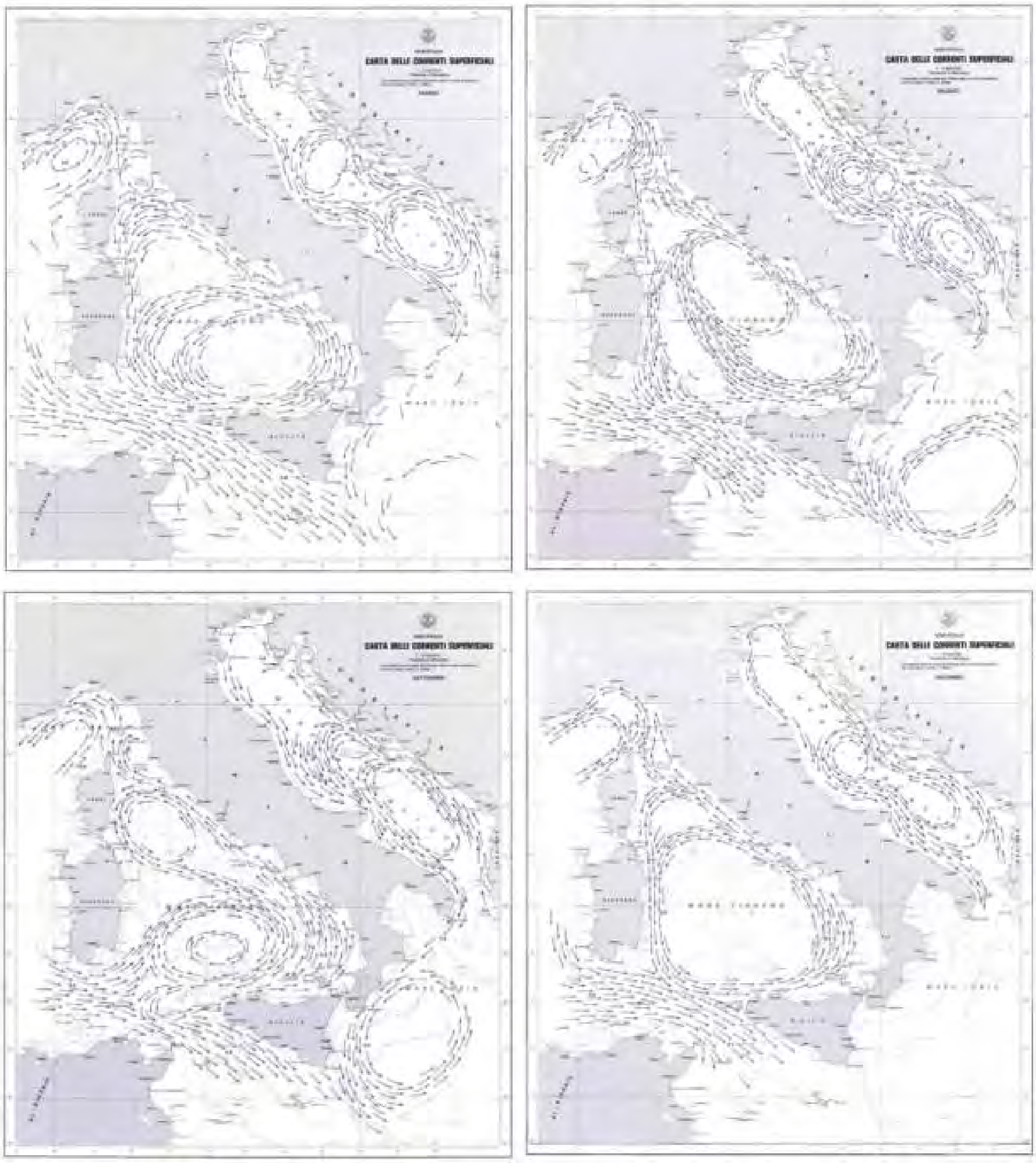
Wind is capable of transferring large amounts of energy to bodies of water through the free surface of the sea. The greater the intensity, duration, persistence along a given direction and the surface area the surface over which the wind acts, the greater the amount of energy transmitted. The shape of the waves generated under the action of the wind is also due to factors dependent on atmospheric circulation, which are therefore linked to the pressure and temperature of both the air and the water.

However, specific studies for the Strait of Otranto (Urusella *et al.*, 2014) rule out that winds, particularly the sirocco winds typical of late autumn and winter (October to April), have a significant impact on sea level. The cause-effect relationship is rather to be found in the generation of waves topographically confined within the strait, which cause a rise in sea level, especially during the daytime, through the phenomenon of resonance in response to the tide.

Furthermore, especially in the summer months, there is a significant contribution from the intensification of currents, both surface and deep, which reach speeds of 10 cm/s.

Figure 5-15 shows the surface current charts prepared by the Italian Navy for the months of March, June, September and December.

Figure 5-15 Italian Navy surface current charts (March, June, September and December)



Source: Hydrographic Institute of the Navy, 1982

In conclusion, with reference to the landing area in the municipality of Santa Cesarea Terme (LE), based on exposure and fetch, the wave climate is characterised by a dominance (in terms of %) of waves coming from the southern quadrants.

5.4 Air quality

5.4.1 National Reference Standards

The regulations on air quality standards in Italy were established by the *Prime Ministerial Decree of 28 March 1983* with regard to certain parameters, subsequently amended by *Presidential Decree 203* of *24 May 1988*, which, incorporating certain European Directives, introduced, in addition to new limit values, guideline values, understood as 'quality objectives' to be pursued by sectoral policies.

These were followed by a series of decrees defining levels and limits, presented below.

Decree of the Minister of the Environment of 15/04/1994 (updated with Decree of the Minister of the Environment of 25/11/1994)

This Decree introduced attention levels (air pollution situations which, if persistent, determine the risk of reaching the alert status) and alert levels (air pollution situations likely to cause environmental and health risks), valid for pollutants in urban areas. The decree also introduced target values for certain new air pollutants not regulated by previous decrees: PM_{10} (inhalable suspended particulate matter), benzene and PAHs (polycyclic aromatic hydrocarbons).

Legislative Decree 351 of 04/08/1999

This Decree transposes *Directive 96/62/EEC* on the assessment and management of air quality, referring to implementing decrees for the introduction of new quality standards.

Ministerial Decree 60 of 2 April 2002

This Decree transposes *Directive 1999/30/EC* on limit values for sulphur dioxide, nitrogen dioxide, nitrogen oxides, particulate matter and lead, and Directive 2000/69/EC relating to limit values for benzene and carbon monoxide in ambient air. The decree repealed the provisions of the previous legislation relating to: sulphur dioxide, nitrogen dioxide, suspended particulate matter, PM_{10}, lead, carbon monoxide and benzene.

Ministerial Decree 60/2002 also introduced criteria for the optimal location of sampling points at fixed sites. For macro-scale location, for human protection purposes, a sampling point should be located so as to be representative of the air in a surrounding area of not less than 200 m², in traffic-oriented sites, and not less than a few km², in urban background sites. For the protection of ecosystems and vegetation, sampling points should be located more than 20 km from agglomerations or more than 5 km from built-up areas other than the above or from industrial installations or motorways; the sampling point should be located so as to be representative of the ambient air quality of a surrounding area of at least 1,000 km².

Finally, Annex *IX of Ministerial Decree 60/2002* sets out the criteria for determining the minimum number of sampling points for measuring levels of sulphur dioxide, nitrogen dioxide, nitrogen oxides, particulate matter (PM_{10}), lead, benzene and carbon monoxide in ambient air at fixed sites. For the human population, separate criteria are given for diffuse sources and point sources. For the latter, the sampling point should be defined on the basis of emission density, the possible air pollution distribution profile and the likely exposure of the population.

Ministerial Decree No. 60/2002 establishes the following for sulphur dioxide, nitrogen dioxide, nitrogen oxides, PM_{10}, benzene and carbon monoxide:

- limit values, i.e. atmospheric concentrations set on the basis of scientific knowledge in order to avoid, prevent or reduce harmful effects on human health and the environment;
- alarm thresholds, i.e. the atmospheric concentration above which there is a risk to human health in the event of short-term exposure and at which immediate action must be taken;
- the margin of tolerance, i.e. the percentage of the limit value by which that value may be exceeded, and the manner in which that margin must be reduced over time;
- the deadline by which the limit value must be achieved;
- the averaging periods, i.e. the period of time during which the data collected are used to calculate the reported value.

<u>Legislative Decree 183 of 21/05/2004</u>

The Decree transposed *Directive 2002/3/EC* on ozone in ambient air; this decree repeals all previous provisions concerning ozone and sets new limits.

<u>Legislative Decree 152 of 03/04/2006</u>

Part V (Regulations on air protection and reduction of emissions into the atmosphere) of this Decree known as the Consolidated Environmental Act, repeals *Presidential Decree 203 of 24/05/1988* described above.

Legislative Decree 152 applies to plants (including civil thermal plants) and activities that produce emissions into the atmosphere, establishing emission values, requirements, sampling and analysis methods for emissions, and criteria for compliance of measured values with limit values. The Decree also defines the product characteristics of fuels (previously regulated by the repealed *Prime Ministerial Decree of 8 March 2002)* that can be used in installations that produce emissions, also providing guidance on the measurement methods to be used to determine them.

It should be noted that *Legislative Decree 152 of 2006* does not amend the provisions of previous decrees on air quality

.

Legislative Decree 152 of 03/08/2007

With regard to heavy metals and polycyclic aromatic hydrocarbons (PAHs), reference should be made *to Legislative Decree No. 152 of 3/8/2007*: "*Implementation of Directive 2004/107/EC on arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in the environment*".

This Legislative Decree aims to improve the quality of ambient air and maintain it.
where appropriate, establishing:

- target values for the concentration in ambient air of arsenic, cadmium, nickel and benzo(a)pyrene;
- the methods and criteria for assessing concentrations in ambient air of arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air;
- the methods and criteria for assessing the deposition of arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons.

Legislative Decree No. 120 of 26/06/2008

The Decree entitled '*Amendments and additions to Legislative Decree No.* 152 *of 3 August 2007*' replaces Annex I to *Legislative Decree No. 152/2007*, maintaining the same target values for arsenic, cadmium, nickel and benzo(a)pyrene.

Legislative Decree 155 of 13/8/2010

The enactment of *Legislative Decree 155/2010* effectively harmonises existing legislation on air quality , bringing together in a single piece of legislation the air quality limits for all pollutants.

The following tables show the main air quality assessment parameters set out in *Legislative Decree 155/2010* for the pollutants considered in this study; the limit values are expressed in terms of concentration normalised at a temperature of 293 K and a pressure of 101.3 kPa.

Table 5.4 Legal Limits for Acute Exposure

Substance	Type	Value	Legislative Reference
NO2	Alarm threshold*	400 µg/m	Legislative Decree 155/2010
	Hourly limit not to be exceeded more than 18 times per calendar year	200 µg/m³	
CO	Maximum daily 8-hour moving average	10 mg/m³	
SO	Hourly limit not to be exceeded more than 24 times per calendar year	350 µg/m	
	24-hour limit not to be exceeded more than 3 times per calendar year	125 µg/m³	
O3	Information threshold (1-hour average) 1 hour)	180 µg/m³	
	Alarm threshold (1-hour average)	240 µg/m³	
PM10	24-hour limit not to be exceeded more than 35 times per calendar year	50 µg/m	
* measured for 3 consecutive hours at a site representative of air quality in an area of at least 100 km², or in an entire zone or agglomeration if these are smaller.			

Source: Legislative Decree 155/2010

Table 5.5 Legal Limits for Chronic Exposure

Substance	Type	Value	Legislative Reference
NO2	Annual limit value for the protection of human health Calendar year	40 µg/m	Legislative Decree 155/2010
O	Target value for health protection not to be exceeded for more than 25 days per year as a 3-year average (otherwise as a 1-year average) 8-hour maximum average daily	120 µg/m³	
PM10	Annual limit value for the protection of human health Calendar year	40 µg/m³	
PM2.5	Annual limit value Calendar year	From 1/1/2015 25 µg/ m³	
Benzo(a)pyrene	Target value Calendar year	1 ng/m³ *	

Source: Legislative Decree 155/2010

5.4.2 Reference regional legislation

The characterisation of air quality levels in the Project Area was obtained from the Annual Report on Air Quality in Puglia in 2021, published in 2022 by ARPA Puglia. The report defines the following pollutants as air quality indicators: $PM_{2.5}$, PM10, NO2, O3, benzene, PAHs and heavy metals, and provides annual concentrations for these pollutants on a provincial scale and a comparison with the regulatory limits imposed by Legislative Decree 155/2010.

As reported in Paragraph 5.4, the Regional Plan for Ambient Air Quality (PRQA), provided for by Regional Law 52 of 11/2019, provides for measures to maintain current air quality levels.

The following section describes the air quality study prepared for the Project Area. The characterisation of air quality levels in the project area was obtained from the Annual Report on *Air Quality in Puglia in 2022*, published in 2023 by ARPA Puglia. The report defines the following pollutants as air quality indicators: $PM_{2.5}$, PM10, NO2, O3, benzene, PAHs and heavy metals, and provides annual concentrations for these pollutants on a provincial scale and a comparison with the regulatory limits imposed by Legislative Decree 155/2010.

ARPA Puglia's Annual Report on Air Quality in Puglia in 2022 regarding regional zoning for air quality. The analysis of air quality was conducted for the main macro-pollutants monitored by the installed network (NO_2, O_3, CO, PM_{10}, $PM_{2.5}$).

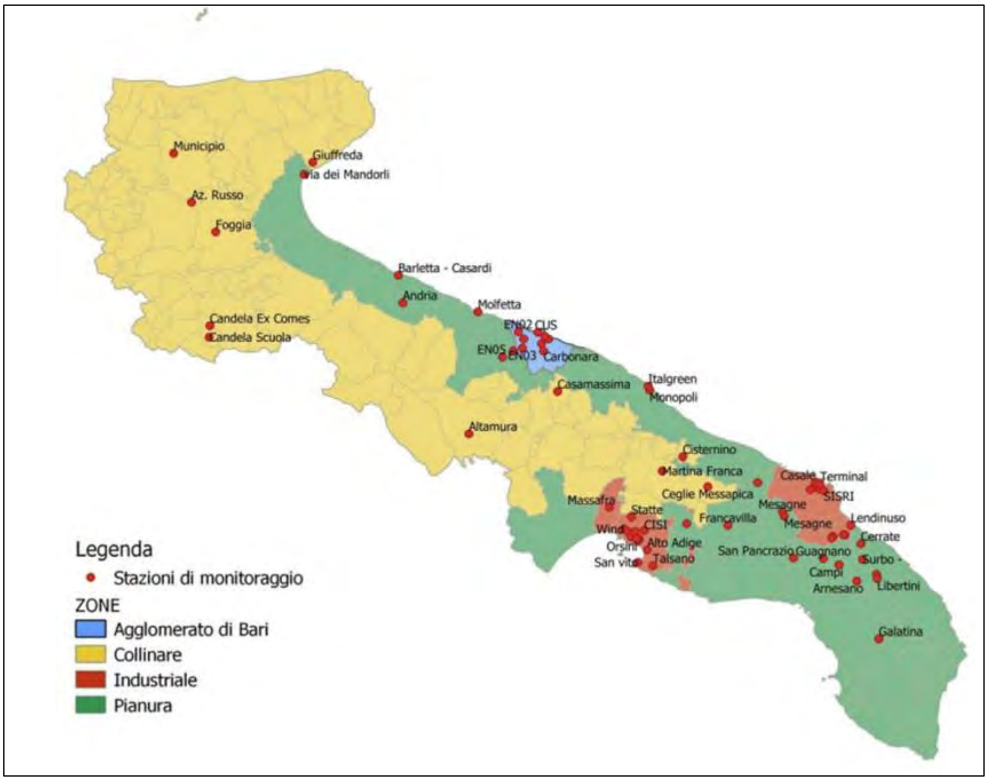
5.4.3 Terrestrial environment

Air Quality Monitoring Network

Legislative Decree 155/2010 assigns to the Regions and Autonomous Provinces the task of zoning the territory (Article 3) and classifying the zones (Article 4). The Puglia Region adopted the Project for the adaptation of regional zoning with Regional Council Decree 2979/2011. With Regional Decree No. 1063 of 9 July 2020, the Region of Puglia approved the 'Classification of zones and agglomerations for the purpose of assessing ambient air quality' (Article 4 of Legislative Decree No. 155/10, as amended and supplemented).

The Regional Air Quality Monitoring Network (RRQA) consists of 53 fixed stations (41 of which are publicly owned and 12 privately owned). These stations are both traffic (urban, suburban), background (urban, suburban and rural) and industrial (urban, suburban and rural). The figure below shows the updated zoning of the territory and the location of the 53 RRQA monitoring stations.

Figure 5-16 Zoning of the territory and location of RRQA stations



Source: Annual Report on Air Quality in Puglia in 2022, ARPA Puglia

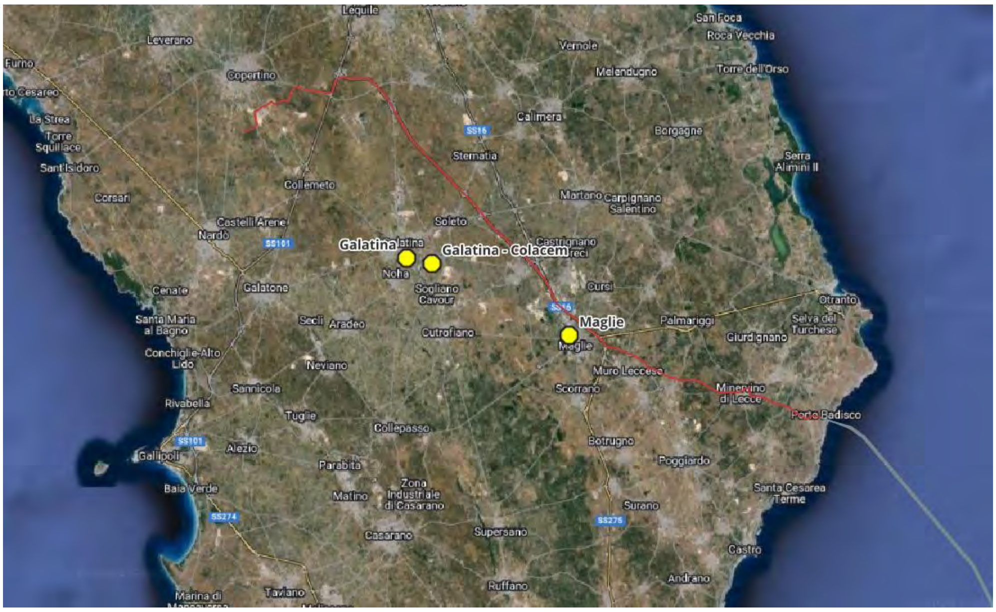
Table 5.6 below shows the parameters measured in 2022 by the monitoring stations closest to the project area along the cable duct route, namely the Galatina, Galatina Colacem and Maglie stations (Figure 5-17). The parameters monitored are PM10, NO2 and O3. The analysis of trends for the Province of Lecce is reported where available.

Table 5.6 Type and location of control units included in the air quality analysis and related pollutants monitored

Station name	Province	Municipality	Station type	Coordinates (UTM33)	Pollutants monitored
Galatina	Lecce	Galatina	Industrial	770356 - 4451121	PM10, NO2, O3
Galatina-Colacem	Lecce	Galatina	Industrial	771953 - 4450838	PM10, NO2
Maglie	Lecce	Maglie	Traffic	780702 - 4446683	NO2, O3

Source: ERM reprocessing of SCIA data, 2022

Figure 5-17 Location of ARPA Puglia network monitoring stations considered for the project under review



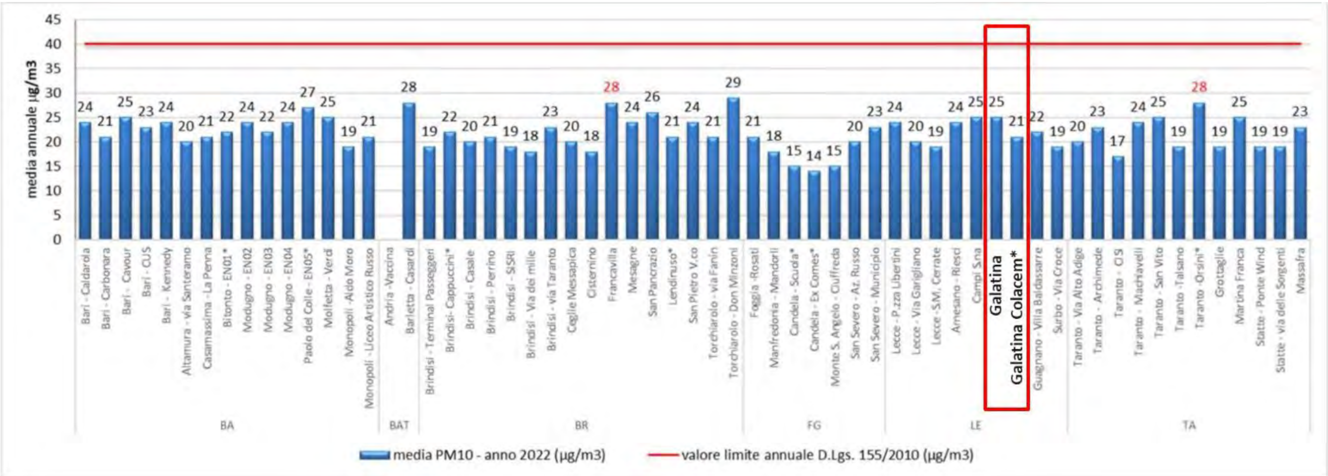
Source: ARPA Puglia, 2022

PM10

The following figures show the annual average value (Figure 5-18), which must be lower than the limit set for human health of 40 µg/m³, and the maximum number of times the daily concentration limit (Figure 5-19) of 50 µg/m³ may be exceeded, which must not exceed 35 times during the calendar year. The data below are based on the latest measurements analysed and presented in the Annual Report on Air Quality in Puglia in 2022.

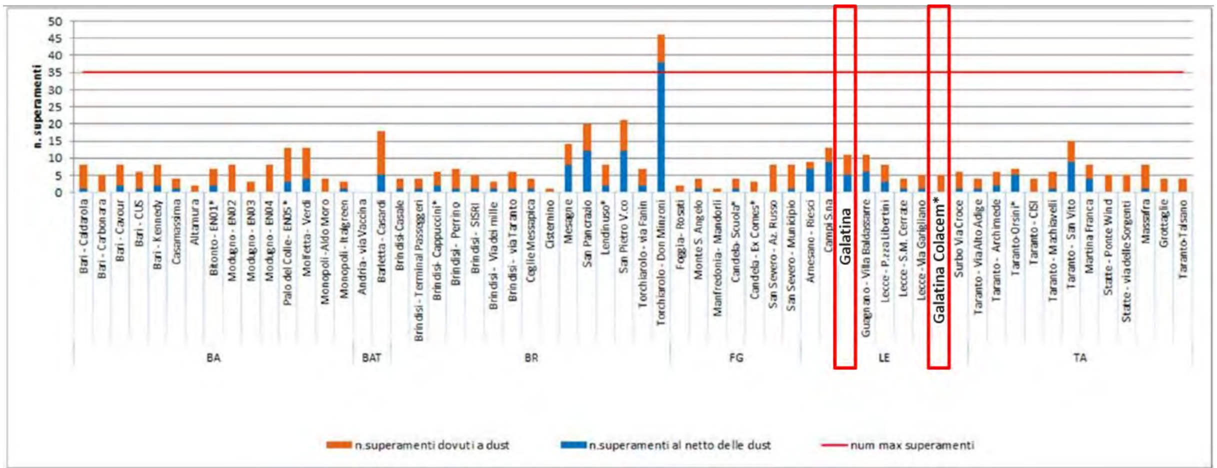
As regards the Galatina and Galatina Colacem stations, during 2022, the identified monitoring stations did not record any exceedances of the two limits set for PM_{10}. However, although remaining below the legal limits, the daily concentration limit was exceeded, partly due to the phenomenon of Saharan dust, i.e. dust from desert areas lifted by convection to considerable altitudes and then transported thousands of kilometres away by winds.

Figure 5-18 PM_{10} - Annual Average Value (Galatina and Galatina Colacem stations highlighted in red)



Source: Annual Report on Air Quality in Puglia in 2022, ARPA Puglia

Figure 5-19 PM_{10} - Daily Limit Exceedances (Galatina and Galatina Colacem stations highlighted in red)



Source: Annual Report on Air Quality in Apulia in 2022, ARPA Puglia

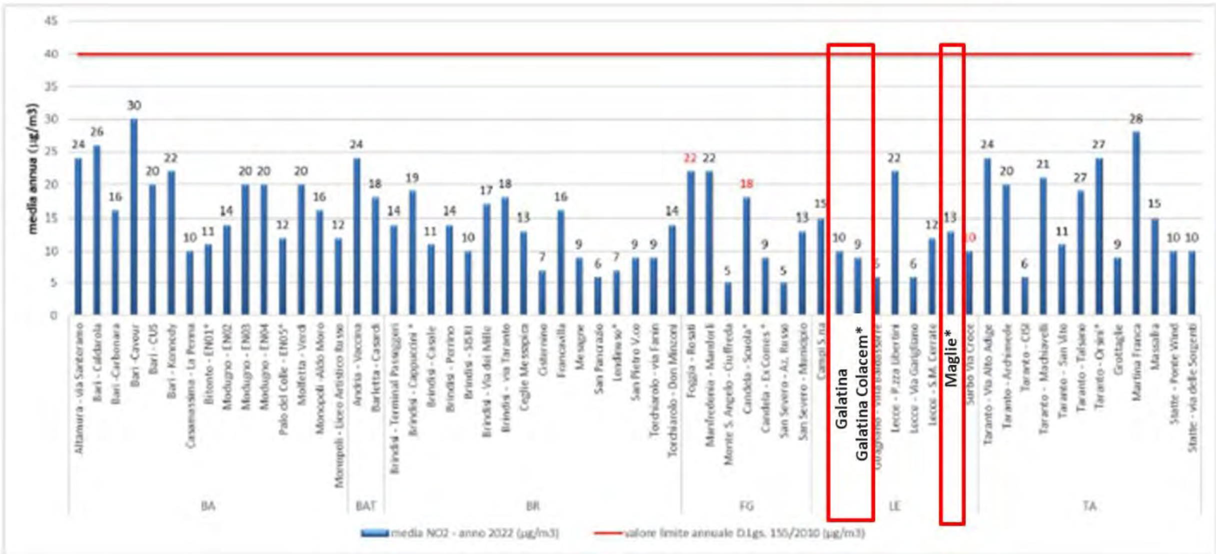
Nitrogen dioxide ($_{NO2}$)

With regard to nitrogen dioxide, Legislative Decree 155/10 sets the following reference limits:

- hourly average of 200 µg/m^3 notto be exceeded more than 18 times during the year;
- annual average of 40 µg/m^3 .

According to the regional agency's Annual Report on Air Quality in Puglia in 2022, the annual average limit was not exceeded at any station. The highest annual average was recorded in Bari-Cavour, with an average value of 30 µg/m^3.

Figure 5-20 $_{NO2}$ - Annual Average Values (Galatina, Galatina Colacem and Maglie stations highlighted in red)



Source: Annual Report on Air Quality in Puglia in 2022, ARPA Puglia

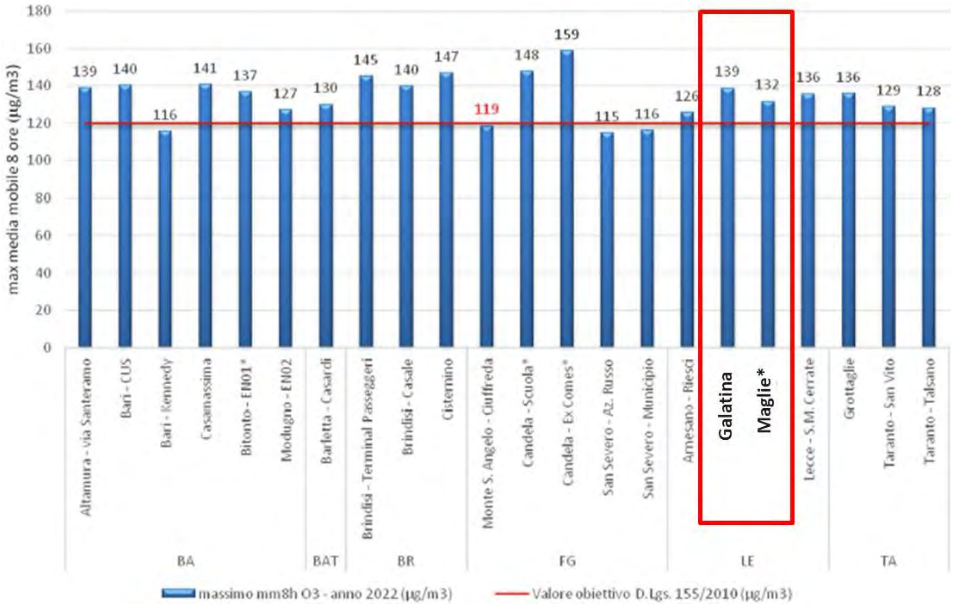
Ozone ($_{O3}$)

With regard to ozone, Italian Legislative Decree 155/10 sets the following reference limits:

- 8-hour moving average of 120 µg/m3, not to be exceeded more than 25 times as a target value for the protection of human health;
- AOT 40 (Accumulated Ozone exposure over a Threshold of 40 ppb) equal to 18.00 µg/m3 h as a target value for the protection of vegetation, assessed only in monitoring stations used for the assessment of vegetation exposure;
- information threshold equal to 180 µg/m3;
- alert threshold equal to 240 µg/m3.

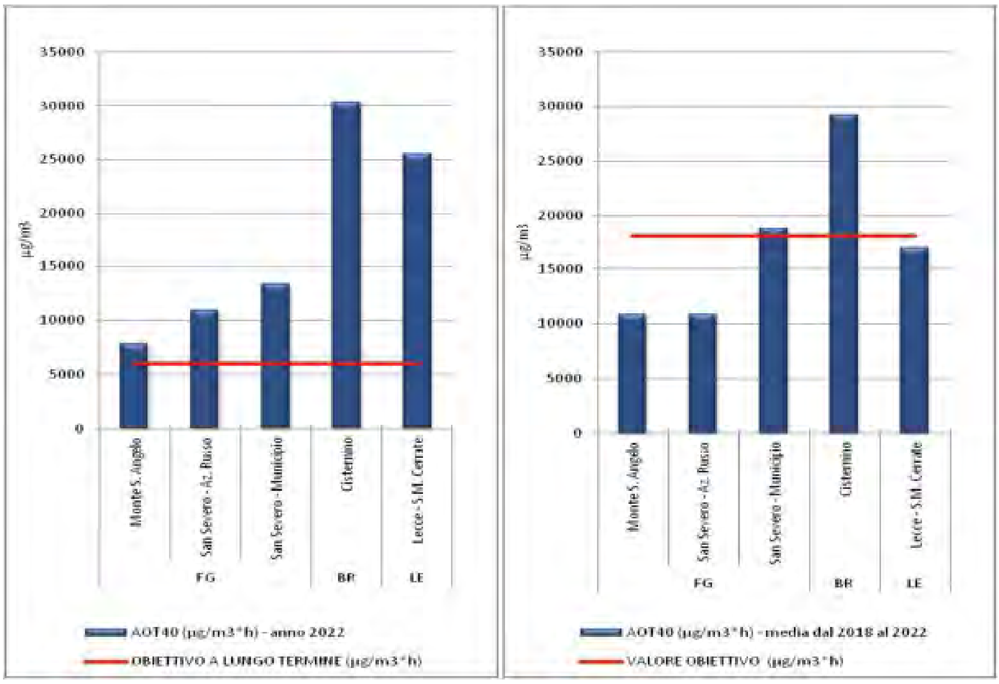
During 2022, the target value for the protection of human health was exceeded at all stations except for the sites of Bari-Kennedy, Monte S.Angelo-Ciuffreda, San Severo-Az Russo and San-Severo- Municipio (Figure 5-21). As regards the AOT 40 value measured at rural background stations, this limit was exceeded at all monitoring stations (Figure 5-22).

Figure 5-21 $_{O3}$ - Maximum 8-hour moving average (Galatina and Maglie stations highlighted in red)



Source: Annual Report on Air Quality in Puglia in 2022, ARPA Puglia

Figure 5-22 O_3 - AOT40, average for the years 2018-2022



Source: Annual Report on Air Quality in Puglia in 2022, ARPA Puglia

5.4.4 Marine environment

The Project Marine Area is located at a minimum distance of approximately 28 km from the Apulian coast and therefore from the relevant sources of air pollution.

For the onshore part, there are no exceedances of the legal limits for pollutants set to protect human health, except for ozone.

Given the morphological characteristics of the marine area, namely the absence of obstacles to air circulation and the windiness of the marine sector covered by the project, it can be assumed that air quality does not represent a critical issue.

5.5 Geology and geomorphology

5.5.1 Geological and geomorphological overview of the sea areas

The Mediterranean Sea basin originated from the convergence of the African and Eurasian plates, which began in the late Cretaceous period. Two main basins can be distinguished, the Western Mediterranean and the Eastern Mediterranean, separated by the Strait of Sicily. They have undergone different tectonic evolution, which is reflected in the different geological processes and seabed morphologies that characterise each of the basins.

The Eastern Mediterranean Sea is currently more tectonically active and has two subduction zones: the Hellenic Trench south of Greece and the Calabrian subduction arc. This includes the two sub-basins of interest to the project, the Adriatic Sea and the Ionian Sea, separated by the Strait of Otranto.

sub-basins of interest to the project under study, the Adriatic Sea and the Ionian Sea, separated by the Strait of Otranto
of Otranto, with diametrically opposed geomorphological characteristics.

The Apulian continental margin, structurally included in the undeformed margin of the African forede-basin (Puglia block), is characterised by a complex topography strongly influenced by gravitational sedimentary processes and currents (Malinverno *et al.*, 2010; Savini and Corselli, 2010). The continental shelf varies greatly in width, from a minimum of 4 km (Taranto) to more than 20 km (off the coast of SM Leuca), and is incised by several orders of Holocene terraces.

The continental slope, eroded by canyons, is the site of intense sediment transport towards the abyssal plain of the Ionian basin. The continuity of the slopes is repeatedly interrupted by weakly inclined morphological structures where thick sedimentary accumulations form (Savini and Corselli, 2010). The most important of these sites is the Mare d'Apulia, bounded to the south-west by a deep, narrow canyon (the Taranto trench). The Apulian wave motion is a submarine extension towards the south-east of the Apulian peninsula that separates the southern Adriatic basin from the Ionian basin (Auroux *et al.,* 1985). At the top of the Apulian bulge, 9 km south of S.M. Leuca, the well-known coral 'banks' are found at depths ranging from about -505 m to more than -900 m (Corselli, 2010).

For details on tectonics, see Section 5.5.4.

5.5.2 Geomorphology and bathymetry

The Project is located in the context of the Strait of Otranto, which geographically separates the Adriatic Sea from the Ionian Sea.

The Adriatic Sea is a shallow basin bordered by the Italian coast to the north and west, and by Slovenia, Croatia and Albania to the east. The eastern coastline is characterised by the Dinaric Alps, which are high and rocky. The Italian coastline, on the other hand, is mainly low and sandy, being fed mainly by the accumulation of river sediments. To the north, the basin is characterised by a shallow seabed, which slopes gently southwards to the -120 m isobath at Pescara. South of this point, there are greater slopes and depressions, reaching -1200 m at the 'Southern Adriatic Trench'. In the Strait of Otranto, the seabed is around -800 m deep, where the Ionian Sea begins.

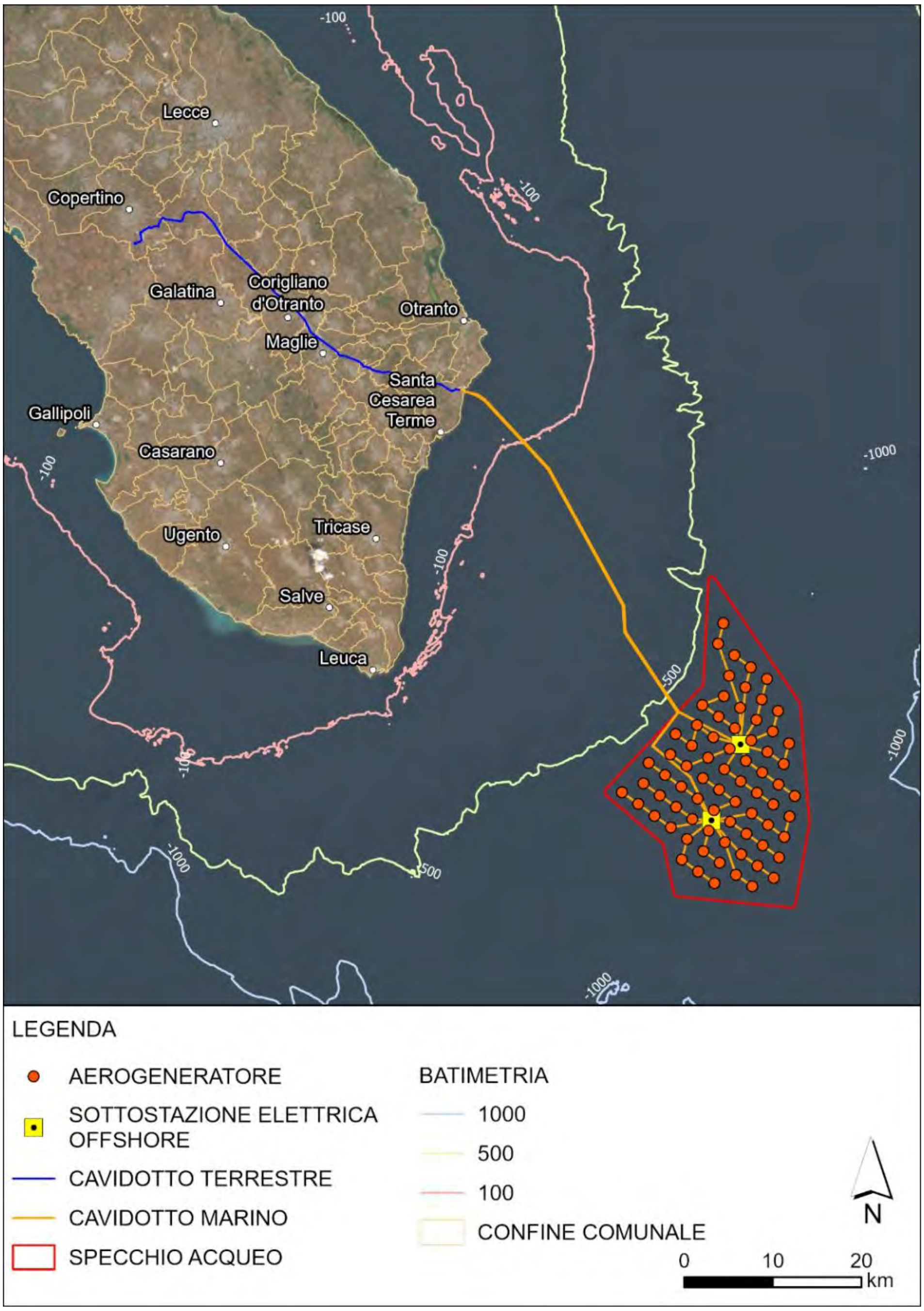
The latter is the deepest basin in the Mediterranean. It connects to the western Mediterranean via the Strait of Sicily, to the Adriatic Sea via the Strait of Otranto, and to the Aegean Sea via the three straits of the Cretan arc. The Ionian Sea is geomorphologically divided by the Taranto Valley, a canyon carved out by the Bradano River running in a north-east to south-west direction and reaching depths of over 2,000 metres on the eastern and south-western sides. The south-western side characterises the southernmost part of Calabria and Sicily, with wide, long sandy beaches alternating with pebble beaches with rocky stretches and cliffs.

The bathymetry of the wind farm area varies in depth from a minimum of -500 m to a maximum of approximately -850 m.

The export cables connect the two offshore electrical substations to the joint pit located near Fraula, in the municipality of Santa Cesarea Terme (LE), for a total length of approximately 53 km and 60 km from each substation. The export cables run from an area at a depth of between -600 and -700 m, where the electrical substations are located. Proceeding northwards, they cross the continental slope off the Apulian coast, reaching a depth of approximately
-200 m. From there, the seabed is almost flat until the landing point.

The bathymetric analysis is summarised in Figure 5-23, which shows the works in the Project together with to the isobaths relating to the marine area of interest.

Figure 5-23 Bathymetry of the marine area of the Project



Source: EMODNet data reprocessing, 2023

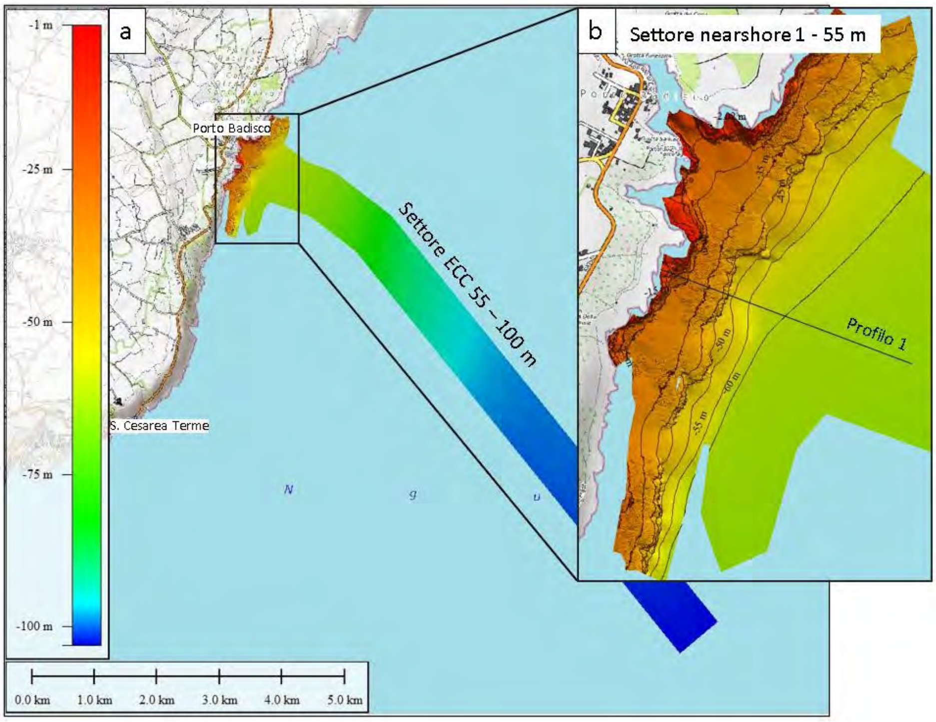
5.5.2.1 Results of geophysical status monitoring campaigns

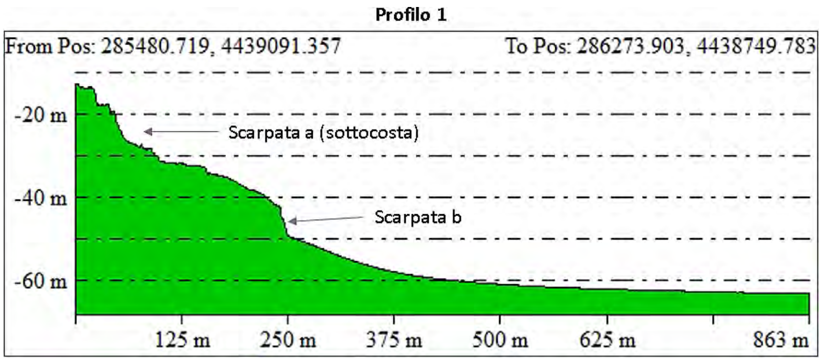
In order to better characterise the wider area, specific environmental surveys were conducted with preliminary acoustic surveys using Multi-beam Echo Sounder (MBES) and Side Scan Sonar (SSS). The surveys were carried out in two different periods, distinguishing between the nearshore sector (considered from the coastline to a bathymetry of -100 m), the offshore sector, which includes the portion of the linear works (route of the cable ducts), and the offshore Project Area (location of the wind turbines).

The nearshore surveys were carried out between 5 and 26 April 2024 and the offshore surveys were carried out between 21 May and 21 June 2024, achieving 100% coverage of the area in both cases. F

The nearshore sector is defined by a gradual increase in depth from the inshore sector towards the open sea (Figure 5-24), with the exception of two breaks in the slope (scarp a-b, profile 1 in Figure 5-24).

Figure 5-24 a) Morpho-bathymetric map of the nearshore sector and the route of the submarine cable (ECC, Export Cable Corridor) b) Detail of the nearshore sector of the study area with the position of the isobaths at 5 m intervals.

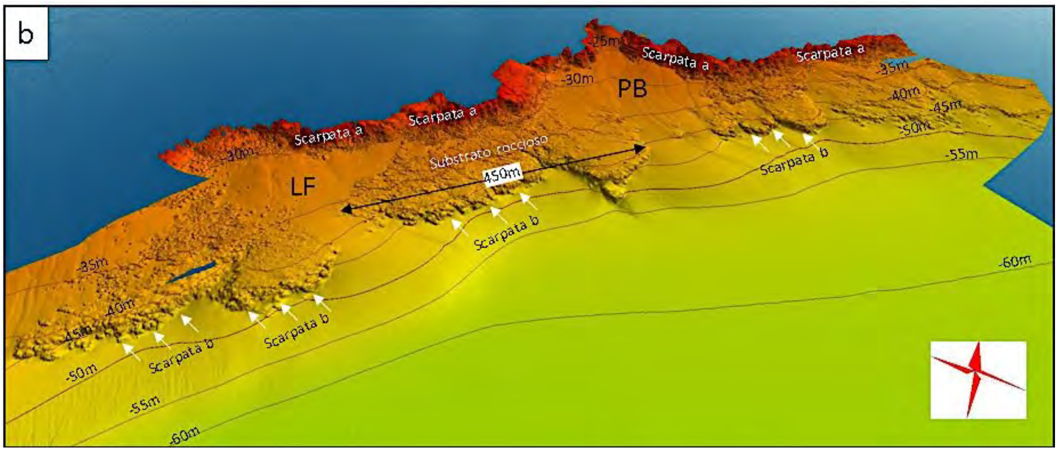




Source: Nearshore Sector - Geophysical and Environmental Survey

This area is characterised by irregular and jagged seabeds associated with a rocky substrate, as confirmed by ROV images. These areas extend from the coastal zone to a depth of approximately -20 m, and between -20 m and -45 m, the continental shelf continues with a mosaic of coastal debris and rocky outcrops. The rocky outcrops extend over a width ranging from 250 m (minimum value) near the coast to 450 m (maximum value) near the b escarpment. The areas with jagged seabeds are interspersed with areas with regular seabeds, located in the continuation of Porto Badisco (PB) and La Fraula (LF) (Figure 5-25). In both areas, there are ripples on the seabed, indicating the presence of a sandy substrate. This type of substrate is affected by a system of erosive incisions (grooves).

Figure 5-25 3D view of the nearshore sector showing the two slopes "a" and "b" and the areas characterised by jagged substrate, alternating with areas with regular substrate (LF, La Fraula location, and PB, Porto Badisco location)

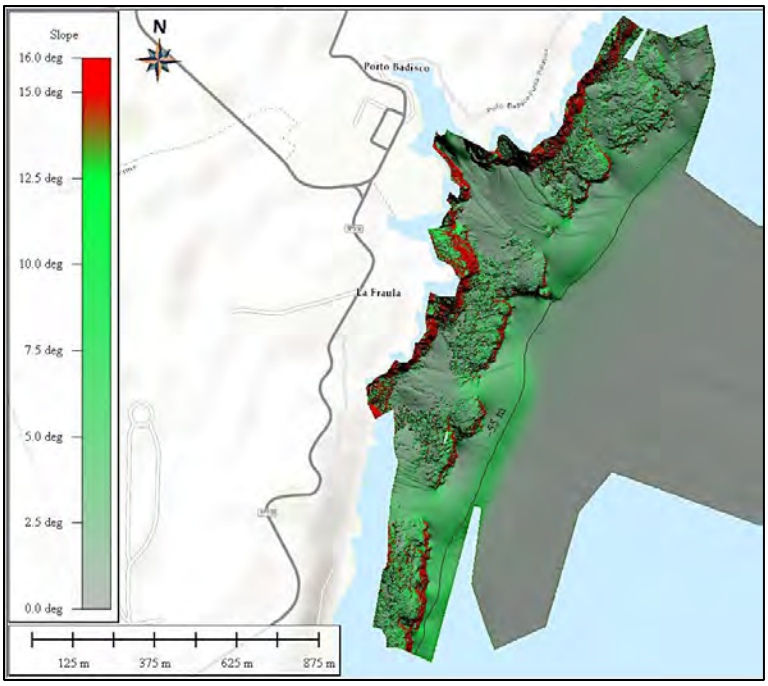


Source: Nearshore Sector - Geophysical and Environmental Survey

The gradient map of the nearshore sector shows a seabed with slopes varying from a few degrees to 16° (Figure 5-26); the different slopes are due to the different substrates identified in the area. The areas characterised by rocky substrate show an average slope of 10°, while in the sectors where sandy substrate outcrops (PB and LF areas), the slopes are a few degrees and increase to about

12° along the banks of the eroded furrows. The maximum inclinations of 15-16° are reached at the two escarpments.

Figure 5-26 Map of gradients in the nearshore sector

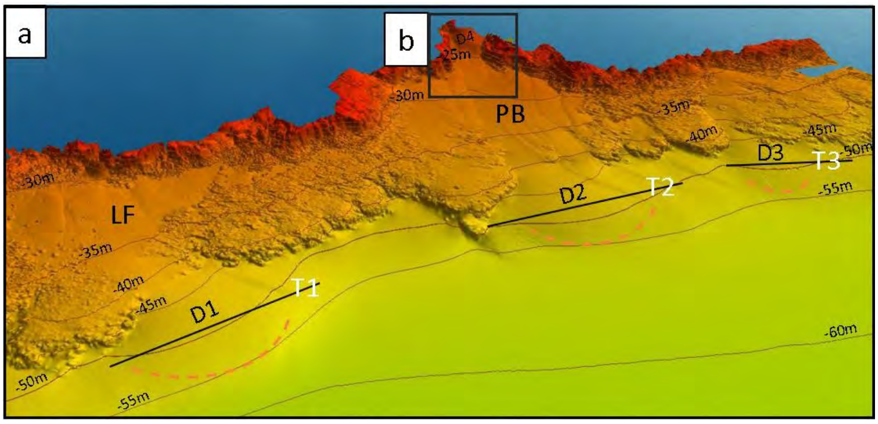


Source: Nearshore Sector - Geophysical and Environmental Survey

The "a" escarpment is located below the coast and extends continuously throughout the investigated area, running from northeast to southwest. The height of this morphostructure is approximately 20 m, while its base is located at a maximum depth of approximately -30 m. The "b" escarpment has been identified at a depth of approximately -40 m in a discontinuous manner in the study area; it has a height varying between 4 m and 7 m.

The "b" escarpment is not present at the lower boundary of the PB and LF zones and in the northernmost part of the investigated area. In these areas, lobed morphologies, named D1, D2 and D3 (Figure 5-27), are observed, probably associated with the presence of gravitational deposits; these rise from the seabed by approximately 2 m, 3 m and 1 m, respectively, and extend for approximately 150 m. The front part of these morphostructures is located at a depth of approximately -55 m. Another lobate morphology, called D4, has been identified in the coastal sector of the PB area (Figure 5-27 b) and, like the previous ones, has been associated with the presence of a gravitational deposit; this has a height of about 3 m and extends for about 100 m to a depth of -22 m.

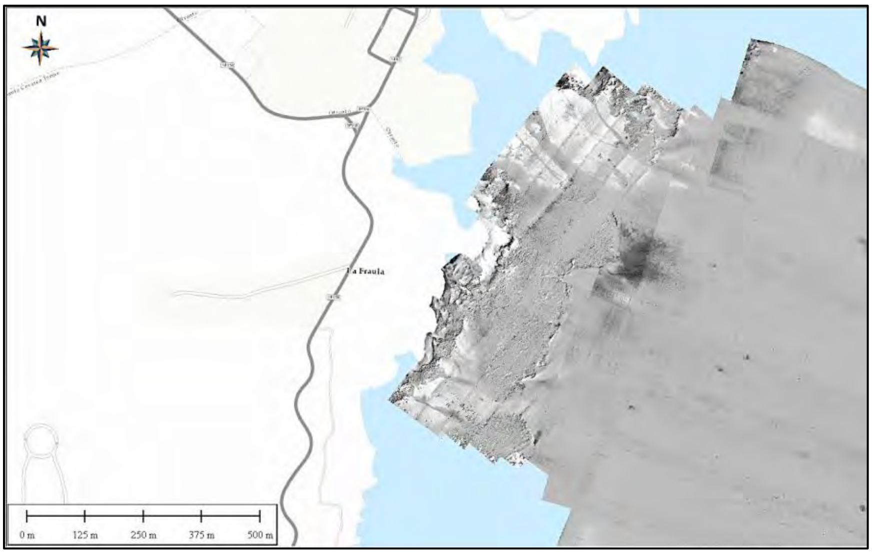
Figure 5-27 3D view of the nearshore sector showing the lobate morphologies (D1-4) identified in the study area



Source: Nearshore Sector - Geophysical and Environmental Survey

The Side Scan data acquired in the nearshore sector shows variable backscatter, particularly in the area close to the coast. The mosaic reflects the complex morphology of the seabed with several sudden changes in backscatter intensity. Rocky areas with coralligenous biocoenosis are clearly visible, characterised by irregular but generally medium-high backscatter, contrasting with sandy areas with lower backscatter indicating the presence of loose sediment (particularly in the area in front of Porto Badisco).

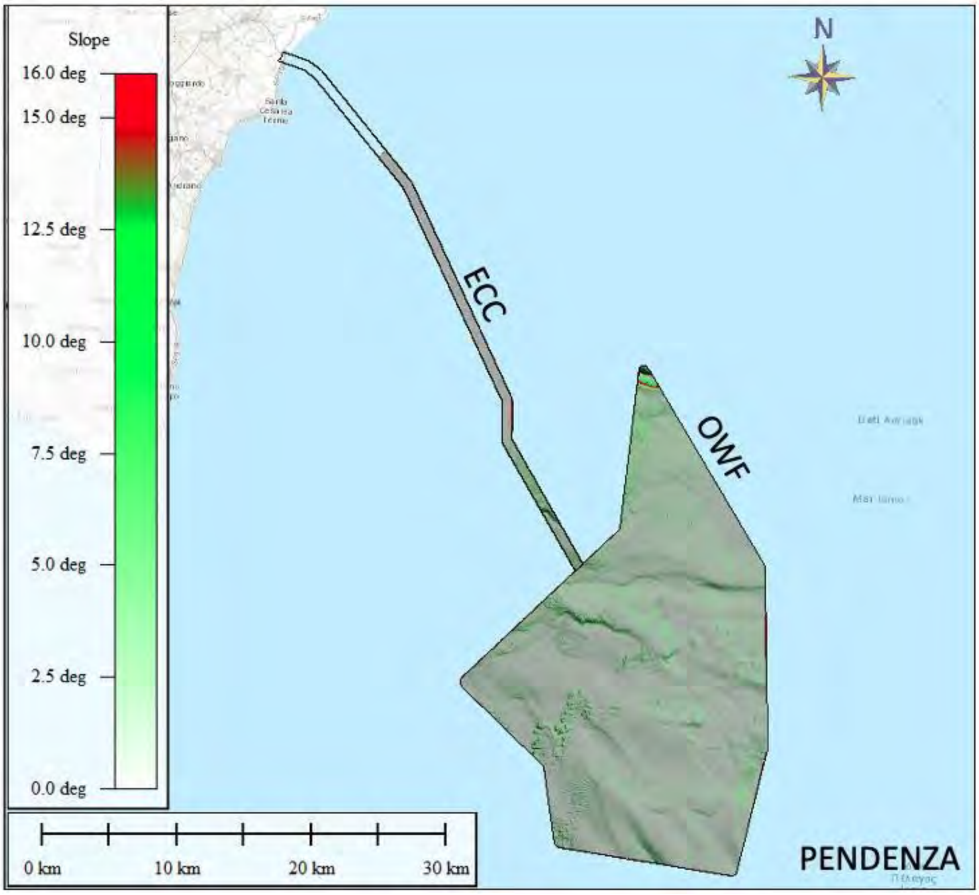
Figure 5-28 Overview of the nearshore mosaic (resolution 0.25 m)



Source: Nearshore sector - Geophysical and Environmental Survey

As regards the ECC sector (between -55 m and approximately -580 m), the data collected using multibeam show that the section under examination has a typical platform profile, with a gentle morphology regular with average gradients below 2°C. Approaching the platform edge (approximately -150 m depth), a slightly more articulated seabed introduces the continental slope characterised by a gradual increase in gradients. It ends on a morphological step (between -390 m and -480 m) of uncertain origin, which produces local gradients of 8-10°. Finally, a slightly lobed sector follows, introducing the OWF site. A map of the slopes is shown in Figure 5-29.

Figure 5-29 Slope map



Source: Offshore Sector - Geophysical and Environmental Survey

The OWF area, on the other hand, shows a moderately articulated morphology that reflects the moderate complexity of the geological structure of the subsoil, consisting of strongly undulating and reworked layers, folds that often evolve into displacements of the surface stratification. In the southern sector, there are articulated areas that reflect the underlying geometries and an area with upward convex structures associated with the presence of fossil bioconstructions (carbonate mounds).

As regards the data acquired by Side Scan Sonar and Backscatter MBES, the section of ECC under examination, between -55 and -580 m, in addition to a fairly homogeneous backscatter, shows abundant traces of trawling activity on the seabed, which tend to stop along the slope. An uneven and generally medium-high response is found along the edge (due to the presence of some clusters blocks) and along the escarpment (due to alternating areas with deposits and chaotic flows).

In the offshore section, in general, the mosaic shows a canyon in the northern sector with an E-W direction and portions of the area with irregular morphology and medium-high backscatter; this is followed by a ridge in the centre of the area, highlighted by higher backscatter than the surrounding area. The remaining eastern part shows a more articulated morphology, which causes a variable backscatter response, generally medium/medium-low, with bands of higher backscatter at the structural highs.

In conclusion, the nearshore area is characterised by irregular and jagged seabeds extending from the coastal area to a depth of -45 m, with slopes varying from a few degrees to 16°. In addition, there are rocky areas with coralligenous biocoenoses, characterised by irregular but generally medium-high backscatter, contrasting with sandy areas with lower backscatter, indicating the presence of loose sediment. The corridor (ECC), between -55 m and approximately -580 m, has a typical platform profile, with a gentle and regular morphology with average gradients below 2°. The continental slope is characterised by a gradual increase in gradients, leading to a slightly lobed sector that introduces the wind farm area. The section of ECC under examination also shows traces of fishing activity on the seabed. Finally, the wind farm area has a moderately articulated morphology, reflecting the moderate complexity of the geological structure of the subsoil, which is characterised by undulating and reworked layers. The southern sector has articulated areas and an area with convex structures, attributable to the presence of fossil bioconstructions.

5.5.3 Geological and geomorphological overview of the onshore areas

The Apulia region is characterised by a variety of landscapes that reflect and bear witness to the different stages of geological evolution that have shaped it and the different lithological nature of the rocks of which it is composed (limestone, clay, sandstone and conglomerates). The onshore cable duct covers part of the Salento peninsula. Salento represents the southern portion of the emerged Apulian foreland and, like the other portions of the foreland, consists of a powerful Mesozoic carbonate succession covered, in a discontinuous manner, by thin, more recent units with a predominantly carbonate constitution (Palmentola, 1987; Ricchetti *et al.,* 1988).

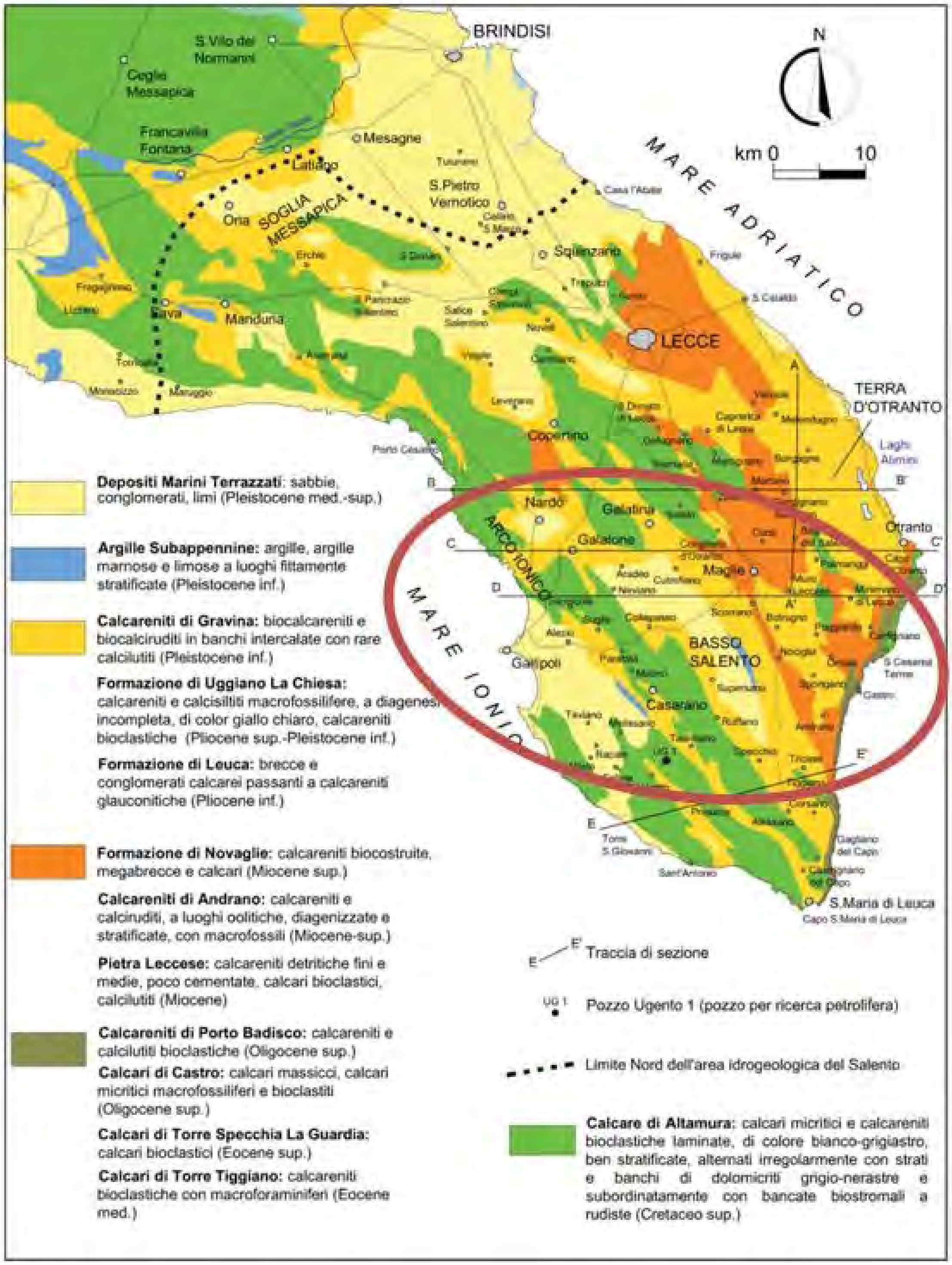
The Salento Peninsula is a vast sub-flat area consisting of terraces sloping down towards the sea and crossed by the Canale Reale watercourse, which extends from the southern end of the Murgia plateau (Soglia Messapica) towards the Adriatic coast to the Serre Salentine hills (a triple series of narrow carbonate ridges, with maximum heights of around 200 m, parallel to each other and extending in a NNO-SSE direction, interspersed with narrow sub-flat depressions) corresponding to the extreme south of the peninsula (ISPRA, 2014).

From a morphological point of view, the south-eastern part of the Salento Peninsula is a sort of modest plateau bounded to the east (towards the sea) by a steep escarpment.

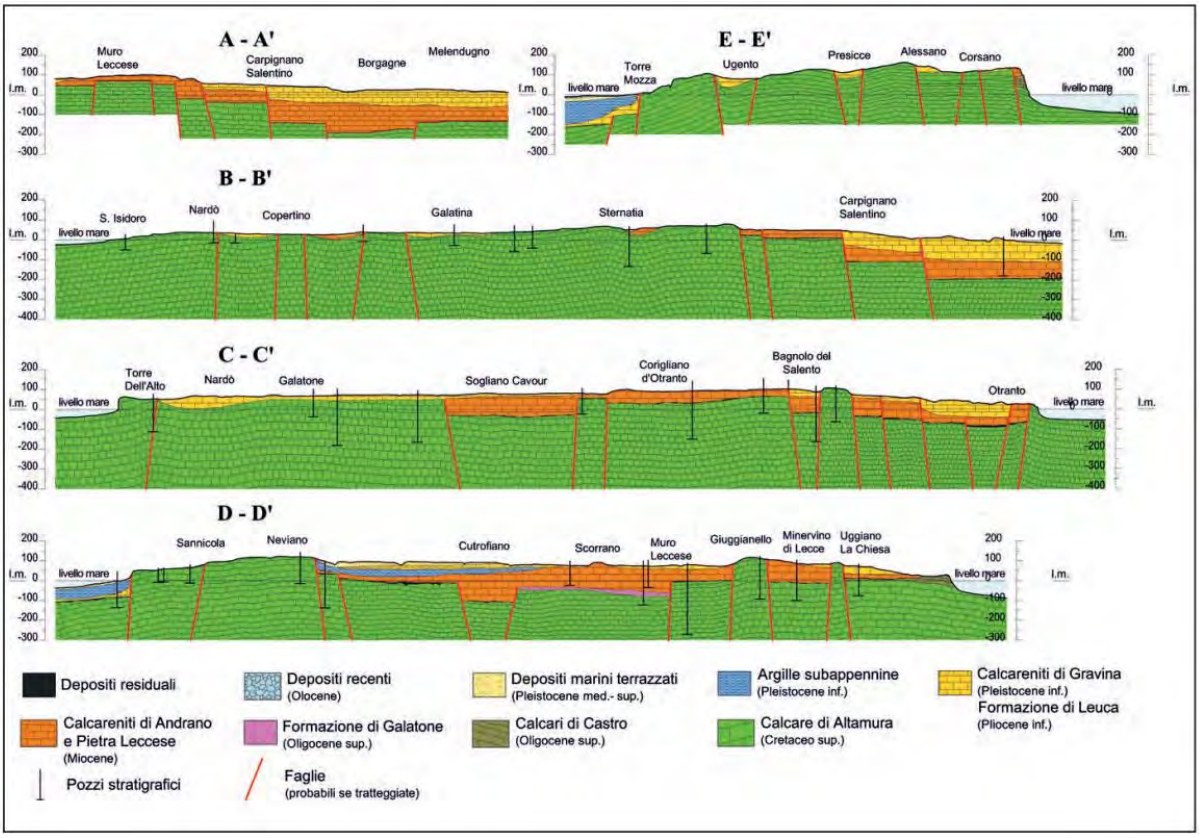
The coastal strip facing the Strait of Otranto (between Otranto and Santa Maria di Leuca) is oriented almost orthogonally to the system of hills and depressions of the Serre and here, as mentioned, the plateau ends towards the sea with a steep, rocky slope that abruptly connects the Serre area to the current continental shelf (Budillon & Aiello, 1999). The rocky slope consists of outcrops of carbonates belonging to different stratigraphic units that are discordant with each other and date back to between the Cretaceous and Quaternary periods.

In the Salento coastal strip, from Otranto to Leuca, Eocene deposits outcrop. In discordance (Paleocene-Lower Eocene gap) on the internal platform limestones of the Altamura Limestone, these deposits are found in limited areas, of modest extent and thickness, consisting of massive calcarenites with alveoli and nummulites (Torre Tiggiano limestones of Lower Lutezian-Bartonian age) or bioclastic limestones rich in fragmented corals and coralline algae (Torre Specchialaguardia limestone of Upper Eocene age). Along the coast between Castro and Leuca, these latter deposits are found both on the oldest Eocene strips and on the Cretaceous layers of the basement (ISPRA, 2014).

Figure 5-30 Geological map (a) and related geological sections (b) of Salento. The Project Area is circled in red.



(a)



(b)

Source: Cotecchia et al., 2014

5.5.4 Seismic, volcanic and tsunami risk classification

According to the seismic risk map prepared by the National Institute of Geophysics and Volcanology, shown in Figure 5-31 with details on the Puglia region, the Lecce area falls within the lowest seismic risk categories.

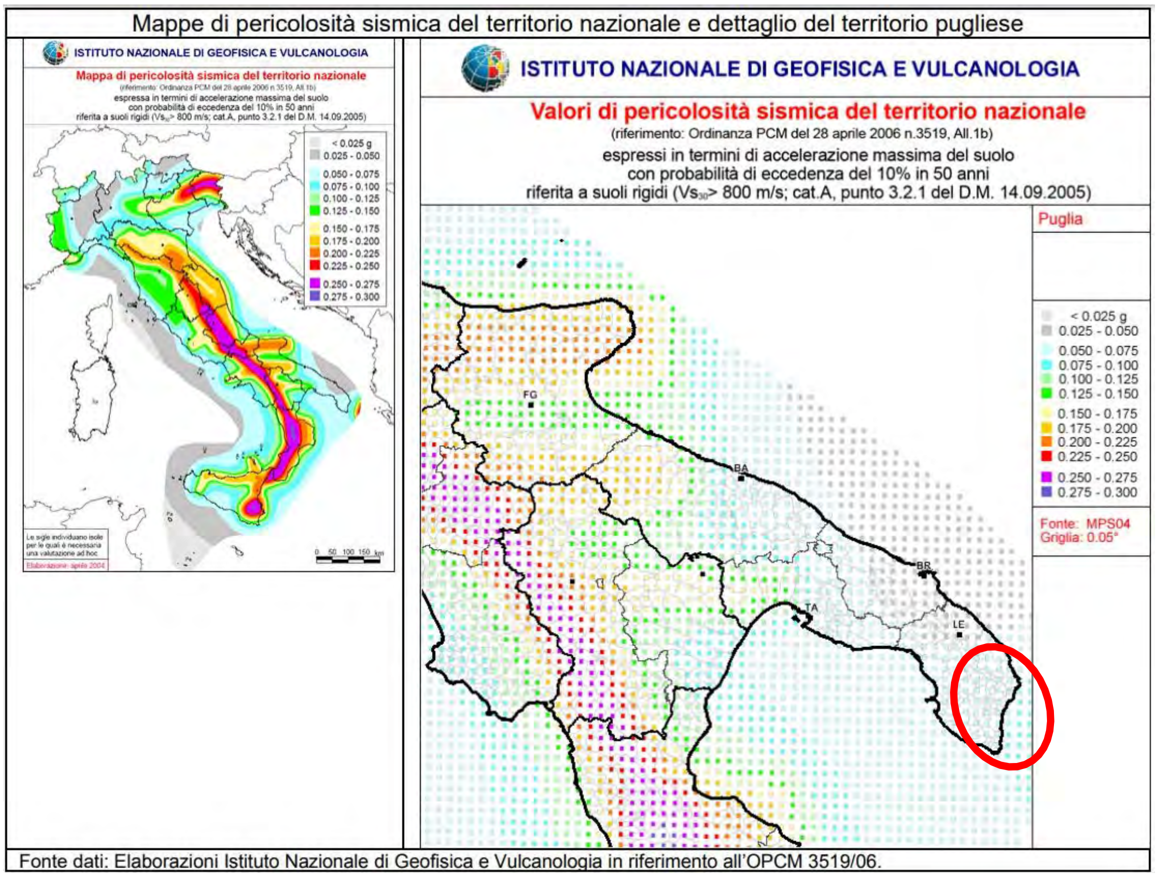
Furthermore, based on the latest information available on the Civil Protection website, the areas crossed by the underground cable duct up to the municipality of Copertino fall within Zone 4 (low hazard level with 'ag' acceleration and a probability of exceedance of less than 0.05% in 50 years).

With regard to its structural configuration, the Salento area is defined by an asymmetrical tectonic pillar, elongated in a NW-SE direction. The western flank is more developed and displaced by direct faults, with a NW-SE direction, in a series of sub-parallel blocks (Ciaranfi et al, 1988). Studies have highlighted a difference in the pattern and nature of the tectonic alignments present in the south-western and north-eastern sectors of the Salento area.

The Salento peninsula, in detail, features hills of tectonic origin, known as Serre, aligned from north-west to south-east. Their heights are modest, but they become more prominent when compared to the topographically depressed areas, also linked to tectonic events, which separate these ridges.

The south-western sector appears to be more deformed and articulated; in fact, in addition to the well-known folds with a wide radius of curvature and NNO-SSE axial surfaces, there are ductile deformations with ENE-OSO and NE-SW axial planes and NW dip (e.g. in the Galatone area). In this sector, the disjunctive tectonics is represented by direct, strike-slip and oblique faults with a NNO-SSE and NE-SE direction (Funciello et al, 1991; Tozzi, 1993). Direct faults become progressively more frequent moving from the south-western to the north-eastern area, where they become predominant, as seen above. The structural layout of the south-western area is therefore represented by a set of blocks (Serre Salentine) and depressions, mainly separated by NNO-SSE faults.

Figure 5-31 Seismic hazard map of Italy – detail of the Puglia region. The Project Area is circled in red.



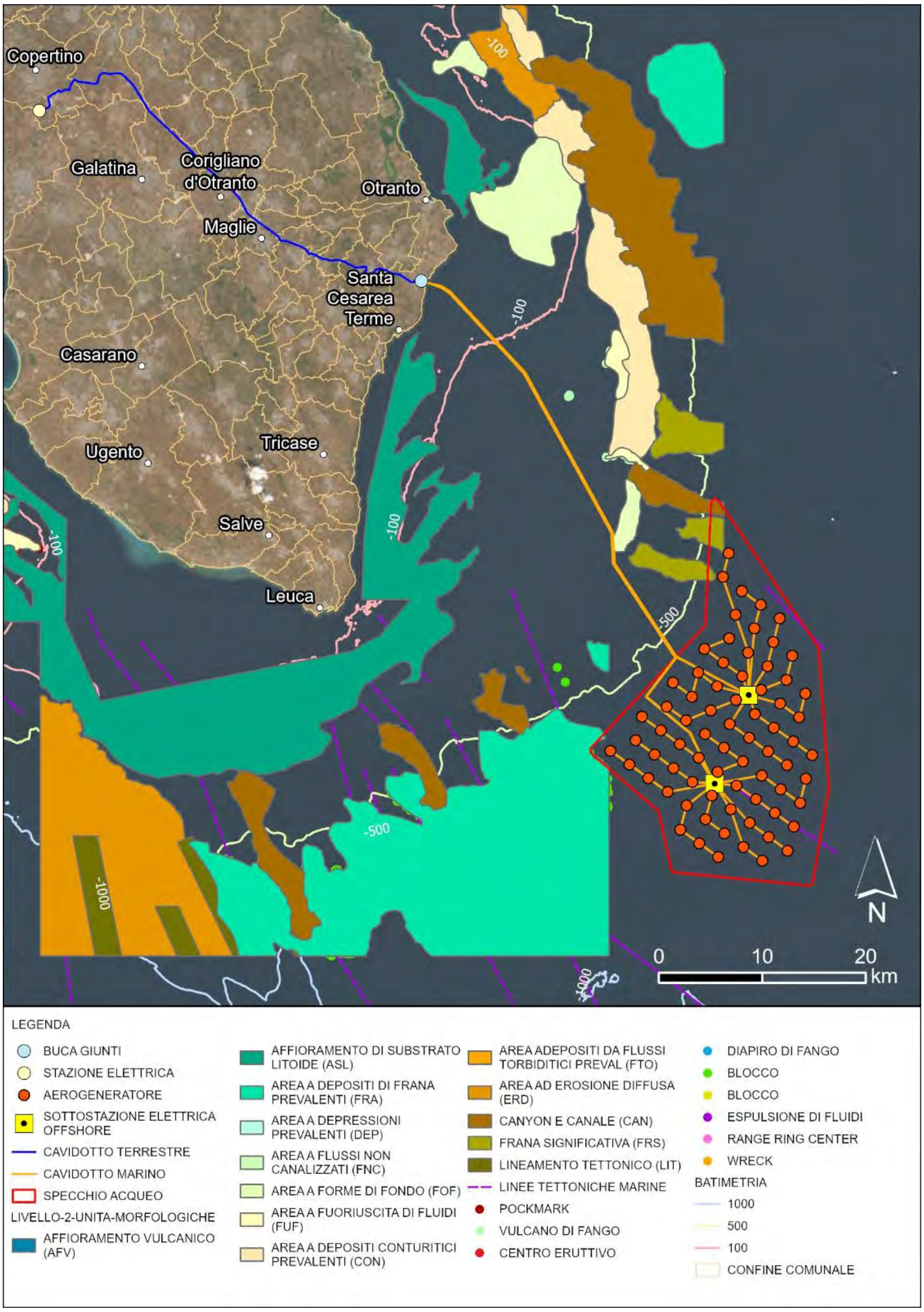
Source: National Institute of Geophysics and Volcanology, 2012

To assess the seismic risk characterising the area of interest, the data contained in the macroseismic database used in 2015 to compile the CPTI15 catalogue (CPTI Working Group, 2015) are useful. Analysis of the information contained in the database has allowed for an initial identification of the 'seismic centres' relevant to the site under consideration and their potential in terms of historically documented epicentral intensities.

The seismic risk assessment for the Offshore Section is in line with that described for the land area. Figure 5-32 shows the geomorphological and tectonic risk map for the marine areas within the area of interest. The presence of several direct and reverse faults is reported, particularly in the shallow waters between Santa Cesarea Terme and Santa Maria di Leuca. There are also several canyons affecting the steepest sections of the continental slope east of Otranto and south of Santa Maria di Leuca. In addition, extensive areas of widespread erosion and areas with prevalent landslide deposits have been identified, as well as several significant landslides, especially along the slope south-east of Santa Cesarea Terme.

Several large debris elements (>256 mm) have been detected downstream of the escarpments east of the coast of Otranto and south of Santa Maria di Leuca, reported as 'blocks' in Figure 5-32 (ISPRA, 2008). Finally, there are mud volcanoes in the waters south-east of Santa Cesarea Terme, at depths between -100 m and -200 m.

Figure 5-32 Geomorphology and tectonics in the marine area of interest



Source: EMODNet data reworked, 2023

As regards tsunami risk, this area has historically been affected by strong earthquakes in neighbouring areas. One example is the earthquake of 1783, located in the northern Ionian Sea, which had an estimated intensity of 7 on the territory and triggered a tsunami that affected the coasts of Puglia and Calabria, with effects documented in contemporary historical sources (CPTI, 2015) (ITED, 2019).

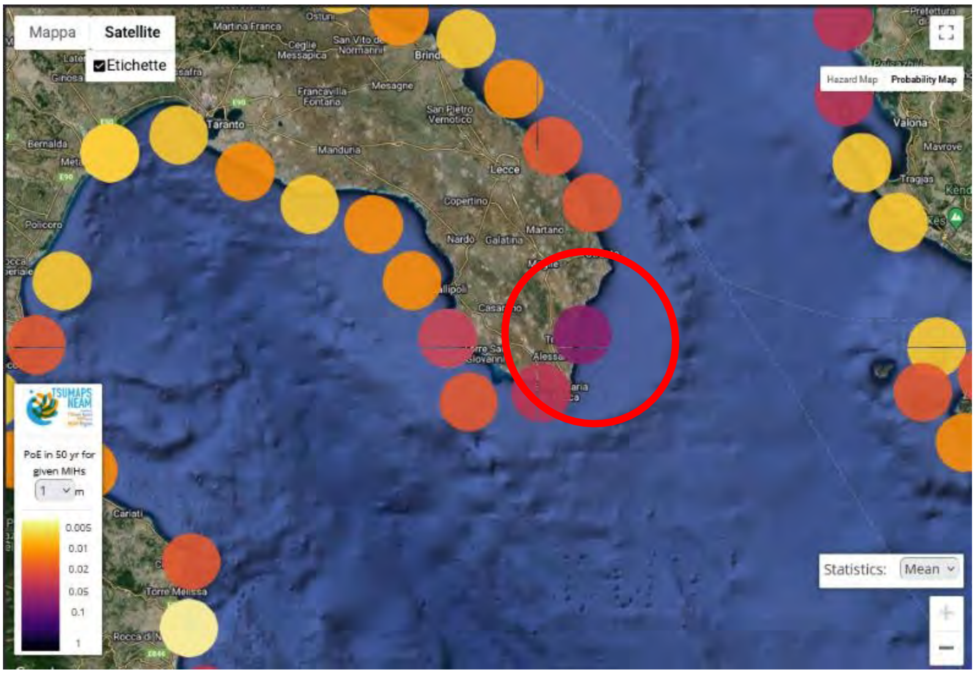
The propensity of the Project Area towards tsunami events can also be investigated by consulting datasets reporting the results of a probabilistic tsunami hazard analysis (PTHA). In the latter, the parameters describing all possible tsunami sources and their occurrence rates are first established; then, the propagation of the tsunami and flood measurements are simulated. The results are then aggregated, providing risk curves that describe the probability exceedance for different tsunami intensity thresholds.

For example, the TSUMAPS-NEAM[4]portal provides information on risks for the Mediterranean Sea and the Atlantic Ocean based on regional modelling and maximum flood height for different return periods. Generally, the threshold value of 1 m (and the corresponding hazard value) is used as the minimum water height to determine vulnerability: that is, for water heights greater than this value, the area of interest can be considered exposed to tsunami risk. As these are probabilistic models, the parameter used for the assessment is actually the 10% probability value of a wave height equal to or greater than 1 m being exceeded in 50 years (Lorito *et al.,* 2015).

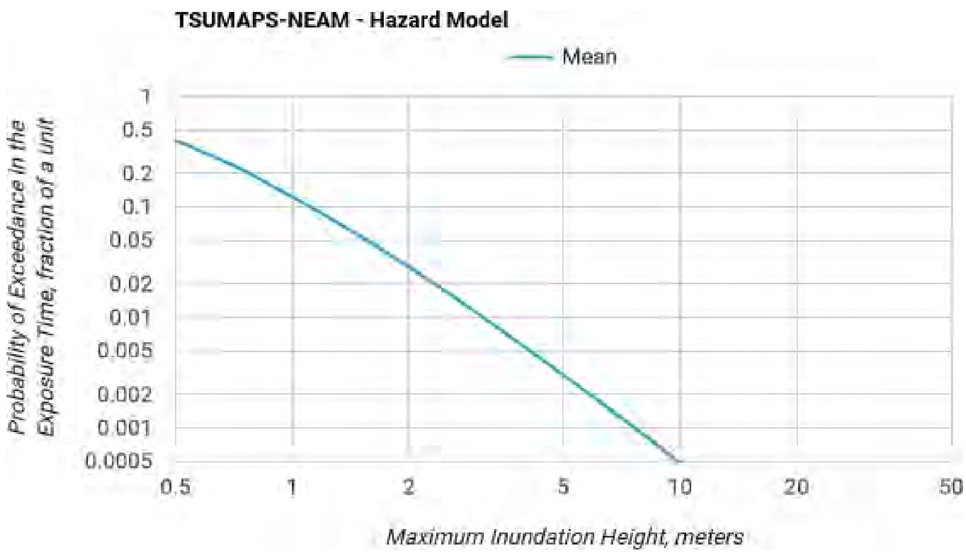
Consulting the above dataset, we find that the part of the coast closest to the area of interest has a probability of just over 10% (approx. 20%) of a wave height equal to or greater than 1 m (Figure 5-33).

[4] https://tsumaps-neam.eu/ (2004)

Figure 5-33 Tsunami risk map for the Area Vasta (a) and expected wave height (b). The Project Area is circled in red



(a)



(b)

Source: TSUMAPS-NEAM – Hazard Model, 2018

The Metereological study assesses the probability of the offshore wind farm area being hit by tsunami waves originating in the Mediterranean Sea. This analysis includes both tsunamis caused by strong underwater earthquakes and those of volcanic origin, drawing on the most recent and reliable research available in the literature. The quantification of the seismic tsunami risk benefits in particular from the data contained in NEAMTHM18 (North-East Atlantic and Mediterranean Tsunami Hazard Model), as well as specific numerical simulations performed using the MIKE 21 HD Hydrodynamic Module. The analyses conducted in the study have led to the conclusion that the tsunami risk is generally low; in particular, it should be noted that the wave heights and current velocities associated with such events, although characterised by very long return periods, are lower than or at most comparable to meteorological events with significantly shorter return periods.

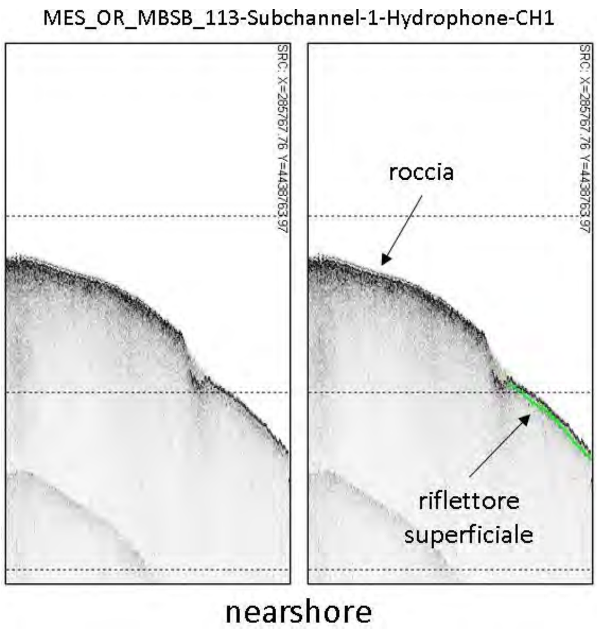
5.5.4.1 Results of geophysical and environmental monitoring campaigns

During the seismic stratigraphic characterisation activities carried out as part of the monitoring campaign in April (nearshore area) and June (offshore area) 2024, the Sub-Bottom Profiler (SBP) grid made it possible to characterise the geological structure of the Project Area to a depth of approximately -20 m from the seabed; It consists of 25 lines, 16 of which cross the nearshore sector (between -5 m and -50 m depth) and the remaining 9 cross the ECC sector (between -5 m and -100 m depth). As regards the offshore sector, the Sub-Bottom Profiler (SBP) grid has made it possible to characterise the geological structure of the Project Area to a depth of approximately -30 m from the seabed in the ECC sector and -90 m from the seabed in the OWF sector. It consists of 110 lines, 10 of which cross the corridor section (-100 m - -580 m WD) and the other 100 cross the OWF sector, between -580 and -800 m WD.

In the nearshore area, analyses confirmed the presence of rocky bedrock in the immediate coastal area and sediment thicknesses present but not excessively developed at depths of -50 m.

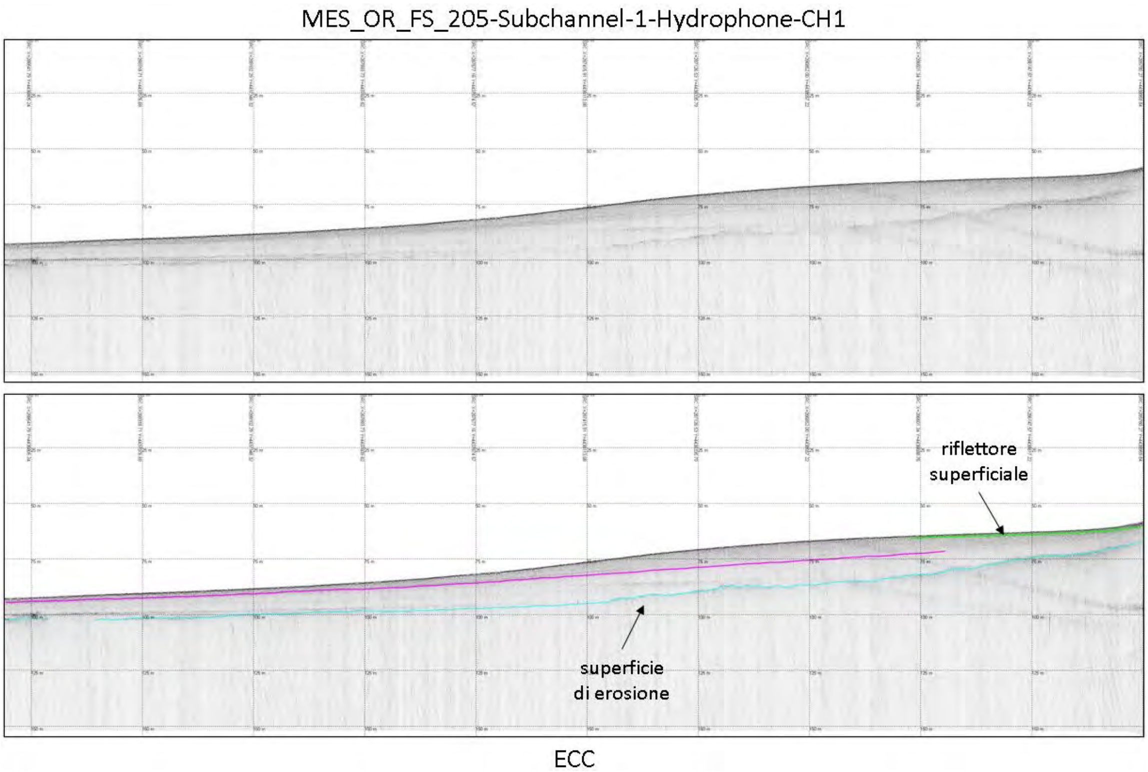
The facies reflect the rocky nature of the coastal stretch alternating with fine sediment from the Porto Badisco area. Just below the sub-vertical wall that characterises the deepest part of the rocky area, there is loose sediment, probably sandy, which allows minimal but present penetration, making it possible to trace a reflector. Figure 5-34 shows the evident lack of seismic penetration in the coastal sector due to the presence of outcropping rock. Figure 5-35, on the other hand, shows a profile of the shallowest part of the corridor, where seismic penetration increases significantly, highlighting two erosion surfaces (purple and cyan lines in the figure). Furthermore, Sparker Profiler (SPK) recordings in the shallower sector of the ECC highlighted two important erosion surfaces (orange and yellow lines in the figure) that outline a first significant thickness of sediments (probably sandy) that prograde towards the open sea and a second thickness of sediments, slightly more chaotic but still stratified and probably sandy, also prograding seaward (Figure 5-36).

Figure 5-34 Example of SBP recording in the 5-50m WD sector (with and without interpretation).



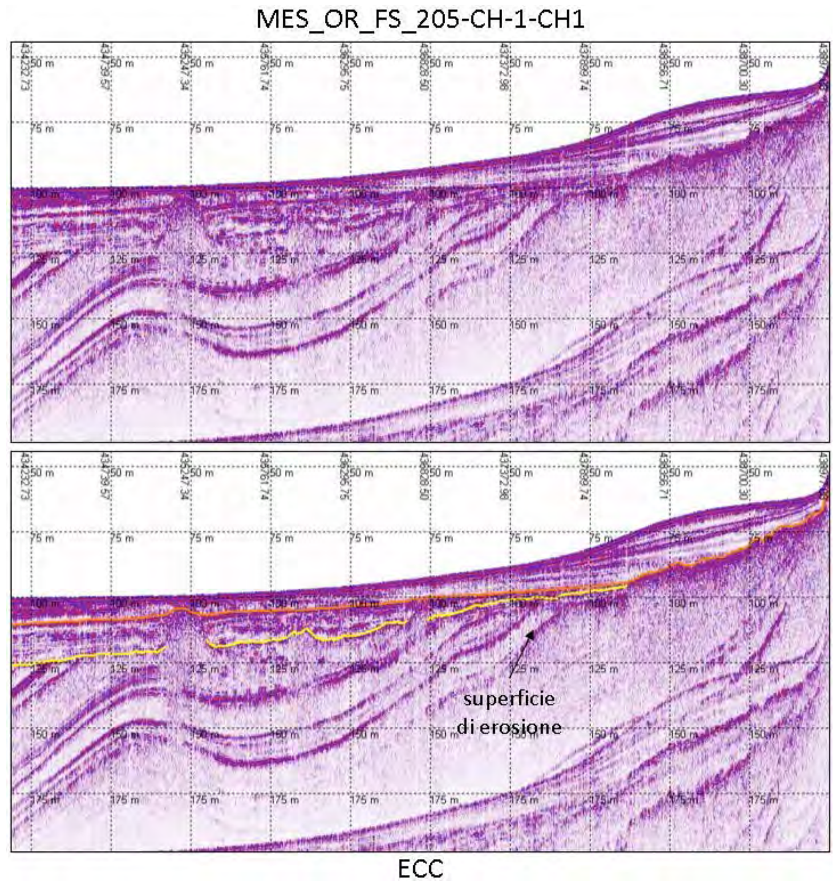
Source: Nearshore Sector - Geophysical and Environmental Survey

00) Figure 5-35 Example of SBP recording in the 50-100m WD sector (with and without interpretation).



Source: Nearshore Sector - Geophysical and Environmental Survey

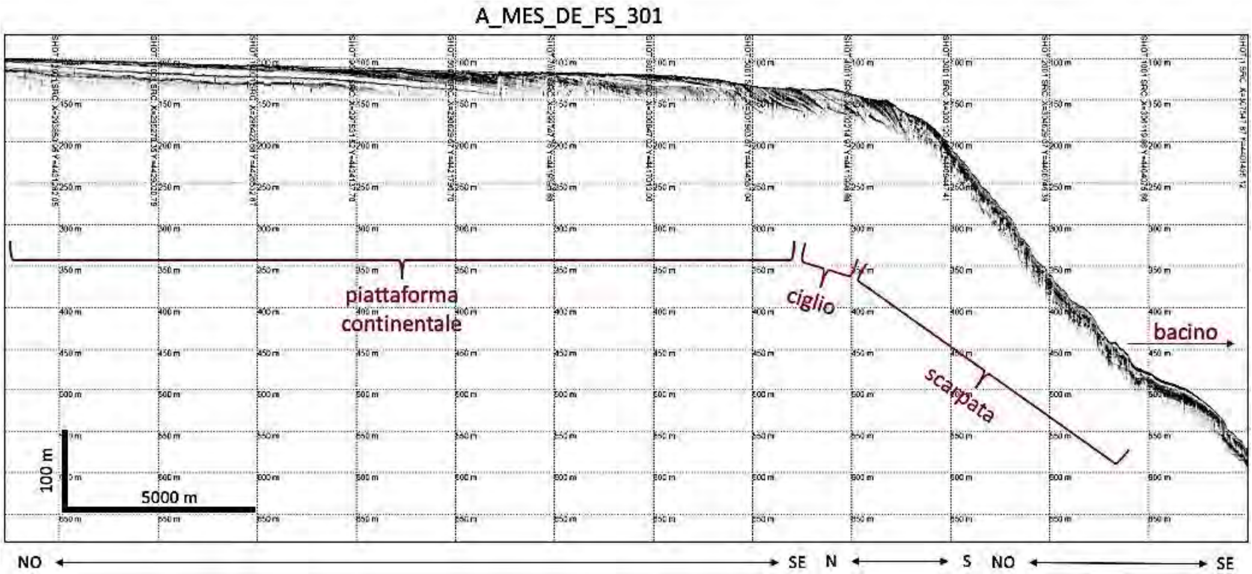
Figure 5-36 Example of SPK recording along the corridor (with and without interpretation).



Source: Nearshore Sector - Geophysical and Environmental Survey

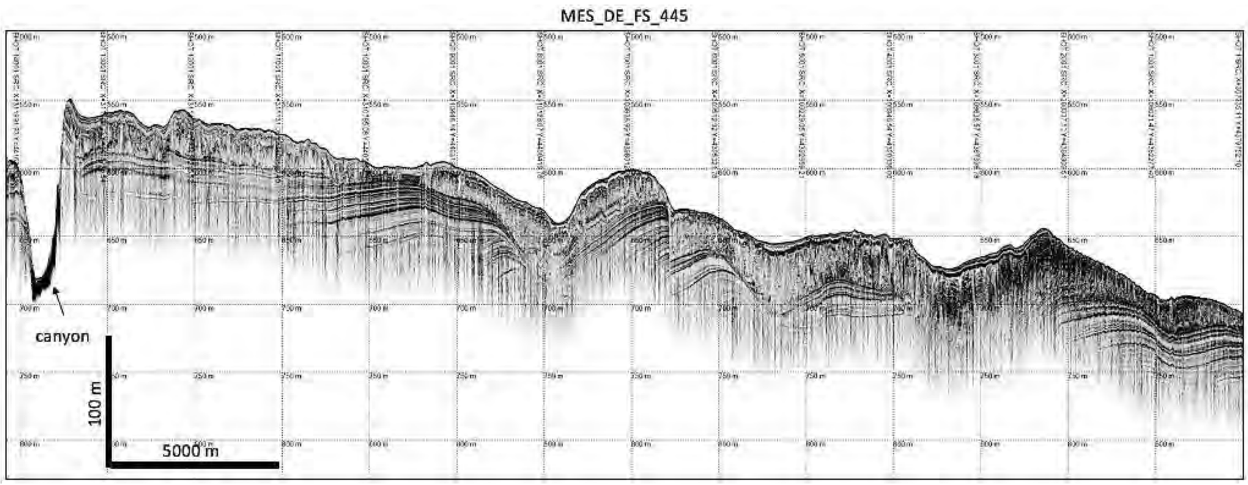
In the offshore area, the data analysed show that the section of the corridor under examination has a profile typical of a platform, with reflectors sloping towards the open sea, with gradually increasing gradients until they reach the edge of the escarpment, where they reach maximum values. The seismic facies of the escarpment is chaotic and unstratified, while sedimentary cumuli are present at the foot of this area. The deepest seismic unit identified in the corridor has thicknesses ranging from -30 m to -100 m. In the OWF area, on the other hand, the geological structure of the subsoil is complex throughout its entire extent. In general, there is a fairly continuous recent sedimentary cover throughout the area. Below this is a stratified acoustic facies, often interrupted by chaotic deposits and semi-transparent zones (reworked material – often affected by the presence of undulations and folds that sometimes evolve into minor displacements that can have a surface morphological expression). At the base (seismic penetration limit of the instrument), there is a well-stratified and continuous facies. Figure 5-37 and Figure 5-38 show two example recordings for the ECC and the OWF site.

Figure 5-37 Generic example of SBP recording along the uninterpreted ECC.



Source: Offshore Sector - Geophysical and Environmental Surveying

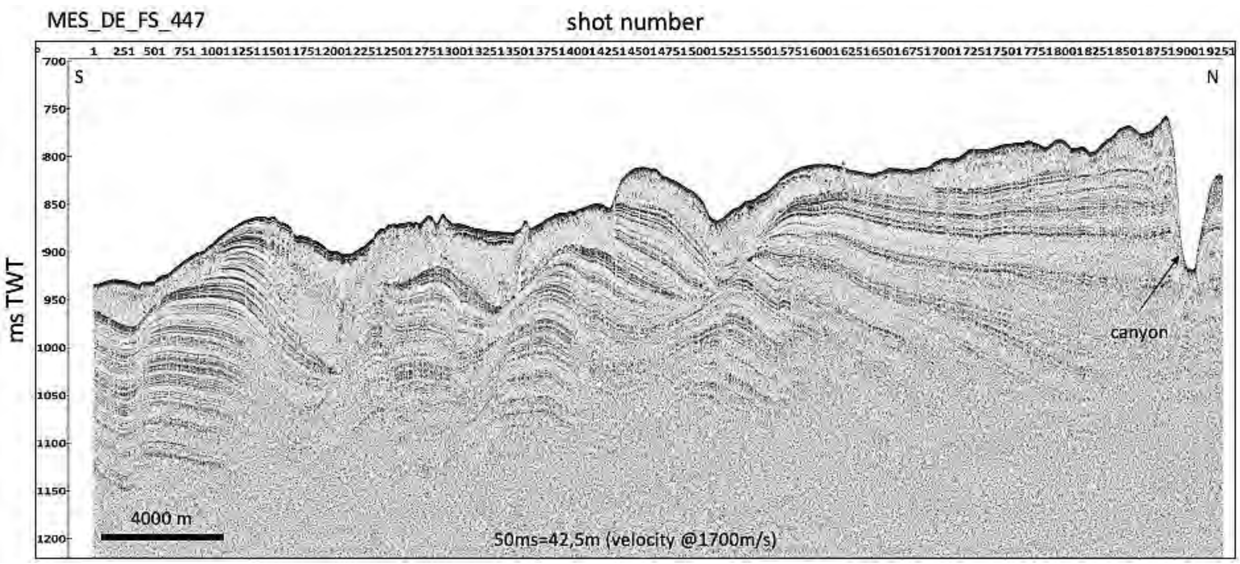
Figure 5-38 Generic example of SBP recording in the OWF area, uninterpreted.



Source: Offshore Sector - Geophysical and Environmental Surveying

In the SPK data, the recordings also highlight a fairly complex geological structure in which, below the recent sedimentary cover, a first stratified but not continuous seismic facies is observed, interrupted by chaotic deposits and disturbed sectors (Figure 5-39).

Figure 5-39 SPK recording example in the uninterpreted OWF area.



Source: Offshore Sector - Geophysical and Environmental Survey

The peculiarity observed in the seismic sections is linked to the presence of reworked material distributed along the escarpment and the basin through the canyon system that borders the OWF area; this material modifies its characteristics laterally and its thickness varies from a few metres to 30 m - 40 m in the northern sector and increases from 40 m - 50 m to about 100 m as it moves from the central to the southern OWF sector. The lateral continuity of this facies is locally interrupted by the presence of structures with upward convex geometry (called 'mounds') limited to two portions of the site, central and south-western. Below the reworked facies is a well-stratified and continuous facies. The unit is affected by a system of folds and locally by faults that do not propagate into the overlying units. The base of this third and last unit cannot be traced as it lies at depths greater than the physical limit of the seismic penetration of the instrument.

In conclusion, in the nearshore area, seismic surveys confirm the presence of a rocky substrate emerging in the immediate coastal area and sediment thicknesses present, but not excessively developed, from a depth of -50 m. The section of the corridor under examination shows the typical profile of a platform, with reflectors sloping towards the open sea, with gradually increasing gradients, up to the edge of the escarpment where they reach maximum values. The seismic facies of the escarpment is chaotic and unstratified, while sedimentary mounds are present at the foot of this area. In the offshore area, on the other hand, the geological structure of the subsoil is articulated throughout its entire extent. The entire area has a fairly continuous recent hemipelagic sedimentary cover draping the underlying material.

5.6 Hydrology

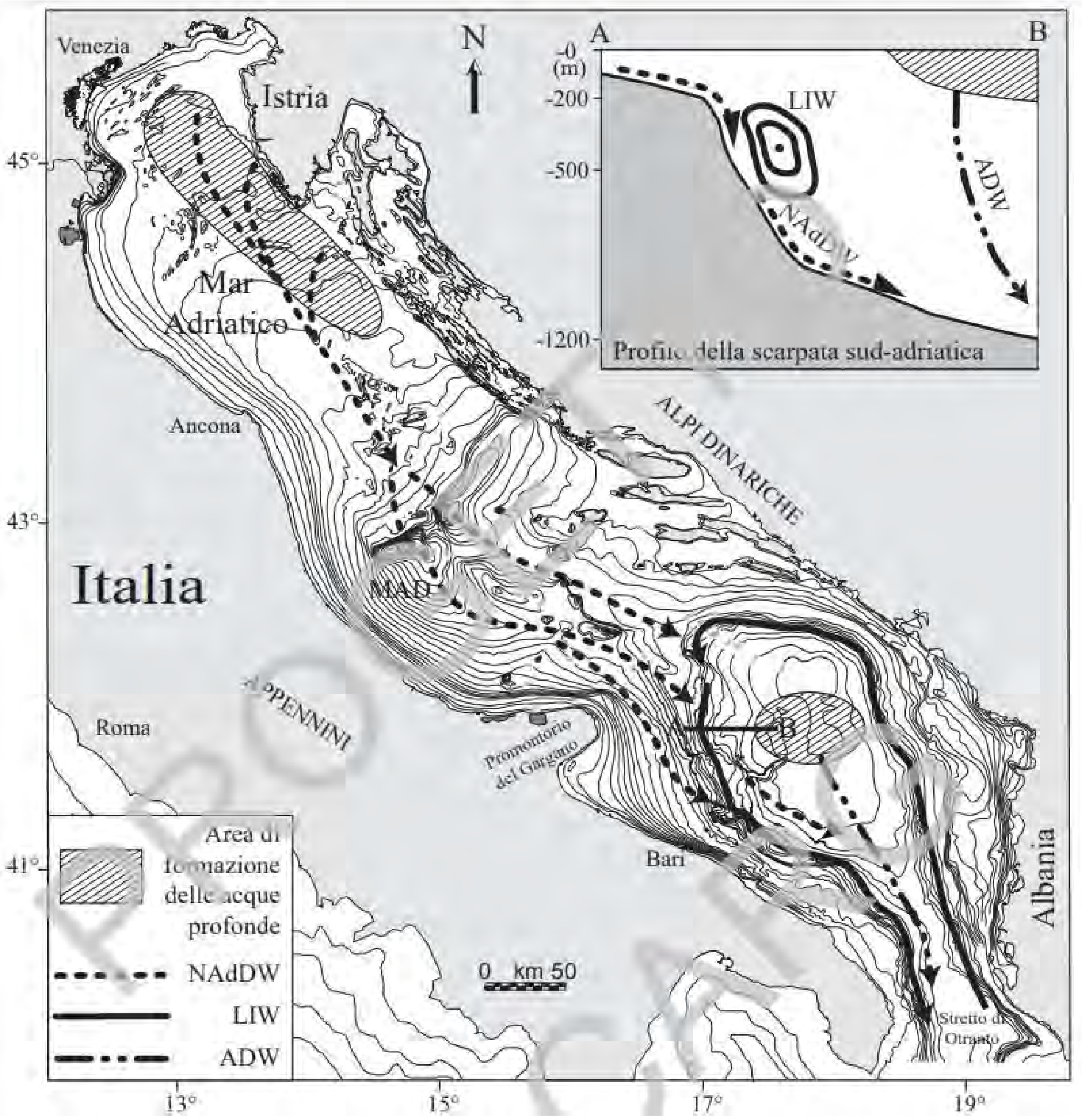
5.6.1 Marine environment

The circulation of the Mediterranean is determined by the exchange and interaction between Atlantic waters (AW) and the outgoing Levantine intermediate waters (LIW) through the Strait of Gibraltar (Zavatarelli and Mellor, 1995). The two largest basins of the Mediterranean, eastern and western, are separated by the Strait of Sicily, where the Atlantic-Ionian Current (AIS) transports modified Atlantic water (MAW) in the surface layers towards the eastern basin (ISMAR, CNR).

The Strait of Otranto separates the Ionian Sea, the deepest basin in the Mediterranean, from the Adriatic Sea, a basin characterised by modest depths.

The Adriatic basin has a microtidal regime, with a tidal range of less than one metre, and is dominated by cyclonic circulation regulated by thermohaline currents that confine low-salinity waters of fluvial origin to the western side of the basin (Bergamasco *et al.*, 2014; Poulain *et al.*, 2013). River inflows mainly affect the northern Adriatic. The introduction of this less dense (and therefore superficial) water mass promotes outflow through the Western Adriatic Coastal Current and has effects on the entire basin due to its function of transporting high loads of sediment, organic matter, nutrients and pollutants (Tesi *et al.,* 2006). In addition to the river forcing, circulation in the Adriatic also responds to wind forcing at the surface, which causes evaporation and cooling of surface waters, leading to the production of deep waters, and morphological forcing, due to the presence of the Strait of Otranto. The depth threshold of -800 m allows warm, salty water to enter, balancing the effects of the other two forces (Figure 5-40).

Figure 5-40 Morphology and circulation in the Adriatic basin



Source: ISPRA, Italian Geological Survey, 2023

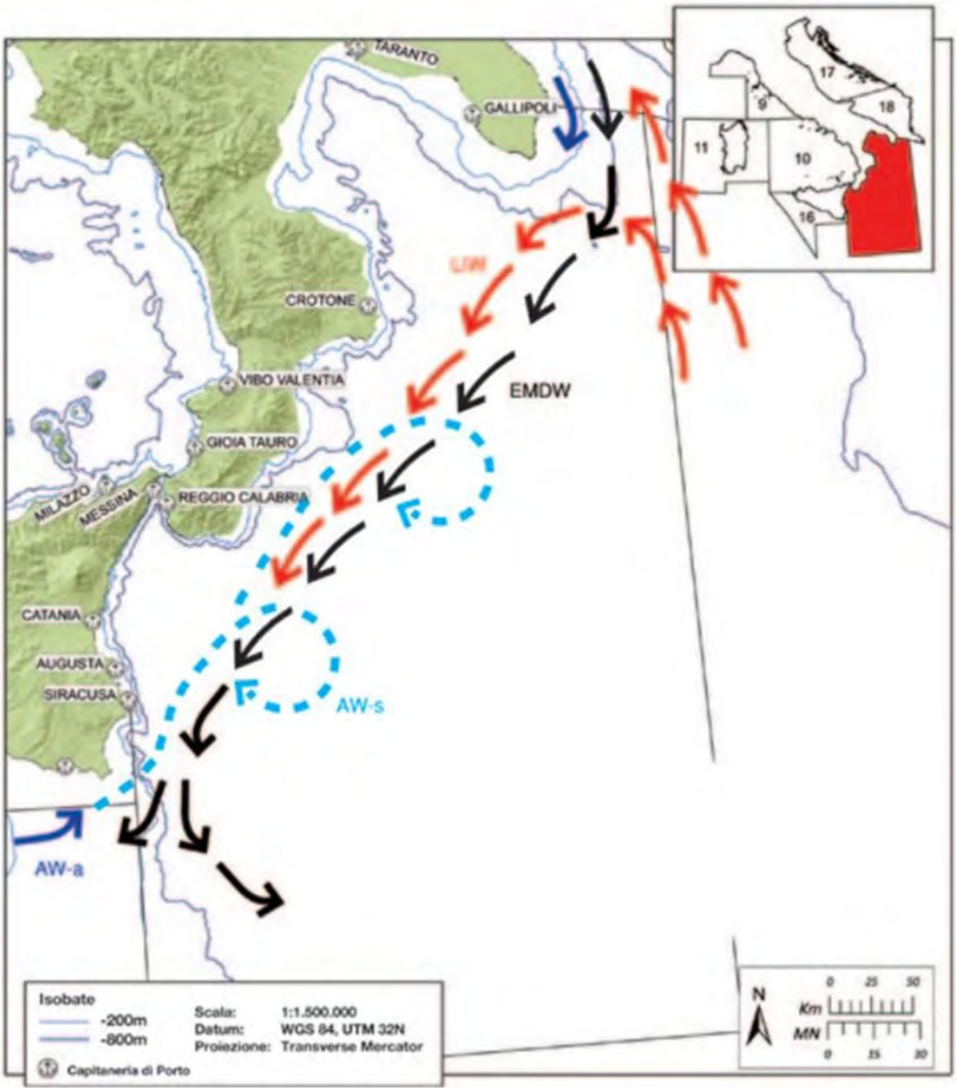
The water exchange in the Ionian basin is closely linked to its interaction with the Tyrrhenian Sea. Ionian waters enter the Tyrrhenian Sea at depth, while surface waters enter the Ionian Sea from the Tyrrhenian Sea. However, this relationship is subject to tidal changes, so that every six hours there is a reversal of the surface current, with currents flowing from the Tyrrhenian Sea to the Ionian Sea and vice versa. This phenomenon is accompanied by large internal waves that cause strong turbulence in the waters. In addition, denser waters due to salinity leave the African coast and, after touching the Greek coast, enter the Gulf of Taranto in an anti-clockwise direction and then descend along Calabria to flow into the western Mediterranean at depths greater than -200 m.

This circulation is more complicated in winter than in summer, but without pronounced seasonal variability. The northern Ionian Sea is occupied by a cyclonic vortex, more intense in winter, which incorporates part of the AIS and exchanges water with the permanent anticyclonic vortex in the northern Adriatic. The NADW (North Atlantic Deep Water) was considered the most important source of dense bottom water in the Eastern Mediterranean (Rubino and Hainbucher, 2007), but hydrographic observations conducted in the 1990s revealed profound variations not only in physical-chemical parameters but also in the circulation of water masses as a result of the climate-driven phenomenon known as the Eastern Mediterranean Transient, which has now come to an end. This led to a substantial influx of dense water from the Aegean Sea, causing changes in the deep circulation of the area (Manca *et al.,* 2002; Roether, 2007).

Figure 5-41 schematically shows the circulation of surface, intermediate and deep currents
deep currents in the stretch of sea along the coast of the Project Area. The following are shown:

- AW-a (blue): annual surface circulation of modified waters of Atlantic origin;
- AW-s (light blue): seasonal surface circulation of modified waters of Atlantic origin;
- LIW (red): circulation of intermediate waters of Levantine origin;
- EMDW (black): deep waters of the eastern Mediterranean.

Figure 5-41 Surface (AW), intermediate (LLW) and deep (EMDW) current circulation



Source: Puglia Fisheries and Biodiversity Report, 1993

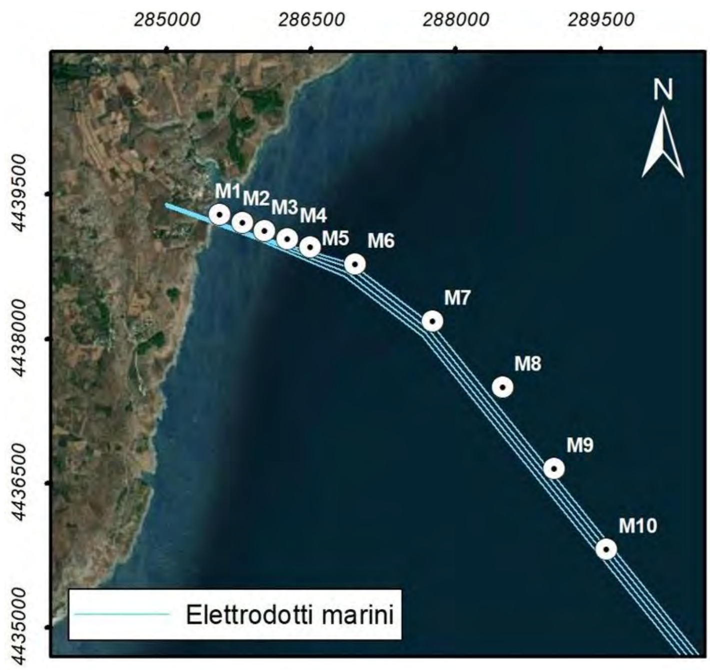
The Marine weather analyses are based on hourly surface data and daily data along the water column (data source: CMEMS from 1987 to 2021). It shows that the surface current generally flows towards the south-west, with intensities greater than 0.1 m/s (74% of the time). Currents greater than 0.4 m/s are rare (approximately 4% of the time). Intensities decrease progressively with distance from the surface: referring to the 99th percentile of the average daily current, at a depth of -100 m the values are in the order of 0.30 m/s, while at -200 m the intensity is reduced to just over 0.20 m/s. At greater depths, the current intensity tends to become more uniform; the 99th percentile reaches values at the bottom in the order of 0.1 m/s.

5.6.1.1 Results of geophysical and environmental monitoring campaigns

As part of the monitoring campaigns carried out in April (nearshore area) and June (offshore area) 2024, sampling activities were also carried out to characterise the environmental component of the water column.

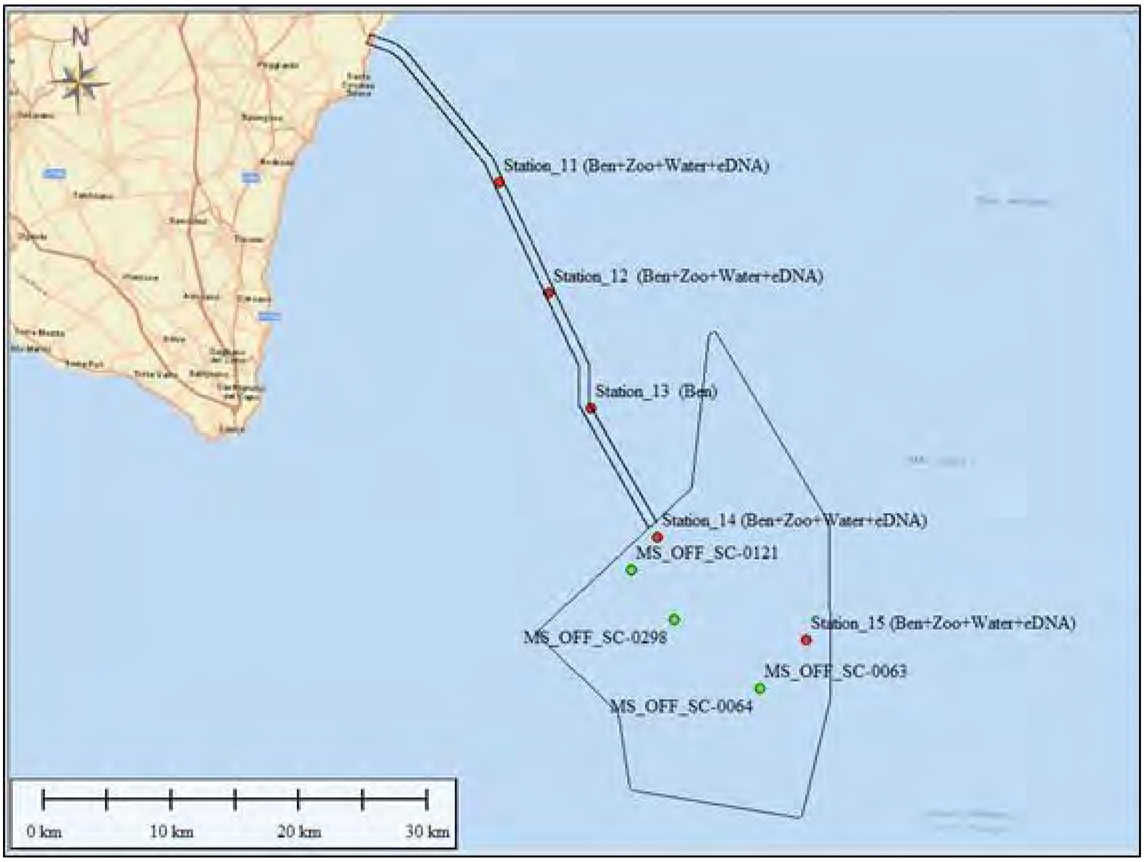
The measurements concerning the characterisation of the water column were taken at three stations in the nearshore area (Station 1, Station 3 and Station 7, Figure 5-42) and four stations for the offshore area (Station M11, Station M12, Station M14 and Station M15, Figure 5-43) and involved the analysis of the water through sampling with a rosette carrying 12 Niskin bottles; This was also combined with a multiparameter probe (CTD) configured with pH/ORP, temperature/conductivity, dissolved oxygen, turbidity and chlorophyll-a sensors using fluorescence. Water samples were taken at three depths: surface, intermediate and deep. The intermediate depth was selected based on the peak *chlorophyll-a* values. The water samples were taken, sorted into different containers and refrigerated at 4 °C on board. After collecting the sample from the Niskin bottle, the samples intended for total nitrogen and phosphorus analysis, approximately 100 ml, were stored without any pre-treatment. The samples intended for dissolved nutrient analysis underwent pre-filtration, approximately 250 ml, using special Whatmann GF/F filters (minimum porosity of 0.7 µm). In both cases, the samples were frozen and kept at -20 °C until they reached the laboratory. Nutrient analyses were performed using an Easy Chem Plus analyser (NH4) or a Braun Luebbe AA3 analyser (total N and P and NO_3 and NO_2).

Figure 5-42 Sampling stations for nearshore environmental surveys



Source: Preliminary report on authorisation for laying cables and pipelines - Legislative Decree 152/2006

Figure 5-43 Offshore environmental survey sampling stations (in red)



Source: Offshore Sector - Geophysical and Environmental Survey

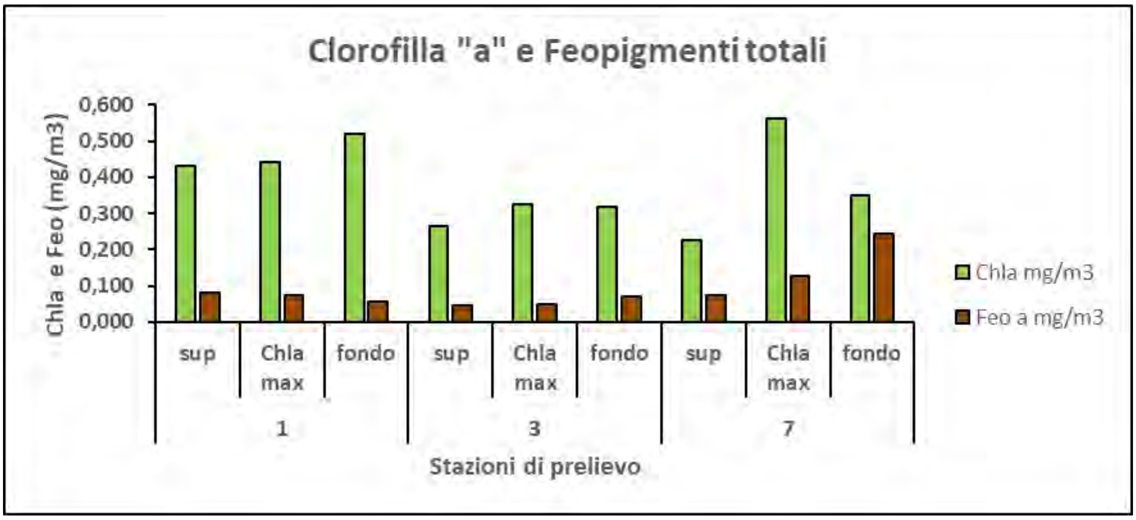
Table 5.7 Nutrients analysed with reference methods and detection limits.

Analysis	Ref. method	Unit of measurement	Detection limit
Phosphates	UNI ISO SW 15923-1	µM	0
Nitrites	EPA 354.1	µM	0.02
Nitrates	EPA 354.1	µM	0.02
Ammonia	APHA 4500	µM	0
Total nitrogen	EPA 354.1	µM	0.02
Total phosphorus	UNI ISO SW 15923-1	µM	0

Source: Nearshore Sector – Geophysical and Environmental Survey

As regards the nearshore area, the total photosynthetic pigments in the water column are mainly composed of Chlorophyll-a (Chla) at all stations (Table 5.7), with maximum values in mg/m3 at station 7 at the deep chlorophyll maximum (Chla max). The trend in chlorophyll concentrations appears consistent with the presence of maximum peaks for stations 3 and 7, while at station 1 the highest concentration was recorded at the bottom. Pheopigment concentrations are an order of magnitude lower than chlorophyll at stations 1 and 3, with a decreasing pattern at station 1 from the surface to the bottom and the opposite pattern at stations 3 and 7. The maximum concentration of phaeopigments is found in the bottom water samples at station 7, where it is almost equal to the chlorophyll concentration; this increase is probably due to the maximum depth of the station (-81.5 m), where radiation is reduced and allows less primary photosynthetic production, thus favouring pigment degradation.

Figure 5-44 Concentrations of chlorophyll pigments (Chla and Feopigments) in the water column expressed in mg/m3.



Source: Nearshore Sector - Geophysical and Environmental Survey

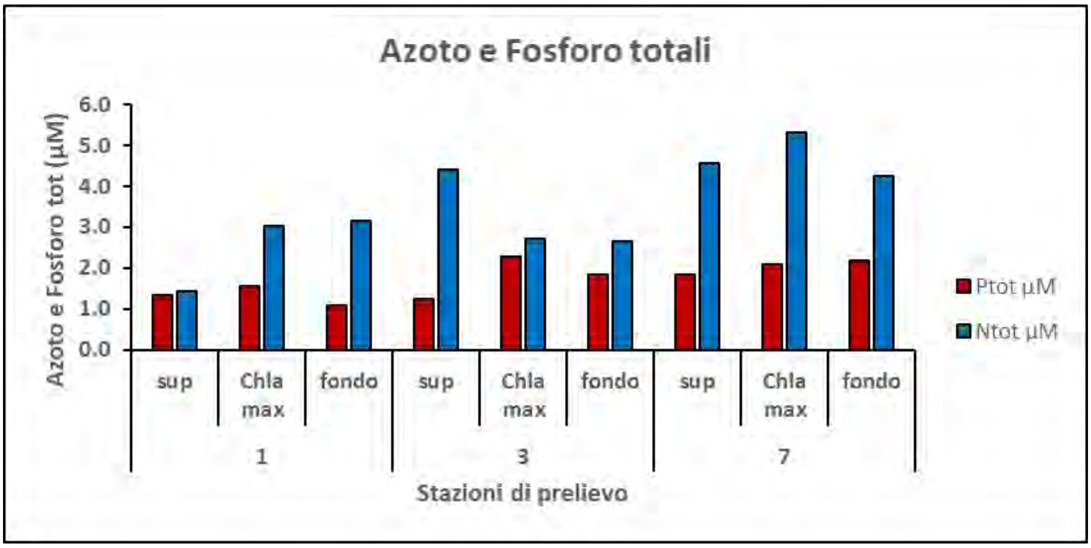
Figure 5-45 shows how, at all depths, the total concentrations of nitrogen (N-tot) in the water column are always higher than those of phosphorus (P-tot). At station 1, nitrogen increases with depth in a pattern similar to that of chlorophyll. At station 3, nitrogen decreases, following a pattern that more closely mirrors that of phaeopigments. Finally, at station 7, there is a peak in nitrogen at the maximum chlorophyll concentration (5.3 µM), which also coincides with the highest nitrogen concentration detected among all stations.

Phosphorus generally has a less variable concentration between the different stations and shows a similar depth-concentration trend between stations 1 and 3, with an increase in P-tot at the depth corresponding to the deep chlorophyll maximum, while at station 7, P-tot concentrations are slightly higher at the bottom.

Among the different forms of nitrogen present in the water column, nitrites (NO_2) are the least concentrated at all stations and at all depths (0.01 µM – 0.04 µM), while nitrates (NO_3) are the most concentrated (0.11 µM – 0.54 µM), with a similar pattern between stations 1 and 7, peaking at the surface, and a bell-shaped trend at station 3, where the maximum is found at the deep chlorophyll maximum. In general, the highest nitrate concentration was found in the surface water at station 1 (

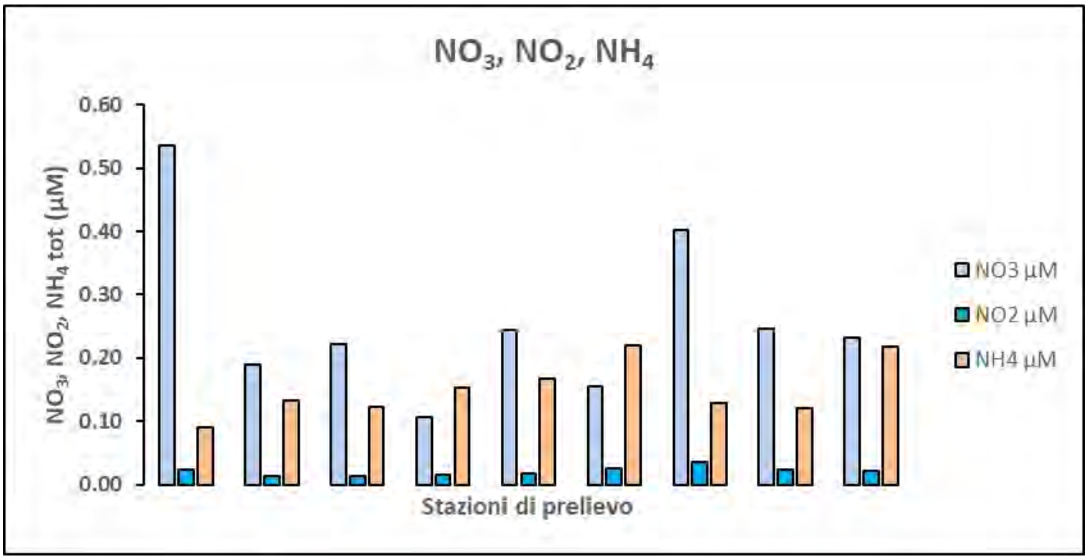
Figure *5-46*).

Figure 5-45 Total nitrogen and phosphorus concentrations in the water column.



Source: Nearshore Sector - Geophysical and Environmental Survey

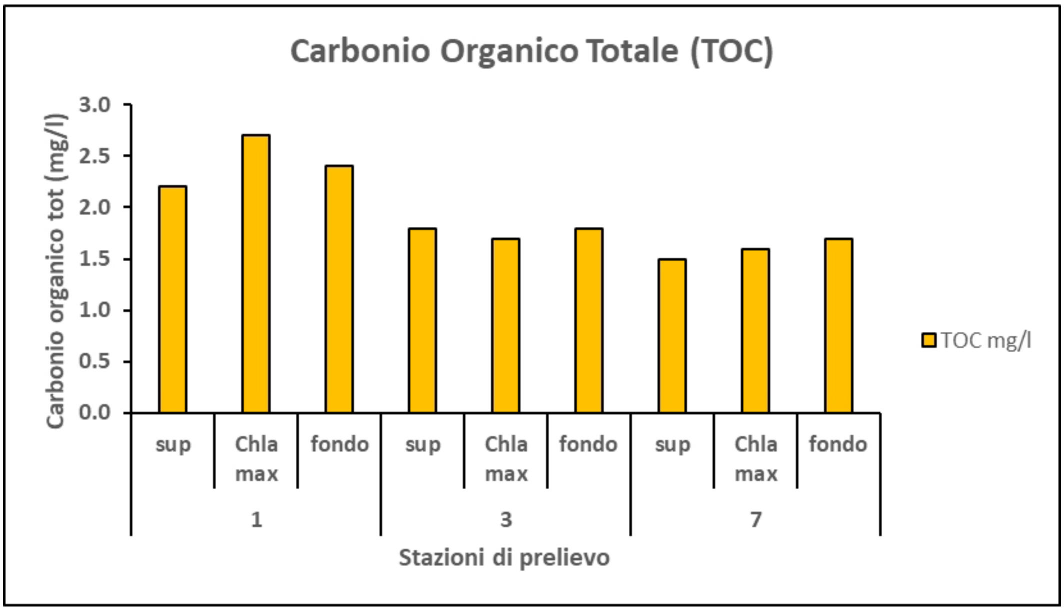
Figure 5-46 Concentrations of nitrates, nitrites and ammoniacal nitrogen in the water column.



Source: Nearshore Sector - Geophysical and Environmental Survey

Total organic carbon (TOC) concentrations are higher at station 1 (2.2 mg/l – 2.7 mg/l), which corresponds to the highest value recorded among all stations (2.7 mg/l) at the deep chlorophyll maximum), while at stations 3 and 7, TOC is fairly constant with values ranging from 1.5 to 1.8 mg/l (Figure 5-47).

Figure 5-47 Total organic carbon concentrations in the water column.



Source: Nearshore Sector - Geophysical and Environmental Survey

Table 5.8 Concentrations of pigments and nutrient salts in the water column for nearshore stations

Station	Prof	Chla (mg/m³)	Feo a (mg/m³)	T.O.C. (mg/l)	Ptot (µM)	Ntot (µM)	NO3 (µM)	NO2 (µM)	NH4 (µM)
1	sup	0.432	0.080	2	1	1.4	0.54	0.02	0.09
	Max Chla	0.441	0.075	2.7	1.6	3	0.19	0.01	0.13
	bottom	0.520	0.055	2.4	1.1	3.2	0.22	0.01	0.12
3	sup	0.266	0.046	1.8	1	4.4	0.11	0.02	0.15
	Max Chla	0.325	0.049	1.7	2.3	2.7	0.24	0.02	0.17
	bottom	0.319	0.070	1.8	1.8	2.7	0.16	0.03	0.22
7	sup	0.225	0.072	1.5	1.8	4.6	0.40	0.04	0.13
	Max Chla	0.560	0.125	1.6	2.1	5.3	0.25	0.02	0.12
	bottom	0.349	0.245	1.7	2.2	4.2	0.23	0.02	0

Source: Nearshore Sector - Geophysical and Environmental Surveys

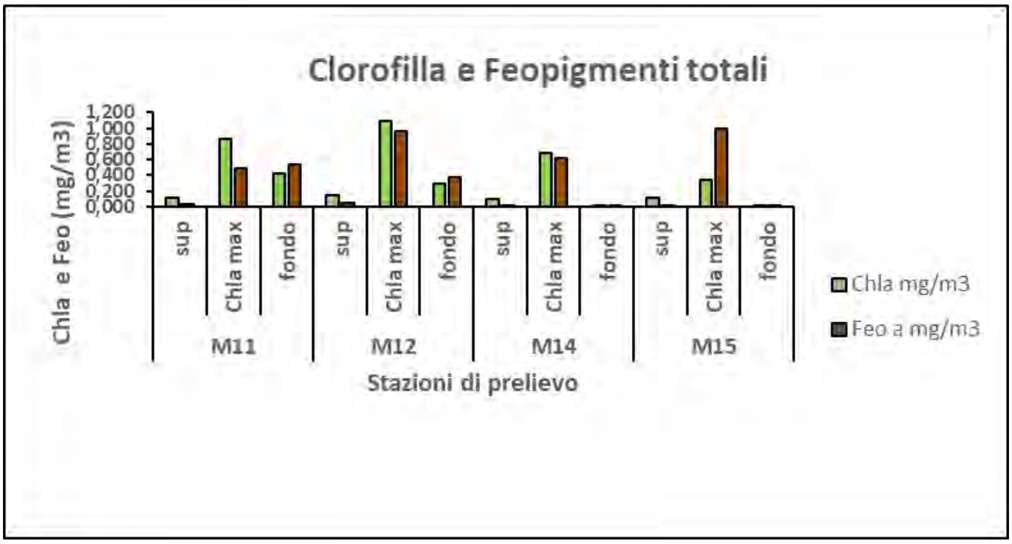
As regards offshore stations, total photosynthetic pigments in the water column are mainly composed of chlorophyll-a (Chla) in all stations except station M15, where there is a peak in phaeopigments of 0.991 mg/m (Table 5.9). The trend in Chl-a concentration is consistent across all stations, with the highest values reaching intermediate depths, with of 1.09 mg/m3 at station M12 at the deep chlorophyll maximum (Chl-a max). Phaeopigment concentrations are low at all stations at the surface depth, while they are higher than Chl-a concentrations at the bottom at stations M11 and M12. High phaeopigment values tend to be linked to sampling depths (> -100 m), as the low light irradiation favours pigment degradation.

Table 5.9 Concentrations of pigments and nutrient salts in the water column for offshore stations

Station	Prof	Chl-a (mg/m^3)	Feo a (mg/m^3)	Ptot (µM)	Ntot (µM)	NO3 (µM)	NO2 (µM)	NH4 (µM)	TOC (mg/l)
M11	sup	0.117	0.029	0.95	1.09	0.04	0.02	0.01	23.3
	Max Chla	0.867	0.492	0.79	1.11	0.04	0.01	0.03	5.3
	fund	0.428	0.536	1.36	2.75	0.93	0.07	0.34	18.6
M12	sup	0.151	0.041	0.94	1.07	0.03	0.01	0.01	9.2
	Max Chla	1.095	0.961	0.88	1.25	0.06	0.05	0.09	5.9
	fund	0.285	0.367	1.08	2.36	0.70	0.10	0.25	4.9
M14	sup	0.089	0.014	0.85	1.90	0.58	0.03	0.09	12.4
	Max Chla	0.690	0.617	0.97	1.44	0.18	0.07	0.09	2.9
	fund	0.003	0.023	1.89	3.57	1.48	0.05	0.45	5.0
M15	sup	0.108	0.007	0.76	1.05	0.02	0.01	0.01	12.6
	Max Chla	0.339	0.991	0.98	1.69	0.27	0.12	0.14	2.9
	bottom	0.001	0.011	1.07	2.02	0.49	0.15	0.14	4

Source: Offshore Sector - Geophysical and Environmental Survey

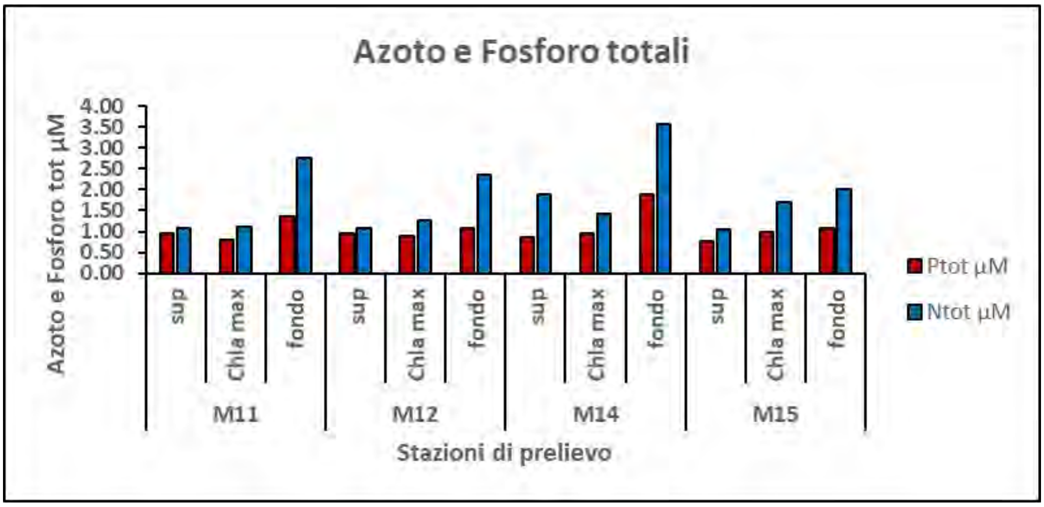
Figure 5-48 Pigment concentrations in the sampled stations.



Source: Offshore Sector - Geophysical and Environmental Survey

Figure 5-49 shows how, at all depths, the total concentrations of nitrogen (N-tot) in the water column are always higher than those of phosphorus (P-tot). At all stations, nitrogen increases with depth, except at station M14, where there is a decrease at the maximum chlorophyll depth. At station M14, there is a peak of 3.57 µM at the bottom depth.

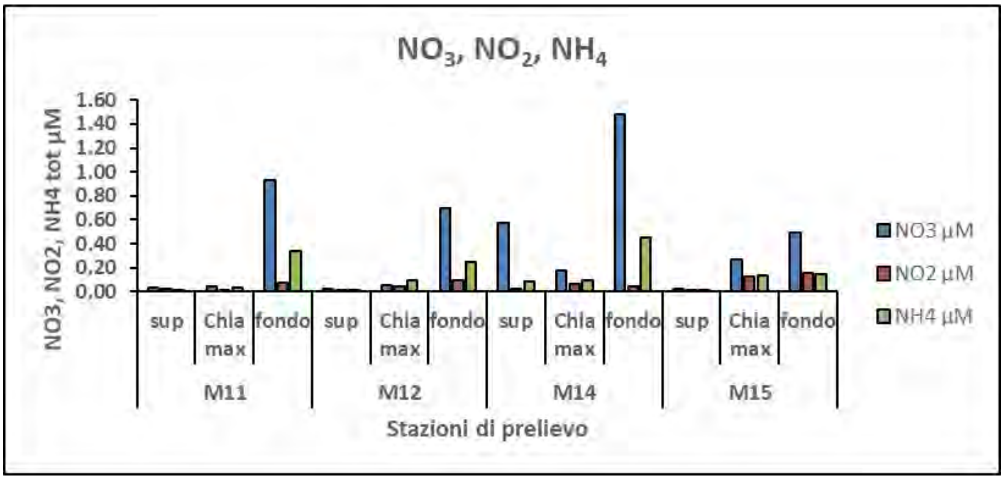
Figure 5-49 Pigment concentrations at the sampling stations.



Source: Offshore Sector - Geophysical and Environmental Survey

Phosphorus, on the other hand, generally has a less variable concentration between the different stations and does not show a clear concentration-depth trend, but the highest concentrations are still found at the bottom depth in all stations (Figure 5-49). Among the different forms of nitrogen present in the water column, nitrites (NO2) are the least concentrated, with values ranging from 0.01 µM to 0.15 µM at all stations, while nitrates (NO3) are the most concentrated at all stations, especially at bottom depths, reaching a peak of 1.47 µM at station M14. Generally, the lowest values of all forms of nitrogen (0.01 µM - 0.03 µM) were found at shallow depths, except for station M14, where nitrate values reached 0.59 µM (Figure 5-50).

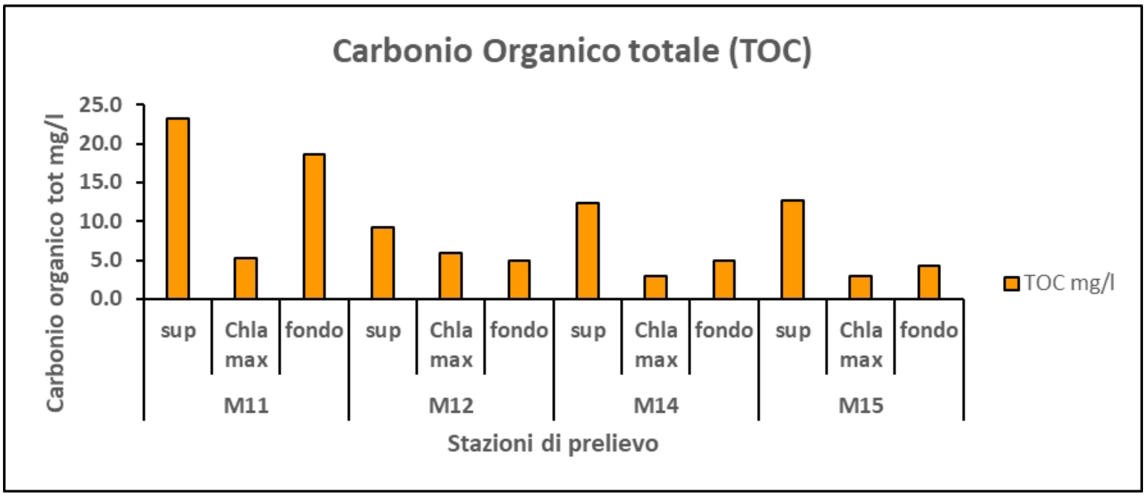
Figure 5-50 Concentrations of different forms of nitrogen (nitrites, nitrates, and ammonium).



Source: Offshore Sector - Geophysical and Environmental Survey

Total organic carbon (TOC) concentrations are higher at station M11, with values of 23.3 mg/l at the surface depth and 18.6 mg/l at the bottom depth. At the other stations, the values are one order of magnitude lower and are more concentrated at surface depths (Figure 5-51).

Figure 5-51 Total Organic Carbon (TOC) concentrations.



Source: Offshore Sector - Geophysical and Environmental Survey

With regard to the chemical analysis of metals and organic contaminants in the water column, based on the analysis of metals and metalloids for the nearshore area, the Limit of Quantification (LOQ) was exceeded for arsenic (As), vanadium (V), copper (Cu), aluminium (Al), iron (Fe) and zinc (Zn). In particular, arsenic and vanadium were detected at all depths at all stations, with very similar concentrations in the water column ([As]=1.94–2.14 µg/l and [V]=1.83–2.11 µg/l) and no significant variation between the three stations or along the vertical profiles of the individual stations. Copper, iron and zinc, on the other hand, were only detected in significant quantities in a few cases. Cu and Al reached values of of 1.28 µM in the bottom waters of station 1 and 40.5 µM in the bottom waters of station 7. Fe was found to be concentrated at 11.90 µM in the bottom waters of station 7. Finally, Zn was detected throughout the water column of station 3 and in lower concentrations in the bottom waters of station 1.

Polycyclic aromatic hydrocarbons (PAHs) remained either below the detection limit or were detected in quantities not significant compared to the LOQ. Only Naphthalene, normally used in dyes, fuels and insecticides, and Phenanthrene, used in the pharmaceutical industry, were detected at all stations and at all depths. The sum of the detectable concentrations of all PAHs analysed (16) exceeded the LOQ by at most one order of magnitude at all stations at different depths. Similarly, for halomethanes and volatile organic compounds (VOCs), 12 out of 13 compounds were not detected, with only chloroform exceeding the LOQ of 0.003 µg/l at all stations and at all depths. Finally, in general, the concentrations of heavy hydrocarbons (IP C>12, chains with more than 12 carbon atoms) and light hydrocarbons (IL C<12, chains with less than 12 carbon atoms) did not exceed the detection limits.

The results of the TRIX index calculation are shown in Table 5.10. In

Figure 5-52 shows the ratings and relative coefficients in accordance with Legislative Decree No. 258/2000.

The waters of sampling stations 1, 3 and 7 show values at the limit between a 'good' and 'moderate' environmental status. These reflect the seasonal conditions at the time of sampling (April 2024) and not an annual trend.

Table 5.10 TRIX values and relative environmental status determined in accordance with Annex 1 of Legislative Decree 258/00.

Index calculation TRIX	**TRIX= (log10(Chla *DIN *O2*Ptot)-(-1.5))/1.2**							
Station	**Depth**	**Chla (mg/m^3)**	**O2 (%)**	**Ptot (ug/L)**	**DIN (µg/L)**	**TRIX index**	**Average TRIX**	**Environmental status**
1	**sup**	0.43	102.20	126.10	36.03	**5.67**	**5.49**	good/mediocre
	Max Chla	0.44	101.80	148.73	14.82	**5.41**		good/mediocre
	fund	0.52	101.90	103.78	16.63	**5.38**		good/mediocre
3	**sup**	0.27	102.20	117.74	10.13	**5.01**	**5.31**	good/mediocre
	Max Chla	0.32	101.80	216.86	18.91	**5.52**		good/mediocre
	fund	0.32	101.70	175.36	14.81	**5.36**		good/mediocre
7	**sup**	0.22	102.00	173.65	28.93	**5.46**	**5.56**	good/mediocre
	Max Chla	0.56	101.70	197.14	18.57	**5.68**		good/mediocre
	fund	0.35	101.60	207.14	19.27	**5.54**		good/mediocre

Figure 5-52 Limits of the trophic scale and related reference values according to Annex 1 of Legislative Decree 258/00.

SCALA TROFICA	STATO	CONDIZIONI
2-4	Elevato	Acque scarsamente produttive. Livello di trofia basso. Buona trasparenza. Assenza di anomale colorazioni. Assenza di sottosaturazione di ossigeno sul fondo.
4-5	Basso	Acque moderatamente produttive. Livello di trofia medio. Buona trasparenza, con occasionali intorbidimenti. Occasionali anomale colorazioni. Occasionali ipossie sul fondo.
5-6	Mediocre	Acque molto produttive. Livello di trofia elevato. Scarsa trasparenza delle acque. Anomale colorazioni. Ipossie e occasionali anossie sul fondo. Stati di sofferenza sul fondo.
6-8	Scadente	Acque fortemente produttive. Livello di trofia molto elevato. Elevata torbidità. Diffuse e persistenti colorazioni. Diffuse e persistenti ipossie/anossie sul fondo. Morie di organismi bentonici. Alterazioni delle comunità bentoniche. Danni economici per turismo, pesca e acquacoltura.

Source: Offshore Sector - Geophysical and Environmental Survey

For offshore stations, on the other hand, the Quantification Limit (LOQ) was exceeded at all stations by arsenic and vanadium at all depths considered. Zinc exceeded the limit at all stations but not at all depths; in particular, at stations M12 and M15, it was high at surface depth, while at station M14, it was high at depths close to the seabed. Mercury exceeded the quantification limit of 0.01 in some cases.

Polycyclic aromatic hydrocarbons (PAHs) remained either below the detection limit or were detected in quantities insignificant compared to the LOQ. Only naphthalene (normally used as a dye), fuels and insecticides were detected at all stations and at all depths. The sum of the detectable concentrations of all PAHs analysed (16) exceeded the LOQ by at most one order of magnitude at all stations at different depths. Halomethanes and volatile organic compounds (VOCs) were not detected. In general, concentrations of heavy hydrocarbons (HC C>12, chains with more than 12 carbon atoms) and light hydrocarbons (HC C<12, chains with less than 12 carbon atoms) did not exceed detection limits.

Finally, the results of the TRIX index calculation are shown in the table below.

Figure 5-52 shows the assessments and related coefficients in accordance with Legislative Decree No. 258/2000. The waters at shallow depths tend to show values corresponding to a 'high/low' environmental status, while at greater depths they tend to be in a 'poor' state. These values reflect the seasonal conditions at the time of sampling (April 2024) and, above all, the distance of the sampling stations from the coast.

Table 5.11 TRIX values and relative environmental status determined in accordance with Annex 1 of Legislative Decree 258/00.

Index calculation TRIX	TRIX= (log10(Chla *DIN*O2* Ptot)-(-1.5))/1.2							
Station	**Prof**	**Chla (mg/m³)**	**O2 (%)**	**Ptot (ug/L)**	**DIN (µg/L)**	**TRIX index**	**TRIX average**	**Environmental status**
M11	**sup**	0.117	101.990	90.05	3.5	4.23	**5.01**	high/low
	Max Chla	0.867	99.430	74.67	3.72	4.90		high/low
	fund	0.428	99.540	129.60	67.33	5.89		poor
M12	**sup**	0.151	101.090	89.58	2.58	4.21	**5**	high/low
	Max Chla	1.095	94.730	83.90	7.30	5.25		low/mediocre
	fund	0.285	89.460	102.62	52.21	5.53		poor
M14	**sup**	0.089	101.900	80.96	38.61	4.96	**4.89**	high/low
	Max Chla	0.690	99.270	91.67	15.78	5.41		low/mediocre
	fund	0.003	84.080	179.54	102.00	4.3		low
M15	**sup**	0.108	101.390	72.29	1.98	3.91	**4.19**	high
	Max Chla	0.339	92.330	93.41	24.74	5.30		low/mediocre
	fund	0.001	84.280	101.38	39.99	3.36		high

Source: Offshore Sector - Geophysical and Environmental Surveys

In conclusion, in the nearshore area, the total photosynthetic pigments present in the water column are mainly composed of chlorophyll-a (Chla) and phaeopigments at all stations, with maximum values in mg/m3 reached at station 7. At all depths, total nitrogen concentrations in water are always higher than those of phosphorus, which generally has less variable concentrations between stations. Nitrites (NO_2) are the least concentrated at all stations and at all depths (0.01 µM – 0.04 µM), while nitrates (NO3) are the most concentrated (0.11 µM – 0.54 µM). In general, the highest nitrate concentration was found in the surface water at station 1. From the analysis of metals and metalloids, the Limit of Quantification (LOQ) was exceeded for arsenic (As), vanadium (V), copper (Cu), aluminium (Al), iron (Fe) and zinc (Zn). Polycyclic aromatic hydrocarbons (PAHs), on the other hand, remained either below the detection limit or were detected in quantities that were not significant compared to the LOQ. The results of the TRIX index calculation show values at the limit between a 'good' and 'poor' environmental status.

In the offshore area, the total photosynthetic pigments present in the water column are mainly composed of chlorophyll-a (Chl-a) at all stations, except for station M15, which shows a peak in phaeopigments. The highest Chl-a values are reached at intermediate depths, with station M12 representing the maximum value of 1.09 mg/m3. High phaeopigment values may be linked to sampling depths, which favour their degradation due to low light irradiation. At all depths, the total concentrations of nitrogen in the water column are always higher than those of phosphorus. Phosphorus generally has a less variable concentration between the different stations and does not show a clear concentration-depth trend, but the highest concentrations are still found at the bottom depth in all stations. The Limit of Quantification (LOQ) was exceeded at all stations by arsenic and vanadium at all depths considered. Finally, the TRIX index showed that the waters at shallow depths have 'high/low' environmental status values, while at greater depths they tend to be in a 'poor' state.

5.6.2 Surface and groundwater

The predominantly karstic nature of the regional territory, with the exception of the Tavoliere, makes Puglia extremely poor in surface water resources. Even in the province of Lecce, there is no well-developed hydrographic network: widespread karstification has led to a scarcity of watercourses, which are short and intermittent. These are fed by underground water of meteoric origin that emerges, generally near the coast, and flows into the sea. The best known are the Fosso dei Samari in Gallipoli, the Idro near Otranto, the Brunese canal in Torre dell'Orso, the Idume near Rauccio, the Giammatteo near Frigole, and the Asso between Galatina, Galatone and Nardò.

In practice, most of the surface water in Salento is found in coastal basins and marshlands such as: Alimini Grande; Pantano Grande and Salapi alle Cesine; the basins of S. Cataldo and Torre Veneri; the Acquatina di Frigole; the Idume Basin in Torre Chianca, all located at a great distance from the onshore project area.

Apulia's surface water bodies are subject to an ecological status monitoring plan by ARPA Puglia, which provides for the calculation of metrics defined for the monitored quality elements for each station and the subsequent integration of the three-year results of the stations on a water body scale.

The ecological status, divided into five quality classes (high, good, sufficient, poor, bad), is derived by selecting the worst result from the combination of five indicators: macroinvertebrates, macrophytes, benthic diatoms, LimEco (level of pollution from macro-descriptors: oxygen saturation, ammoniacal nitrogen, nitric nitrogen and total phosphorus), and average concentration of hazardous substances. In 2022, 66 monitoring points were checked and the percentage distribution of the ecological status classes resulting from the monitoring is reported.

For Apulian watercourses, the ecological status is 'Poor' in 5.3% of cases (2 water bodies), 'Bad' in 39.5% of cases (15 water bodies), 'Sufficient' in 39.5% of cases (15 water bodies) and 'Good' in 15.8% of cases (6 water bodies). For reservoirs, on the other hand, the ecological status is 'sufficient' in 100% of cases (6 water bodies).

In the Salento Peninsula, it is possible to distinguish a deep aquifer, which continuously engages the Mesozoic limestone and dolomite masses throughout the area, and a series of local aquifers hosted in the overlying Tertiary and Quaternary deposits, often referred to as 'shallow aquifers', with very modest water potential. The aquifers are fed by rainfall in the area and, in the north-west, by groundwater from the aquifer of the Murgia Hydrogeological Area.

The underground water reserves of Salento, particularly those of the deep carbonate aquifer, have been the main source of growth for the area's agricultural sector over the last century, as well as being the basic resource for drinking water, thus contributing to the socio-economic development of this land. However, the deep aquifer is subject to intense and uncontrolled extraction, often carried out illegally, which over time has led to a reduction in the thickness of the freshwater lens and a consequent increase in the salinity of the groundwater (Cotecchia *et al.,* 2014). Groundwater bodies are also monitored by ARPA Puglia to verify their compliance with environmental quality standards identified at EU level and with threshold values identified at national level. The methodology identified by Legislative Decree 30/2009 for the classification of chemical status requires, for each monitoring station, the calculation of annual average values and their subsequent comparison with the environmental quality standards set out in the legislation in force. Specifically, a station is assigned a poor chemical status when the annual average value exceeds the threshold values and environmental quality standards for even a single parameter. Conversely, if the limits set by the legislation are not exceeded, the status assigned is good.

With regard to water bodies, it should be noted that 10.3% are in good condition, equal to 3 water bodies out of a total of 29, 79.3% are in poor condition, while the remaining 10.3% fall into the 'chemical status not determinable' category.

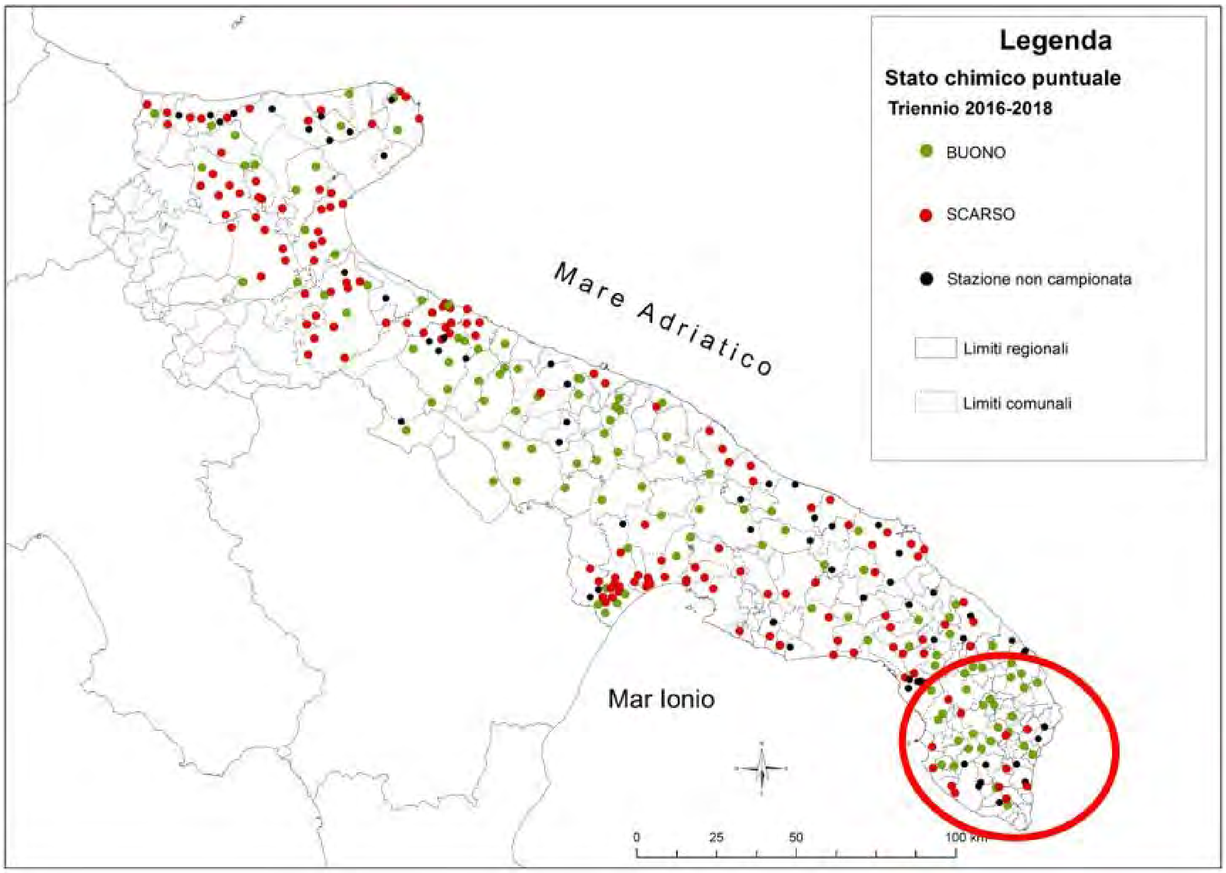
Figure 5-53 Quality of groundwater bodies recorded in the three-year period 2016-2018. The aquifers within the area of interest are highlighted in orange.

interest are highlighted in orange.

Corpo Idrico		Stato chimico triennio 2016-2018
1-1-1	Gargano centro-orientale	SCARSO
1-1-2	Gargano meridionale	SCARSO
1-1-3	Gargano settentrionale	SCARSO
1-2-1	Falda sospesa di Vico Ischitella	BUONO
2-1-1	Murgia costiera	SCARSO
2-1-2	Alta Murgia	BUONO
2-1-3	Murgia bradanica	SCARSO
2-1-4	Murgia tarantina	SCARSO
2-2-1	Salento costiero	SCARSO
2-2-2	Salento centro-settentrionale	SCARSO
2-2-3	Salento centro-meridionale	SCARSO
3-1-1	Salento miocenico centro-orientale	N.D.
3-2-1	Salento miocenico centro-meridionale	N.D.
4-1-1	Rive del Lago di Lesina	SCARSO
4-1-2	Tavoliere nord-occidentale	SCARSO
4-1-3	Tavoliere nord-orientale	SCARSO
4-1-4	Tavoliere centro-meridionale	SCARSO
4-1-5	Tavoliere sud-orientale	SCARSO
4-2-1	Barletta	SCARSO
5-1-1	Arco Ionico-tarantino occidentale	SCARSO
5-2-1	Arco Ionico-tarantino orientale	SCARSO
6-1-1	Piana brindisina	SCARSO
7-1-1	Salento leccese settentrionale	SCARSO
7-2-1	Salento leccese costiero Adriatico	N.D.
7-3-1	Salento leccese centrale	BUONO
7-4-1	Salento leccese sud-occidentale	SCARSO
8-1-1	T. Saccione	SCARSO
9-1-1	F. Fortore	SCARSO
10-1-1	F. Ofanto	SCARSO

Source: ARPA Puglia - Quality monitoring of groundwater bodies in the Puglia Region - 'Progetto maggiore', 2020

Figure 5-54 Point chemical status for groundwater bodies in the Apulia region.



The project area is circled in red.

Source: ARPA Puglia - Quality monitoring of groundwater bodies in the Puglia Region – 'Progetto maggiore', 2020

Unlike surface water bodies, groundwater bodies do not require an ecological status assessment. Nevertheless, recent research has highlighted the ecological importance of stygobitic organisms that inhabit the subsoil, suggesting a future need to consider the 'health' of 'living' animal and plant communities in environmental status assessments.

It should be noted that there are no watercourses or streams along the planned onshore route of the Project; furthermore, the landing area, where excavation is planned during the construction phase, does not intersect any underground water bodies.

5.7 Marine sediments

Sediments can be defined as an agglomeration of non-living and living material, of an inorganic and organic nature, with variable physical, chemical and biological composition. Marine sediments consist mainly of rock and soil particles transported from land areas to the sea by wind, ice and rivers; they can also consist of remains of marine organisms, products of submarine volcanism, chemical precipitates from seawater and materials from space (e.g. meteorites) that accumulate on the seabed. They can consist of particles of varying sizes, from very coarse to extremely fine, present in different percentages depending on the depositional environment.

Sediments are an environmentally important component as they accumulate and store contaminants of various kinds, acting as a temporary and/or permanent reservoir (sink) for these substances, but they can also be a source of contamination. The processes of exchange between sediments, the water column and living organisms are fundamental in this context.

5.7.1 Grain size

The term granulometry encompasses all the tests necessary to define the granulometric curve, which is the final result of the analysis. The grain size distribution curve is the representation on a semi-logarithmic plane of the diameters of the particles constituting a soil as a function of their percentage by weight. Studying the grain size of sediment means defining the sizes of the particles that compose it and classifying them. The most widely used classification system in sedimentology is that proposed by Udden in 1898 and then modified by Wentworth in 1922.

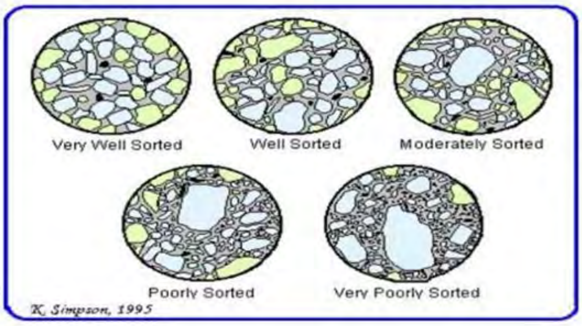
Romano *et al.* (2016) define marine sediments as composed of particles of varying sizes, from very coarse to extremely fine, present in different percentages depending on the depositional environment according to this classification (Figure 5-55):

- GRAVEL (> 2000 µm) – these are lithic fragments or semi-consolidated or semi-coherent sediments indicative of the lithology of the parent rock. The more or less rounded shape depends on the texture of the parent rock and the degree of degradation of the grain itself;
- SAND (2000 µm< x <63 µm) – these are mainly monomineral grains (crystals and fragments thereof), but with lithic fragments in medium and coarse sand. The most common mineral, because it is the most stable, is quartz;
- LIMI (63 µm < x <4 µm) and ARGILLE (x >4 µm) – consisting of the same minerals as sand, but with a higher quantity of less stable minerals (hemic feldspars) than quartz. Clay minerals are present below 20 µm. Clays are made up of phyllosilicates (hydrated silicates with a lamellar structure), generically defined as clay minerals. They do not derive directly from the parent rock (primary minerals) but are the product of the interaction between igneous rocks and the exogenous environment (secondary minerals).

Figure 5-55 Relationship between diameters and class according to current methodologies and definitions

Scala φ	Intervallo dimensionale (metrico)	Classi granulometriche (Wentworth)
< −8	> 256 mm	Blocchi
da −6 a −8	64–256 mm	Ciottoli
da −5 a −6	32–64 mm	Ghiaia molto grossa
da −4 a −5	16–32 mm	Ghiaia grossa
da −3 a −4	8–16 mm	Ghiaia media
da −2 a −3	4–8 mm	Ghiaia fine
da −1 a −2	2–4 mm	Ghiaia molto fine
da 0 a −1	1–2 mm	Sabbia molto grossa
da 1 a 0	0,500–1 mm	Sabbia grossa
da 2 a 1	0,250–0,500 mm	Sabbia media
da 3 a 2	0,125–0,250 mm	Sabbia fine
da 4 a 3	0,063–0,125 mm	Sabbia molto fine
da 8 a 4	0,004–0,063 mm	Limo
> 8	< 0,004 mm	Argilla
>10	< 0,001 mm	Colloide

Molto classato	$0 < \sigma < 0{,}35\phi$
Ben classato	$0{,}35 < \sigma < 0{,}50\phi$
Moderatamente classato	$0{,}50 < \sigma < 1\phi$
Mal classato	$1 < \sigma < 2\phi$
Molto mal classato	$2 < \sigma < 4\phi$
Estremamente mal classato	$\sigma > 4\phi$



Source: Romano et al., 2016

The sediments present along the Italian coastline reflect the complex geology of the territory, both in terms of grain size and mineralogy. Their grain size depends on the morphology of the coastline and their distribution is influenced by various factors, including river deposits, currents, wave motion and the morphology of the seabed. The deposition of marine sediments and their textural characteristics are influenced by multiple factors such as hydrodynamic conditions, the presence or absence of river mouths, the characteristics of outcropping rocks, seabed morphology, etc. (Ricci and Lucchi, 1980). Sediments tend to deposit according to a grain size gradient that generally decreases from the coast towards the open sea, with coarser sediments near the coast (submerged beach) and finer grain sizes further from the coast (AA.VV., 1997). This general pattern is modified by local hydrodynamic (currents and tides) and morphological conditions, which can cause a reversal of the deposition gradient as well as the formation of low-energy zones in areas otherwise characterised by high energy.

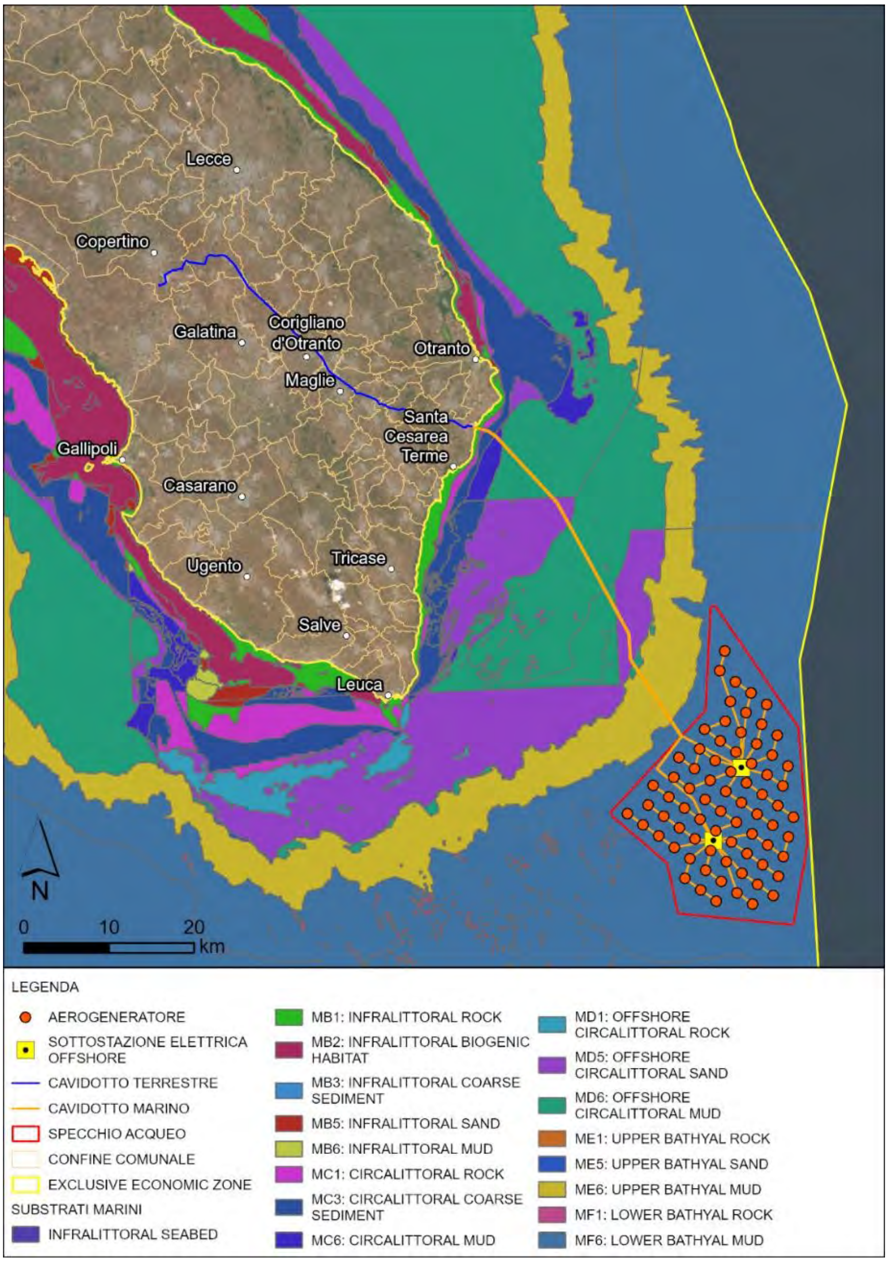
The Otranto Basin area is characterised by turbidite systems that were probably deposited during repeated phases of sea level fall and low sea level (SIGEA, 2010).

The deposition of marine sediments and their textural characteristics are influenced by multiple factors such as hydrodynamic conditions, the presence or absence of river mouths, the characteristics of outcropping rocks, the morphology of the seabed, etc. (Ricci Lucchi, 1980). Sediments tend to deposit according to a generally decreasing grain size gradient from the coast towards the open sea, with coarser sediments near the coast (submerged beach) a n d finer grain sizes further from the coast. This is confirmed by Figure 5-56, where coarse rocks and sediments are prevalent close to the coast, giving way to sand and, above all, silty substrates at increasing depths.

In particular, the seabed off the coast of Santa Cesarea Terme is characterised by rocks in the infralittoral zone, which continue into the circalittoral zone, giving way to coarse sediments and then sand. From a depth of about -100 m, the seabed is mainly composed of silty sand and fine silt.

The wind farm area is characterised by a sandy silt seabed. Broadly speaking, it can be said that granitic, tuffaceous and arenaceous rocks give rise to predominantly sandy sediments, while the coarser component derives mainly from calcareous, lava and schistose rocks. The sediments deposited along the Italian coastline consist of gravel, sand and pelites in varying proportions depending on the energy characteristics of the depositional environment (Anselmi *et al.,* 1978). From a mineralogical point of view, however, the composition varies according to the petrographic characteristics of the upstream basins.

Figure 5-56 Map of sediments and main substrates in the marine area of interest



Source: EMODNet 2023 data reprocessing

5.7.1.1 Results of geophysical and environmental monitoring campaigns

Following the monitoring campaign carried out in April (nearshore area) and June (offshore area) 2024, a granulometric analysis was performed on the sediments collected from the sampling sites (Stations 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10 for the nearshore area, Figure 5-42, and stations M11, M12, M13, M14, M15 for the offshore area, Figure 5-43). This analysis made it possible to determine the distribution of particle sizes within the samples, providing essential information on the composition and physical characteristics of the sediments.

Table 5.12 and Table 5.13 show the results for the nearshore and offshore areas obtained from the grain size analysis and the percentage representation of the main grain size classes found according to the Udden-Wentworth scale. The results, expressed in grams of fraction retained by the corresponding mesh after dry sieving, show that for the nearshore area, the most abundant classes were sand and silt, with the latter being more characteristic of the deeper stations sampled. as regards the offshore area, the most abundant classes are: silt for more than 50% in all stations and sand especially at station M12. Gravel is not present in any of the stations sampled, which is typical of high depths.

Table 5.12 Passing grain size analysis (fractions expressed in grams) of the nearshore area.

Passing grain size analysis (fractions in grams)											
	Gravel	Sand									Pelitic
Station	≥ 20 µm	1400 µm	1000 µm	710 µm	500 µm	355 µm	250 µm	180 µm	125 µm	90 µm	63 µm	(< 63 µm)
1	0.0	0	0.8	1.6	3.3	4.9	17.5	35.9	29.3	5.7	0.6	0.2
2	1.3	0.6	0.6	0.6	0	1.0	2.1	4.7	10.4	14.5	8.7	54.9
3	0.4	0.3	0.3	0.4	0.6	1.1	2.2	5.4	11.4	14.4	10.5	53.0
4	0.2	0.3	0.3	0.3	0.5	0.7	0.9	2.4	6.5	12	9.6	66.4
5	0.0	0.2	0.3	0	0.4	0.7	0.9	2.7	7.2	13.7	11.8	61.8
6	0	0.1	0.3	0	0	0.7	1	1.9	4.4	8.3	9.0	73.5
7	0.1	0.2	0.2	0	0.5	0.7	1.1	2	7.7	11.8	2.2	72.9
8	0.1	0.2	0.2	0.4	0.9	1.4	2.7	6.7	23.5	19.5	8.5	35.7
9	0	0.4	0.4	0.6	0.8	0.9	2.3	5.8	19	15.0	6.4	48.5
10	0	0.2	0.2	0.2	0.7	1.6	3.8	9.5	38.3	11.7	3	30

Source: Nearshore Sector - Geophysical and Environmental Survey

Table 5.13 Passing grain size analysis (fractions expressed in grams) of the Offshore area.

Passing grain size analysis (fractions in grams)											
	Gravel	Sand									Pelitic
Station	≥ 20 µm	1400 µm	1000 µm	710 µm	500 µm	355 µm	250 µm	180 µm	125 µm	90 µm	63 µm	(< 63 µm)
M11	0	0	0	0	0	0.4	0	1.4	4	3.4	1.2	88.3
M12	0	0	0	0	0	0.2	0.1	0	0	0.4	0.6	98
M13	0	0.7	0	0	1.7	2.1	2.4	3.5	12	13.5	5	57.1
M14	0	0	0	0	0	0.4	0.5	0.7	0.8	1	1.3	94.1
M15	0	0	0	0	0.2	0.3	0.2	0.4	0.9	2.8	1.7	93.6

Source: Offshore Sector - Geophysical and Environmental Survey

Colour analysis (Munsell scale), on the other hand, for the nearshore area highlights the homogeneity of the samples detected in almost all stations except for station 1, where the colour is clearly different, probably due to significant terrigenous inputs due to the proximity of the coastline.

Table 5.14 MUNSELL scale colour analysis nearshore

Sample	Colour (Munsell)	Notes
	10YR 7/3	very light brown
2	2.5Y 7/1	light grey
3	2.5Y 7/1	light grey
4	2.5Y 7/1	light grey
5	2.5Y 7/1	light grey
6	2.5Y 7/1	light grey
7	2.5Y 7/1	light grey
8	2.5Y 7/1	light grey
9	2.5Y 7/1	light grey
10	2.5Y 7/1	light grey

Source: Neashore Sector - Geophysical and Environmental Surveying

In the offshore area, sample homogeneity was detected at all stations, with a colour typical of the depths sampled.

Table 5.15 Offshore MUNSELL colour analysis

Sample	Colour (Munsell)	Notes
1	2.5Y 6/2	light brownish grey
12	2.5Y 6/2	light brownish grey
13	2.5Y 6/2	light brownish grey
14	2.5Y 6/2	light brownish grey
15	2.5Y 6/2	light brownish grey

Source: Offshore Sector - Geophysical and Environmental Survey

In conclusion, in the nearshore area, the grain size analysis showed that sand and pelite were the most abundant classes, while gravel was not present in any of the sampling stations, as is typical of high depths. Colour analysis showed homogeneity in all stations except station 1, which has a distinctly different colour, probably due to significant terrigenous inputs due to its proximity to the coastline.

In the offshore area, the most abundant classes were also pelite (more than 50% in all stations) and sand, especially in station M12, while gravel was not present in any station. Colour analysis was homogeneous in all stations.

5.7.2 Chemical-physical parameters

To describe the chemical status, a set of priority substances identified by Legislative Decree 152/06, subsequently supplemented by Legislative Decree 172/15, are sought in the sediments and reported in the table below.

Table 5.16 Priority substances to be sought in sediments

Parameters common to Tables 2/A and 3B		Parameters Table 3/A	Parameters Table 3/B
Cadmium	α-hexachlorocyclohexane	Benzo[a]pyrene	Arsenic
Mercury	β-hexachlorocyclohexane	Benzo[B]fluoranthene	Total chromium
Lead	γ-hexachlorocyclohexane	Benzo[ghi] Perylene	Chromium VI
Anthracene	DDT	Benzo[k]fluoranthene	Total PCBs
Naphthalene	DDD	Indenopyrene	
Aldrin	DDE	Fluoratene	
Dieldrin	TBT	Hexachlorobenzene	
		ΣT.E. PCDD, PCDF (dioxins and furans and PCB dioxin-like compounds)	

Source: ARPA, 2017

The possible classification levels for the chemical layer of sediments are Good or Not Good and depend on a comparison with the Environmental Quality Standards of Legislative Decree 172/15 and Regional Resolution 264/2018, relating to background values.

The sedimentation rate in the Ionian Sea, equal to 0.17 mm per year, appears to be much lower than the typical values for the central-southern Adriatic, calculated at between 3 mm and 5 mm per year.

As regards the mineralogical composition of the sediments, the Ionian Sea has an organic carbon content of 0.38%, while the central and southern Adriatic Sea has values ranging from 0.3% to 1% (Olivieri *et al.*, 2013; Ilijanic *et al.,* 2014, Lopez-Rocha *et al.,* 2017).

Studies show that the natural background concentration of trace heavy metals is to some extent linked to the grain size of the seabed, with higher concentrations corresponding to finer grain sizes (Lapizer *et al.*, 2022).

Samples taken along the Adriatic and Ionian coasts showed Hg and Cu concentrations between 1.5 and 2.6 times higher than normal background values. The highest concentrations were found in the central Adriatic, an area affected by both mineralogical and anthropogenic inputs of these elements.

For lead, on the other hand, typical background concentrations range between 10,000 $\mu g\ kg^{-1}$ and 23,000 $\mu g\ kg^{-1}$. Higher concentrations are commonly found near sources of lead pollution, such as ports and industrial areas. Figure 5-57 shows the lead concentration measured along the Adriatic and Ionian coasts.

The tables provide a comparison between the expected background values (Table 5.17) and the values recorded in the coastal and offshore areas (Table 5.18 and

Table 5.19).

Table 5.17 Expected background values for heavy metal concentrations in the seabed of the Eastern Mediterranean (in µg $^{kg-1}$ dry weight)

Element	Units	BC ranges	
		BCMin	BCMax
Cd	µgkg^{-1} dw	118	600
Hg	µgkg^{-1} dw	12	130
Pb	µgkg^{-1} dw	10,000	46,000
As	µgkg^{-1} dw	4,000	19,100
Cr	µgkg^{-1} dw	35,990	194,200
Cu	µgkg^{-1} dw	4,100	49,150
Ni	µgkg^{-1} dw	23,000	195,000
Zn	µgkg^{-1} dw	34,600	103,000
Co	µgkg^{-1} dw	11,800	29,100
V	µgkg^{-1} dw	34,465	109,000

Source: Lapizer et al., 2022

Table 5.18 Average concentration values of heavy metals in the seabed of the Eastern Mediterranean – coastal zone (in µg kg−1 dry weight)

Element	Units	Offshore sediments concentration ranges	
		OffshoreMin	OffshoreMax
Cd	µgkg^{-1} dw	120	400
Hg	µgkg^{-1} dw	32	419
Pb	µgkg^{-1} dw	5,000	72,500
As	µgkg^{-1} dw	1,000	36,500
Cr	µgkg^{-1} dw	24,000	312,000
Cu	µgkg^{-1} dw	6,000	60,000
Ni	µgkg^{-1} dw	23,000	407,000
Zn	µgkg^{-1} dw	29,880	124,000
Co	µgkg^{-1} dw	5,000	31,000
V	µgkg^{-1} dw	36,630	142,000

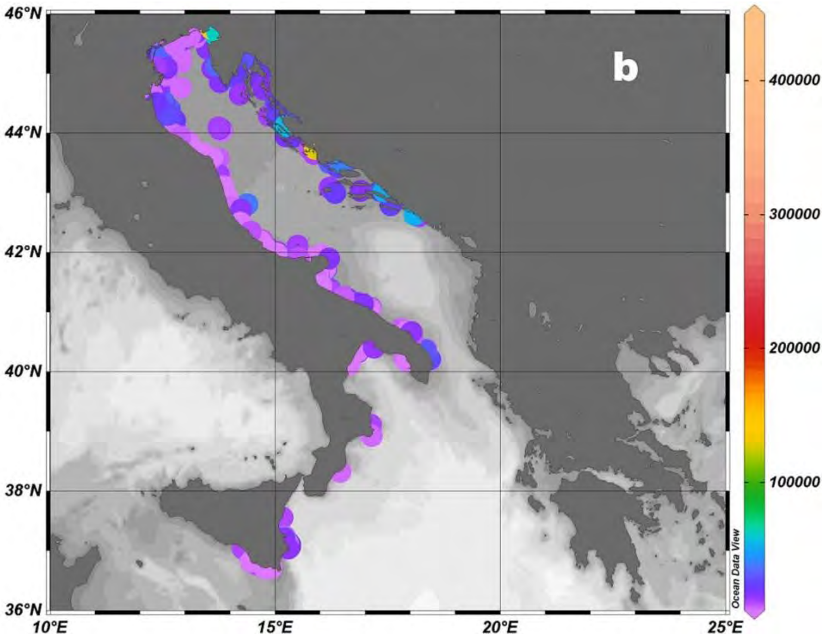
Source: Lapizer et al., 2022

Table 5.19 Average concentration values of heavy metals in the seabed of the Eastern Mediterranean – offshore zone (in µg $^{kg-1}$ dry weight)

Element	Unit	Coastal sediments concentration ranges	
		CoastMin	CoastMax
Cd	µgkg^{-1} dw	20	10,500
Hg	µgkg^{-1} dw	10	14,920
Pb	µgkg^{-1} dw	5,000	373,900
As	µgkg^{-1} dw	3,100	178,500
Cr	µgkg^{-1} dw	14,800	694,000
Cu	µgkg^{-1} dw	2,900	365,300
Ni	µgkg^{-1} dw	9,100	808,000
Zn	µgkg^{-1} dw	11,600	982,200
Co	µgkg^{-1} dw	1,100	99,000
V	µgkg^{-1} dw	4,600	157,300

Source: Lapizer et al., 2022

Figure 5-57 Lead (Pb) concentration along the Adriatic and Ionian coasts



Source: Lapizer et al., 2022

5.7.2.1 Results of geophysical and environmental monitoring campaigns

As part of the environmental monitoring campaign carried out in April (nearshore area) and June (offshore area) 2024, primary data was collected through specific sampling conducted on site using appropriate equipment. Sediment sampling was carried out using appropriate equipment on board by the operator in charge. In particular, a box corer was used at all sampling stations planned for monitoring, and samples were taken both for the characterisation of the macro-zoobenthic community (3 replicates for each station) and for chemical, ecotoxicological and microbiological analyses (with one replicate for each station) (Figure 5-42 and Figure 5-43). In order to comply with the 'holding time' (24 hours = maximum storage time), the samples taken for microbiological analysis were collected first and landed immediately. During sampling, pH and redox potential analyses were carried out using a probe on sterile cores taken at the opening of the bucket.

Analyses were conducted on Total Organic Carbon, Nitrogen and Total Phosphorus in the sediments. All parameters analysed fell within the detection range. Phosphorus and nitrogen concentrations, expressed in mg/kg of dry sediment, were at least two orders of magnitude higher than the limit of quantification (LOQ) at all stations in both the nearshore and offshore areas.

Phosphorus shows much higher concentrations near the coast (station 1, -31 m), which halve at -38 m (station 2) and remain around 500 mg/kg d.w. down to -80 m (station 7), before reaching a minimum of approx. 400 mg/kg d.w. in the three deepest stations. As for nitrogen, at stations between -30 m and -80 m depth (stations 1–7), concentrations remain in the range 670–760 mg/kg d.w., with a maximum of 830 mg/kg d.w. at -62 m (station 4); the maximum nitrogen concentrations were found between -91 m and -95 m depth in stations 8 and 9. Total organic carbon (TOC) was measurable in the sediments of all stations, with a bell-shaped pattern in which the values increase away from the coast to a depth of -66 m (stations 1–6), and then decreasing by up to three times (from 1.55% to 0.48% s.s.) at station 10 (-98 m). The percentage of dry residue was always one order of magnitude higher than the LOQ, with a decrease between stations 1 and 7 and a slight increase in the last three stations.

For the offshore area, no significant variations in the concentrations of either nutrient were observed either between stations or with depth. Phosphorus concentrations ranged between 350 and 556 mg/kg, while nitrogen concentrations ranged between 730 mg/kg and 910 mg/kg. Station M15, the deepest station, had the lowest concentrations, while the highest values for both nutrients were recorded at station M12. Total organic carbon (TOC) was also detected at all stations, with concentrations ranging from 0.2% to 0.65%, again being lower at station M15 and higher at M12. Finally, the percentage of dry residue was always one order of magnitude higher than the LOQ.

As regards metals, comparing the data obtained from sediment analysis with the concentration limits imposed by the reference regulations, always taking into account the most restrictive one, it can be seen that the values of arsenic (As), total chromium (Cr tot) and nickel (Ni) exceed those imposed by the decrees. Arsenic exceeds the concentration limit in 50% of the stations analysed, but without showing a specific correlation with depth for either nearshore or offshore stations. Total chromium values are slightly above the limits at stations 7 and 9. Nickel, on the other hand, has low concentrations at stations 1 and 2, then increases by an order of magnitude and reaches levels very close to the threshold, which is only slightly exceeded at stations 7 and 9, as for total Cr, while for offshore stations, nickel exceeds the threshold at all stations sampled.

The same regulations also refer to concentration limits for organic contaminants, which include PAHs, PCBs, pesticides (DDD, DDE and DDT) and organotin compounds (used in marine antifouling paints). The data obtained from the sediment analyses were compared with the reference threshold values expressed in µg/kg of dry sediment, always taking into account the most restrictive value.

As regards nearshore areas, among the various categories of organic contaminants, polycyclic aromatic hydrocarbons (PAHs) were all found to exceed the detection limit, but their total concentration ΣPAH does not exceed the *thresholds* imposed by current regulations. On the contrary, none of the polychlorinated biphenyls (PCBs) were significantly detectable and the ΣPCB does not exceed the limits imposed by current regulations. In general, light hydrocarbons (HC C<12) were never detected, while heavy hydrocarbon chains (HC C>12) were detected at all stations except station 1, i.e. at depths of -38 m and below, unlike the results obtained in water samples. Among the various categories of organochlorine pesticides, the isomeric forms of dichlorodiphenyldichloroethylene DDE-p,p and para-dichlorodiphenyltrichloroethane DDT-p,p exceed the detection limit at all stations. Hexachlorobenzene exceeds the LOQ at all stations except station 1, and finally pentachlorobenzene only at stations 2 to 7. Comparing the concentrations detected in the sediment with the most restrictive limits imposed by current regulations, the ΣDDD, ΣDDE and ΣDDT do not exceed these concentration limits. Finally, organotin compounds also do not have concentrations in sediment that exceed current regulations, considering the most restrictive D.lgs. 152/06, as they did not even fall within the detection range.

In offshore samples, however, polycyclic aromatic hydrocarbons remained below the detection limit or were detected in quantities that were insignificant compared to the LOQ. Only naphthalene (normally used for dyes), fuels and insecticides were detected at all stations and at all depths. The sum of the detectable concentrations of all PAHs analysed (16) exceeded the LOQ by at most one order of magnitude at all stations at different depths. Halomethanes and volatile organic compounds (VOCs) were not detected. Finally, in general, the concentrations of heavy hydrocarbons (IP C>12, chains with more than 12 carbon atoms) and light hydrocarbons (IL C<12, chains with less than 12 carbon atoms) did not exceed the detection limits.

Microbiological analyses were also carried out in sediments to measure the presence of total coliforms, faecal coliforms, faecal streptococci, and clostridium spores and sulphite reducers. At all nearshore stations, the measured values were below the minimum detection levels of the methods. Therefore, the results show a total absence of bacteriological contamination. For offshore sampling, only at station M15 were the results of all parameters analysed below the minimum detection limits (LOQ) of the methods, indicating a total absence of bacteriological contamination. At the other stations, the parameter values were higher, albeit only slightly. In particular, the high number of Clostridium spores and sulphite reducers was evident. On the other hand, the values for enterococci (faecal streptococci) are lower, indicating the absence of contamination.

As regards ecotoxicological tests in sediments, at the nearshore sampling stations analysed, the average immobilisation percentage varies from 4% to 10%. In particular, percentage values that deviate from the controls were found at stations 1 and 3, while lower values, close to 4%, were found at stations 4 and 10 (Table 5.20). A biological test was also carried out with P*. Tricornutum,* and Table 5.21 shows the results for the 10 sampling stations. The average algal density values after 72 hours show deviations of less than 3% from the control. Very high EC20 and EC50 values suggest that the marine sediments sampled have low toxicity towards P. tricornutum algae.
P. tricornutum. In other words, the algae are able to grow without significant reductions in density even in the presence of marine sediments. An EC50 greater than 100 indicates that the sediments do not contain levels of toxic contaminants of concern for *P. tricornutum*, as a very high concentration is required to significantly reduce algal growth.

Table 5.20 Biological assay with chronic Acartia tonsa.

STATION	MOBILITY % AVERAGE (± ST. DEV. %)			IMMOBILISATION % AVERAGE (± SD %)			IMMOBILISATION % AVERAGE CORRECT ABBOTT
Control	93	±	0.58	6.67	±	0.58	
1	86.67	±	0.58	13.33	±	0.58	7.14
2	96.67	±	0.58	3.33	±	0.58	-3.57
3	83.33	±	1.15	16.67	±	1.15	10.71
4	90.00	±	0	10.00	±	0	3.57
5	96.67	±	0.58	3.33	±	0.58	-3.57
6	93.33	±	0.58	6.67	±	0.58	0.00
7	96.67	±	0.58	3.33	±	0.58	-3.57
8	93.33	±	1.15	6.67	±	1.15	0.00
9	93.33	±	0.58	6.67	±	0.58	0
10	90.0	±	0	10	±	0	3.57

Source: Nearshore Sector - Geophysical and Environmental Survey

Table 5.21 Biological assay with P. tricornutum

Station	Average algal density at maximum concentration (No. of cells± r DS)			The 72 hours %	EC20 %	EC50 %
Control	731733	±	38039		-	-
1	640267	±	14970	3.11	≥100	>100
2	663133	±	2040	2.29	≥100	>100
3	60760	±	33948	4.33	≥100	>100
4	643533	±	2040	2.99	≥100	>100
5	64680	±	2592	2.87	≥100	>100
6	640267	±	11316	3.11	≥100	>100
7	643533	±	14970	2.99	≥100	>100
8	64680	±	980	2.87	≥100	>100
9	669667	±	1497	2.06	≥100	>100
10	63700	±	42717	3.23	≥100	>100

Source: Nearshore Sector - Geophysical and Environmental Survey

Based on the results reported in Table 5.22, station 1 has a mainly sandy composition with a measured toxicity of zero, indicating no toxicity detected. Station 2 shows a balanced composition between sand and pelite, with a measured toxicity below the natural threshold. The data for station 3 also show a balanced distribution of sand and pelite, with a toxicity measured slightly higher than station 2, but still below the natural threshold. A toxicity measured above the natural threshold emerges from the values obtained for sampling stations 4, 5, 6, 8, 9 and 10. Finally, despite the predominance of pelite, the measured toxicity is slightly below the natural threshold. In general, although the measured toxicity exceeds the natural toxicity at some stations, the sediment toxicity index is always <3 and therefore negligible compared to the references in the 'Analytical Reference Methods for Sea Monitoring, ICRAM'.

Table 5.22 Vibrio fischeri biological test (solid phase)

Station	Sand < 1mm (%)	Pelite (%)	Natural Tox Threshold (TU)	Measured Tox (TU)	95% confidence range (TU)		R2 (%)	S.T.I.
1	99.85	0.15	25.84	0	0	0	0.92	0.00
2	43.66	56.34	201.70	130.54	103.25	165.07	0.97	0.65
3	46.49	53.51	192.85	148.54	123.07	179.27	0.98	0.77
4	33.08	66.92	234.83	303.92	206.32	447.79	0.94	1.29
5	37.91	62.09	219.70	281.22	202.56	390.29	0.96	1.28
6	26.22	73.78	256.31	274.69	210.45	358.44	0.97	1.07
7	26.82	73.18	254.41	247.98	175.57	980.93	0.95	0.97
8	64.08	35.92	137.77	207.30	173.06	248.14	0.99	1.50
9	51.15	48.85	178.26	330.61	246.61	443.19	0.97	1.85
10	69.82	30.18	119.83	143.71	107.34	192.43	0.96	1.20

Source: Nearshore Sector - Geophysical and Environmental Survey

At offshore sampling stations, the average immobilisation percentage varies from 3% to 14%, with values deviating from the controls found at station M13, while lower values, close to 3%, are found at station M14 (Table 5.23).

Table 5.23 Biological assay with chronic Acartia tonsa.

Sample	Average mobility % (± st. dev. %)			Average immobilisation % (± st. dev. %)			Average immobilisation Correct Abbott
Control	96.67	±	0.58	3.33	±	0.58	
M11	96.67	±	0.58	3.33	±	0.58	0
M12	96.67	±	0.58	3.33	±	0.58	0
M13	86.67	±	0.58	13.33	±	0.58	10.34
M14	93.33	±	0.58	6.67	±	0.58	3.45
M15	96.67	±	0.58	3.33	±	0.58	0

Source: Offshore Sector - Geophysical and Environmental Survey

As regards the biological test with *P. tricornutum*, Table 5.24 shows the results for the five sampling stations. The average algal density values after 72 hours show deviations of around 0%, if not negative, compared to the control. Very high EC20 and EC50 values suggest that the marine sediments sampled have low toxicity towards P*. tricornutum* algae. In other words, the algae are able to grow without significant reductions in density even in the presence of marine sediments.

An EC50 greater than 100 indicates that the sediments do not contain levels of toxic contaminants that are of concern for *P. tricornutum*, as a very high concentration is required to significantly reduce algal growth (Table 5.24).

Table 5.24 Biological assay with P. tricornutum

Sample	Average algal density at maximum concentration (No. of cells± r DS)			I 72 h	EC20 %	EC50 %
Methodological control	731733	±	38039		-	-
M11	666667	±	53541		≥100	>100
M12	78000	±	3000	-3.74	≥100	>100
M13	67000	±	36056	-0.12	≥100	>100
M14	646667	±	15275	0.73	≥100	>100
M15	68000	±	36056	-0.47	≥100	>100

Source: Offshore Sector - Geophysical and Environmental Survey

Based on the results in Table 5.25, all stations have a predominantly pelitic composition with negative toxicity values below the natural toxicity threshold. Consequently, the absence of toxicity due to the presence of *Vibrio fischeri* is confirmed.

Table 5.25 Vibrio fischeri biological test (solid phase)

Sample	Sand < 1mm (%)	Pelitic (%)	Natural Tox Threshold (TU)	Measured Tox (TU)	95% confidence range (TU)		R2 (%)	S.T.I.
M11	11.59	88.41	302.08	-46.87	-25.40	-86.50	0.85	-0.16
M12	1.92	98.08	332.36	-45.30	-26.96	-76.15	0.90	-0.14
M13	42.02	57.98	206.84	-56.88	-34.05	-95.06	0.91	-0.27
M14	5.53	94.47	321.04	-63.00	-31.98	-124.20	0.86	-0.20
M15	6.40	93.60	318.32	-65.89	-39.34	-110.34	0.92	-0.21

Source: Offshore Sector - Geophysical and Environmental Survey

In conclusion, the analyses conducted on Total Organic Carbon, Nitrogen and Total Phosphorus showed that all parameters fall within the detection range. Sediment analyses reported that the values of Arsenic (As), Total Chromium (Cr tot) and Nickel (Ni) exceed those imposed by the decrees in the nearshore area. Arsenic exceeded the concentration limit in 50% of the stations analysed, but did not show a specific correlation with depth. Polycyclic aromatic hydrocarbons (PAHs) were also found to be above the detection limit, but their total concentration ΣIPA did not exceed the *thresholds* imposed by current regulations. The isomeric forms of dichlorodiphenyldichloroethylene DDE-p,p and para-dichlorodiphenyltrichloroethane DDT-p,p also exceed the detection limit in all stations. Hexachlorobenzene exceeds the LOQ in all stations except station 1 and, finally, pentachlorobenzene only in stations 2 to 7.

2 to 7. Microbiological analyses of sediments reported no bacteriological contamination

. Furthermore, ecotoxicological tests in sediments showed low toxicity to *P. Tricornutum* algae, with very high EC20 and EC50 values. Finally, despite the predominance of pelite, the measured toxicity is slightly below the natural threshold. In general, although the measured toxicity exceeds the natural level at some stations, the sediment toxicity index is always < 3 and therefore negligible compared to the references in the 'Analytical Reference Methods for Sea Monitoring, ICRAM'.

Even in the offshore area, the concentrations (mg/kg of dry sediment) of phosphorus and nitrogen were two orders of magnitude higher than the limit of quantification (LOQ) at all stations. No significant variations in the concentrations of either nutrient were observed, although the percentage of dry carbon residue was found to be one order of magnitude higher than the LOQ. Sediment analyses showed that the values for arsenic (As), total chromium (Cr tot) and nickel (Ni) exceeded the limits set by the decrees. Arsenic exceeded the concentration limit in 50% of the stations analysed, but did not show a specific correlation with depth. Nickel also exceeded the threshold in all sampled stations. Polycyclic aromatic hydrocarbons, on the other hand, remained below the detection range with the exception of naphthalene, fuels and insecticides. The sum of the detectable concentrations of all PAHs analysed (16) exceeds the LOQ by at least one order of magnitude at all stations at different depths. Microbiological analyses showed a total absence of contamination only at station M15. At the other stations, the number of Clostridium spores and sulphite reducers is high. Finally, very high EC20 and EC50 values suggest that the marine sediments sampled have low toxicity towards P*. Tricornutum* algae *and* have a predominantly pelitic composition with negative toxicity values below the natural toxicity threshold.

5.8 Soil and subsoil

Within the hydrogeological area of Salento, two zones with different characteristics can be identified: flat surfaces of varying extent, connected to the Brindisi Plain, characterise the northern sector, while very gentle limestone hills, known as the "Serre Salentine", interspersed with depressions of varying extent, define the southern sector, known as Basso Salento. The Mesozoic limestones, which outcrop with the Cretaceous strata in the Serre area, form, in continuity with the nearby Murgia environment, the basic framework on which the carbonate and clayey-sandy deposits belonging to the transgressive-regressive cycles of the Miocene and Pliocene-Pleistocene rest (Cotecchia V., 2014).

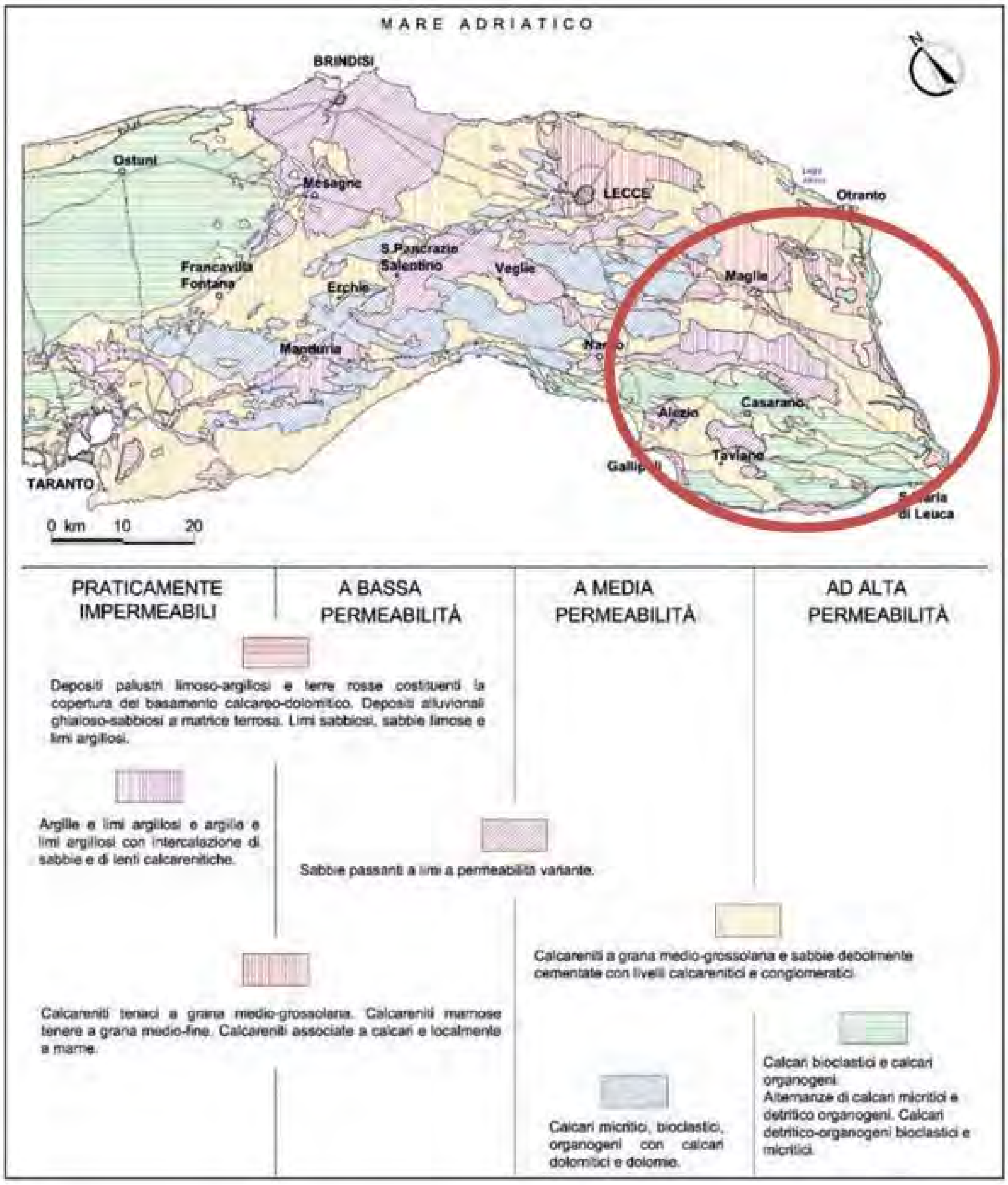
The subsequent stratification of permeable carbonate rocks, followed by less permeable or impermeable layers that were subsequently eroded, has led to a particular conformation of the territory, subject to karst phenomena with the presence of deep carbonate aquifers. Figure 5-58 illustrates the current state of the surface lithotypes found in the Lecce area of Salento, and an indication of their relative permeability. Note how in the area covered by the project, between Otranto and the north-west of Maglie, the prevailing lithologies are medium to high permeability. This corresponds to an area characterised by the widespread presence of sinkholes and dolines (Figure 5-59).

In Salento, which is characterised by the almost exclusive presence of carbonate rocks, the karst process has shaped a wide variety of both epigeal and hypogeal forms, developing with different effects and in different ways depending on the outcropping lithology and the characteristics of the territory. The karst landscape of the Salento Peninsula is characterised by the presence of complexes of non-contemporary forms, shaped during several morphogenetic phases that took place between the Cretaceous and the present day. The most evident karst forms are sinkholes and swallow holes (vore). Along the Ionian coast, 'spunnulate' sinkholes are also particularly frequent, formed by the collapse of the vault of underlying cavities.

The main vore of Salento represent the final destination of partially developed endorheic networks, whose hydrographic basins extend over vast areas, covering tens of square kilometres. Formed in highly fractured rocks at an average depth of about -30 m, these sinkholes can be divided into: punctual recharge sinkholes, alluvial sinkholes (cover sinkholes), collapse sinkholes (cave-collapse sinkholes) and normal solution sinkholes (Refolo *et al.,* 2007).

However, the onshore route does not intersect any of the geomorphological structures described above.

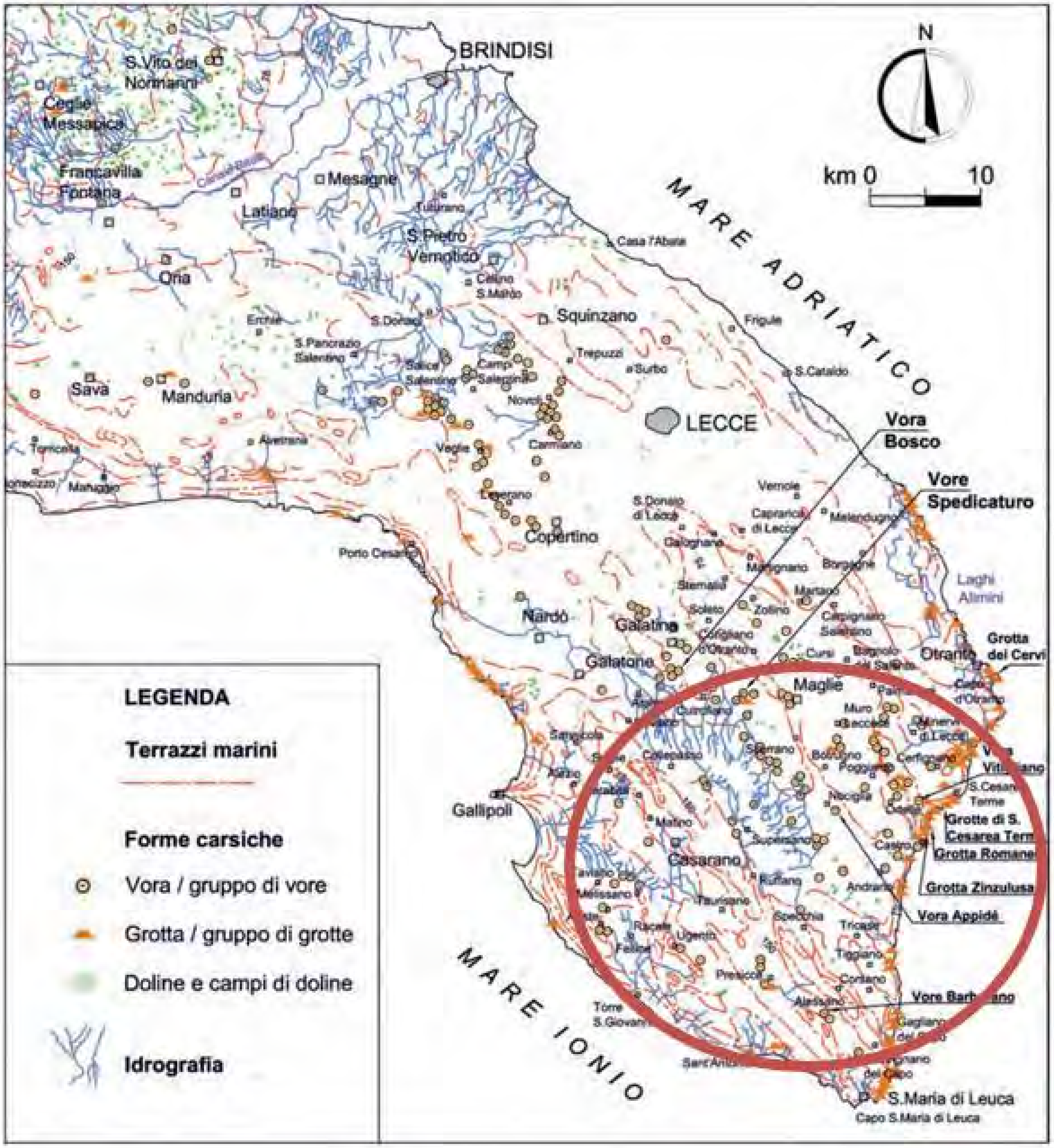
Figure 5-58 Permeability of outcropping litholiths in the hydrogeological area of Salento.



Note: The Project Area is circled in red.

Source: Cotecchia, 1992

Figure 5-59 Geomorphological map of the Salento peninsula.

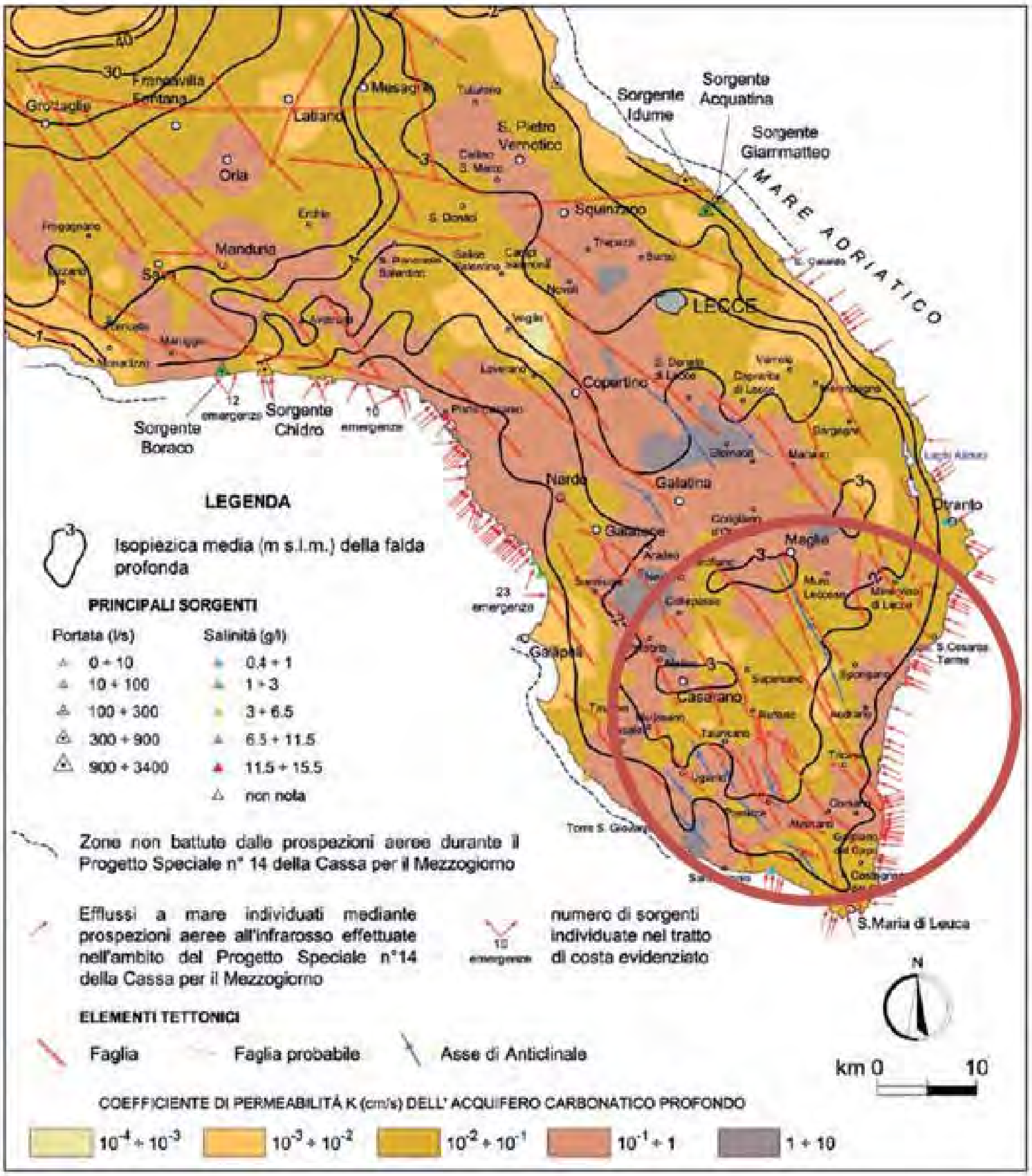


Note: The Project Area is circled in red.

Source: Cotecchia, 2014

Looking at the piezometry of the deep aquifer, it can be seen that the underground watershed runs parallel to the direction of maximum elongation of the peninsula. It is significantly closer to the Adriatic Sea than to the Ionian Sea due to the presence of clay deposits between Lecce and Otranto, which impede the flow of water towards the Adriatic Sea. The trend of the isopiezes and the distribution of the aquifer permeability coefficient show that, in correspondence with some coastal fronts, generally characterised by the presence of springs, there is a significant underground water flow (Figure 5-60).

Figure 5-60 Isopiezes of the deep aquifer, main sources and distribution of the permeability coefficient of the deep Cretaceous carbonate aquifer belonging to the hydrogeological area of the Salento peninsula.



Note: The Project Area is circled in red.

Source: Cotecchia, 2014

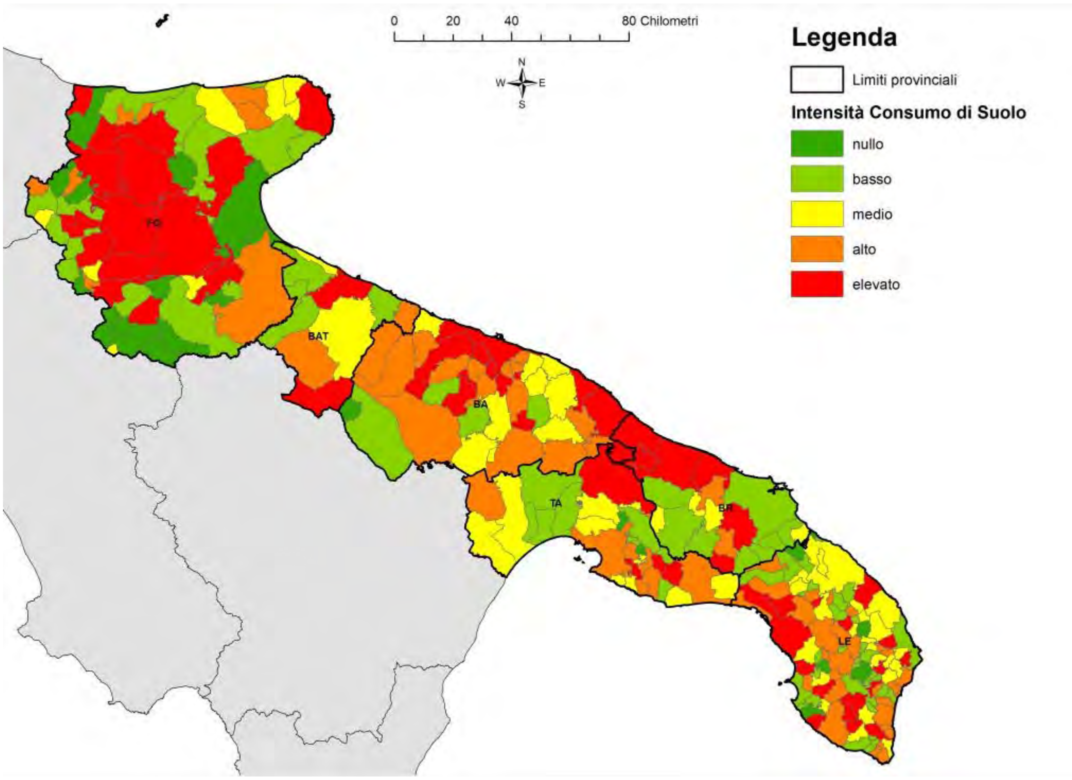
The central part of the Salento Peninsula is characterised by a deep aquifer with an almost horizontal geometry due to the presence of a hydrogeological watershed.

This situation exacerbates the problem of the ever-decreasing availability of water expected in the near future due to climate change, on which soil productivity also depends.

Apulia is among the regions with the highest percentage of land at risk of degradation, with almost 60% of the regional area classified as 'highly sensitive' to desertification and over 30% classified as 'sensitive' (MATTM, 2014).

Finally, if we look at the intensity of land consumption, i.e. the percentage increase in land consumption over time in a given reference area, the trend in Puglia is increasing at the regional level.

Figure 5-61 Intensity of land consumption in Puglia (2019)



Source: ARPA Puglia – National Land Use Map, 2019

According to the report 'Land consumption in Italy 2023', published by the National System for Environmental Protection (SNPA), by 2022, artificial coverage on the national territory will extend over 21,500 km^2, 7.14% of Italian soil (7.25% excluding rivers and lakes). New artificial coverings affected another 76.8 km^2(Table 5.26), 10.2% more than in 2021.

Table 5.26 National estimate for the period 2021-2022 of annual land consumption

Consumo di suolo (km²)	76,8
Consumo di suolo netto (km²)	70,8
Consumo di suolo netto (incremento %)	0,33
Densità del consumo di suolo netto (m²/ha)	2,35
Impermeabilizzazione complessiva (km²)	22,3
Incremento altre coperture non considerate (km²)	8,5

Source: SNPA Report, 2022

With regard to soil types, the report refers to the Italian Soil Map, which shows the main Italian soil landscapes divided into 10 Soil Regions (SR). Overlaying the soil consumption map updated to 2022, 5.27, we obtain the data shown in Tablerelating to soil consumption by SR. Considering soil consumption in hectares, the most affected PR is L 'Soils of the plains and low hills of central and southern Italy', followed by G 'Soils of the hills of central and southern Italy on neogenic marine sediments and limestone'. The soil region F 'Soils of the mountains of Sardinia and Sicily on igneous and metamorphic rocks' is among the least affected by land consumption.

Table 5.27 Soil consumption by soil region

Regioni pedologiche		Suoli: gruppi principali	Suolo consumato 2022 (ha)	Suolo consumato 2022 (%)	Consumo di suolo 2021-22 (%)	Densità di consumo di suolo 2021-22 (m²/ha)
A	Suoli delle Alpi e Prealpi	Cambisol, Leptosol, Phaeozem, Luvisol, Podzol	153.970	3,08	0,23	0,71
B	Suoli degli Appennini a clima temperato	Cambisol, Leptosol, Phaeozem, Luvisol, Calcisol	125.799	3,58	0,15	0,54
C	Suoli delle colline del nord Italia su sedimenti marini neogenici e su calcari	Cambisol, Regosol, Luvisol, Calcisol	62.853	5,85	0,15	0,89
D	Suoli della pianura padana e colline associate	Cambisol, Calcisol, Luvisol, Vertisol, Fluvisol	691.034	14,49	0,38	5,46
E	Suoli degli Appennini centrali e meridionali	Cambisol, Regosol, Calcisol, Luvisol, Umbrisol	108.614	3,64	0,28	1,02
F	Suoli delle montagne della Sardegna e Sicilia su rocce ignee e metamorfiche	Leptosol, Cambisol, Umbrisol, Andosols, Luvisol	34.559	2,65	0,46	1,22
G	Suoli delle colline del centro e sud Italia su sedimenti marini neogenici e su calcari	Cambisol, Regosol, Calcisol, Phaeozem, Luvisol	235.545	4,96	0,26	1,31
H	Suoli delle colline del centro e sud Italia su depositi vulcanici e su calcari	Cambisol, Regosol, Andosol, Leptosol, Luvisol	107.711	6,81	0,53	3,59
I	Suoli delle colline e dei terrazzi marini del sud Italia su sedimenti calcarei	Luvisol, Cambisol, Regosol, Phaeozem, Vertisol	116.960	6,73	0,40	2,66
L	Suoli delle pianure e basse colline del centro e sud Italia	Cambisol, Luvisol, Calcisol, Vertisol, Regosol	246.941	9,22	0,46	4,18

Source: ISPRA calculations based on MIPAAF and SNPA cartography, 2022

Similarly, the 2023 Report on Land Consumption analysed consumption between 2021 and 2022 within different types of landscape, using the 'Physiographic Landscape Units' as a reference. In Italy, 2,160 Physiographic Landscape Units have been mapped, each of which

It belongs to one of the 37 "physiographic landscape types" identified for the national territory. As shown in Table 5.28, the landscape areas most affected by the phenomenon in terms of percentage of land consumed concern the physiographic units describing flat and hilly landscapes, such as the coastal plain (18.8%), the morainic hills (18.2%), the open plain (14.7%) and valley floor (14.1%), confirming the national picture, which shows a higher percentage in flat areas. The lowest percentages of land consumption are recorded in the physiographic units describing high-altitude mountain landscapes, where environmental conditions are less favourable to human activities: 0.1% in the Dolomite rock landscape and 0.3% in the high-altitude glacial landscape.

Table 5.28 Land consumption by physiographic unit

Unità fisiografiche del paesaggio		Suolo consumato 2022 (%)	Consumo di suolo 2021-2022 (ha)	Consumo di suolo 2021-2022 (%)
1	Paesaggio glaciale di alta quota	0,3	14,53	0,50
2	Valle montana	2,2	50,71	0,24
3	Pianura di fondovalle	14,1	617,72	0,31
4	Montagne metamorfiche e cristalline	3,2	78,62	0,16
5	Montagne carbonatiche	2,6	149,77	0,23
6	Conca intermontana	9,8	71,87	0,38
7	Montagne terrigene	3,6	91,95	0,09
8	Paesaggio dolomitico rupestre	0,1	1,09	1,77
9	Montagne porfiriche	4,2	9,67	0,17
10	Montagne dolomitiche	2,7	16,21	0,09
11	Altopiano intramontano	3,0	16,66	0,60
12	Lago	0,8	1,40	0,12
13	Colline carbonatiche	6,4	111,46	0,27
14	Pianura aperta	14,7	2459,95	0,39
15	Colline terrigene	6,0	417,43	0,25
16	Colline moreniche	18,2	132,98	0,29
17	Pianura golenale	7,5	58,03	0,31
18	Tavolato carbonatico	11,7	416,51	0,38
19	Lagune	2,9	3,80	0,11
20	Paesaggio collinare vulcanico con tavolati	8,8	365,51	0,39
21	Paesaggio collinare terrigeno con tavolati	7,1	426,63	0,44
22	Pianura costiera	18,8	812,63	0,38
23	Piccole isole	9,6	3,43	0,08
24	Rilievo roccioso isolato	3,2	0,21	0,01
25	Colline argillose	5,4	312,77	0,32
26	Paesaggio collinare eterogeneo	3,3	70,48	0,24
27	Rilievo costiero isolato	9,9	4,15	0,11
28	Montagne vulcaniche	2,5	0,52	0,05
29	Edificio montuoso vulcanico	6,1	5,11	0,09
30	Rilievi terrigeni con penne e spine rocciose	4,6	242,78	0,38
31	Paesaggio a colli isolati	6,6	7,70	0,15
32	Colline granitiche	2,6	62,25	0,57
33	Colline metamorfiche e cristalline	2,1	14,25	0,20
34	Montagne granitiche	1,3	2,02	0,13
35	Tavolato lavico	3,1	17,07	0,40
36	Paesaggio collinare eterogeneo con tavolati	7,8	3,23	0,05
37	Paesaggio con tavolati in aree montuose	2,1	0,00	0,00

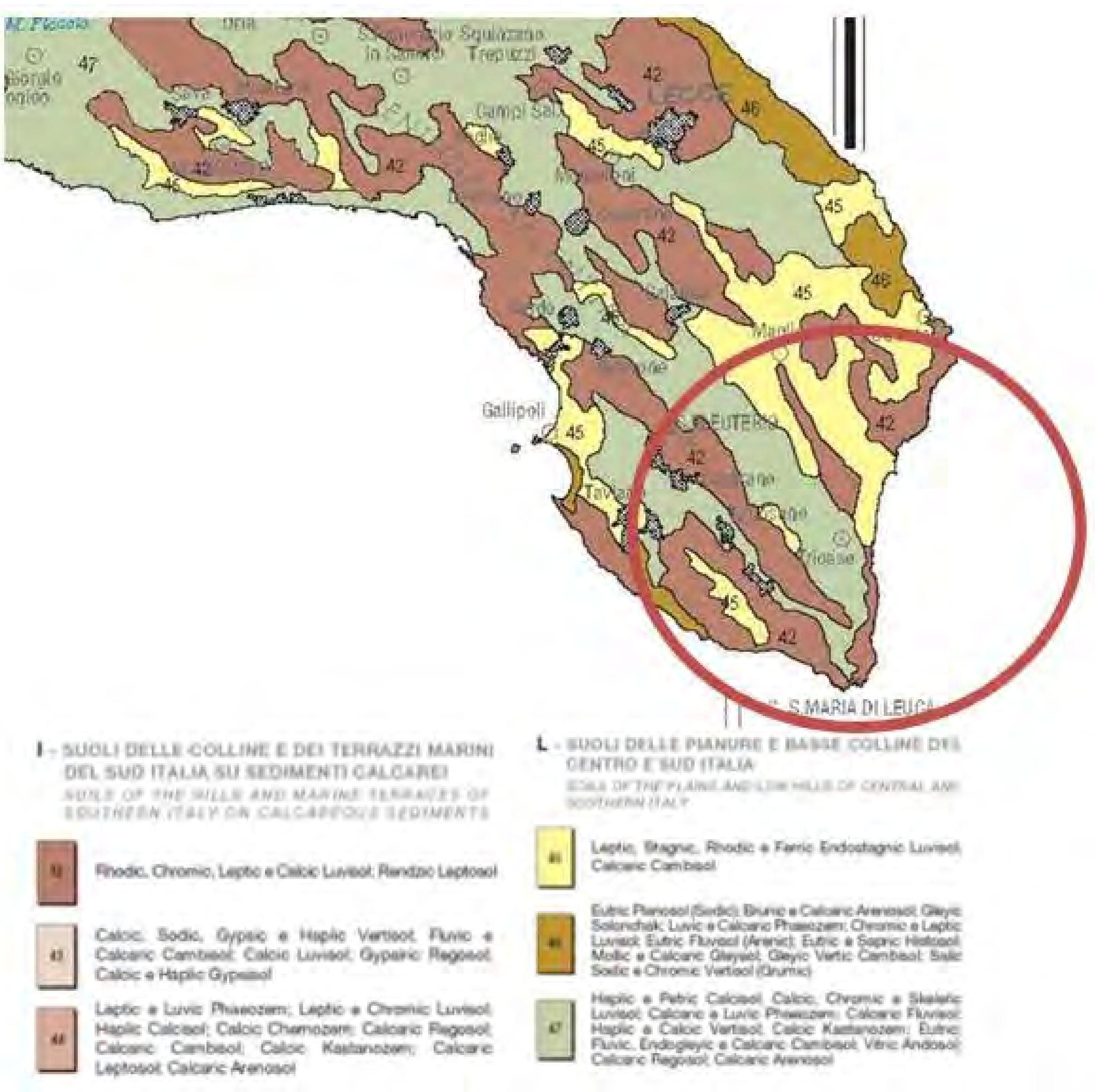
Source: ISPRA calculations based on SNPA nature map and cartography, 2022

According to the latest data available from ISPRA, in Puglia, in 2022, land consumption amounted to 159,459 hectares, an increase of approximately 764 hectares compared to the previous year. Land consumption exceeding

5,000 hectares is recorded in the municipalities of Taranto (5,339 hectares) and Bari (5,024). The percentage of soil consumed out of the total municipal area is over 20% in 34 municipalities in Puglia. The highest values are found in the municipalities of Bari (43.2%) and Modugno (42.0%). Compared to 2006, the percentage of soil has increased by less than 4 points in all municipalities in Apulia, with the exception of Carosino, where the change is 5.2 percentage points.

With regard to the Project Area, with reference to the Italian Soil Map, it falls within RP 'I' and 'L' and PP '47' and '45'.

Figure 5-62 Soil types



Source: Soil Map of Italy, 2019

5.9 Noise and vibrations

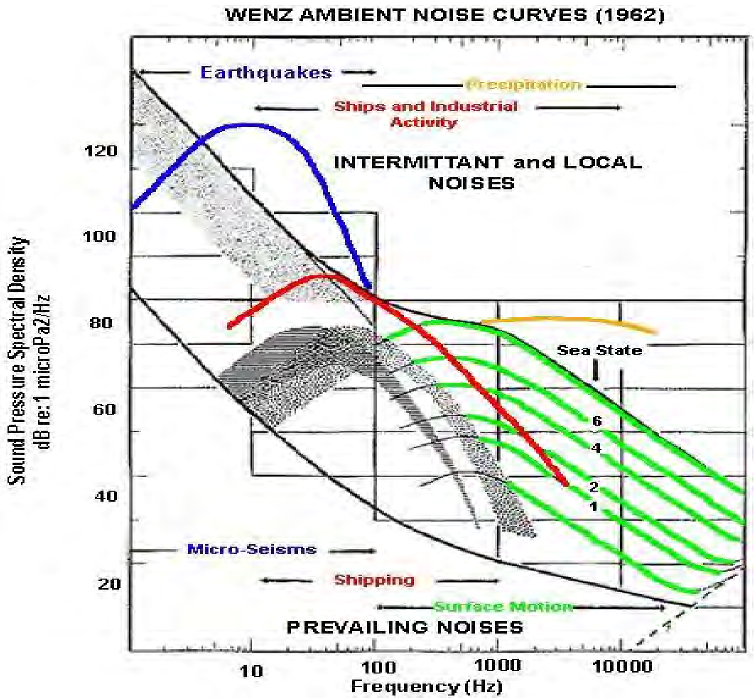
The European Environment Agency (Technical report No 11/2010) defines noise as 'audible sound that causes annoyance or damage to health'. The legislator, with Legislative Decree 194/2005 'Implementation of Directive 2002/49/EC relating to the assessment and management of environmental noise', defines 'environmental noise' as 'unwanted or harmful sounds in the outdoor environment produced by human activities, including noise emitted by transport, traffic, railways, air traffic and industrial sites'.

In Italy, the reference legislative instrument for noise assessments is Law 447/1995 "Framework Law on Noise Pollution" (recently amended by Legislative Decree 42/2017), which establishes the fundamental principles for the protection of the external environment and the living environment from noise pollution. It defines noise sources and the limit values they must comply with; the law establishes the responsibilities of the State, Regions, Provinces, Municipalities and transport infrastructure managers/owners, referring to specific decrees for general implementation aspects. It also provides guidelines for the preparation of noise abatement plans and noise impact assessments.

5.9.1 Underwater noise

The acoustic landscape is composed of the sum of anthropogenic and natural noise (Pijanoswski *et al.*, 2011). Sounds of natural origin are in turn divided into sounds of biological origin (many animal species voluntarily or involuntarily produce sounds) and geophysical origin (e.g. the noise of wind, waves, earthquakes, rain). Consequently, temporal variations in noise levels can follow daily and seasonal patterns depending on weather and sea conditions, anthropogenic and biological activities (Buscaino *et al.,* 2016; Wenz, 1962). Figure 5-63 shows Wenz's curves explaining how noise levels can vary depending on frequencies and environmental and biological forcing.

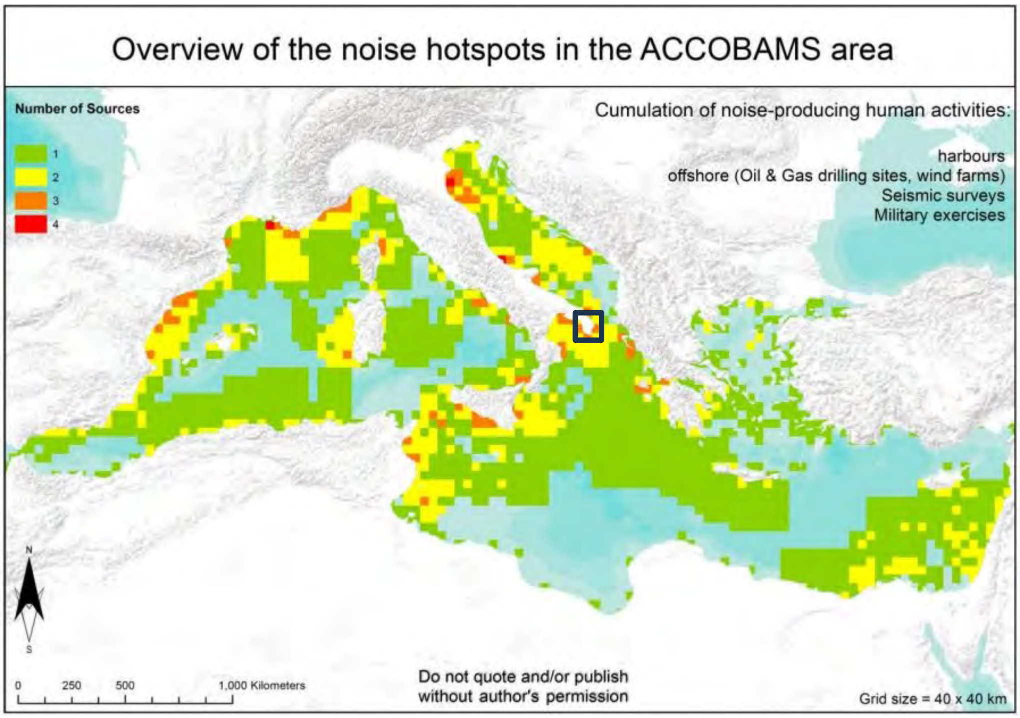
Figure 5-63 Diagram of underwater environmental noise



Source: Wenz et al., 1962

With regard to anthropogenic sources, a distinction is made between impulsive and generally higher-energy sources (airguns, sonar, pile driving) and continuous, lower-frequency sources (mainly maritime traffic). As shown in the Wenz diagram, anthropogenic activities generate noise in a fairly wide frequency band ranging from a few Hz to over 10 kHz (there are sonars that produce pulses at frequencies above 200 kHz). Shipping generates lower frequency noise (below kHz), although the latest generation of ships and small boats can also produce noise at higher frequencies (above 20 kHz). Figure 5-64 shows the cumulative noise due to anthropogenic activities in the Mediterranean estimated using indirect data (Automatic Identification System data – known as AIS data –, presence of ports, seismic surveys, military exercises) (Maglio *et al.,* 2015).

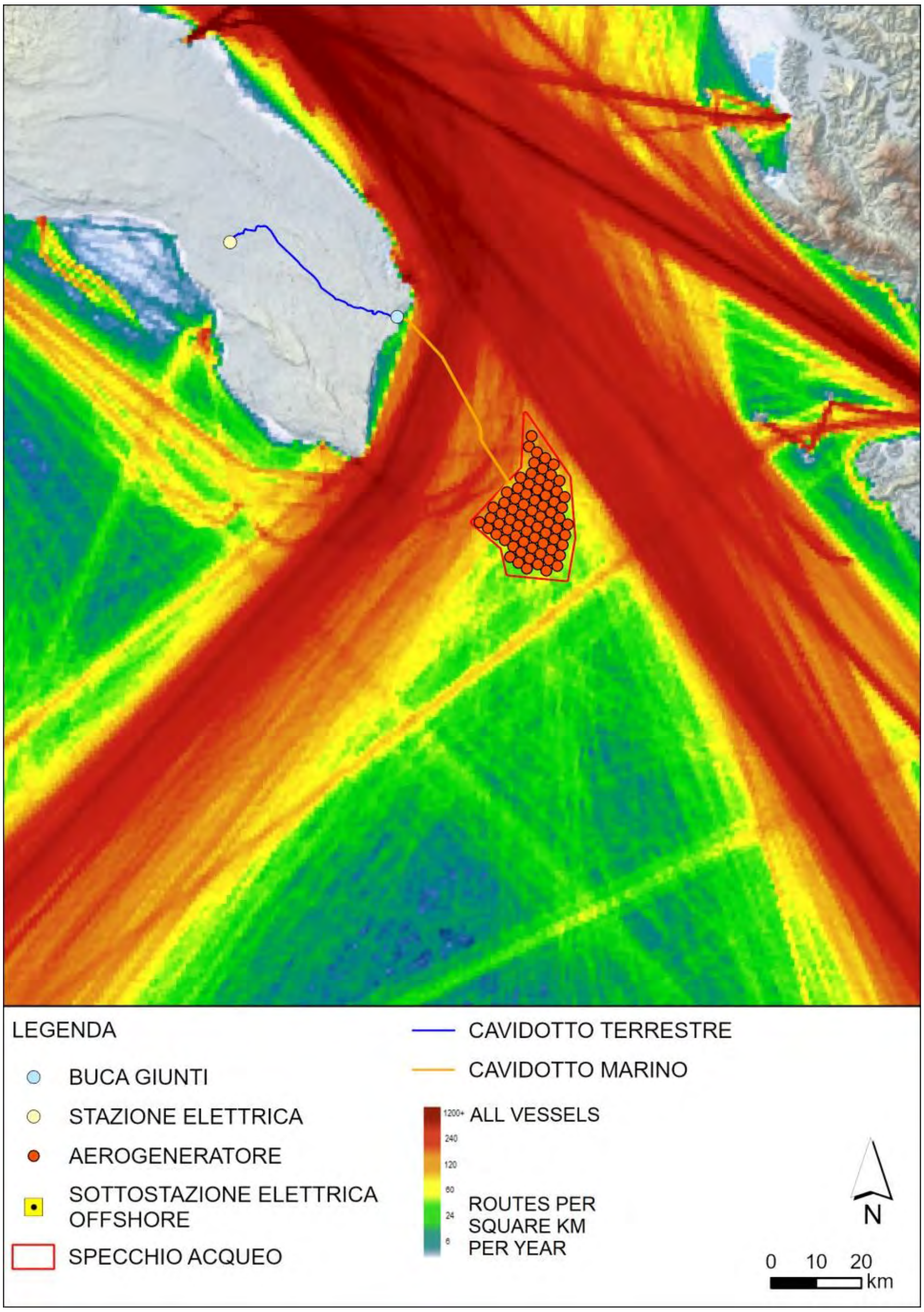
Figure 5-64 Graphical representation of cumulative noise due to human activities in the Mediterranean



Source: Maglio et al., 2015

Figure 5-65 shows maritime traffic based on AIS data from 2019 to 2023.

Figure 5-65 Maritime traffic - Route density



Source: EMODnet Map Viewer, 2024

The generation of underwater noise during wind farm operation is mainly attributable to the transmission of acoustic emissions induced by the rotation of the turbine blades from the air to the aquatic environment and the transmission of vibrations induced by the above-water structure to the submerged structure and, subsequently, by the aquatic environment. The noise generated by the rotation of the blades depends on their speed (higher speeds correspond to higher noise levels) and on the acoustic performance of the installed machine. The transmission of vibrations from the superstructure to the submerged structure is, in turn, a function of the type of foundation and anchoring. To date, few studies are available on the noise produced by floating offshore installations, but most of the data available for fixed-foundation wind farms show that the impact associated with noise production during operation is insignificant. As summarised in Farr *et al. (*2021), operational noise from fixed-foundation wind farms currently in operation is typically within regulatory thresholds, at low frequencies and low intensities, with a likely low risk of impact on marine fauna (Madsen *et al.,* 2006; Thomsen *et al.,* 2015; NYSERDA 2017). Research indicates that operational noise, although continuous and detectable by some marine mammals and fish, is of such low magnitude and intensity that it does not cause physiological damage (Wahlberg and Westerberg 2005; Madsen *et al.,* 2006; Tougaard *et al.,* 2009; Marmo *et al.,* 2013).

The modelled scenarios presented in Marmo *et al. (*2013) predicted that only a small percentage (<10%) of minke whales (*Balaenoptera acutorostrata)* and harbour porpoises (*Phocoena phocoena)* would show behavioural responses up to approximately 18 km away from an OWF, while most of the animals studied would not show a behavioural response, indicating a low potential for displacement. Further monitoring at Horns Rev in the North Sea revealed that operational noise from the OWF had no detectable effect on harbour porpoise abundance (Tougaard *et al.,* 2006). Furthermore, analysis of noise measurements from two fixed-foundation OWFs in Denmark (Middelgrunden and Vindeby) and Sweden (Bockstigen-Valar) concluded that operational noise levels are unlikely to harm or mask acoustic communication in harbour seals (*Phoca vitulina)* and porpoises (Tougaard *et al.,* 2009).

The underwater noise impact study prepared for this Project, with the aim of defining and characterising the source levels associated with the activities planned for the various phases of the wind farm project, showed that underwater noise during the most critical phase of operation is slightly higher than ambient noise only in the vicinity of the turbines; however, noise levels drop to ambient levels (i.e., below an Lp of 111 dB re 1 µPa calculated over 10 seconds) within a few metres of the source.

5.9.1.1 Results of geophysical and environmental monitoring campaigns

During the monitoring campaigns, autonomous recorders were used to monitor acoustic signals for a prolonged period of 24 hours. The noise values obtained from quantitative analyses showed fairly constant trends for each category during the various monitoring campaigns, with a minimum value between 104.6 and 111.3 dB and a maximum value between 131.1 and 150.1 dB. Most of the acoustic energy identified is attributable to the moderate ship traffic detected. The qualitative analysis also showed a uniform acoustic landscape in different seasons, with anthropogenic emissions represented by a few boat passages, rarely in the vicinity of the instruments, and occasional high-frequency emissions attributable to sonar.

In conclusion, the acoustic environment detected does not appear to be particularly affected by anthropogenic noise, which is limited to that produced by ship traffic that seems to be generally distant from the area under investigation. Furthermore, the acoustic landscape appears uniform throughout the seasons in both qualitative and quantitative terms.

5.9.2 Land noise and vibrations

The Municipal Acoustic Classification Plan (PCCA) is the planning tool used to divide the municipal territory into six acoustically homogeneous classes, taking into account the existing land uses already identified by the urban planning instruments in force:

- I - particularly protected areas: this class includes areas where quiet is a basic requirement for their use: hospital areas, school areas, areas intended for rest and recreation, rural residential areas, areas of particular urban interest, public parks, etc.
- II – areas intended for mainly residential use: this class includes urban areas mainly affected by local vehicle traffic, with low population density, limited commercial activity and no craft or industrial activity.
- III – mixed-use areas: this class includes urban areas mainly affected by vehicular or through traffic, with medium population density, commercial activities, offices, limited craft activities and no industrial activities; rural areas affected by activities that use operating machinery.
- IV – areas of intense human activity: this class includes urban areas affected by heavy vehicular traffic, with high population density, a high presence of commercial activities and offices, and the presence of craft activities; areas near major roads and railway lines, port areas, and areas with a limited presence of small industries.
- V – predominantly industrial areas: this class includes areas affected by industrial settlements and with a shortage of housing;
- VI – exclusively industrial areas: this class includes areas exclusively affected by industrial activities and with no residential settlements.

Based on this classification, the limits set out in the Prime Ministerial Decree of 14/11/97 are defined as follows:

- EMISSION LIMIT VALUE: the maximum noise value that can be emitted by a sound source, measured in the vicinity of the source itself;
- IMISSION LIMIT VALUES: the maximum noise value that can be emitted by one or more sound sources into the living environment and the external environment, measured in the vicinity of the receptors;

- QUALITY VALUES: noise values to be achieved in the short, medium and long term with the available remediation technologies and methods, in order to achieve the protection objectives set out in this law.

5.9.2.1 Results of the onshore noise monitoring campaign

In order to characterise the current acoustic climate of the project area, an acoustic monitoring campaign was carried out in April 2024. Based on the data and information collected during specific field inspections, six receptors were identified as suitable for indicating the acoustic climate of the area (Table 5.29 and Figure 5-66).

Table 5.29 Acoustic monitoring points

Measurement station	UTM coordinates 32N - WGS84		Description
	X [m]	Y [m]	
P1	280	4440970	Receiver located in an urban area facing the cable duct route in the municipality of Minervino
P2	276	444203	Receiver located in an urban area facing the cable duct route in the municipality of Guggianello.
P	25	446098	Receiver located in an urban area facing the cable duct route in the municipality of Copertino.
P	249436	445827	Receiver located on a residential development facing the SSE and SE in the municipality of Copertino.
P	2	443947	Receptor located on residential settlement 340m south of the landing place
P7	285041	4439074	Receiver located on residential settlement 120 m north of the landing site

Source: Onshore Acoustic Impact

Figure 5-66 Location of receptors identified in the study area

Source: Onshore Noise Impact

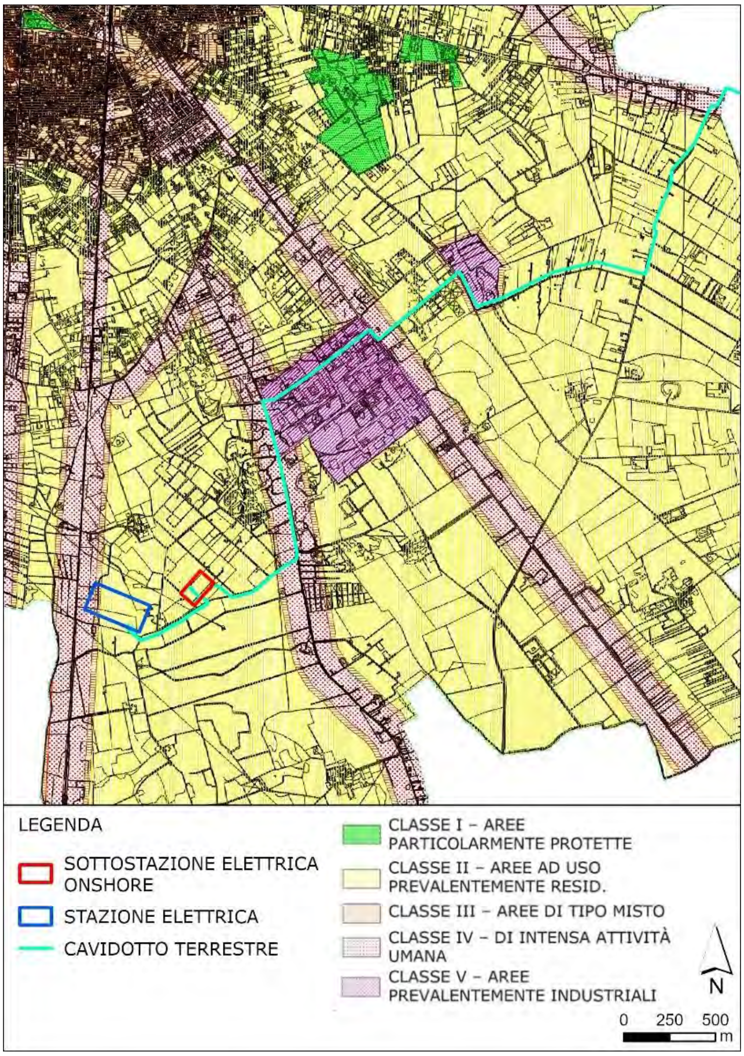
The measured values were compared with the limits imposed by the Acoustic Zoning Plans in the municipalities of Copertino (Figure 5-67) and Lequile (Figure 5-68), or with the limits imposed by the Prime Ministerial Decree of 1991 for areas 'throughout the national territory' where these are not present. In the latter case, a precautionary comparison was also made with a hypothetical Class III limit, considered plausible in the context of the project's development. As can be seen in Table 5.30, all measurements comply with the emission limits imposed.

Table 5.30 Experimental campaign results

Receptor	Acoustic class	Daytime level dB(A)	L90	Daytime emission limit
P1	DPCM 91 / Class III	53.5	32.5	70 / 60
P2	DPCM 91 / Class III	56.4	38.7	70 / 60
P3	Class III	53.6	39.4	60
P4	Class II	53.4	33.5	55
P6	DPCM 91 / Class III	47	34.2	70 / 60
P7	DPCM 91 / Class III	42.6	38.2	70 / 60

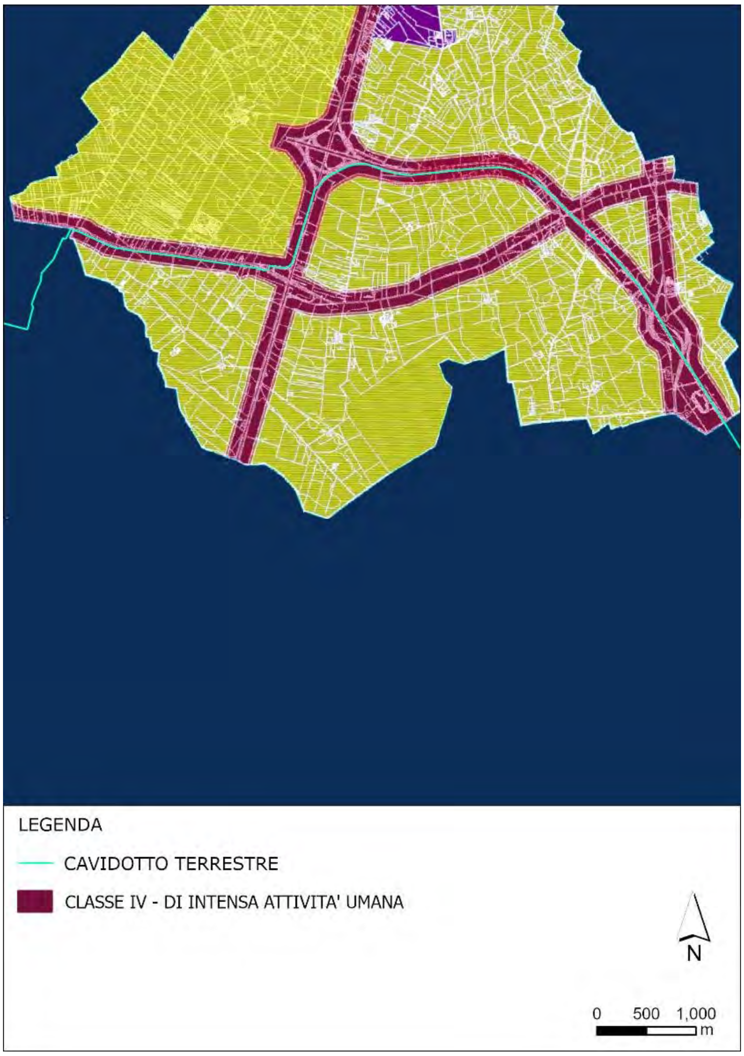
Source: Onshore Noise Impact

Figure 5-67 Acoustic zoning plan for the Municipality of Copertino (SE and OSS area)



Source: Onshore Acoustic Impact

Figure 5-68 Acoustic zoning plan for the municipality of Lequile (area along the underground cable duct)



Source: Onshore Acoustic Impact

5.10 Electric, magnetic and electromagnetic fields and radiation

The electromagnetic field is the field that describes electromagnetic interaction and consists of a combination of electric and magnetic waves. Electromagnetic waves are sinusoidal oscillatory phenomena consisting of two quantities that vary periodically over time: the electric field and the magnetic field. The two fields determine the propagation of an electromagnetic field, regardless of the electric charges and currents that generated them. The transfer of electromagnetic energy can occur both in free space (via the ether) and through appropriate transmission lines – such as waveguides and coaxial cables – capable of confining the radiation and facilitating its transfer.

Non-ionising radiation (NIR) consists of electromagnetic waves with a frequency between 0 Hz and 300 GHz and insufficient energy to ionise the atoms of the exposed material.

Electromagnetic waves of different frequencies interact in different ways with biological systems, such as plants, animals or humans. The biological effects, which are highly dependent on frequency, vary depending on the parameter considered and the target. In particular, studies distinguish between thermal effects, where the target is the whole body or a single organ and the parameter studied is the power absorbed per unit mass, and specific effects, which are studied at the cellular or molecular level (ISS([5])).

Exposure to radiofrequency (RF) electromagnetic fields can cause heating or induce electric currents in body tissues. Heating is the main interaction of high-frequency RF fields above approximately 1 MHz. Below this threshold, the dominant action of RF exposure is the induction of electric currents in the body. Given the correlation between biological effect and emission frequency, it is appropriate to distinguish the following cases:

- Extremely low frequency electric and magnetic fields (ELF – 50-300 Hz): human exposure associated mainly with the production, transmission and use of electricity (high-voltage power lines, household appliances). The fundamental action of these fields on biological systems is the induction of electric charges and currents. Almost none of the electric field penetrates the human body.
- Intermediate frequency fields (ELF – 300 Hz-10 MHz): human exposure is linked, for example, to the use of computers.
- Radiofrequency fields (ELF 10-30 MHz): human exposure is due to the use of devices such as radios, televisions, mobile phone antennas and microwave ovens.

The International Agency for Research on Cancer (IARC) has classified radiofrequency electromagnetic fields (RFEs) as Group 2B carcinogens, i.e. possibly carcinogenic to humans: agents for which there is limited evidence of carcinogenicity in humans and insufficient evidence of carcinogenicity in laboratory animals (IARC, 2002; IARC, 2013).

Despite numerous studies, while the mechanisms underlying thermal effects are well understood, the phenomena related to specific effects are not yet fully clarified. It is therefore not yet possible, according to the WHO, to define with certainty all the possible biological effects of electromagnetic fields. For this reason, the WHO itself, the European Union and numerous international organisations continue to promote specific and comparative studies (ISS[6]).

Law No. 36 of 22 February 2001 (Framework Law on Protection from Exposure to Electric, Magnetic and Electromagnetic Fields) regulates exposure limits to artificial electromagnetic fields, defining exposure limits, attention values and quality objectives.

5 Istituto Superiore di Sanità (ISS), Epicentro: Epidemiology for public health, https://www.epicentro.iss.it/ (2024)
6 Istituto Superiore di Sanità (ISS), Epicentro: Epidemiology for public health, https://www.epicentro.iss.it/ (2024)

The Decree of the President of the Council of Ministers of 8 July 2003 also set exposure limits, attention values and quality objectives for the protection of the population from exposure to electric and magnetic fields at mains frequency (50 Hz) generated by power lines:

- For exposure limits, the exposure limit of 100 µT for magnetic induction and 5 kV/m for the electric field must not be exceeded;
- the attention values for magnetic induction are set at 10 µT, as the median of the values over a 24-hour period under normal operating conditions;
- the quality objective for magnetic induction is set at 3 µT, as the median of the values over 24 hours under normal operating conditions.

In Puglia, electromagnetic fields produced by fixed telecommunications and radio communication systems are subject to continuous monitoring and analysis in accordance with Regional Law No. 5 of 8 March 2002, Regional Regulation No. 14 of 2006, and the Prime Ministerial Decree - 8 July 2003 and subsequent amendments and additions, of the Electronic Communications Code of 1 August 2003 and subsequent amendments and additions.

For high-frequency electromagnetic waves (RF), controls involve surveys of the territory using mobile monitoring units, which carry out continuous measurements lasting approximately 15-30 days, and probes for instantaneous measurements.

For low-frequency electromagnetic waves (power lines), the controls involve measuring both the electric field and the magnetic field. Of the two, the most relevant is the magnetic field which, unlike the electric field, is not shielded by buildings or vegetation. Magnetic field measurements are performed with mobile monitoring units that measure the intensity for several consecutive days. Specific probes are also used for instantaneous measurements of both the electric and magnetic fields (ARPA Puglia([7]) ,ARPAV([8])).

Monitoring conducted by ARPA Puglia, including several in Maglie, did not detect any exceedances of the legal limit of 20 V/m. In no case was the attention value of 6 V/m exceeded (Figure 5-69). Furthermore, it is important to note that the intensity of the magnetic field decreases rapidly with distance: at a distance of between 50 m and 100 m, the intensity of the electromagnetic field is in fact usually the same as that detected in areas far from high-voltage power lines (CNR([9])).

7 ARPA Puglia, arpa.puglia.it (2024)
8 ARPA Veneto, arpa.veneto.it (2024)
9 CNR, niremf.ifac.cnr.it (2024)

Figure 5-69 Map of electromagnetic field monitoring conducted by ARPA Puglia in the Area Vasta

Source: ARPA Puglia, 2009

The marine environment is also characterised by the presence of electric and electromagnetic fields of both natural and anthropogenic origin. Boats and electrical and telecommunications cables are the main sources of anthropogenic electromagnetic fields (Hutchison *et al.*, 2020).

Electric cables installed in the marine environment emit a 50 Hz magnetic field that decreases in intensity very rapidly as the distance from the cable increases. This magnetic field induces a low-value electric field. As a result, only biotic communities in the immediate vicinity of the cable are likely to be exposed to the magnetic field.

Furthermore, electric fields increase with increasing voltage and can reach 1000 µV/m for an electric cable (Gill and Taylor, 2001), but are generally effectively confined within the cables by the armouring. The characteristics of electromagnetic fields depend on the type of cable (distance between conductors, load balance between phases in the cable, etc.), power and type of current (direct or alternating current).

When the electrical cable is buried, the sediment layer does not completely eliminate the electromagnetic field generated, but reduces the intensity of the electromagnetic field, which is greater in direct contact with the cable (CMACS, 2003).

The strength of the induced magnetic and electric fields increases proportionally with the current flow and decreases rapidly with distance from the cable (Normandeau Associates Inc 2011). Electric currents with intensities of 1600 A are common in submarine cables. As a result, magnetic fields of approximately 3200 µT are generated, decreasing to 320 µT at a distance of 1 m, 110 µT at 4 m and values similar to those of the Earth's magnetic field (50 µT) already at 6 m (Bocher and Zettler, 2006).

Based on the data available to date, there is no evidence of electromagnetic fields (EMFs) associated with marine renewable electricity generation having an impact (positive or negative) on wildlife species in the Area Vasta (Copping 2018).

However, several globally distributed marine fauna species are known to be sensitive to electromagnetic fields, including:

- elasmobranchs (rays and sharks);
- bony fish;
- marine mammals;
- sea turtles;
- molluscs;
- crustaceans.

In fact, it is well known that most of these animals use the Earth's geomagnetic field for orientation and migration (Lohman and Ernst, 2914). Elasmobranchs, for example, can detect electric fields and magnetic fields of even very low intensity (Bochert and Zettler, 2006). Electric cables that produce high-intensity magnetic fields can repel many species of elasmobranchs, altering or preventing certain movements between areas of ecological importance for the species (such as feeding, mating and breeding areas). As for bony fish (teleosts), it has been shown that some species use electromagnetic fields to guide their migrations, such as eels (*Anguilla anguilla)*, which appear to modulate their swimming speed according to the intensity of the Earth's magnetic field (Westerberg and Lagenfelt, 2008). Furthermore, according to the guidelines

According to the OSPAR (2012) guidance, marine teleost fish show physiological reactions to electric fields at minimum field intensities of 7 mV/m and behavioural responses at 0.5-7.5 V/m (Poleo et al. 2001).

With regard to invertebrates, data are scarce except for a few studies on minor or insignificant impacts of anthropogenic electromagnetic fields on benthic invertebrates (Bochert and Zettler, 2006).

With regard to the possible effects on marine mammals, sea turtles and pelagic species in general, there is a general lack of data that does not allow for the quantification and assessment of the possible impacts of electromagnetic fields on species potentially present in the area affected by the cable laying. The only marine mammal currently known to show any response to electromagnetic fields is the Guiana dolphin (*Sotalia guianensis),* which has been shown to possess an electroreceptive system that uses vibrissae crypts on its rostrum to detect electrical stimuli such as those generated by small and medium-sized fish (Czech-Damal et al. 2013); it should be noted that this species is widespread along the coasts of South America and therefore not in the Vasta Area.

In conclusion, the presence of electromagnetic fields can potentially interfere with the most sensitive marine fauna species, with particular attention to benthic and demersal organisms living in the lower layers of the water column, near the bottom.

The consequences of electromagnetic fields may include the following effects:

- effects on predator/prey interactions;
- repulsion/attraction effects and other behavioural effects;
- effects on the navigation/orientation abilities of species;
- physiological and developmental effects.

5.10.1 Results of geophysical and environmental monitoring campaigns

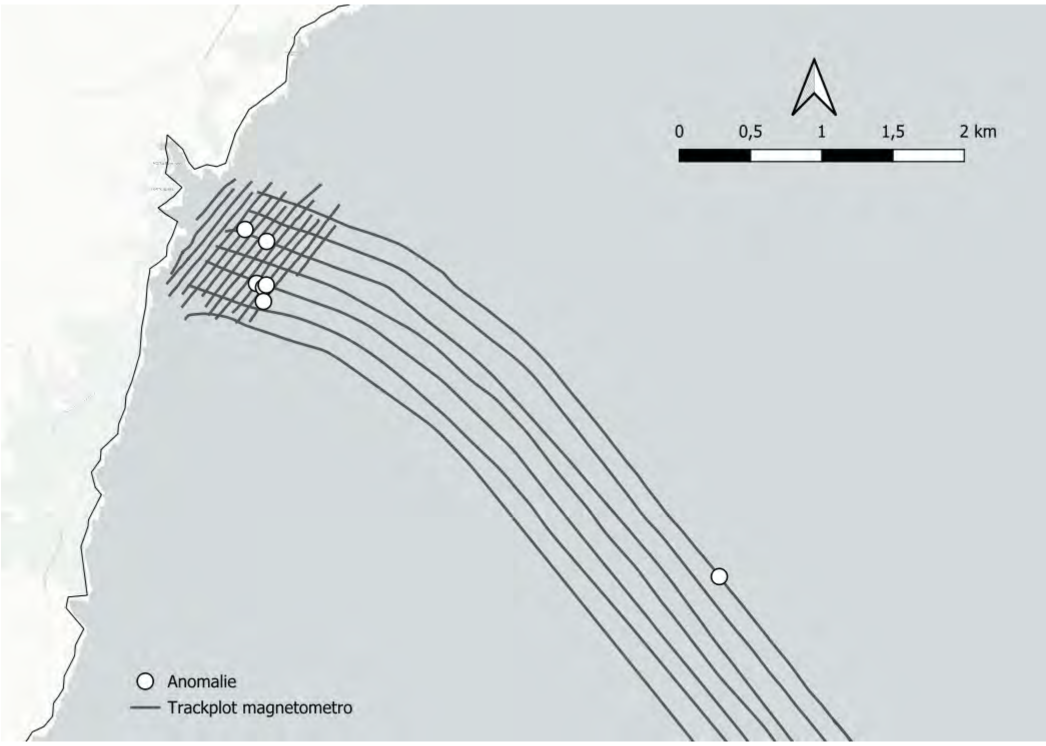
During monitoring carried out in April (nearshore area) and June (offshore area) 2024, a series of magnetic anomalies were identified.

In the nearshore area, seven anomalies were detected, six of which were within -60 m depth (nearshore sector and shallowest section of the ECC) and one at approximately 96 m WD (along the ECC). The gamma values ranged from 2.3 µT to 16.4 µT.

In the ECC sector, several areas were observed where the magnetometric signal was disturbed. The origin of this disturbance is presumably linked to the possible presence of upwelling structures, associated with the presence of salt diapirs or exhausted gas upwelling phenomena.

An overview of the magnetic anomalies identified is shown in the figure below.

Figure 5-70 Location of magnetic anomalies and areas with diffuse signal disturbance in the nearshore area

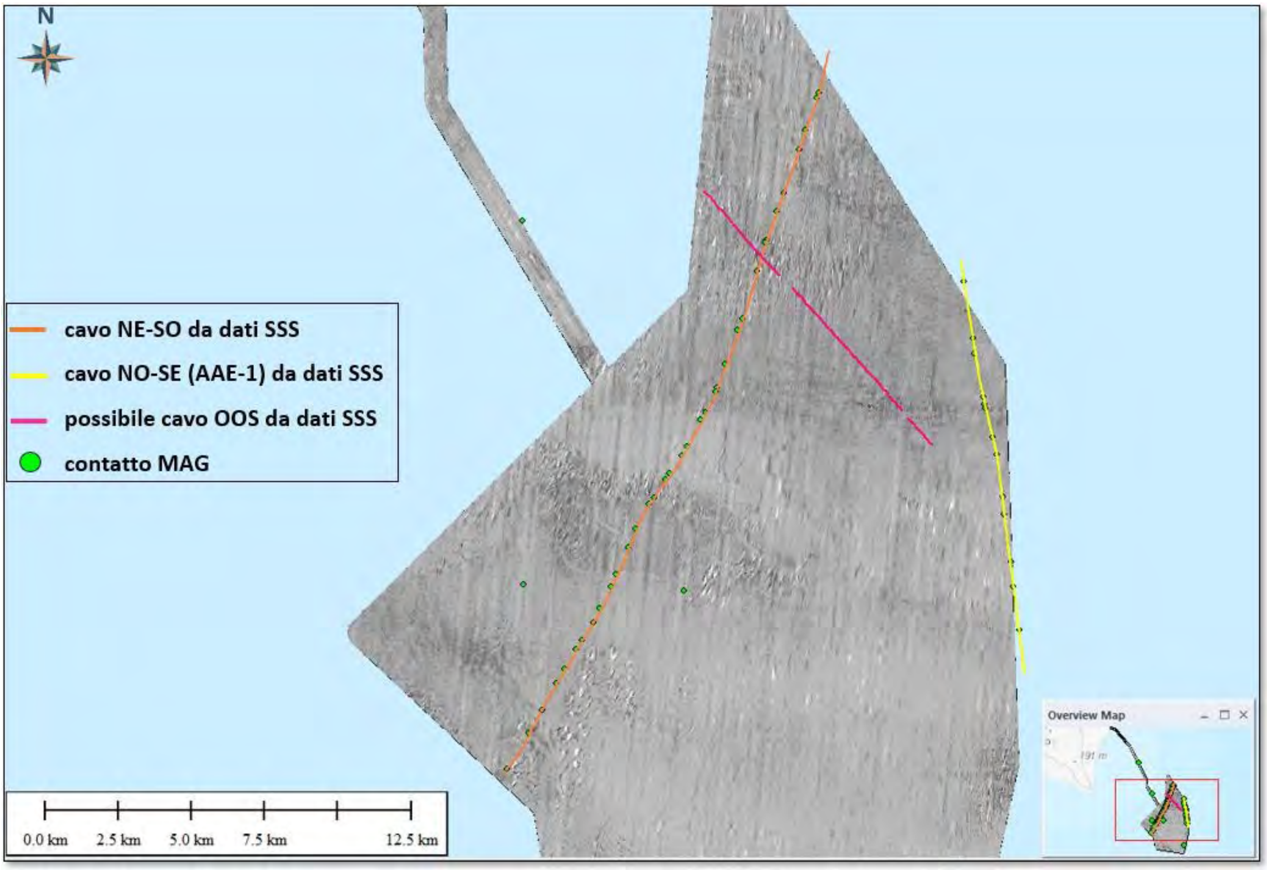


Source: Nearshore Sector - Geophysical and Environmental Surveys

For the offshore area, most anomalies are related to the presence of submarine cables. Both the sonograms and the magnetometer data revealed the presence of three very continuous features that were interpreted as cables, two of which are in service (cutting across the area approximately from N to S, one of which was identified as AAE_1) and one out of service and partially severed (cutting across the area approximately E-W).

In the ECC sector, a magnetic anomaly identified as a wreck has been detected. It is a monopole with an amplitude of 225.8 m and is equal to approximately 2.6 nT. The Offshore Sector - Geophysical and Environmental Survey shows a comparison between the MAG contacts and the cable layout identified in the offshore sector using SSS. It can be seen that, in addition to the NE-SO and NO-SE cables (AAE-1), there is also a third cable which, however, did not show any magnetic anomalies; for this reason, it is assumed to be an old cable that is out of service and partially severed.

Figure 5-71 Comparison between MAG contacts identified and cable traces as identified on SSS data in the offshore sector.



Source: Offshore Sector - Geophysical and Environmental Survey

The NO-SE cable crosses the OWF along the eastern edge for approximately 12 km; the information available online would seem to confirm that the cable in question is the AAE-1 (Asia-Africa-Europe 1), and in particular the segment landing in Bari. The infrastructure is the result of collaboration between several telecommunications companies and global network operators, the largest of which are China Unicom, Etisalat and Telecom Egypt.

5.11 Flora and fauna

The Project Area includes the Southern Adriatic and Northern Ionian Sea, with a focus on the stretch of sea off the Apulian coast between the municipalities of Otranto and Castrignano del Capo, both in the province of Lecce.

5.11.1 Marine biodiversity

5.11.1.1 Marine habitats and benthic communities

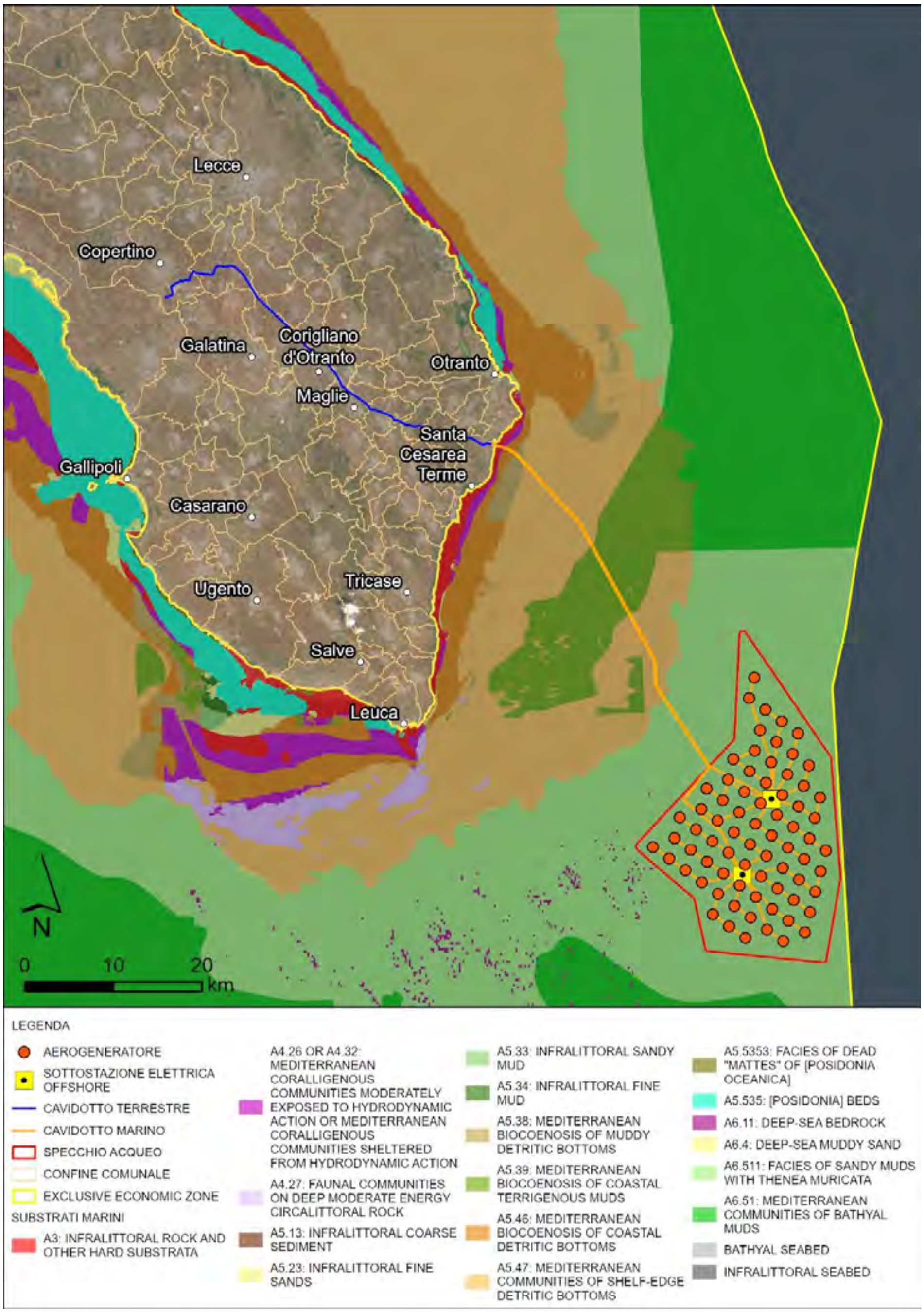
The Southern Adriatic is characterised by a sub-planar seabed with a maximum depth of approximately -1200 m, which is mainly muddy (EMODnet, 2022). The continental shelf break is located at a variable distance between 20 km and 36 km from the Italian coast and at a depth of approximately -200 m.

The best possible detail of the distribution of benthic habitats in the Project Area from bibliographic data is represented by the map that can be downloaded from the EMODnet portal. By superimposing the Project Area on the EUSeaMap 2021 map (broad-scale seabed habitat map for Europe) according to the EUNIS 2007 classification, six habitats are found (Figure 5-72) (for each habitat, the corresponding code according to the classification drawn up by the RAC/SPA is reported):

- **Infralittoral rocks (MB1.5 - Infralittoral rock):** infralittoral rocks include habitats characteristic of rocky bottoms, outcrops, boulders or pebbles, found in the shallow subtidal zone and generally hosting communities of algae.
- **Coralligenous communities (MB1.55 - Coralligenous; MC1.51 - Coralligenous):** this refers to coralligenous concretions found on rocky substrates where calcareous algae can build biogenic structures. These communities are present in the Mediterranean on hard and/or biogenic rocky substrates at depths of -10-100 m with low hydrodynamic action.
- **Coastal detritus bottoms (MC3.5 - Coastal detrit bottoms; Circalittoral coarse sediment**): these communities are found on a substrate whose nature has a different origin and depends largely on the morphology of the coast and nearby infralittoral formations. The substrates can therefore be gravel and sand from the predominant local rocks, shell debris, and more or less corroded debris from branched bryozoans. The interstices between these various components are characterised by a greater or lesser percentage of sand and mud.
- **Muddy detrital bottoms (MC4.51):** this biocoenosis develops in areas where a detrital bottom is covered by mud formed by terrigenous deposits from rivers. The sediment is very muddy sand or sandy mud, or even fairly compacted mud, rich in shell debris or volcanic fragments (scoria); sedimentation is slow enough to allow the development of sessile epifauna. Gravel, sand and mud are mixed in varying quantities, but mud always predominates.
- **Shelf-edge detrital bottoms (MD3.51 - Shelf_edge detritic bottoms; offshore circalittoral detritic bottoms):** These communities are found in detrital bottoms with an abundance of dead shells, bryozoans and coral skeletons.
- **Coastal terrigenous muds (MC6.51):** the sediment is always pure mud, more or less clayey, almost always of fluvial origin. Any coarse debris deposited is quickly covered, with the result that no epifauna develops.

The Project Area falls mainly on muddy seabeds mixed with sand, while the cable corridor
It intersects a rocky area with coralligenous formations in the shallower bathymetric zones (within -30 m depth).

Figure 5-72 EUSeamap 2021 habitat mapping according to the EUNIS 2007 classification.



Source: EUSeamap, 2024

As regards the vegetation component, the 'Inventory and mapping of Posidonia meadows in the maritime compartments of Manfredonia, Molfetta, Bari, Brindisi, Gallipoli and Taranto' does not report the presence of Posidonia in the Project Area.

Results of the geophysical and environmental monitoring campaigns

As presented in chapter 5.5.2.1, the results of geophysical and environmental surveys showed that the nearshore sector is characterised by a composite morphology consisting of alternating rocky areas (outcrops and sub-outcrops) and an extensive coralligenous biocoenosis, with more regular (sandy) areas where bottom forms and incisions are not very developed. The benthic habitats present include infralittoral rocky reefs dominated by photophilic macroalgae (MB1.51; MB1.51a), coarse sand under the influence of bottom currents (MB3.51), infralittoral sand (MB5.5; MB5.52), circalittoral rocky reefs with coralligenous (MC1.5; MC1.51), and muddy detrital bottoms (MC3.51). The alphanumeric codes used refer to the Barcelona Convention and the manuals of the Specially Protected Areas Regional Activity Centre (SPA/RAC) (SPA/RAC-UN Environment/MAP, 2019; Montefalcone et al., 2021). Figure 5-73 shows the habitats highlighted only in the section closest to the coast, which is avoided by laying the cables with TOC.

The visual survey using ROVs for the first four transects (from MES_TR_01 to MES_TR_04) shows the presence of large rock structures hosting the coralligenous habitat in the deepest parts, where it is possible to detect some organisms characteristic of this habitat, such as various species of poriferans and coralline algae.

In the infralittoral zone, down to a depth of 20 m, the rocky reefs are dominated by photophilic brown algae such as *Cystoseira* spp., *Ericaria* spp., *Padina pavonica*, *Dictyota dichotoma*, *Halopteris scoparia*, polychaetes such as *Sabella spallanzanii* and red algae such as *Ceramium virgatum*. Between -20 and -45 m depth, the continental shelf continues with a mosaic of coastal detritus and rocky outcrops, which, passing into the circalittoral zone, become characterised by coralligenous populations. Among the various small rocky outcrops with coralligenous, sandy bottoms can be found, ranging from coarse to fine, with a relatively low number of conspicuous species evident on the bottom but normally associated with a high overall diversity in the infauna component.

Along the export cable corridor, starting from the -100 m bathymetric line to the wind farm area, the biocoenosis of coastal terrigenous mud has been highlighted, with a seabed that slopes down to the continental slope and shows numerous traces of trawling (Figure 5-73). The identified biocoenoses include open sea circalittoral sands (MD5.5), circalittoral muds (MD6.5) and bathyal muds (MF6.5) (Figure 5-73).

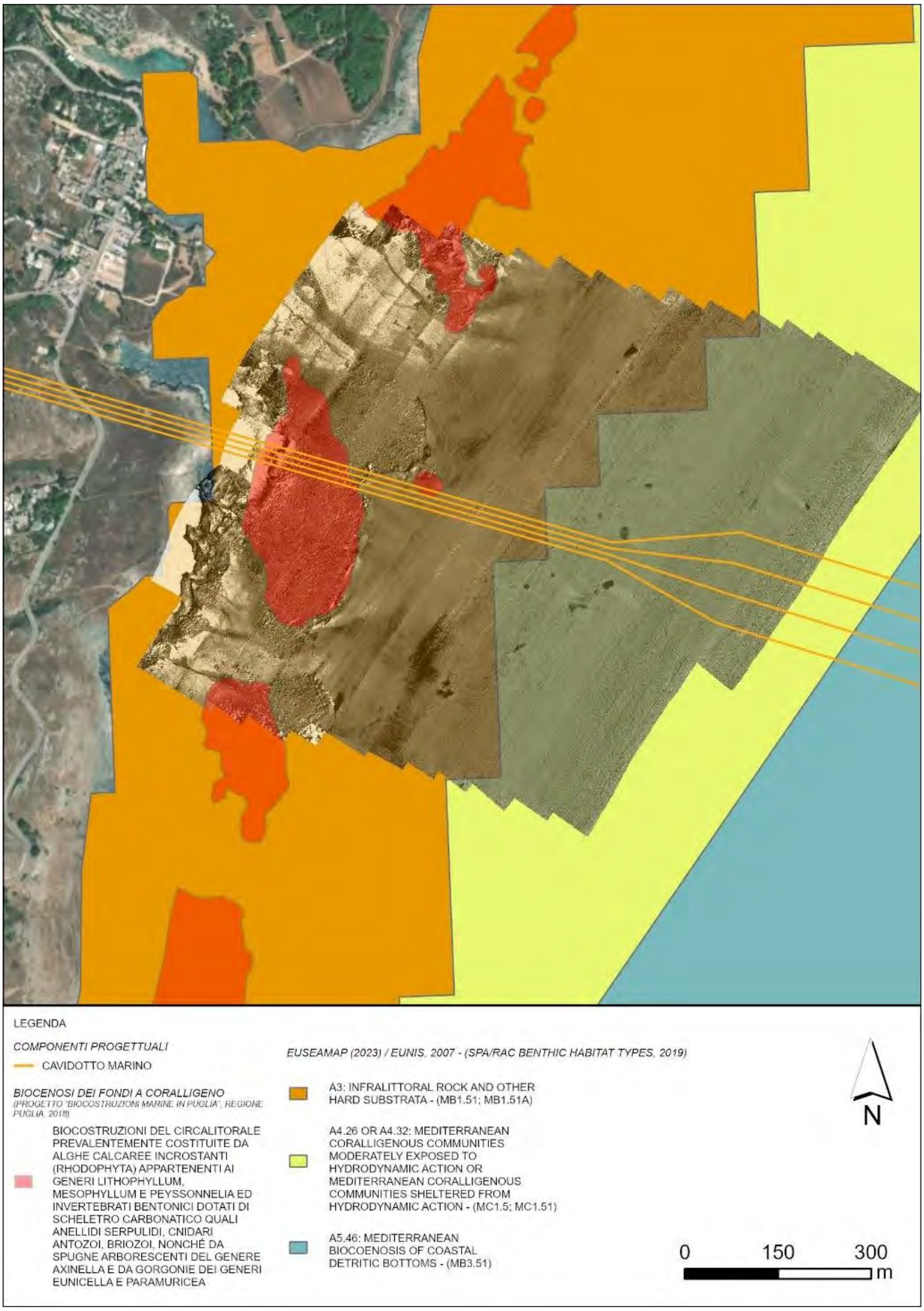
In the wind farm area, the predominant biocoenoses are those typical of the bathyal plains of circalittoral muds (MD6.5) and the SSS and MBES revealed sporadic areas with rocky outcrops indicating biogenic habitats of bathyal rocky bottoms (ME1.5, dominated by invertebrates ME1.51) and habitats of the upper bathyal (ME2.4) and lower (MF2.5) zones. Figure 5-74 Figure 5-75 shows the results of the

Slightly overlapping SSS and MBES geophysical surveys showing the relative homogeneity of the area of the wind farm with predominantly sandy seabeds and areas with rocky relief.

The habitats were confirmed by video footage taken with ROVs along five transects (Figure 5-43) in accordance with Ministerial Decree 24/01/96 and Legislative Decree 152/2006 and ISPRA guidelines. In addition, specific archaeological targets were inspected. The surveys report a predominantly sandy/silty seabed typical of the habitat of bathyal mud, characterised by deep-water species such as *Funiculina quadrangularis,* several species belonging to the order *Pennatulacea and* the pencil urchin (*Stylocidaris affinis)*. The sandy seabed is sporadically interspersed with rocky outcrops colonised mainly by Serpulidae and Porifera and by 'Scleractina facies' characterised by the colonial madreporarian *Madrepora oculata.* There are also numerous abandoned fishing nets and some fish such as *Zeus faber and* numerous horse mackerel (*Trachurus trachurus).*

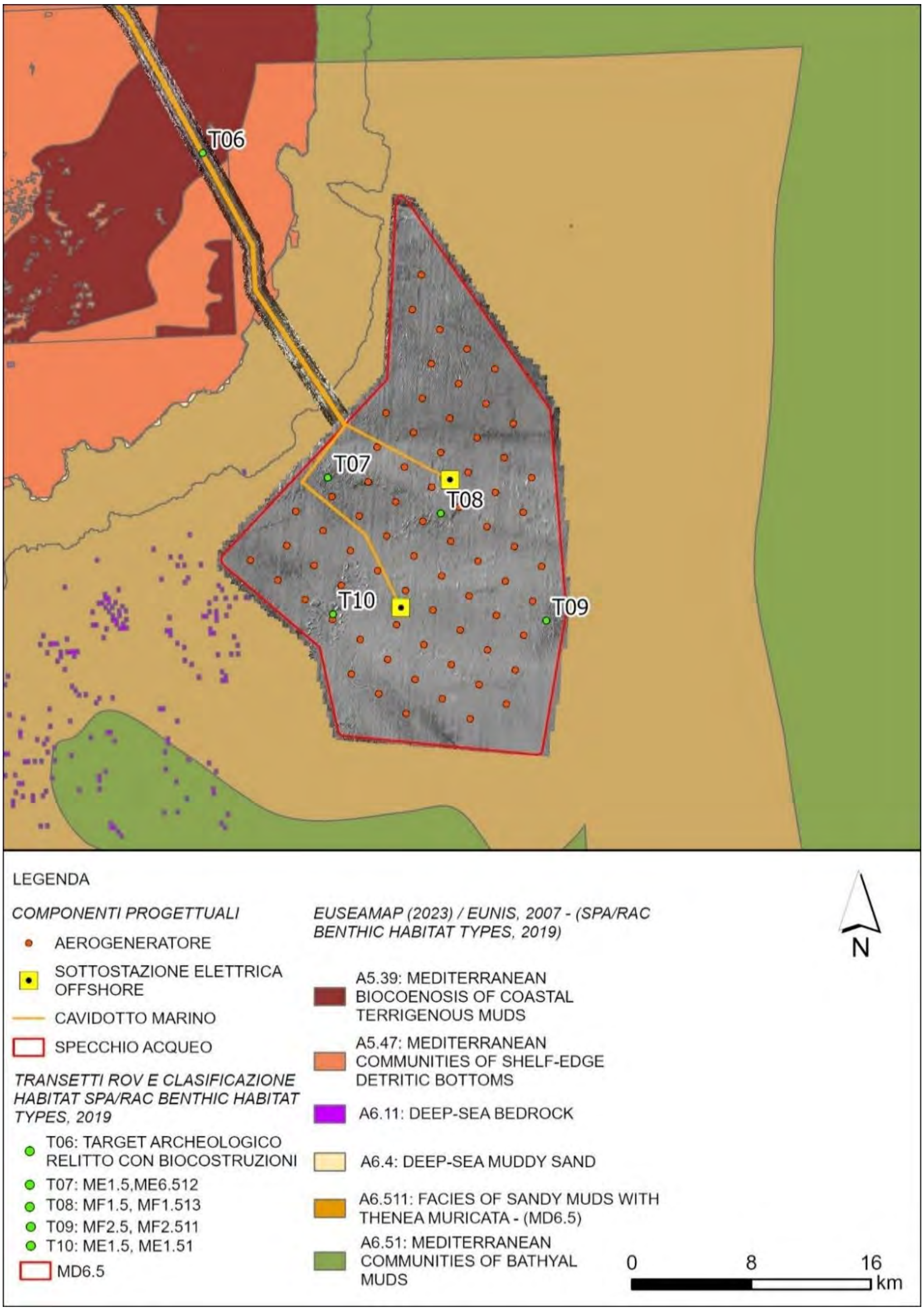
From a biological point of view, archaeological surveys have reported the presence of hydrozoans, bivalves and sponges (*Aplysina*) on the surface of the wreck. There are also numerous entangled and abandoned fishing nets.

Figure 5-73 Habitats present in the coastal section of the export cables



Source: Nearshore Sector - Geophysical and Environmental Survey, EMOdnet, 2024, and SPA/RAC Benthic Habitat Types, 2019 and Puglia Region, 2018.

Figure 5-74 Habitats present in the offshore wind farm area



Source: Offshore Sector - Geophysical and Environmental Survey , EMOdnet, 2024, 2024 and SPA/RAC Benthic Habitat Types, 2019 and Puglia Region, 2018.

In addition to habitat characterisation using SSS, MBES and ROV video, sediment sampling was carried out to characterise the macro-benthic communities. In the nearshore area, material was collected using a Van Veen grab at 10 stations (Figure 5-42) and samples were taken both for the characterisation of the macro-benthic community (3 replicates for each station) and for chemical, ecotoxicological and microbiological analyses (with one replicate for each station).

The following taxa were identified from observations, as shown in Table 5.31. The macrozoobenthic community is dominated by the class Polychaeta, which accounts for 56% of total diversity, with representatives of the families *Lumbrineridae, Spionidae, Eunicidae, Glyceridae, Cossuridae, Cirratulidae, Capitellidae, Paraonidae, Onuphidae, Syllidae, Sternapsidae, Nephtyidae, Polynoidae, Maldanidae, Orbinidae, Nereididae, Terebellidae, Pilargidae, Phyllodocidae, Goniadidae, Sigalionidae and Aphroditidae.* Other abundant taxa are the subphylum *Crustacea (*14%) and the family *Sipunculidae (*13%).

Table 5.31 Taxa found in the macrozoobenthic community analysis in the nearshore sampling stations

	ST1	ST	ST	ST	ST	ST6	ST7	ST8	STG	ST10
Onuphidae	5.00	5.5	0.0	0.00	0.00	0.00	0.00	0	0	0.00
Polychaeta	1.67	10.00	0.50	1.33	2.00	1.50	1.00	1.33	3.33	3.67
Cirratulidae	0.00	2.00	1.0	0	0	0	1.00	1.33	1.00	0
Glyceridae	2.67	2.50	0.5	0.67	1.00	1.50	1.33	0.67	1.67	2.00
Goniadidae	0.33	0.00	0.00	0.0	0.00	0.00	0	0	0	0.00
Pilargidae	1.0	0.5	0	0	0.00	0.00	0.00	0	0	0.00
Polynoidae	0	1.5	0	0	1.0	0	0.00	0.00	0.00	0.00
Capitellidae	0.33	4.5	0	0	0.5	1.00	0.00	0.33	0.00	0.00
Paraonidae	0.33	2.00	0.50	0.33	0.5	0.00	0.33	0.00	0.00	0.33
Orbinidae	1.33	0.00	0	0.0	0.00	0.00	0.33	0.00	0.00	0.00
Maldanidae	0.33	1.50	0	0	0.00	0.50	0.00	0.00	0.33	0.00
Spionidae	0.33	2.00	0.00	0.33	1.5	1.50	3.00	3.00	4.33	1.67
Syllidae	0.33	5.00	0.00	0.00	0.5	0.00	0.00	0.33	0.00	0.00
Terebellidae	0.	2.0	0	0	0	0	0.00	0.00	0.33	0.00
Cossuridae	0	0.50	1.00	0	1.0	0.50	0.33	0.67	0.00	1.00
Sigalionidae	0.00	0.50	0	0	0	0.00	0.00	0	0	0
Lumbrineridae	0.33	5.00	2.00	2.00	1.00	1.00	1	2.33	2.00	3
Phyllodocidae	0.00	2.50	0	0	0	0.00	0.00	0	0	0.
Nephtyidae	0	3.0	0	0	0	0	0.00	0.33	1.33	0.
Eunicidae	0.00	9.00	0.00	1.33	0.5	0.50	0.33	1.00	3.33	5.33
Nereididae	0.00	0.5	0.00	0.33	0	0.00	0.00	0.00	0.00	0
Aphroditidae	0	0.50	0	0	0	0.00	0.00	0	0	0
Sternapsidae	0	0	0.50	0	0.5	0	0	0.00	0.33	0.33
Sipunculidae	4	6.00	1.5	2.00	0.50	1.00	1.33	5.33	5.67	5.33
Decapoda	0.67	1.50	1.00	0.00	0.5	0.00	1.00	0.33	1.67	0.00
Brachyura	0.33	0	0.00	0.00	0.00	0.50	0.33	1.00	0.00	0.67
Paguroidea	0.00	0.5	0	0	0	0.00	0.00	0	0	0
Amphipoda	13.67	3.00	0	0	0.5	0.00	0.67	0.67	0.67	0.00
Tanaidacea	2.33	5.00	0.50	0	0.00	0.00	0.00	0.67	2.33	2.33
Copepoda	0.33	0.50	0	0	0.5	0.00	0	0	0.00	0.33
Isopoda	0.33	1.50	0	0	0.00	1.00	0.00	0	0.00	0
Cumacea	0.33	0.50	0	0	0	0.00	0.00	0	0	0
Gastropoda	0.67	1.00	0.50	0.33	0.50	0.00	2.00	0.33	0.33	0.00
Bivalvia	2.33	10.00	2.50	0.67	1.00	0.00	1.67	1.00	0.00	0
Ophiuroidea	0.67	5.5	0	0	0.00	0.50	0.00	0.67	0.00	0.00
Holothuroidea	0	0.00	0	0	0.00	0	0	0	0.00	0.33
Nematoda	3.00	5.50	0.0	0	0.00	0.00	1.67	0.00	0.33	1.00
Ostracoda	2.33	0.00	0.00	0.00	0.00	0.00	0	0	0	0.00
Branchiostoma	1.00	0.	0.00	0	0.0	0	0	0	0	0
Nemertea	0.33	6.00	0	0.00	1.00	1.00	0.33	0.33	0.67	0.00
Scaphopoda	0.33	1.00	0.00	0.00	0	0.00	0	0	0	0

Source: Nearshore Sector - Geophysical and Environmental Surveys

In the offshore sector, sampling of organisms belonging to the macrozoobenthos community was carried out using box corers. Three replicates (i.e. three box corer drops) were performed at each station; each of these was screened through special 500 µm mesh sieves (lower limit of macrobenthos size) and the retained material was placed in 1 litre jars with ethanol in a 1:3 ratio.

In addition, the macrozoobenthic communities of the sediments were analysed, from which the taxa listed in Table 5.32 were identified. The macrozoobenthic community is dominated by the Sipunculidae family at stations M11, M12 and M13, i.e. at the shallowest stations (approximately -100 m). An unusual peak in bivalves was also observed at station M11. Stations M14 and M15, at depths of -608 m and -754 m respectively, were the least diverse and least abundant, as expected.

Subsequently, the disturbance of the macro-zoobenthic communities was classified using the AMBI and M-AMBI indices. The AMBI index expresses the degree of ecological disturbance by calculating the proportion of sensitive, tolerant and opportunistic species present in the samples. There are five possible levels: no disturbance, slight disturbance, moderate disturbance, heavy disturbance and extreme disturbance.

It appears that stations M11 and M13 fall into the 'moderately disturbed' classification, while station M12 is 'slightly disturbed' and stations M14 and M15, the deepest, are 'heavily disturbed'. These results are also confirmed by the calculation of the M-AMBI index, which showed an 'elevated' ecological quality ratio (EQR) only at station M12 and 'poor' at station M15. These results therefore show lower biodiversity in the macrozoobenthic community, as expected at greater depths.

Table 5.32 Taxa found in the macrozoobenthic community analysis at the sampled stations

	St. M11	St. M12	St. M13	St. M14	St. M15
Sipunculidae	60	40	90	0	3.3
Polychaeta ind.	10	0	10	3.33	0
Paraonidae	6.67	0	0	0	0
Onuphidae	0	0	6.67	3.3	3.3
Capitellidae	0	3.3	0	0	0
Eunicidae	3.33	10	0	3.33	0
Glyceridae	3.3	3.33	0.00	0.00	0
Lumbrineridae	0	10	0	0	0
Spionidae	0	3.33	0	0	0
Cirratulidae	3.33	0	0	0	0
Amphipoda	3.3	6.67	3.3	3.33	0
Isopoda	0	0	3.33	0	0
Copepoda	3.3	6.67	0	0	0
Crustaceans ind.	3.33	0	0	0	0
Ophiuroidea	0	0	3.33	0	0
Oligochaeta	0	3.33	0	0	0
Gastropoda	0	3.33	0	0	0
Bivalves	663.33	3.33	0	6.67	0

Source: Offshore Sector - Geophysical and Environmental Survey

Finally, during the environmental monitoring campaign, environmental DNA (eDNA) analysis was carried out at four nearshore stations (Stations 1, 2, 5 and 8, Figure 5-42) and four offshore stations (Stations M11, M12, M14 and M15 in Figure 5-43) in order to draw up a list of species present in the Project Area. The eDNA from the water was collected by filtering 10 l of water (2 aliquots of 5 l for each station), while the eDNA from the sediments was collected by taking two 2-l jars filled with ¼ sediment and ¾ ethanol.

All samples were collected, refrigerated on board and subsequently taken to the laboratory in accordance with national legislation (Ministerial Decree 24/01/96 and Legislative Decree 152/2006) and ISPRA guidelines.

For nearshore stations, the two databases relating to 18S and cytochrome oxidase I (COI) provide two different community descriptors: using 18S, it was possible to classify the stations based on the eukaryotic species present. The metabarcoding data relating to 18S in the water matrix show a high level of biodiversity in all stations with high alpha diversity (Shannon index) in all stations. Analysis with the 18S marker identified a total of between 75 and 87 eukaryotic species (station ST9 with the highest number of annotated species), which were grouped into 10 kingdoms containing species (belonging to different phyla, classes and orders) mainly from phyto-/zooplankton. Alignments with the SILVA database allowed the identification of animal species belonging mainly to Annelida and Arthropoda.

With regard to the analysis of sediment eDNA, despite the complexity of the matrix and the low number of species recorded, the stations showed a good level of biodiversity, with some species of particular interest, including fungi. A non-native species was also identified, namely the polychaete *Aricidea wassi (*shared by almost all stations), a species of Atlantic origin that is expanding in the Mediterranean.

Unlike the nearshore sediment samples (Stations 1, 2, 5, 8), where the extracted DNA was amplifiable and sequenceable with the 18S marker in most samples, the DNA extracted from offshore sediment samples (M11, M13, M14, M15) was not amplifiable (and therefore not sequenceable) with the 18S marker.

Considering that the samples were extracted using the same extraction protocol used for the nearshore samples, the lack of amplification could be due to the different grain size of the sediment itself, which in the case of the latter sediments was found to be extremely rich in fine particulates. The M13OF water sample was also found to be non-amplifiable with the 18S marker.

The two databases relating to 18S and cytochrome oxidase I (COI) provide two different descriptors of the communities: through 18S, it was possible to classify the stations based on the eukaryotic species present, while with the mitochondrial gene, it was possible to characterise the stations based on the fish communities.

The metabarcoding data relating to 18S in the water matrix show a high level of biodiversity in all stations with an alpha diversity (Shannon index) always >5.

Analysis with the 18S marker allowed the identification of a total of between 31 and 49 eukaryotic species (station ST9 with the highest number of species recorded), which were grouped into 10 kingdoms containing species (belonging to different phyla, classes and orders), mainly from phyto-/zooplankton, as well as probable pelagic stages of benthic species.

Alignments with the SILVA database allowed the identification of animal species belonging mainly to Annelida, Arthropoda, Cnidaria and Ctenophora. No alien species (NIS) were detected among the species identified using the 18S marker.

In conclusion, eDNA analysis of water samples revealed high levels of biodiversity at all stations with slight differences.

In conclusion, in the nearshore area, the Polychaeta class represents 56% of total diversity. Metabarcoding data for 18S in the water matrix show a high level of biodiversity at all stations, with high alpha diversity (Shannon index) at all stations. A non-native species was also identified, namely the polychaete *Aricidea wassi,* a species of Atlantic origin that is expanding in the Mediterranean.

Biological surveys in the offshore area have revealed a predominantly sandy/silty seabed typical of the habitat of bathyal mud. The sandy seabed is sporadically interspersed with rocky outcrops colonised mainly by Serpulidae and Porifera and by 'Scleractinia facies'. Numerous abandoned fishing nets have also been reported. Archaeological surveys carried out from a biological point of view report the presence of hydrozoans, bivalves and sponges (*Aplysina)* on the surface of the wreck. The shallower stations were dominated by the Sipunculidae family, while the deeper stations were less diverse and less abundant. Furthermore, stations M11 and M13 fall into the 'moderately disturbed' classification, while station M12 is 'slightly disturbed' and stations M14 and M15, the deepest, are 'heavily disturbed'. These results are also confirmed by the calculation of the M-AMBI index, which showed a 'high' ecological quality ratio (EQR) only at station M12 and 'poor' at station M15. Finally, eDNA analysis of water samples showed high levels of biodiversity at all stations with slight differences.

5.11.1.2 Plankton

Plankton consists of all aquatic organisms that float in the water column and cannot move in a direct direction. Plankton can be divided into phytoplankton (plant organisms) and zooplankton (animal organisms) and, by size, into:

- Femtoplankton (0.02 µm – 0.2 µm), consisting of viruses and bacteria;
- Picoplankton (0.2 µm – 2 µm), including bacteria, cyanobacteria and prochlorophytes;
- Nanoplankton (2 µm – 10 µm), including phytoflagellates, coanoflagellates, dinoflagellates and ciliates;
- Microplankton (10 µm – 200 µm), including diatoms, tintinnids, dinoflagellates, radiolarians, ciliates, larvae and eggs of metazoans;
- Mesoplankton (0.2 µm – 20 mm), consisting of crustaceans such as copepods, euphausiids and cladocerans;
- Macroplankton (2 µm – 20 cm) composed of jellyfish;
- Megaplankton (20 µm – 200 cm) includes jellyfish and tunicate colonies.

The environmental characterisation of the Area Vasta places it within an EBSA[10] (i.e. Ecologically or Biologically Significant Areas) (Figure 5-75). The EBSA is located in the centre of the southern part of the Southern Adriatic and Northern Ionian Sea basin and can be considered a pelagic ocean habitat (Fonda-Umani, 1996). It is characterised by steep slopes, high salinity and a maximum depth of between -200 m and -1500 m. It is an area where deep waters of the Southern Adriatic Sea form locally. Water exchange with the Mediterranean Sea occurs through the Strait of Otranto, which has a deep sill at -800 m, forcing all circulation; for more details on the EBSA, see Section 5.12.3.3.

10 https://www.cbd.int/ebsa/ (2024)

Figure 5-75 Location of EBAs with focus on the Adriatic Sea and the Ionian Sea

Source: EBSA, 2024

5.11.1.3 Phytoplankton

Phytoplankton is composed of the fraction of unicellular plant taxa that populate the water column. Their photosynthetic pigments are capable of converting light energy into chemical energy through chlorophyll photosynthesis and are therefore also called autotrophic organisms. However, some species are also able to use organic compounds dissolved in the water column as an energy source and in this case are defined as mixotrophic or facultative autotrophic organisms. Plant plankton is mainly composed of single-celled organisms that are the major primary producers in aquatic ecosystems. As they are at the base of marine food chains, they ensure a constant flow of energy between the various levels. More than 90% of annual primary production in the marine environment is carried out by microphytoplankton organisms, which play a concrete role in the recycling of oxygen, nutrients and, above all, carbon, both globally and at the ecosystem level. Thanks to photosynthesis, they generate about 50% of the Earth's total oxygen (D'Alelio, 2020) and are the main producers in marine ecosystems. Phytoplankton species are not only unicellular, but also have short life cycles and, for these reasons, react quickly to changes in the chemical, physical and biological parameters of the environment.

Phytoplankton is a fundamental component of aquatic ecosystems, as it forms the basis of food webs. Primary phytoplankton production ensures the flow of matter and energy necessary for the maintenance of heterotrophic organisms. Any alterations to the phytoplankton community can be caused by toxic or eutrophicating effects, which can consequently modify the structure and functioning of an entire ecosystem. Phytoplankton is also important as an indicator, as it includes a large number of species with different ecological values, many of which are sensitive to organic and inorganic pollution and to changes in salinity, temperature and trophic level.

A high quantity of phytoplankton leads to 'algal blooms', which consist of an increase in biomass; this event involves the production of surplus organic matter that can act as a substrate for the growth of the microbial community and the consumption of nutrients to the detriment of other species. Conversely, low phytoplankton levels have the opposite effect, i.e. less biomass and less production of nutrients needed to maintain high levels of biodiversity.

Phytoplankton is one of the Biological Quality Elements (EQB) that contribute to determining the ecological status of marine and coastal water bodies, an index that considers the quality of the structure and functioning of aquatic ecosystems (Ministerial Decree 260/2010; Water Framework Directive 2000/60/EC). In addition to the EQBs, other supporting physical-chemical quality elements are monitored, assessed through the application of the TRIX index (dissolved oxygen, nutrients and chlorophyll 'a'), as well as specific pollutants not included in the priority list (Table 1/B of Ministerial Decree 260/10).

For the characterisation of phytoplankton types, the ARPA report of September 2014 on the Regional Environmental Protection Programme - Provincial Implementation Plan was analysed.

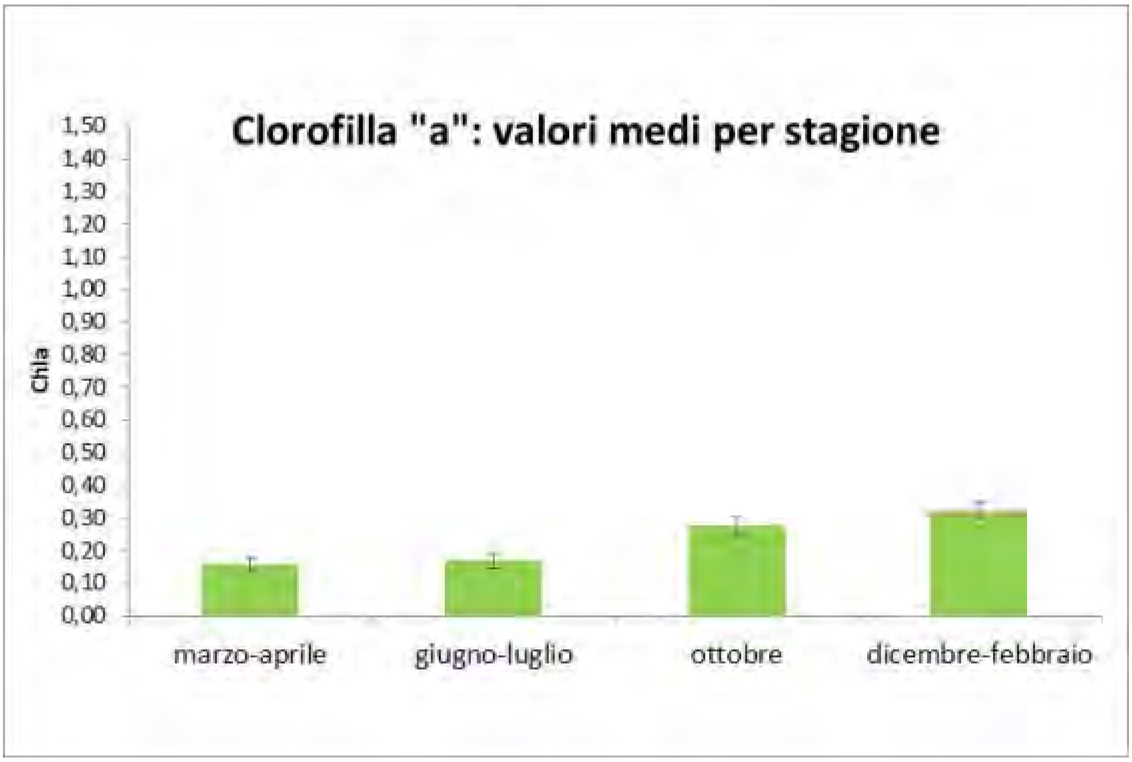
The presence of phytoplankton is measured by its biomass based on the amount of chlorophyll measured at the surface and included in the TRIX index (trophic status). Chlorophyll 'a' is a primary indicator of phytoplankton biomass and is sensitive to changes in trophic levels determined by nutrient inputs (e.g. N and P). The availability of these nutrients, in their dissolved mineral form, produces a response from the ecosystem in terms of increased primary production. The fundamental role of the chlorophyll a parameter is to document this increase. The higher the chlorophyll a levels, the greater the phytoplankton biomass.

In the province of Lecce, the analysis was carried out in 56 coastal areas.

Overall, the chlorophyll a values measured were generally low, typical of an oligotrophic environment; seasonal average estimates show an upward trend in autumn and winter (Figure 5-76).

Furthermore, all areas investigated and assessed for their ecological status were classified as 'High'.

Figure 5-76 Seasonal averages of chlorophyll 'a' (µg/l) for the entire coastline of the Province of Lecce. The graph also shows also shows the bars relating to the standard error.

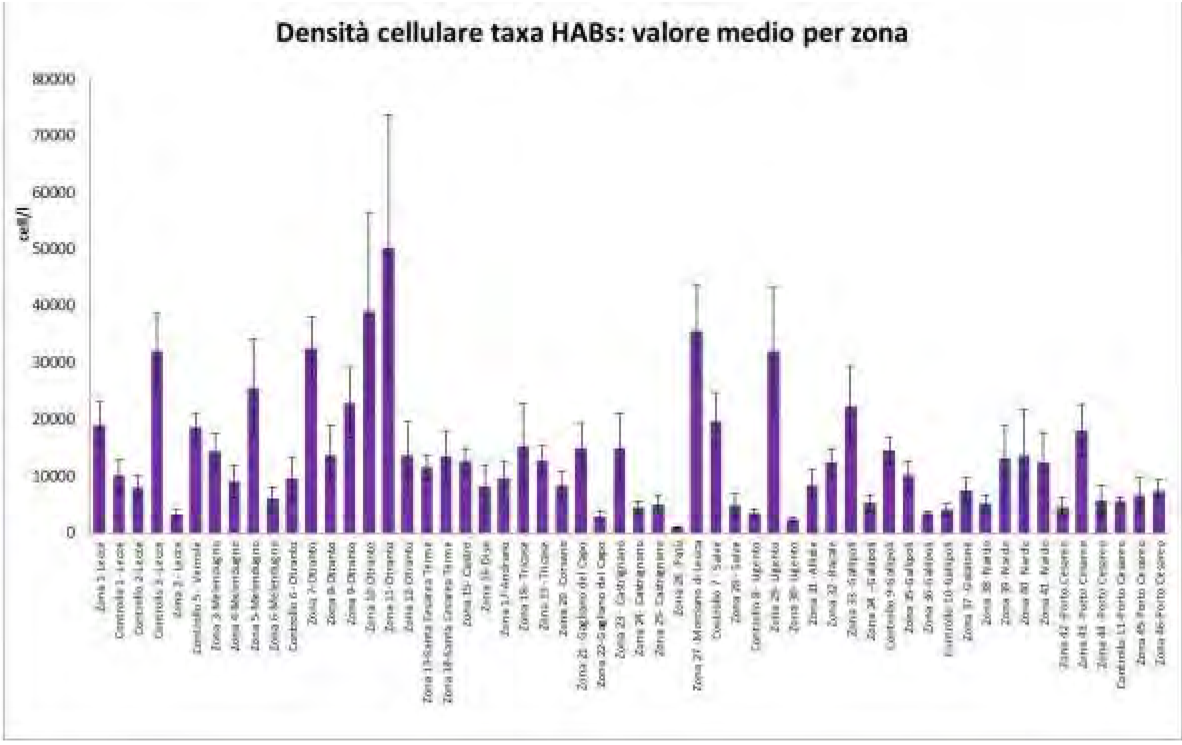


Source: ARPA Puglia, 2014

During the entire monitoring period, 320 phytoplankton taxa were collected and identified, of which 17 9 belonging to the Diatom group (56%), 74 to Dinoflagellates (23%) and 67 to the macro-category 'Other phytoplankton' (21%).

Among the species collected and identified, some are classifiable as potentially toxic to humans; in particular, the presence of 8 Harmful Algal Bloom (HAB) taxa (3 species of diatoms and 5 species of dinoflagellates) was recorded throughout the monitoring period (Figure 5-77).

Figure 5-77 Average cell density (cells/l) of HAB species for the different coastal areas investigated in the province of Lecce.



The graph also shows the bars relating to the standard deviation. Source:

ARPA Puglia, 2014

Taking into account the entire monitoring cycle, the qualitative and quantitative presence of phytoplankton was variable, both spatially and temporally; only in very rare cases, and exclusively during the first year of monitoring, were abundances of individual species estimated as 'blooms'. Potentially toxic species were found occasionally in the samples, and in any case with relatively low abundance values.

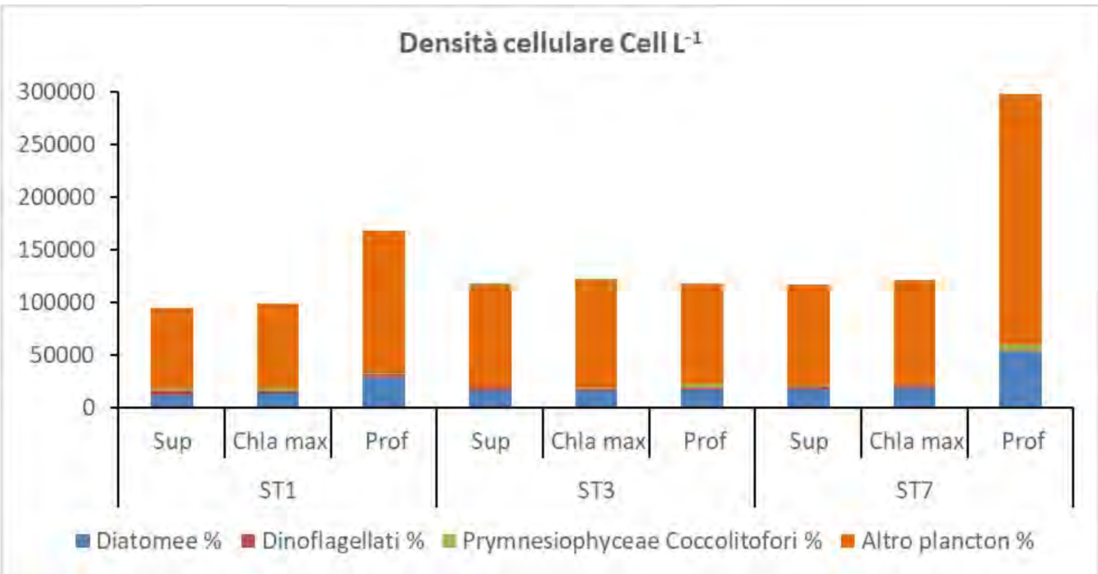
<u>*Results of the geophysical and environmental monitoring campaigns*</u>

For the counting and identification of phytoplankton organisms present in the samples, 250 ml of water were collected using Niskin bottles during environmental monitoring campaigns carried out in April (nearshore area) and June (offshore area). The samples were fixed with formaldehyde (37%) neutralised with sodium tetraborate (final concentration 0.74%), stored in dark bottles and then observed under an optical microscope after sedimentation, according to standard methods (Zingone *et al.,* 2010). From the initial volume of 250 ml, suitably mixed, a 10 ml subsample was allowed to settle and then observed under a Zeiss IM35 inverted optical microscope (magnification 400×). The sedimentation area was then observed by visual fields, counting up to a number of cells considered representative (Zingone *et al.,* 2010). For taxonomic determination, the texts indicated in Zingone *et al. (*2010) were used for taxonomic determination. The Shannon diversity index (H') was calculated for each sample using the taxa determined at species or genus level.

Observations identified taxa (at various levels of determination) belonging to diatoms, dinoflagellates and coccolithophores. Nanoflagellates belonging to other classes were also identified*,* such as *Cryptophyceae, Chrysophyceae, Dictyochophyceae, Euglenophyceae, Prasinophyceae, Meringophyceae, Prymnesiophyceae, Prasinophyceae, Raphidopyceae, Katablepharidophyceae, Litostomatea* and others that were undetermined and/or of uncertain systematic classification, referred to as unidentified flagellates and others.

The total cell densities found at the three nearshore sampling stations are summarised in Figure 5-78. Cell density values ranged from a minimum of 45,536 cells L-1 at the surface at station 1 to a maximum of 126,985 cells L-1 at depth at station 7. At stations 1 and 7, the maximum cell density was observed at depth, whereas at station 3, the maximum was observed at the chlorophyll peak.

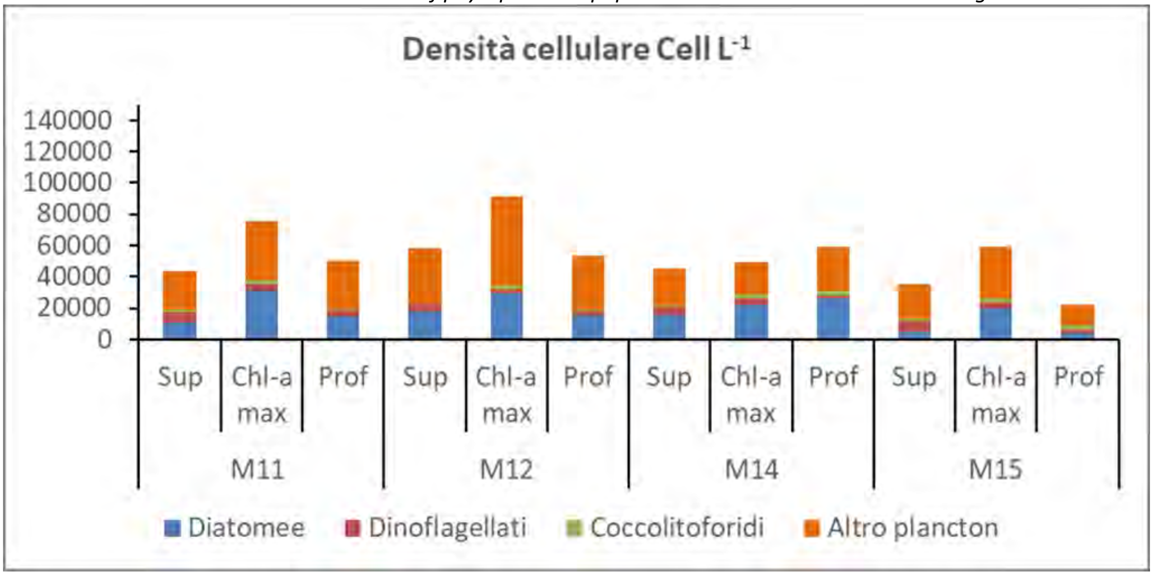
Figure 5-78 Total cell densities (cells L-1) divided between the main classes of phytoplankton populations in the three nearshore stations investigated.



Source: Nearshore Sector - Geophysical and Environmental Survey

The total cell densities found at the four offshore sampling stations are summarised in Figure 5-79. Cell density values ranged from a minimum of 21,953 cells L-1 at depth at station M15 (consistent with the depth of the sampling station, i.e. approximately -750 m) to a maximum of 91,072 cells L-1 at intermediate depth (i.e. the depth corresponding to the maximum chlorophyll values) at station M12.

Figure 5-79 Total cell densities (cells L-1).
Divided into the main classes of phytoplankton populations at the three stations investigated



Source: Offshore Sector - Geophysical and Environmental Survey

In conclusion, in the nearshore area, cell density values varied between a minimum of 45,536 cells L-1 at the surface at station 1 and a maximum of 126,985 cells L-1 at depth at station 7, confirming an oligotrophic environment even near the coast. Cell density values in the offshore area varied between a minimum of 21,953 cells L-1 at depth at station M15 and a maximum of 91,072 cells L-1 at intermediate depth at station M12. The low cell density of phytoplankton communities confirmed an oligotrophic state of the entire water column, including the seabed, at the time of sampling.

5.11.1.4 Zooplankton

Zooplankton is the collective name for the animal organisms that make up plankton. It consists of a wide variety of zoological phyla and is characterised by high biodiversity. The single-celled heterotrophic organisms that form zooplankton are ciliated and flagellated protozoa, foraminifera and radiolarians, while the multicellular organisms that make up zooplankton belong to many zoological phyla such as crustaceans, molluscs, echinoderms, cnidarians, tunicates a n d fish, some of which are only marine, such a s chetognaths a n d ctenophores. The

Zooplankton is a key link in the transfer of energy from the autotrophic phytoplankton compartment to carnivores, which occupy the upper levels of food chains. Nitrogen regeneration through zooplankton excretion helps sustain the production of bacteria and phytoplankton. Microbes colonise zooplankton faecal pellets and zooplankton carcasses, making them rich sources of organic carbon for detritivores. Zooplankton therefore also supports the microbial community with faecal pellets, carcasses, etc., which slowly sink to the seabed, also supporting various benthic communities. Zooplankton also plays a fundamental role in the production of particulate and dissolved organic matter transferred to decomposers, which in turn release nutrients that can be assimilated by microalgae and bacteria. Zooplankton therefore actively contributes to the carbon, phosphorus and nitrogen cycles. Given the fundamental ecological role that zooplankton plays in marine ecosystems, it is used in the assessment of environmental quality (Weber *et al.* 2010) and considered an indicator of ecosystem change (Hooff and Peterson, 2006; Valdés *et al.* 2004, Valdés *et al.* 1998).

Information on the distribution and composition of zooplankton in the Area Vasta was obtained from a study carried out along the Apulian coast between the South-Western Adriatic Sea and the Northern Ionian Sea between January 2008 and February 2010 (Barbone *et al.*, 2014). During this study, 141 zooplankton taxa were identified, 72 of which at species level. However, most of the taxa (79) were common to the three types of habitat investigated (i.e., Adriatic estuary stations, Adriatic coastal stations and Ionian coastal stations). Data analysis revealed extreme heterogeneity in the zooplankton community, but zooplankton distribution was also strongly influenced by freshwater inputs and the geographical distribution of sampling stations between the Southern Adriatic and Ionian Seas. Although river inputs clearly influenced zooplankton assemblages in the Apulian Adriatic waters, other significant differences in zooplankton abundance were found between the Adriatic and Ionian sampling sites. This could be a reflection of different oceanographic characteristics resulting from the general circulation of water masses. Although the areas analysed in the Adriatic and Ionian waters are conventionally classified as oligotrophic, higher particulate values in the southern Adriatic compared to the northern Ionian, derived from the northern Adriatic water masses, could influence pelagic food webs and, consequently, stationary zooplankton stocks. While in the southern Adriatic, particulate matter is influenced by autochthonous processes and inputs from the northern Adriatic, in the northern Ionian Sea, particulate matter mainly originates from local inputs.

Results of geophysical and environmental monitoring campaigns

During the geophysical and environmental monitoring campaign carried out in April for the nearshore area and in June for the offshore area, water analysis was performed using Niskin bottle sampling. Zooplankton sampling was carried out at three nearshore stations: 1, 3 and 7 (Figure 5-42), while for the offshore area it was carried out at four stations: M11, M12, M14 and M15 (Figure 5-43).

Zooplankton was collected by lowering a net with a mesh size of 200 µm along the water column to the seabed; this net is equipped with an analogue flow meter to measure the volume of water filtered and standardise the number of zooplankton organisms found.

The following taxa were identified for the nearshore area, as shown in Table 5.33. The zooplankton community is dominated by Calanoid copepods, copepodites and Cyclopoida copepods, which account for 49%, 11% and 10% of the entire community, respectively.

Table 5.33 Taxa found in the zooplankton community analysis at the stations considered, expressed as No. ind/m3.

	ST1	ST3	ST
Calanoid copepods	3	50.99	43.09
Copepodites	3.87	6.65	4.07
Cyclopoid copepods	14.5	5.14	6.5
Cladocera	0	0	2.74
Appendicularia	0.2	0.81	1.42
Amphipoda	0	0	0
Radiolarians	6.3	3.63	4.2
Ascidiacea	0	0	0
Asteroidea	0	0	0.00
Bivalves	4.1	4.23	2.24
Bryozoa	0	0	0
Chaetognatha	2.28	1.91	0.61
Cirripedia - Cipris/Nauplio	0	0	0
Cnidaria - Ephyra	0.4	0	0
Cnidaria - Medusoids	0	0	0
Ctenophora	0	0	0
Decapoda	0	0	0
Echinoidea larvae	11.84	9.27	8.1
Euphausiacea	0	0	0
Euphausiacea larvae	0	2.62	4.37
Gastropoda	5.2	5.54	4.17
Holothuroidea	0	0	0
Isopoda	0	0	0
Malacostraca	0	0	0
Misidacea	0	0	0
Ophiuroidea	0	0	0
Ophiuroidea larvae	3.19	1.51	2.85
Ostracoda	0.68	0.30	1.12
Pisces larvae	0	0	0
Pisces eggs	0	0.1	0
Polychaeta	0	0	0

	ST1	ST3	ST7
Pteropoda	0	0	0
Siphonophora	0.68	0	0.41
Tunicate	0.23	0	0

Source: Offshore Sector - Geophysical and Environmental Survey

For the offshore area, on the other hand, the following taxa were identified, as shown in Table 5.34 The zooplankton community is dominated by Calanoid copepods, copepodites and Cyclopoida copepods, which account for 49%, 11% and 10% of the entire community, respectively. Stations M14 and M15, which are deeper and further from the coast, are the least abundant, with average values between replicates of 3.84 ind/m(3) and 4.97 ind/m(3) respectively.

Table 5.34 Taxa found in the zooplankton community analysis at the stations considered, expressed as No. ind/m3.

	M11	M12	M14	M15
Calanoid copepods	35.5	134.4	1.02	1.09
Copepodites	2.30	24.30	0.19	0.31
Cyclopoid copepods	22.76	66.41	0	0.54
Cladocera	145.26	46.97	0.12	0.40
Appendicularia	10.49	17.82	0.08	0.13
Amphipoda	0.00	6.48	0.06	0.02
Radiolarians	4.6	19.44	0.42	0
Ascidiacea	0	0	0	0
Asteroidea	0	0	0	0
Bivalvia	0	0	0.02	0.19
Bryozoa	0	0	0	0
Chaetognatha	8.95	32.39	0.02	0.13
Cirripedia - Cipris/Nauplio	0	0	0	0
Cnidaria - Ephyra	0.7	0	0	0
Cnidaria - Medusoids	0	0	0	0
Ctenophora	0	0	0	0
Decapoda	0	0	0	0
Euphausiacea	0	0	0	0
Euphausiacea larvae	0	42.1	0.83	0.83
Gastropoda	0	4.86	0.02	0.17
Holothuroidea	0.00	0.00	0	0
Isopoda	0	0	0	0
Decapod crustacean larva	0	4.86	0	0
Malacostraca	0.00	0	0	0
Misidacei	0	0	0	0
Ophiuroidea	0	0	0	0
Ophiuroidea larvae	0.77	8.1	0.06	0.48
Ostracoda	1.28	14.58	0.12	0.12

	M11	M12	M14	M15
Pisces larvae	0	0	0	0
Pisces eggs	0	0	0.12	0.06
Polychaeta	0.51	1.62	0.02	0.04
Pteropoda	0.00	0.00	0	0
Scaphopods	0.51	3.2	0	0.04
Siphonophora	0	0	0.04	0.02
Ovigerous sacs	0.77	11.34	0.19	0
Tunicate	0.26	8.10	0.06	0.06

Source: Offshore Sector - Geophysical and Environmental Survey

In conclusion, in the nearshore area, during the geophysical and environmental monitoring campaign, it was found that the zooplankton community is dominated by Calanoid copepods, copepodites and Cyclopoida copepods, which account for 49%, 11% and 10% of the entire community, respectively.

In the offshore area, the community was also zooplanktonic, dominated by Calanoid copepods, copepodites and Cyclopoida copepods, accounting for 49%, 11% and 10% of the entire community, respectively. The least abundant areas were the deepest stations furthest from the coast.

5.11.1.5 Fish fauna

The area affected by the wind farm falls within GSA-19 "Western Ionian Sea", which includes the entire Western Ionian Sea, the coasts of northern Puglia, Basilicata, northern Calabria and eastern Sicily.

According to the GSA 19 management plan, the most important demersal species in GSA 19 are:

Table 5.35 Demersal fish species of commercial interest in GSA19[11]

Common name	Scientific name	Common name	Scientific name
Red mullet	*Mullus barbatus*	**Potassolo**	*Micromesistius potassou*
Rock mullet	*Red mullet*	**Anglerfish**	*Lophius piscatorius and Lophius budegassa*
Hake	*Merluccius merluccius*	**Musdea**	*White gurnard*
White shrimp	*Parapenaeus longirostris*	**Redfish**	*Helicolenus dactylopterus*
Norway lobster	*Norway lobster*	**Shrimps**	*Plesionika edwardsii and Plesionika martia*
Purple shrimp	*Aristeus antennatus*	**Blackmouth**	*Galeus melastomus*
Red shrimp	*Aristaeomorpha foliacea*	**Sagrì**	*Etmopterus spinax*
Octopus	*Octopus vulgaris*	**Mirrorfish**	*Hoplostethus mediterraneus*
Cuttlefish	*Sepia officinalis*	**Ratfish**	*Coelorhynchus coelorhynchus*
Red sea bream	*Red sea bream*	**Spiny red porgy**	*Squid*
Moscardini	*Spotted garden eel*	**Mouse fish**	*Hymenocephalus italicus*

Source: GSA Management Plan 19

The GSA 19 Management Plan includes management measures for the sustainable exploitation of three fish species, those of greatest importance in terms of volume and economic value of landings produced within the GSA 19:

- Hake (*Merluccius merluccius*), FAO code HKE;
- Pink shrimp (*Parapenaeus longirostris*), FAO code DPS;
- Red shrimp (*Aristaeomorpha foliacea*), FAO code ARS.

11 National Management Plan for fishing fleets catching demersal resources in GSA 19 (Western Ionian Sea)

In addition to the target species, other species referred to as 'associated' are also monitored in relation to their composition in landings, which account for 75% of the total volume of landings from trawling in GSA 19. These species are represented by red mullet (*Mullus barbatus*), striped red mullet (*Mullus surmuletus*) and purple shrimp (*Aristeus antennatus)*.

The biological characteristics of the target stocks of GSA 19 are reported in the Fisheries Management Plan for the Ionian Sea (pursuant to Article 24 of Regulation (EC) No 1198/2006 and Article 19 of Regulation (EC) No 1967/2006) and combine the latest assessments available from the Scientific, Technical and Economic Committee for Fisheries (STECF) and the General Fisheries Commission for the Mediterranean (GFCM) with information from surveys on the relative biomass of the main associated demersal species (MEDISEH, 2013). The relative biomass of the species of greatest commercial interest refers to the percentage of the target species in the total catch, conducted during the 1994-2016 time series of MEDITS trawl fishing campaigns, from which the following is derived for the species in question. Below is information on the biology and ecology of the GSA 19 target stocks in relation to the Project.

It should also be noted that the Messapia wind farm area falls outside the main fishing areas in the Strait of Otranto and outside the main nursery and spawning areas of the main commercial fish species.

Nursery areas

Hake (*Merluccius merluccius*) – GSA 19

Hake individuals inhabiting GSA 19 are considered a single stock, although a single hake population inhabiting the entire central Mediterranean Sea basin has been observed (Fiorentino *et al*., 2015).

This species has a wide range, moving between 14 and 800 metres, making it one of the most important fish species in GSA 19. Adult specimens are mainly concentrated in the slope area, while juveniles and recruits are more common in the continental shelf area and at shallower depths. Sizes vary from 3 cm to 90 cm depending on age.

The most important nursery areas (Figure 5-80) are located between Otranto and Santa Maria di Leuca, around the Amendolara shoal, and between Syracuse and Capo Passero at a depth of about 200 m (Carlucci *et al*., 2009; Murenu *et al*., 2010; D'Onghia *et al.*, 2012). Nursery areas are located along the Greek coast of the GSA 20.

Hake reproduce throughout the year with varying intensity, and as a result, juveniles are present in different months. The first maturity size has been estimated at around 31 cm TL (total length), while the recruitment size has been observed to be around 13 cm.

The area covered by the 'Messapia' project **is outside** the nearest hake nursery area.

Figure 5-80 Merluccius merluccius – Nursery areas

Note: the red circle identifies the Messapia wind farm area. The legend shows the relative biomass percentage of M. merluccius in the area

Source: Masaf, 2022

Pink shrimp *(Parapenaeus longirostris)* – GSA 19

Pink shrimp (also known as white shrimp) living in GSA 19 are considered a single stock as there is insufficient information on the population. The species is distributed between -20 and -270 metres throughout the Mediterranean, concentrating mainly in mud and sand at depths between -200 and -400 metres (Politou *et al.*, 2005). Adult individuals show a preference for greater depths, while younger individuals prefer shallower waters (Abellò *et al.*, 2002).

Within GSA 19, the recruitment areas (Figure 5-81) of this species are located between Otranto and Santa Maria di Leuca, off Torre Ovo (Carlucci *et al*., 2009), and along the eastern coast of Sicily. The spawning areas (Figure 5-82), on the other hand, are mainly located along the eastern coast of Calabria and in south-western Apulia. This species is characterised by rapid growth, and the reproductive period extends from late spring to autumn, while the highest percentage of mature females has been observed in autumn.

The area covered by the 'Messapia' project **is outside** the nearest pink shrimp nursery area and **only slightly interferes** with the spawning area, which nevertheless has an extremely low relative biomass.

Figure 5-81 Parapenaeus longirostris – Nursery areas

Note: the red circle identifies the area of the Messapia wind farm. The legend shows the relative percentage of biomass of P. longirostris in the area

Source: Masaf, 2022

Figure 5-82 Parapenaeus longirostris – Spawning areas

Note: the red circle identifies the Messapia wind farm area. The legend shows the relative biomass percentage of P. longirostris in the area

Source: Masaf, 2022

Red shrimp (*Aristaeomorpha foliacea*) – GSA 19

Individuals living in GSA 19 are considered as a single stock since no particular differences have been found between the various populations from different areas of the Mediterranean Sea (Fiorentino *et al*., 2015).

The red shrimp is a fish species distributed over a wide area. Catches of this species have been recorded at depths ranging from 127 to 1,146 metres (Maiorano *et al*., 2010) and include a wide range of sizes.

The main nursery areas are located in the upper part of the slope along the coast between Santa Maria di Leuca and Gallipoli, as well as in the south-eastern part of the Amendolara shoal up to the area between Capo Trionto and Punta Alice. Off the coast of Crotone, Capo Rizzuto and in the area between Catanzaro and Punta Stilo, important nurseries are also observed (Figure 5-83). The spawning areas (Figure 5-84), on the other hand, are located on the seabed east of Santa Maria di Leuca and off the coast of Gallipoli and Punta Stilo, thus partially overlapping with the nursery areas.

This species is seasonally iteroparous, with a reproductive period extending from spring to summer (D'Onghia *et al*., 2012). The recruitment size ranges from 18 to 27 mm CL (carapace length), while the maturity size has been estimated at around 44 mm CL for females (Carlucci *et al.*, 2006).

The area covered by the 'Messapia' project appears to **interfere only slightly** with the nursery and spawning area of the
red shrimp, which, however, have an extremely low relative biomass.

Figure 5-83 ristaeomorpha foliacea - Nursery areas

Note: the red circle identifies the area of the Messapia wind farm. The legend shows the relative percentage of biomass of A. foliacea in the area

Source: Masaf, 2022

Figure 5-84 Aristaeomorpha foliacea - Spawning areas

Note: the red circle identifies the area of the Messapia wind farm. The legend shows the relative biomass percentage of A. foliacea in the area

Source: Masaf, 2022

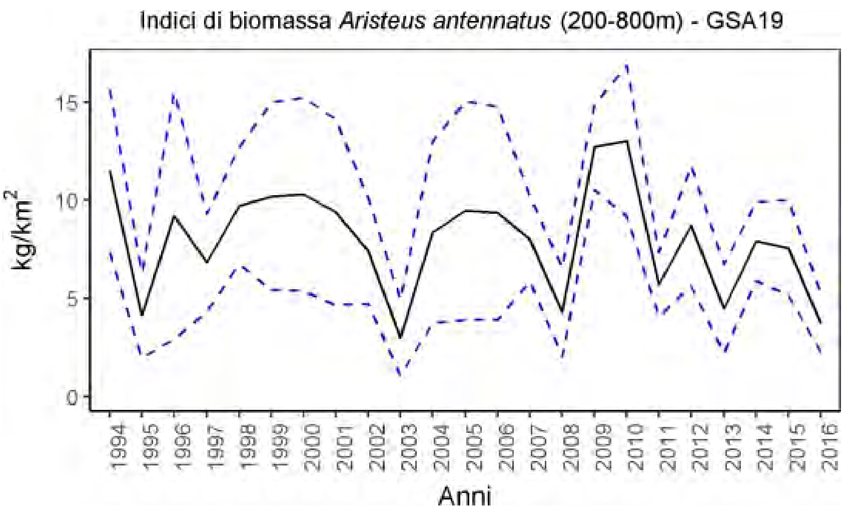
The species associated with the target species were identified by considering the species that make up 75% of the total volume of landings related to trawling in GSA 19 using STECF data (STECF, 2015). Excluding target species such as hake (*Merluccius merluccius)*, pink shrimp (*Parapenaeus longirostris)* and red shrimp (*Aristaeomorpha foliacea)*, the associated species in this area are red mullet, striped red mullet (*Mullus barbatus)* and black seabream (*Mullus surmuletus)* and purple shrimp (*Aristeus antennatus)*.

<u>*Biomass indices of target stocks in GSA 19*</u>

The species associated with the target stocks are identified by considering the species that make up 75% of the total volume of landings from trawling in GSA 19; for this area, these are: red mullet, striped red mullet (*Mullus barbatus*) and black seabream (*Mullus surmuletus*) and purple shrimp (*Aristeus antennatus*).

For purple shrimp, the biomass index in **Error! Reference source not found.Error! Reference source not found.** shows a constant trend characterised by annual fluctuations throughout the period covered by the series (1994-2016).

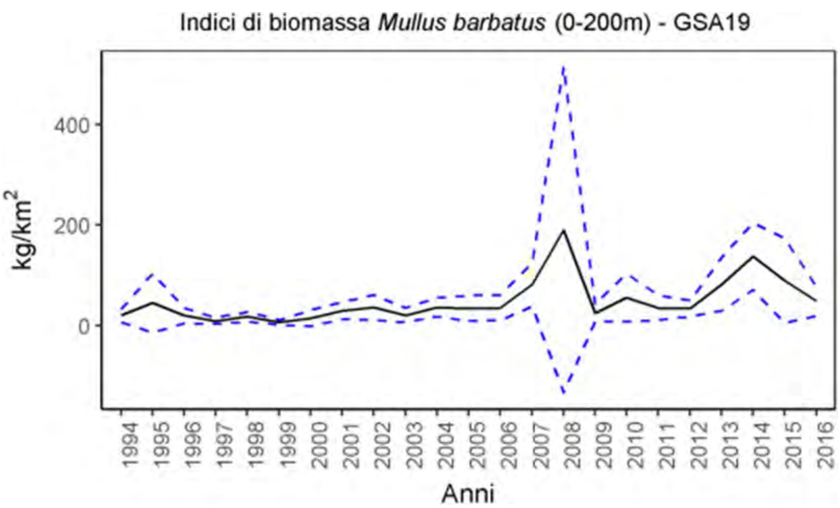
Figure 5-85 86Biomass index of purple shrimp (Aristeus antennatus) in GSA 19. MEDITS data for the period 1994-2016.



Source: MIPAAFT, 2019 (MATTM, 2014)

The biomass index for red mullet in Figure **5-87Error! Reference source not found.** shows a steady trend, with two peaks in 2007 and 2014.

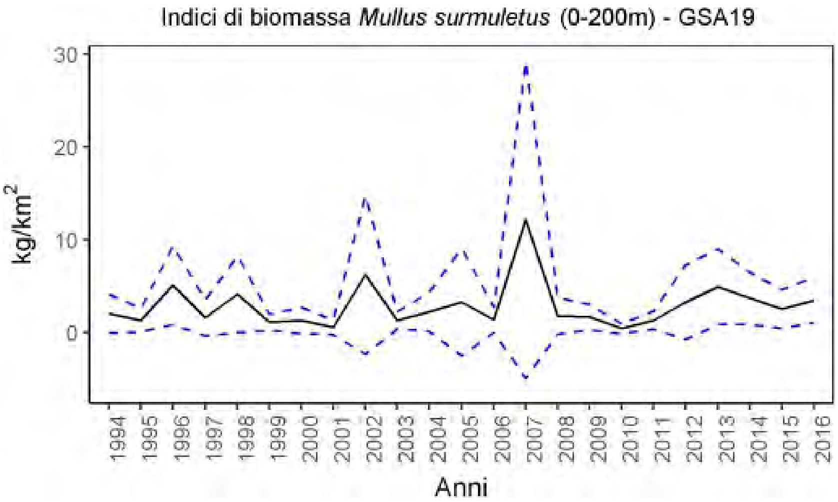
Figure 5-87 Biomass index for red mullet (Mullus barbatus) in GSA 19. MEDITS data for the period 1994-2016.



Source: MIPAAFT, 2019 (MATTM, 2014)

The biomass index for red mullet in Figure **5-89Error! Reference source not found.** shows slight annual fluctuations during the period considered, but the trend remained constant.

Figure 5-89 Biomass index for red mullet (Mullus surmuletus) in GSA 19. MEDITS data for the period 1994-2016.

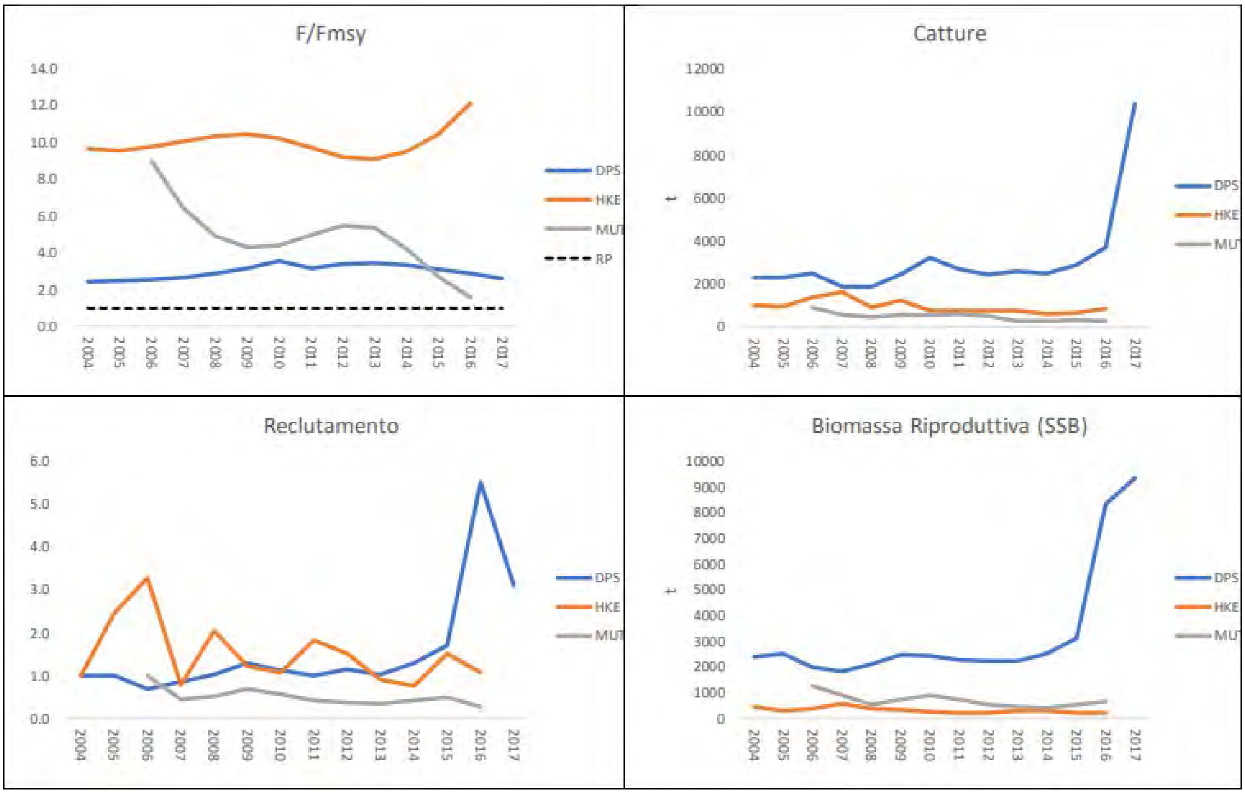


Source: MIPAAFT, 2019 (MATTM, 2014)

Among the stocks exploited by trawling in the western Ionian Sea sub-area, pink shrimp, cod and red mullet account for 35% in volume and 30% in value of the total production of the fishing segments classified as trawling (2017 data). The F/Fmsy([12]),trendsreported in **Error! Reference source not found. ,** show values above 1 for the entire duration of the historical series for all stocks. A situation of generalised overfishing of fish resources is therefore evident. In recent years, only red mullet has shown a downward trend and an approach to the Fmsy value. The biomass of spawners has increased significantly in the last two years for pink shrimp, while decreasing trends are estimated for cod and red mullet. Catches and recruitment reflect biomass trends, with improvements for pink shrimp and negative trends for cod and red mullet.

12 F, Fishing mortality; Fmsy (Maximum Sustainable Yield) represents the fishing pressure that guarantees the maximum sustainable yield in the long term. An F value greater than Fmsy means that fishing catches are excessive.

Figure 5-88 Biological indicators – GSA 19. DPS Pink shrimp; HKE Cod; MUT Red mullet.



Source: MIPAAFT, 2019 (Beck et al., 2018)

Based on the assessments of various working groups, the Scientific, Technical and Economic Committee for Fisheries (STECF) concluded that all stocks are to be considered overexploited.

<u>*Results of geophysical and environmental monitoring campaigns*</u>

During the environmental monitoring campaign carried out in April (nearshore area) and June (offshore area), environmental DNA (eDNA) analysis was performed at four nearshore stations (Stations 1, 2, 5 and 8) and four offshore stations (Stations M11, M12, M14 and M15) in order to draw up a list of fish species present in the Project Area. The eDNA from the water was collected by filtering 10 litres of water (2 aliquots of 5 litres per station), while the eDNA from the sediments was collected by taking two 2-litre jars filled with ¼ sediment and ¾ ethanol.

All samples were collected, refrigerated on board and then taken to the laboratory in accordance with national legislation (Ministerial Decree 24/01/96 and Legislative Decree 152/2006) and ISPRA guidelines.

Analysis of the nearshore stations (Figure 5-42) showed that the mitochondrial marker identified 41 different orders and between 216 and 327 fish species, with the most highly represented being within of the orders Blenniformes, Gobiiformes, Perciformes, Pleuronettiformes, Gadiformes (Actinopteri). Station ST1 showed the highest number of species recorded. Nine orders of cartilaginous fish (Chondrichthyes) were also identified, containing between 21 and 26 species (ST1 had the highest number). The most represented order of Chondrichthyes was Charcariniformes.

Looking at the COI results, DNA belonging to fish species typical of Mediterranean areas was detected, as well as DNA from species not normally found in the Mediterranean (NIS, Non-Indigenous Species), which could potentially have entered directly through the Suez Canal or indirectly through, for example, ship ballast water.

Error! Reference source not found. Table 5.36 and Table 5.37 were therefore prepared to highlight, within all the species recorded, those species actually present and reported in the Mediterranean (native or introduced, but in any case present). Among the native species, species of commercial importance for professional and artisanal fishing have been identified, such as the red mullet (*Mullus surmuletus)*, the striped red mullet (*Mullus barbatus)*, the skipjack tuna (*Katsuwomis pelamis)* and the hake (*Merluccius merluccius)*. The DNA of five species considered alien (NIS) has also been identified, including *Pampus argenteus,* belonging to the Scombriformes*,* which is present in all stations. It should be noted that this mesopelagic oceanic species of subtropical origin (Indian Ocean) has so far only been reported occasionally in the Mediterranean Sea.

Table 5.36 List of native Actinopterygii (bony fish) species identified in the Mediterranean Sea

	Actinopterygii (bony fish)				
	Species	ST1	ST7	ST9	o_:Order; f_:Family
1	*Atherina boyeri*	X			o__Atheriniformes; f__Atherinidae
2	*Aulopus filamentosus*			X	__Aulopiformes; f__Aulopidae
3	*Tylosurus acus*		X		o__Beloniformes;f__Belonidae
4	***Tylosurus crocodilus***	**X NIS**		**X NIS**	**__Beloniformes;f__Belonidae**
5	*Parablennius rouxi*	X			__Blenniiformes;f__Blenniidae
6	*Gouania willdenowi*	X			o__Blenniiformes;f__Gobiesocidae
7	*Tripterygion tripteronotum*	X	X	X	o__Blenniiformes;f__Tripterygiidae
8	*Trisopterus minutus*	X	X	X	o__Gadiformes;f__Gadidae
9	*Molva molva*		X		__Gadiformes;f__Lotidae
10	*Merluccius merluccius*	X		X	__Gadiformes;f__Merlucciidae
11	*Lebetus guilleti*	X			__Gobiiformes;f__Gobiidae
12	*Apogon imberbis*	X	X	X	__Kurtiformes; f__Apogonidae
13	*Chelon ramada*	X			o__Mugiliformes;f__Mugilidae
14	*Gonichthys cocco*	X	X	X	o__Myctophiformes;f__Myctophidae
15	*Porcupinefish*	X	X	X	o__Perciformes;f__Scorpaenidae
16	***Serranus hepatus***	**X NIS**			**__Perciformes;f__Serranidae**
17	*Microchirus variegatus*	X			__Pleuronectiformes;f__Soleidae
18	*Solea aegyptiaca*	X	X	X	o__Pleuronectiformes;f__Soleidae
19	*Skipjack tuna*	X	X	X	__Scombriformes;f__Scombridae
20	***Pampus argenteus***	**X NIS**	**X NIS**	**X NIS**	**o__Scombriformes;f__Stromateidae**
21	*Tetragonurus cuvieri*	X			__Scombriformes; f__Tetragonuridae
22	*Spicara smaris*	X			o__Spariformes;f__Centracanthidae
23	***Nemipterus randalli***	**X NIS**			**o__Spariformes;f__Nemipteridae**
24	***Rhabdosargus haffara***	**X NIS**		**X NIS**	**__Spariformes;f__Sparidae**
25	*Synchiropus phaeton*	X		X	__Syngnathiformes;f__Callionymidae
26	*Mullus barbatus*	X		X	o__Syngnathiformes;f__Mullidae
27	*Mullus surmuletus*	X		X	__Syngnathiformes;f__Mullidae
28	*Chromis chromis*	X			o__Unclassified;f__Pomacentridae

Non-indigenous species (NIS) are highlighted in bold. Species are divided by individual station.

Source: Nearshore Sector - Geophysical and Environmental Survey

Table 5.37 List of Chondroichthyes (cartilaginous fish) species identified in the Mediterranean Sea

Chondrichtyes (cartilaginous fish)					
Species	ST1	ST7	ST9	o_:Order; f_:Family	IUCN Red List
Carcharhinus brachyurus		X		o__ Carcharhiniformes; f__ ~~Carcharhinidae~~	VU-Global DD-Mediterranean
Cuvier's shark	X	X		or Carcharhiniformes;f Carcharhinidae	NT-Global DD-Europe
Scyliorhinus stellaris	X	X	X	or Carcharhiniformes;f Scyliorhinidae	VU-Global NT-Mediterranean
Raja miraletus	X	X	X	__ Rajiformes; f__ Rajidae	LC
Somniosus rostratus	X	X		o Squaliformes;f Somniosidae	LC-Global DD- Mediterranean

Species are divided by individual station. The last column on the right specifies the extinction risk level derived from the IUCN Red List (VU: vulnerable; NT: near threatened; LC: least concern; DD: data deficient), together with the regional scale (Global, Europe, Mediterranean).

Source: Nearshore Sector - Geophysical and Environmental Survey

As regards offshore stations (Figure 5-43), mitochondrial markers identified 39 different orders and between 115 and 182 fish species, mainly represented within the orders Blenniformes, Characiformes, Gobiiformes and Perciformes (Actinopteri). Station M11OF showed the highest number of species recorded. Ten orders of cartilaginous fish (Chondrichthyes) were also identified, containing between 12 and 17 species (M11OF and M15OF had the highest numbers). The most represented orders of Chondrichthyes were Charcariniformes and Rajiformes.

Looking at the results for fish communities, DNA belonging to fish species native to the Mediterranean area was detected, as well as DNA from alien species (NIS, Non-Indigenous Species) reported as present in the Mediterranean by the AQUANIS database and other databases (e.g. SIBM). The presence of alien species DNA could be due to either the actual presence of the species or the exclusive presence of DNA that arrived in the Project Area indirectly, for example through the ballast water of ships.

Table 5.38 summarises and highlights, within the species listed, those actually present and reported in the Mediterranean (native or introduced, but in any case present), divided by station. A total of 24 species of Actinopterygii and 8 species of Condrichthyes reported in the Mediterranean were identified at all stations. Among the Actinopterygii, some species of great commercial interest have been identified, such as bluefin tuna (*Thynnus thynnus)*, anchovy (*Engraulis encrasicolus)*, silverside (*Atherina boyeri)* and dolphinfish (*Coryphaena hippurus)*. Alongside these species considered native, the DNA of four alien species (NIS) was sequenced: *Pempheris rhomboidea (*Acropomatiformes, rarely reported in the Mediterranean), the goby *Ctenogobius boleosoma (*widely present), the banded grouper *Epinephelus fasciatus (*Leissepsian migration, rarely reported) and the sergeant major fish *Abudefduf vaigiensis (*Leissepsian migration, widely present). The presence of these species has been validated by the AQUANIS database.

Table 5.38 List of species identified in the Mediterranean by station and taxonomic position.

		o_: Order; f_:Family	Station code	M11OF RI	M13OF RI	M14OF RI	M15OF RI
			Internal coding	MAOF.11	MAOF.13	MAOF.14	MAOF.15
	Class: Actinopterygii						
1	*Pempheris rhomboidea*	or__ Acropomatiformes;f__ Pempheridae		X NIS			
2	*Chlopsis bicolor*	__ Anguilliformes;f__ Chlopsidae				X	
3	*Muraena helena*	__ Anguilliformes;f__ Muraenidae				X	X
4	*Atherina boyeri*	__ Atheriniformes;f__ Atherinidae			X		
5	*Aulopus filamentosus*	__ Aulopiformes;f__ Aulopidae			X	X	X
6	*Clinitrachus argentatus*	__ Atheriniformes;f__ Atherinidae		X	X		
7	*Tripterygion tripteronotum*	or__ Blenniiformes;f__ Tripterygiidae					X
8	*Coryphaena hippurus*	__ Carangiformes;f__ Coryphaenidae		X			
9	*Sprattus sprattus*	__ Aulopiformes;f__ Aulopidae			X	X	
10	*Engraulis encrasicolus*	or__ Aulopiformes;f__ Aulopidae		X			
11	*Merlangius merlangus*	__ Gadiformes;f__ Gadidae				X	X
12	*Mora moro*	or__ Gadiformes; f__ Moridae					X
13	*Bathygobius soporator*	__ Gobiiformes;f__ Gobiidae				X	
14	*Ctenogobius boleosoma*	or Gobiiformes;f Gobiidae		X NIS	X NIS	X NIS	X NIS
15	*Apogon imberbis*	__ Kurtiformes;__ Apogonidae		X	X	X	X
16	*Lobotes surinamensis*	or__ Stomiiformes; f__ r Stomiidae		X			
17	*Dofleini lobianchia*	__ Myctophiformes;f__ Myctophidae			X		
18	*Epinephelus fasciatus*	__ Perciformes;f__ Serranidae		X NIS	X NIS		
19	*Serranus hepatus*	or__ Perciformes;f__ Serranidae		X			
20	*Serranus scriba*	__ Perciformes;f__ Serranidae		X			
21	*Thunnus thynnus*	__ Scombriformes;f__ Scombridae		X			
22	*Spicara maena*	__ Scombriformes;f__ Scombridae		X			
23	*Stomias boa*	or__ Stomiiformes; f__ Stomiidae					X
24	*Abudefduf vaigiensis*	__ Unclassified;f__ Pomacentridae		X NIS	X NIS	X NIS	X NIS
	Class: Condrichthyes						
1	*Galeocerdo cuvier*	or Carcharhiniformes;f Carcharhinidae					X
3	*Scyliorhinus stellaris*	__ Carcharhiniformes;f__ Scyliorhinidae;		X	X	X	X
4	*Isurus oxyrinchus*	__ Lamniformes;f__ Alopiidae				X	
5	*Carcharias taurus*	__ Lamniformes;f__ Odontaspididae					X
6	*Odontaspis ferox*	or__ Lamniformes;f__ Odontaspididae		X			
7	*Raja miraletus*	__ Rajiformes;f__ Rajidae		X	X		
8	*Raja undulata*	__ Rajiformes;f__ Rajidae			X		

NIS: Non-Indigenous Species. Highlighted in grey: species shared by all stations. Source:

Nearshore Sector - Geophysical and Environmental Survey

Among the Actinopterygii species identified, it should also be noted that, from a conservation point of view, bluefin tuna is considered a 'vulnerable' species on the IUCN (International Union for Conservation of Nature) Red List.

The taxon Condrichthyes (cartilaginous fish) in the Mediterranean Sea includes a total of about 80 species and is considered a taxonomic group at risk of conservation due to overfishing and by-catch, climate change and pollution. Among the eight species of Condrichthyes identified, the following species are classified as 'critically endangered' by the IUCN: *Odontaspis ferox (*dogfish), *Isurus oxyrinchus (*shortfin mako shark

), *Carcharias taurus* (bull shark). The species *Echinorhinus brucus* (frilled shark) is classified as 'endangered'. The two species *Scyliorhinus stellaris* (leopard cat shark) and *Raja undulata* (undulate ray) are classified as 'near threatened'.

In conclusion, environmental DNA (eDNA) analysis in the nearshore area identified 41 different orders and between 216 and 327 fish species. DNA belonging to species not normally found in the Mediterranean was also detected, potentially entering through the Suez Canal or indirectly through ships' ballast water. Among the alien species identified is one belonging to the Scombriformes *Pampus argenteus,* of subtropical origin.

In the offshore area, 39 different orders and between 115 and 182 fish species were identified. Alien species (NIS) were also identified in this area, probably arriving in the Project Area indirectly, through the ballast water of ships. In addition, bluefin tuna, considered 'vulnerable' from a conservation point of view (IUCN), was reported among the species identified. Furthermore, the taxon Condrichthyes in the Mediterranean Sea is also considered a taxonomic group at risk of conservation due to overfishing, by-catch, climate change and pollution.

5.11.1.6 Reptiles

Three of the seven sea turtles known worldwide are found in the Mediterranean Sea, which are the only marine reptiles to frequent the basin.

Sea turtles

The species of sea turtles found in the Mediterranean Sea are *Chelonia mydas*, *Dermochelis coriacea* and *Caretta caretta*.

Caretta caretta

Figure 5-90 Caretta caretta

Source: artescienza.org, 2024

It is by far the most widespread species in the Mediterranean Sea, moving from the eastern Mediterranean basin to the Tyrrhenian and Adriatic waters during the feeding and wintering season. The Mediterranean is home to both a local population of *Caretta caretta* and individuals from populations on both sides of the Atlantic Ocean (Clusa *et al.*, 2014).

It can travel very far from the coast and to considerable depths, even more than 100 m, but usually stays close to rocky coasts, lagoons, large inlets and river mouths. It is the smallest of the Mediterranean turtles, reaching a length of 110 cm, with a weight ranging from 100 kg to 180 kg, and is estimated to live between 13 and 30 years.

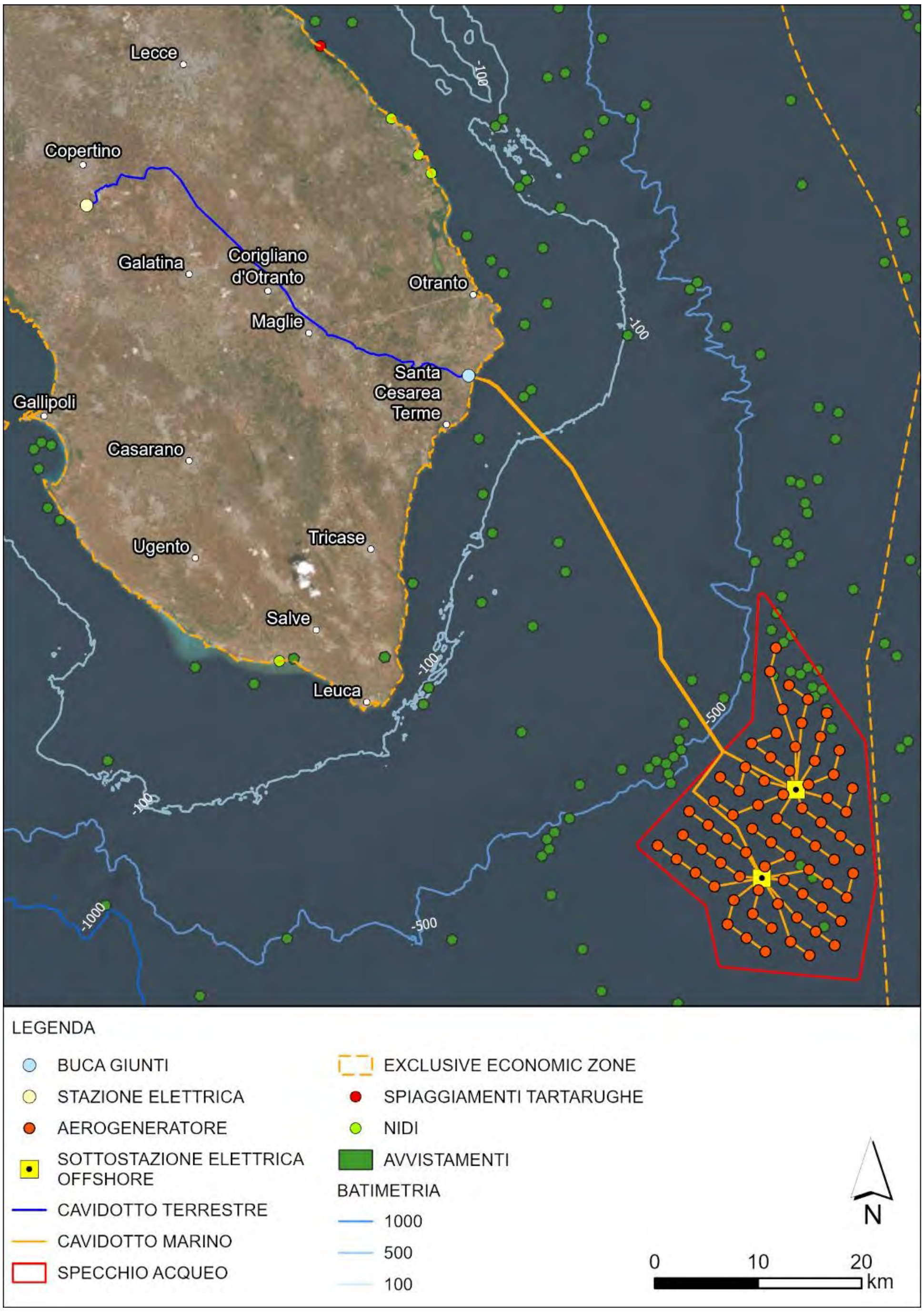
The reddish-brown carapace of young turtles has a serrated dorsal keel, while the plastron is yellowish in colour. The head is covered with scales and two pairs of prefrontal scales are also present between the eyes. A distinctive feature between males and females is the tail, which is significantly longer in males.

Based on available data, it appears that in the Mediterranean, *Caretta caretta* can nest when it reaches a length of about 60 cm, a size that is assumed to be reached after 10 years. Egg laying usually takes place at night and involves the release of 40 to 190 white, spherical eggs with a leathery consistency. The size of the eggs depends on the size of the mother, but on average they are around 4 cm in diameter and weigh approximately 35 g. The nesting period in the Mediterranean is from late spring to early autumn and probably consists of between 1 and 3 clutches per season. In the Mediterranean, the laying sites are mainly located in the east and include the coasts of Greece, Turkey, Cyprus and Libya.

The diet includes both benthic organisms and planktonic animals such as some jellyfish and gelatinous organisms that form colonies several metres long, such as salps. It also feeds on fish such as seahorses and pipefish that frequent Posidonia meadows.

This species has been recorded in both the western Ionian Sea and the southern Adriatic Sea. Distribution and density estimates carried out in the three-year period 2010-2013 in the Adriatic Sea showed an average value in the basin of approximately 2 individuals per 10 km(2) ,with a higher density in the northern sector (Fortuna *et al.,* 2018). Figure 5-91 shows that it is very likely that the turtle frequents the Project Area; no nesting sites have been identified along the coast between Otranto and Santa Maria di Leuca.

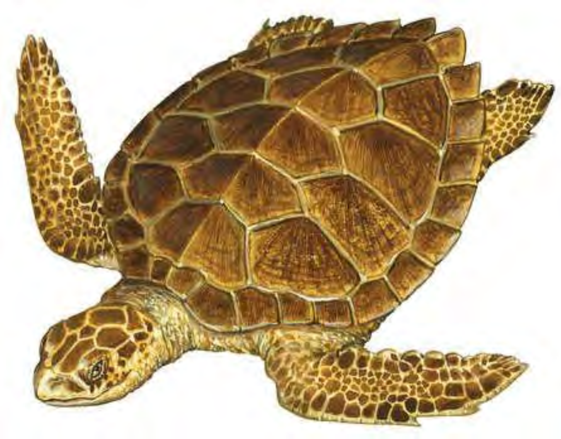
Figure 5-91 Distribution map of Caretta caretta records along the Apulian coast and project location. Data include strandings, sightings and nesting.



Source: EMODNet data processing, 2023

Chelonia mydas

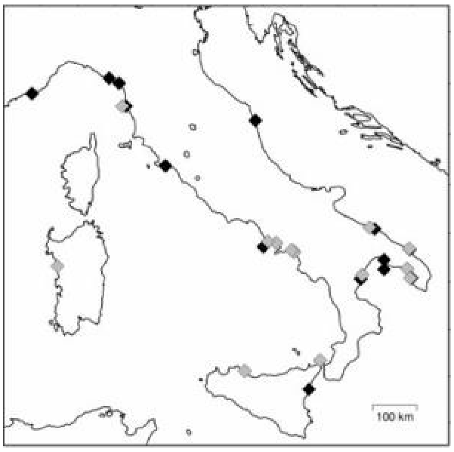
Figure 5-92 Chelonia mydas



Source: artescienza.org, 2024

It is relatively rare in the Mediterranean Sea and can be observed almost exclusively in the eastern basin, with main breeding areas along the southern coasts of Turkey, Syria and Cyprus (Kasparek *et al.*, 2001). The species frequents Italian waters, probably driven by the search for food, limited to the warmer seasons (Bentivegna *et al.,* 2011) (Figure 5-93).

Figure 5-93 Map showing the location of green turtle strandings/sightings in Italian waters



Black symbols indicate locations where dead turtles were found, grey symbols indicate locations where live turtles were found.

Source: Bentivegna et al., 2007

Dermochelys coriacea

Figure 5-94 Dermochelys coriacea

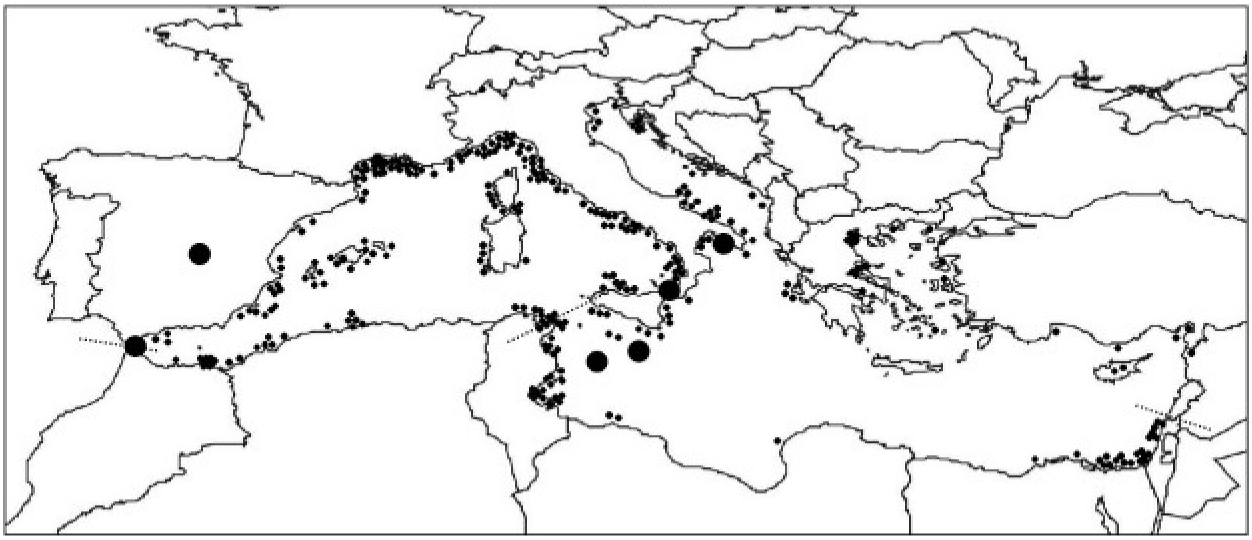
Source: NOAA Fisheries, 2024

Dermochelys coriacea is a cosmopolitan species, found in various areas (except for polar regions), displaying the widest distribution range among sea turtles. Mediterranean individuals are part of the North Atlantic population and enter the basin via the Strait of Gibraltar (Caracappa *et al.,* 2017; Karaa *et al.,* 2013). These are adult individuals, both male and female, but no nesting sites have been identified.

It has been occasionally observed in the Southern Adriatic and the Ionian Sea, although its presence in the Project Area is unlikely.

Taking into account only specimens caught in nets, most (84.4%; n=32) were caught on the western side (Tyrrhenian Sea). Although it cannot be ruled out that this difference is due to different fishing efforts, this pattern is consistent with a strong west-east gradient, with most records in the western basin explained by the Atlantic origin of the specimens (Casale *et al.,* 2003).

Figure 5-95 Geographical distribution of Dermochelys coriacea sightings in the Mediterranean



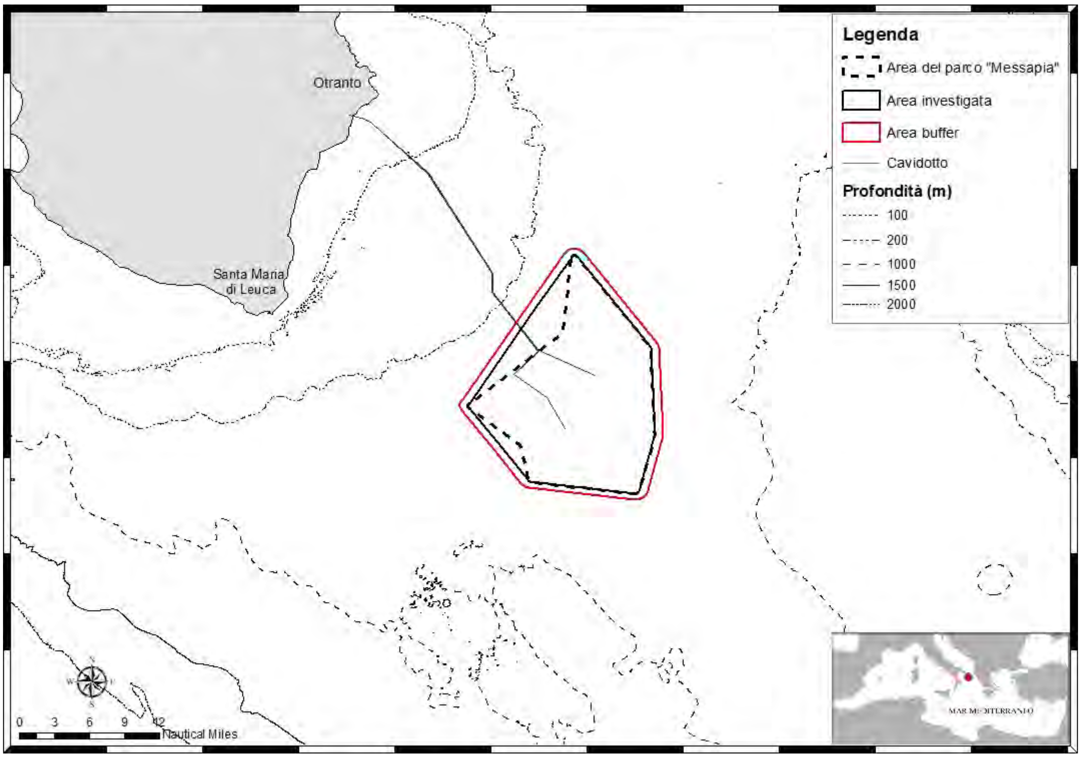
The size of the circles represents the number of records.

Source: Casale et al., 2003.

<u>*Results of geophysical and environmental monitoring campaigns*</u>

In order to document the presence of sea turtles in the Project Area, a one-year pre-operational monitoring plan was scheduled with seasonal campaigns of 7 transects each, for a total of 28 transects, in order to obtain a complete investigation of the park's surface area. The monitoring campaigns, each consisting of seven transects, took place in the following seasons: winter (6-8 March 2024), spring (13, 14, 19 and 20 May 2024), summer season (7, 8 and 12 August 2024) and autumn season (2, 3 and 6 October 2024). The sea area covered by the survey was larger than the perimeter of the park concession (approximately 476 km^2), and was further extended by a 1 km buffer, for a total area of approximately 652 km^2 (Figure 5-96).

Figure 5-96 Area covered by the survey



Source: Offshore sector – environmental survey report (

Sea turtle monitoring was carried out through visual sampling by ACCOBAMS-certified operators, using the Conventional Distance Sampling (CDS, Buckland *et al.*, 2001, 2004), which allows the density or abundance of a species in an area to be estimated by creating linear or point transects where the perpendicular distances from the animals sighted, the number of individuals and the search effort (km or NM) are recorded.

In particular, among the methods listed in the CDS, the "zig-zag line transect sampling" method was adopted, which involves the use of linear transects that run through the study area following a zig-zag path, with a length established for these campaigns of approximately 20 nm.

The data collected during the campaigns carried out to date are shown in Table 5.39.

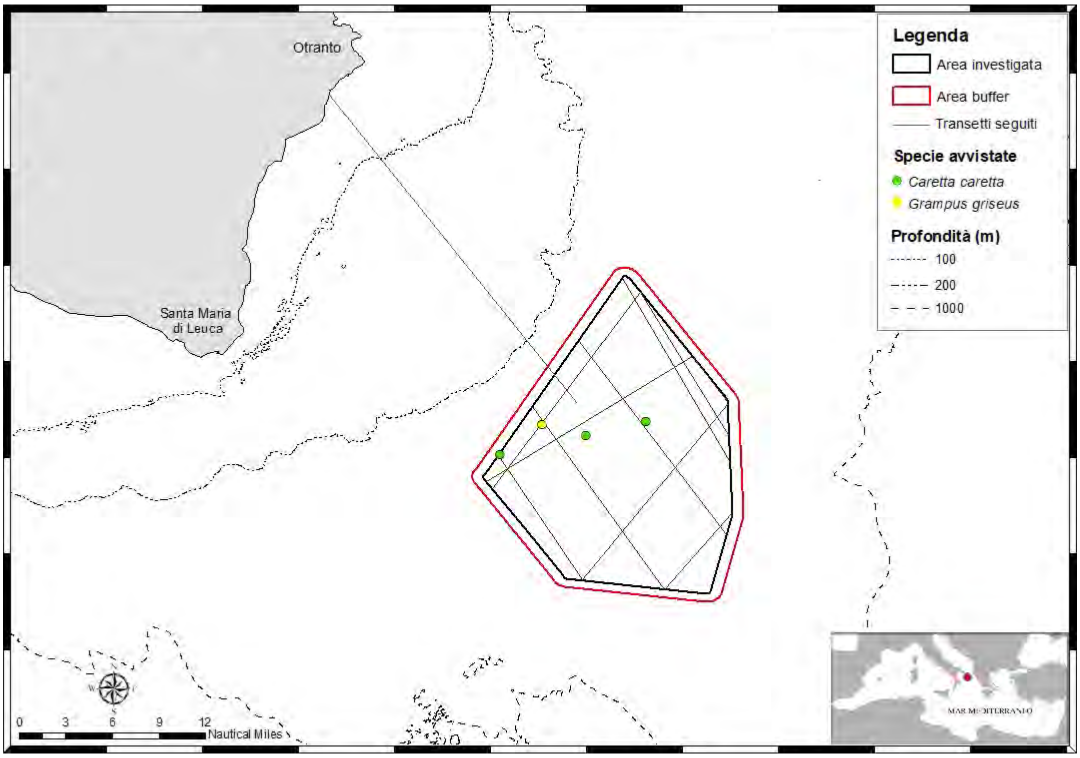
Table 5.39 Summary of monitoring activities with indication of sampling effort in nautical miles travelled, sampling date, species sighted, number of individuals and depth at which they were sighted.

Season	Effort (NM)	Date	Species	No. of individuals	Depth (m)
Winter	138.7	06/03	-	-	-
		07/03/2024	-	-	-
		08/03/2024	*C. caretta*	1	645
			C. caretta	1	580
			C. caretta	1	555
Spring	136.65	13	-	-	-
		14/05/2024	-	-	-
		19/05/2024	-	-	-
		20/05	*C. caretta*	1	542
			C. caretta	1	589
			C. caretta	1	700
			C. caretta	1	730
			C. caretta	1	800
Summer	120.70	07/08/2024	-	-	-
		08/08/2024	-	-	-
		12/08/2024	*C. caretta*	1	700
Autumn	128.50	07/10/2024	*C. caretta*	1	765
		08/10/2024	*C. caretta*	1	776
			C. caretta	1	691
			C. caretta	1	623
		11/10/2024	-	-	-

Source: Offshore sector – environmental survey

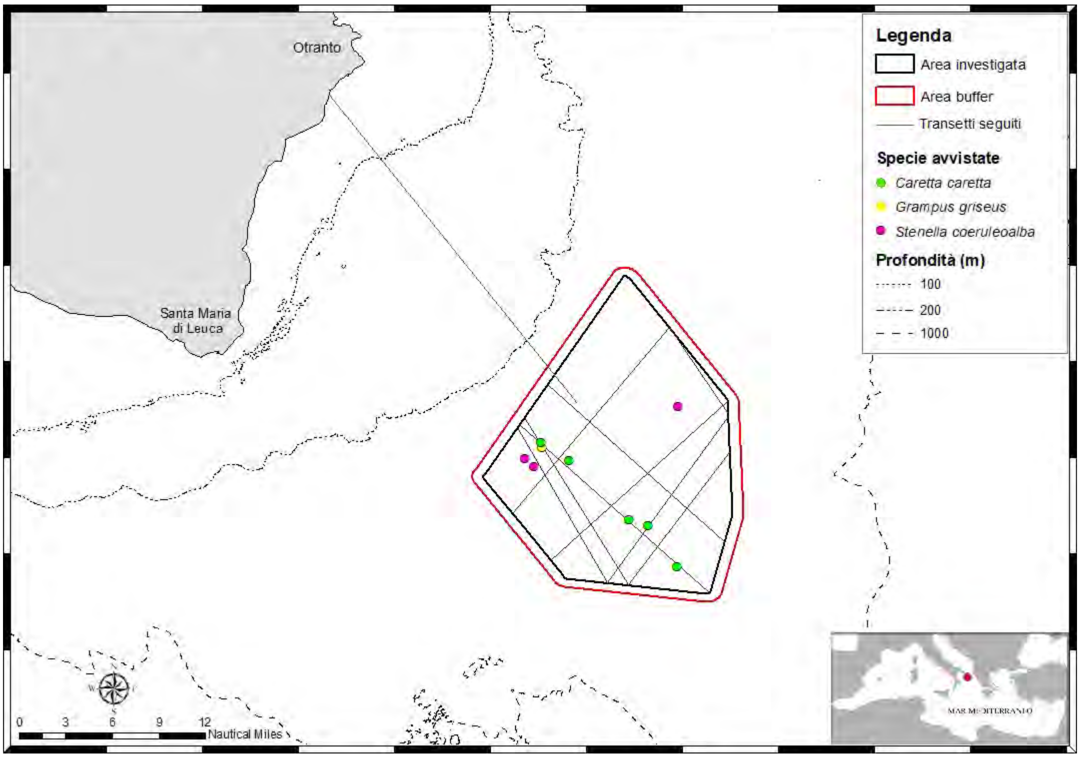
During the winter survey, three specimens of Caretta caretta were sighted at depths ranging from -555 m to -645 m (Figure 5-97), while during the spring survey, five specimens of Caretta caretta were sighted at depths ranging from -542 m to -800 m (Source: 'Environmental survey, Figure 5-98).

Figure 5-97 Map of transects followed and sightings made during the winter monitoring campaign of the Messapia offshore floating wind farm.



Source: Offshore sector – environmental survey

Figure 5-98 Map of transects followed and sightings made during the spring monitoring campaign.



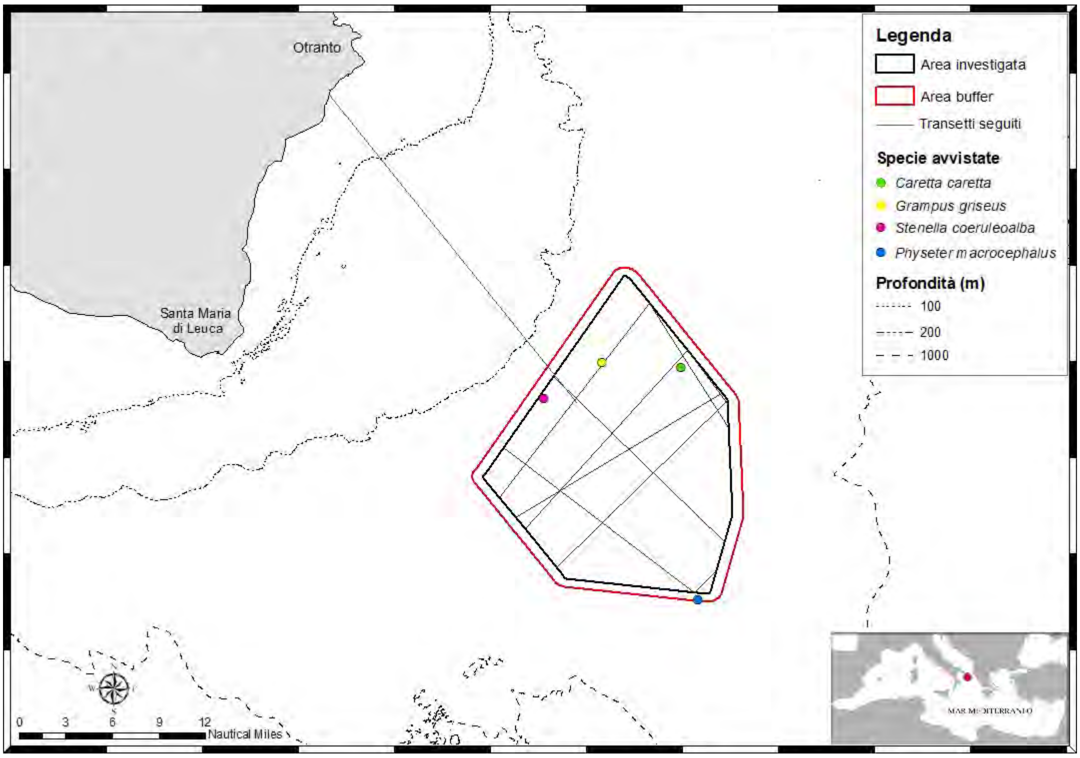
Source: Offshore sector – environmental survey

Figure 5-99 Examples of C. caretta sightings during winter (left) and spring (right) monitoring campaigns at the Messapia offshore floating wind farm.

Source: Offshore sector – environmental survey

During the summer monitoring campaign, a single specimen of *Caretta caretta* was identified at a depth of -700 m (Figure 5-100).

Figure 5-100 Map of transects followed and sightings made during the summer monitoring campaign.



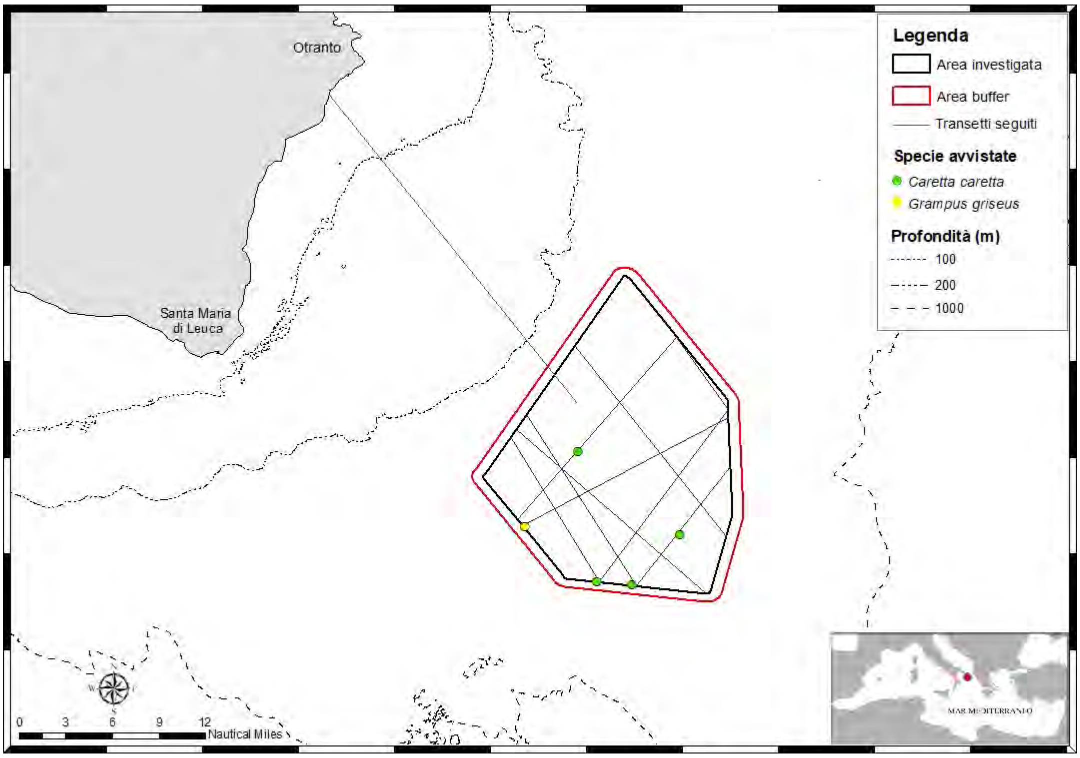
Source: Offshore sector – environmental survey

Figure 5-101 Example image of Caretta caretta sighting during the summer monitoring campaign of the Messapia offshore floating wind farm.

Source: Offshore sector – environmental survey

During the autumn monitoring campaign, a total of four individual *Caretta caretta* specimens were observed during the first two transects, at depths between -623 m and -765 m.

Figure 5-102 Map of transects monitored and sightings made during the autumn monitoring campaign.



Source: Offshore sector – environmental survey

Figure 5-103 Examples of Caretta caretta sightings during the autumn monitoring campaign at the Messapia offshore floating wind farm.

Source: Offshore sector – environmental survey

In conclusion, a total of 13 *Caretta caretta* specimens were observed during the monitoring campaigns*:* 3 in winter, 5 in spring, 1 in summer and 4 in autumn, with bathymetric depths always greater than -500 m.

5.11.1.7 Avifauna and Migratory Routes

Stretching like a natural bridge between Europe and Africa, Italy as a whole is a route of utmost importance for a wide range of species and huge numbers of migratory birds. Like many other regions, Puglia is a transit region during migration but also a favourable area for nesting and raising young. Italy is crossed by migration twice a year, in spring when wildlife populations leave their wintering grounds in Africa and reach Europe to nest, and in autumn when they leave Europe to spend the winter on the southern shores of the Mediterranean Sea or south of the Sahara. Migration can therefore be defined as a recurring and periodic movement in alternating directions.

In order to assess the main migratory routes that characterise the Italian context, ISPRA has carried out several monitoring campaigns in the past, the results of which have been published in the 'Atlante della Migrazione degli Uccelli in Italia, Passeriformi e non Passeriformi' (Atlas of Bird Migration in Italy, Passerines and Non-Passerines). Spina F. Volponi S., 2008. Together with this document, the Atlante delle migrazioni in Puglia (La Gioia & Scebba 2009) is also of great interest for a preliminary assessment of the Apulian migratory system.

The main migratory route in Europe is north-east to south-west. Between the departure and arrival areas, there are intermediate stopover areas along the route, where migrating birds find favourable environmental conditions, food and shelter where they can rest and refuel before continuing their flight. In Italy, one of the main stopovers is the Venetian Lagoon. To reach the areas covered by this study, the species then head along the coast in a north-west/south-east direction to Lake Lesina and Varano. From these two important wetlands, they then disperse throughout the territory.

As for species coming from the south-east, they usually arrive along the Apulian coast. After landing on the Salento peninsula, migratory birds pass through rest areas located along the route (Le Cesine, Torre Guaceto, Laghi Alimini, etc.) before reaching the Sipontine Marshes. Species coming from the east, on the other hand, use the route of the small islands (including the Tremiti Islands) that connect the shores of the Adriatic, reducing the stretch of open sea to be crossed (Figure 5-104). In good weather conditions and without obstacles (mountain ranges), the flight altitude for many bird species is usually between 300/400 m and 800/900 m above sea level, where the air is more stable, resulting in considerable energy savings.

Figure 5-104 Main migratory routes of birdlife in the Adriatic sector. The project area is circled in red.

Source: ISPRA, 2008

The data available and reported in the 'Atlas of Migration in Puglia' has provided important information for understanding the status of some species in the Area Vasta. Laridae nesting in Puglia (lesser black-backed gull, black-headed gull, herring gull and roseate gull) migrate to winter along the entire western Mediterranean coast, although with a preference for an east-west direction, and some go as far as the Atlantic (black-headed gulls and, above all, herring gulls show continuous movements between the two sides of the Adriatic). The nesting areas, and therefore the areas of origin, of individuals wintering in Puglia are mainly located in Central Europe and Scandinavia, with an average direction of origin of 15°, although these locations are distributed throughout Europe from Spain to central Russia. The Mediterranean gulls and black-legged kittiwakes wintering in Puglia, on the other hand, come largely from the Black Sea, crossing the Adriatic. Furthermore, the birds engaged in autumn migration come mainly from the north, although, especially in July and August, the departure areas are quite scattered, ranging from the Netherlands to central Russia.

Although birds, at least non-seabirds, tend to avoid large stretches of sea, which could prove fatal if they run out of the resources necessary for crossing, numerous sightings of different species of birds unable to swim (black-bellied sandpiper, kingfisher, skylark, song thrush, blackbird, blackcap, starling, greenfinch) suggest that crossing the lower Adriatic Sea can be easily accomplished.

About 28 km from the offshore area of the wind farm is the IBA area "Coast between Capo d'Otranto and Capo S. Maria di Leuca (IBA147)". This area includes the entire stretch of high, rocky coastline between Otranto and Santa Maria di Leuca. It is the stretch of coastline most used by migratory birds of prey and also includes some agricultural areas of particular interest for resting and foraging. The IBA has been designated for its importance as a "bottleneck" for birds of prey migrating along the Adriatic coast in spring. The IBA fact sheet reports that more than 3,000 migratory birds of prey pass through the area each spring, but the data are incomplete and outdated.

The study by La Gioia *et al.* (2009), on the other hand, reports data relating to surveys carried out in the springs of 2005-2006. The maximum number of birds of prey sighted in a single day was 147 in 2005 and 63 in 2006, with a total of 3,009 birds recorded: 1,791 in 2005 and 1,218 in 2006. The daily average number of birds of prey sighted is very similar between the two years, 21.84 and 17.40 respectively, but the very high standard deviations indicate large differences in numbers between days. In addition, specimens belonging to a total of 21 species of birds of prey were sighted, 19 in 2005 and 16 in 2006, and one subspecies (steppe buzzard *Buteo b. vulpinus)*. The percentage of specimens considered to be migrating compared to the total number of daily sightings is approximately 60%. This percentage varies greatly between the species observed: it is very high in some species, reaching 100%, while it is very low in others, especially kestrels and little bustards. The most numerous species was the honey buzzard, followed by the marsh harrier, with 524 and 486 specimens migrating in the two years of the study, respectively. The lesser kestrel, the lesser spotted eagle and the cuckoo falcon also reached reasonable numbers, followed by the pallid harrier and the black kite. However, the number reported for the lesser kestrel is probably not entirely realistic (see specific description of the species).

Table 5.40 Data relating to spring migration in the Salento area

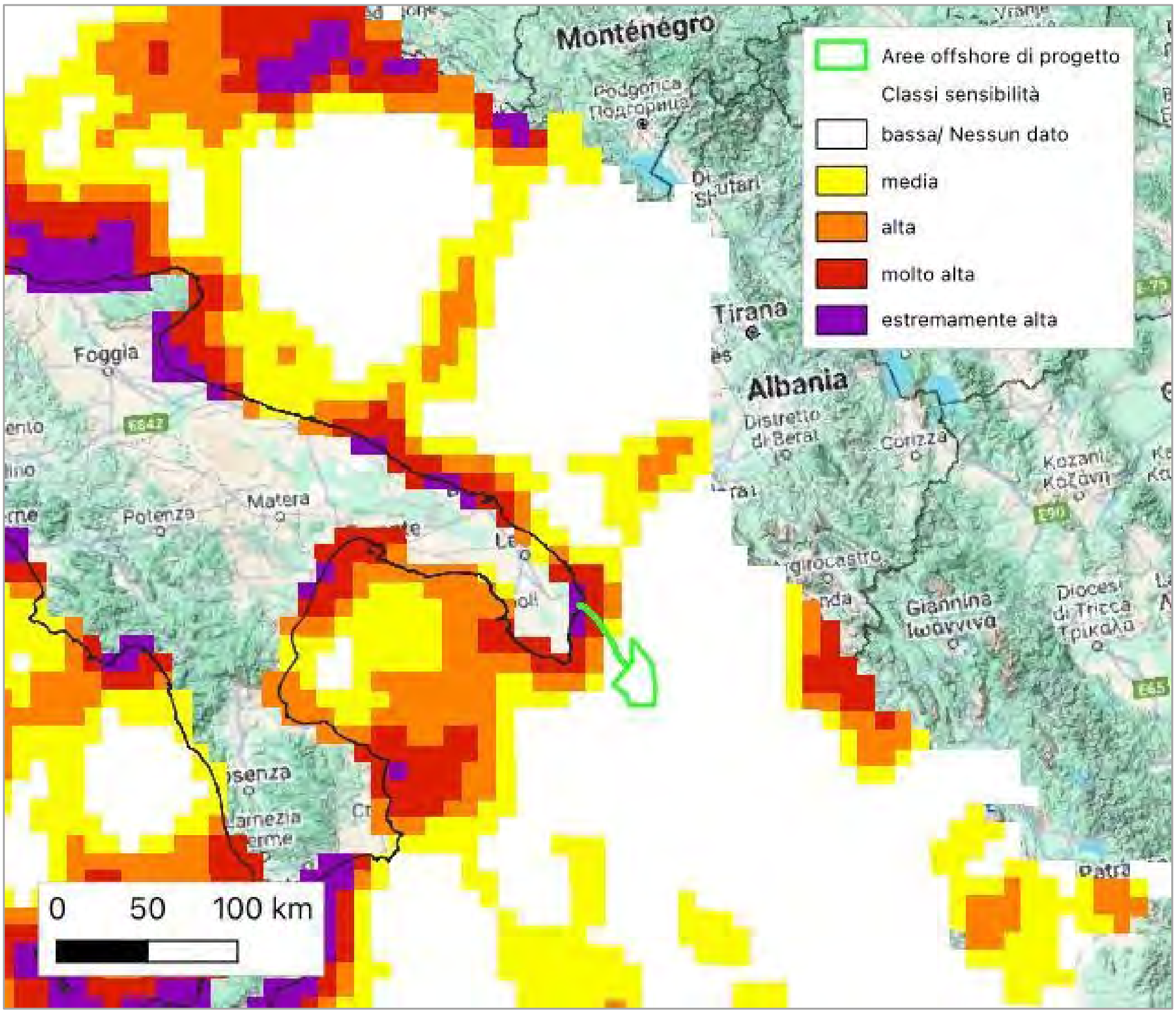
Species	2005		2		Total	
	No. of migrants	% of total	No. of migrants	% of total	No. of migrants	% of total
Lesser kestrel	3	97	1	90.23	524	95.10
Marsh harrier	251	69.34	235	71.43	4	70.33
Grillaio	137	23.50	123	43.77	260	30.09
Lesser kestrel	111	47.84	101	59.76	2	52.87
Cuckoo falcon	56	62.92	83	64.84	1	64.06
Pallid harrier	27	44.26	17	43.59	44	44.00
Black kite	21	100.00	21	80.77	42	89.36
White-tailed buzzard	9	81.82	2	15.38	1	45.83
Common buzzard	9	100.00	1	100	1	100.00
Buzzard	3	50.00	7	100.00	10	76.92
Lodolaio	5	100.00	4	30.77	9	50.00
Lesser kestrel	5	55.56	3	75.00	8	61.54

Species	2005		2006		Total	
Steppe buzzard	6	75.00			6	75
Pilgrim	4	57.14	2	100.00	6	66.67
Sparrowhawk	1	100.00	2	100.00	3	100.00
Queen's falcon	2	100.00			2	100.00
Osprey			2	66.67	2	66.67
Kestrel	1				1	
Lanner falcon	1	100.00			1	100.00
Smeriglio	1	100.00			1	100.00
Mallard minor			1	1	1	1
Circus sp.	1	62.50	3	37.50	13	54.17
Grillaio/Kestrel	19	55.88	3	100.00	2	59.46
Falco sp.	13	41.94	1	100.00	14	43.75
Buteo sp.	2	100.00			2	100.00
Unidentified birds of prey identified	5	100.00	14	100.00	19	100.00
TOTAL	**1,066**	**56.79**	**782**	**64.20**	**1,848**	**59.71**

Source: La Gioia et al., (2009)

The Messapia wind farm area is located in a context of low sensitivity or lack of data for migratory movements, while the connection works affect coastal areas with higher sensitivity classes up to extremely high (Figure 5-105).

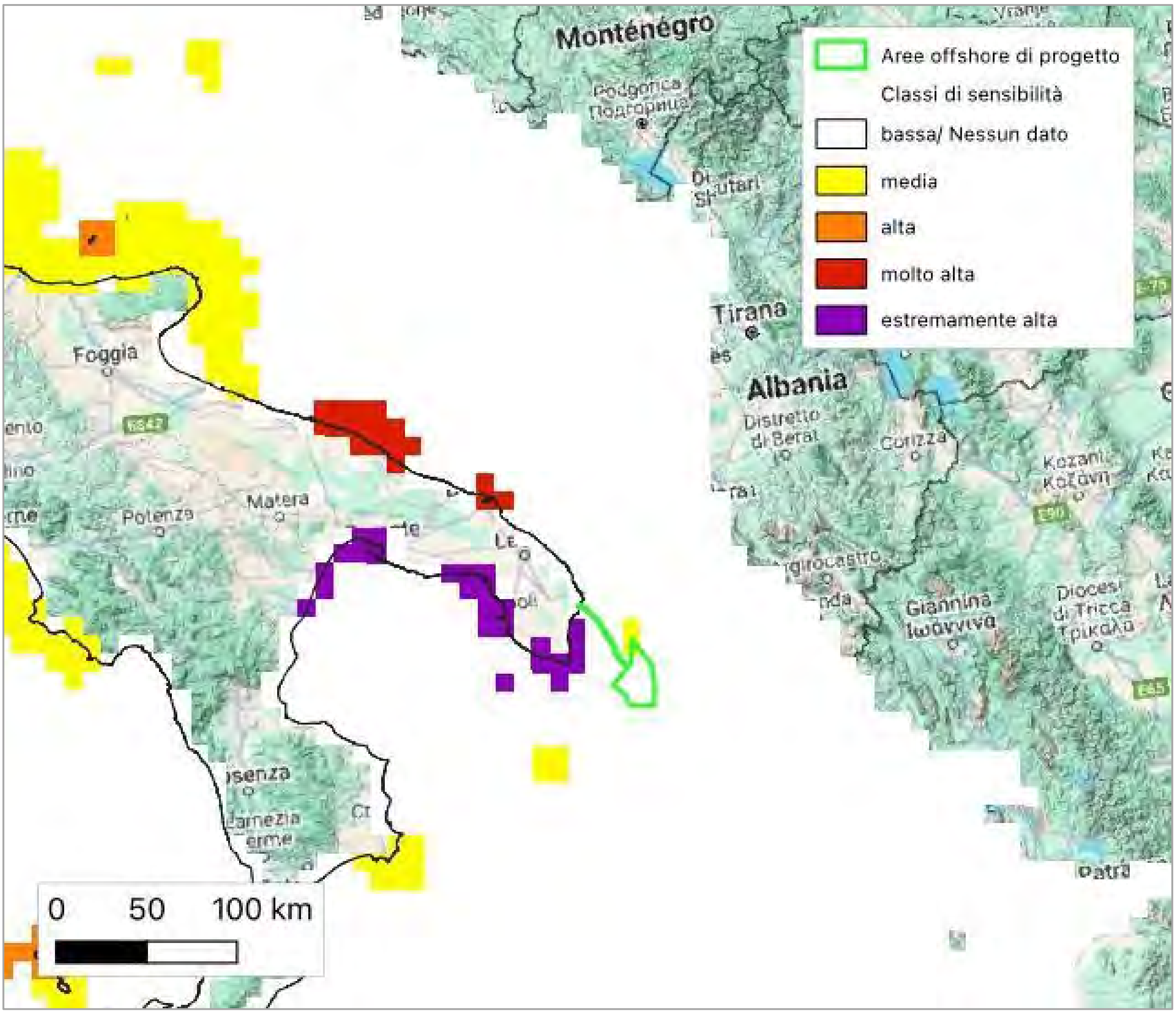
Figure 5-105 Location of the project area in relation to areas of sensitivity to migratory movements



Source: ISPRA 2021

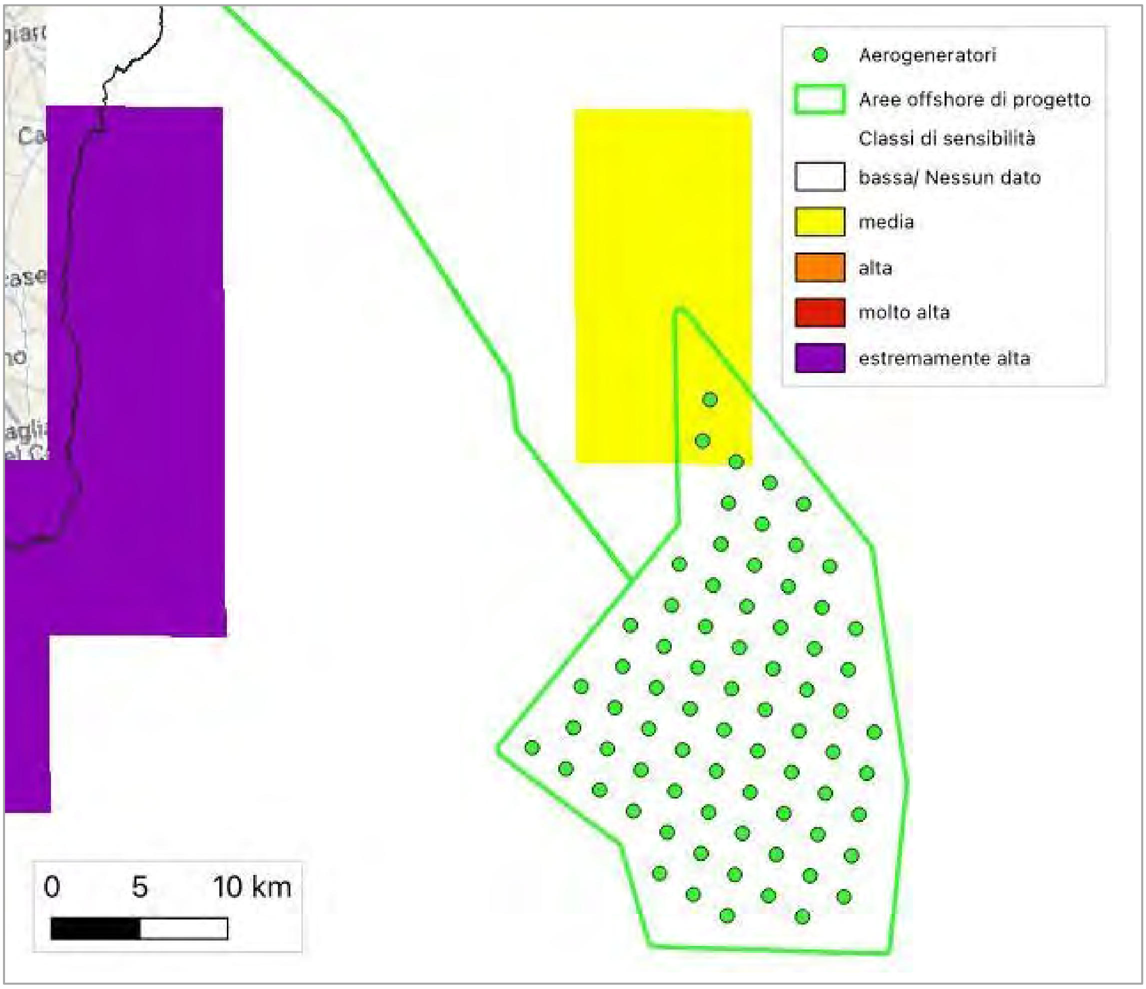
With regard to foraging movements during the breeding season, the Project is located in an area with low sensitivity or no data, although it is adjacent to and slightly overlaps with an area of medium sensitivity (Figure 5-106), which directly affects only the three northernmost wind turbines (Figure 5-107).

Figure 5-106 Location of the Project area in relation to areas sensitive to seabird movements in feeding areas during the breeding season



Source: ISPRA 2021

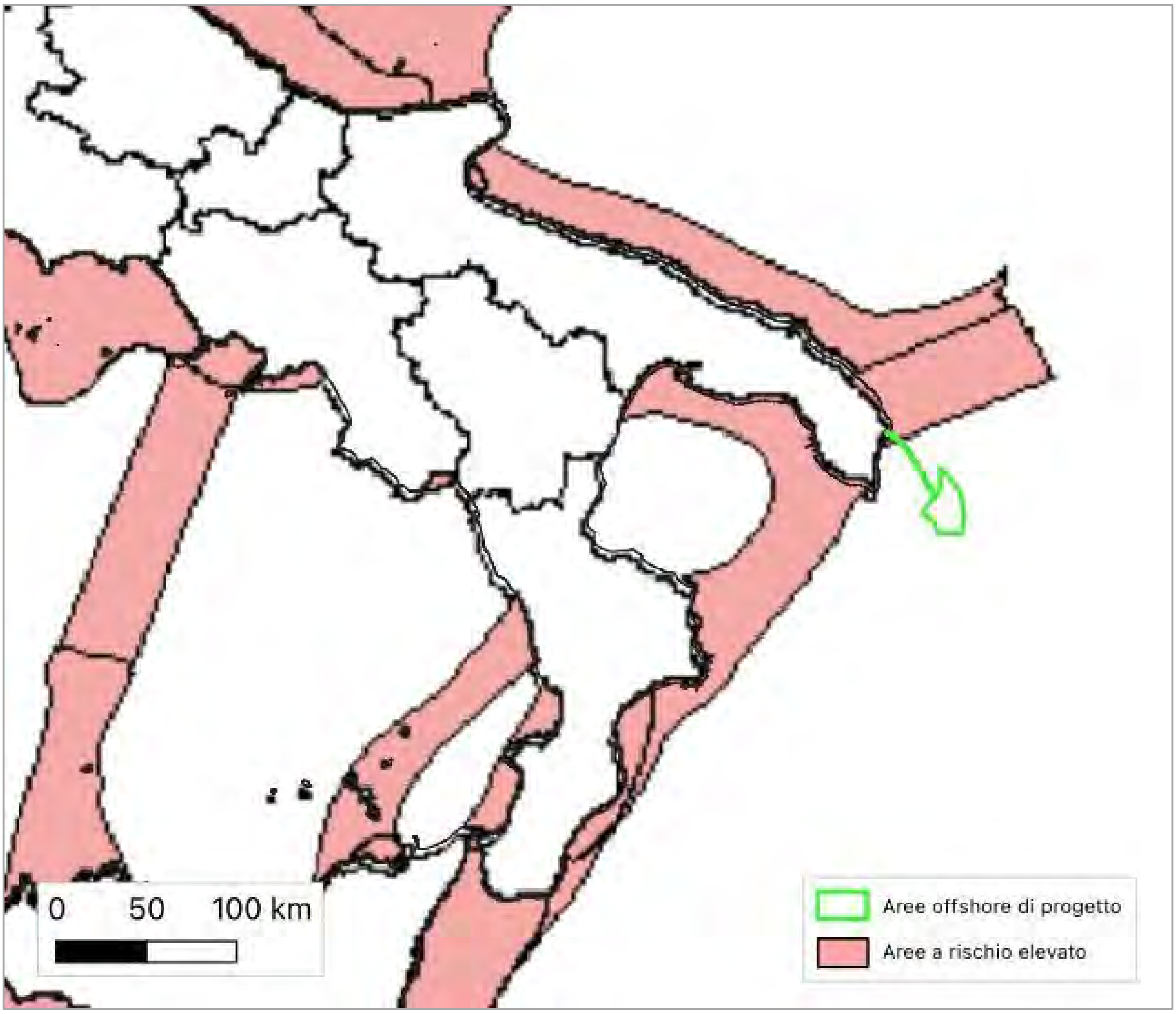
Figure 5-107 Detail of the location of the Project area in relation to sensitive areas for seabird movements in feeding areas during the breeding season



Source: ISPRA 2021

In addition, LIPU, together with the group led by Gustin et al. (2024), carried out a further risk map for birdlife based on the most recent data available. The project area does not fall within the areas of greatest risk for birdlife, and the connection works only intersect a high-risk area near the coast for a few kilometres (Figure 5-108).

Figure 5-108 Location of the Project area in relation to areas of high risk for birdlife (in red) from offshore wind farms



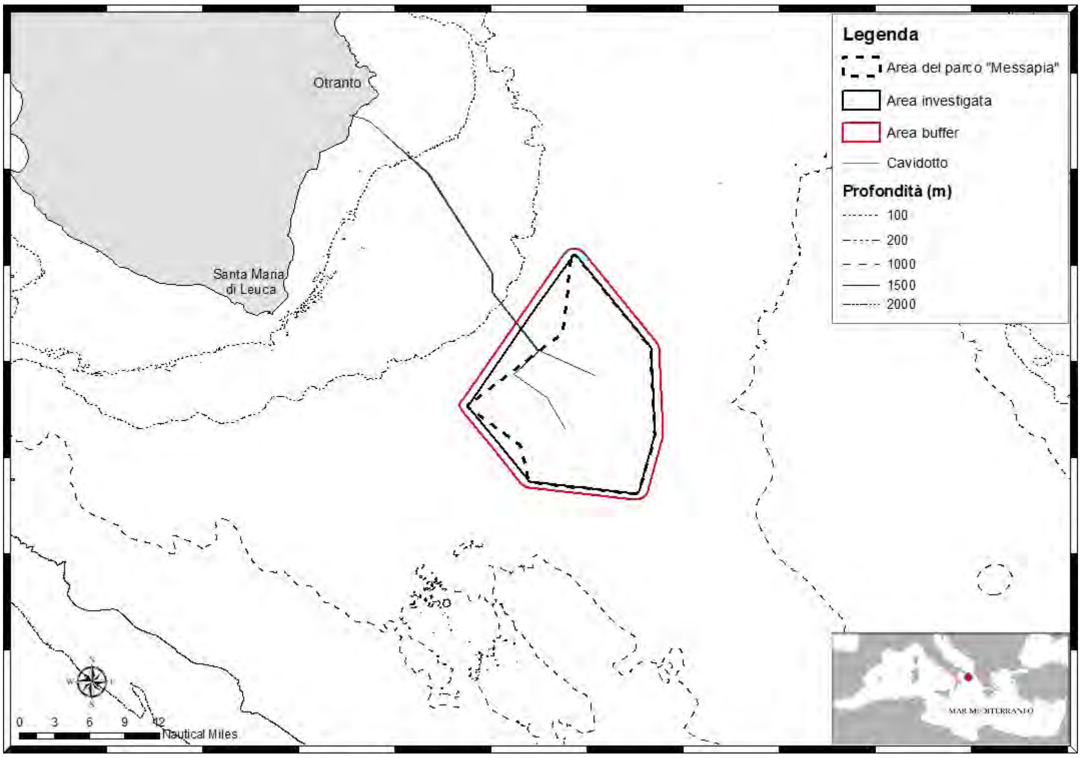
Source: *Gustin* et al. *2024*

<u>*Results of geophysical and environmental monitoring campaigns*</u>

In order to document the presence of seabird species, a one-year *pre-construction* monitoring plan was drawn up, consisting of seasonal campaigns of seven transects each, for a total of 28 transects, so as to obtain a complete survey of the park's surface area. The monitoring campaigns took place in the following seasons: winter (6-8 March 2024), spring (13, 14, 19 and 20 May 2024), summer (7, 8 and 12 August 2024) and autumn (7, 8
and 11 October 2024).

The sea area covered by the survey was larger than the perimeter of the park concession (approximately 476 km^2), and was further extended by a 1 km buffer, for a total area of approximately 652 km^2.

Figure 5-109 Area covered by the survey



Source: Offshore sector – environmental survey

Monitoring is mainly focused on seabirds nesting in the Mediterranean (great shearwater, Mediterranean shearwater, storm petrel) and the main species of wintering seabirds (terns, deep-sea gulls, skuas), in order to estimate their density (number of individuals/km2) on standardised linear transects (*line transects)*, based on the principles of distance sampling. Only birds in flight or perched on the water within an imaginary strip 300 m wide and perpendicular to the direction of navigation are taken into account and counted.

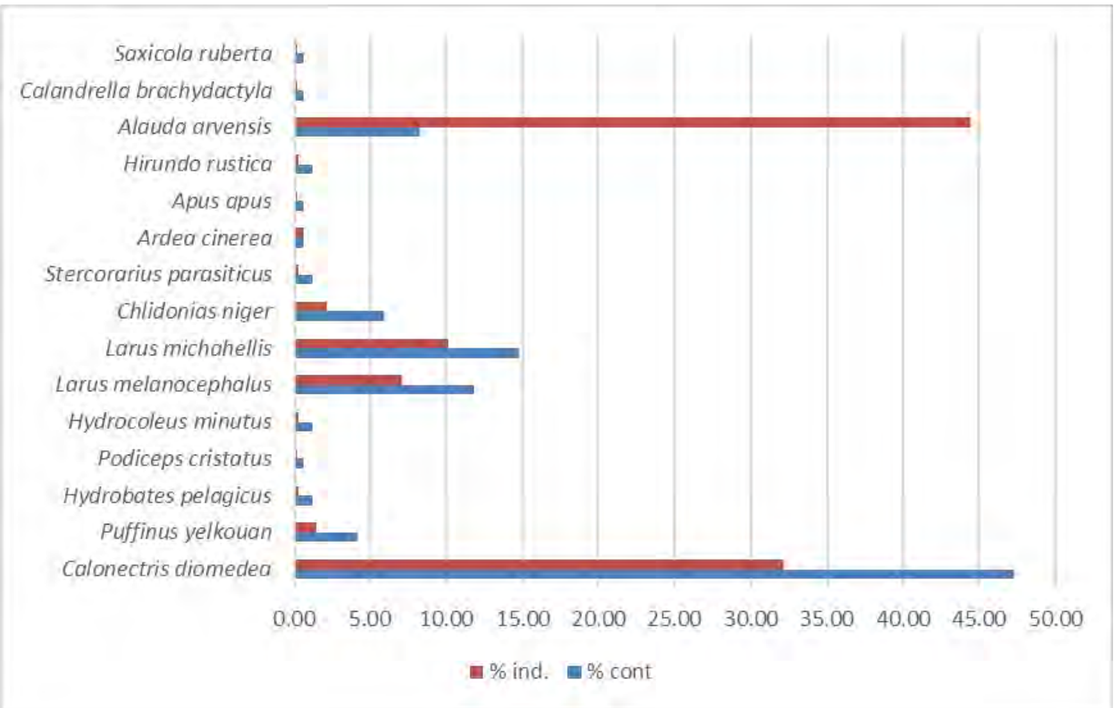
During the monitoring seasons, 169 contacts were made and 621 birds belonging to 15 species were observed, of which 6 were non-marine:

- 3 species of Procellariiformes: Storm petrel (*Hydrobates pelagicus),* Cormorant (*Calonectris diomedea*), Lesser Shearwater (*Puffinus yelkouan);*
- 1 species of Podicipediformes: Great crested grebe (*Podiceps cristatus)*;

- 5 Caradiformes: Little tern (*Hydrocoleus minutus*), Mediterranean gull (*Larus melanocephalus*), Yellow-legged gull (*Larus michahellis*), Black tern (*Chlidonias niger*) and Arctic tern (*Stercorarius parasiticus);*
- one Pelecaniformes: the Grey Heron (*Ardea cinerea*);
- one Caprimulgiformes: Common Swift (*Apus apus*);
- 4 Passeriformes: Barn Swallow (*Hirundo rustica*), Skylark (*Alauda arvensis*), Short-toed Lark (*Calandrella brachydactyla*) and Stonechat (*Saxicola ruberta*).

Figure 5-110 shows all the species observed with the relative percentage of contacts and numbers of individuals observed during the four monitoring campaigns carried out. The species Cory's shearwater (*Calonectris diomedea)* was found to have the highest number of contacts (47.3%).

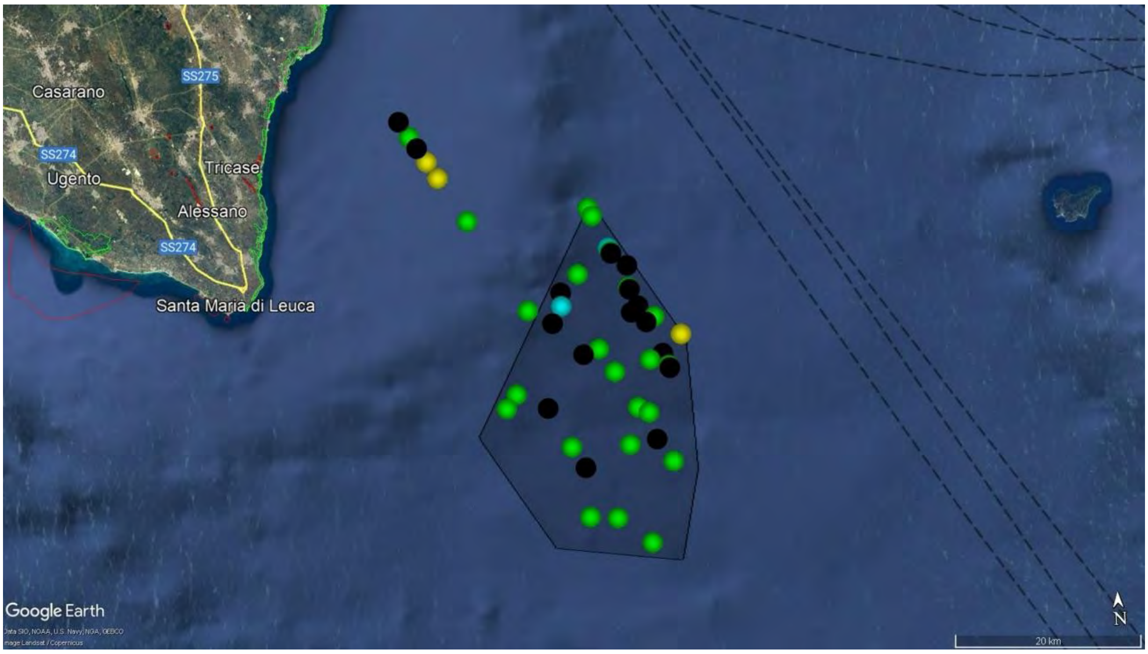
Figure 5-110 Percentage of individuals observed and number of contacts made during the four days of monitoring.



Source: Offshore sector – environmental survey

During winter monitoring, 69 sightings of 441 individuals belonging to 7 different species were made: Short-tailed Shearwater, Lesser Shearwater, Great Crested Grebe, Little Gull, Mediterranean Gull, Yellow-legged Gull and Skylark (Figure 5-111 and Figure 5-112).

Figure 5-111 Location of target species contacts in the Project Area during the winter monitoring campaign.



Note: green = greater shearwater; yellow = lesser shearwater; blue = little gull; black = Mediterranean gull Source: Offshore sector – environmental survey

Figure 5-112 Location of skylark contacts in the Project Area during the winter monitoring campaign.

Source: Offshore sector – environmental survey

Figure 5-113 Examples of sightings of Calocectris diomedea (left) and Alauda arvenis (right) during the winter monitoring campaign of the Messapia offshore floating wind farm.

Source: Offshore sector – environmental survey

During the spring monitoring campaign, 41 sightings of 49 individuals belonging to nine different species were made, including six marine species: storm petrel, greater shearwater, lesser shearwater, herring gull, sandwich tern, and three migrating passerines: corn bunting, swallow, and sand martin (Figure 5-114)..

Figure 5-114 Location of target species contacts in the Project Area during the spring monitoring campaign

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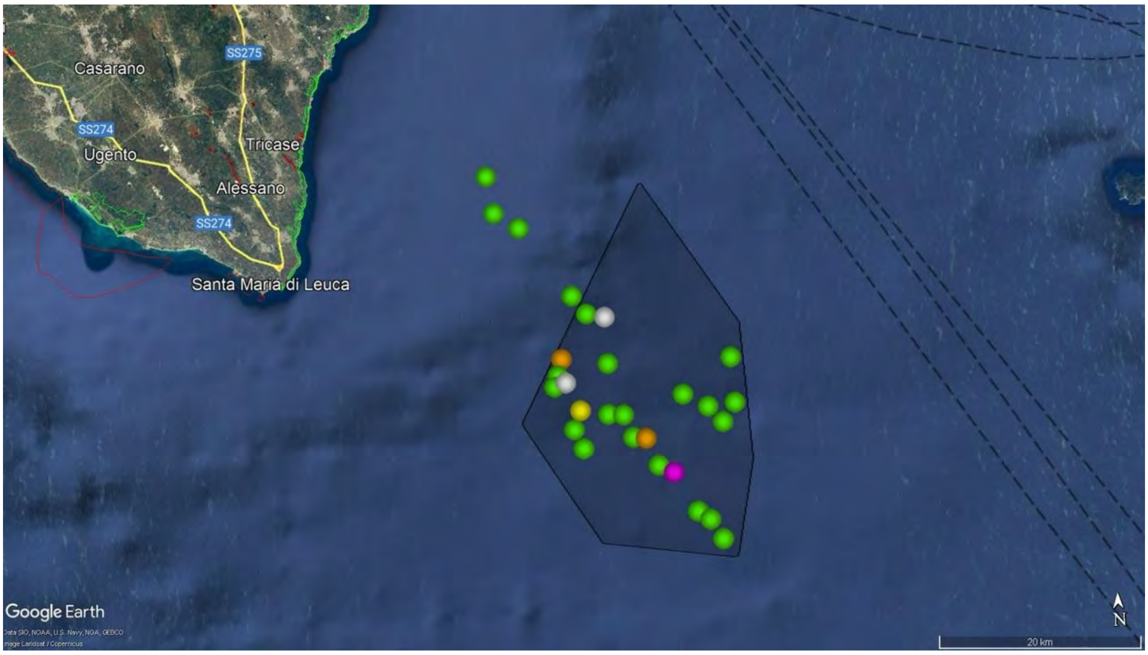
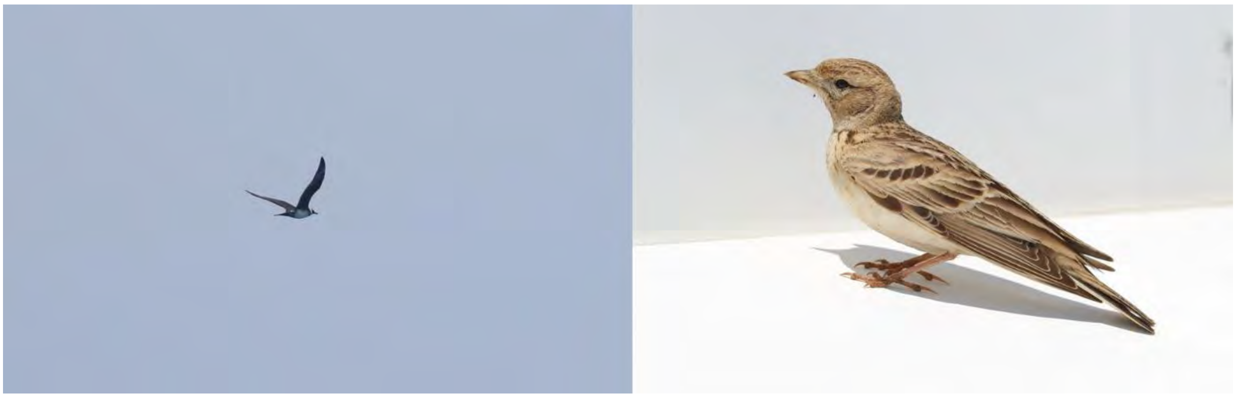


Note: yellow = Lesser Shearwater; green = Greater Shearwater; purple = Storm Petrel; white = Common Tern; orange = Labbeidae

Source: Offshore sector – environmental survey

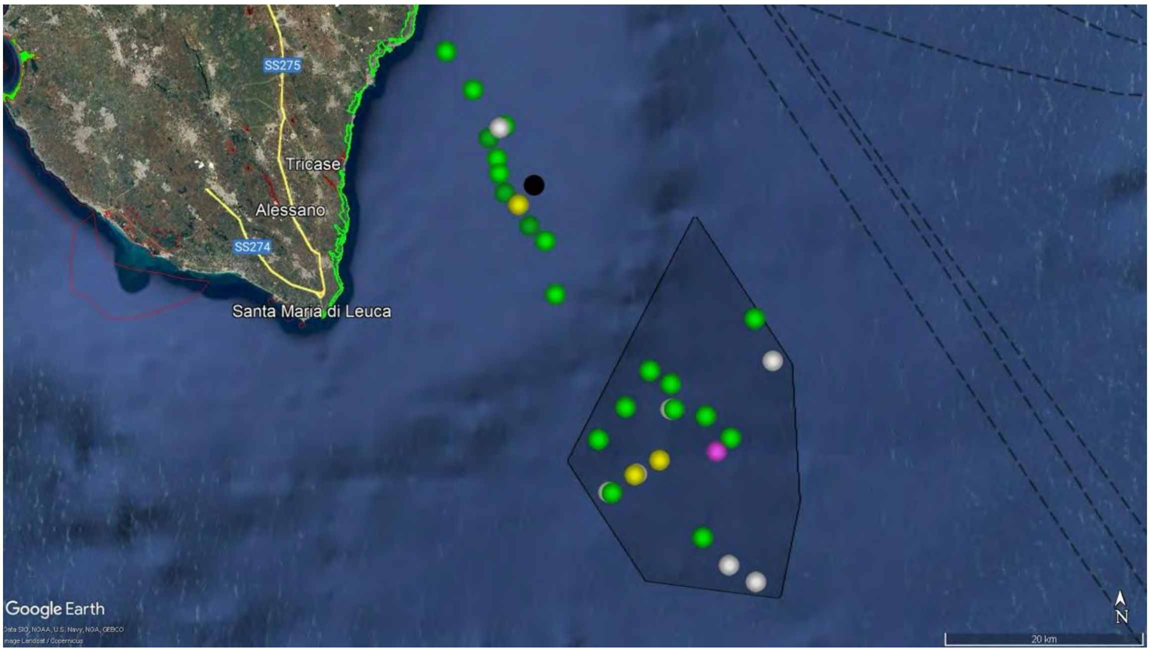
Figure 5-115 Examples of sightings of Stercorarius parasiticus (left) and Calandrella brachydactyla (right) during the spring monitoring campaign at the Messapia offshore floating wind farm.



Source: Offshore sector – environmental survey

During the summer campaign, 35 sightings were made, relating to 89 individuals belonging to 7 species, 6 of which were marine: storm petrels, greater shearwaters, lesser shearwaters, Mediterranean gulls, yellow-legged gulls and black-legged kittiwakes, to which should be added a common swift, probably migrating (Figure 5-116).

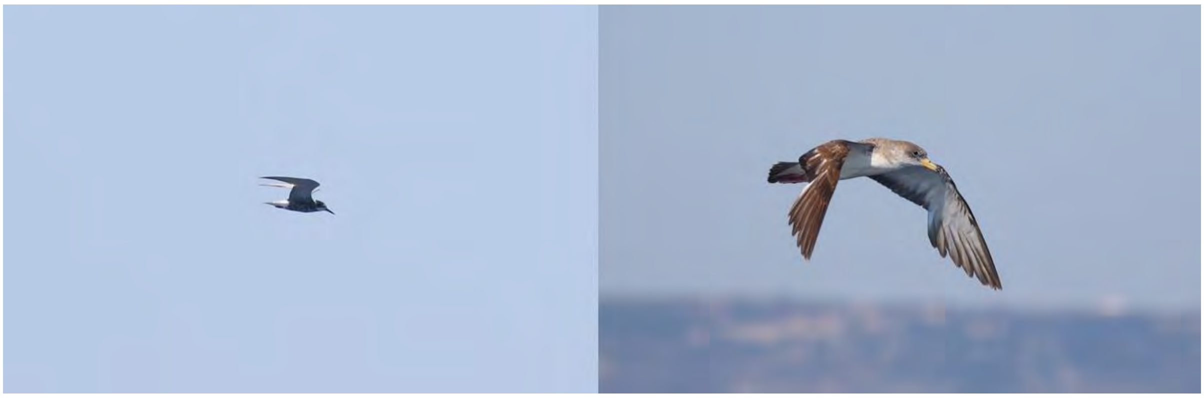
Figure 5-116 Location of target species contacts in the Project Area during the summer monitoring campaign.



Note: yellow = Lesser Shearwater; green = Greater Shearwater; purple = Storm Petrel; white = Common Tern; black = Mediterranean Gull

Source: Offshore sector – environmental survey

Figure 5-117 Examples of sightings of Chlidonias niger (left) and Calonectris diomedea (right) during the summer monitoring campaign of the Messapia offshore floating wind farm.



Source: Offshore sector – environmental survey

Finally, during the autumn monitoring campaign, 24 sightings were made, relating to 42 individuals belonging to five different species, including four marine species: Cory's shearwater, Mediterranean gull, yellow-legged gull and common tern, in addition to one sighting of four migrating grey herons (Figure 5-118).

Figure 5-118 Location of target species contacts in the Project Area during the autumn monitoring campaign.

Note: green = Lesser Black-backed Gull; white = Common Tern; black = Mediterranean

Gull Source: Offshore sector – environmental survey

Figure 5-119 Examples of sightings of Larus melanochephalus (left) and Larus michahellis (right) during the autumn monitoring campaign at the Messapia offshore floating wind farm.

Source: Offshore sector – environmental survey

In conclusion, the number of specimens sighted during the winter monitoring campaign (441) is far greater than the numbers recorded during other campaigns (49 in spring, 89 in summer and 42 in autumn). Among the species considered targets for monitoring, the importance of the area under study for the Cory's Shearwater (47.3% of contacts) and the Mediterranean Gull (14% of contacts) is highlighted, while the area appears to be unrepresentative for the Lesser Shearwater and other pelagic species.

5.11.1.8 Marine mammals

Marine mammals can be divided into four different taxonomic groups: cetaceans, pinnipeds, marine fissipeds and sirenians. These species play a fundamental ecological role in maintaining the balance of the marine ecosystem, but despite this, they are subject to numerous threats, both anthropogenic and natural.

There are eight regular cetacean species in the Mediterranean Sea: fin whale (*Balaenoptera physalus*) - the only mysticete -, sperm whale (*Physeter macrocephalus*), beaked whale (*Ziphius cavirostris)*, long-finned pilot whale (*Globicephala melas)*, Risso's dolphin (*Grampus griseus)*, bottlenose dolphin (*Tursiops truncatus)*, striped dolphin (*Stenella coeruleoalba)* and common dolphin (*Delphinus delphis)* (Notarbartolo di Sciara, 2002) (Notarbartolo Di Sciara *et al.,* 1993; Notarbartolo Di Sciara & Demma, 2004; Reeves & Notarbartolo di Sciara, 2006).

The cetacean species present and sighted in the Ionian Sea, and in particular in the Gulf of Taranto, do not differ from the cetacean fauna generally found in the Mediterranean Sea. However, there are differences in the distribution and abundance of species due to the different geomorphological and chemical-physical characteristics of the Ionian basin compared to the Tyrrhenian Sea and the Adriatic Sea (Whale Watching - Jonian Dolphin Conservation). In general, there are about 20 species of cetaceans belonging to the suborders Mysticeti and Odontoceti in the Mediterranean Sea (Santoro *et al.,* 2015). However, the Apulian coast and the Strait of Otranto are a transit area for many of these species.

The monk seal (*Monachus Monachus*) is the only species of pinniped resident in the Mediterranean and the Vasta Area
Vast Area.

The following is a list of marine mammal species considered resident in the Mediterranean basin
and potentially present in the Area Vasta considered.

Cetaceans
The entire Ionian Sea represents a unique natural system covering a vast area. Although it is a small sea within a larger enclosed sea, the Mediterranean, various organisations and associations carry out intensive scientific research, data collection and reporting of cetacean sightings and strandings along the Ionian coast. Coordination and collaboration between these organisations is essential in order to achieve results of high scientific and educational value.

The activities of cetaceans are varied and unpredictable and vary according to the personal needs of a solitary individual or a group or the entire group; therefore, it is absolutely impossible to predict them with any accuracy. The precise behaviour of cetaceans in terms of their routes, feeding, socialisation, reproduction and echolocation is therefore equally unpredictable, as these are strongly influenced by these conditions throughout their lives.

The cetacean population inhabiting the area under consideration consists of several species, which, depending on the availability of prey, their seasonal migratory routes, the activities that characterise their complex behaviour or their specific individual needs, choose to cross the area by exploiting the currents or settle there to forage, socialise, reproduce, give birth and raise their young.

Balaenoptera physalus

The fin whale (*Balaenoptera physalus)* constitutes a separate population in the Mediterranean from that of the North Atlantic, with very limited gene flow (Bérubé *et al.*, 1993). It mainly uses the slope areas between -400 m and -2,500 m and is recorded in upwelling areas, where the rise of nutrients favours the presence of zooplankton aggregations (Notarbartolo-Di-Sciara *et al.,* 2003; Panigada *et al.,* 2008). Sightings have been reported in the northern Adriatic, suggesting that the southern Adriatic is a transit area; their presence in the northern Ionian Sea has been confirmed (Lipej *et al.,* 2004; Carlucci *et al.,* 2021).

Delphinus delphis

The common dolphin (*Delphinus delphis*) is a cosmopolitan species that inhabits both pelagic and coastal waters in the Mediterranean. In recent decades, common dolphin populations have undergone a drastic reduction in the basin (Bearzi *et al.,* 2003). The presence of common dolphins is occasional in Italian waters, except in the area of Lampedusa and the island of Ischia, where two resident populations have been recorded. In the Ionian sector under consideration, their presence can be considered rare and occasional.

Globicephala melas

In the Mediterranean, the species is found mainly in the western and central basin, although the highest densities are found in the westernmost areas at depths greater than -500 m (Verborgh *et al.*, 2016). The ISPRA report 'Strategy for the marine environment - Mammals' (ISPRA, 2012) reports that no specimens of this species have been sighted in the Ionian Sea. The presence of long-finned pilot whales in the area under investigation can be considered rare.

Physeter macrocephalus

The sperm whale (*Physeter macrocephalus*) is present in the Mediterranean with a single population, genetically distinct from that of the Atlantic, and distributed throughout all basins, with a prevalence in deeper areas (> -1000 m) (Drouot *et al.*, 2004). The population of this species has declined over the last 20 years. To date, no more than 2,500 mature individuals are estimated to remain in the entire Mediterranean Sea, and this number is decreasing. The main threats include fishing nets, collisions with vessels and disturbance from heavy maritime traffic. Sperm whales are present throughout the Mediterranean, including the Ionian Sea. However, the area under consideration is located near several underwater canyons and their presence cannot therefore be ruled out.

Stenella coeruleoalba

The striped dolphin is the most common dolphin in the Mediterranean. It is a pelagic species that prefers deep waters and is frequently sighted in the southern Adriatic and Ionian Sea, with populations numbering approximately 15,350 and 30,500 individuals in 2012 (ISPRA, 2012).

Grampus griseus

The grampo prefers deep habitats in the Mediterranean with underwater slopes and canyons, even at the edge of the continental shelf (Azzellino *et al.*, 2008). In the area between the southern Adriatic Sea and the Ionian Sea, the presence of grampus is evidenced by stranding data and sightings from the air and from boats (ISPRA, 2012; Carlucci *et al.,* 2020).

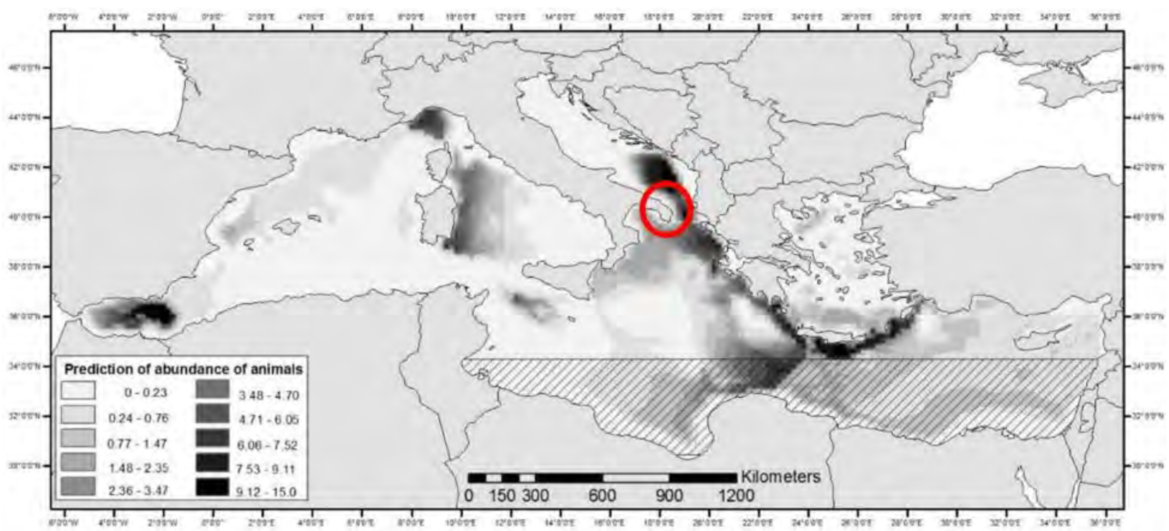
Tursiops truncatus

The bottlenose dolphin is the most commonly sighted species in the Mediterranean Sea and is widespread off the Italian coast. A study conducted in 2014 using visual surveys on ferries in the Adriatic and Ionian Seas confirmed that the bottlenose dolphin is regularly present in the Area Vasta (Fanizza *et al.*, 2014; Azzolin *et al.*, 2016; Holcer *et al.,* 2007).

Ziphius cavirostris

The Cuvier's beaked whale is a species that mainly inhabits waters deeper than 500 m, especially between 1,000 and 2,000 m and in underwater canyons (Tepsich *et al.*, 2014). The southern Adriatic and Ionian Sea areas could be considered potentially important habitats for this species (ISPRA, 2012). The presence of canyons and high depths not far from the Project Area could represent a habitat of interest for the species (Cañadas *et al.,* 2018) (Figure 5-120).

Figure 5-120 Estimated abundance of Ziphius cavirostris in the Mediterranean Sea.



Note: The Area Vasta is circled in red.

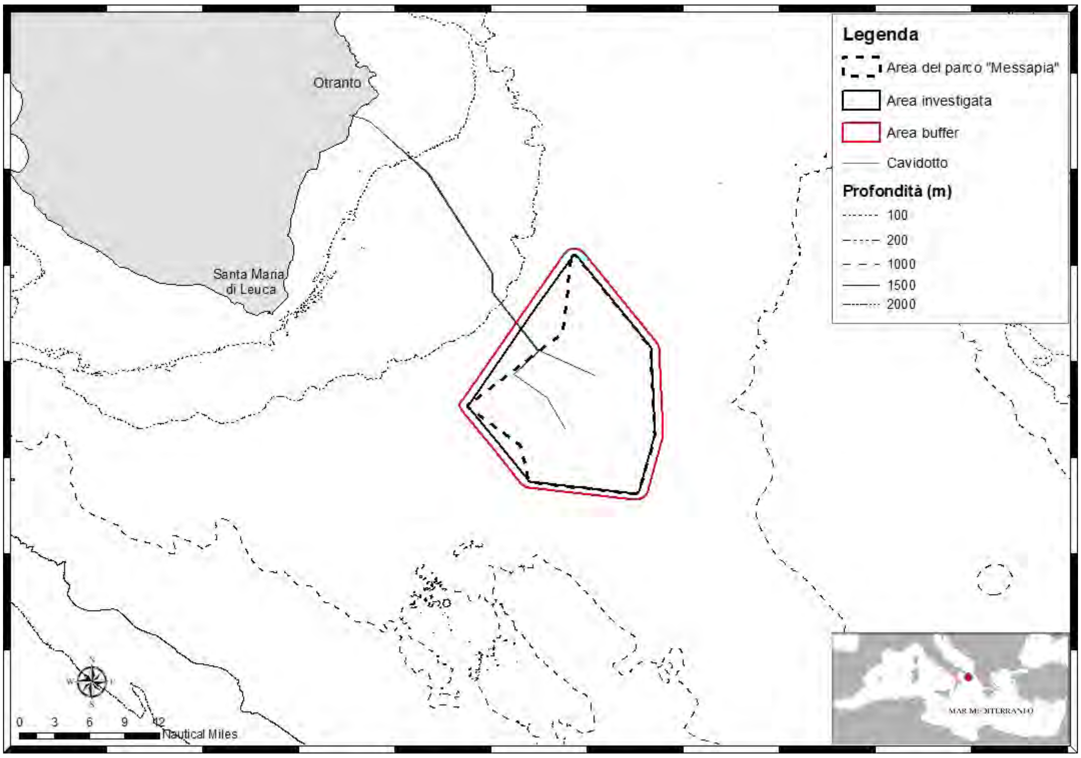
Source: Cañadas et al., 2018

Results of geophysical and environmental monitoring campaigns

In order to document the presence of marine mammals in the park area, a one-year pre-operational monitoring plan was designed with seasonal campaigns of seven transects each, for a total of 28 transects, in order to obtain a complete survey of the park's surface area. The monitoring campaigns, each consisting of seven transects, took place in the following seasons: winter (6-8 March 2024), spring (13, 14, 19 and 20 May 2024), summer
(7, 8 and 12 August 2024) and autumn season (7, 8 and 11 October 2024).

The sea area covered by the survey was larger than the perimeter of the park concession (approximately 476 km^2), and was further extended by a 1 km buffer, for a total area of approximately 652 km^2. For the monitoring of the Project Area, the average daily effort for the completion of a transect was set at 20 nautical miles (nm).

Figure 5-121 Area covered by the survey



Source: Offshore sector – environmental survey report

Cetacean monitoring was carried out by visual sampling supported by acoustic detection, using the Conventional Distance Sampling (CDS) approach (Buckland *et al.*, 2001, 2004), which allows the density or abundance of a species in an area to be estimated by creating linear or point transects in which the perpendicular distances from the animals sighted, the number of individuals and the search effort (km or NM) are recorded.

In particular, among the methods listed in the CDS, the "zig-zag line transect sampling" method was adopted, which involves the use of linear transects that run through the study area following a zig-zag path, with a length established for these campaigns of approximately 20 nm.

Following the Conventional Distance Sampling approach, monitoring was carried out by three operators certified by ACCOBAMS as Marine Mammal Observers (MMO) and Passive Acoustic Monitoring (PAM), and acoustic detection was performed using a single hydrophone capable of detecting and transducing acoustic frequencies in the range from 10Hz to 98 kHz. The potential of acoustic detection during monitoring activities lies in ascertaining the presence of cetaceans when they are not visible on the sea surface, making the presence data provided more accurate, as well as in the possibility of hearing the vocalisations emitted by different species in the different contexts in which they are encountered.

The data collected during the campaigns are shown in Table 5.41.

Table 5.41 Summary of monitoring activities with indication of sampling effort in nautical miles travelled, sampling date, species sighted, number of individuals and depth at which they were sighted.

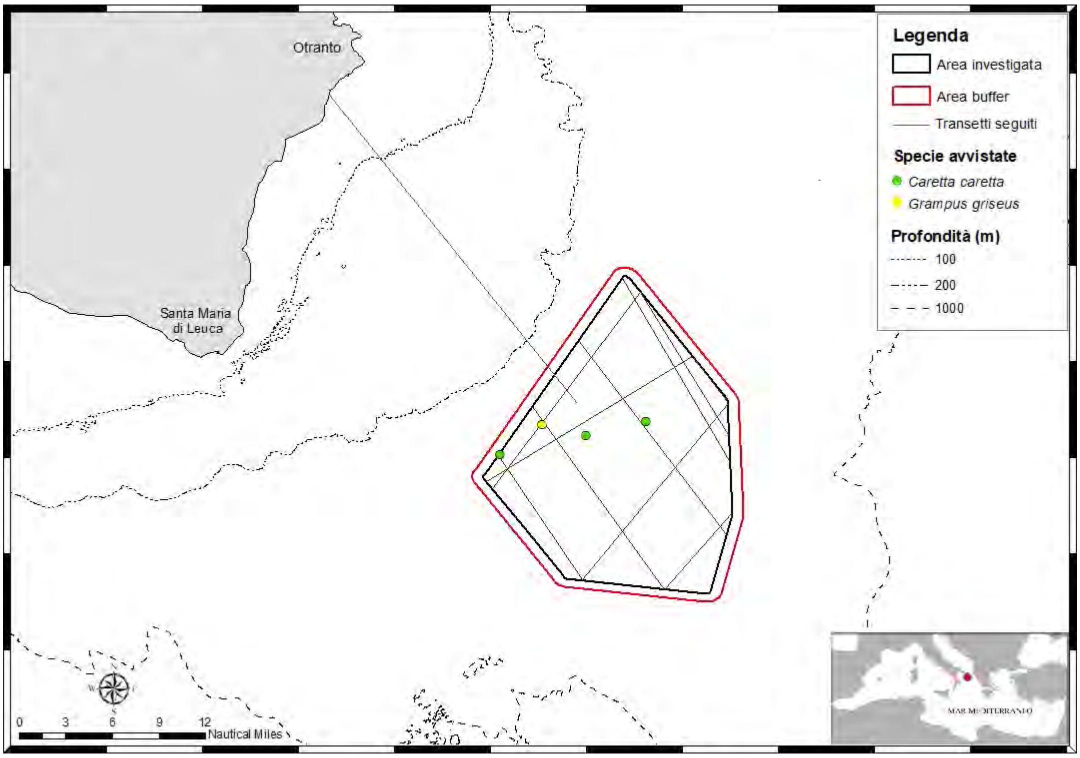
Season	Effort (NM)	Date	Species	No. of individuals	Depth (m)
Winter	138.7	06/03/2024	*G. griseus*	1	55
		07/03/2024	-	-	-
		08/03/2024	-	-	-
Spring	136.65	13/05/2024	*G. griseus*	7	450
			S. Coeruleoalba	20	583
		14/05/2024	*S coeruleoalba*	15	680
		19/05	*S. coeruleoalba*	5	576
Summer	120.70	07/08/2024	-	-	-
		08/08	*P macrocephalus*	5	760
			G. griseus	7	570
		12/08/2024	*S Coeruleoalba*	20	420
Autumn	128.50	07/10/2024	*G. griseus*	3	65
		08/10/2024	-	-	-
		11/10/2024	-	-	-

Source: Offshore sector – environmental survey

During the winter monitoring campaign, a group of 10 *Grampus griseus* individuals was sighted at a depth of -500 m, 9 of which were photo-identified. At the acoustic level, the following were recorded:

- **Clicks**: short broadband sound pulses with a peak frequency of around 50 kHz, produced for echolocation. They are mainly used during navigation and foraging, during which pilot whales echolocate continuously;
- **Click trains**: a series of clicks produced at short intervals during the search for food, increasing in speed as the animal approaches an object or prey;
- **Buzzes**: very rapid sequences of clicks lasting an average of 1-2 seconds and consisting of 100-600 clicks, generally used in the final stages of hunting to improve accuracy;
- **Barks**: impulsive, intense sounds, often associated with social interactions.

Figure 5-122 Map of transects followed and sightings made during the winter monitoring campaign.



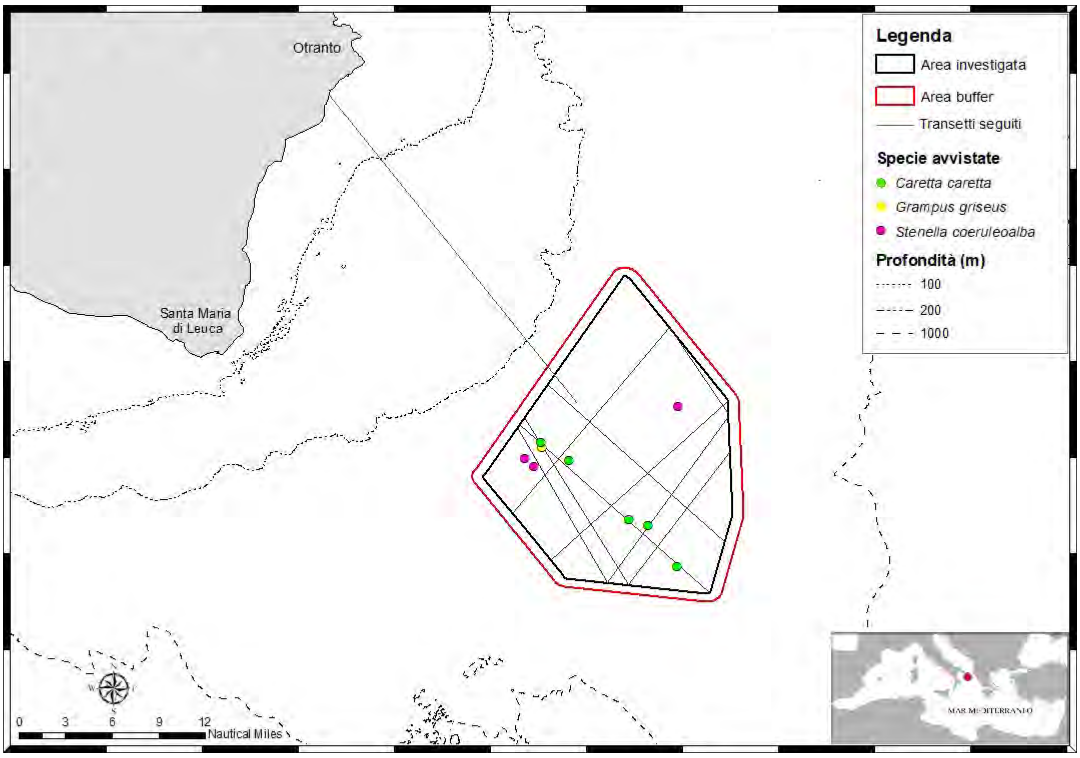
Source: Offshore sector – environmental survey

Figure 5-123 Example image of G. Griseus sighting during the winter monitoring campaign of the Messapia offshore floating wind farm.

Source: Offshore sector – environmental survey

During spring monitoring, during the first transect, a group of seven pilot whales (*Grampus griseus*) was sighted at a depth of -450 m, and a group of 20 striped dolphins (*Stenella coeroluea*) at a depth of -583 m, both groups engaged in navigation activities. All *G. griseus* individuals were photo-identified and, by comparing them with those already included, it was possible to establish that none of these individuals had already been sighted during the winter campaign. Along the second transect, a group of 15 spinner dolphins was observed at a depth of -680 m, while along the third transect, a group of five spinner dolphins was sighted at a depth of -576 m.

Figure 5-124 Map of transects followed and sightings made during the spring monitoring campaign.



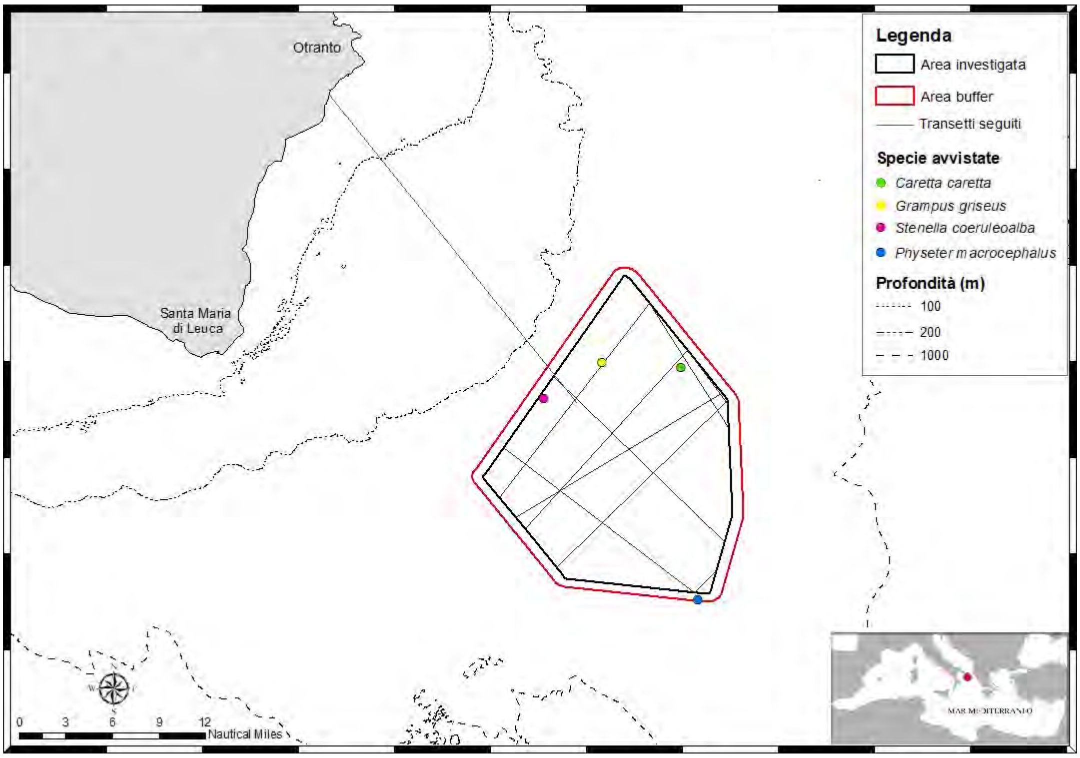
Source: Offshore sector – environmental survey

Figure 5-125 Examples of sightings of Grampus griseus (left) and Stenella Coeruleoalba (right) during the spring monitoring campaign of the Messapia offshore floating wind farm.

Source: Offshore sector – environmental survey

During the summer monitoring, a group of seven pilot whales (*Grampus griseus*) was sighted at a depth of -570 m during the first transect, and a group of five sperm whales (*Physeter macrocephalus*) was sighted at a depth of -760 m*.* All *G. griseus* individuals *and* 2 of the 5 sperm whales were photo-identified. By comparing the grampus specimens with those already included it was possible to establish that none of these individuals had been sighted during previous campaigns. Along the third transect, a group of 20 stenella delfinia was observed navigating at a depth of - 420 m.

Figure 5-126 Map of transects followed and sightings made during the summer monitoring campaign.



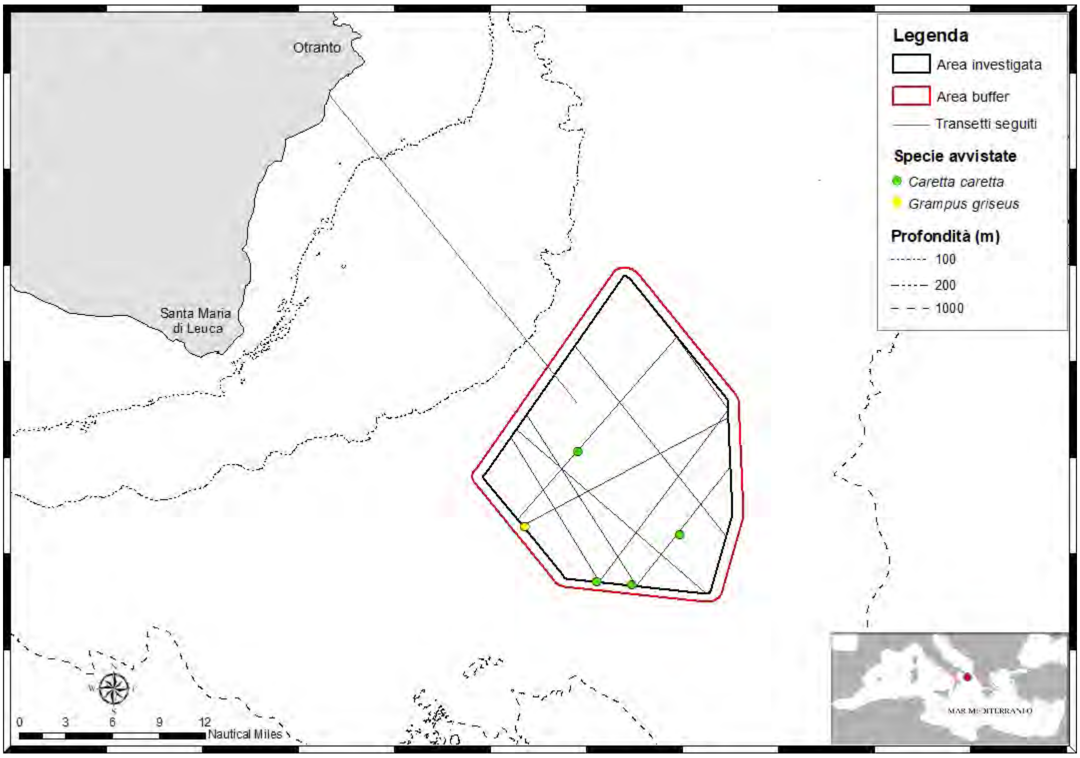
Source: Offshore sector – environmental survey

Figure 5-127 Examples of sightings of Physeter macrocephalus (left) and Grampus griseus (right) during the summer monitoring campaign of the Messapia offshore floating wind farm.

Source: Offshore sector – environmental survey

During the autumn monitoring campaign, a group of three pilot whales was sighted at a depth of -650 m. Only one of the three pilot whales was photo-identified and, by comparing it with those already included it was possible to establish that it had not been previously sighted in previous campaigns.

Figure 5-128 Map of transects followed and sightings made during the autumn monitoring campaign.



Source: Offshore sector – environmental survey

Figure 5-129 Examples of sightings of Grampus griseus during the autumn monitoring campaign of the Messapia offshore floating wind farm.

Source: Offshore sector – environmental survey

In conclusion, during the monitoring campaigns carried out, four groups of *Grampus griseus* were identified (for a total of 27 individuals: 10 in winter, 7 in spring, 7 in summer and 3 in autumn), four groups of *Stenella coeruleoalba (*a total of 60 individuals, 40 in spring and 20 in summer) and one group of *Physeter macrocephalus (*a total of five individuals, all sighted in summer). All sightings occurred at a bathymetric range between -420 m and -760 m.

<u>*Pinnipeds*</u>

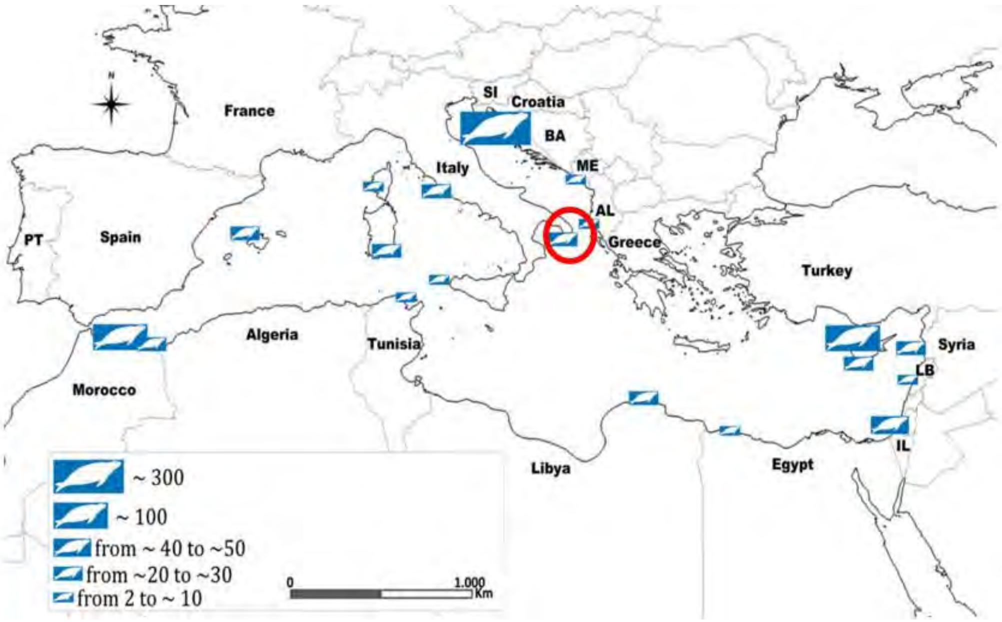
Monachus monachus

Figure 5-130 Monachus monachus

Source: NOAA Fisheries, 2024

Of all pinnipeds, the monk seal is considered the most endangered species. It is the only species of pinniped resident in the Mediterranean. The largest number of seals are found in the eastern Mediterranean basin, especially in the Ionian and Aegean Seas. Figure 5-131 shows between 20 and 30 sightings in the period 2000-2014 near the Area Vasta considered. The coast near the Project Area is characterised by large stretches of rocky areas, which are habitats of interest for the species.

Figure 5-131 Number of monk seal sightings in the Mediterranean basin (excluding Greece and Turkey) in the period 2000-2014.



Note: the Area Vasta is circled in red.

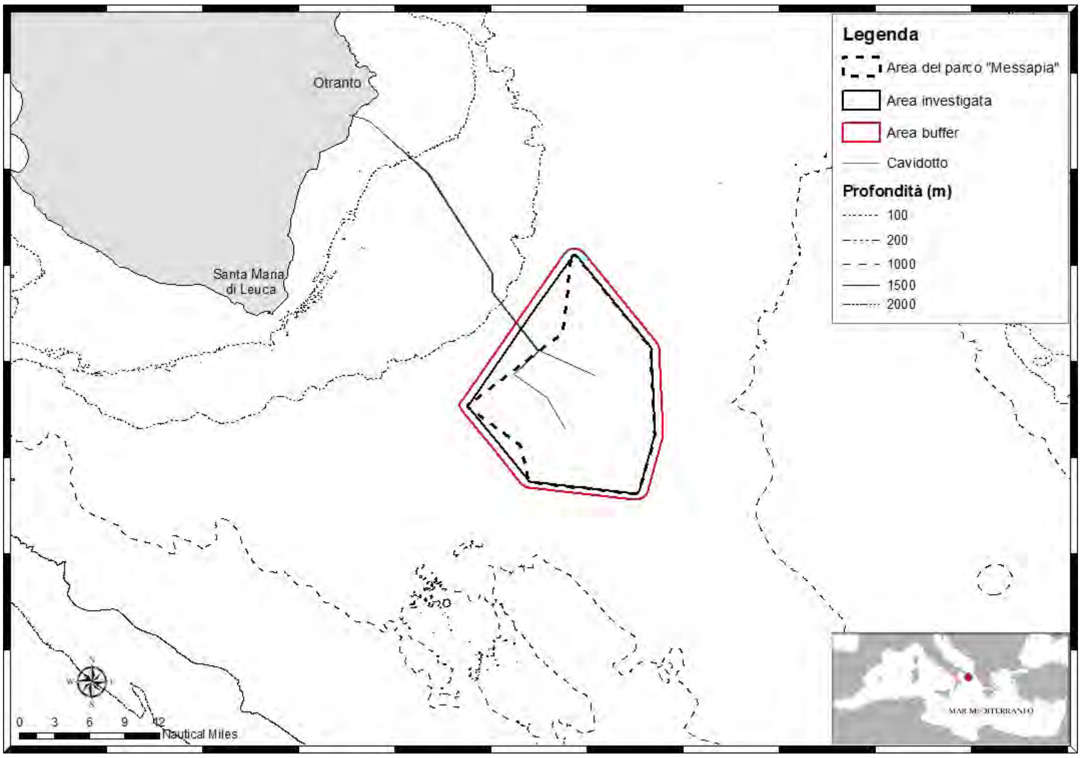
Source: Budone et al., 2019

Results of the geophysical and environmental monitoring campaigns

In order to document the presence of marine mammals in the Project Area, a one-year pre-operational monitoring plan was scheduled with seasonal campaigns of 7 transects each, for a total of 28 transects, in order to obtain a complete investigation of the park's surface area. The monitoring campaigns, each consisting of seven transects, took place in the following seasons: winter (6-8 March 2024), spring (13, 14, 19 and 20 May 2024), summer (7, 8 and 12 August 2024) and autumn (2, 3 and 6 October 2024).
(7, 8 and 12 August 2024) and autumn season (2, 3 and 6 October 2024).

The sea area covered by the survey exceeded the perimeter of the park concession (approximately 476 km^2), and was further extended by a 1 km buffer, for a total area of approximately 652 km^2. For monitoring the Project Area, the average daily effort for completing a transect was set at 20 nautical miles (nm).

Figure 5-132 Area covered by the survey



Source: Offshore sector – environmental survey

Marine mammals were monitored through visual sampling supported by acoustic detection, using the Conventional Distance Sampling (CDS) approach (Buckland *et al.*, 2001, 2004), which allows the density or abundance of a species in an area to be estimated by creating linear or point transects where the perpendicular distances from the animals sighted, the number of individuals and the search effort (km or NM) are recorded.

In particular, among the methods listed in the CDS, the "zig-zag line transect sampling" method was adopted, which involves the use of linear transects that traverse the study area following a zig-zag path, with a length established for these campaigns of approximately 20 nm.

Monitoring was carried out by three operators certified by ACCOBAMS as Marine Mammal Observers (MMO) and Passive Acoustic Monitoring (PAM), and acoustic detection was performed using a single hydrophone capable of detecting and transducing acoustic frequencies in the range from 10 Hz to 98 kHz. The potential of acoustic detection during monitoring activities lies in ascertaining the presence of marine mammals when they are not visible on the sea surface, making the presence data provided more accurate, as well as in the possibility of hearing the vocalisations emitted by different species in the different contexts in which they are encountered.

During the monitoring carried out, no individuals belonging to the *Monachus Monachus species* were observed.

5.11.2 Terrestrial biodiversity

5.11.2.1 Terrestrial habitat

The Area Vasta mainly features systems linked to modification and anthropic management,
ranging from traditional and extensive agricultural systems to industrial areas and urban centres.

Anthropogenic structures are widespread throughout the Area Vasta: in addition to the urban centres, which are of significant size, there are mining and industrial activities and local and long-distance rail and road networks.

The land cover is mainly agricultural with traditional and extensive systems. Extensive crops, olive groves, vineyards, orchards and, to a lesser extent, conifer and eucalyptus plantations are found.

As regards natural habitats, the Area Vasta is mainly represented by xeric grasslands, i.e. areas characterised by semi-natural dry grasslands and facies covered by bushes on a limestone substrate.

The habitats of conservation interest most represented in the Area Vasta are priority habitat 6220 - 'Substeppe grasslands with annual plants of the Thero-Brachypodietea' and habitat 1240 - 'Mediterranean coastal cliffs with vegetation with endemic Limonium spp.' with a prevalence in the coastal and sub-coastal areas.

The Area Vasta includes a portion of the SPA "Costa Otranto - Santa Maria di Leuca" (IT9150002) and a portion of the Costa Otranto - Santa Maria Di Leuca and Bosco Di Tricase Regional Nature Park, partially overlapping the above SPA (see paragraph 5.12.2 for further details).

It should be noted that the underground cable duct and the joint pit cross the habitat *'MED6220 Substeppe grasslands with annual plants of the* Thero-Brachypodietea' for a short distance near the coast. It also runs alongside the habitat *'MED9340 Forests of Quercus ilex and Quercus* rotundifolia' for a short distance.

5.11.2.2 Vegetation and flora

The natural habitats present in the Area Vasta are mainly represented by garrigue and steppe grasslands, xeric, very extensive in the inland areas and bordering the strip facing the coast, where there are habitats characterised by poor soil and influenced by the presence of salt.

There are several species endemic to Italy that are potentially present in the survey area, such as *Asteraceae Centaurea leucadea, Centaurea nobilis and Centaurea tenacissima,* followed by *Erodium nervulosum, Iris pseudopumila, Limonium japygicum, Ophrys apulica and Vicia giacominiana.*

Among the species of conservation interest, we note the potential presence of *Aegilops uniaristata*, classified as 'vulnerable' (VU) in the Italian Red List, *Centaurea leucadea, Centaurea nobilis and Centaurea tenacissima* classified as 'near threatened' (NT) at Italian level, as well as *Echinops spinosissimus.* Finally, the species *Vicia giacominiana* is listed as 'critically endangered' (CR) in Italy.

With regard to vegetation, the project route runs along the road network, thus crossing an environment characterised by anthropogenic vegetation.

5.11.2.3 Fauna

Fauna refers to all animal species residing in a given territory or in a particular environment, in a specific historical or geological period. Wildlife consists of all species and populations of animals, vertebrates and invertebrates, residing in a given territory and included in its ecosystems.

Mammals

The absence of significant woodland within the Area Vasta makes it unlikely that
forest species or species linked to forest habitats, at least for part of their life cycle.

On the other hand, the territory is well characterised by 'agroecosystems', especially along the innermost parts of the study area, as evidenced by the presence of cultivated land, wooded countryside and orchards, interspersed with residual xeric grasslands, infrastructure and urban centres. However, along the coast, sub-steppe grasslands, cliffs and thermo-Mediterranean scrubland, some of which are of high naturalistic value, become more prevalent.

This mosaic of habitats is home to various species of mammals, mainly small and medium-sized, such as rodents, soricomorphs and mustelids, as well as other generalist species.

It should be noted that the wolf (*Canis lupus*) is also potentially present within the Area Vasta, a species that has recently changed from 'vulnerable' to 'near threatened' status according to the Red List of Italian vertebrates (IUCN, 2022).

Reptiles

The mosaic of habitats that characterises the Project Area, as presented above, is well suited to hosting reptile species, including those of conservation interest. In particular, along the coast, the alternation of xeric herbaceous formations, shrublands and outcropping rocks constitutes a habitat of choice for species belonging to this taxon.

Table 5.42 lists the reptile species potentially present in the Vasta Area as reported in the SCZ IT9150002 form, including 9 of conservation interest included in Annex IV of the Habitats Directive, 4 mentioned in Annex II (*Elaphe quatuorlineata, Emys orbicularis, Testudo hermanni, Zamenis situla)*, of which the European pond turtle (*Emys orbicularis)* and Hermann's tortoise (*Testudo hermanni)* are listed as 'endangered' (EN) according to the national IUCN Red List.

Table 5.42 Reptiles, species present or potentially present within the Area Vasta

Scientific name	Common name	IUCN Red List Italy	Habitat Directive
Chalcides chalcides	Luscengola	LC	-
Austrian coronella	Smooth snake	LC	Annex IV
Kotschyi's gecko	Kotschyi's gecko	LC	Annex IV
Elaphe quatuorlineata	Four-lined snake	LC	Annex II, IV
European pond turtle	Marsh turtle	EN	Annex II
Hemidactylus turcicus	Warty gecko	LC	-
Hieropis viridiflavus	Green tree snake	LC	Annex IV
Lacerta bilineata	Western green lizard	LC	Annex IV
Green lizard	Eastern green lizard	NA	Annex IV
Natrix natrix	Grass snake	LC	-
Podarcis sicula	Field lizard	LC	Annex IV
Tarentola mauritanica	Common gecko	LC	-
Testudo hermanni	Hermann's tortoise	EN	Appendix II, IV
Asp viper	Common viper	LC	-
Zamenis situla	Leopard snake	LC	Annex II, IV

Source: Standard Form ZSC IT9150002

<u>*Amphibians*</u>

The Project Area is not characterised by surface water bodies, including lotic or lentic water bodies, of significant size. Although wetlands such as springs, ditches, irrigation channels, stagnant pools and temporary watercourses, which are ideal habitats for the proliferation of batrachofauna, can be found in the wider area.

Table 5.43 lists mainly generalist species commonly found in Italy; four species included in Annex IV of the Habitats Directive (*Bufo balearicus, Lissotriton italicus, Rana dalmatina, Rana italica*) are worth noting. Only one species (common toad – *Bufo bufo)* is considered 'vulnerable' (VU) by the IUCN Red List, while the rest are all 'least concern' (LC).

Table 5.43 Amphibians, list of species present or potentially present within the Area Vasta

Scientific name	Common name	IUCN Red List	Habitat Directive
Balearic toad	Italian emerald toad	LC	Annex IV
Common toad	Common toad	VU	-
Pelophylax kl. hispanicus	Green frog	LC	All. V
Hyla intermedia	Italian tree frog	LC	-
Italian smooth newt	Italian newt	LC	Annex IV
Salamandra salamandra	Spotted salamander	LC	-
Dalmatian frog	Agile frog	LC	All. IV
Italian frog	Appennine frog	LC	Annex IV

Source: Standard Form ZSC IT9150002, 2022

Lepidoptera

Within the Natura 2000 site called 'Costa Otranto - Santa Maria di Leuca', there are no reports of presence of Lepidoptera among the species of interest for the local fauna.

Chiroptera

In 2011, the Costa Otranto – Santa Maria di Leuca and Bosco di Tricase Regional Nature Park promoted the conservation of bats in coastal caves with a project approved and funded by the Puglia Region, which also included the protection of the caves, their habitat of choice and a site of Community interest (HABITAT Directive 1992/43/EC). The project, developed in collaboration with the University of Salento (Department of Biological and Environmental Sciences and Technologies), provides for specific protection measures: the protection of certain coastal caves through transit bans, the installation of bat boxes, the distribution of drinking troughs during the summer months, and the monitoring and health surveillance of mammals.

Several colonies of bats live in the more than 130 caves in Salento. A study conducted in 2001 highlighted the presence of bats belonging to five different species (*Myotis myotis, Miniopterus schreibersi, Rhinolophus euryale, Rhinolophus ferrumequinum, Pipistrellus kuhli)* in three of the five caves examined, including the Zinzulusa Cave in the municipality of Castro and the Monaca Cave in the municipality of Otranto (Mucedda *et al.,* 2003).

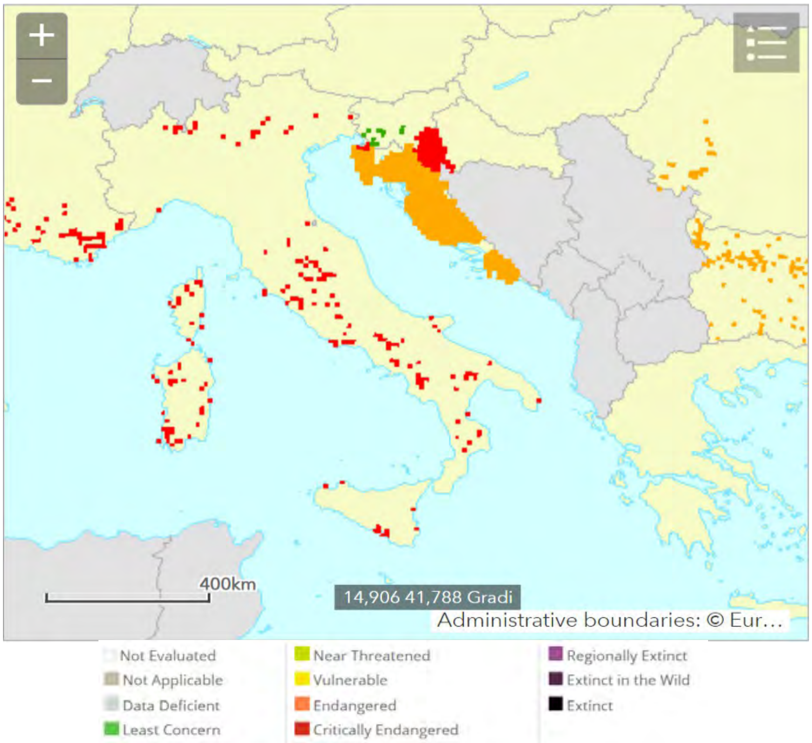
The Standard Form for the ZSC "Costa Otranto - Santa Maria di Leuca" reports the presence of the species *Miniopterus sch*reibersii, whose typical habitats are agricultural landscapes, grasslands, sparsely vegetated land, but also wooded or urbanised areas. The species is classified as 'near threatened' (NT) according to the IUCN Red List.

Another species belonging to the order Chiroptera present in the area is the Capaccini's bat (*Myotis capaccinii),* a species classified as 'vulnerable' at European level, but 'critically endangered' (CR) at national level and in the protected area falling within the project area (Figure 5-133).

Leisler's bat (*Nyctalus leisleri*) and the common long-eared bat (*Plecotus auritus*) are present in the same SAC with vulnerable species status, while they fall into the 'least concern' category at

EU level. The Kuhl's pipistrelle (*Pipistrellus kuhlii*) is not a threatened species and is reported its presence within the Natura 2000 site 'Costa Otranto – Santa Maria di Leuca'.

Figure 5-133 Distribution and conservation status of the bat Myotis capaccinii in the period 2013-2018



Source: European Environment Agency[13]*, 2019*

However, it should be noted that, considering the location of the project, no interference with the bat fauna is expected.

Avifauna

With regard to terrestrial avifauna, the considerations made in the paragraph on the importance of the coastal area for migratory bird species.

The standard form for the SCI IT9150002 'Costa di Otranto-Santa Maria di Leuca' reports the presence of 12 species of birds as listed in the table below.

13 eunis.eea.europa.eu (2004)

Table 5.44 SAC IT9150002 'Coast of Otranto-Santa Maria di Leuca' - Birds included in the Birds Directive 2009/147/EC

Species	Population in the site	Category
Short-toed lark	breeding	very rare
Calonectris diomedea	concentration	present
Circus aeruginosus	concentration	present
Circus cyaneus	concentration	present
Circus macrourus	concentration	present
Circus pygargus	concentration	present
Columba livia	reproduction	rare
Eleonora's falcon	concentration	very rare
Falco peregrinus	permanent	very rare
Melanocorypha calandra	permanent	rare
Monticola solitarius	permanent	rare
Tetrax tetrax	concentration	very rare

Source: Standard form ZSC IT9150002, 2022

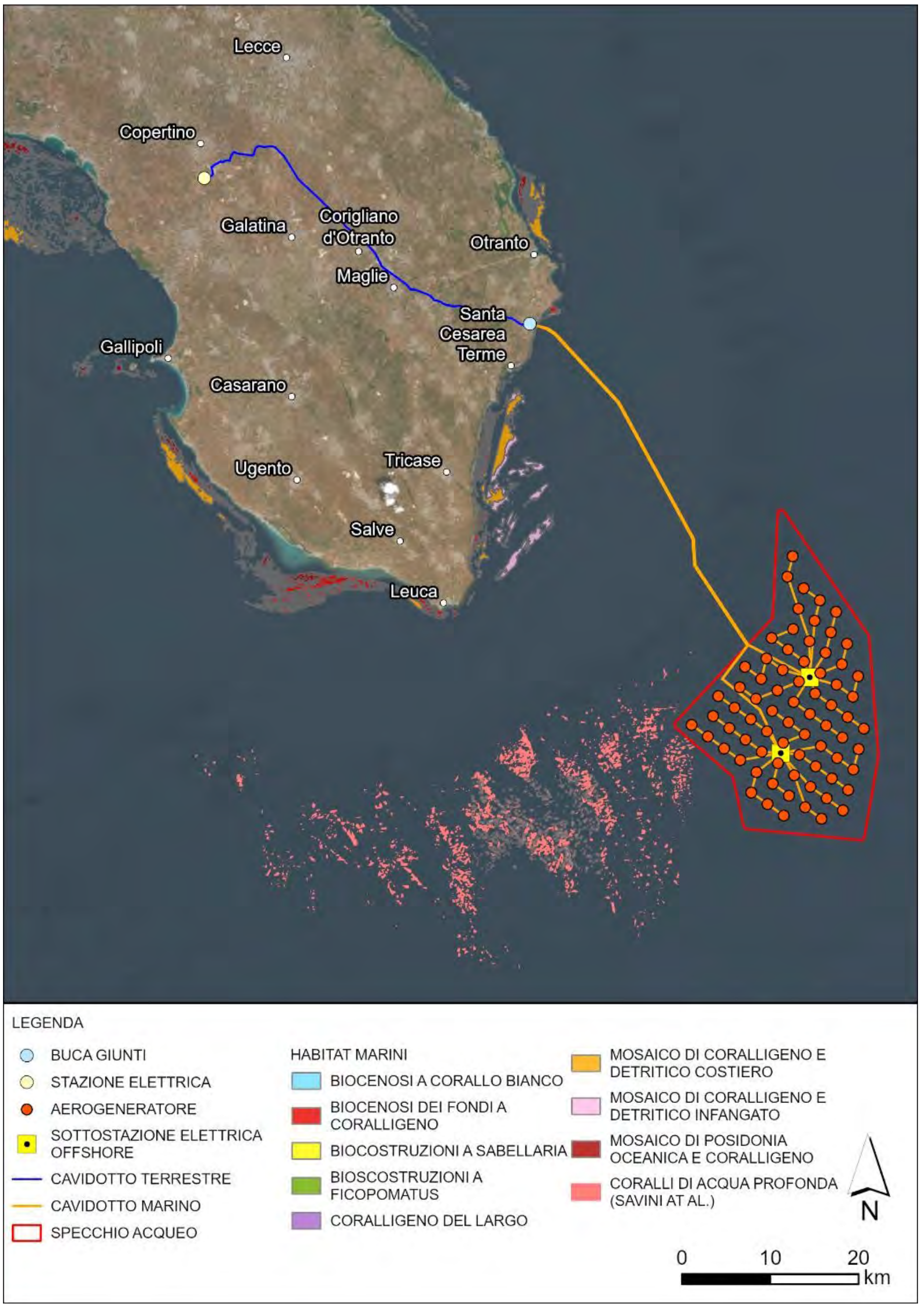
5.11.3 Protected and Conservation Species

The presence of coralligenous habitats has been identified in the coastal area of interest at depths of up to -20 m along the section of the cable duct that passes through the TOC. Images collected by the ROV have revealed species characteristic of coralligenous rocky reefs. Although the surveys did not detect them, some species of conservation interest are reported in the literature as typical of this habitat. No Posidonia beds were found in the Area of Interest, and there are areas with coralligenous habitats along the coast, mainly on a mosaic of detrital bottoms.

The area south of Santa Maria di Leuca is known for its deep corals, whose current distribution is shown in Figure 5-134. However, environmental surveys have found that the offshore area of Messapia is characterised by a typical bathyal seabed with sandy/silty expanses and few rocky outcrops. In some rocky outcrops, especially in the marginal area to the east of the wind farm area, some outcrops with white corals *Desmophyllum pertusum* have been identified, classified as critically endangered according to the European IUCN Red List and included in Annex 2 of the Habitats Directive. However, it should be noted that there will be no wind turbines in these rocky outcrops.

As regards large pelagic fauna, the most important species potentially present in the Ionian Sea are marine mammals and sea turtles. The entire Ionian Sea is a unique natural system covering a vast area.

Figure 5-134 Distribution of coralligenous habitats in the Vasta Area



Source: EMODNet data processing, 2023

Protected species and species of conservation interest on land have been described in detail for each group in section 5.11.2 . aboveThe information gathered is summarised in the table below, taken from the standard form for SAC IT9150002 'Costa di Otranto-Santa Maria di Leuca', which lists the species of conservation interest present in the site, with a focus on the species included in Article 4 of the Birds Directive (2009/147/EC) and Annex II of the Habitats Directive (92/43/EEC).

Table 5.45 List of species of conservation interest present or potentially present within the Area Vasta

Scientific name	Common name	Population in the site (permanent, breeding, transit, wintering)	Abundance	Group
Calandrella brachydactyla	Calandrella	reproduction	very rare	birds
Calonectris diomedea	Great Shearwater	transit	present	birds
Circus aeruginosus	Marsh harrier	transit	present	birds
Circus cyaneus	Northern harrier	transit	present	birds
Circus macrourus	Pallid harrier	transit	present	birds
Circus pygargus	Lesser kestrel	transit	present	birds
Columba livia	Wild pigeon	reproduction	rare	birds
Elaphe quatuorlineata	Cervone	permanent	present	reptiles
Elaphe situla	Colubro leopard	permanent	present	reptiles
Eleonora's falcon	Queen's falcon	transit	very rare	birds
Peregrine falcon	Peregrine falcon	permanent	very rare	birds
Melanocorypha Calandra lark	Calandra	permanent	rare	birds
Miniopterus schreibersii	Miniottero	permanent	present	mammals
Monachus monachus	Monk seal	permanent	present	mammals
Monticola solitarius	Solitary sparrow	permanent	rare	birds
Myotis capaccinii	Capaccini bat Capaccini	permanent	present	mammals
Austrian feather grass	Stipa austroitalica	perennial		plants
Tetrax tetrax	Meadow hen	transient	very rare	birds

Source: Standard form ZSC IT9150002, 2022

5.11.4 Alien and invasive species

Alien and invasive species are also known as non-native or invasive exotic species. Invasive alien species are therefore animal and plant species that have been deliberately or accidentally transferred by humans outside their natural range (the geographical area within which a species is distributed) and have developed the ability to establish and maintain viable populations in the wild. Climate change also plays a decisive role in these movements, as it can create ideal environmental conditions for the expansion of species outside their natural range.

Invasive alien species are among the main causes of biodiversity loss in Italy and worldwide because, in addition to competing directly with some native species, they can alter the state of habitats and their natural ecosystems, sometimes causing significant economic damage to productive activities such as agriculture and the exploitation of forest and pastoral resources. By way of example, the damage caused by invasive alien species in Great Britain alone in 2015 was estimated at around €2 billion.

In line with all the main international conventions on biodiversity protection and with the National Biodiversity Strategy, Italy is actively working to prevent the spread of invasive alien species and to control or eradicate those species that are already present on our territory. In fact, **Regulation 1143/2014,** containing provisions to prevent and manage the introduction and spread of invasive alien species, has been in force in European Union countries since 1 January 2015. On 14 February 2018,Legislative Decree, the published in the Official Gazette on 30 January 2018, came into force.

The measure establishes rules to prevent, minimise and mitigate the adverse effects on biodiversity caused by the introduction and spread, whether deliberate or accidental, of invasive alien species within the European Union, as well as to minimise and mitigate the impact these species may have on human health or the economy. The measures are based on prevention, early detection and rapid eradication or management in the case of species that are already widely spread.

To date, four lists of exotic plant and animal species of Union concern have been published in the Official Journal of the European Union (14 July 2016, 12 July 2017, 25 July 2019 and 12 July 2022), which together constitute a list of 88 species.

There are approximately 12,000 exotic species in Europe, of which approximately 10% to 15% are considered invasive; these are the species covered by Regulation (EU) No 1143/2014 to protect biodiversity and ecosystem services and to minimise or mitigate the impact that these species may have on human health or the economy([14])

14 https://www.mase.gov.it/pagina/specie-esotiche-invasive

Article 6 of Legislative Decree 230/2017 prohibits the deliberate or negligent introduction into the EU, reproduction, cultivation, transport, purchase, sale, use, exchange, possession and release of invasive alien species of Union concern.

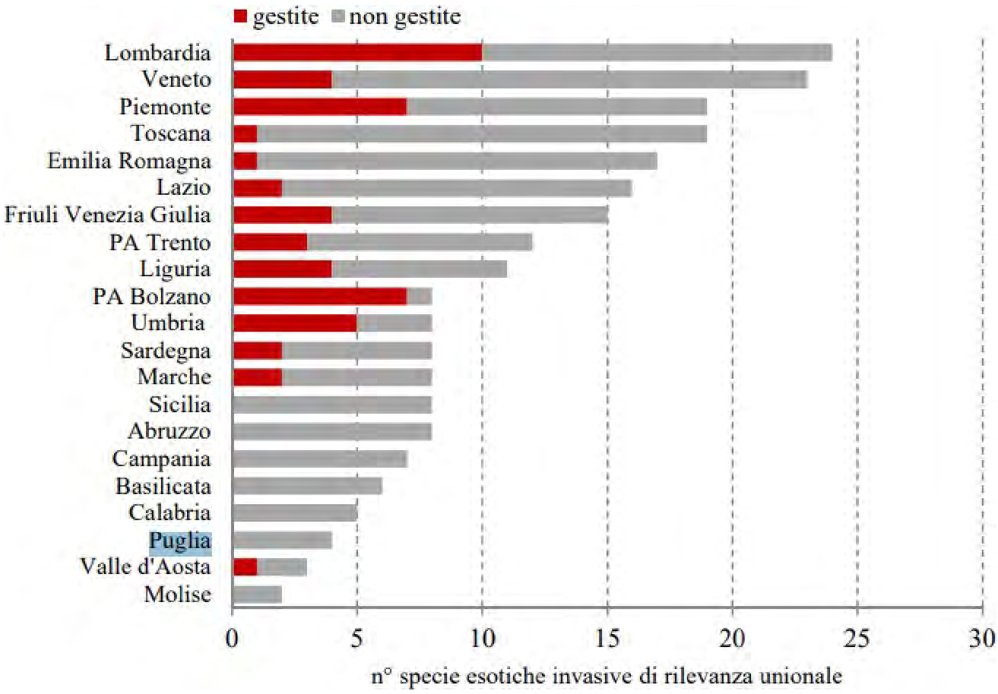
This list of species is periodically updated, giving priority to species whose inclusion would prevent, minimise and mitigate the adverse effects of such species in an effective and cost-efficient manner.

The presence and possible introduction of new alien species can be more dangerous in the Mediterranean than in other basins, due to the fact that the Mare Nostrum, despite accounting for less than 1% of the total marine waters of our planet, is home to approximately 7.5% of the world's animal species (approximately 17,000, a specific richness 10 times higher than the average).

On average, a new non-native species is reported every nine days, but it is almost impossible to provide an exact number of the alien species currently finding a favourable environment along our coasts. Furthermore, given the particular morphology of the Mediterranean and its connections with adjacent basins, the increase has been significantly higher than in other basins such as the Black Sea, the Baltic Sea or the Atlantic Ocean.

As reported and analysed in the ISPRA Nature Directives Report (2013-2018), the overall picture is different when considering the number of species subject to management measures in relation to those present (Figure 5-135). The Puglia region does not manage any alien species.

Figure 5-135 Number of invasive alien species of Union concern managed and not managed in each Region/Autonomous Province (data for the period 2016-2018)



Source: ISPRA, 2018

Again according to the same ISPRA publication, the invasive alien animal species of Union concern in Puglia are:

- *Procambarus clarkia*
- *Pseudorasbora parva*
- *Threskiornis aethiopicus*
- *Trachemys scripta*

Some specific information on this subject is provided below.

Table 5.46 Alien species found in the Apulia region

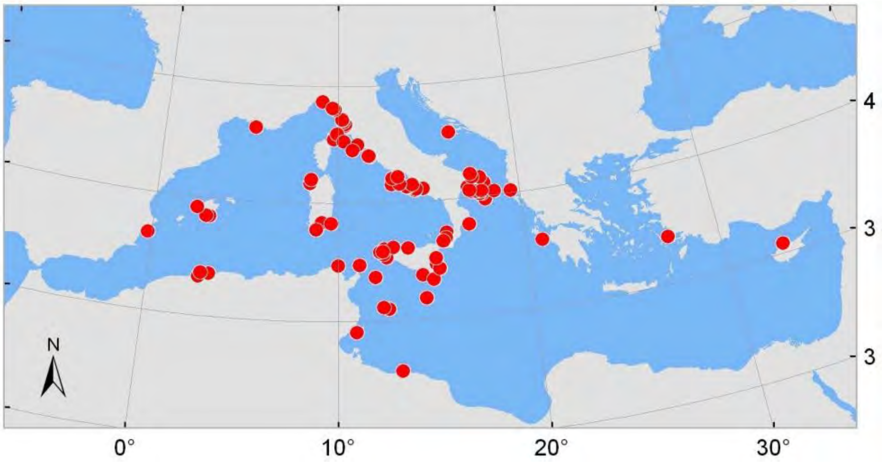
Species	Route of introduction	Distribution
Procambarus clarkia	Introduced both in confined areas and in the wild, with the aim of establishing populations for food and commercial purposes. Introductions have also been reported due to its use as live bait and for control molluscs and invasive plants.	The species is present throughout the country except for Valle d'Aosta, Abruzzo and Molise. Localised occurrences are reported only in Liguria, Trentino, Campania, Basilicata, Puglia, Calabria and the major islands.
Pseudorasbora parva	Introduced through use as live bait in sport fishing or accidentally as contamination of fish stocks intended for release.	The species is present in most Italian regions, more continuously in the Po Valley. Absent in Valle d'Aosta, Molise and Sicily.
Threskiornis aethiopicus	It was introduced mainly due to animals escaping from captivity in private collections and zoos. Its current distribution has been greatly influenced by natural dispersal	The species has been reported in 14 regions (including islands).
Trachemys scripta	Introduced as a pet and subsequently spread into the wild as a result of escape and abandonment	The species is widespread throughout the country.

Source: ISPRA, 2018

In the marine environment, the adaptive success of alien species is favoured by the tropicalisation processes of the Mediterranean Sea. In 2011, a non-native seaweed, *Halophila stipulacea,* was recorded for the first time along the Apulian coast off Otranto. This aquatic plant is native to the Indian Ocean, the Red Sea and the Persian Gulf, and studies suggest that it is potentially highly invasive (Toso and Musco, 2023).

Another example is the spread of algae of the Caulerpa genus, which poses a serious threat to Posidonia populations. This invasive algae has been present along the Ionian coast of Apulia for years.

Figure 5-136 Spread of Caulerpa racemosa in the Mediterranean Sea.



Source: ISPRA - Si.Di.Mar, 2019

Figure 5-137 Caulerpa cylindracea (light green) near a Posidonia oceanica meadow (dark green)

Source: www.vglobale.it (©Lucio Rositani), 2021

Caulerpa species, like other exotic algae, have two different mechanisms of interaction with native populations (Meinesz *et al.*, 2001). The first of these is pure competition. Some species plants are able to colonise any type of substrate in a short time, supplanting the species already present. An example of this is the expansion of *Caulerpa taxifolia.* In fact, in the areas of its initial colonisation in the north-western Mediterranean, this species has covered many hectares of seabed, often long abandoned by Posidonia beds in poor condition due to environmental degradation and unfavourable conditions. In some areas of the Ionian Sea, this did not constitute a destructive event for the pre-existing populations. This species colonised areas almost entirely devoid of vegetation, consisting of sandy and pebbly seabeds in highly rheophilic environments. This is demonstrated by the increased plant diversity of populations with C*. taxifolia* as a characteristic species.

The second mechanism of interaction with pre-existing populations consists in filling the niches left vacant by the destruction of the original populations or due to the climatic events that have affected the Mediterranean Sea for decades and have contributed to eliminating the distances between the ecological niches of the infralittoral zone with the rarefaction, in shallower habitats, of specialist species and the consequent increase in generalist species.

Related to the spread of Caulerpa, some contrasting effects have also been described (Cinar *et al.*, 2021): for example, in *C. taxifolia* beds*,* a decrease in the number of native polychaetes, especially amphipod species, and a decrease in fish and sea urchin populations have been observed, while mollusc diversity has increased. On the other hand, it has also been observed that C*. taxifolia* beds seem to provide favourable environments for the recruitment of certain fish species in autumn.

5.12 Protected Natural Areas and Natura 2000 sites

5.12.1 Protected Areas

The system of protected and safeguarded natural areas in Apulia is of great importance due to the number and extent of the areas and the richness and diversity of their natural heritage. The protection measures considered in the selection include:

- Protected natural areas included in the official list of the Ministry of the Environment and Energy Security (National Parks, Regional and Interregional Natural Parks, Nature Reserves, Wetlands of International Importance, other protected natural areas, terrestrial and marine areas of special interest).
- The Natura 2000 network, which is the main instrument of the European Union's policy for the conservation of biodiversity. It is an ecological network spread across the entire territory of the Union, established under Directive 92/43/EEC 'Habitats' to ensure the long-term conservation of natural habitats and species of flora and fauna that are threatened or rare at Community level. However, the Habitats Directive aims to ensure the protection of nature while also taking into account 'economic, social and cultural requirements, as well as regional and local characteristics'. The Natura 2000 network consists of:
  - Sites of Community Importance (SCIs), identified by Member States, which host habitats and species listed in Annexes I and II of the Habitats Directive;

- Special Areas of Conservation (SACs), designated following the adoption of the lists of SCIs by the European Commission;
- Special Protection Areas (SPAs), for sites identified under the Birds Directive, which in Italy are designated by the regions and autonomous provinces.

- Important Bird Areas (IBAs): areas that play a fundamental role for wild birds and are an essential tool for their protection and study. Created as part of a BirdLife International project, these areas are identified in Italy by LIPU according to a set of internationally agreed criteria.
- Areas protected under the Ramsar Convention: otherwise known as the Convention on Wetlands of International Importance, this is an agreement signed in Ramsar, Iran, by a group of governments, scientific institutions and international organisations, with the collaboration of the International Union for Conservation of Nature (IUCN) and the International Council for Bird Preservation (ICBP).
- Geosites: the Italian Geosites Inventory contains information on 'geosites' of geological, naturalistic and geoarchaeological interest, collected by ISPRA since 2002.
  naturalistic and geoarchaeological interest, collected by ISPRA since 2002.
- Areas protected by national regulations not included in the previous categories.

A section of the onshore cable duct crosses (for approximately 2.3 km) the Costa Otranto Regional Nature Park - Santa Maria di Leuca and Bosco di Tricase" (EUAP1192), a regional park in Apulia established by Regional Law No. 30 of 26 October 2006. The nature park covers an area of 3,227 hectares and, with approximately 57 km along the eastern coast of Salento, is the largest of the regional parks established in the province of Lecce. It includes 12 municipalities: Alessano, Andrano, Castrignano del Capo, Castro, Corsano, Diso, Gagliano del Capo, Ortelle, Otranto, Santa Cesarea Terme, Tiggiano and Tricase. The park also includes the area where the Punta Palascìa lighthouse stands, the easternmost point of Italy.

The protected area, located along the eastern coast of Salento (a high coastline overlooking the sea), aims to conserve and recover animal and plant species, safeguard historical and architectural heritage, increase the surface area and improve the ecological functionality of natural environments, introduce sustainable mobility measures, promote education, training and scientific research and sustainable recreational activities, and finally promote and redevelop compatible economic activities in order to improve the quality of life of the resident population.

For these reasons, activities and works that may compromise the protection of the landscape and protected natural environments are prohibited throughout the protected area, with particular regard to protected flora and fauna and their habitats.

The surface of the park is characterised by a very unusual stratigraphic architecture due to the fact that various carbonate systems, dating from the Late Cretaceous to the Quaternary period, are arranged laterally and variously "interlocked" with each other. These layers, which remain unaltered in some areas, are quite thick and form spectacular landscapes that bear witness to the complex events of the long geological evolution over the last 65 million years.

A fundamental feature of this stretch of coastline is the presence of cavities linked to karst phenomena and the interaction of coastal springs combined with erosion caused by the sea.

Among the most important caves are:

- the Cervi cave;
- the Romanelli cave;
- the Zinzulusa cave.

Numerous fossil remains dating back to the Palaeolithic and Neolithic periods have been found here.

The park extends along a large SCI (Site of Community Importance) and includes or connects to four other sites of particular conservation importance, designated as SCIs under the Habitats Directive 92/43 EEC.

Most of the protected area is located along the coastline and is characterised by a variety of environments such as holm oak woods, pine forests, scrubland with thorny oak and other sclerophyllous plants, garrigue, old pastures, cliffs and sea cliffs.

From a botanical point of view, the area is divided into strips running parallel to the coastline. In the first strip, there is little vegetation cover. The only species that can survive in this extreme habitat are halophytes, such as *Limonium virgatum (*limonium virgatum), *Salicornia fruticosa (*salicornia fruticosa), *Critmum maritimum (*sea fennel) and *Capparis spinosa (*caper).

The flora is also rich in rare endemic species included in the national 'Red List' and the presence of trans-Adriatic and trans-Ionian species enhances the phytogeographical value of the coast.

The rocky cliffs are populated by a rich rock flora with plant species of great conservation importance, some of which are considered endemic to Salento. These include *Centaurea leucadea* (Leuca cornflower), *Centaurea nobilis (*noble cornflower), *Centaurea japigica (*Salento cornflower), *Dianthus japigicus (*Salento carnation) and *Vicia giacominiana (*Giacomini vetch).

There are also species of phytogeographical interest, found in the eastern area, such as: *Aurinia leucadea* (Leuca alyssum), *Campanula versicolor* (Apulian bellflower), *Ephedra campylopoda* (oriental ephedra), *Echinops spinosissimus* (bullet thistle), *Umbilicus cloranthus* (greenish navelwort).

Further inland, at higher altitudes, there is a vast rocky plateau characterised by pseudo-steppe formations of *Stipa austroitalica* (fairy flax) and *Cymbopogon hirtus (*Mediterranean barboncino), belonging to the *Thero-Brachypodietea* phytosociological class*,* a priority habitat under the Habitats Directive 92/43 EEC, and garrigue. The area also features Mediterranean scrub, characterised by the presence of prickly oak (splendid in the Le Orte area) and groves of vallonea oak and holm oak.

Finally, the richness of karst and erosion phenomena finds its maximum expression in the myriad of coastal caves, often semi-submerged, which are true sanctuaries of geomorphological value and animal rarities.

As for fauna, this area was home to the last regional population of Europe's rarest mammal, the monk seal (*Monachus monachus*).

The area is affected by a significant migratory passage of the following bird species:

- *Tetrax tetrax*
- *Circus cyaneus*
- *Circus macrourus*
- *Ichthyaetus melanocephalus*
- *Pandion haliaetus*
- *Circus aeruginosus*
- *Circus pygargus.*

Several karst cavities are home to rare underground communities and numerous species of endemic invertebrates.

The wider area also includes a marine conservation area: 'Capo d'Otranto - Grotte Zinzulusa e Romanelli - Capo di Leuca' (Law 394/91), which has not yet been established. As reported in the "Report on the implementation of Law No. 394 of 1991 - year 2016" by the Ministry of the Environment and Protection of the Territory and the Sea (now MASE), for the collection area in question, previously named "Salento Peninsula (Zinzulusa and Romanelli Caves)", on 2 August 2016, an agreement was signed between the MATTM (DPNM) and ISPRA for activities relating to the preliminary investigations necessary for the establishment of the marine protected area; subsequently, in December 2016, an extension was agreed with ISPRA for the activities provided for in the agreement. Finally, Legambiente's report '2021 La legge quadro sulle aree protette compie 30 anni' (2021 The framework law on protected areas turns 30) indicates that the studies, which began in 2018, have not yet been completed. The information currently available is scarce, and the official data on the status of the establishment of this area are not up to date.

The boundaries of the marine area of origin: 'Capo d'Otranto - Grotte Zinzulusa e Romanelli - Capo di Leuca' are currently available in preliminary form and defined in the preliminary study by the Ministry of the Environment and Protection of the Territory and the Sea (MASE); Based on these preliminary boundaries, the cable duct crosses the Capo d'Otranto - Grotte Zinzulusa and Romanelli - Capo di Leuca area for approximately 6 km.

5.12.2 Natura 2000 sites

The Park includes several Sites of Community Importance under the Habitats Directive 92/43/EC (Figure 5-138):

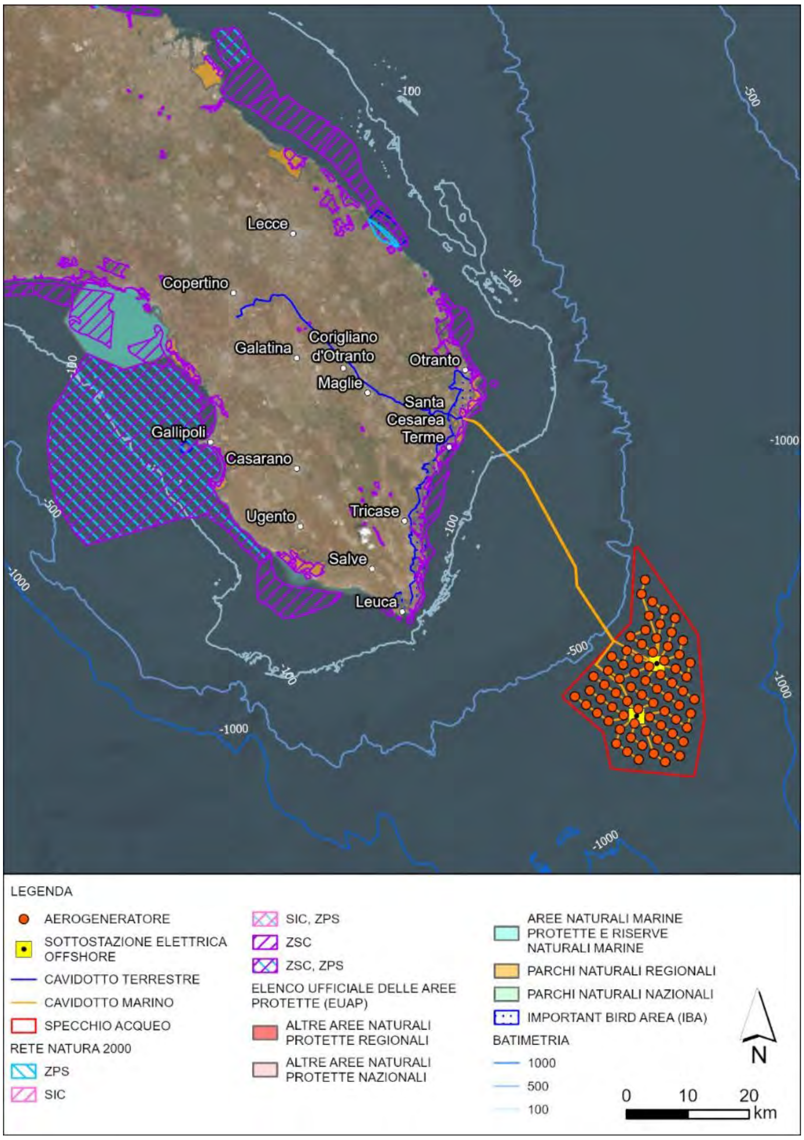
- Costa Otranto – Santa Maria di Leuca (IT9150002): this is a site of great scenic value consisting of rocky cliffs overlooking the sea, formed from Cretaceous limestone. Its importance is due to the presence of endemic and trans-Adriatic species, including 12 protected bird species, 2 reptile species (*Elaphe quatuorlineata and Elaphe situla) and* 3 mammal species (2 bats and the monk seal), as well as 1 protected plant species (*Stipa austroitalica)*. Also noteworthy are the encrusting algae floors and a significant red coral facies.
- Boschetto di Tricase (IT9150005): this is the only forest of Vallonea oak (*Quercus macrolepis*) in Italy with monophytic purity, preserving majestic, centuries-old specimens. This plant finds optimal environmental conditions here for its spontaneous reproduction and is the habitat of two protected species of snakes (*Elaphe quatuorlineata and Elaphe situla)*.
- Castro Oak Park (IT9150019): this is a forest with a prevalence of holm oaks (*Quercus ilex*) and the presence of mesophilic species such as terebinth (*Pistacia terebinthus*) and medlar (*Mespilus germanica*). It is home to two protected species of snakes (*Elaphe quatuorlineata and Elaphe situla)*.

<u>The route crosses the Natura 2000 site called 'Costa Otranto – Santa Maria di Leuca', which also includes approximately 350 m of marine strip facing the coast.</u>

The other two sites mentioned are located approximately 18 km (Boschetto di Tricase) and 9 km from the Castro Oak Park.

Furthermore, within the municipality of Soleto, the route skirts the site of "Lago del Capraro" without crossing it. The site consists of temporary Mediterranean ponds, which are very small bodies of water and represent rare environments. They are home to a rich biodiversity with rare and internationally protected species. Puglia, like few other areas in Italy, is particularly rich in these ponds, and the territory of Soleto and Sternatia is home to several of them, some of which are recognised as Sites of Community Importance. The lake area is a subcircular sinkhole colonised by a mosaic of herbaceous communities distributed according to soil moisture gradient and anthropogenic disturbance. The outer perimeter of the sinkhole is entirely surrounded by a natural road, partly paved with local stone blocks. The surrounding land is cultivated with olive trees. Since 2000, signs of disturbance caused by ploughing and mowing of the vegetation at the bottom of the sinkhole have been observed.

Figure 5-138 Protected and preserved areas



Source: MASE data reworked, 2023

Table 5.47 Natura 2000 areas near the intervention area and relative distance

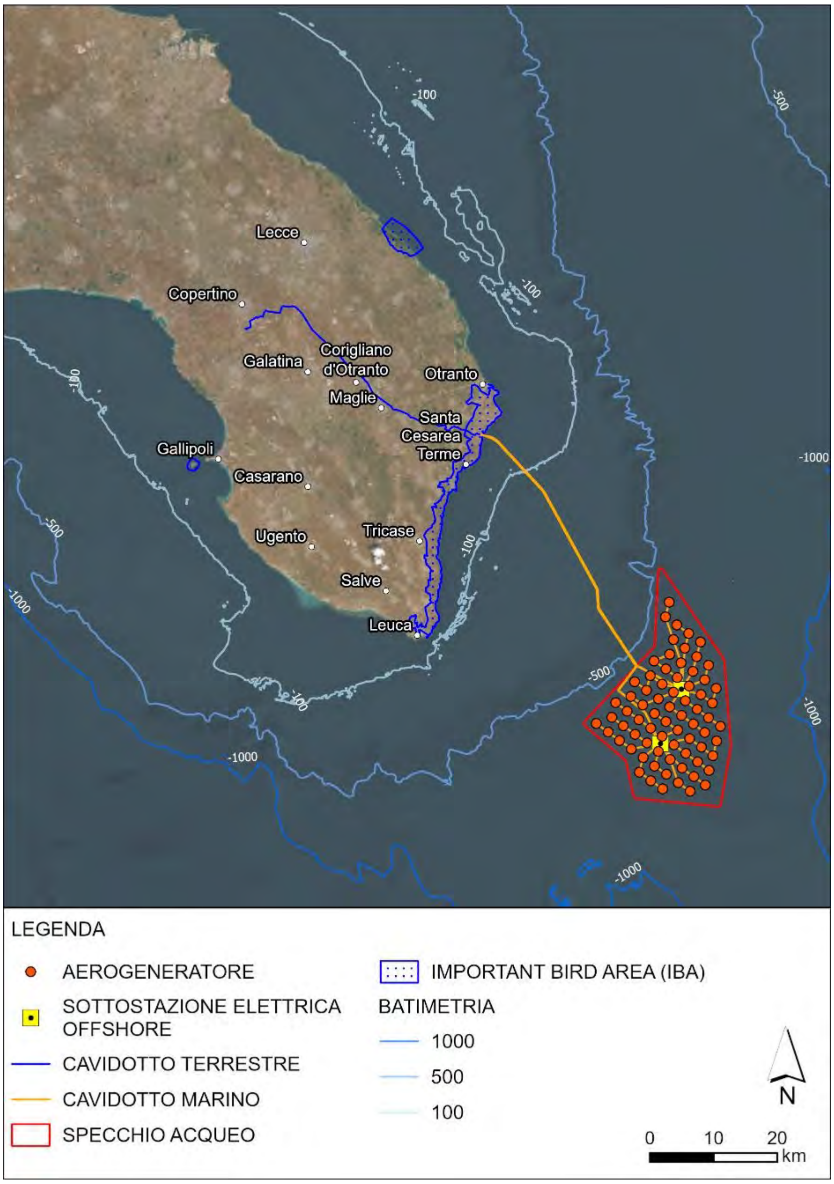
Nature code 2000	Site Name	Distance from Project Area Project Area (km)	Distance from connection
Marine sites			
ZSC IT9150002	Otranto Coast - Santa Maria di Leuca	2	Intersects in the TOC section
ZSC IT9150034	Posidonia field Capo San Gregorio - Punta Ristola	29	29
ZSC IT9150009	Ugentine coastline	3	29
Marine/Terrestrial Sites			
ZSC/ZPS IT9150015	Gallipoli coastline and Isola S. Andrea	>50	13.1
ZSC IT9150008	Montagna Spaccata and Rupi di San Mauro	>50	13
Terrestrial Sites			
ZSC IT9150036	Lake Capraro	>50	Bordering along existing road network
ZSC IT9150020	Pecorara Forest	48.4	6
ZSC IT9150016	Otranto Forest	4	6.9
ZSC IT9150011	Alimini	3	7
ZSC IT9150019	Castro Oak Park	3	8
ZSC IT9150035	Mancina Marsh	4	13
ZSC IT9150001	Guarini Forest	3	17
ZSC IT9150005	Tricase Grove	36	18
ZSC IT9150021	Le Chiuse Wood	3	19.6
ZSC IT9150018	Bosco Serra dei Cianci	37	27

5.12.3 Areas of importance for biodiversity

5.12.3.1 Important Bird Areas (IBA)

The landing area is also protected as an area of importance for birdlife, under the name 'Costa tra Capo d'Otranto e Capo S. Maria di Leuca' (IBA147), and is crossed by the existing road network.

Figure 5-139 Areas of Importance for Birdlife in the Project Area



Source: MASE data reprocessing, 2023

5.12.3.2 Key Biodiversity Areas (KBA)

The landing area falls within the KBA 'Coast between Capo d'Otranto and Capo Santa Maria di Leuca' (ID 2844), as shown in Figure 5-140. This area was designated on the basis of the criteria established for the designation of IBAs presented in the previous chapter (Key Biodiversity Areas Partnership, 2024).

Figure 5-140 KBAs in the Project area

Source: Key Biodiversity Areas Partnership, 2024

5.12.3.3 Ecologically or Biologically Significant Marine Areas (EBSA)

The Project covers the entire portion of the offshore wind farm area and part of the marine cable duct within the EBSA "Southern Adriatic and Strait of the Ionian Sea" (EBSA, 2024). This area extends to the centre of the southernmost part of the southern Adriatic Sea basin and the northernmost part of the Ionian Sea (Figure 5-141). As illustrated in Section 5.11.1.2, this area is important for nutrient exchange. In addition, this area is considered important for biodiversity due to the presence of the Cuvier's *beaked* whale (*Ziphius cavirostris)* and the high density of large pelagic marine fauna, such as mobula rays (*Mobula mobular)*, striped dolphins (*Stenella coeruleoalba)*, monk seals (*Monachus monachus)* and loggerhead turtles *(Caretta caretta),* species included in Annex II of the SPA/BD protocol, identified as potentially present in the Project area, with *Stenella coeruleoalba a n d Caretta caretta* also confirmed by environmental monitoring

(Paragraphs 5.11.1.6 and 5.11.1.8). Another factor that makes the area significant is the presence of deep-water corals and aggregations of Porifera, as indicators of organic matter accumulation contributing to the introduction of organic matter into the food web. Environmental surveys have identified white coral madreporites in some areas (Paragraph 574205304.40.-1260800721.32761).

Figure 5-141 EBSA in the project area

Source: EBSA, 2024

5.12.3.4 Ramsar sites

Ramsar sites are wetlands of international importance identified on the basis of the Ramsar Convention on Wetlands (2024). The Project area is not close to any Ramsar sites.

There are no Ramsar sites, but the "Le Cesine" wetland (area of 620 ha, 40°20'N 018°21'E) is the closest to the Project area
at 17.7 km to the north (Figure 5-142).

Figure 5-142 Ramsar site closest to the Project

Source: Ramsar Convention on Wetlands, 2024

5.13 Landscape System, Cultural and Archaeological Heritage

5.13.1 Landscape

The offshore wind farm will be located at a considerable distance (minimum distance of approximately 28 km) from the Salento coast between Tricase and the marine area south-east of Capo Santa Maria di Leuca, in the Province of Lecce. The project involves the laying of four electricity export cables (export cables) landing in the municipality of Santa Cesarea Terme (LE) and an onshore cable duct section of approximately 49 km to the delivery point, approximately 1.4 km south-east of the Copertino industrial area. The route of the land cable duct crosses the municipalities of Santa Cesarea Terme, Otranto, Minervino di Lecce, Giuggianello, Sanarica, Muro Leccese, Maglie, Melpignano, Corigliano d'Otranto, Soleto, Sternatia, Lequile and Copertino, exclusively within the province of Lecce.

Paragraph 4.4.3 analyses in detail the landscape components described in the Regional Landscape Plan (PPTR) and, above all, highlights how the ground works essentially affect the existing road network without significantly altering the most significant elements of the landscape. According to the Regional Landscape Plan (PPTR), the underground cable duct affects 'Area 11/Salento delle Serre' from Santa Cesarea Terme to Muro Leccese, and 'Area 10/Tavoliere salentino' from Maglie to Copertino.

Area 11 is mainly characterised by the orographic conformation of the Salento greenhouses, an alternation of ridges and depressions that run in a north-east direction. Due to the lack of obvious and characteristic morphological features and clear boundaries between crops, the perimeter of the area has been established along the municipal boundaries. The coastal areas show extreme morphological variability, due to the numerous and varied types of coastline in the Salento area. There is a gradual but rapid transition from extensive sandy coasts, bordered by dune ridges, to rocky coasts, rich in ravines and inlets, to sheer cliffs or falaises, rising several tens of metres above sea level and rich in sea caves that can be visited from both the sea and land (PPTR Puglia Elab. 5, 2015).

The area in question is structurally characterised by a profound influence of hydro-geo-morphological features on urban, rural and coastal landscapes. The tuffaceous soils, clayey layers and calcareous-marly layers (Lecce stone), which are widespread but small in size, do not allow for the presence of surface watercourses (while endorheic basins are widespread), but nevertheless retain water, allowing aquifers to form at shallow depths (from -10 m to -14 m). These aquifers are extensive but shallow and not very abundant (and therefore more suitable for scattered exploitation), on which a dense network of settlements with low population density and a tendency towards low hierarchy has developed. Compared to neighbouring areas, the geological contrast is more evident in the Serre. The wooded and olive-covered limestone ridges contrast with the tuffaceous valleys, where the inhabited centres are mainly located, generally close to the Serre, creating a long string of settlements crossed by roads and surrounded by olive groves, arable land and uncultivated land. The olive grove landscape, which dominates the area, becomes more complex near small urban centres, creating a mosaic landscape oriented towards polyculture, which historically has seen vineyards and olive groves combined with arable land even during periods of severe recession in woody crops and the advance of cereal cultivation and grazing. In fact, it is the arable land in these areas that has been structurally weak, leading to the need for external supplies at various times. Furthermore, for natural reasons and historical events (insecurity and the presence of marshes, also linked to deforestation by man), the polycentric settlement network has structurally established itself in contrast to the coast, which alternates between rocky areas rich in cliffs and sea caves and extensive dune ridges rich in spontaneous vegetation. Excluding the cases of Gallipoli and Otranto, which are nevertheless unable to organise the surrounding territory over a wide area, the

Settlements are located inland and only very recently (from a historical point of view) have small towns, known as 'marine', been established, which are mainly residential and tourist centres (PPTR Puglia, Elab. 3.3, 2015[15]).

Area 10 is mainly characterised by a network of small towns connected by a dense provincial road network. Within this homogeneous general structure, there are several recognisable landscapes that identify the numerous territorial features. Due to the lack of obvious and characteristic morphological features and clear boundaries between crops, the perimeter of the area is entirely within the municipal boundaries. This territory is characterised by low average altitude, which has led to intensive cultivation. The main feature is, in fact, the almost continuous cultivation of the land, except for a fairly fragmented system of scattered rocky pastures. Only along the coastal strip is there a fair amount of natural areas, consisting of wetlands and scrubland. This system is interrupted by numerous urban settlements, both compact and scattered.

Salento is mostly a karst plain, the "Tavoliere", within which the only visual references of morphological character are represented by the "Serre". These appear as alternating flat areas of varying sizes, separated by low hills that run in a north-east direction. They are more rugged and closer together in the western part, which slopes down towards the Ionian Sea, and more sparse in the eastern part, where they intersect with the coast, creating high cliffs and deep inlets. Crossing the karst plain, the serre appear as more or less gentle olive groves that stand out from the surrounding flat land, while travelling along them in a longitudinal direction, where the olive groves allow, it is possible to enjoy a view of the landscape that flanks them all the way to the sea. The elements of the visual perception change dramatically when crossing the northern Tavoliere. Here, in the absence of any morphological reference points, the only visual relationships are provided by man-made elements such as bell towers, domes and towers that rise above the olive trees or stand out at the edges of slight depressions (Valle della Cupa). The landscape seen from the dense road network is characterised by a mosaic of vineyards, olive groves, arable land, horticultural crops and pastures. It varies imperceptibly with the prevailing crop, the densification of the agricultural fabric and the concentration of historical anthropic signs. In central Salento, where a web of roads connects small rural centres a few kilometres apart, the agricultural landscape is dominated by stone and outcropping rock, with small plots alternating with small pastures and sparse wooded areas, delimited by a dense mosaic of dry stone walls and numerous stone shelters (pagghiare, furnieddhi, chipuri and calivaci) dotted throughout the landscape. Proceeding towards the eastern sub-coastal strip, the landscape is dominated by olive groves. The coastline is never monotonous but always varied and jagged.

15 Regional Landscape Plan for the Apulia Region, 2015. Interpretations of identity and status

5.13.2 Areas of archaeological interest on land

The areas subject to protection by the PPTR are divided into:

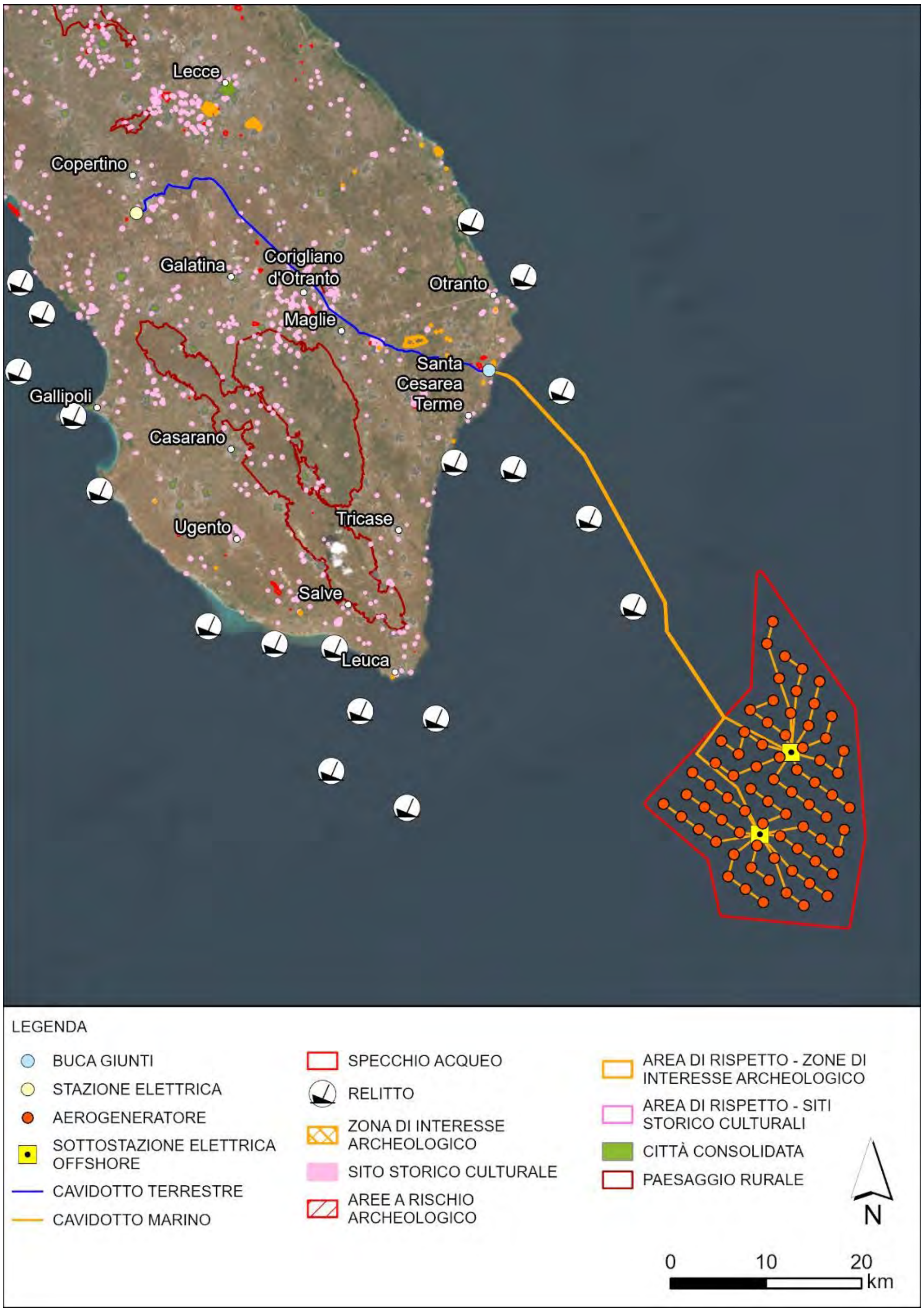
- Landscape assets, pursuant to Article 134 of the Code;
- Other landscape contexts pursuant to Article 143(1)(e) of the Code;

Landscape assets are further divided into two categories of assets:

- Properties and areas of significant public interest (pursuant to Article 136 of the Code), i.e. those areas for which a declaration of significant public interest has been issued;
- Areas protected by law (pursuant to Article 142 of the Code).

The Salento area is characterised by numerous archaeological sites and points of historical and artistic interest. As shown in Figure 5-143, there are sites of archaeological interest near the route. However, it should be noted that the route of the underground cable duct, with the exception of the landing area, the joint pit and the area of the future connection station, will affect the existing road network.

Figure 5-143 Sites of archaeological interest and presence of wrecks



Source: EMODnet 2023 data reprocessing

Data analysis has highlighted the presence of the following assets in the vicinity of the Project Area:

- Grotta Badisco (ARC0308), prehistoric cave settlement in the municipality of Otranto;
- Masseria Consalvi, subject to architectural reporting as a settlement in the municipality of Otranto;
- Palate, area subject to architectural reporting as a settlement in the municipality of Otranto;
- Grotte "Ignazio Spagnolo" (ARC0316-ARC0317), prehistoric cave settlement in the municipality of Santa Cesarea Terme;
- Masso della Vecchia-Monte San Giovanni (LE019-LE064), area of archaeological interest in the municipality of Giuggianello;
- Messapian walls, area subject to architectural reporting as a village in the municipality of Muro Leccese;
- Masseria Murichella-Masseria Caggiula, area subject to architectural reporting as a settlement in the municipality of Corigliano d'Otranto;
- Masseria Colmaria archaeological area, area subject to architectural reporting as an archaeological area in the municipality of Soleto;
- Cornula, area subject to architectural reporting as a rural settlement in the municipality of Nardò.

5.13.3 Underwater areas of archaeological interest

As regards the offshore section, analysis of nautical charts did not reveal the presence of any known wrecks in the immediate vicinity of the planned works. Near the landing area, approximately 7 km from the coast, there is an underwater wreck dating back to between 100 and 50 BC. The site is located at the base of a rocky escarpment close to the coast, at a depth of between -26 m and -30 m (Figure 5-143) (General Catalogue of Cultural Heritage([16]).

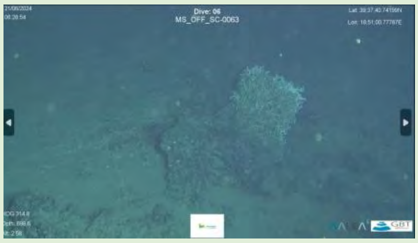
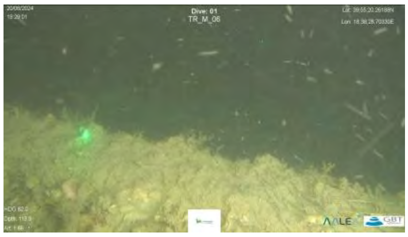
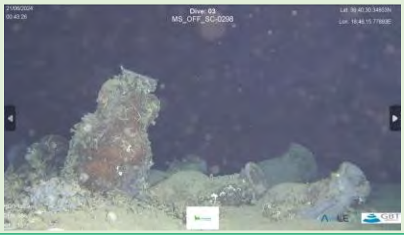
5.13.3.1 Results of the Preliminary Archaeological Interest Assessment

The survey activities carried out between April and June 2024 allowed us to acquire a good set of data, thanks to which a complete and exhaustive interpretation of the Project Area was possible, including from an archaeological point of view.

Examination of the sonograms acquired during the instrumental investigations made it possible to isolate five targets, four within the wind farm area and one in the ECC section, which, in terms of shape and size, presented profiles of potential cultural interest.

16 General Catalogue of Cultural Heritage, catalogo.beniculturali.it, consulted on 20/03/2024

Table 5.48 Results of visual inspection of targets

TGT	Inspection date	Identification	Notes	Image
MS_OFF_SC_0063	21/06/2024	Batymorphological anomaly	Rock outcrops with coral	
MS_OFF_SC_0064	2	Batymorphological anomaly	Rock outcrops with coral	
MS_OFF_SC_0121	2	Debris	Remains of rocks or bioconcretions transported by fishing nets.	
MS_OFF_SC_0129	20/06/2024	Wreck	Remains of a metal hull with nets. Currently being analysed.	
MS_OFF_SC_0298	21	Wreck	Amphorae from the late Roman Empire. Currently being analysed and prepared for communication to SN-Sub	

Source: Preliminary Offshore Archaeological Interest Assessment

With regard to target MS_OFF_SC_0298, the ROV survey documented several amphorae exposed above the topographic roof of the seabed, as well as intact bodies that were semi-buried and emerging.

majority of the exposed amphorae are in good condition, generally covered by marine bioconcretions. Many of the visible specimens are in a stowed position, on several levels.

Figure 5-144 In the central area, several levels of amphorae in stowage position can be seen

Source: Preliminary Offshore Archaeological Interest Assessment

From the first images acquired, it seems possible to identify the find as a homogeneous load from a late imperial-era cargo ship, dating back to between the 3rd and 4th centuries AD.

With regard to the degree of archaeological potential, the survey area has been divided into three components: the nearshore corridor, the offshore corridor, and the wind farm area, to which a fourth zone has been added, corresponding to the location of the Roman wreck, with a buffer zone of approximately 200 metres centred on the coordinates of the acoustic anomaly detected and investigated. The archaeological potential was then assessed according to the criteria of the National Archaeology Geoportal (GNA) Template, as specified in the tables produced by the GNA Template (available in the above-mentioned Annex).

Table 5.49 Determination of the Degree of Archaeological Potential according to the parameters of the GNA template

Area	Archaeological Potential Rating
Nearshore Corridor	Analysis of various databases listing known sites and wrecks along the Salento coast allows the nearshore corridor, i.e. the portion of the project area between the coast of Porto Russo and the -100 metre bathymetric line, to be assigned a HIGH archaeological potential. On the one hand, several archaeological finds have been reported near the natural landing places of Porto Badisco and the coast south of Portorusso. the presence of known shipwrecks in this area confirms the existence of routes that, from ancient times to the present day, have used the Salento coast as a reference point for coastal navigation and not only as a point of departure and landing for trans-Adriatic routes. For this reason, considering the difficulty of identifying small and medium-sized ceramic remains isolated and scattered on the topographical roof of the seabed through acoustic and seismic surveys alone, it cannot be ruled out that the area between the coast and the imaginary line of 5/6 nautical miles may in fact contain further remains of cultural interest, evidence of the long use of the routes that crossed along the Salento coast.
Offshore Corridor	Limiting the analysis to the corridor alone, it seems possible to attribute a LOW archaeological potential to this area. While it is possible to hypothesise that ancient coastal shipping routes did not pass through this stretch of sea, given its distance from the coast and possible landing places, the investigations carried out here have ruled out the presence of concentrations of remains that could suggest the presence of wrecks of possible historical or archaeological interest.
Wind farm area	The results of the instrumental surveys carried out allow this area to be classified as having LOW archaeological potential. The identification of a small ancient wreck, measuring approximately 5 x 10 metres, where the potential must be considered HIGH, as well as the verification of other potentially interesting acoustic anomalies, which have instead proved to be of natural or anthropogenic origin but of contemporary age, confirm that, despite being located on Adriatic and trans-Adriatic shipping routes, the area does not preserve further evidence of these navigations. However, the presence of isolated finds that are not recognisable by the investigation methods adopted at this stage.
Roman wreck	In the vicinity of the wreck and for a buffer zone of at least 200 metres radius, the archaeological potential must be considered HIGH.

Source: Offshore Archaeological Interest Preliminary Assessment

As with the potential, the Archaeological Risk Level was also calculated according to the criteria of the GNA Template.

Table 5.50 Determination of the Archaeological Risk Level according to the parameters of the GNA template

Area	Archaeological Risk Level
Nearshore Corridor	The presence, especially near the coast, of known sites and finds at a short distance from the corridor and the possibility that scattered remains may be preserved that cannot be detected with the methods used at this stage suggest a HIGH archaeological risk, also in light of the need to bury the cables below the topographic roof of the bottom layer. topographical layer of the seabed.
Offshore Corridor	Although no finds have been made, it cannot be ruled out that the seabed may contain remains of archaeological interest that cannot be detected with the methods used in this phase of the survey, even if buried. For this reason, the archaeological risk, also in light of the need to bury the cable ducts, appears to be MEDIUM.
Wind farm area	Although investigations have made it possible to locate a Roman wreck, where the risk is HIGH, and to rule out the presence of further elements of cultural interest, the impossibility of identifying any small objects scattered on the seabed, as well as of accurately investigating the stratigraphy buried at the wind turbine anchor points and cable laying sites, means that the area must be classified as having a MEDIUM archaeological risk. MEDIUM.
Roman wreck	At the wreck and for a buffer zone of at least 200 metres, the archaeological risk must be considered HIGH.

Source: Offshore Archaeological Interest Preventive Assessment

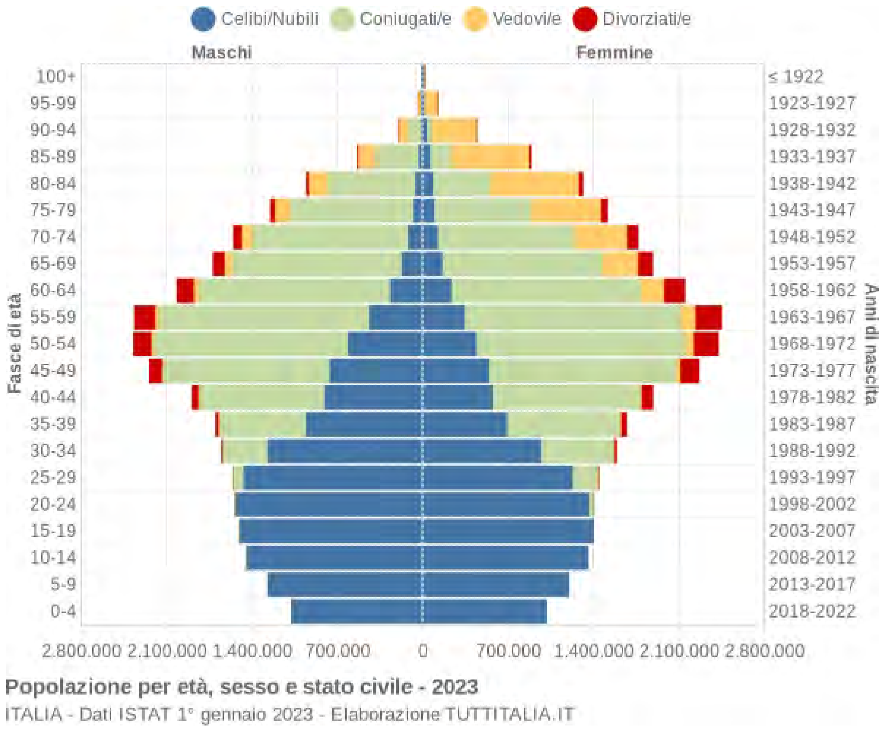
In conclusion, one wreck of archaeological interest has been identified, with most of the amphorae in good condition, generally covered by marine bioconcretions. The archaeological potential has therefore been assessed according to the criteria of the National Archaeology Geoportal Template (GNA): HIGH for the nearshore corridor, LOW for the offshore corridor, LOW for the wind farm area and HIGH for the Roman wreck.

5.14 Population and public health

5.14.1 Population

As of 1 January 2023 (ISTAT data), the Apulia region had 3,922,941 inhabitants, of whom 48.7% were male and 51.3% female.

Figure 5-145 Population of the Puglia Region by Age, Gender and Marital Status



Source: ISTAT data, 1 January 2023 – Processed by tuttitalia.it, 2024

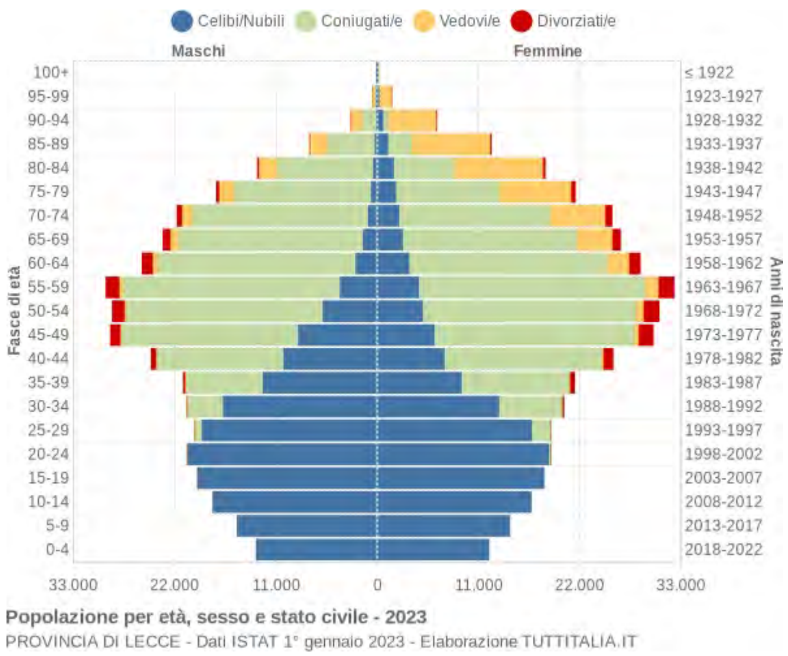
The demographic trend in the Puglia Region in the period from 2001 to 2022 shows an increase in population until 2010, followed by a steady decline starting in 2013, which was particularly pronounced in the years 2018-2020 (Figure 5-146).

Figure 5-146 Trend in the resident population in Puglia, 2001-2022

Source: ISTAT data as of 31 December each year – Processed by tuttitalia.it, 2023

At the provincial level, Lecce has 771,230 inhabitants (ISTAT data, 2023), of whom 48.1% are male and 51.9% are female. The most representative age groups are those between 50 and 54 and between 55 and 59, both accounting for 7.8% of the population (Figure 5-147).

Figure 5-147 Population of the Province of Lecce by age, gender and marital status



Source: ISTAT data, 1 January 2023 – Processed by tuttitalia.it, 2024

The demographic trend in the Province of Lecce in the period from 2001 to 2022 shows steady growth until 2010, followed by a decline, which was particularly pronounced in the years 2018-2020 (Figure 5-148).

Figure 5-148 Resident population in the Province of Lecce, 2001-2022

Source: ISTAT data as at 31 December – Processed by tuttitalia.it, 2023

5.14.2 Life expectancy

Life expectancy is one of the most frequently used indicators of the health status of the population. In Italy, in 2019, life expectancy at birth was 81.1 years for men and 85.4 years for women. In the four years from 2016 to 2019, men gained 0.5 years and women 0.3 years. In 2020, however, following the COVID-19 pandemic, life expectancy at birth fell compared to 2019, with values of 79.8 years for men and 84.5 years for women. However, in 2021, life expectancy at birth is slightly higher, at 80.1 years for men and 84.7 years for women. Although the gap between the average life expectancy of women and men is narrowing (+4.4 years in 2016 vs +4.2 years in 2019), it is still clearly in favour of women.

Regional differences are not closing with the passing of the years: the gap between the most favoured and least favoured regions is around 3 years for both men and women. For both genders, the Autonomous Province of Trento has the highest life expectancy at birth. The most disadvantaged region for both men and women is Campania.

For the Puglia region, life expectancy at birth in 2021 is 79.6 years for men and 84.1 years for women, both lower than the national average. In detail, for the province of Lecce, life expectancy at birth in 2021 is 80.8 years for men and 84.9 years for women. The table below analyses the values of this indicator at birth, broken down by gender and region of residence.

Table 5.51 Life expectancy at birth and absolute changes by gender and region of residence (2017-2021)

Regioni/Macroaree	Maschi 2017	2018	2019	2020	2021*	Δ (2020-2019)	Δ (2021-2020)	Femmine 2017	2018	2019	2020	2021*	Δ (2020-2019)	Δ (2021-2020)
Piemonte	80,4	80,5	80,8	79,1	80,1	-1,7	1,0	84,7	84,9	85,2	83,9	84,8	-1,3	0,9
Valle d'Aosta	79,8	79,1	79,9	78,4	80,1	-1,5	1,7	84,3	84,8	85,6	83,5	84,3	-2,1	0,8
Lombardia	81,2	81,3	81,5	79,0	80,8	-2,6	1,8	85,5	85,7	85,9	84,0	85,4	-1,9	1,4
Bolzano-Bozen	*81,4*	*81,7*	*81,8*	*80,7*	*81,1*	*-1,1*	*0,4*	*86,2*	*86,1*	*86,2*	*85,0*	*85,5*	*-1,2*	*0,5*
Trento	*81,6*	*82,0*	*82,0*	*80,5*	*81,3*	*-1,5*	*0,8*	*86,3*	*86,2*	*86,6*	*85,2*	*86,3*	*-1,4*	*1,1*
Veneto	81,3	81,4	81,7	80,7	81,0	-1,1	0,3	85,6	85,8	86,1	85,2	85,6	-0,9	0,4
Friuli Venezia Giulia	80,7	80,8	81,3	80,3	79,6	-1,0	-0,7	85,5	85,4	85,9	85,1	84,8	-0,8	-0,3
Liguria	80,6	80,5	80,9	79,3	80,4	-1,5	1,1	84,9	85,0	85,5	84,1	85,0	-1,4	0,9
Emilia-Romagna	81,2	81,5	81,6	80,3	80,8	-1,3	0,5	85,4	85,6	85,7	84,8	85,1	-0,8	0,3
Toscana	81,3	81,6	81,7	81,1	81,1	-0,6	0,0	85,4	85,7	85,8	85,3	85,2	-0,5	-0,1
Umbria	81,3	81,8	82,1	81,2	80,9	-0,9	-0,3	85,4	85,8	86,2	85,7	85,4	-0,5	-0,3
Marche	81,2	81,6	81,9	81,0	80,9	-1,0	-0,1	85,5	85,9	86,1	85,2	85,1	-0,9	-0,1
Lazio	80,4	81,0	81,4	80,5	80,4	-0,9	-0,1	84,7	85,1	85,5	84,9	84,9	-0,5	0,0
Abruzzo	80,3	80,8	81,2	80,2	80,0	-0,9	-0,2	84,9	85,3	85,7	85,1	84,7	-0,6	-0,4
Molise	79,9	80.1	80,5	79,8	78,3	-0,6	-1,5	84,9	85,4	85,7	84,7	84,0	-1,0	-0,7
Campania	78,9	79,3	79,7	78,5	78,3	-1,2	-0,2	83,3	83,7	83,9	83,4	82,9	-0,5	-0,5
Puglia	80,6	81,0	81,4	80,2	79,6	-1,1	-0,6	84,8	85,1	85,4	84,6	84,1	-0,8	-0,5
Basilicata	79,9	80,3	80,4	80,0	79,7	-0,4	-0,3	84,8	85,1	84,8	84,6	84,4	-0,2	-0,2
Calabria	79,9	80,3	80,3	79,9	79,0	-0,4	-0,9	84,4	84,7	84,8	84,5	83,6	-0,3	-0,9
Sicilia	79,5	79,9	80,2	79,4	78,7	-0,8	-0,7	83,7	84,0	84,2	83,7	83,1	-0,4	-0,6
Sardegna	80,3	80,7	80,4	79,8	79,8	-0,7	0,0	85,3	85,6	85,8	85,0	85,4	-0,8	0,4
Nord	*81,0*	*81,2*	*81,4*	*79,6*	*80,7*	*-1,8*	*1,1*	*85,4*	*85,5*	*85,8*	*84,4*	*85,2*	*-1,4*	*0,8*
Centro	*80,8*	*81,3*	*81,5*	*80,8*	*80,7*	*-0,7*	*-0,1*	*85,0*	*85,4*	*85,6*	*85,1*	*85,1*	*-0,5*	*0,0*
Mezzogiorno	*79,6*	*80,1*	*80,3*	*79,5*	*79,0*	*-0,8*	*-0,5*	*84,0*	*84,5*	*84,6*	*84,1*	*83,7*	*-0,5*	*-0,4*
Italia	80,6	80,9	81,1	79,8	80,1	-1,3	0,3	84,9	85,2	85,4	84,5	84,7	-0,9	0,2

Source: Osservasalute Report, based on ISTAT data available on the website ***www.demo.istat.it****., 2022*

5.14.3 Mortality and morbidity

With regard to mortality by cause, data on the main causes of death at national, regional (Apulia) and provincial (Lecce) level were used, while for the mortality rate, data were reported by region and age group.

In 2019, in Italy, in the 1-19 age group, the highest mortality rates were recorded for external causes of trauma and poisoning in males (0.6) and for cancer in females (0.3). In second place, mortality by cause was cancer in males and external causes of trauma and poisoning in females.

In the 20-39 age group, in 2019, the region with the highest mortality rate for men was Valle d'Aosta (6.9 deaths per 10,000 inhabitants), while the independent province of Bolzano had the highest rate for women (3.3 deaths per 10,000 inhabitants). As in the 1-19 age group, the highest mortality rates by cause are recorded for external causes of trauma and poisoning in males (2.2) and cancer in females (1). These are followed by cancer in males and external causes of trauma and poisoning in females.

As regards the 40-59 age group, in 2019, Molise had the highest mortality rate for men (32.9 deaths per 10,000 inhabitants), while Campania had the highest rate for women (19.2 deaths per 10,000 inhabitants). In this age group, the highest mortality rates by cause are attributable to cancer for both sexes (10.4 and 9.8 for males and females respectively). This is followed by diseases of the circulatory system.

Data for the 60-74 age group in 2019 show Campania as the region with the highest mortality rate for both men (158) and women (90.9). As in the previous age group, the highest mortality rates by cause are attributable to cancer for both sexes, with a higher rate for men than for women (62 and 37.7 respectively). This is followed, again, by diseases of the circulatory system for both sexes.

Finally, for the 75-89 age group, in 2019, the Campania region had the highest mortality rate for both men (695.7) and women (480.9). The highest mortality rates by cause are attributable to diseases of the circulatory system for both men and women (196.7 and 144.5 respectively). These are followed by cancer for both sexes.

From a general point of view, the Campania region ranks first with an overall mortality rate of 116.8 for men and 80.8 for women, followed by Sicily (112.4) and Valle d'Aosta (107.2) for men and Sicily (79.1) and Calabria (72.2) for women.

The National Institute of Statistics provides data on the main causes of death in Italy, broken down by region and province. As can be seen from the table below, in the province of Lecce, the leading cause of death in 2019 was circulatory diseases, followed by cancer and then respiratory diseases, while other diseases were less prevalent. Compared to 2010, all causes of death increased, particularly diseases of the circulatory system, which recorded an increase of 108 cases, followed by mental and behavioural disorders, with an increase of 59, and then cancer, with an increase of 56 cases.

At the regional level, similar to the provincial data, the leading causes of death were diseases of the circulatory system, followed by cancer and then diseases of the respiratory system. Here too, the trend was upward for all diseases compared to 2010.

Table 5.52 Main causes of death at national, regional and provincial level (absolute values) – Years 2010 and 2019

Cause of death	20					
	Italy	Apulia	Province Lecce	Italy	Apulia	Province Lecce
Tumours	175040	10058	2249	178,440	10,923	2344
Endocrine, nutritional and metabolic diseases	25766	192	362	28801	2254	394
Mental and behavioural disorders	14659	650	125	26006	1249	250
Diseases of the nervous system and sensory organs	22454	1491	318	30281	1972	367
Circulatory system diseases	22117	12723	2867	2204993	13855	3030
Respiratory diseases	38798	2425	594	53446	3275	845
Digestive system diseases	23808	1532	282	23022	1497	298
External causes, trauma and poisoning	466	191	283	2911	146	283

Source: ERM analysis based on Istat data (last updated in 2019)

5.15 Human activities

5.15.1 Infrastructure

For the purposes of this study, a set of elements has been selected to assess the presence of infrastructure that is generally considered a potential obstacle to the implementation of offshore wind projects, particularly with regard to cable laying, in relation to the measures and techniques applicable to avoid such obstacles. Based on publicly available data, the following have been selected:

- existing submarine cables (transmission lines, pipelines and telecommunications);
- Oil & Gas structures (gas pipelines and boreholes) and areas subject to exploration permits;
- Mooring and anchoring platforms;
- Lighthouses;
- Ports.

As shown in Figure 5-149 and Figure 5-150, there are two submarine cables (one of which crosses the entire wind farm area, while the other is tangential to it) and an extraction area not far from the planned wind farm, as highlighted during the geophysical and environmental monitoring campaign in Section 5.10.1.

There are 10 ports and marinas in the project area. The most important and most affected are listed below:

- **Port of Otranto**:

  The port of Otranto consists of a large inlet protected in part by the three-armed pier of S. Nicola , facing NW, WNW and NW. Numerous piers extend from the shore.

- **Port of Marina di Tricase**:

  The port of Tricase, part of the maritime district of Gallipoli, consists of a north-facing breakwater and two completely quayed docks, the old port and the new port. It offers shelter to vessels with south-westerly to north-easterly winds (IV quadrant); the seabed is 3 m at the entrance, between 2.5 m and 3 m in the centre of the basin down to a minimum of 2 m, and tend to decrease.

- **Port of Marina di Leuca**:

Fishing harbour protected by a three-armed breakwater facing south-west; a jetty located approximately 200 m from the head of the breakwater, together with the breakwater (facing south-south-east and approximately 155 m long), marks the entrance to the harbour. From the base of the breakwater pier, there is a quay approximately 132 m long from which several floating pontoons branch off.

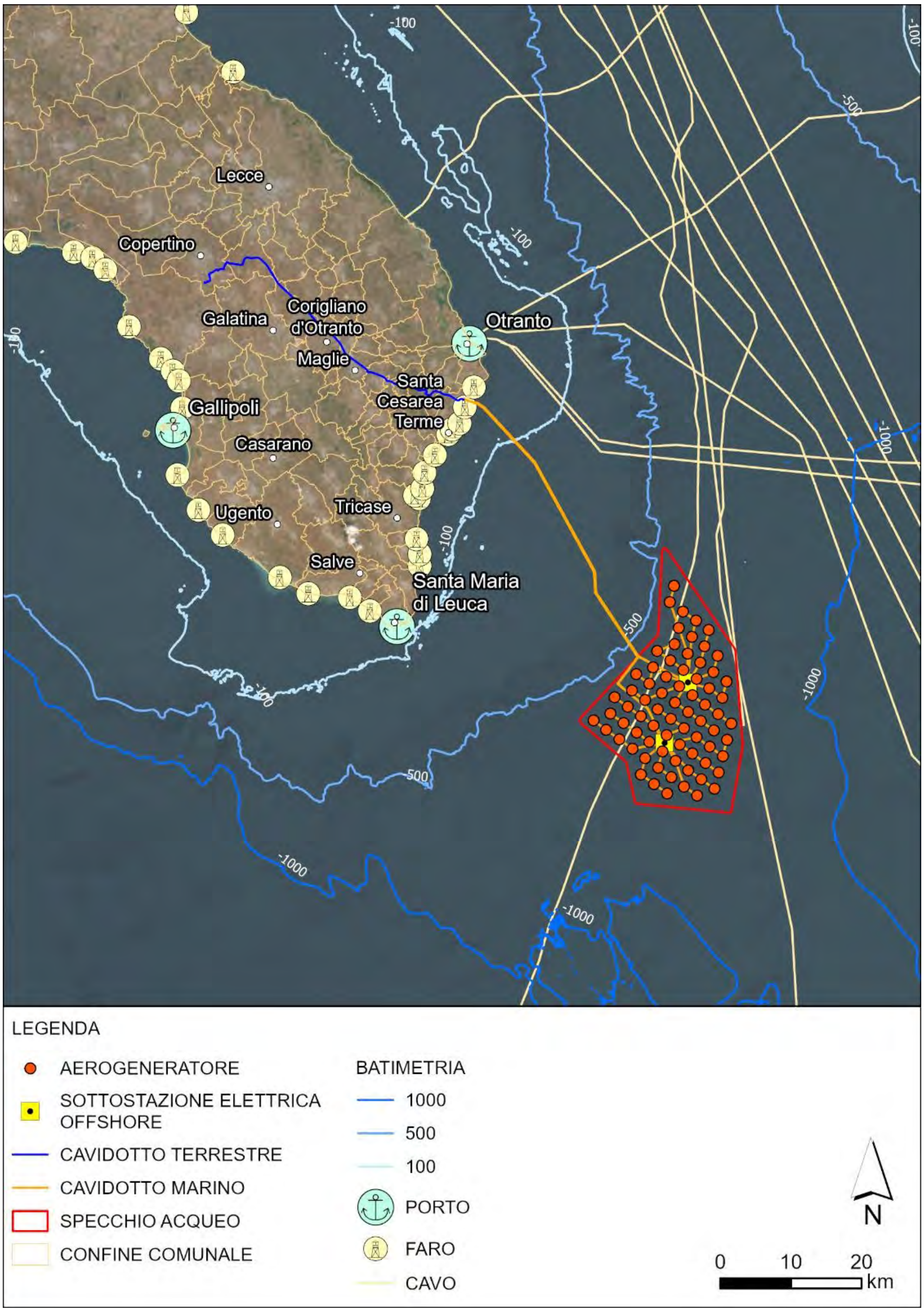
The area of interest of the Project includes several Port Authorities:

- Otranto Maritime District Office.
- Local Maritime Office of Castro Marina.
- Tricase Local Maritime Office.
- Local Maritime Office of Santa Maria di Leuca.
- Local Maritime Office of Torre San Giovanni d'Ugento.
- Port Authority of Gallipoli.

Lighthouses are also considered infrastructure to be taken into account in the Project Area:

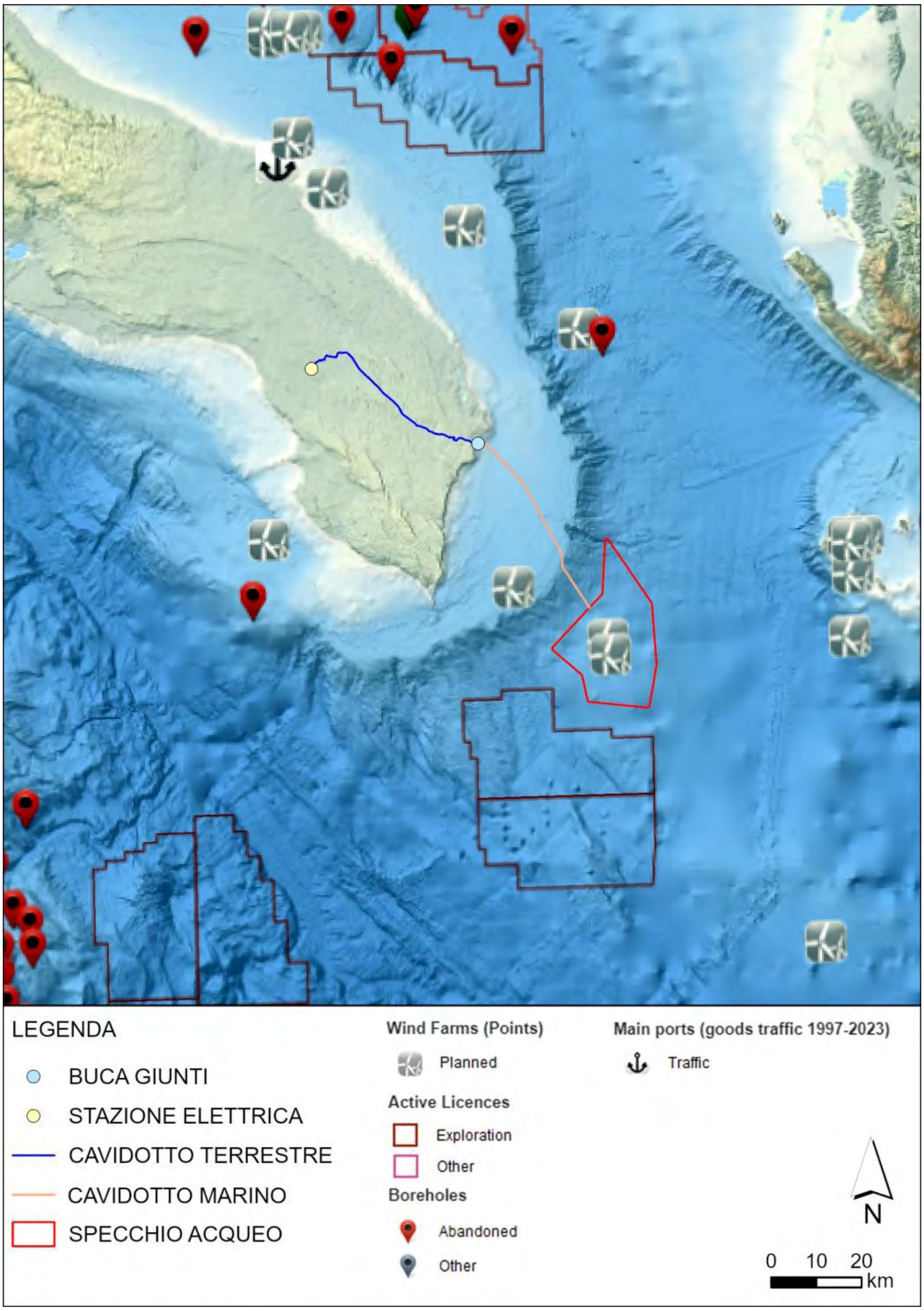
- Punta Palascia lighthouse.

Figure 5-149 Activities, structures and infrastructure in the project area



Source: EMODNet data processing, 2023

Figure 5-150 Ports, areas subject to exploration permits, drilling rigs and wind farms



Source: EMODnet, 2023

It should also be noted that the construction of the Poseidon offshore gas pipeline[17]in, has been proposed the wider areawhich would connect Turkey, Greece and Italy (Figure 5-151). It runs north-east of the project area and affects a limited portion of the wind farm area.

Figure 5-151 Route of the Poseidon gas pipeline

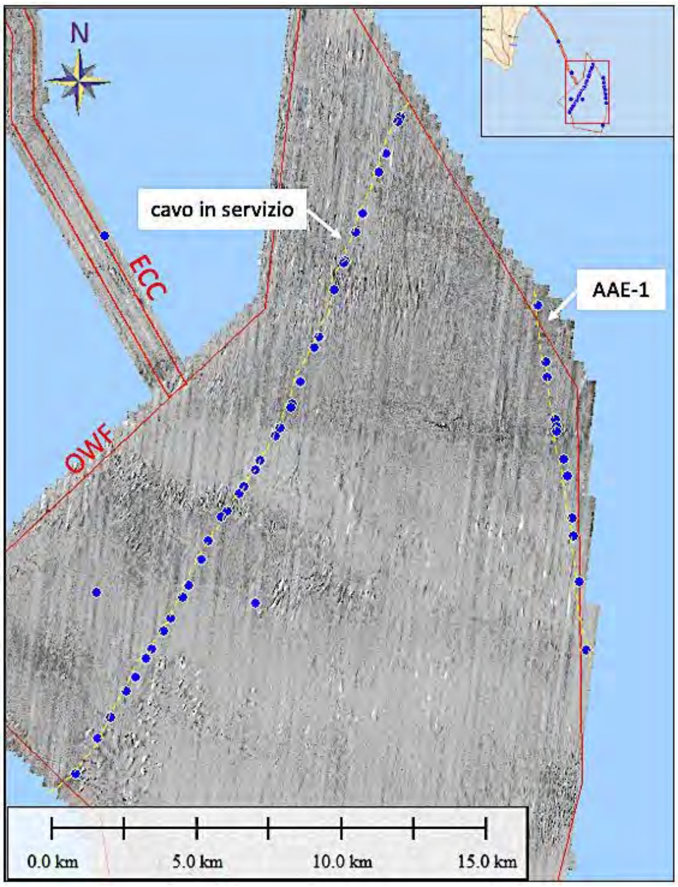
Source: ERM analysis based on Global Energy Monitor data, 2024

17 https://globalenergymonitor.org/projects/europe-gas-tracker/tracker-map/ (2024)

5.15.1.1 Results of geophysical monitoring campaigns

In the OWF area, both sonograms and magnetometer data revealed the presence of three very continuous features that were interpreted as cables, two of which are in service (cutting across the area approximately from N to S, one of which was identified as AAE_1) and one probable partially severed cable that is out of service (cutting across the area approximately E-W)..

Figure 5-152 Positioning of cables in service highlighted by magnetic anomalies



Source: Offshore Sector - Geophysical and Environmental Survey

5.15.2 Waste

The Consolidated Environmental Act, in Article 183, defines waste as any substance or object that the holder discards or has decided or is required to discard. The regulation classifies waste according to its origin as municipal waste and special waste and according to its hazardousness as hazardous and non-hazardous waste.

The analyses of waste production and separate collection were carried out on the basis of the 'Urban Waste Report – 2023 Edition' (2022 data)[18] and the 'Special Waste Report – 2023 Edition' (2022 data)[19] drawn up by ISPRA (Higher Institute for Environmental Protection and Research).

5.15.2.1 Urban waste

Table 5.53 shows data on urban waste (RU) production for the Apulia Region and for the entire country, in the period between 2018 and 2022.

In 2022, national municipal waste production was approximately 29.1 million tonnes, a decrease of 1.8% (544,000 tonnes) compared to the previous year. In the same year, municipal waste production in the Puglia region was 1,829,588 tonnes.

Looking at a longer period, it can be seen that between 2009 and 2010, production remained above 32 million tonnes. Subsequently, after a sharp decline in the two-year period 2011-2012, in line with the contraction in gross domestic product and household consumption, production stabilised at below 30 million tonnes until 2015. Since 2016, with the exception of 2017, there has been an increase in production, exceeding 30.1 million tonnes, before beginning to decline modestly in 2019 and more significantly in 2020 due to the pandemic. In 2021, there was a reversal of this trend, in line with the post-pandemic economic recovery, with production still below 30 million tonnes. Finally, in 2022, there was another decline in municipal waste production.

Table 5.53 Total municipal waste production by region in tonnes, 2018–2022

Region	2018	20	20	20	2
Apulia	1,898,348	1,871,828	1,851,161	1,864,835	1,829,588
Italy	30,158,280	30,023,033	28,941,376	29,595,522	29,051,314

Source: ISPRA, 2023

In 2022, per capita waste production at national level stood at 494 kilograms per inhabitant (based on a population of 58,850,717 in 2022, according to ISTAT data), showing a percentage decrease of 1.6% compared to 2021, as shown in Table 5.54. As for the Puglia region, which had a population of 3,900,852 inhabitants in 2022 (ISTAT data), the per capita value recorded in the same year was approximately 469 kg of municipal waste per inhabitant.

18 https://www.isprambiente.gov.it/it/pubblicazioni/rapporti/rapporto-rifiuti-urbani-edizione-2023
19 https://www.isprambiente.gov.it/it/pubblicazioni/rapporti/rapporto-rifiuti-speciali-edizione-2023

*Table 5.54 Per capita production of municipal waste by region in kg/inhabitant*year, 2018–2022*

Region	2	2	20	20	2022
Apulia	477.5	473.5	471.4	476.7	469.0
Italy	504.2	503.4	488.4	501.8	493.6

Source: ISPRA, 2023

As regards separate collection of municipal waste, the target set by legislation (Legislative Decree No. 152/2006 and Law No. 296 of 27 December 2006) is 65%; Apulia still stands at 58.6%, failing to meet the national target, but has nevertheless shown an increase compared to previous years. Table 5.55 shows the percentages of separate collection of municipal waste for the Apulia Region and the national figures from 2018 to 2022.

Table 5.55 Separate collection rates for municipal waste by region, 2018-2022

Region	20	20	2	2	2
Apulia	45.4	50.6	54.5	57.2	58.6
Italy	58.2	61.3	63	64	65.2

Source: ISPRA, 2023

5.15.2.2 Special waste

In 2021, Lombardy was the leading producer of special waste at national level, accounting for 38.8% of the total special waste generated in Northern Italy, equal to approximately 96.4 million tonnes. It was followed by Veneto, Emilia-Romagna and Piedmont. The Puglia region produced approximately 11.4 million tonnes, accounting for 27.6% of the total for the geographical macro-area (approximately 41.3 million tonnes), followed by Sicily and Campania, representing 6.9% of the national total.

The regional distribution of non-hazardous special waste generally reflects that observed for total production. It should be noted that the largest quantities of special construction and demolition waste are found in the North. In the South, where total construction and demolition waste production is just over 19 million tonnes, the regions producing the most significant quantities are Sicily with almost 5.7 million tonnes (29.7% of the macro-area total), Campania with 4.7 million tonnes (24.8%) and Puglia with over 3.7 million tonnes (19.6%)..

As regards hazardous waste, Lombardy emerges as the region with the highest production, generating 3.3 million tonnes, equivalent to 8.8% of the total special waste produced at regional level and 45.5% of the hazardous special waste in the North, which amounts to almost 7.3 million tonnes. In the South, Puglia has hazardous waste production values close to 400,000 tonnes.

The main types of waste produced in Puglia are construction and demolition waste (32.9% of total regional production) and waste from thermal processes (31%).

In 2021, almost 1.9 million tonnes of special waste were recovered in co-incineration plants. Compared to 2020, there was a slight increase (+1.3%) attributable to the gradual economic recovery of production activities.

Table 5.56 shows the data relating to the quantities of special waste co-incinerated in the two-year period 2020-2021. In 2021, over 1.7 million tonnes of non-hazardous special waste were treated (93.5% of the total), with a slight increase of 0.9% compared to 2020. Hazardous special waste co-incinerated amounted to 121,000 tonnes (6.5% of the total), an increase of 7.6%. Most of the plants are located in the North (199), followed by the South (62) and finally the Centre (41).

Table 5.56 Quantity of special waste co-incinerated, by region (tonnes), 2020–2021

Region	Hazardous special waste (tonnes)		Non-hazardous special waste (tonnes)		Total special waste (tonnes)		%
	2020	2021	2020	2021	2020	2021	2021
Apulia	-	-	86,583	60,918	86,583	60,918	3.3
Italy	112,534	121,044	1,716,104	1,731,009	1,828,638	1,852,053	100

Source: ISPRA, 2022

In 2021, 1.1 million tonnes of special waste were sent for incineration, of which 653,000 tonnes (59.2% of the total) were non-hazardous and approximately 450,000 tonnes were hazardous (40.8% of the total). Most of the plants are located in the North (46), followed by the South (21) and the Centre (7).

Table 5.57 shows the data relating to the quantities of special waste incinerated in the two-year period 2020-2021.

Table 5.57 Quantities of special waste incinerated, by region (tonnes), 2020–2021

Region	Hazardous special waste (tonnes)		Non-hazardous special waste (tonnes)		Total special waste (tonnes)	
	2020	2021	2020	2	20	2021
Apulia	6,316	7,442	8,130	11,960	14,446	19,402
Italy	416,437	449,864	899,366	653,580	1,315,803	1,103,444

Source: ISPRA, 2022

Special waste disposed of in landfills is mostly waste produced by waste treatment operations, waste from construction and demolition operations, and waste produced by thermal processes. Table 5.58 below shows the quantities of special waste disposed of in different landfill categories, by type of waste and by region, in 2020 and 2021.

Table 5.58 Special waste disposed of in landfills, by region and category (tonnes), 2020-2021

Region	Landfills for waste inert		Landfills for non-hazardous waste hazardous		Hazardous waste landfills hazardous		Total	
	2020	2021	2020	2021	2020	2021	2020	2021
Apulia	158,735	191,614	720,004	699,526	4,006	6,042	882,745	897,182
Italy	3,592,148	3,758,445	5,305,732	5,291,644	974,978	1,131,544	9,872,858	10,181,633

Source: ISPRA, 2022

5.15.3 Transport and mobility

The Transport and Mobility component analyses internal mobility in the Project Area. This section describes the road, rail and port networks and the airport system.

Data relating to the road and rail network were considered, taken from the 2021-2030 Implementation Plan of the Regional Transport Plan of the Puglia Region, approved by Regional Council Resolution No. 1832 of 07/12/2023 "LR 18/2002 art. 7 paragraph 4 - Regional Law 16/2008, Article 2, paragraph 1([20]) .

5.15.3.1 Road network and traffic analysis

Currently, the road network in Apulia comprises 314 km of motorways, over 1,600 km of state roads, approximately 20 km of regional roads and approximately 9,200 km of provincial roads.

The main road network in Puglia consists of the A14 motorway (Autostrada Adriatica), which connects Bologna to Taranto, and the A16 motorway, which connects Naples to Canosa di Puglia. Another important road is the SS 16, which runs from Bari to Foggia, crossing the entire region from north to south along the coast.

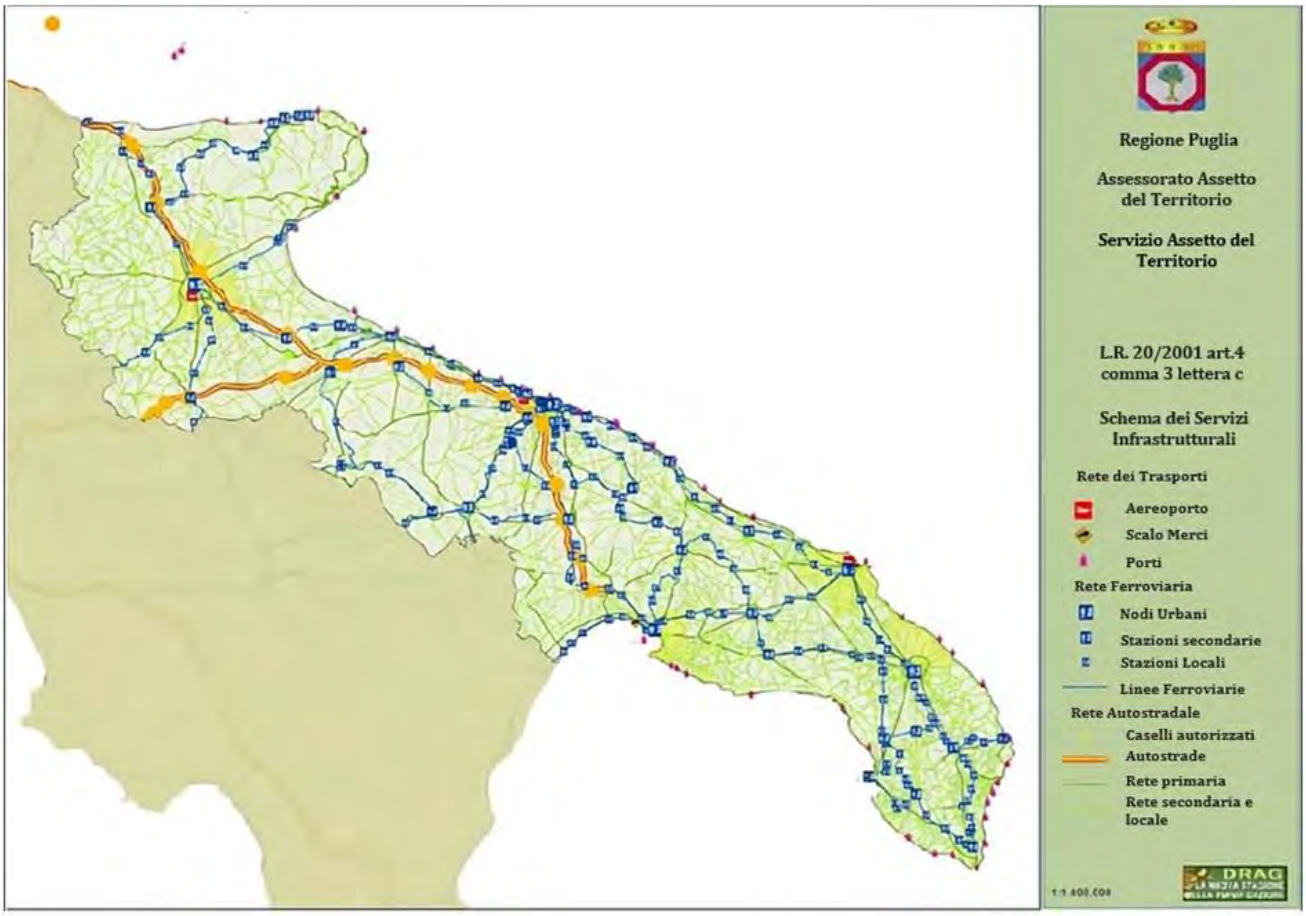
The most important roads, classified as state roads or motorways, include:

- The Bari-Lecce motorway;
- State Road 100, which connects Bari to Taranto;
- State Road 106 Jonica, which connects Taranto to Reggio Calabria;
- The Taranto-Brindisi motorway;
- The Taranto-Lecce expressway.

Figure 5-153 shows the Apulian road network complete with the functional classification of the region's roads, while Table 5.59 shows the length in kilometres of each category of road for each province.

20 https://www.regione.puglia.it/web/territorio-mobilita-e-infrastrutture/-/pa_prt_2021_2030_approvazione

Figure 5-153 Functional classification of the Apulia road network (PA 2021-2030 traffic model)



Source: Puglia Region, 2021

Table 5.59 Developments in the Apulian road network by province and type of road.

Province	Motorways (km)	Roads of national interest (km)	Roads of national interest (km)	Provincial roads (km)	Roads to be classified	Total (km)
Bari	77	251	-	1565	-	1893
Barletta – Andria – Trani	44	131	-	584	-	759
Brindisi	-	136	-	927	-	1063
Foggia	170	636	20	2741	2	3569
Lecce	-	236	-	2196	-	2432
Taranto	23	212	-	1191	108	1534
Total	***314***	***1602***	***20***	***9204***	***11***	***1125***

Source: ACI, Puglia Region, 2021

In the Project Area, the main road is the Adriatic State Road (SS16), which connects Otranto to Padua via Maglie and Lecce, together with the Salentina di Gallipoli State Road 101. The provincial road 367 Mediana del Salento (SP367) connects Maglie to the vicinity of the Galatina Military Airport. Minor roads complete the road network in the wider area.

5.15.3.2 Rail

The Apulia railway system has a significant concentration of services along the Adriatic coast, with the regional capital of Bari as the main hub. Around Bari, there is a large suburban area stretching from Barletta to Fasano, directly serving towns with a total population of almost 1 million. Another significant hub is Foggia, with services along the Adriatic coast and connections to Basilicata, the main towns in the province and the Gargano area.

Since December 2018, the local public transport system (LPT) in Puglia, especially along the main axis, has undergone a structural overhaul aimed at achieving regular services and effective integration between rail and bus.

On the Adriatic route, there are fast extra-urban services such as Foggia-Bari and Bari-Lecce, as well as extensive suburban services such as Barletta-Fasano, with integrated frequencies ensuring services every hour or every half hour, with 15-minute intervals in some locations.

The integration of local public transport with market services is guaranteed in Foggia and Barletta, while in Bari, connections with fast suburban services are available at various stations along the route, such as Barletta, Trani, Bisceglie, Molfetta, Monopoli and Bari Torre a Mare. A project to revise timetables is currently being studied to ensure effective integration with Ferrovie del Sud Est services in the city of Bari.

Other services in the region are operated by Ferrovie del Gargano, Ferrovie Appulo Lucane (narrow gauge), Ferrotramviaria and Ferrovie del Sud Est, which together operate 505 million train kilometres per year. The main stations connecting and interchanging between the national railway network and the regional networks are: S. Severo, Foggia, Barletta, Bari, Taranto, Lecce and Francavilla Fontana.

The Apulian railway network extends for almost 19,600 km, of which about 70% is electrified and the remaining 30% is diesel-powered. Of the more than 19,100 km of electrified network, 551 km are double track and 566 km are single track.

Lecce is connected to Otranto by the single-track, non-electrified Ferrovie del SE line. On 18 January 2021, electrification work began between Lecce and Zollino and between Maglie and Otranto. It should be noted that the underground cable duct does not intersect any railway lines.

5.15.4 Fishing and aquaculture

Italian fishing is regulated by Law 963/1965 and by the Decree of the President of the Italian Republic No. 1639/1968 entitled 'Regulations for the implementation of Law No. 963 of 14 July 1965 concerning the regulation of sea fishing". These regulations contain provisions delegating the adoption of secondary legislation for specific sectors. Fisheries management is also based on Law No. 41 of 1982, which aims to promote the rational exploitation and enhancement of marine biological resources through the balanced development of sea fishing.

The General Commission for the Fisheries of the Mediterranean (GFCM) is the regional fisheries organisation responsible for managing fishery resources in the Mediterranean and Black Seas, with the aim of promoting the rational and optimal use of living marine resources.

Industrial fishing, i.e. fishing that can be monitored using objective systems such as AIS, is carried out by vessels measuring more than 12 m in length and equipped with various instruments. It is classified as follows:

- Trawling;
- Purse seine fishing;
- Longline fishing.

The following figures show the fishing effort for the various types along the Italian coast: trawling (Figure 5-154), purse seine fishing (

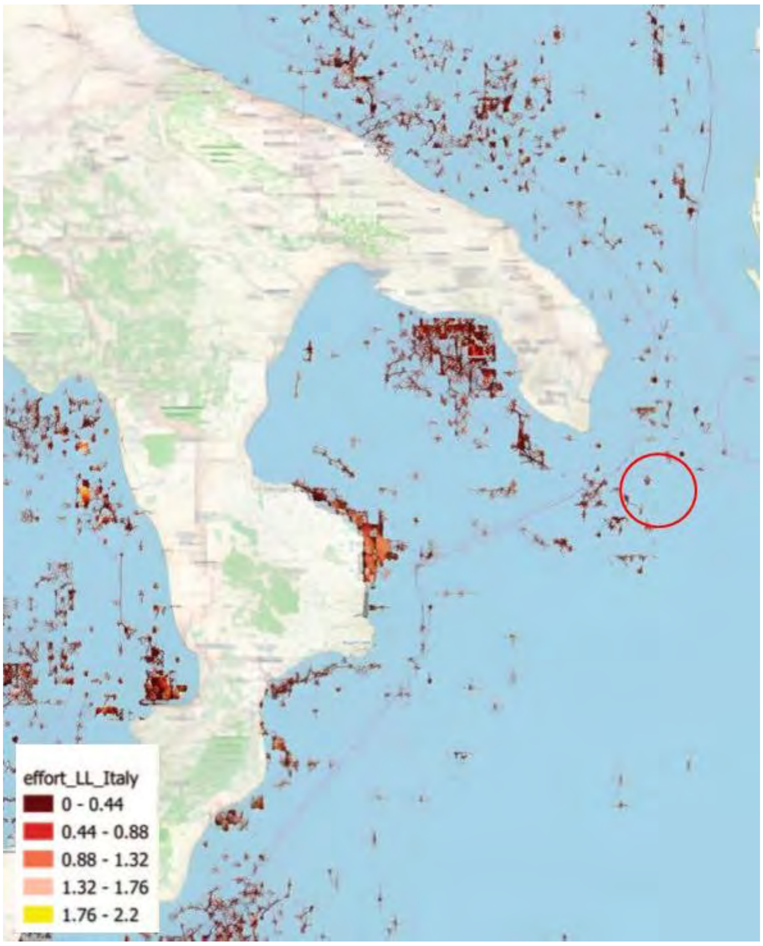
Figure 5-155) and longline fishing (Figure 5-156). Italian Fishing in the Use of Maritime Space, F. Andaloro 2022). As shown in the following images, the offshore wind farm does not interfere with areas with the highest density of fishing activity.

Figure 5-154 Trawling activity

Note: Project area highlighted in red Source: FLAI

Nazionale, 2023

Figure 5-155 Driftline fishing activities



Note: Project area highlighted in red Source: FLAI

Nazionale, 2023

Figure 5-156 Fishing with Purse Seine Nets

Note: Project area highlighted in red Source: FLAI

Nazionale, 2023

The area affected by the wind farm falls within GSA-19 'Western Ionian Sea', which includes the entire Western Ionian Sea, the coasts of northern Puglia, Basilicata, northern Calabria and eastern Sicily.

The main species fished in the Project Area are:

- European hake (*Merluccius merluccius*);
- Pink shrimp (*Parapenaeus longirostris*);
- Red shrimp (*Aristaeomorpha foliacea*).

With regard to the regulatory framework, the technical management measures currently adopted in Italy refer to Regulation (EC) No 1967/2006. According to this Regulation, the technical measures relating to the use of towed nets (bottom trawls and fast trawls) are as follows:

- Fishing is prohibited within 3 miles of the coast or within the -50 m isobath when this depth is reached at a shorter distance from the coast. In any case, the use of towed nets is prohibited within 1.5 miles of the coast. Trawling is also prohibited at depths greater than -1000 m;
- Use of square mesh netting with a minimum mesh size of 40 mm in the codend or a diamond mesh of 50 mm (subject to notification).

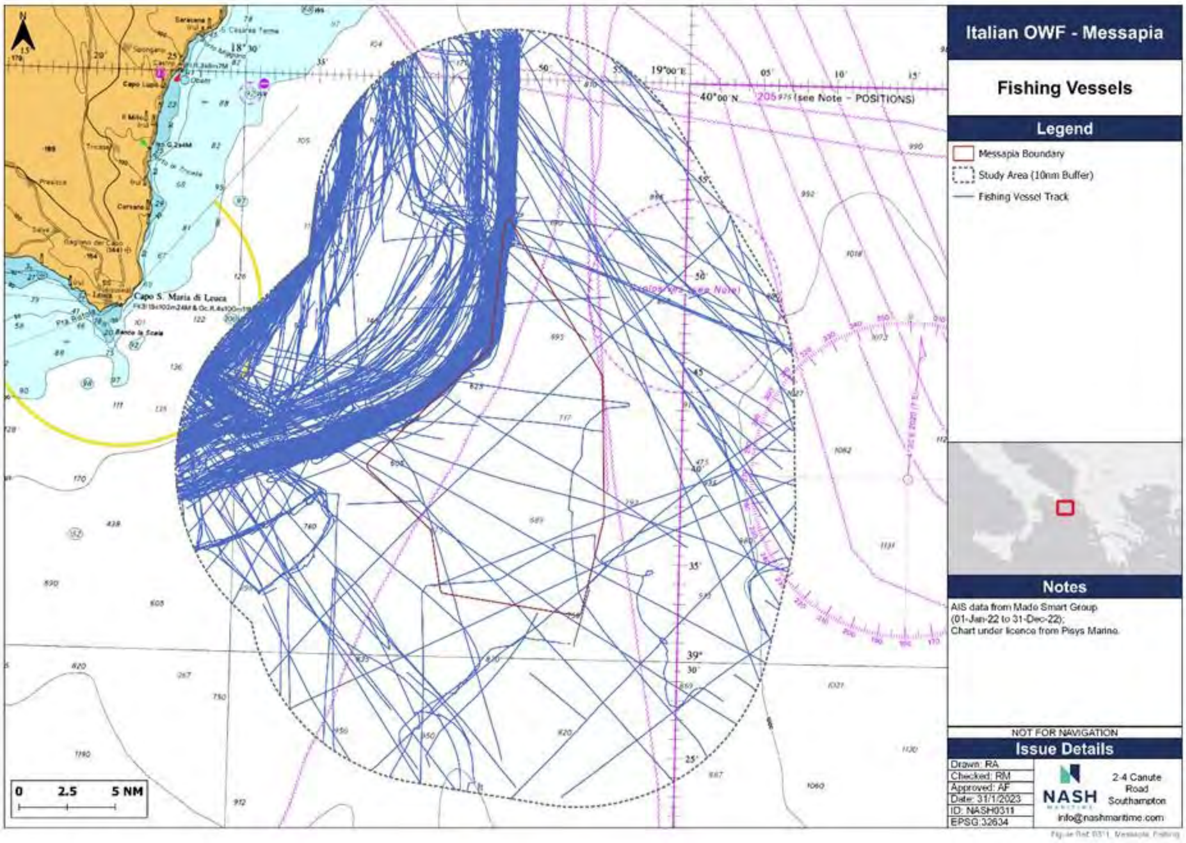
The fleet belonging to GSA 19 is evenly distributed between Puglia, the Ionian coast of Calabria and the Ionian coast of Sicily, concentrated in the fishing ports of Corigliano Calabro, Crotone, Gallipoli and Taranto. In 2015, small-scale fishing accounted for over 70% of the total fleet (GSA 19). The trawl fleet is mainly concentrated in Calabria and Puglia, while 80 longliners operate in the Ionian Sea off Sicily. Overall, according to GSA 19, the trawl fleet consists of 223 vessels with a total tonnage of 4,900 GT and an engine power of just over 34,000 kW (GSA 19, period 2011-2017).

During the period 2004-2015, the composition of the landings of the three species covered by the Plan changed radically due to a significant reduction in landings of pink shrimp and cod, offset by a substantial increase in red shrimp. The incidence of the three target species on the total volume landed for the selected segments varied over time, from 13% in 2004 to 22% in 2015, as a result of the increase in red shrimp production (La Pesca Italiana nell'Uso dello Spazio Marittimo, F. Andaloro 2022).

In GSA 19, the distribution of the trawl fleet's fishing activity is mainly concentrated in the northern part of the area. The highest fishing pressure is recorded in the central area corresponding to the Calabrian coast, but, as shown in Figure 5-154, the marine strip south of the coast between Capo Santa Maria di Leuca and Otranto is also subject to significant fishing effort.

In terms of spatial distribution, fishing activity appears to have remained constant over the three-year period considered, although there has been a reduction in intensity across the entire GSA. Fishing activity distribution was calculated by analysing VMS signals for the GSA 19 trawl fleet. Fishing hours were counted using a grid with 5 km cells. The calculated value represents the total annual fishing hours per cell reported on a logarithmic scale based on 10 (to obtain greater visual effectiveness of the pattern obtained in the maps). The data relating to fishing effort are shown in Figure 5-157.

Figure 5-157 Fishing vessel routes



Source: EMODNet, 2022, reworked by NASH on project layout by Messapia Floating Wind Srl, 2024

The data relating to the fleet were retrieved from the Registers of Small Vessels and Floating Objects (RR.NN.MM.e GG) of the Port Authority of Gallipoli, the Maritime District Office of Otranto and the Local Maritime Offices of Castro, Tricase and Leuca (Table 5.60).

Table 5.60 Fleet Size Characteristics

Registration office	Total number of boats	n boats (< 12 m)	n boats (<= 12 m; >24 m)
Gallipoli	157	115	42
Castro	25	25	0
Otranto	36	27	9
Tricase	9	9	0
Leuca	28	20	8

Source: Port Authority of Gallipoli, Maritime District Office of Otranto and Local Maritime Offices of Castro, Tricase and Leuca, 2023

Most vessels over 12 m in length that use trawl gear (OTB) are concentrated in Gallipoli. In the offices of Otranto and Leuca, although the number of vessels over 12 m is limited, over 75% of them use this **towed** gear. With regard to vessels under 12 m, longlines are the most common primary gear in all fishing fleets.

Table 5.61 Characteristics of the distribution of fishing gear

Registration office	GNS (< 12 m)	GNS (<= 12 m; >24 m)	LLS (< 12 m)	LLS (<= 12 m; >24 m)	OTB (< 12 m)	OTB (<= 12 m; >24 m)
Gallipoli	26	6	88	0	1	35
Castro	5	0	17	0	3	0
Otranto	0	9	26	0	1	7
Tricase	0	0	9	0	0	0
Leuca	3	8	17	0	0	6

Source: Port Authority of Gallipoli, Maritime District Office of Otranto and Local Maritime Offices of Castro, Tricase and Leuca, 2023

Apulia plays an extremely important role in aquaculture, as it is one of the most productive areas in Italy. This situation stems from the presence of two factors essential for development in the region: professional and cultural potential, and environmental potential. Apulia has ancient traditions and a high level of professionalism in fishing and the management of coastal lagoons and lakes. In addition, the length of its coastline, the presence of large areas of wetlands and lagoons, and finally the environmental characteristics, such as temperature and water quality, have been the favourable environmental conditions that have allowed its development. In addition to these factors, the conditions of the Apulian fish market and, more generally, of the entire commercial system of Southern Italy, which is very receptive to high-quality and highly fresh fish products, have had a decisive influence. This market is in continuous and constant expansion.

A study conducted by the Puglia Region, aimed at summarising an initial analysis of all the data available in the various databases, shows that the current fleet of 1,474 fishing vessels has an average age of 38 years and consists of 62% vessels less than 12 m in length. It is distributed as follows: 68% in

GSA 19 and is mostly equipped with passive systems. The 173 fish farms registered in the National Zootechnical Register are mostly concentrated in the Taranto and Foggia areas and show a prevalence of shellfish farming (over 80%). The Register of Companies lists 1,946 entities included in the ATECO codes relating to fishing, aquaculture, processing and trade in fish products (Puglia Region, 2021).

5.15.5 Maritime traffic

The Apulian port system consists of three main ports, Bari, Brindisi and Taranto, which are ports of national interest and home to Port Authorities, and six smaller ports of regional interest: Manfredonia (FG), Barletta (BA), Molfetta (BA), Monopoli (BA), Otranto (LE) and Gallipoli (LE).

The project is located in the Ionian Sea within Italian waters, south-east of the coast of Otranto. The wind farm area is located approximately 15 nautical miles south-east of Capo Santa Maria di Leuca and 19 nautical miles north of the Strait of Otranto, which marks the separation between the Ionian Sea and the Adriatic Sea.

There are no ports near the landing area; the nearest port is Otranto; the distances from other ports in the region are summarised in Table 5.62.

Table 5.62 Main ports and distances from the landing point

Port	Description	Distance
Otranto	Large recreational port with stops for cruise ships from	6 nautical miles
Santa Maria di Leuca	Tourist port	19 nautical miles
Gallipoli	Large marina with stops for cruise ships for cruise ships	44 nautical miles
Taranto	Large commercial port	90 nautical miles

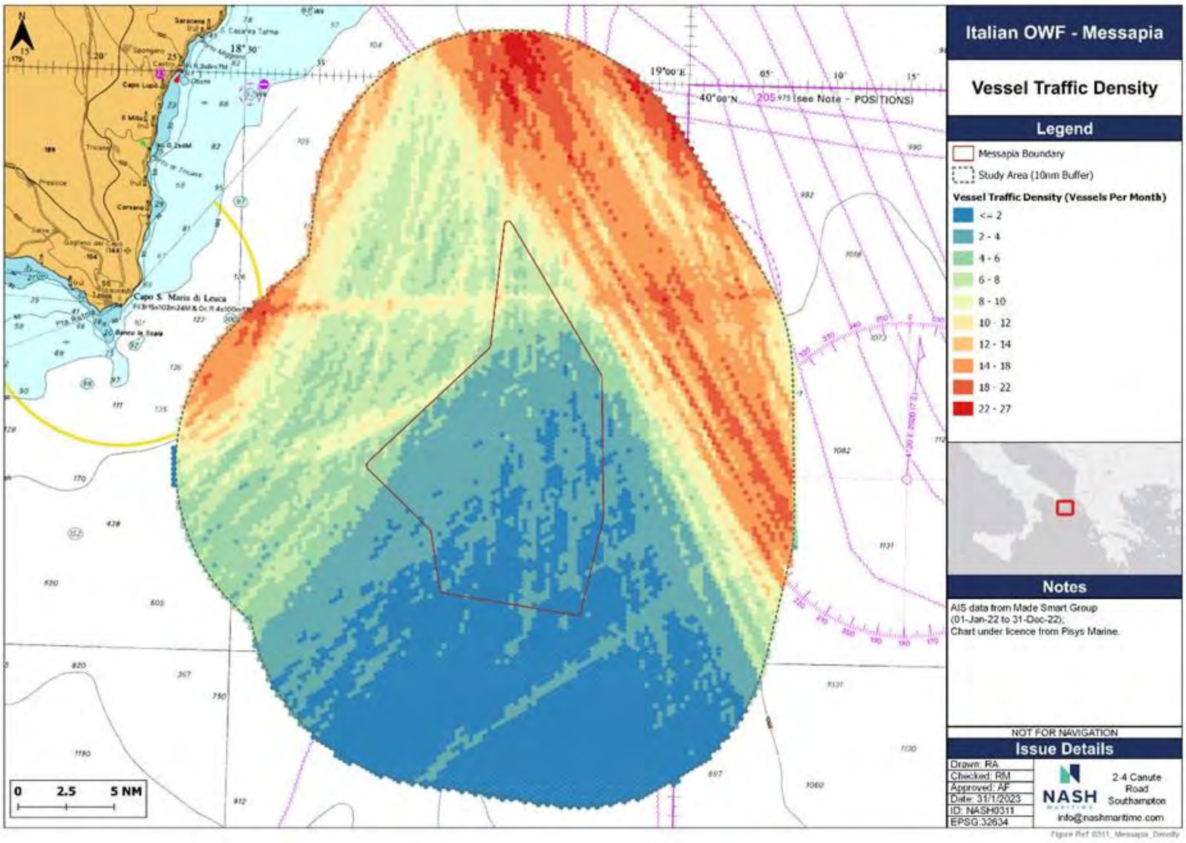
Maritime traffic data was taken from two sources and used to determine shipping activity in the Project Area:

- Automatic Identification System (AIS) data for 2022 for the Project Area;
- European Marine Observation and Data Network (EMODnet, 2022): vessel density grids by season for the Project Area.

The data were collected over a 12-month period (01/12/2022 to 31/12/2022) according to the latest data from the MadeSmart Group, taking into account seasonal and temporal variability as well as vessel type and size.

The ship traffic density for all vessels is shown in Figure 5-158, which shows a higher density of shipping routes to the north-east and north-west of the Project Area. Ship traffic density is lower within the array area, with a higher density in the northern area, where a line of higher density can be seen from west to east.

Figure 5-158 Ship Traffic Density in the Project Area

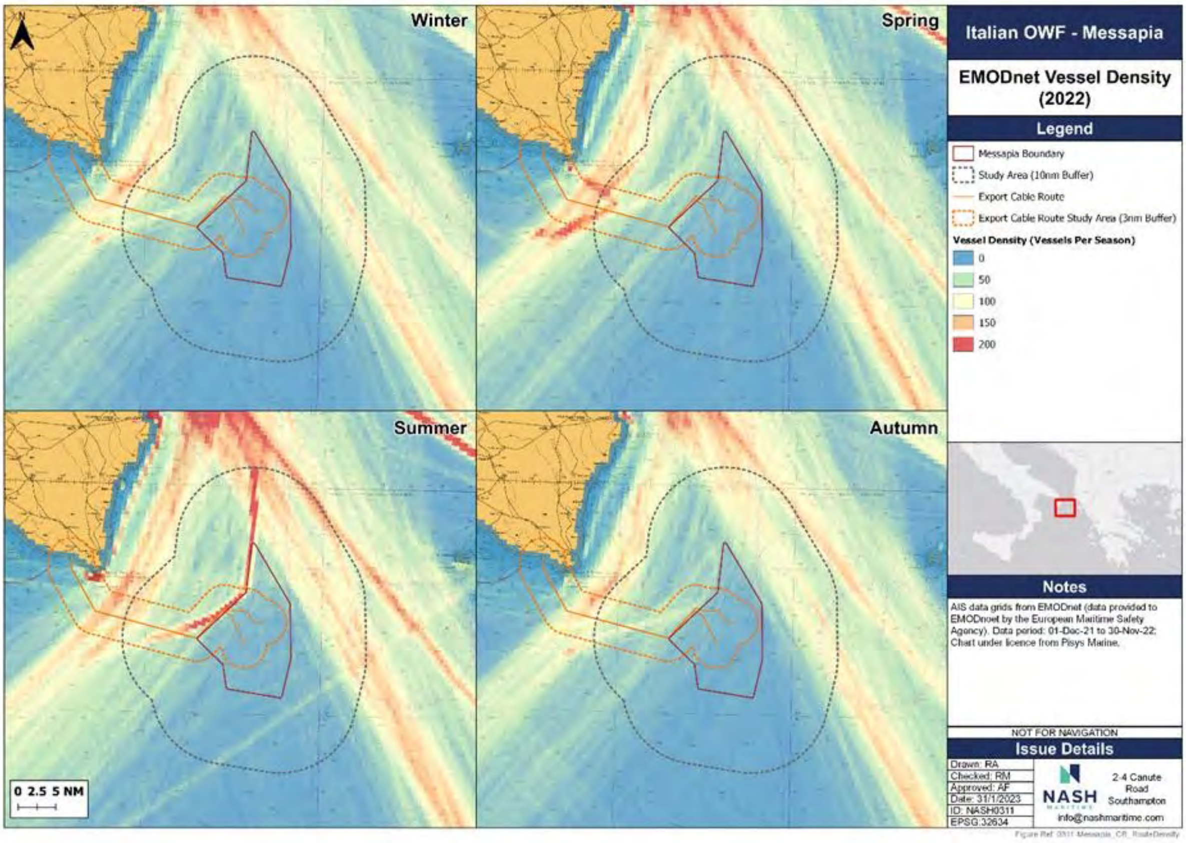


Source: EMODnet data processing, 2023

5.15.5.1 Maritime traffic by season

Looking at ship traffic density for the Project Area by season, there is an increase in route density in summer, with a higher frequency of ships travelling north/south than in other seasons (Figure 5-159).

Figure 5-159 Shipping Traffic Density by Season



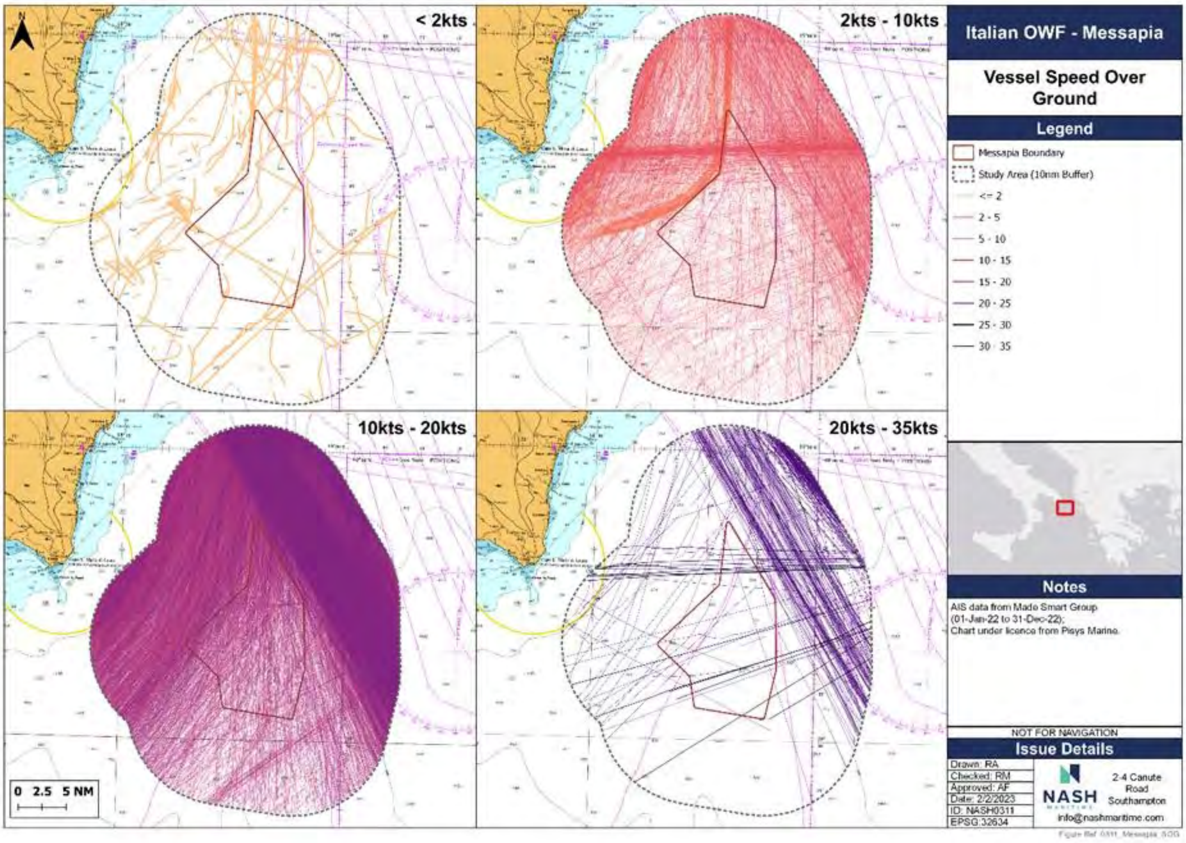
Source: EMODNet, 2022, reworked by NASH based on project layout by Messapia Floating Wind Srl, 2024

5.15.5.2 Maritime traffic by speed

There are few ship routes travelling at speeds below 2 knots through the Project Area, which could mean that prolonged stops or standstills are unlikely to occur. In fact, due to the significant water depth in the Project Area, anchoring would be impossible at any point. The most frequent speed of ships through the Project Area is between 10 and 25 knots, which is the speed at which most commercial ships sail when passing between ports.

A small number of vessels have transited the Project Area at speeds between 25-35 knots, mainly following the routes used by recreational craft. Further analysis of the routes indicates that all vessels transiting in an east-west direction are recreational craft and the tracks in the north-eastern part of the Project Area are fast ferries (Figure 5-160).

Figure 5-160 Ship routes based on ship speed



Source: EMODNet, 2022, reworked by NASH based on project layout by Messapia Floating Wind Srl, 2024

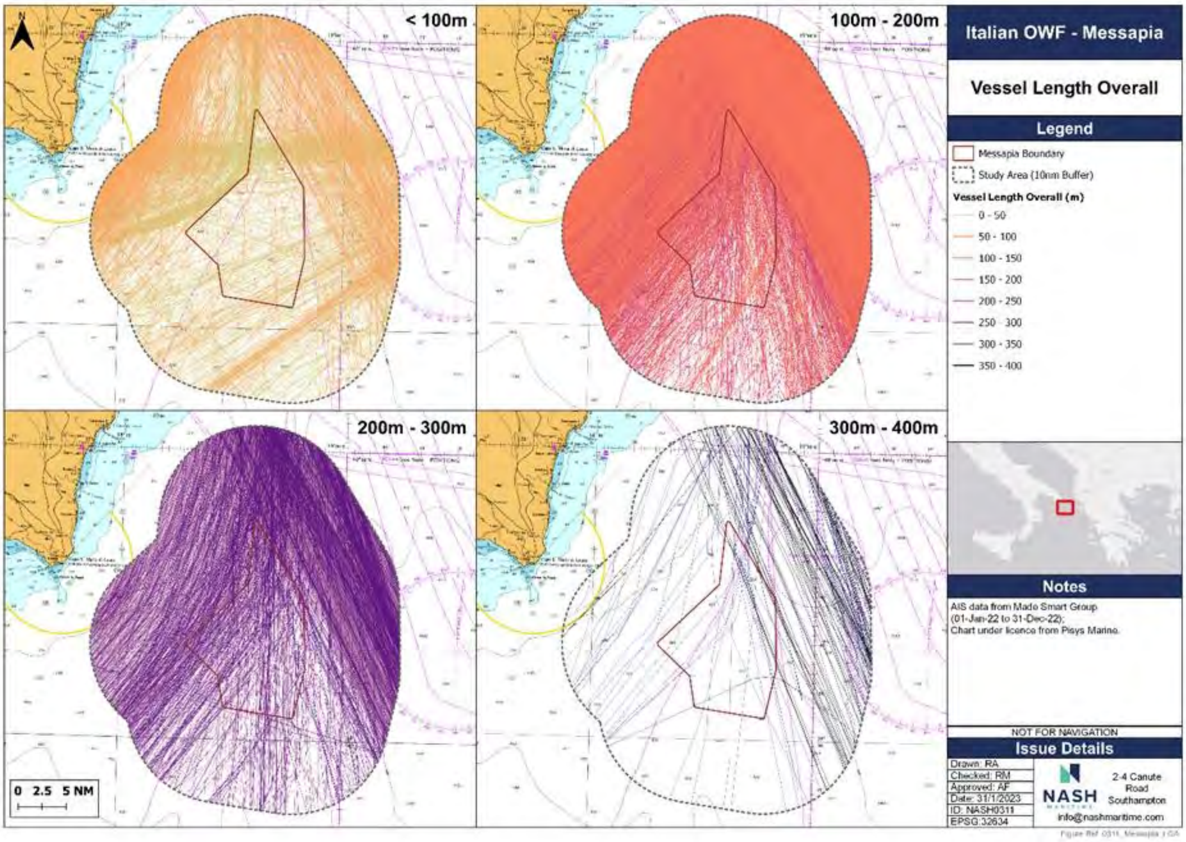
5.15.5.3 Maritime traffic by size

Looking at ship traffic by vessel size, it can be seen that for vessels with a length of 50 m or less, the area is crossed by routes distributed along the north-western edge of the Project Area boundary.

Vessels between 100 m and 300 m in length have less defined routes, which converge or diverge as they approach or leave the Strait of Otranto.

Larger vessels, between 300 m and 400 m in length, mostly transit along the eastern side of the Project Area.

Figure 5-161 Ship routes based on ship size



Source: EMODNet, 2022, reworked by NASH based on project layout by Messapia Floating Wind Srl, 2024

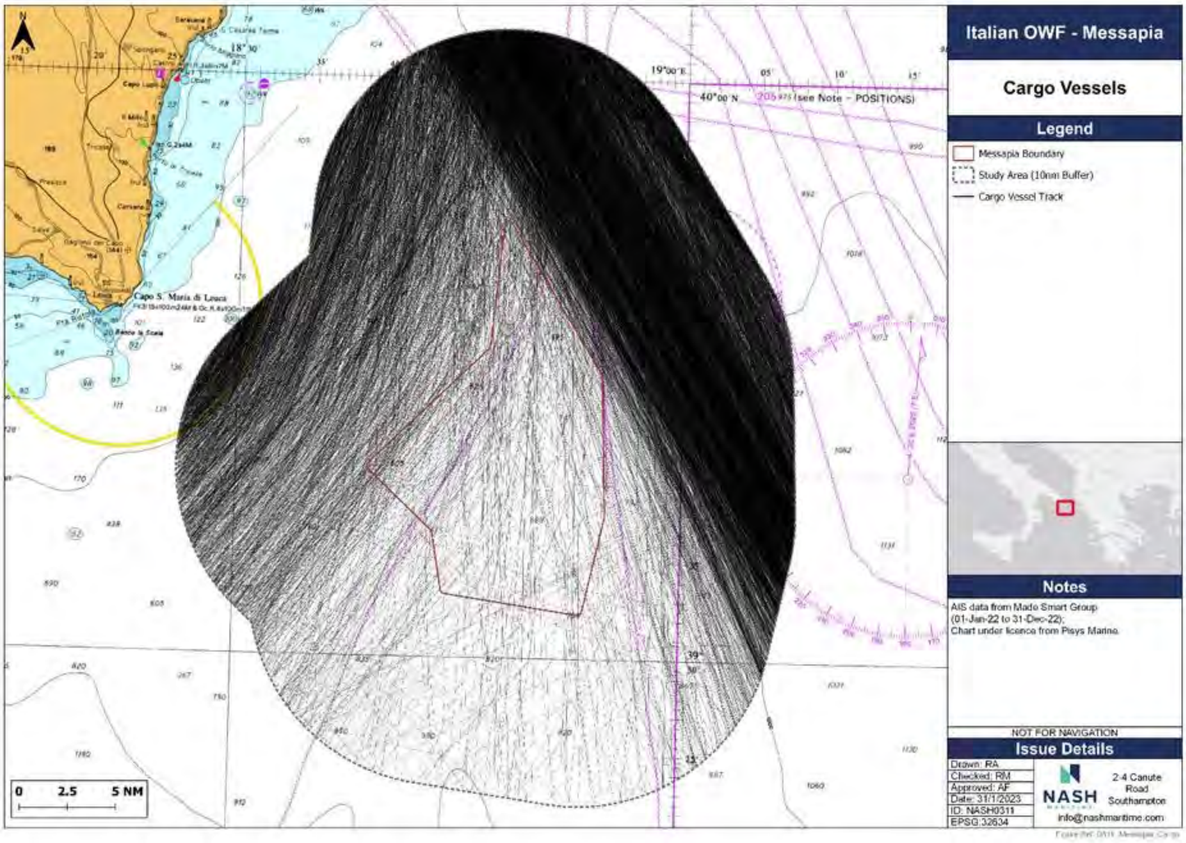
5.15.5.4 Maritime traffic by type of vessel

Cargo ships, such as container ships, travel further east and west of the Vasta Area. To the east, cargo ships are found on routes that include the ports of the Adriatic Sea, the eastern Mediterranean, the Black Sea or the Suez Canal. There are few natural features that restrict shipping in this area, with a vast expanse of sea allowing ships to navigate freely and choose the best route to their destination.

In contrast, shipping routes to the west of the Area Vasta are located on coastal routes to and from the Adriatic Sea, with more routes shown at the western end of the Project Area, as ships will generally take the shortest route between ports (Figure 5-162).

A total of 398 cargo ships have been identified crossing the Area Vasta.

Figure 5-162 Cargo ship routes

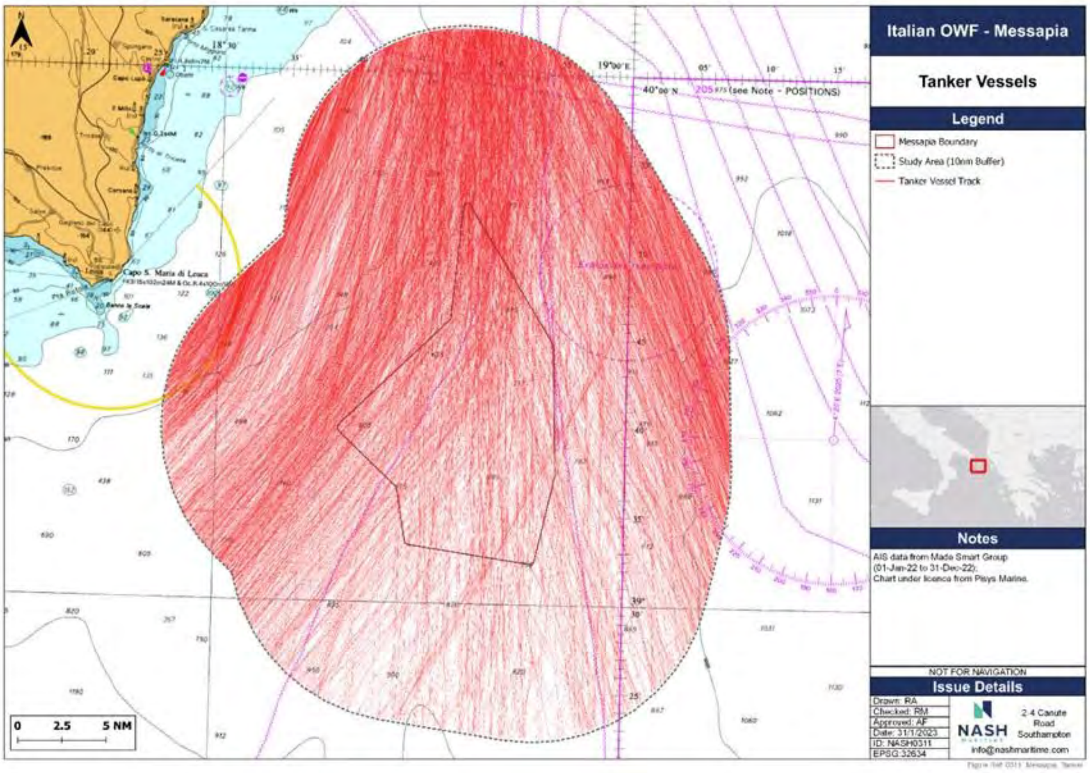


Source: EMODNet, 2022, reworked by NASH based on project layout by Messapia Floating Wind Srl, 2024

Oil tankers, commercial ships that transport liquid cargo (e.g. oil and chemicals), frequently transit (932 routes, 25% of the total) and although the Project Area has a more diverse range of routes than cargo ships, there are still more routes passing east and west of the Vasta Area than within it (Figure 5-163).

A total of 501 oil tankers were identified passing through the wider area.

Figure 5-163 Oil tanker routes



Source: EMODNet, 2022, reworked by NASH based on the Messapia Floating Wind Srl project layout, 2024

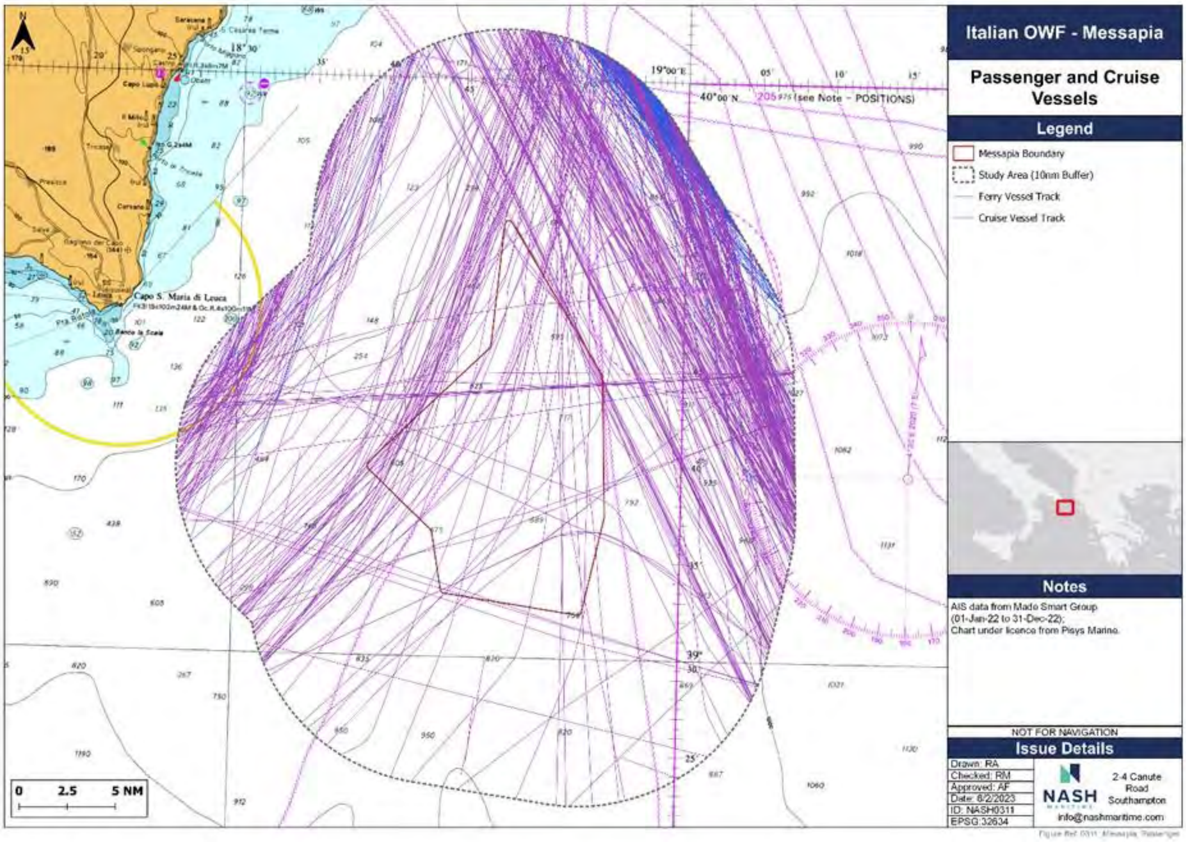
Passenger ships are divided into ferries and cruise ships.

There are no ferry routes crossing the array area, most of which are located at the north-eastern end of the Project Area, which is dominated by the route between Ancona and Patras (Greece). Other routes using this area connect Brindisi with various Greek islands and ports, in particular Kefalonia, Zakynthos, Patras and Igoumenitsa.

The cruise ship routes identified in the study follow the same routes as those for cargo ships (Figure 5-164).

Twenty-eight cruise ships were identified in the wider area.

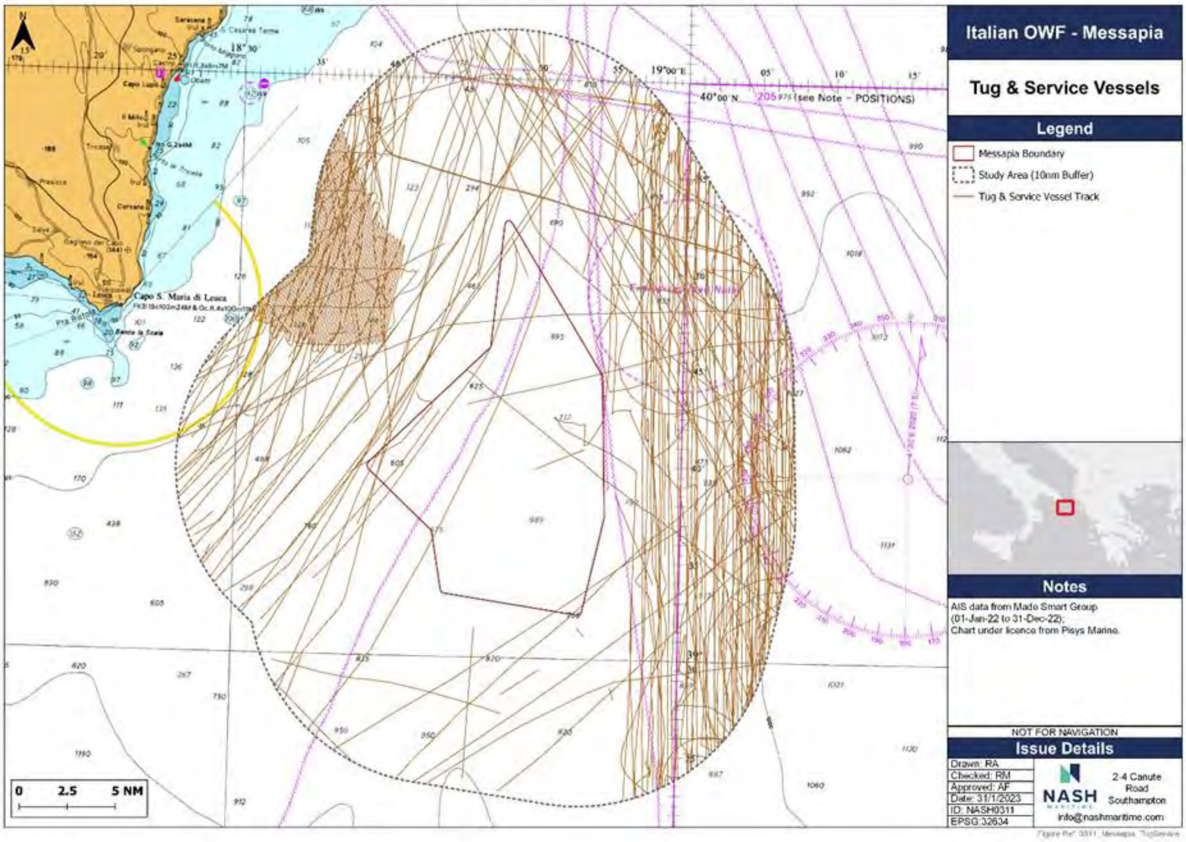
Figure 5-164 Passenger ship routes



Source: EMODNet, 2022, reworked by NASH based on project layout by Messapia Floating Wind Srl, 2024

Service vessels and tugboats follow irregular routes, probably due to the fact that they tend to move between ports and projects in the immediate vicinity. To the east of the area, there are more north-south routes, due to seismic survey activities. To the west of the area, the routes followed are associated with activities related to an offshore wind farm (Figure 5-165).

Figure 5-165 Tugboat and service vessel routes

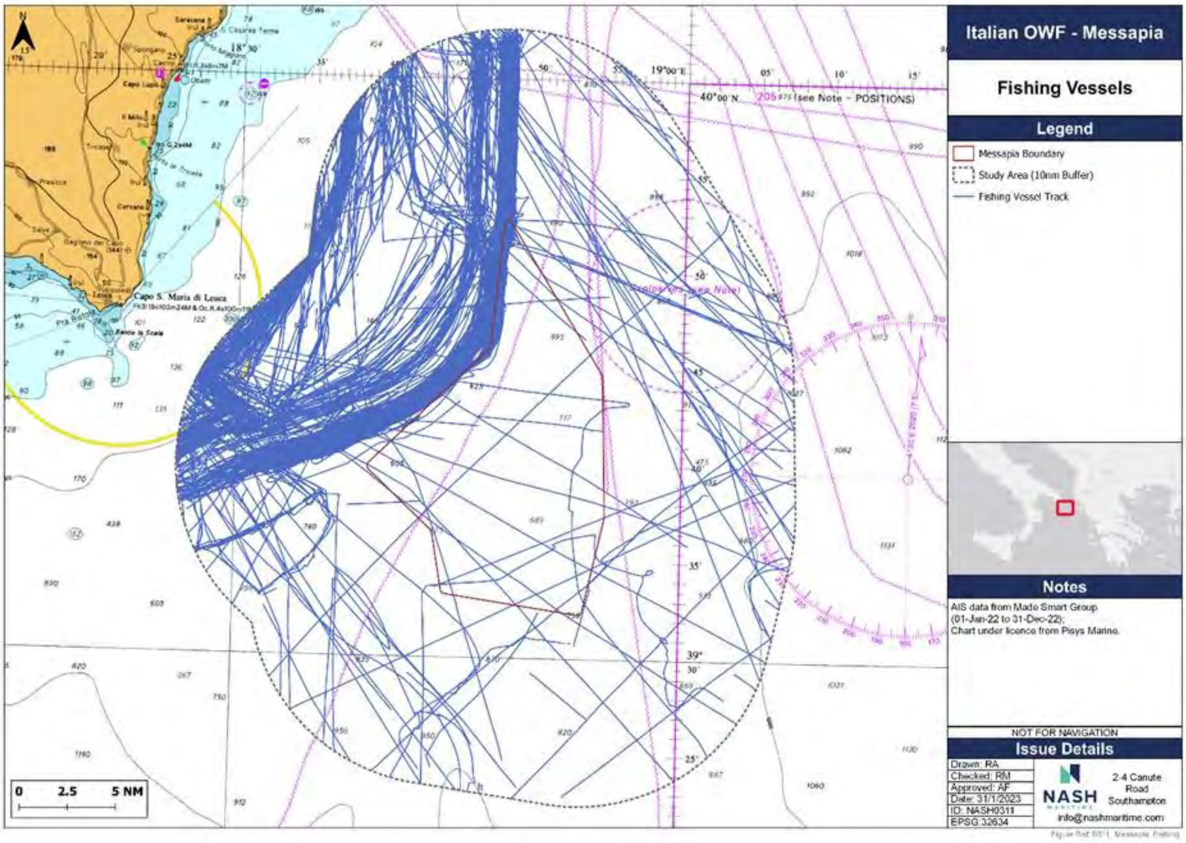


Source: EMODNet, 2022, reworked by NASH based on project layout by Messapia Floating Wind Srl, 2024

The activity of fishing vessels shows that a significant part of the routes are located to the north-west of the Vasta Area. The routes immediately adjacent to the park boundary follow the natural depression of the seabed and are probably engaged in trawling in this area rather than passing through (given the speed of the vessel of less than 5 knots) or anchoring (given the depth of more than 100 m). It is not possible to identify whether other fishing vessel routes are used for fishing or passing through the Project Area.

In the array area, 126 fishing vessel tracks were identified following the natural depression of the seabed (indicating trawling activity). In addition, 26 other tracks were identified in the Project Area that did not follow the seabed boundary and did not indicate any recognisable route through the area.

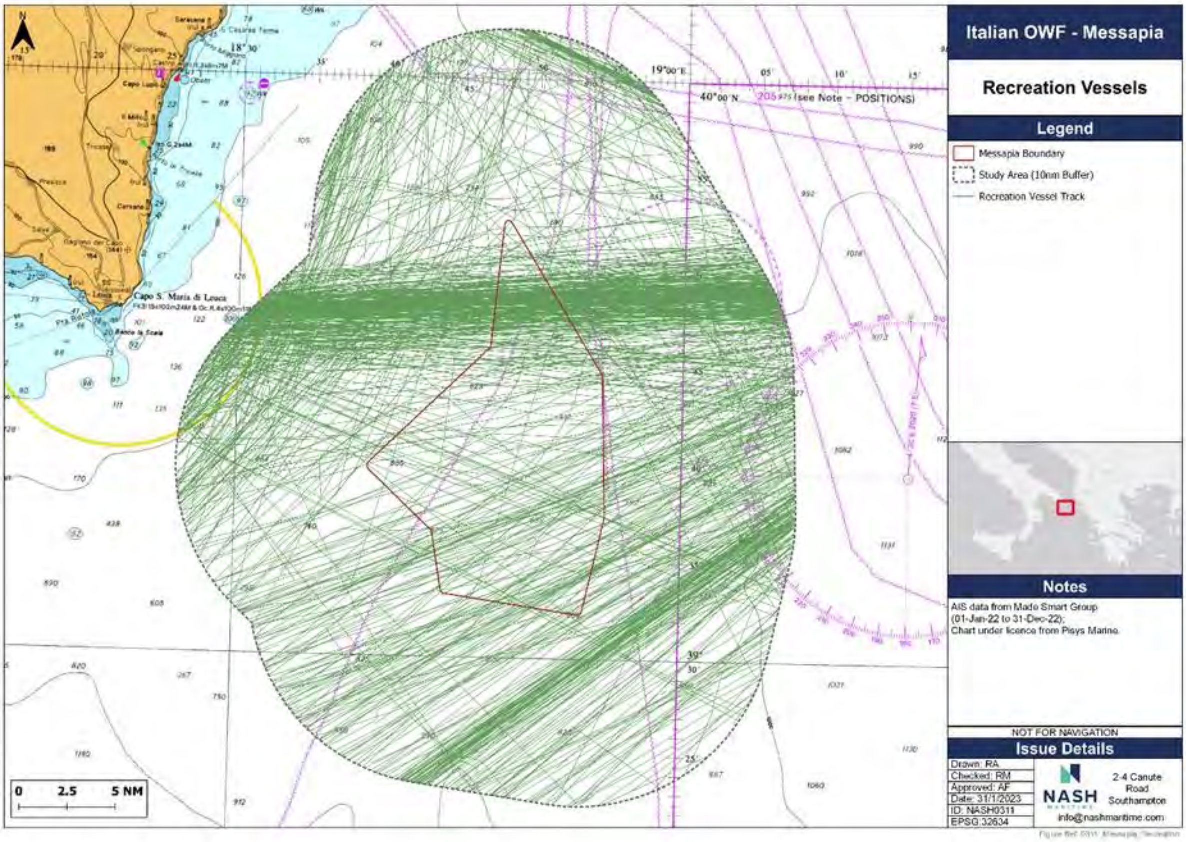
Figure 5-166 Fishing vessel routes



Source: EMODNet, 2022, reworked by NASH on Messapia Floating Wind Srl project layout, 2024

Recreational boating routes indicate significant activity in the study area and across the wider area. Routes have been identified running east-west to the north, across and to the south of the area. These are probably routes used by boats transiting between Italian ports/marinas or locations in the western Mediterranean and Greece. Some north-south routes have also been identified, but recreational boats generally sail closer to the coast, where possible, to avoid the routes used by larger commercial vessels. A total of 428 boats were identified.

Figure 5-167 Recreational vessel routes



Source: EMODNet, 2022, reworked by NASH based on Messapia Floating Wind Srl project layout, 2024

5.15.6 Tourism[21]

The summer of 2022 saw more than 10 million visitors and more than 2 million arrivals in Puglia. The constant growth in Puglia's appeal is evidenced by the increases recorded in the three summer months, both compared to 2021 and 2019.

During the period between June and August 2022, there were 2,181,102 arrivals and 10,221,699 overnight stays, showing a positive increase of +4.2% and +3.1% compared to the same period in 2019, mainly driven by the recovery of international tourism. Tourist flows from abroad during the three summer months grew by +13% in terms of arrivals compared to the pre-pandemic summer, while domestic tourism showed more modest growth of +2%. July was particularly positive, with a +16% increase in arrivals and +5.5% in overnight stays; in June, the trend was +2.2% for arrivals and

21 https://www.agenziapugliapromozione.it/portal/osservatorio-del-turismo (2024)

+6.4% for overnight stays. In August, overnight stays approached pre-pandemic levels, with a significant increase in foreign visitors, exceeding 2019 figures for both arrivals and overnight stays.

Figure 5-168 Tourism in Puglia

MESE	ITALIANI			STRANIERI			TOTALE		
	Arrivi	Presenze	Permanenza media	Arrivi	Presenze	Permanenza media	Arrivi	Presenze	Permanenza media
GIUGNO	411.908	1.512.369	4	181.140	649.850	4	593.048	2.162.219	4
LUGLIO	567.771	2.808.989	5	203.643	827.420	4	771.414	3.636.409	5
AGOSTO	649.001	3.723.590	6	167.639	699.481	4	816.640	4.423.071	5
TOTALE	1.628.680	8.044.948	5	552.422	2.176.751	4	2.181.102	10.221.699	5

Source: Puglia Promotion Agency, 2023

Figure 5-169 Summer flows 2022

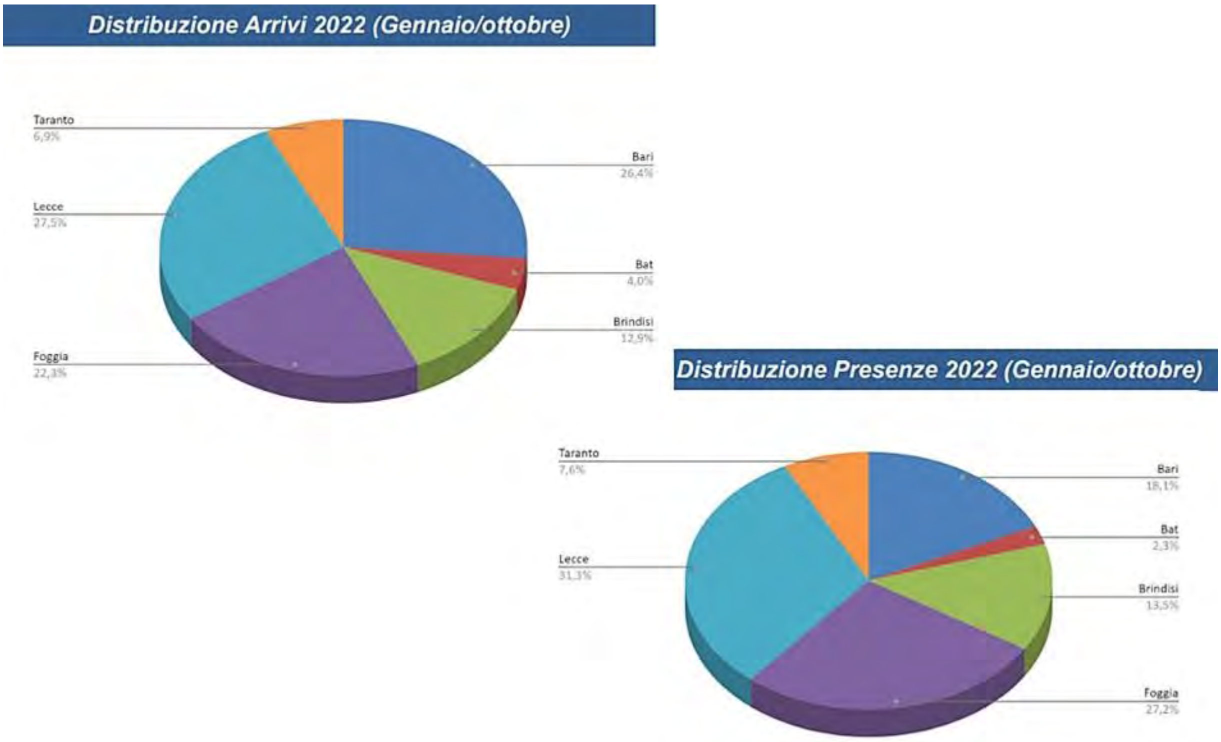
Source: Puglia Promotion Agency, 2023

The internationalisation rate in summer 2022 saw the share of foreign visitors reach 25% for arrivals and 21% for overnight stays, slightly exceeding pre-pandemic levels.

Compared to 2021, arrivals and overnight stays grew by +9% and +5% respectively in 2022, mainly thanks to the foreign component, which exceeded the previous year's arrivals and overnight stays by 80 percentage points (Figure 5-169).

In summer 2022, 31% of travellers stayed in the province of Lecce, followed by Foggia with 26% and Bari with 20%. Compared to 2019, tourist flows increased in almost all provinces, with the largest increases recorded in Bari and Brindisi. The provinces with losses were Foggia and Taranto. The most visited summer destination was Vieste, followed by Bari, Lecce, Otranto and Ugento (Figure 5-170).

Figure 5-170 Provincial tourism trends



Source: Puglia Promotion Agency, 2023

In 2022, summer tourist flows from abroad set a new record. The main markets of origin were France, Germany, Switzerland, the United Kingdom and the United States of America. Among the emerging non-EU markets in 2022, Australia, Canada and Brazil are worth mentioning. Russia, which was among the top 10 markets in 2019, declined significantly, recording just over 2,500 arrivals in 2022 compared to 14,000 in 2019.

Figure 5-171 Provincial tourism trends.

Provenienza per Paese Estero (Top 20 Arrivi 2022) e variazione % 2019 e 2022 (Gennaio/ottobre)				
Top 20	**Arrivi**	**Presenze**	**Var. % arrivi 2019-2022**	**Var. % presenze 2019-2022**
Francia	208.737	576.862	+36,5	+36,7
Germania	154.346	774.506	+4,0	+5,9
Stati Uniti d'America	86.842	243.803	+14,3	+25,4
Regno Unito	85.247	305.332	-0,7	+0,4
Svizzera	82.847	339.243	+21,6	+22,4
Paesi Bassi	72.112	252.609	+2,2	+2,2
Belgio	50.352	194.272	+3,4	+6,0
Polonia	48.302	156.183	+3,4	+5,1
Spagna	46.862	118.428	+19,8	+24,8
Austria	29.590	122.032	+12,9	+15,6
Canada	21.745	59.743	+14,7	+27,0
Romania	21.377	73.583	+12,3	+13,4
Australia	19.075	53.768	-28,9	-24,2
Brasile	17.741	48.871	-7,2	+5,6
Israele	17.117	37.637	+132,5	+144,7
Ungheria	15.453	51.285	+29,0	+24,5
Irlanda	14.985	50.045	+8,1	+8,1
Svezia	14.868	48.255	+58,2	+67,6
Altri Paesi Europei	13.533	45.031	-2,6	+2,4
Repubblica Ceca	12.846	57.084	9	-2
Resto del mondo	163.031	499.218	/	/
TOTALI	**1.197.008**	**4.107.790**	**+6,8**	**+11,0**

Source: Puglia Promotion Agency, 2023

The change in tourist flows from abroad in summer 2022, compared to 2021, recorded an increase of +80% for both arrivals and overnight stays, with the largest increases coming from the United Kingdom and the United States (Figure 5-171).

In summer 2022, almost all the municipalities surveyed exceeded the arrivals recorded in the same period of 2021, with a significant increase in overnight stays in the municipality of Bari and a strong recovery in arrivals in the municipality of Brindisi compared to 2021.

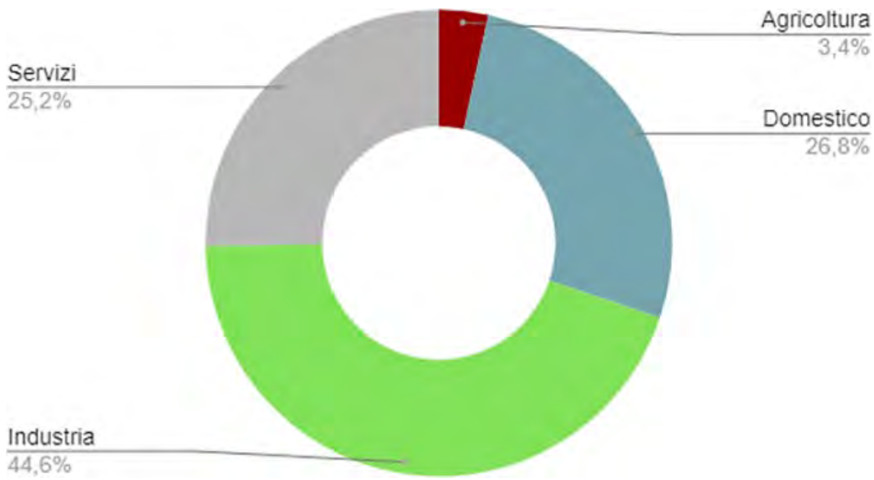
5.15.7 Energy

The data needed to analyse the Energy component were taken from the Regional Statistics report 2022[22] produced by Terna.

In 2022, energy production in Puglia amounted to 34,398.8 GWh and consumption amounted to 16,181.8 GWh. The most energy-intensive sector is industry, with regional consumption of around 7,000 GWh.

Figure 5-172 confirms industry as the most energy-intensive sector in the region, accounting for over 44% of consumption. This is followed by the domestic sector (26.8%), services (25.2%) and agriculture (3.4%).

Figure 5-172 Electricity consumption by sector in Puglia



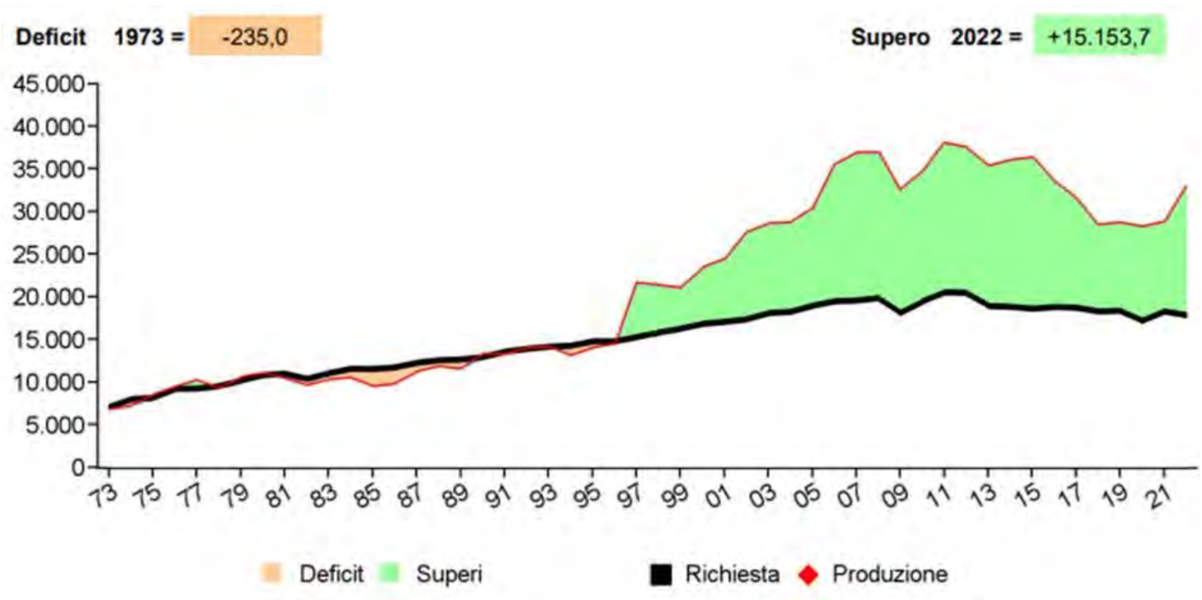
Source: Terna – Puglia Region, 2022[23]

Most of the production comes from traditional thermoelectric power (24,836.7 GWh), followed by wind power (5,361.3 GWh) and photovoltaic power (4,190.5 GWh). The remainder is produced by hydroelectric power.

Over the last 25 years, energy production in the region has exceeded demand (Figure 5-173). The latest available data for 2022 shows an energy surplus of over 15,000 GWh for the region. Furthermore, in 2022, Puglia recorded a 6.3% drop in consumption compared to the previous year. Contrary to the national trend, the most significant decline was in the services sector (-14.5%), followed by the industrial sector (-6%).

22 https://download.terna.it/terna/ANNUARIO%20STATISTICO%202022_8dbd4774c25facd.pdf
23 https://www.regione.puglia.it/web/ufficio-statistico/-/terna.-dati-statistici-sull-energia-elettrica.-anno-2022

Figure 5-173 Historical series of electricity demand and production in Puglia (in GWh), 1973-2022



Source: Terna – Puglia Region, 2022[24]

24 https://download.terna.it/terna/ANNUARIO%20STATISTICO%202022_8dbd4774c25facd.pdf

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