SAKARYA GAS FIELD DEVELOPMENT PROJECT – ENHANCEMENT OF SUBSEA PRODUCTION CAPACITY AND FLOATING PRODUCTION UNITS

Chapter 6.3 Offshore Physical and Biological Baseline

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6.0 ENVIRONMENTAL AND SOCIAL BASELINE

6.3 Offshore Physical and Biological Baseline

6.3.1 Physical environment

This section describes the offshore physical environment, including the components not considered to be affected by the project as evaluated in Chapter 5.2.

Such components are the following:

- Seafloor morphology;
- Sediments (grain size and chemical characterization);
- Physical oceanography (currents and waves).

6.3.1.1 Seafloor morphology

Table 6-1: General overview of the seafloor component

Definition	Seafloor morphology is defined as the shape of the seabed. Most of the ocean is very deep, where the seabed is known as the abyssal plain. From the abyssal plain, the seabed slopes upward toward the continents and becomes, in order from deep to shallow, continental rise, slope, and shelf. Like land terrain, the ocean floor presents mountains, including volcanoes, ridges, valleys, and plains. Most of the oceans have a common structure, created by common physical phenomena: tectonic movements and sediment transportation. Sediment on the seafloor originates from a variety of sources, including biota from the overlying ocean water, eroded material from land transported to the ocean by rivers or wind, ash from volcanoes, and chemical precipitates derived directly from seawater. Sea currents transport sediments which interact with the seafloor. These interactions create vary geological structures that occur both near the coast and at greater depths.
Study Area	**RSA**: The Black Sea with focus on the Turkish continental shelf, slope and abyssal plain. **Rationale**: The Turkish continental shelf of the Back Sea shows several prominent structures such as slumping, pockmarks, mud volcanoes, sliding and faults (ÇİFÇİ et al., 2002). **AoI**: The project footprint plus a buffer of 500 m per side. **Rationale**: Seafloor morphology is a seascape component. Impacts (if any) may only occur in the near proximity of the project footprint because of the limited influence on the local hydrodynamism. A buffer of 500 m is considered as highly precautional for the pipeline laying and even for the activities of dredging and deposition of the sediments at the temporary storage area.

Data sources	**Primary sources:** Geophysical data gathered through Side Scan Sonar (SSS), Sub Bottom Profiler (SBP) and Multibeam Echosounder (MBES) and reported in the report “Hydrographical and Oceanographic Survey Report” by DenAr (Deniz Araştırmaları A.Ş, 2024). **Secondary sources**: Secondary data from scientific papers, grey literature, and databases.
Sensitivity	**Medium-high**

Methodological approach

Data to describe the regional context (i.e., RSA) were collected through literature review (references reported in 13.0), whereas the local context (i.e., AoI) was assessed by both literature review and the gathering of field data.

In particular, primary data on bathymetry were gathered in the AoI by DenAr in the first half of 2024 using an Autonomous Underwater Vehicle (AUV). The AUV measurements were conducted in the Infield, FPU area, as well as in Area1 and Area2 between KP0 and approximately KP30, as shown in the Figure 6-1 and Figure 6-2. Bathymetric data were collected with a 0.50 m resolution and 40-meter line spacing.

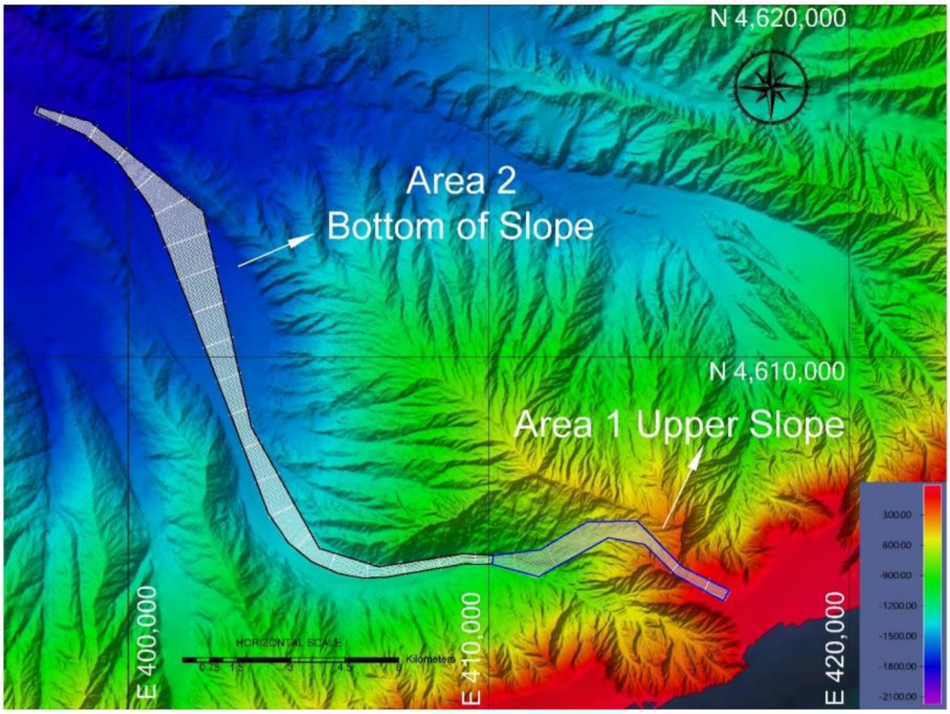


Figure 6-1: Area 1 and Area 2

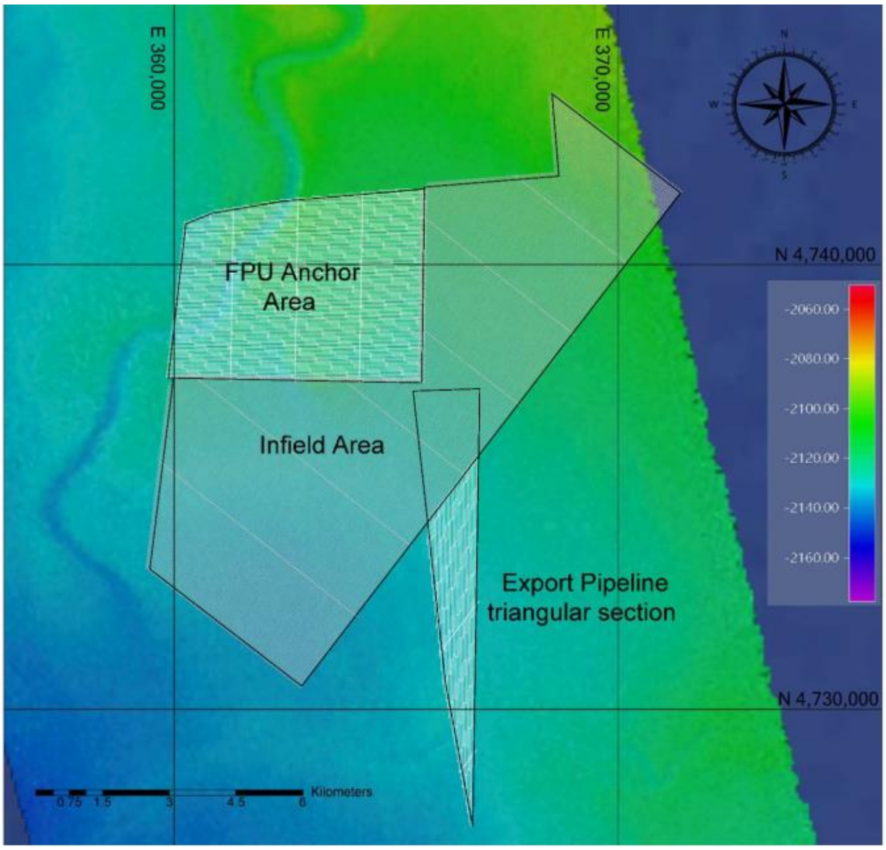


Figure 6-2: PU, Infield Area and Export Pipeline Triangular Section.

Bathymetry maps were then created based on the gathered data.

Regional context (RSA)

The Black Sea is one of the largest and deepest inland seas, with a total area of 420,325 km^2 and an average depth of about 1,500 m (Ross et al.,1974; Özsoy & Ünlüata, 1997). Its maximum depth reaches the mark of 2,258 m (Kostianoy et al., 2008; Krivoguz et al., 2020; see Figure 6-3).

The continental shelf of the Black Sea can vary dramatically according to the location. A wide shelf occurs in the northwestern and northern Black Sea basin, while in the eastern and southern part of the Black Sea (including Turkish coastline) the continental shelf is very narrow (Özsoy & Ünlüata, 1997; Panin & Jipa, 2002; Panin, 2005).

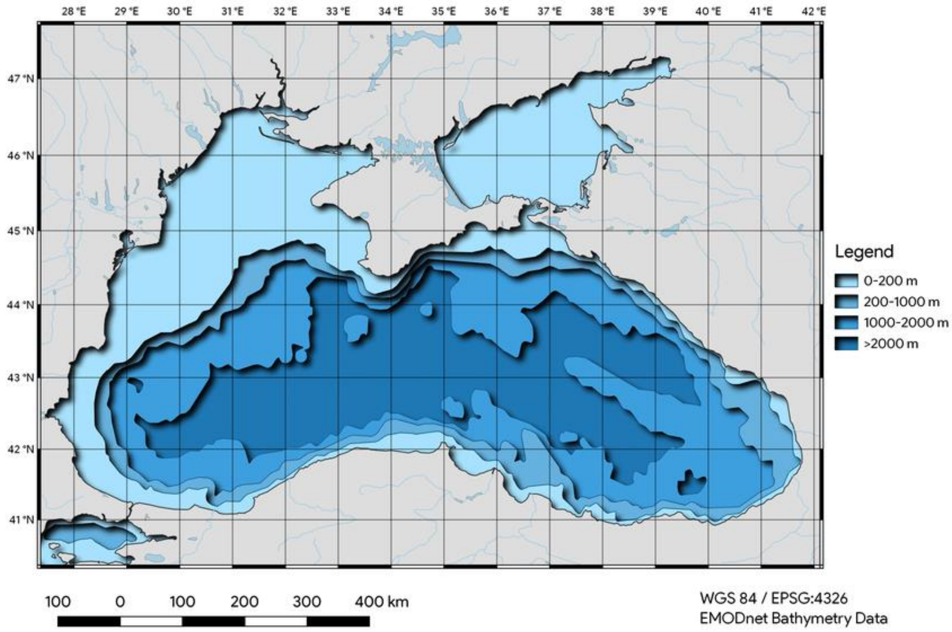


Figure 6-3: Bathymetry of the Black Sea: different colors indicate different depths (Denis, 2000).

Many submarine canyons incise the Black Sea continental slope, and they are grouped into four main areas: a northwestern area (including the Danube and Dnieper canyons), a western area (Istanbul), a southern area (Samsun) and an eastern area (Batumi-Sochi). Those categories were made by considering only large canyons, the ones that span a bathymetry interval of at least 1,000 m, with a channel depth reaching at least 100 m (Jipa & Panin, 2020) (see Figure 6-4).

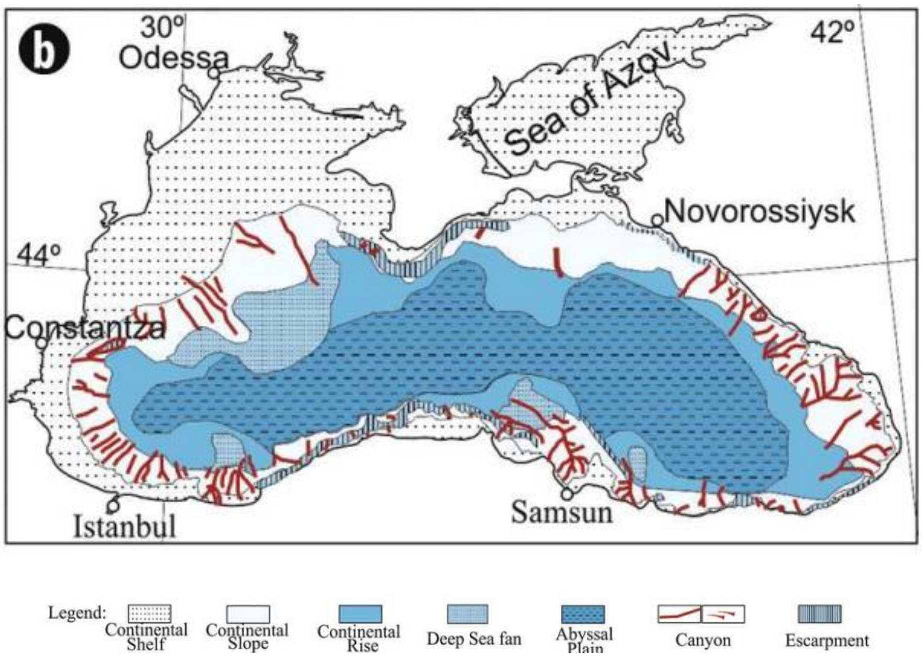


Figure 6-4: Black Sea canyon systems (Jipa et al., 2020).

The Black Sea is characterized by slope failures and sediment instability related to high amounts of gas and gas hydrate that may pose a threat to offshore installations. The formations of submarine mud diapirs, mud volcanoes and gas leaks are linked to the upward migration of free gas in the sediments on the continental edges (Wan et al., 2021) (see Figure 6-5).

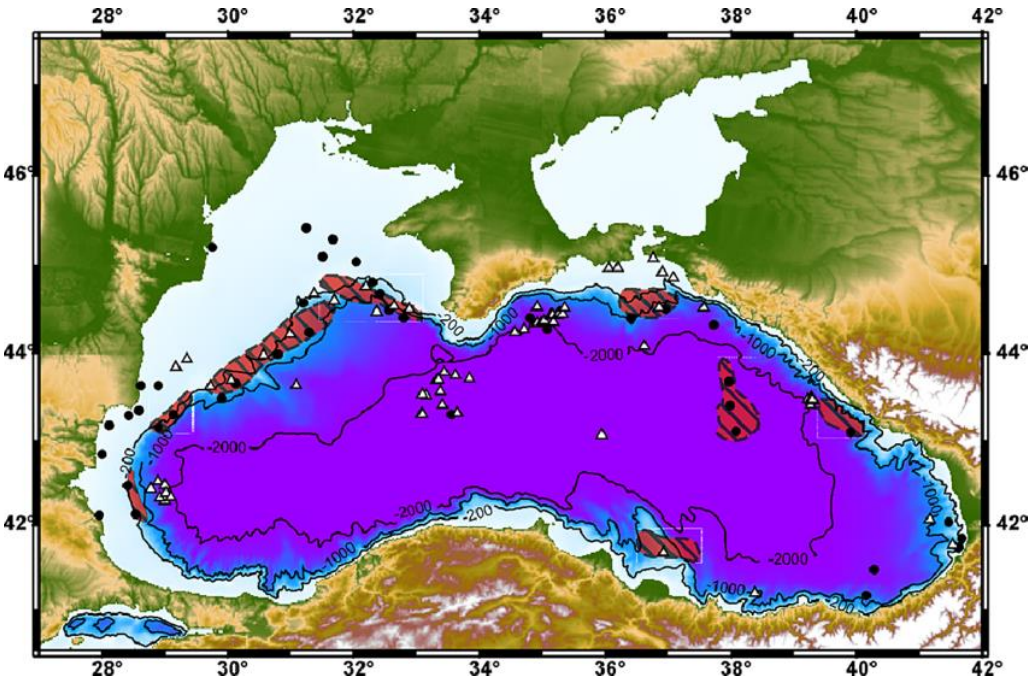


Figure 6-5: Location of mud volcanoes (yellow triangles) and areas of intense fluid discharge (black dots) in the Black Sea. The red areas represent regions of gas seepage and seabed pockmarks (Schmale et al., 2010).

Specifically, the Turkish seafloor (including the western area – Istanbul and the southern area - Samsun) shows several prominent structures such as slumping, pockmarks, mud volcanoes, sliding and faults (ÇİFÇİ et al., 2002). The “Hydrographical and Oceanographic Survey Report” by DenAr Deniz Araştırmaları A.Ş., reports that Türkiye’s continental margin has a narrow shelf (up to 10 km width) located at a water depth of 100 m, a steep continental slope (inclination up to 25 degrees) scoured by the canyon systems, a continental elevation with mild and soft incline, and a smooth abyssal plane with maximum water depth of 2,200 m.

Local context (AoI)

Figure 6-6 shows the AoI and the Project components (i.e., existing offshore pipeline, future offshore pipeline and FPU area) whereby the areas investigated by the AUV are highlighted by the red polygons.

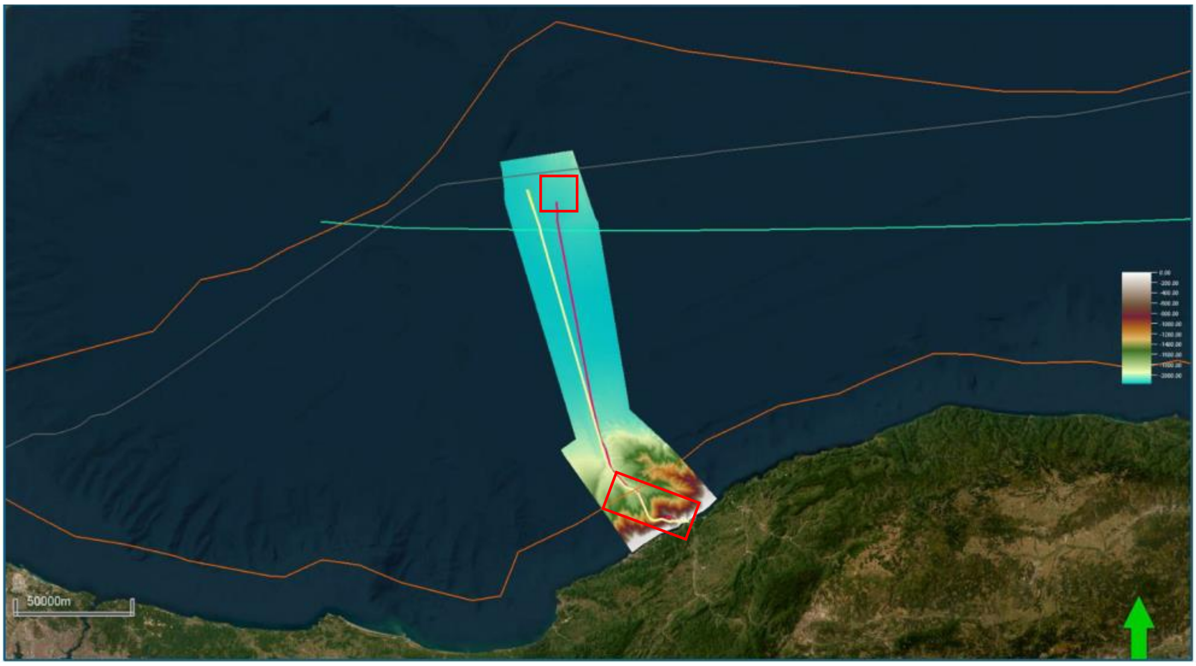
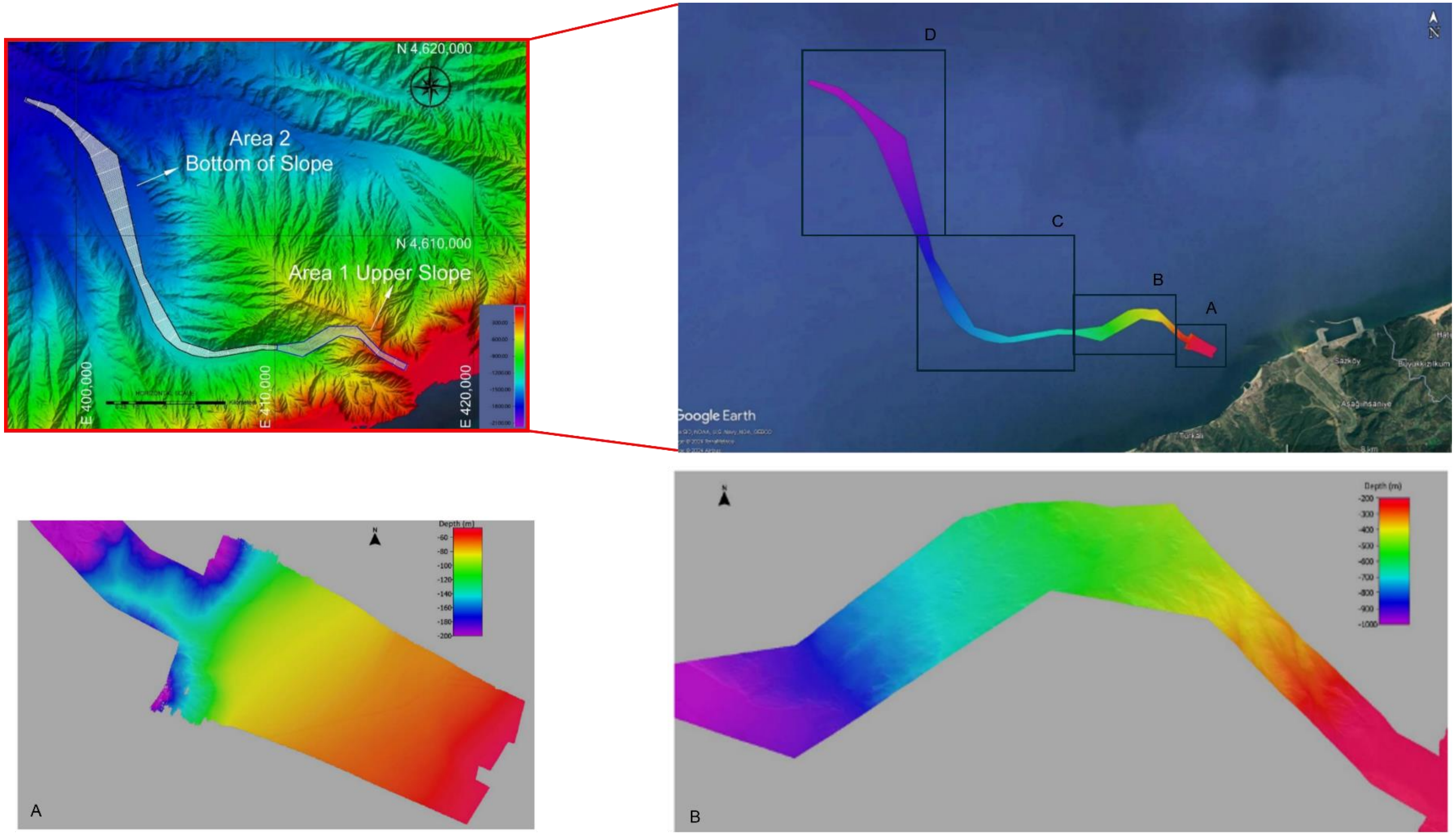


Figure 6-6: Existing and future Project facilities. Areas investigated through collection of primary data are reported in red.

Primary data (i.e., AUV) were mainly focused on the nearshore pipeline route and FPU areas, whose characteristics are described as follow:

- **Nearshore Route (Escarpment)**: The part between Filyos port and the escarpment end area is defined as nearshore. In this area, the water depth typically varies between 0 m and approximately 1000 m. The escarpment area starts from the landfall area to about 50 km offshore; it is approximately 50 km in length and 30 km in width, covering a total area of 1500 km².
- **FPU Anchor Location**: The area is defined as the deep offshore FPU anchor location where the installation of FPU with mooring lines and connection with wells will take place. In this area, the water depth is typically comprised between 2100 m and 2200 m.

A detailed bathymetry map of the investigated nearshore area is shown in Figure 6-7.


N 4,620,000
Area 2
Bottom of Slope
N 4,610,000
Area 1 Upper Slope
E 400,000
E 410,000
E 420,000
D
C
B
A
Google Earth
Depth (m)
-60
-80
-100
-120
-140
-160
-180
-200
A
Depth (m)
-200
-300
-400
-500
-600
-700
-800
-900
-1000
B

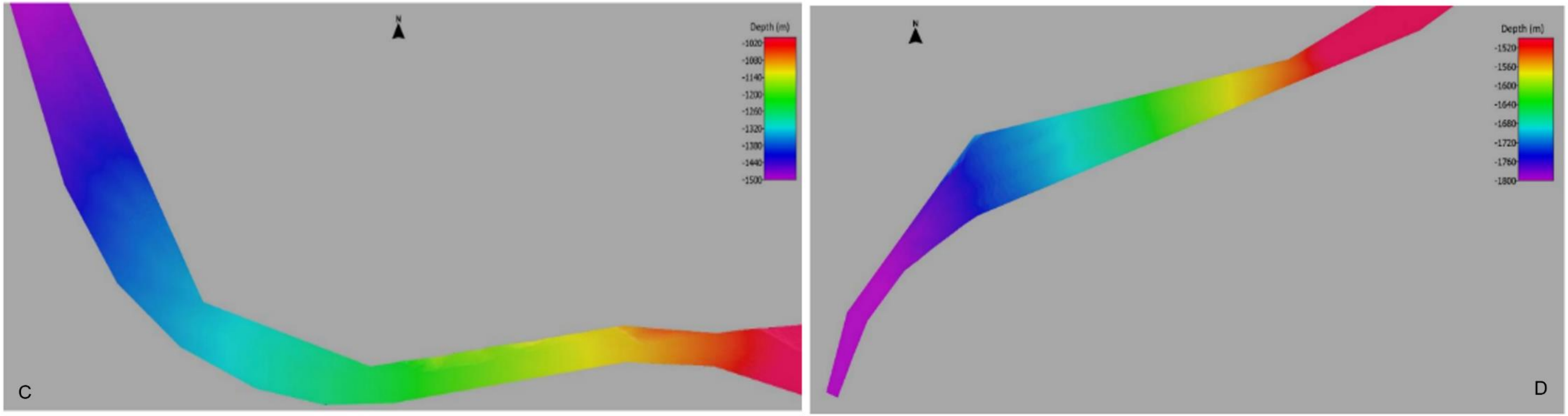


Figure 6-7: Area1 and Area2 bathymetric measurements collected by using Autonomous Underwater Vehicle.

The bathymetric measurements conducted in Area1 and Area2 cover water depths ranging from 40 to 1800 m. This region begins nearshore before the escarpment and extends to the end of the escarpment. Notably, the bathymetric data from this area reveal a wreck ship (**section C** of Figure 6-7). The images below present segmented bathymetric views to highlight depth variations more clearly, along with bathymetric images believed to represent the wreck ship.

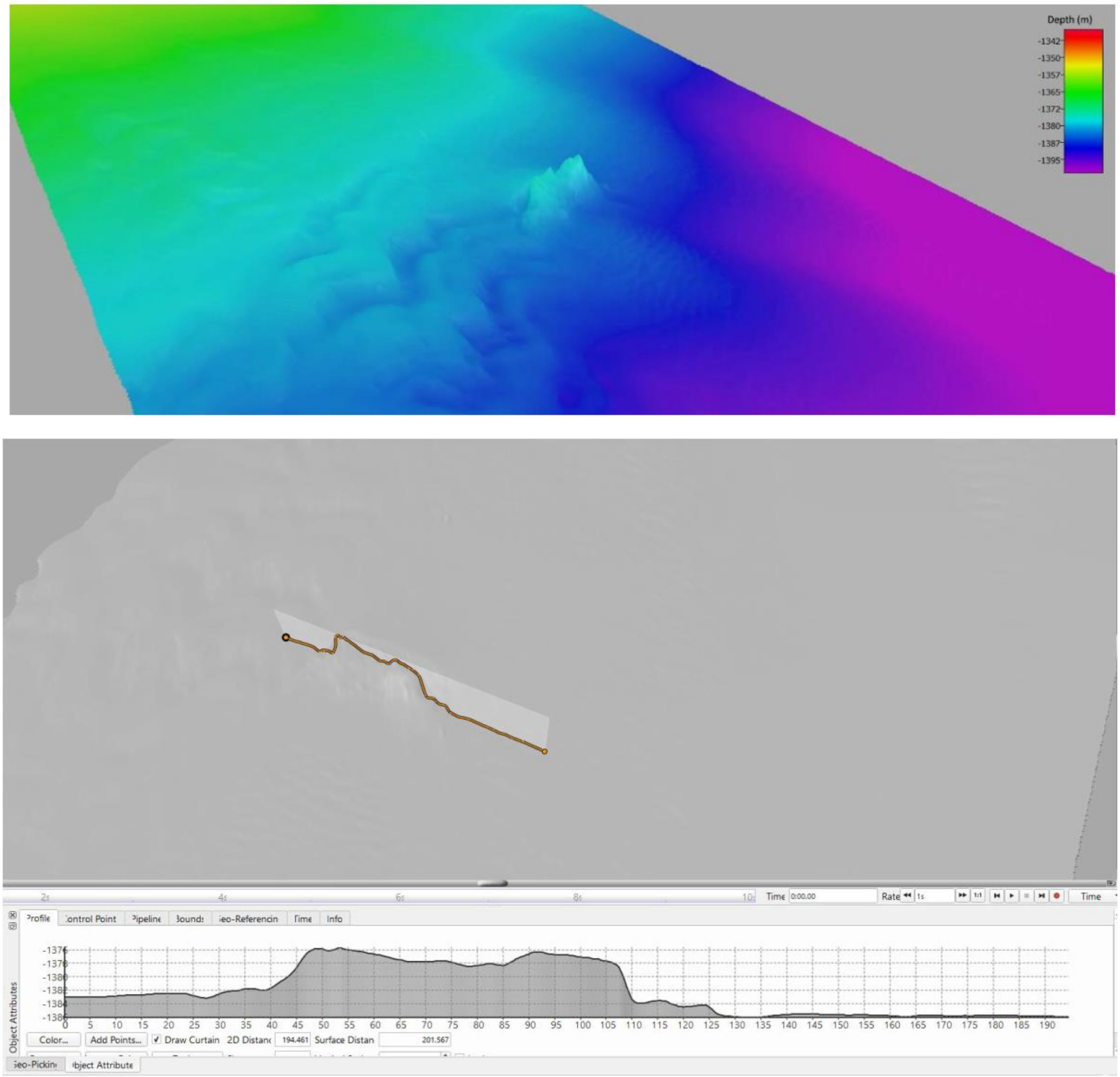


Figure 6-8: Bathymetric images and depth variations shown by segmented bathymetric views to highlight a hypothetical wreck ship.

Regarding the FPU investigated area, a detailed bathymetry map is shown in the figures below.

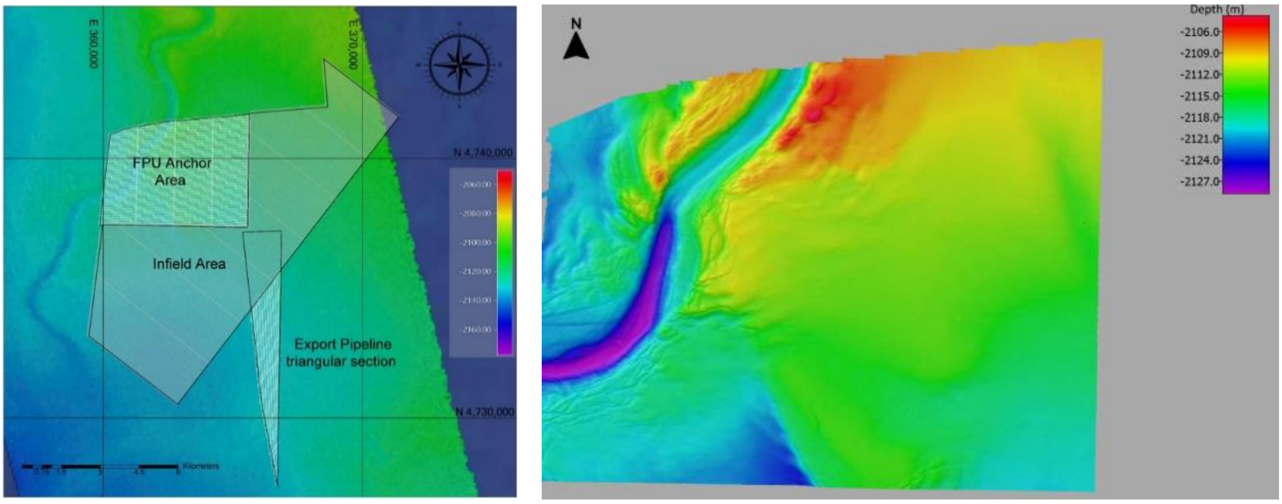


Figure 6-9: AUV FPU Area MBES Survey Bathymetry Map.

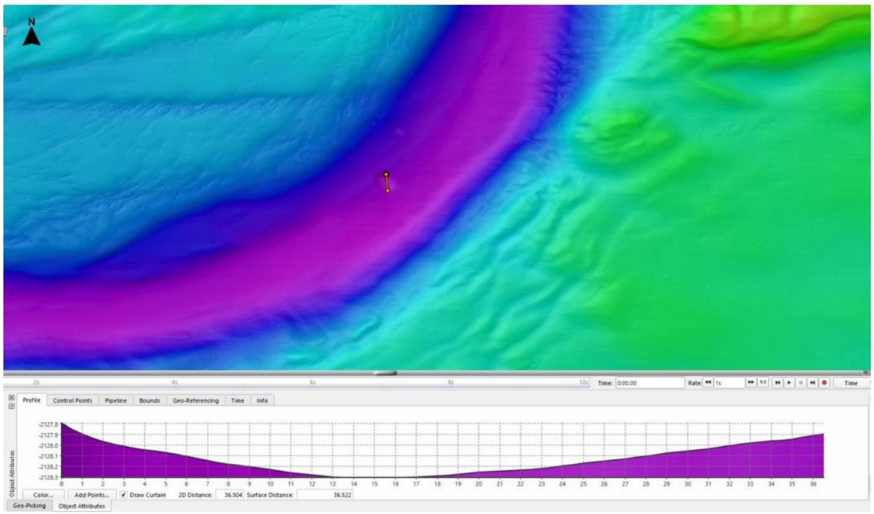


Figure 6-10: FPU Area Profile-1.

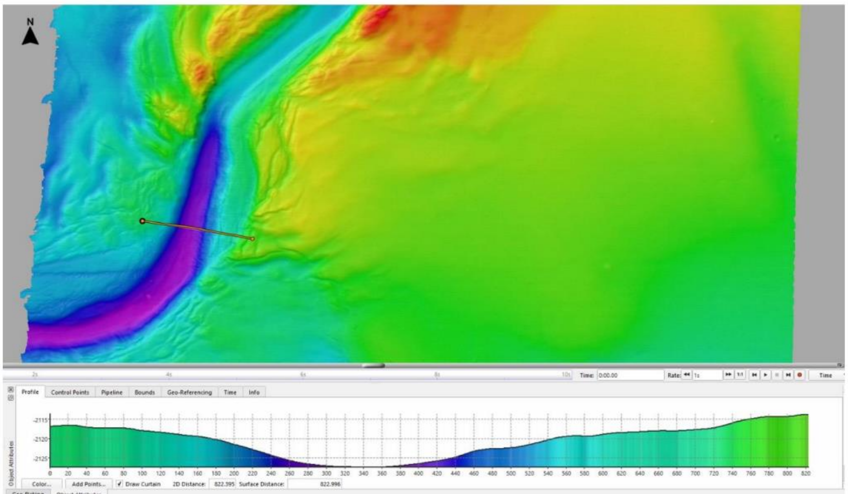


Figure 6-11: FPU Area Profile-2.

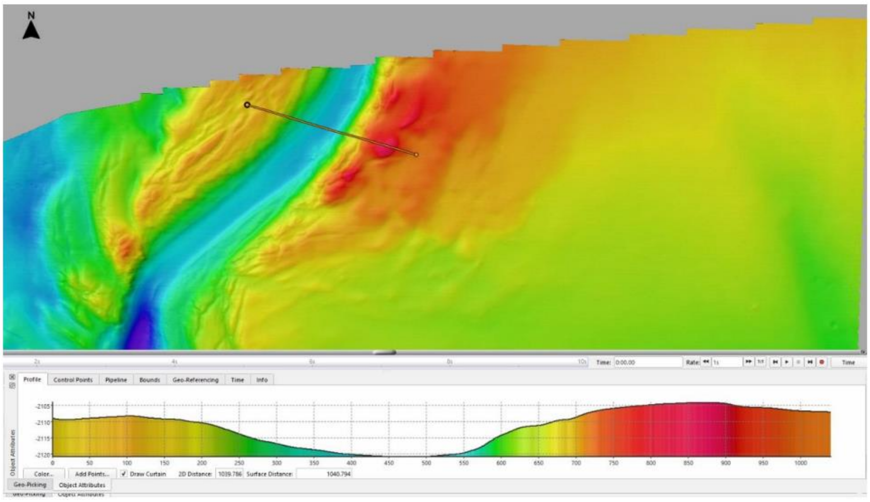


Figure 6-12: FPU Area Profile-3.

In periodic IMR measurements conducted over the past year, changes in the seabed have generally been observed within the first kilometres of the umbilical route. This area, which is close to the shore, clearly exhibits the influence of the Filyos River. The river's current has created movement in the seabed as far as its influence can reach. This change has sometimes resulted in sediment deposition and at other times in deepening along the umbilical path. Environmental factors such as heavy rainfall and floods have caused more radical changes in this region. In this report, we will present 3D bathymetric images comparing our latest measurement with the previous one and the as-built measurement. Sections containing all the IMR measurements are provided as well. In the shallow area, specifically at KP0.240, deepening of the seabed has been observed. This deepening on the umbilical reaches approximately 0.80 meters. This value represents the maximum deepening measured on the umbilical during this survey. The most significant observation here is the reduction of material on the seabed, which consequently brings it closer to the umbilical. If this reduction continues, the umbilical will become exposed.

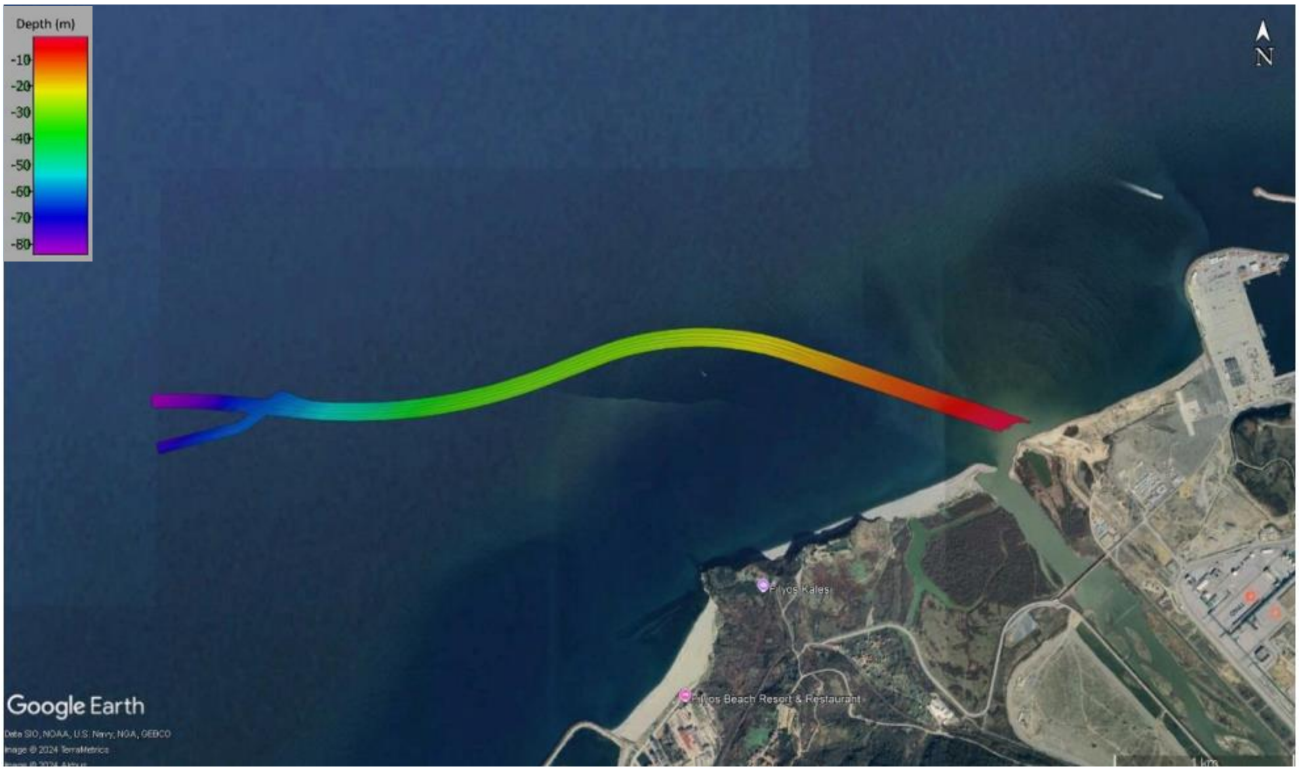


Figure 6-13: IMR MBES Survey Bathymetry Map.

Mud volcanoes

Mud volcanoes erupt with very dense or expulsive gas emissions from the seabed with average time interval of 20 years up to 60 years, resulting in violent outbursts. Sediments mixed with water rich in gases and minerals is pushed out during those eruptions (Dimitrov, 2002).

Using primary data gathered by DenAr (2021) in the Continental Ascension region at the top of the sedimentary ridges along the canyon edges, seven mud volcanoes in the form of cones were determined and they are all located on shallow mud diapirs.

The closest mud volcano is named "Mud volcano 3" and is located at about 6 km north-eastwards to the AoI or the Project. This volcano is not expected to pose a threat to the project being a cone-type mud volcano (a mean surface slope of >10°) with episodic massive mud eruptions that are several orders of magnitude smaller than the ones of the pie-type mud volcanoes (Kioka & Ashi, 2015).

Mud volcanoes may be considered the main cause of seismic activity recorded in the AoI.

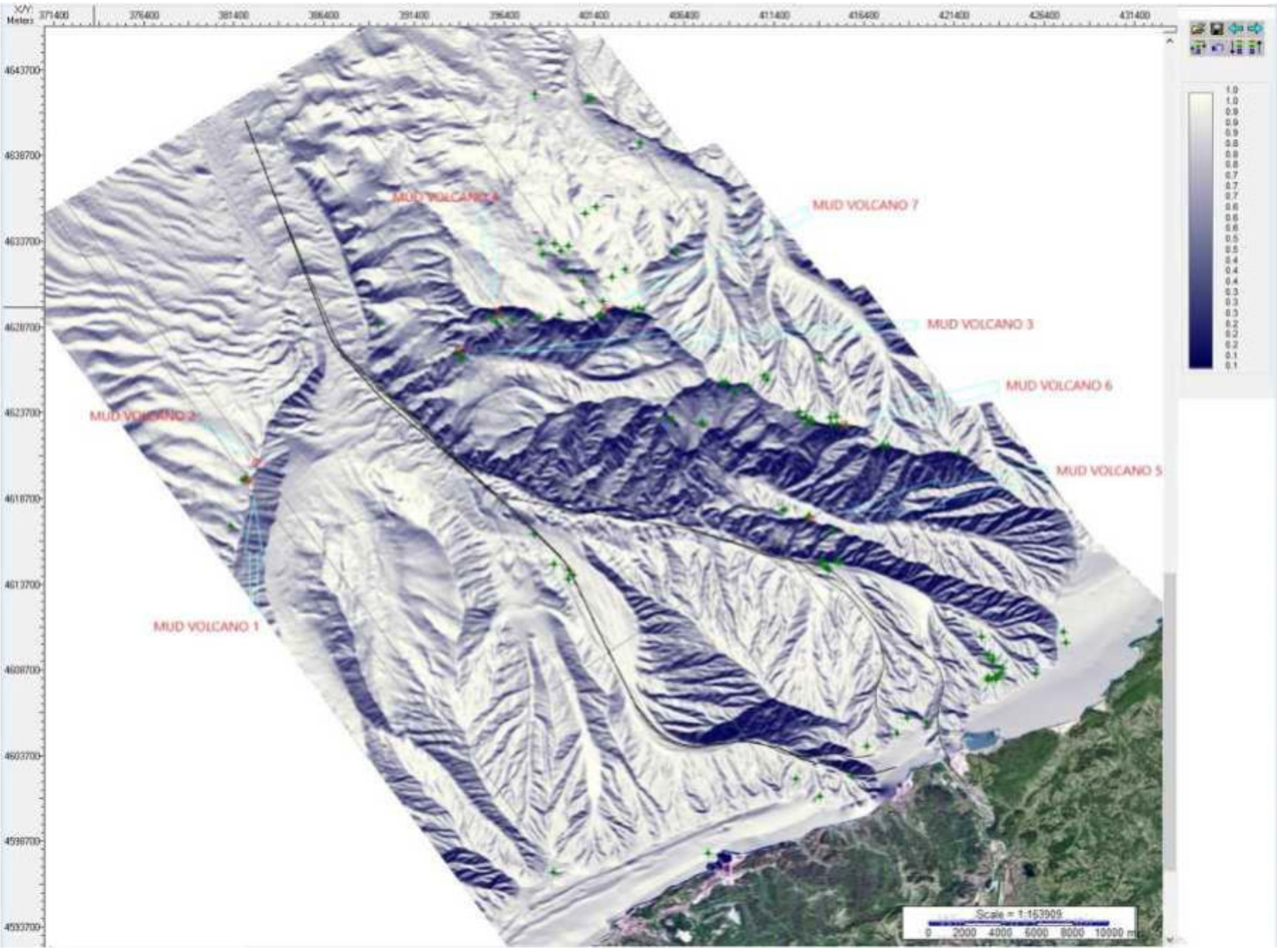


Figure 6-14: Mud volcanoes locations with reference to the AoI.

Mud diapirs

A mud diapir is an intrusive geomorphic structure characterized by a slowly upward migrating mass of clay-rich sediment and fluid discharge (Kopf, 2002). A mud volcano usually occurs above the diapir, because of fluid migration directly along the body of the mud diapir or through faults (fractures) connected to the mud diapirs.

Mud volcanoes represent the last manifestation of diapirism (Chen et al., 2014).

Gas outlets

Acoustic transparency in the sediments caused by upwardly moving gases, leaking slowly, that blur the sedimentary stratification. Gas leaks usually occur near submarine mud volcanoes and mud hills. Water column acoustic anomalies are located close to these structures, which indicates that these structures are active gas discharge areas.

Several gas leaks in the area along the top of the sedimentary ridges near possible mud volcanoes, mud piles, and pockmarks[1] are reported by DenAr (2021) for Phase 1 investigations.

Sensitivity Assessment

Sensitivity features	Supported by	Sensitivity value
Absence of rocky outcrops and gently sloping bathymetry upon the continental slope Presence of sedimentary waves in the canyon area Possible presence of a ship wrack in the nearshore AoI Presence of Mud Volcano 3 at about 6 km from the AoI Medium Seismicity Several gas leaks in the AoI	Primary data (DenAr, 2024) and secondary data	**Medium-high**

1 Craters that commonly occur world-wide on muddy seabeds. They are formed by fluid flow and are indicators of past and present hydraulic seabed activity (Hovland & Judd, 1988).

6.3.1.2 Sediments

Table 6-2: General overview of the sediment component.

Definition	Marine sediments are a mixture of material deposited on the seafloor that originated from the erosion of continents, volcanism, biological productivity, hydrothermal vents, and/or cosmic debris. The contributions of these sediment sources to the seafloor are controlled by wind, ocean circulation, and water depth that collectively determine the transport, deposition, and preservation of each sediment type. The alteration of these sediment types is also an important process affecting the final composition of marine sediment. Both natural and human-made perturbations have the capability to alter the chemical-physical characteristics of the sediment (Boggs Jr. & Boggs, 2009). In addition, where/if contaminants are present, they tend to accumulate within the sediment (Lijklema et al., 1993). Thus, both sediment composition and contaminants can be used as indicators of the ecosystem health (Handley et al., 2014).
Study Area	**RSA**: Western Black Sea basin. **Rationale**: The Andrusov Ridge and Archangelsky Ridge extending south from the Crimean Peninsula divide the Black Sea into two depositional basins: the Western Black Sea and the Eastern Black Sea (Shillington et al., 2008). **AoI**: The project footprint plus a buffer of 500 m per side. **Rationale**: The activity of pipeline laying onto the seafloor may resuspend a limited amount of sediment with scarce possibility to be transported through long distances. A buffer of 500 m is considered as highly precautional even for the activities of dredging and deposition of the sediments at the temporary storage area.
Data sources	**Primary sources**: Sediment samples collected (in 2021 and 2024) from the AoI at different depths and analyzed for chemical-physical properties (DenAr, 2024). **Secondary sources**: Secondary data from scientific papers, grey literature, and databases.
Sensitivity	**Low**

Methodological approach

Data to describe the regional context (i.e., RSA) were collected through literature review (references reported in Chapter 13.0 of the present ESIA), whereas the local context (i.e., AoI) was assessed by both literature review and the gathering of field data.

In particular, a total of 37 sediment samples were collected along the pipeline and from the nearshore and FPU areas in June 2024 using a Box Core and an 8-L grab. Specifically, 4 samples were collected along the pipeline route, 5 samples were collected from the FPU area, and 28 samples from the nearshore area.

The figures below show a general map of the sampling stations within the AoI followed by a detailed map of the sampling locations within the nearshore area.

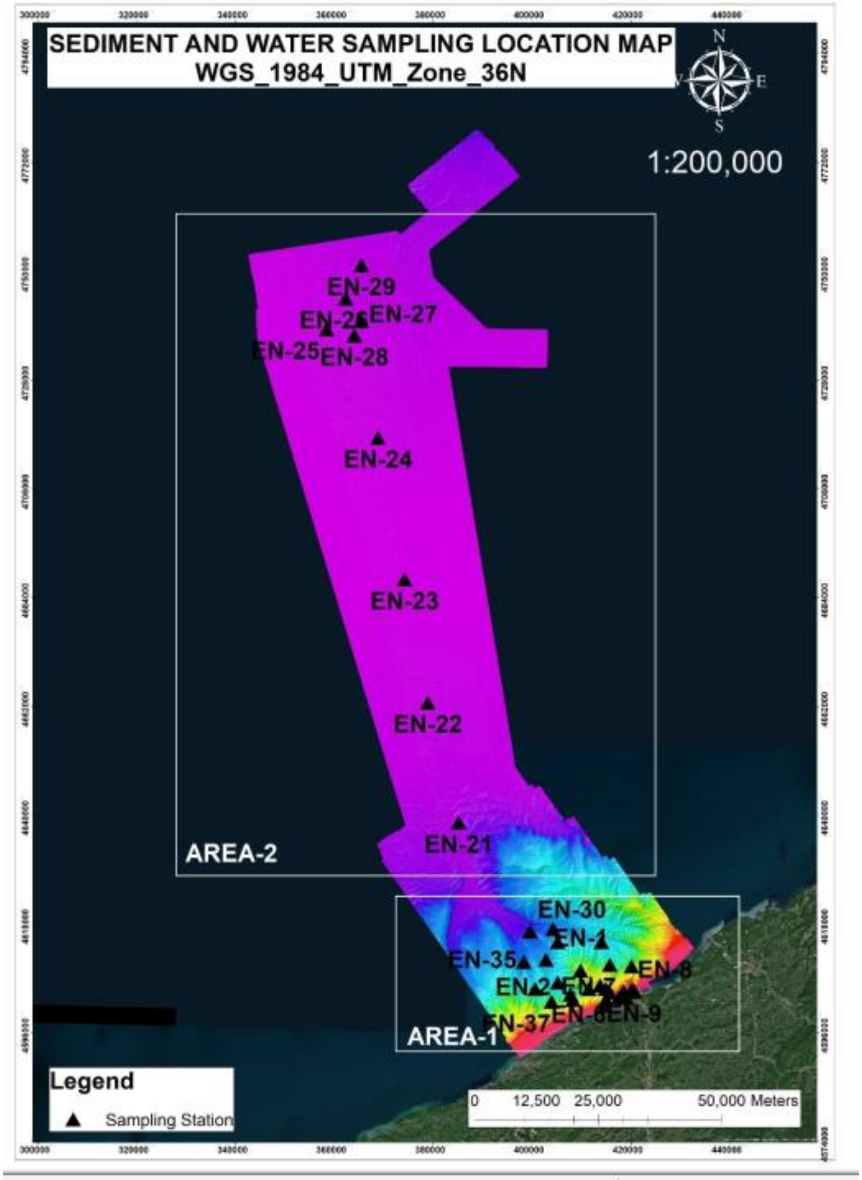


Figure 6-15: General map of the Sediment Sampling Stations.

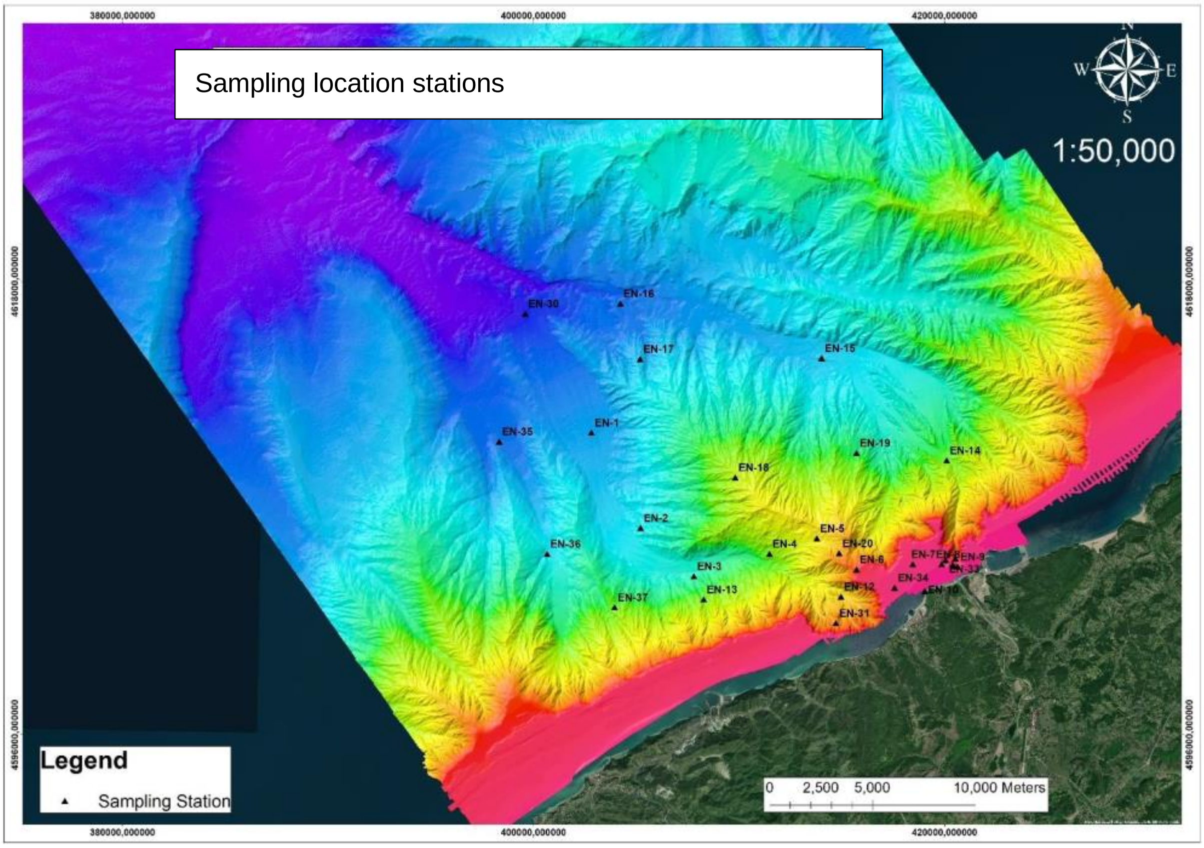


Figure 6-16: Detailed map of the Sediment Sampling Stations in the nearshore area.

Samples were analyzed by the NEN Mühendislik ve Laboratuvar Hizmetleri Ltd. for both granulometry and contaminants determination and quantification in accordance with the “Regulation on the Environmental Management of the Dredged Material” that came into effect through publication on the Official Gazette No. 31008 dated 14/01/2020 and IFC PS3 standards.

Regional context (RSA)

The Western Black Sea basin is characterized by Danube deep-sea fan that extends for about 150 km downslope the edge of the continental shelf, and the distal end of the fan reaches the abyssal plain at 2,200 m water depth. Such system is responsible for the higher supply of terrigenous sediments to the basin. Beyond the Danube, this abyssal fan is also fed by important rivers, such as the Dnepr, the Dnestr and the Southern Bug (also known as Boh River) (Popescu et al., 2001).

With a multiannual mean flow of 6,510 m^3/sec and a multiannual average suspended sediment discharge of 1,619 kg/sec at the delta, the Danube contributes large amounts of sediments to the Western Black Sea basin (Bondar, 2008). The main components of those Black Sea sediments are organic carbon and calcite. Organic carbon shows a high degree of preservation due to anoxia in the waters below 100 - 150 m of depth, making 90% of its water mass as anoxic. This is translated as the world largest anoxic water mass (Sorokin, 1983).

Local context (AoI)

Primary data were collected within the AoI for sediment composition and possible presence and concentration of contaminants DenAr (2021 and 2024).

The AoI is located in close proximity to the Filyos River mouth, whose waters influence the amount of sediment discharged in the AoI and sediment characteristics. The Filyos River has an annual sediment transport of approximately 233 m^3/(year*km^2), which consists mainly of sand and silt (Donders, 2010).

Sediment grain-size

Based on the results reported by DenAr (2024), the sediments of the AoI show the following composition:

- sand ranges from 35.06 % to 95.52 % with average 72.94%,
- clay ranges from 2.42 % to 60.78% with average 23.35%
- silt ranges from 0.99% to 7.84% with average 3.7%,

Gravel was not observed in any of the collected samples.

Primary data collected in 2024 are similar to those collected in 2021 but with some differences.

In fact, primary data from 2021 show that sand is present in all the analyzed samples and dominates till the bathymetry of 25 m where it starts to decrease, and sediments become gradually dominated by muds (till 50 - 60 m depth) and clay from 60 m depth (DenAr 2021). According to these data, enclaves of clay interrupt the sand-dominated seabed between the coastline and the first 25 m of depth. A relevant amount of clay, forming tridimensional structures, is present in the pipeline corridor between 15 m and 20 m depth (DenAr 2021).

Primary data collected in 2024 show that sand is found in all the analyzed samples from 0 m to 2,000 m dept and represents the dominant sediment component despite samples were collected at different depths (from shoreline EN-10 to 2,000 m EN-29).

The only exception is represented by 4 stations, namely EN-5, EN-9, EN- 13 and EN- 20 where clay dominates over sand. On average, sand represents about 73% of the sediment components. Clay is the second most abundant sediment component within the AoI with an average concentration of about 23%. Silt represents the less abundant sediment component with an average of 3.7%. Finally, gravel is never detected within the analyzed samples.

It is possible that changes in the sediment composition between 2021 and 2024 may be related to changes in the detritus composition discharged by the Filyos River in the past 3 years.

Chemical characterization

Table 6-3 and Table 6-4 show the chemical characteristics of sediment within the AoI, from sediment composition to the presence of contaminants and their concentrations.

Table 6-3: Characterization of sediments within the AoI for the 37 samples collected between 0 and 2,000 m depth.

Parameter	Unit	EN-1	EN-2	EN-3	EN-4	EN-5	EN-6	EN-7	EN-8	EN-9	EN- 10	EN- 11	EN- 12	EN- 13	EN- 14	EN- 15	EN- 16	EN- 17	EN- 18	EN- 19	EN- 20
Cadmium	mg/kg	<0,5	0.93	<0,5	<0,5	0.68	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5	0.73	<0,5	<0,5	1.14	0.51	<0,5
Lead	mg/kg	12.78	23.36	11.05	18.47	19.30	21.05	5.70	5.08	14.16	3.80	5.30	3.97	9.77	12.19	16.12	10.30	6.70	20.66	12.31	14.06
Arsenic	mg/kg	<0,4	<0,4	<0,4	<0,4	<0,4	<0,4	<0,4	<0,4	<0,4	<0,4	<0,4	<0,4	<0,4	<0,4	<0,4	<0,4	<0,4	<0,4	<0,4	<0,4
Chrome	mg/kg	13.60	13.84	13.02	10.34	15.03	15.66	13.15	8.95	11.04	11.69	9.98	11.62	3.95	12.37	14.58	12.40	9.32	14.35	15.64	13.23
Copper	mg/kg	4.06	5.13	3.77	5.12	5.24	5.19	2.33	<2	4.39	2.07	2.22	<2	<2	4.43	5.09	4.09	2.88	4.43	4.98	4.53
Nickel	mg/kg	10.38	11.29	14.58	12.04	11.17	10.60	11.81	9.94	10.25	8.07	9.87	8.40	12.57	11.75	12.31	12.89	10.46	12.21	13.17	11.64
Zinc	mg/kg	108.39	150.10	103.64	116.18	120.95	100.80	2.33	1.71	8.92	1.65	1.87	26.71	15.90	4.99	59.35	43.53	2.77	48.47	45.99	45.89
Mercury	mg/kg	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5	1.30	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5
Total PCBs (Polychlorinat ed Biphenyls)	µg/kg	<0,5	2.94	1.22	0.52	4.43	10.23	1.55	<0,5	0.93	2.63	<0,5	<0,5	5.46	1.49	1.75	2.13	0.73	8.42	1.24	0.84
Sand	%	87.19	56.07	66.22	57.08	35.06	54.66	92.34	93.82	37.38	95.52	87.20	94.79	74.79	36.96	61.50	62.46	76.78	55.16	71.41	39.20
Clay + Silt	%	12.81	43.93	33.78	42.92	64.94	45.34	7.66	6.18	62.62	4.48	12.80	5.21	25.21	63.04	38.50	37.54	23.22	44.84	28.59	60.80
Clay	%	9.24	33.56	31.35	36.20	60.78	40.56	5.37	5.25	57.27	2.42	9.23	3.32	22.07	59.93	35.47	33.42	22.23	40.74	25.98	54.49
Silt	%	3.57	10.37	2.44	6.71	4.16	4.78	2.29	0.93	5.35	2.06	3.57	1.89	3.15	3.11	3.03	4.12	0.99	4.10	2.61	6.32

Table 6-4: Characterization of sediments within the AoI for the 37 samples collected between 0 and 2,000 m depth (cont'd)

Parameter	Unit	EN- 21	EN- 22	EN- 23	EN- 24	EN- 25	EN- 26	EN- 27	EN- 28	EN- 29	EN- 30	EN- 31	EN- 32	EN- 33	EN- 34	EN- 35	EN- 36	EN- 37
Cadmium	mg/kg	0.96	1.02	1.09	3.55	3.16	3.16	2.47	4.06	3.80	0.66	<0,5	<0,5	<0,5	<0,5	<0,5	0.52	<0,5
Lead	mg/kg	18.69	25.15	19.61	12.08	16.43	13.95	9.50	16.06	27.64	17.77	4.94	15.78	4.01	5.44	5.30	8.23	6.66
Arsenic	mg/kg	<0,4	<0,4	<0,4	<0,4	<0,4	<0,4	<0,4	<0,4	<0,4	<0,4	<0,4	<0,4	<0,4	<0,4	<0,4	<0,4	<0,4
Chrome	mg/kg	13.59	15.71	14.64	4.67	4.24	4.72	3.30	5.16	2.67	16.18	9.67	11.97	8.08	7.95	10.79	9.13	9.07
Copper	mg/kg	5.05	4.99	4.05	3.59	2.94	3.56	2.62	4.88	4.95	6.45	<2	5.06	<2	<2	2.12	3.95	2.65

Parameter	Unit	EN- 21	EN- 22	EN- 23	EN- 24	EN- 25	EN- 26	EN- 27	EN- 28	EN- 29	EN- 30	EN- 31	EN- 32	EN- 33	EN- 34	EN- 35	EN- 36	EN- 37
Nickel	mg/kg	12.71	13.36	13.11	15.28	13.63	15.22	13.61	14.48	13.49	11.38	9.88	10.06	9.64	10.45	10.34	11.33	10.55
Zinc	mg/kg	41.33	43.89	36.03	17.30	16.10	13.16	4.10	8.26	11.61	8.34	1.30	5.46	0.61	0.81	0.95	3.10	1.67
Mercury	mg/kg	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5	2.43	<0,5	<0,5	<0,5	<0,5	<0,5
Total PCBs (Polychlorinat ed Biphenyls)	µg/kg	3.92	2.88	6.46	4.57	7.14	1.96	3.78	2.85	6.38	1.30	<0,5	0.75	<0,5	<0,5	<0,5	15.02	<0,5
Sand	%	67.79	71.43	84.08	85.84	82.93	76.45	72.56	86.72	83.56	72.59	95.28	46.03	95.13	94.93	88.69	81.72	77.42
Clay + Silt	%	32.21	28.57	15.92	14.16	17.07	23.55	27.44	13.28	16.44	27.41	4.72	53.97	4.87	5.07	11.31	18.28	22.58
Clay	%	28.20	24.01	9.50	11.67	15.68	18.10	20.02	10.68	14.04	24.61	2.55	46.19	2.63	2.74	10.39	13.97	20.27
Silt	%	4.02	4.56	6.42	2.49	1.39	5.45	7.42	2.61	2.40	2.81	2.17	7.79	2.24	2.33	0.92	4.32	2.31

Table 6-5 shows the threshold values for the analyzed contaminants according to the Turkish regulation and international standards (NOAA).

Table 6-5: Limit Values and Upper Limit Values set by the Turkish regulation and international standards for sediment contaminants.

	Parameter	Unit	Turkish Regulation		NOAA Standards	
			TLV[1]	ULV[2]	TELs[3]	PELs[4]
	Aluminum	mg/kg	NE	NE	NE	NE
	Arsenic	mg/kg	30	50	7.24	41.6
	Cadmium	mg/kg	1.5	2.5	0.68	4.21
	Chromium	mg/kg	850	1300	52.3	160
	Copper	mg/kg	100	200	18.7	108
	Nickel	mg/kg	1000	1750	15.9	42.8
	Lead	mg/kg	100	200	30.24	112
	Zinc	mg/kg	200	400	124	271
	Mercury	mg/kg	0.5	2	0.13	0.7
	Total Organic Carbon	%	NE	NE	NE	NE
	Total Oil Hydrocarbons	mg/kg	NE	NE	NE	NE
PAH	Napthalene	mg/kg	NE	NE	0.0346	0.391
	Acenapthylene	mg/kg	NE	NE	0.00587	0.128
	Acenapthene	mg/kg	NE	NE	0.00671	0.0889
	Fluorene	mg/kg	NE	NE	0.0212	0.144
	Phenantherene	mg/kg	NE	NE	0.0867	0.544
	Anthracene	mg/kg	NE	NE	0.0469	0.245
	Pyrene	mg/kg	NE	NE	0.153	1.398
	Benzo(a)anthracene	mg/kg	NE	NE	0.0748	0.693
	Chrysene	mg/kg	NE	NE	0.108	0.846
	Benzo(b)fluoranthene	mg/kg	NE	NE	NE	NE
	Benzo(k)fluoranthene	mg/kg	NE	NE	NE	NE
	Benzo(a)pyrene	mg/kg	NE	NE	0.0888	0.763
	Indeno(1.2.3-cd) pyrene	mg/kg	NE	NE	NE	NE
	Dibenzo(ah)anthracene	mg/kg	NE	NE	0.0634	0.135
	Benzo(ghi)perylene	mg/kg	NE	NE	NE	NE

[1] Threshold Limit Value; [2] Upper Limit Value; [3] Threshold Effect Levels; [4] Probable Effect Levels NE= Not Evaluated

When examining the results of the sediment chemical analyses presented in Table 6-3 and Table 6-4, it is clear that all the contaminant levels are below the Limit Value set by the Turkish regulations with the only exception of cadmium and mercury at some stations.

- Cadmium:

- Minimum value = <0,5 mg/kg at EN-1, EN-3, EN-4, from EN-6 to EN-14, EN-16, EN-17, EN-9, EN-14, EN-8, EN-32, EN-34, EN-7, EN-31, EN-33, EN-12, EN-6, EN-20, EN-35, EN-3, EN-4, EN-1, EN-16
- Maximum value = 4.06 mg/kg at EN-28 station
- Average value = 1.78 mg/kg.

▪ Lead:

- Minimum value = 3.80 mg/kg at EN-10 station
- Maximum value = 27.64 mg/kg at EN-29 station
- Average value = 12.80 mg/kg.

▪ Arsenic:

- The value = <0,4 mg/kg at all sample stations

▪ Chrome:

- Minimum value = 2.67 mg/kg at EN-29 station
- Maximum value = 16.18 mg/kg at EN-30 station
- Average value = 10.68 mg/kg.

▪ Copper:

- Minimum value = 2.07 mg/kg at EN-10 station
- Maximum value = 6.45 mg/kg at EN-30 station
- Average value = 4.09 mg/kg.

▪ Nickel:

- Minimum value = 8.07 mg/kg at EN-10 station
- Maximum value = 15.28 mg/kg at EN-24 station
- Average value = 11.73 mg/kg.

▪ Zinc:

- Minimum value = 0.61 mg/kg at EN-33 station
- Maximum value = 150.10 mg/kg at EN-2 station
- Average value = 33.09 mg/kg.

Cadmium concentrations exceed the maximum concentration set by the Turkish regulation in 6 stations, namely EN- 24 (3.55 mg/kg), EN- 25 (3.16 mg/kg), EN- 26 (3.16 mg/kg), EN- 27 (2.47 mg/kg), EN- 28 (4.06 mg/kg) and EN- 29 (3.80 mg/kg). Mercury concentrations exceed the maximum concentration set by the Turkish regulation in 2 stations, namely EN-32 (2.43 mg/kg) and EN-10 (1.30 mg/kg).

Similarly, the chemical analyses show that none of the elements exceed the Probable Effect Levels (PEL) of the National Oceanic and Atmospheric Administration (NOAA), where the concentration levels of the contaminant frequently pose adverse effects (Port of London Authority, 2022).

Nevertheless, it must be stated that Cadmium and Mercury concentrations detected in some of the analyzed samples are comprised between the Threshold Effect Levels (TELs) and PELs of the NOAA. In particular, Cadmium concentrations are comprised between NOAA's TEL and PEL at 3 stations, namely EN-24 (3.55

mg/kg), EN-28 4.06 (mg/kg) and EN-29 3.80 (mg/kg) while Mercury concentrations are comprised between NOAA's TEL and PEL at 2 stations, namely EN-10 (1.30 mg/kg) and EN-32 (2.43 mg/kg).

Sensitivity Assessment

Sensitivity features	Supported by	Sensitivity value
Limited presence of fine sediment in the excavation area (trench) Absence of significant contamination	Primary data	**Low**

6.3.1.3 Seawater

Table 6-6: General overview of the seawater component.

Definition	Seawater is the largest aqueous ionic solution on the earth: 3.3% of its chemical composition consists of dissolved salts, and seven ions (Na, Mg, Ca, K, Cl, S, and Br) account for 93.5% of the total species. Over the globe, sea surface salinity varies from 32 to 37 PSS; on average, seawater surface salinity is about 35 PSS. The temperature of ocean water varies with depth and latitude. At high latitudes, ocean waters receive less sunlight, in fact, the poles receive only 40% of the heat that the equator does. These variations in solar energy mean that the ocean surface can vary in temperature from a warm 30°C in the tropics to a very cold -2°C near the poles. The average ocean surface temperature is 17 C while the deep ocean (below about 200 meters depth) is cold, with an average temperature of only 4°C. Cold water is also denser, and as a result heavier, than warm water. Seawater has an extremely high dilution power against pollutants, providing itself a so-called “auto-depuration”. It is estimated that ~2.2 million of species live in the seawater and that 91% of earth species in the ocean still await a description (Mora et al., 2011).
Study Area	**RSA**: The Black Sea **Rationale**: All the basin is characterized by a permanent halocline and anoxic zone with a limited input of saltwater from the Mediterranean Sea at about 100-150 m of depth (Tuğrul et al., 2014). **AoI**: The project footprint plus a buffer of 500 m per side. **Rationale**: Water has a great diluting effect, depending on the flow rate and the dimensions of the basin (Farhadian et al., 2015). A buffer of 500 m is considered as highly precautional for the pipeline laying and even for the activities of dredging and deposition of the sediments at the temporary storage area.
Data sources	**Primary sources**: Seawater samples collected in May and June 2024 from the AoI at different depths and analyzed for chemical-physical properties. **Secondary sources**: Secondary data from scientific papers, grey literature, and databases.
Sensitivity	**High**

Methodological approach

Data to describe the regional context (i.e., RSA) were collected through literature review (references reported in 13.0), whereas the local context (i.e., AoI) was assessed by both literature review and the gathering of field data.

Regarding the seawater physical analyses, primary data were gathered in the AoI by DenAr in May and June 2024 through multiparametric probe to get the CTD (Conductivity, Temperature and Depth) profile of the water column at 40 stations, including the nearshore and FPU areas and along the pipeline corridor (**Figure 6-17**).

For the seawater chemical analyses, water samples were collected from the AoI and analyzed to be compliant to the Water Pollution Control Regulations (Official Gazette, dated 31 December 2014 No. 25687) and IFC PS3 standards. Samples were taken in May and June 2024 from 37 samples using a SBE32 Carousel Sampler (or "Rosette") and analyzed by "Febas Çevre Analiz Laboratory" accredited by Republic of Türkiye Ministry of Environment, Urbanisation and Climate Change and Turkish Accreditation Agency (**Figure 6-18**).

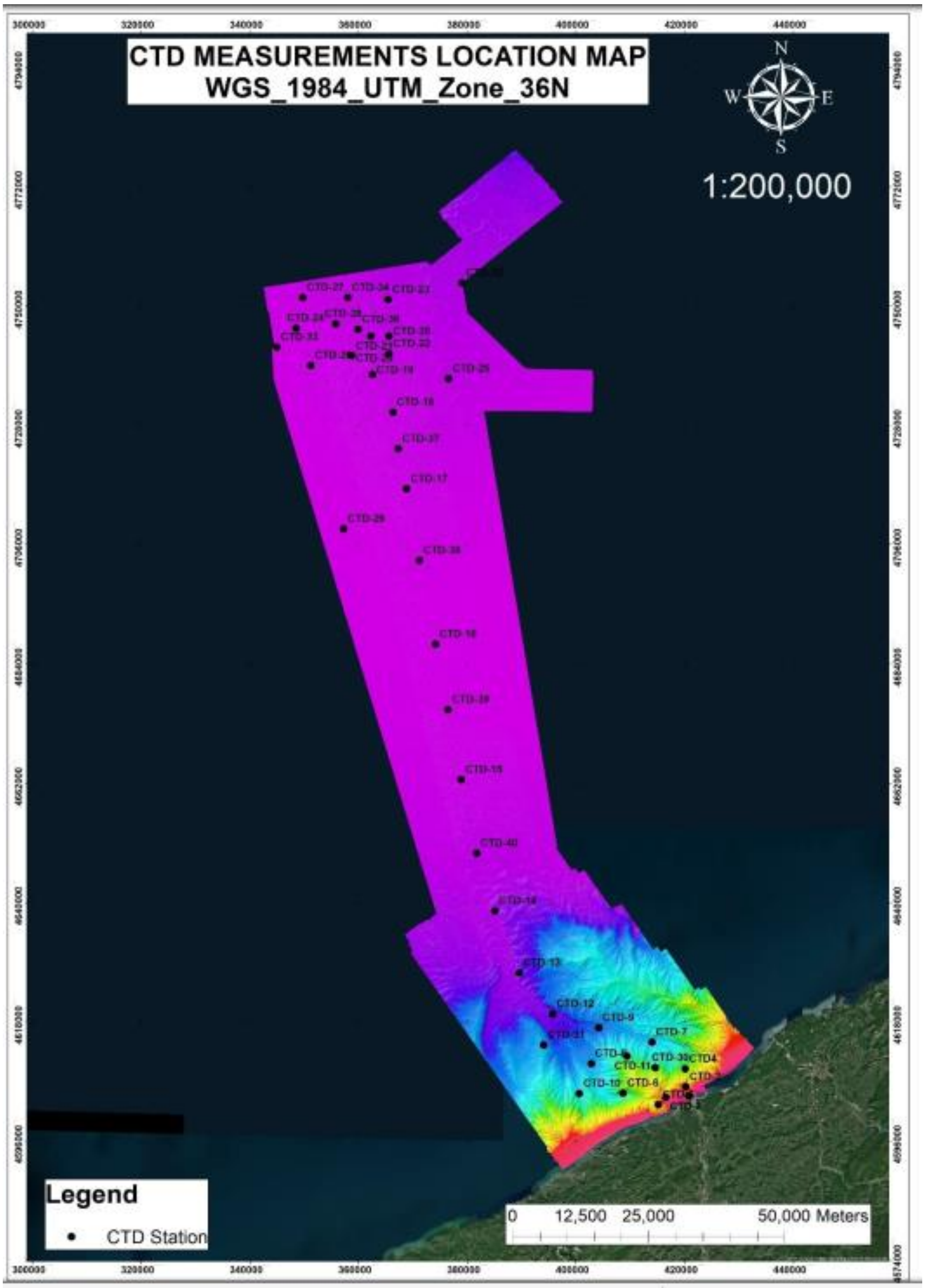


Figure 6-17: Location map of seawater physical (CTD) samples in the nearshore and offshore areas (2022 and 2023).

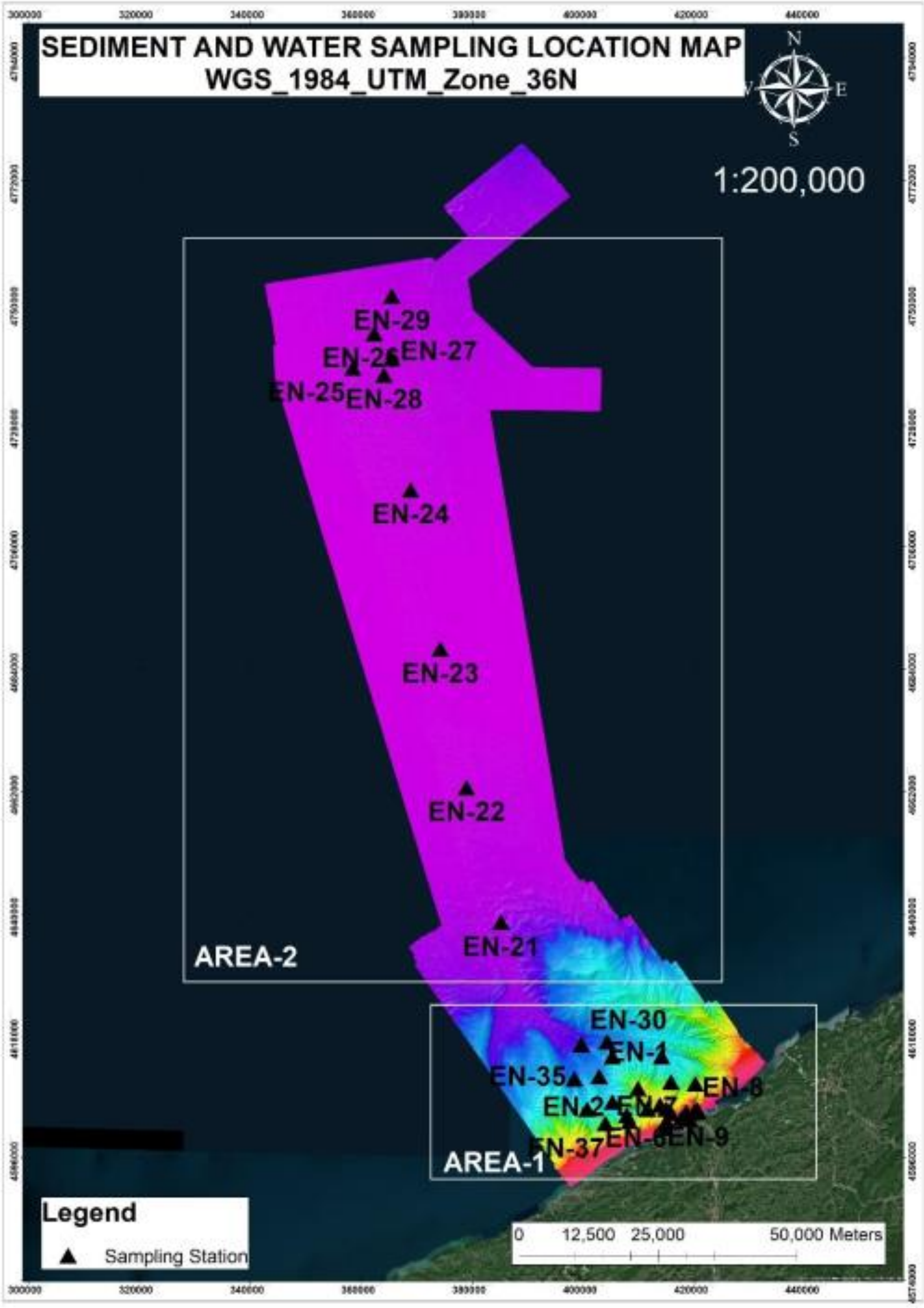


Figure 6-18: Location map of seawater samples analyzed for chemicals in the nearshore and offshore (2022 and 2023).

Regional context (RSA)

The Black Sea is characterized by four vertical water layers that do not mix, with the bottom one being the largest anoxic water body on Earth (Toderascu & Rusu, 2013). The surface layer spreads from the sea level up to 50 m depth, and it is strongly influenced by seasonal temperature variations and wind fields. The second layer represents the cold intermediate layer, whose depth stretches from 50 m up to 180 m. Below the second layer, a permanent pycnocline is present characterised by a constant temperature (between 6 °C and 8 °C) because it is not influenced by temperature changes in the upper layers (Kostianoy et al., 2008; Stanev et al., 2019). The bottom layer begins below 200 m depth and presents mostly stagnant waters with slight changes in their properties (Toderascu & Rusu, 2013). While the intermediate and deep waters present a relatively stable temperature, surface waters are subject to strong seasonal temperature variations.

The strong pycnocline and water stratification of the Black Sea is reflected in the variation of salinity among the water layers. The top layer influenced by fluvial inputs and rain presents a lower salinity (17.5 - 18.5 psu) than the bottom layer (21 - 22 psu) fed by warm salty waters from the Mediterranean Sea through the Bosporus (Shapiro, 2009; Cochran et al., 2019).

Limited exchanges of dissolved oxygen (O2) and nutrients are reported to occur between the surface and the deeper water layers because of the permanent pycnocline. As consequence, permanent anoxia characterized deeper waters, below 125 - 200 m depth (Oguz, 2008).

The absence of upwelling makes the primary production in the Black Sea dominated by nutrients inputs from precipitation during the spring-autumn period and from major rivers especially present in the Western Basin (Medinets & Medinets, 2012). Chlorophyll-a concentration may be used to measure phytoplankton biomass, distribution and seasonal and inter-annual variability. Thus, it can be used as an indirect measurement of nutrient concentration present in the sweater (Huot et al., 2007). The natural pattern of the Chlorophyll-a annual cycle in the middle latitudes of the Black Sea shows two peaks in spring and autumn (February/March, with a maximum value of 2.25 mg m-3, and October, with a maximum value of over 1.0 mg m-3) and a minimum in summer (Chu et al., 2005).

Climate change and anthropogenic actions have modified, in the last decades, the water features of the Black Sea: sulphides and nutrients in the anoxic zone have had an increase in their concentration, whereas the concentration of oxygen in the upper layer (i.e., the oxygenated layer) has decreased. These changes suggest an increase of the flux of sinking Particulate Organic Matter (POM) on the seafloor. The balance in the distribution of the nutrients that was present before the early 1970s has been modified due to intensive eutrophication (Konovalov & Murray, 2001).

Local context (AoI)

Physical Analyses

In the sections below are reported the primary data concerning the physical characteristics of the seawater within the AoI.

Temperature (Deg C) and Salinity (PSU)

Temperature and salinity of the seawater within the AoI were measured using CTD casts at 40 points. The resulting temperature and salinity profiles (data collected in May 2024 and June 2024) show as the water in the upper [0-150m] and lower layers [>150m] are well mixed. Temperature varied between 8.83 C and 21.12 C, salinity varied between 2.12 and 22.33 PSU, as shown in **Figure 6-19**. In the upper layers, average temperature and salinity values were 11.72 C and 19.10 PSU, respectively. In the lower layers, average temperature and salinity values were 8.97 C and 22.16 PSU, respectively.

According to literature, the average Black Sea surface temperature is 14.87 °C in the upper layer (0 – 300 m) and 8.99 °C in the deeper layers. Primary data are, therefore, in line with scientific literature.

Salinity in the Black Sea depends upon the balance between freshwater discharged by rivers and the water exchanged through the Bosporus. Excess of freshwater input with river runoff and precipitation over evaporation leads to a relatively low salt content compared to most seas. The salinity of the surface layer of the Black Sea (17.85 PSU) is two times less than the salinity of the World Ocean surface waters. The average within the Black Sea is 21.96 PSU in the upper layer (0-300 m) and 20.26 PSU in the deeper layers. Once again, primary data are in line with the salinity expected within the AoI.

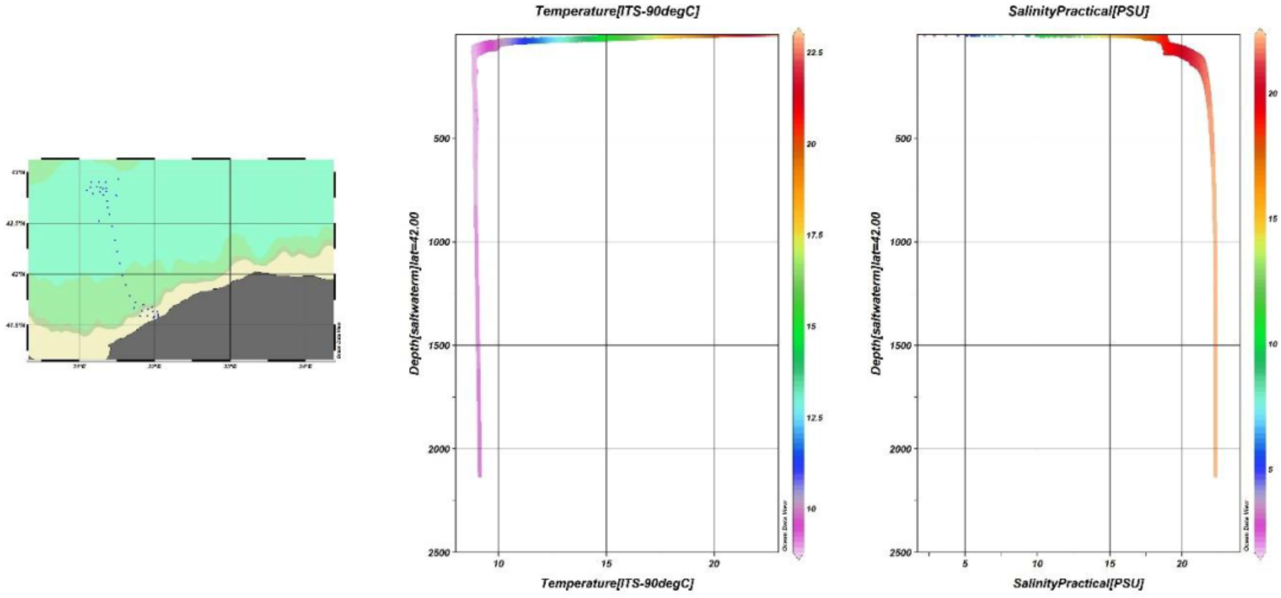


Figure 6-19: Temperature and salinity registered at all stations.

Below are reported the temperature and salinity values and their variation according to depth.

<u>Temperature</u>

- Temperature values at 0-5m vary between 15.34 – 21.12 C
- Temperature values at 20m vary between 11.40 – 16.13 C
- Temperature values at 100m vary between 8.83 – 8.97 C
- Temperature values at 500m vary between 8.90 – 8.95 C
- Temperature values at 1000m vary between 8.96 – 8.97 C
- Temperature values at 2000m is 9.10 – 9.11 C

<u>Salinity</u>

- Salinity values at 0-5m vary between 12.52 – 18.87 PSU
- Salinity values at 20m vary between 17.44 – 18.87 PSU

- Salinity values at 100m vary between 2.12 – 21.22 PSU
- Salinity values at 500m vary between 22.02 – 22.09 PSU
- Salinity values at 1000m vary between 22.28 – 22.29 PSU
- Salinity values at 2000m vary between 22.32 – 22.33 PSU

Density(kg/m³) and Conductivity(ms/cm)

Density and conductivity of seawater were measured using CTD casts at 40 points. The resulting density and conductivity profiles registered in May and June 2024 are shown in **Figure 6-20**.

Density varied between 8.15 and 17.23 kg/m^3; conductivity varied between 18.02 and 26.52 ms/cm. In the upper layer, average density and conductivity values were 14.26 kg/m^3 and 22.91 ms/cm, respectively. In the lower layers, average density and conductivity values were 17.10 kg/m^3 and 24.86 ms/cm, respectively.

The low salinity of the Black Sea leads to less dense waters compared to the Mediterranean Sea. The maximum water density in the Black Sea deep layers does not exceed 17.2 kg/m^3 while the waters of Mediterranean origin spilling through the Bosporus Strait have density 26–28 kg/m^3. Similar to density, conductivity is also directly linked to salinity; there is a nearly linear relationship between conductivity and concentration of a specific ion or salt. In both cases (density and conductivity), primary data are in line with scientific literature.

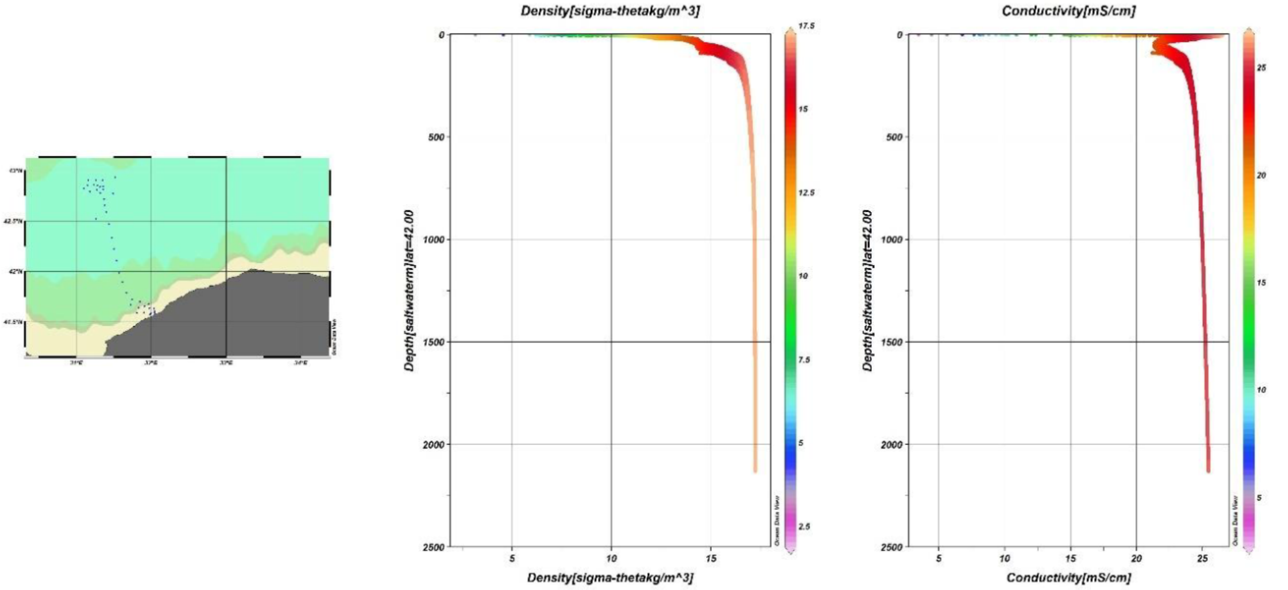


Figure 6-20: Values of density and conductivity of seawater analyzed in the AoI.

Below are reported the density and conductivity values and their variation according to depth.

Density

- Density values at 0-5m vary between 8.15 – 13.43 kg/m^3
- Density values at 20m vary between 12.26 – 14.14 kg/m^3
- Density values at 100m vary between 15.27 – 16.37 kg/m^3
- Density values at 500m vary between 17.00 – 17.05 kg/m^3

- Density values at 1000m vary between 17.19 – 17.20 kg/m^3
- Density values at 2000m vary between 17.23 kg/m^3

<u>Conductivity</u>

- Conductivity values at 0-5m vary between 18.02 – 26.52 ms/cm
- Conductivity values at 20m vary between 20.02 – 24.64 ms/cm
- Conductivity values at 100m vary between 22.18 – 23.57 ms/cm
- Conductivity values at 500m vary between 24.53 – 25.54 ms/cm
- Conductivity values at 1000m vary between 24.97 – 24.98 ms/cm
- Conductivity values at 2000m is 24.41 – 25.41 ms/cm

<u>Turbidity (NTU) and Sound velocity</u>

Turbidity and sound velocity of seawater were measured using CTD casts at 40 points (results shown **Figure 6-21**). According to the CTD data, the seawater turbidity in in the upper [0-150m] and lower layers [>150m] were between 0.62 NTU and 4.48 NTU. In the upper seawater layer, average turbidity value was 1.04 NTU while the average turbidity was 0.82 NTU in the lower layers. Sound velocity varied between 1464.42m/s and 1504.50 m/s, with an average sound velocity was 1477.26 m/s in the upper layers and 1487.12 m/s, in the lower layers.

The speed of sound in seawater is not a constant value as it depends on temperature, salinity and pressure. These physical properties have major effect on how the sound travels in seawater and as a result, the sound velocity varies seasonally, temporally and by depth. The average sound speed of the Black Sea basin is equal to 1487.0 m/s. Primary data are, therefore, in line with bibliographic data. According to scientific papers, the turbidity in the Black Sea is highly variable, mostly controlled by external processes such as rivers' discharges. Turbidity values are, therefore, dependent on the rivers' discharges.

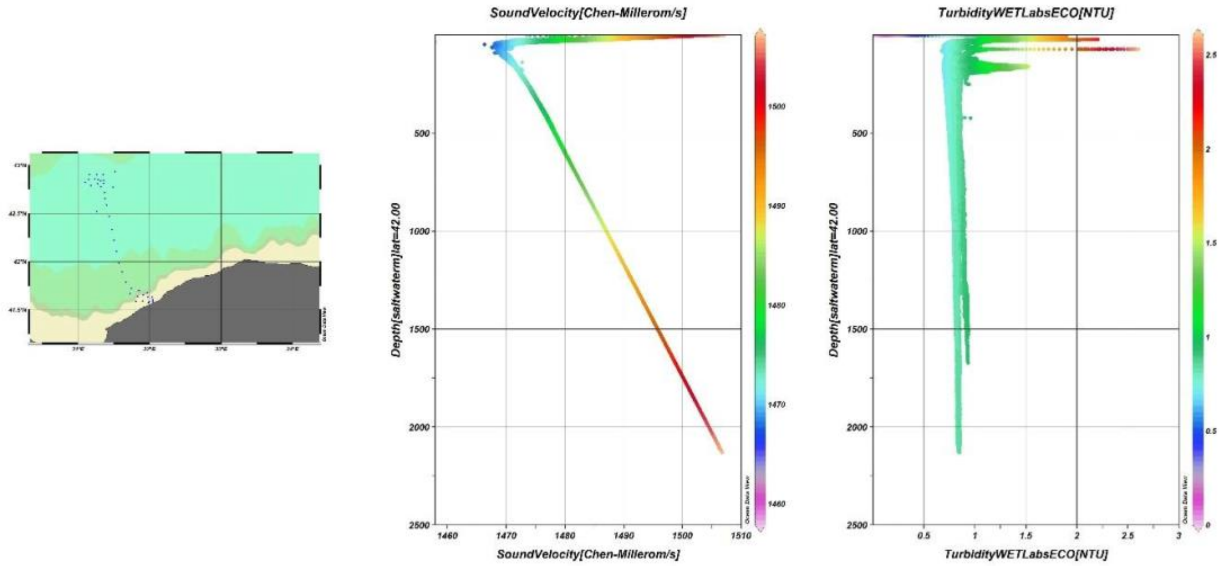


Figure 6-21: Turbidity values of the seawater analyzed in the AoI.

Below are reported the turbidity and sound velocity values and their variation according to depth.

Turbidity

- Turbidity values in 0-5m vary between 0.62 – 4.48 NTU
- Turbidity values in 20m vary between 1.04 – 1.60 NTU
- Turbidity values in 100m vary between 0.71 – 0.95 NTU
- Turbidity values in 500m vary between 0.74 – 0.86 NTU
- Turbidity values in 1000m vary between 0.79 – 0.90 NTU
- Turbidity values in 2000m vary between 0.82 – 0.85 NTU

Sound velocity

- Sound Velocity values at 0-5m vary between 1470.99 – 1504.24 m/s
- Sound Velocity values at 20m vary between 1475.72 – 1490.36 m/s
- Sound Velocity values at 100m vary between 1464.42 – 1470.34 m/s
- Sound Velocity values in 500m vary between 1478.23 – 1478.40 m/s
- Sound Velocity values in 1000m vary between 1487.03 – 1487.06 m/s
- Sound Velocity values in 2000m vary between 1504.49 – 1504.50 m/s

Chemical Analyses

In Table 6-7 is reported the primary data concerning the chemical characteristics of the seawater within the AoI, including possible presence of contaminants and their concentrations.

Table 6-7: Chemical characteristics of the seawater analyzed in the AoI for the 37 samples collected between 0 and 2,000 m depth.

Parameter	Unit	EN-1	EN-2	EN-3	EN-4	EN-5	EN-6	EN-7	EN-8	EN-9	EN- 10	EN- 11	EN- 12	EN- 13	EN- 14	EN- 15	EN- 16	EN- 17	EN- 18	EN- 19	EN- 20
ph		7.07	7.21	7.98	7.30	7.60	7.25	8.38	8.44	8.30	8.34	8.02	7.36	8.02	8.25	7.21	7.60	8.10	7.28	8.02	7.41
Dissolved Oxygen	mg/L O2	8.00	8.14	8.80	7.91	8.16	8.11	8.93	8.82	7.95	7.89	8.02	8.98	8.15	8.25	8.23	8.34	8.10	8.51	7.00	8.12
Color	Pt-Co	<5	<5	<5	<5	<5	<5	<5	<5	7.32	<5	9.74	<5	<5	<5	<5	<5	<5	17.26	<5	<5
Turbid	NTU	1.28	0.72	1.34	0.74	0.28	0.19	0.56	0.42	0.64	0.31	3.83	1.04	1.04	0.37	3.35	1.30	0.42	0.78	1.84	0.05
Floating Matter		not detected	not detected	not detected	not detected	not detected	not detected	not detected	not detected	not detected	not detected	not detected	not detected	not detected	not detected	not detected	not detected	not detected	not detected	not detected	not detected
Suspended Solid	mg/L	<2	<2	2.00	<2	<2	<2	<2	<2	<2	<2	<2	4.30	<2	2.30	5.40	<2	<2	<2	<2	<2
Biochemical Oxygen Demand	mg/L	6.91	5.51	8.21	4.01	2.51	5.61	6.74	2.02	4.54	4.74	3.84	25.81	2.51	6.04	12.41	5.81	6.09	6.54	3.21	5.34
Crude Oil and Petroleum Derivatives	mg/L	0.01	<0.001	0.01	0	0.01	0.02	<0.001	0.00	<0.001	0.01	<0.001	<0.001	0.01	0.01	0.00	<0.001	0.00	0.00	0.00	0.00
Total Phenol	mg/L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Copper	mg/L	<1	2.11	<1	<1	1.47	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cadmium	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Chrome	mg/L	4.18	3.67	4.40	4.44	4.31	3.59	3.88	3.85	3.60	3.82	2.21	3.72	4.43	3.7	4.55	4.45	3.54	4.51	4.49	4.29
Lead	mg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Nickel	mg/L	1.16	<1	1.15	1.16	1.11	<1	2.11	2.09	1.98	2.08	14.3	<1	1.16	2.04	1.06	1.15	1.91	2.66	1.20	2.54
Zinc	mg/L	<1	<1	<1	1.03	1.54	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Mercury	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.17
Arsenic	mg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Ammonia	mg/L	0.83	0.4	0.42	0.88	0.59	<0.02	0.21	<0.02	0.36	0.17	0.28	0.39	0.82	0.09	0.99	0.93	0.09	0.05	0.82	<0.02

Parameter	Unit	EN-21	EN-22	EN-23	EN-24	EN-25	EN-26	EN-27	EN-28	EN-29	EN-30	EN-31	EN-32	EN-33	EN-34	EN-35	EN-36	EN-37
ph		7.80	7.21	7.25	7.33	7.05	8.15	7.51	7.45	8.01	8.87	8.34	8.84	8.38	8.40	7.43	8.33	8.01
Dissolved Oxygen	mg/L O2	8.50	7.13	8.52	7.13	8.20	8.45	7.26	8.70	8.19	8.87	8.10	8.84	8.78	8.88	8.10	8.14	8.19
Color	Pt-Co	<5	<5	<5	<5	<5	<5	<5	<5	17.08	<5	<5	<5	<5	<5	<5	5.89	17.08
Turbid	NTU	1.62	0.72	1.04	0.85	5.49	1.26	0.66	20.70	1.24	0.49	0.23	0.51	0.34	0.39	3.50	0.53	1.24
Floating Matter		not detected	not detected	not detected	not detected	not detected	not detected	not detected	not detected	not detected	not detected	not detected	not detected	not detected	not detected	not detected	not detected	not detected
Suspended Solid	mg/L	3.00	<2	2.80	<2	6.80	3.60	<2	7.00	<2	2.80	<2	<2	<2	<2	<2	<2	<2
Biochemical Oxygen Demand	mg/L	9.01	58.71	4.41	6.01	6.91	6.91	4.71	9.71	15.84	5.24	3.04	3.84	3.74	4.74	15.31	5.41	15.84
Crude Oil and Petroleum Derivatives	mg/L	0.00	0.00	0.00	<0.001	<0.001	0.00	0.00	<0.001	0.00	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.00
Total Phenol	mg/L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Copper	mg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cadmium	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Chromium	mg/L	4.20	4.72	4.45	4.49	4.57	4.58	4.40	4.56	4.53	3.78	3.72	3.92	3.91	3.86	4.39	3.67	4.53
Lead	mg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Nickel	mg/L	1.17	1.20	1.14	1.15	1.16	1.16	1.14	1.18	2.71	2.03	1.98	207	2.06	202	1.14	1.93	2.71
Zinc	mg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Mercury	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.12	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.12
Arsenic	mg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Ammonia	mg/L	0.83	1.63	0.60	0.83	0.81	0.83	0.84	0.74	0.09	0.18	0.05	0.80	0.18	0.15	0.82	0.20	0.09

Table 6-8 shows the threshold values for the analysed contaminants according to the Turkish regulation and the NOAA acute and chronic standards.

Table 6-8: Analysed parameters and threshold values set by the Turkish regulation and international standards.

Water Pollution Control Regulation, Table 4			NOAA Standards	
Parameter	Criteria	Notes	Acute	Chronic
pH	6-9		-	-
Colour and turbidity	Natural	It should be such that the photosynthetic activity necessary for natural aquatic life does not affect the normal value at measurement depth by more than 90%.	-	-
Floating Material	-	Floating oil, tar etc. garbage with liquids, etc. liquids, garbage, etc. solids must not be found.	-	-
Total Suspended Solids (mg/L)	30	-	-	-
Dissolved oxygen (mg/L)	More than 90% of saturation	Dissolved oxygen values should be monitored throughout the depth.	-	-
Degradable Organic Pollutants (BOD)	-	After dilution, it should not be in an amount that would jeopardize the presence of dissolved oxygen more than the value predicted above.	-	-
Crude oil and petroleum derivatives (mg/L)	0.003	The water should be evaluated separately in biota and sediment and preferably not found at all.	-	-
Radioactivity	-	The natural radioactivity types and levels of the said marine environment shall not be exceeded. Artificial radioactivity will be present at an immeasurable level.	-	-
Productivity	-	Seasonal productivity levels of the said marine environment will be maintained.	-	-
Toxicity	No toxicity	-	-	-
Phenols (mg/L)	0.001	-	5.8	0.4
Various heavy metals	-	-	-	-
Copper, (mg/L)	0.01	-	0.048	0.0031
Cadmium, (mg/L)	0.01	-	0.04	0.088
Chromium, (mg/L)	0.1	-	-	-
Lead, (mg/L)	0.1	-	0.21	0.08
Nickel, (mg/L)	0.1	-	0.074	0.0082
Zinc, (mg/L)	0.1	-	0.09	0.081
Mercury, (mg/L)	0.004	-	0.0018	0.00094
Arsenic, (mg/L)	0.1	-	0.069	0.036
Ammonia, (mg/L)	0.02	-	-	-

When examining the results of the sediment chemical analyses presented in the table above, almost all the contaminant levels are above the Limit Value set by both the Turkish regulations and the NOAA acute and chronic standards.

- pH

- Minimum value = 7.04 at EN-29 station
- Maximum value = 8.87 at EN-31 station
- Average value = 7.80

■ Dissolved Oxygen

- Minimum value = 7.00 mg/L O2 at EN-19 station
- Maximum value = 8.98 mg/L O2 at EN-12 station
- Average value V 8.22

■ Colour

- Colour values are generally below 5 in all stations, except for EN-11, EN-9, EN-37, EN-4, EN-18, EN-30, EN-23, and EN-24.
- Maximum value: 17.26 at EN-18 station

■ Turbidity

- Minimum value = 0.05 NTU at EN-20 station
- Maximum value = 20.70 NTU at EN-28 station
- Average value = 1.89

■ Floating Matter

- Floating matter was not observed in all stations

■ Suspended Solid

- Suspended solid value were generally below 2 mg/L in all stations, except for EN-3, EN-12, EN-15, EN-21, EN-23, EN-25, EN-26-EN-28, EN-29, EN-31.
- Minimum value: 17.26 mg/L at EN-29 station

■ Biochemical Oxygen Demand

- Minimum value = 2.02 mg/L at EN-8 station
- Maximum value = 58.71 mg/L at EN-22 station
- Average value = 1.89

■ Crude Oil and Petroleum Derivatives

- The station EN-6 showed the highest level at 0.02 mg/L followed by EN-1, EN-5, EN-10, EN-13 and EN-14 with concentrations of 0.01 mg/L while many other stations have levels too low to detect or extremely low.

■ Total Phenol

- Phenols were not detected in all stations.

■ Copper

- Copper values were generally <1 mg/L in all stations. The only exceptions were EN-2 and EN-5 stations with concentrations of 2.11 mg/L and 1.47 mg/L, respectively.

- Cadmium
  - Cadmium was not detected in all stations with values below 0.02 mg/L.
- Chrome
  - Minimum value = 2.21 mg/L at EN-11 station
  - Maximum value = 4.72 mg/L at EN-22 station
  - Average value = 4.11 mg/L
- Lead
  - Lead concentrations were below the detection limit (<1 mg/L) in all the analyzed stations
- Nickel
  - Minimum value = 1.11 mg/L at EN-5 station
  - Maximum value = 2.71mg/L at EN-3,0 station
  - Average value = 1.61 mg/L
- Zinc
  - Zinc concentrations were below the detection limit (<1 mg/L) in all the analyzed stations with the exceptions of 1.03 mg/L detected at EN-4 station and 1.54 mg/L at EN-5 station.
- Mercury
  - Mercury concentrations were below the detection limit (<0.05 mg/L) in all the analyzed stations with the exceptions of 0.09 mg/L detected at EN-7, 0.12 mg/L at EN-30 and 0.28 mg/L at EN-18.
- Arsenic
  - Arsenic concentrations were below the detection limit (<1 mg/L) in all the analyzed samples.
- Ammonia
  - Minimum value = 1.63 mg/L at EN-22 station
  - Maximum value = 0.05 mg/L at EN-18 station
  - Average value = of 0.54 mg/L.

Specifically, Nickel concentrations are always above the limits set by the Turkish regulation and NOAA acute and chronic standards.

Chromium and Ammonia concentrations, for which no NOAA standards are available, are above the Turkish limit in all samples except for EN – 20, with an ammonia concentration below 0.02 mg/L.

Cadmium concentrations are below the standards set by the NOAA. However, it is not possible to make a comparison with the Turkish limit values as the thresholds are below the detection limit of the instrumentation used.

Copper exceeds both the Turkish regulation and NOAA limits in 2 stations, namely EN-2 (2.11 mg/kg) and EN-5 (1.47 mg/kg) while for the remaining 35 stations is not possible to make a comparison as the thresholds are below the detection limit of the instrumentation used. Similarly, Mercury concentrations exceed both the Turkish regulation and NOAA limits in 3 stations EN- 20 (0.17 mg/L), EN-29 (0.12 mg/L) and EN-37 (0.12 mg/L) while for the remaining 34 stations is not possible to make a comparison as the thresholds are below the detection limit of the instrumentation used.

Finally, it is not possible to make a comparison between the Lead, Zinc and Arsenic detected concentration and standards as the thresholds are below the detection limit of the instrumentation used.

Sensitivity Assessment

Sensitivity features	Supported by	Sensitivity value
CTD measurements in line with the regional context AoI located mainly in open sea area with good water circulation Contaminants levels are above the Limit Value set by the Turkish regulations and NOAA	Primary data	**High**

6.3.1.4 Physical oceanography

Table 6-9: General overview of the physical oceanography component.

Definition	Physical oceanography refers to the dynamics of seawater masses at both surface and deeper layers that influence the productivity and diversity of marine ecosystems at different scales (Lévy, Franks, & Smith, 2018). Such movements are the main responsible for particle transport and pollutant dilution and dispersion throughout the oceans. Currents are underwater streams made of vertical and horizontal movements in the circulation system of the ocean waters produced by gravity, wind and water density variations (Gordon & Cenedese, 2021). Water waves are a swell or ridge in the surface of a body of water normally having an oscillatory motion and a distinct forward motion of the particles that consecutively compose it. Gravity and surface tension are the two physical mechanisms that control and maintain wave motion (Cenedese & Tricker, 2018).
Study Area	**RSA**: The Black Sea **Rationale**: A basin-wide gyre called Rim Current is present in the Black Sea and numerous eddies are present along the coastline. Eddies and the Rim Current keep interacting by merging and detaching creating a big current system in the Black Sea (Oguz et al., 1993). **AoI**: The project footprint plus a buffer of 500 m per side. **Rationale**: Water has a great diluting effect, depending on the flow rate and the dimensions of the basin (Farhadian et al., 2015). A buffer of 500 m is considered as highly precautional for the pipeline laying and even for the activities of dredging and deposition of the sediments at the temporary storage area.
Data sources	**Primary sources**: Data were gathered in the AoI by DenAr (2024) through the Acoustic Doppler Current Profiler (ADCP) to measure the sea current velocity, wave buoy and meteorology system were used to monitor waves and meteorology features of the project area. **Secondary sources**: Secondary data from scientific papers, grey literature, and databases
Sensitivity	**Medium-low**

Methodological approach

Data to describe the regional context (i.e., RSA) were collected through literature review (references reported in Chapter 13.0), whereas the local context (i.e., AoI) was assessed by both literature review and the gathering of field data.

In particular, primary data were gathered by DenAr (2024) through Acoustic Doppler Current Profiler (ADCP) to measure the sea current velocity at two stations (at about -215 and -250 m depth), both located in the AoI, as shown in **Figure 6-22**.

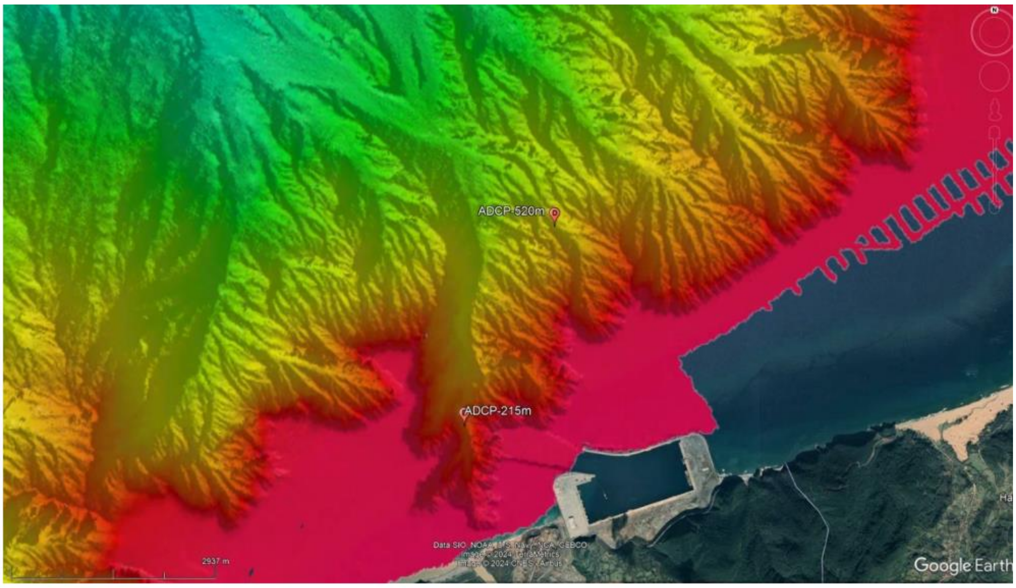


Figure 6-22: locations of the ADCP in the AoI.

Data from the ADCP were retrieved from different water layers as shown in Table 6-10.

Table 6-10: ACDP results for different water layers

Water Layer	Water Depth (m)	Water Depth (m)
	ADCP-215	**ADCP-250**
Layer-I	176-185 m	481-490
Layer-2	186-195 m	491-500
Layer-3	196-205 m	501-510
Layer-4	206-215 m	511-522

Additionally, a real-time measured wave buoy (outside the harbor) and meteorology system (inside the harbor) were used to monitor the wave and meteorology features of the project area. Both the wave boy and the meteorological system locations are reported in **Figure 6-23**. Further details are reported in DenAr (2024).

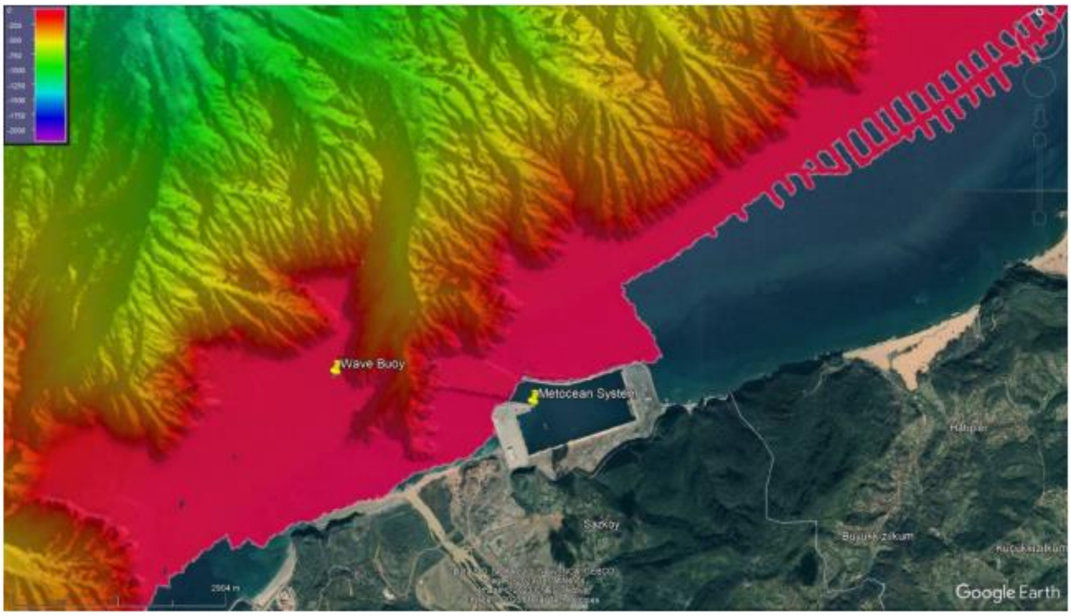


Figure 6-23: locations of the wave sensors and meteorology system in the AoI.

Data retrieved from the wave sensors and meteorology system are reported in detail in Table **6**-11.

Table 6**-11: location, data and time period of gathered data.**

Used sensor	Gathered data	Time period
Metocean Sytem Log_aLevel Location: inside the harbor	Wind Speed/Direction Air Pressure Air Temperature Relative Humidity Water Level Significant Wave Height	September 2022-July 2024
Wave Buoy Wave Rider Location: outside the harbor	Significant Wave Height	April 2021 – July 2024

Regional context (RSA)

According to scientific data, the Black Sea is characterized by the presence of a permanent cyclonic coastal current referred to as the Rim Current (RC; Figure 6 29, a; Shapiro 2009; Kershaw & Liu, 2015). The RC flows across the entire basin along the shoreline at depths like the continental slope. The average RC speed is 0.2 ms−1 at the surface and rarely exceeds 1 ms-1, with a width of 40–70 km (Oguz et al., 1993; Toderascu & Rusu, 2013).

Traditionally, the cyclonic wind pattern has been recognized as the primary driver of cyclonic surface circulation. The surface water movement is driven by westward-moving winds from the Caucasus Mountains in the northeast, to produce an anticlockwise RC (Zatsepin et al., 2007, 2011; Kershaw & Liu 2015). However, data suggests that the seasonal thermohaline, together with water masses of diverse density due to river runoff, can enhance the effects of wind-driven circulation (Ozer et al., 2022). The low-salinity surface waters, which are formed over the northwest shelf due to intense river discharge, travel with the RC and reach the Anatolian coast where their properties changes (i.e., higher salinity) due to the layer mixing.

Several anticyclonic eddies are formed between the RC and the coast and in the central area of the Black Sea. While the three major anticyclonic gyres exist as permanent features in the central basin, minor eddies develop seasonally across the Black Sea and are unstable (Korotenko, 2017). In general, small coastal anticyclonic eddies forms during warm seasons and they have a short life span (few weeks) compared to larger anticyclonic eddies (Shapiro, 2009; Oguz et al., 1993).

Figure 6-24 shows the Black Sea major current (i.e. RC) together with major and minor gyres.

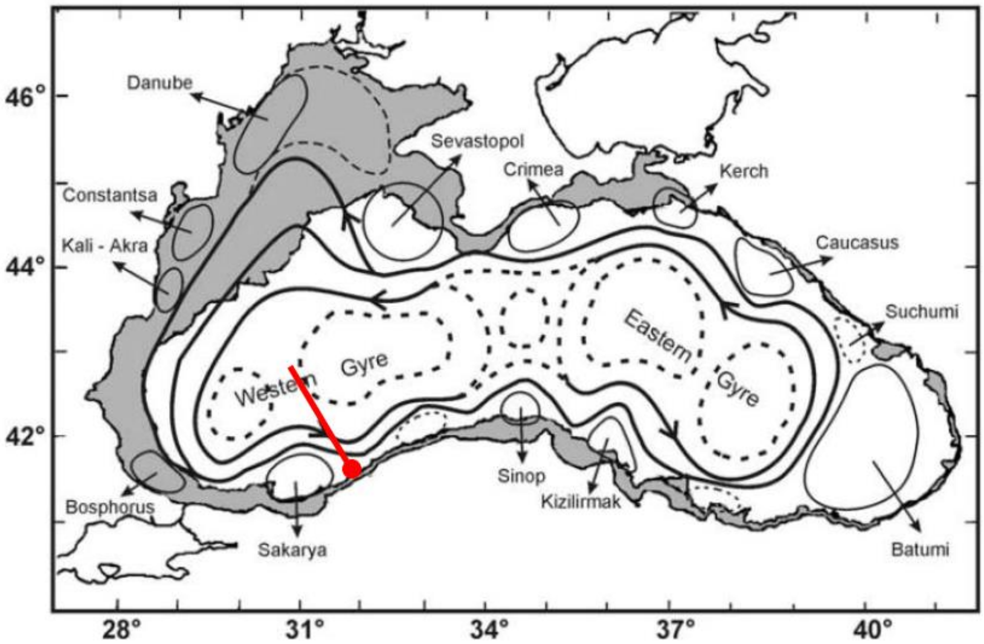


Figure 6-24: The Black Sea circulation (source: Korotaev et al., 2003). The red dot and line indicate the Project location.

Permanent or quasi-permanent eddies are shown as solid lines, whereas recurrent are drawn as dashed lines. For instance, the Bosphorus eddy is observed on the average for 260 days per year, whereas the chain of eddies present along the Anatolian coast have more an on-and-off character and slowly travel to the east along the coast. The Sakarya, Sinop and Kizilirmak eddies tend to exhibit more quasi-permanent character due to controls exerted by regional topographies (see 6.2.1.4 and 6.3.1.1) (Korotaev et al., 2003).

A more in-depth map (see **Figure 6-25**) of the Black Sea circulation that includes both RC and eddies directions was developed by Staneva et al. (2001) using the DieCAST Ocean Circulation Model (Sheng et al., 1998). Such model allows for identifying zones of sea level variations, highlighting potential areas of upwelling (warm colours in the map) and downwelling (cold colours in the map).

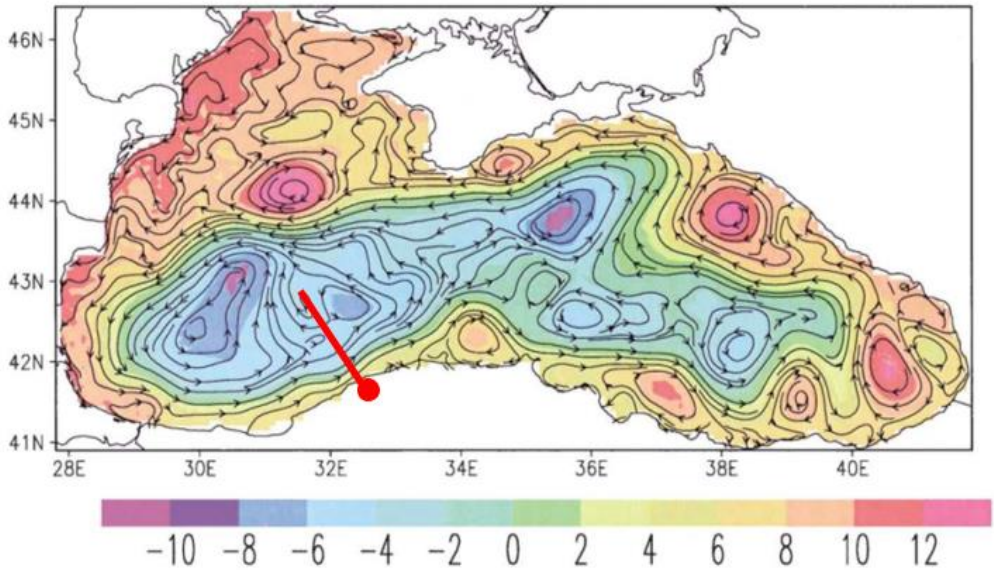


Figure 6-25: DieCAST Ocean Circulation Model of the Black Sea circulation (source: Staneva et al., 2001). The coloured scale indicates the sea level variations in cm, whereas the red dot indicates the Project location.

Beside the sea currents, wave dynamics in the Black Sea are generally determined by two processes:

The propagation of Atlantic cyclones over the Black Sea that result in strong waves in the northeastern part of the sea; and

The propagation of anticyclones with their centre in Eastern Europe that cause waves in the south-western regions of the sea, which encompasses the project location.

Two types of ocean waves can be identified at the ocean surface: wind sea and swell. During the generation and growing processes, they are identified as wind sea. They are instead called swell when the waves propagate away from their area of generation or when their phase speed overcomes the overlaying wind speed. The wind seas are generated locally and are strongly coupled to local winds. Unlike the wind seas swell, waves are generated remotely and are not directly coupled to the local wind field as they travel long distances across the globe (Semedo et al., 2011).

Spatial distribution of the maximum waves in the Black Sea indicates that favourable conditions for developing extreme wave heights of about 12 m may occur. According to models developed by Divinsky et al. (2020) probable real maximum waves could be as high as 19 m. Those extreme conditions follow different seasonal patterns in three distinct regions inside the Black Sea (Divinsky et al., 2020).

1) In the southwestern part of the sea, where the project is located, the extreme events occur usually in December and January.

2) In the southern coast of the Crimea Peninsula, extreme events are most likely to occur in February.

3) In the northeastern part of the sea, extreme events could occur in November.

The southeastern and far eastern parts of the sea are mostly subjected to strong swell, while July and August are calmest months in the entire Black Sea (Divinsky et al., 2020).

Tides in the Black Sea are semidiurnal (i.e., having two high waters and two low waters each lunar day, with little or no diurnal inequality) and they are classified as microtidal. In fact, diurnal and semidiurnal tides are nearly nonexistent in the Black Sea (Tides of the Black Sea mirplaneta.com). Offshore the water level of the Black Sea is subject to seasonal fluctuations averaging about 20 cm (Shapiro, 2009). For these reasons, tides may be considered as negligible in the Black Sea.

Local context (AoI)

Current Velocity

According to the Black Sea Sailing Directions and to scientific papers (Filippov, 1964; Blatov et al., 1980, 1984), there are three major regions with different regimes of currents: (i) a coastal zone with variable flow and current speeds of up to 20 – 30 cm/s, (ii) the Main Black Sea Current zone, which has jet-stream character, with width of 40 – 80 km and current speed of 40 – 50 cm/s, reaching values of 1–1.5 m/s, and (iii) the open sea area, where the current velocity decreases gradually from the periphery to the centre, not exceeding 5 – 15 cm/s (Ivanov and Belokopytov.2013).

Wind cyclonic rotation and river runoff have traditionally been considered the main cause of the Black Sea circulation (Ivanov and Belokopytov, 2013). In most of the studies which made such assessments, it is stated that the effect of wind is the main cause of the observed circulation pattern (Sarkisian, Dzhioyev, 1974; Dzhioyev, Sarkisian, 1976; Moskalenko, 1975; Marchuk et al, 1975; Stanev et al., 1988; Stanev, 1990, 2005; Oguz, Malanotte-Rizzoli, 1995, 1996; Korotayev, 2001; Korotaev et al., 2003). In addition to generating wind-driven currents in the surface layer of the sea, wind energy is spent to increase the available potential energy, which is converted into kinetic energy of cyclonic movement throughout the water column, including the deep layers (Ivanov and Belokopytov, 2013).

For the analysis of the current velocity within the AoI, as described in the methodology section, 4 water layers have been analysed at two sampling stations using an Acoustic Doppler Current Profiler (ADCP).

The maximum and average current velocities and prevailing current directions are reported for each layer.

For ADCP-215:

- Layer-1 (176-185 m): 3.41 cm/s
- Layer-2 (186-195 m): 3.28 cm/s
- Layer-3 (196-205 m): 2.94 cm/s
- Layer-4 (206-215 m): 2.78 cm/s

For ADCP-520:

- Layer-1 (481-490 m): 2.22 cm/s
- Layer-2 (491-500 m): 1.81 cm/s

- Layer-3 (501-510 m): 1.79 cm/s
- Layer-4 (511-520 m): 1.86 cm/s

Table 6-12 and Table 6-13 show the maximum and average current velocity detected at different water depths together with the prevailing current direction. The maximum current velocity (i.e., 7.83 and 7.15 cm/sec) was detected in the upper layers in April 2024. Generally, the deeper layers (< 500 m depth) present a current characterized by a lower velocity with a maximum speed of 5.89 cm/sec and an average speed of 1.55 cm/sec.

Table 6-12: ADCP- 215 m Down-Looking Buoy Mounted ADCP Results

Months	Depth range	Maximum current velocity (cm/sec)	Prevailing current direction	Average current velocity (cm/sec)
April 2024	176-185 m	7.83	SSE	2.44
	186-195 m	7.15	SE	2.30
	196-205 m	6.33	E	1.85
	206-215 m	4.78	NE	1.88

Table 6-13: ADCP- 250 m Down-Looking Buoy Mounted ADCP Results

Months	Depth range	Maximum current velocity (cm/sec)	Prevailing current direction	Average current velocity (cm/sec)
April 2024	481-490	5.89	SE	1.93
	491-500 m	5.72	SSE	1.46
	501-510	6.37	ESE	1.61
	511-520	5.25	E	1.56
May 2024	481-490	4.83	SSE	1.96
	491-500 m	4.53	SE	1.55
	501-510	5.00	SSW	1.55
	511-520	4.44	WSW	1.27

The prevailing current in terms of velocity (i.e., flow rate) is the one directed sud-sudeastwards in both stations (when considering May 2024 for ADCP -250m) and east-sudeastwards in station ADCP -250m in April 2024.

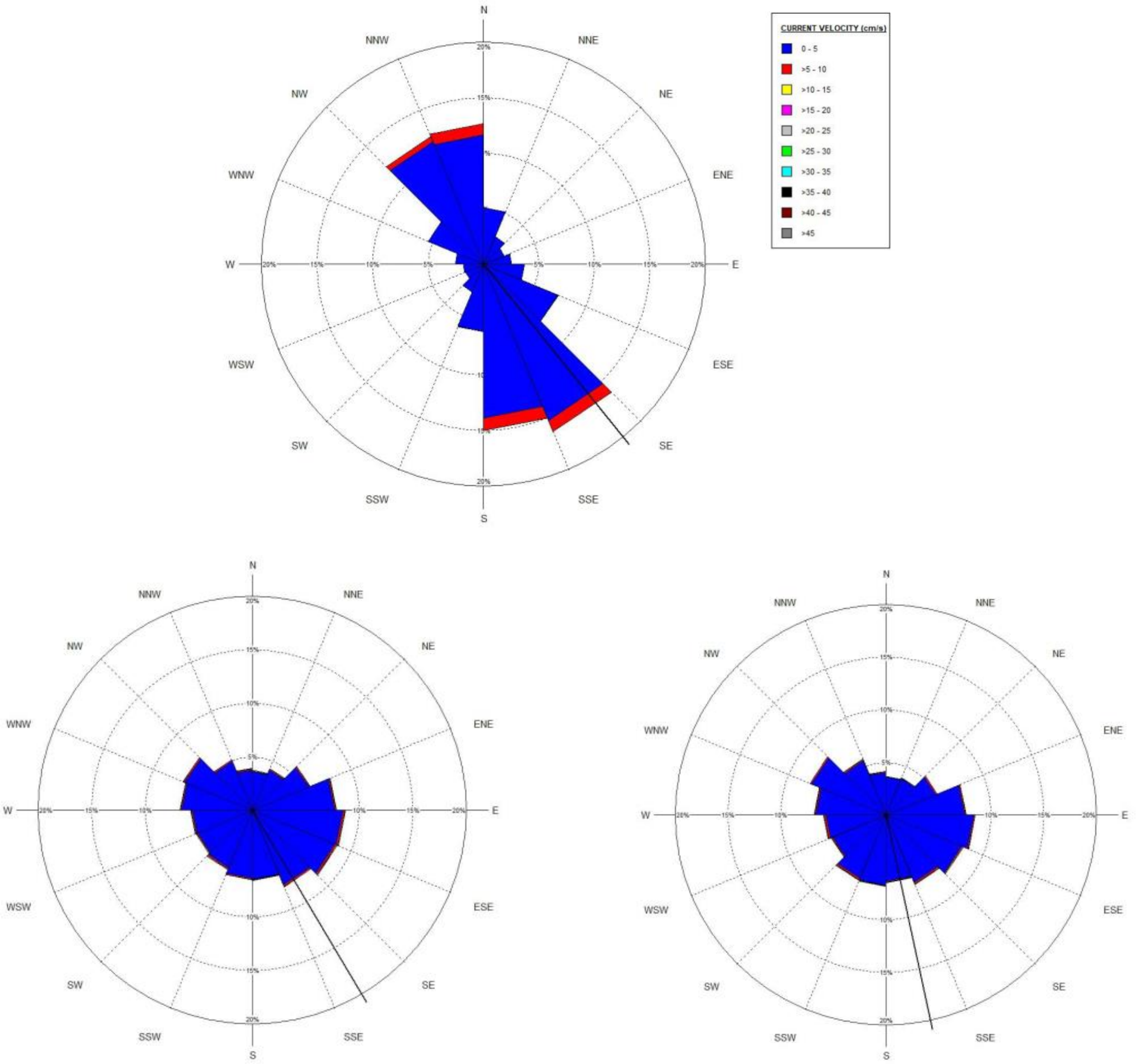


Figure 6-26: Top image - Current Polar Graph for ADCP-215m (April 2024), bottom images - Current Polar Graph for ADCP-520m in April 2024 (left) and May 2024 (right).

Real-time measured wave buoy (outside the harbor) and meteorology system (inside the harbour) were successfully installed at locations in Aoi in order to monitor waves and meteorology of the project area.

Results of Waverider Buoy show as the majority of the wave's height in the AoI is comprised between 0.3 and 1.4 m and the current velocity nearshore rarely exceed 0.75 m/sec.

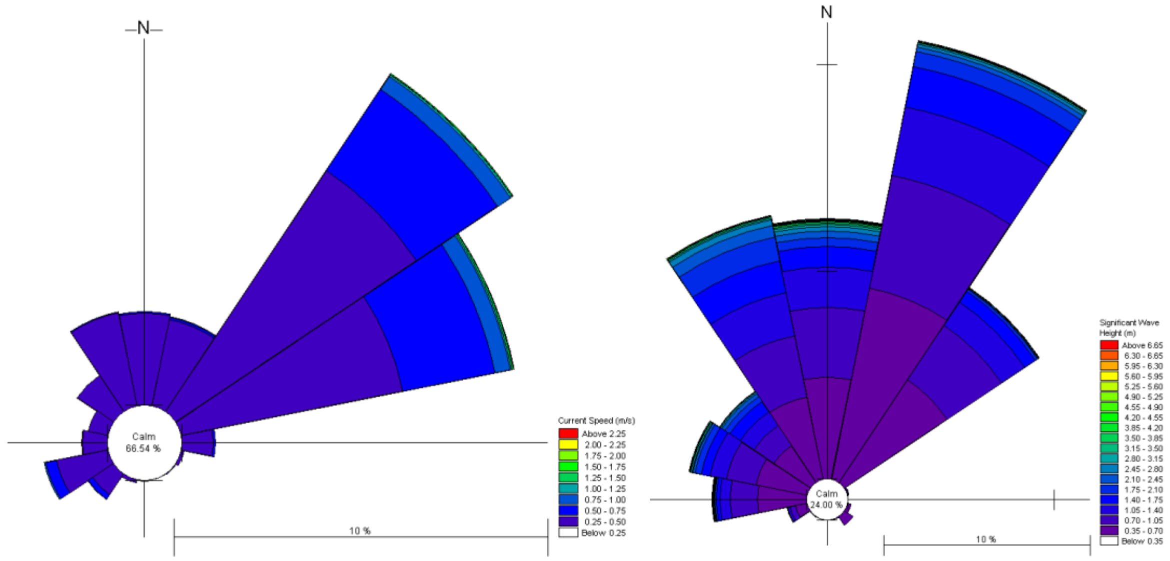


Figure 6-27: on the left - wave rose (April 2021 – July 2024); on the right – current velocity rose (April 2021 – July 2024).

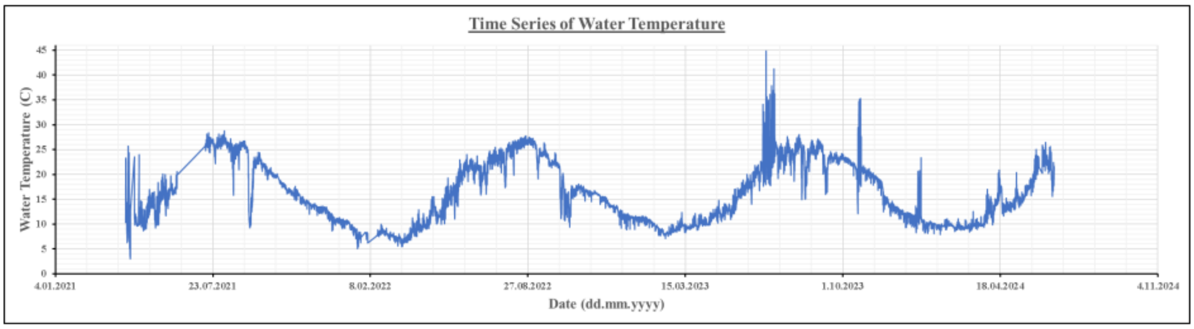


Figure 6-28: Time series of Water Temperature (April 2021 – July 2024).

Table 6-14: Maximum, minimum and average wave heigh, current speed and water temperature measured in the AoI between April 2021 and July 2024.

	Hs (m)	Current Speed (m/s)	Water Temperature ('C)
Minimum	6.780	2.047	44.840
Maximum	0.010	0.001	3.020
Average	0.772	0.223	16.064
Standard Deviation	0.594	0.163	5.971
Mode	0.280	0.140	9.740
Median	0.600	0.185	15.030

<u>Results of Metocean Data</u>

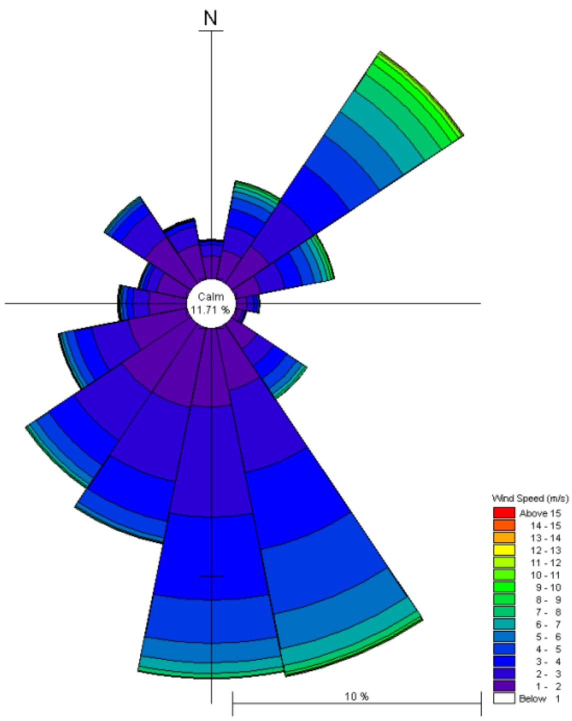


Figure 6-29: Wind Speed Rose (September 2022 – July 2024).

The wind speed within the AoI never exceeded 12-13 m/sec. Prevailing wind direction is Northeastwards and south-Southeastwards. Regarding the water level, the highest value was recorded in January 2024 (about 2 m).

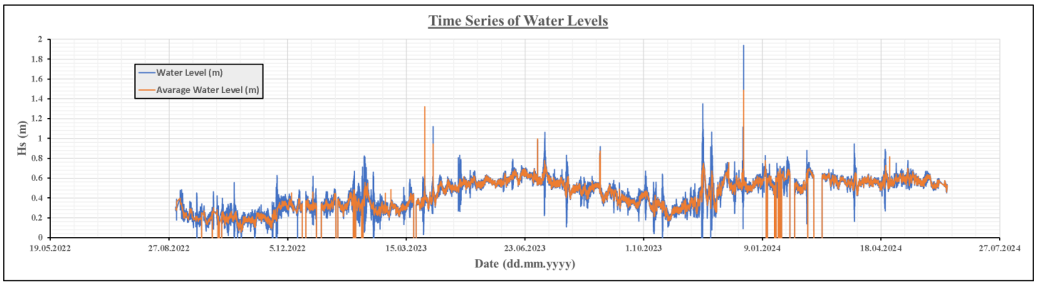


Figure 6-30: Time series of water level measured from September 2022 to July 2024.

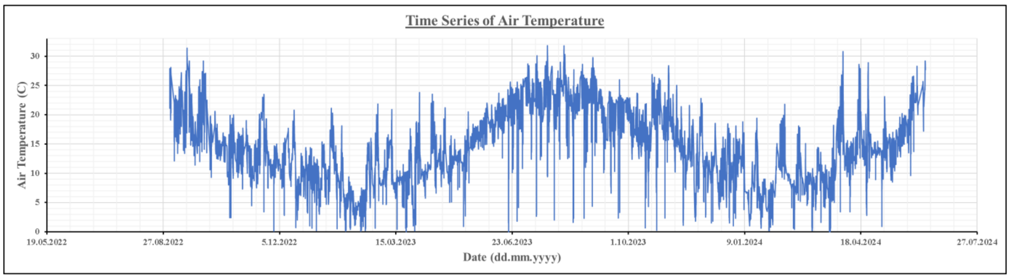


Figure 6-31: Time series of air temperature from September 2022 to July 2024.

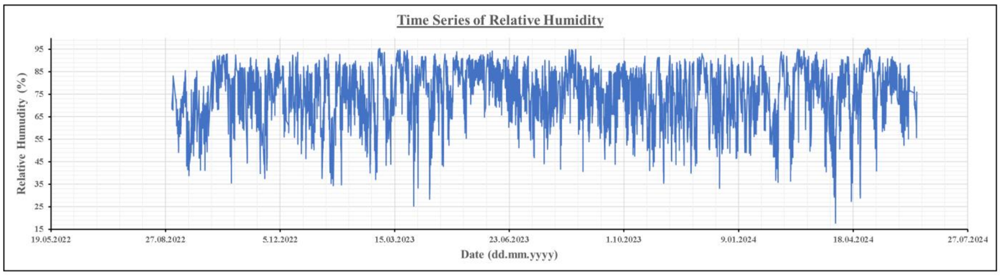


Figure 6-32: Time series of relative humidity from September 2022 to July 2024.

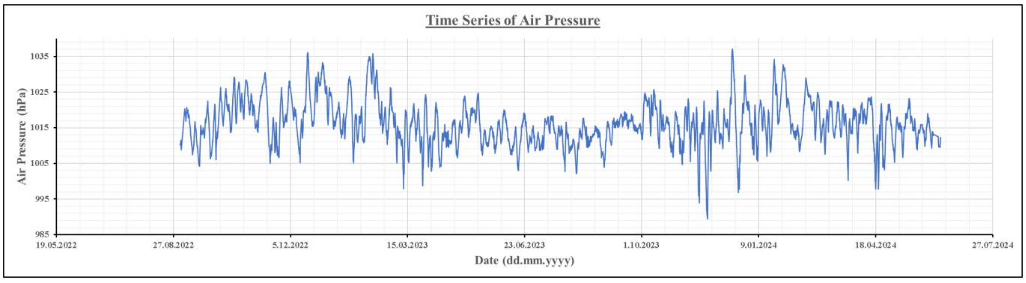


Figure 6-33: Time series of air pressure from September 2022 to July 2024.

Metocean Data Statistic (September 2022 – July 2024).

	Water Level	Significant Wave Height	Average Water Level	Air Temperature	Relative Humidity	Air Pressure	Wind Velocity
Minimum	-7.695	0.000	-7.687	0.000	17.720	989.400	0.000
Maximum	1.925	10.988	1.476	31.800	95.450	1.037.100	15.300
Average	0.209	0.054	0.209	16.008	73.680	1.016.039	2.769
Standard Deviation	1.210	0.115	1.212	6.042	12.321	5.906	1.830
Mode	0.553	0.015	0.563	13.600	85.790	1.014.500	1.500
Median	0.447	0.032	0.450	15.600	74.990	1.015.800	2.300

Sensitivity Assessment

Sensitivity features	Supported by	Sensitivity value
Absence of local upwelling phenomena Low probability of extreme wave events	Primary and secondary data	**Medium-low**

6.3.1.5 Underwater noise

Table 6-15: General overview of the underwater noise component.

Definition	In acoustics, the term "sound" is usually referred to as the acoustic energy radiated from a vibrating object, with no reference for its function or potential effect, whereas "noise" is usually referred to as the acoustic emission causing specifically described adverse effects (Southall et al., 2009) or technical distinctions (i.e., ambient noise). Sounds are omnipresent in the underwater environment and can be produced by both natural and anthropogenic sources (OSPAR, 2015).
Study Area	**RSA**: Turkish EEZ of the Black Sea. **Rationale**: The majority of maritime routes intersect with the Turkish Exclusive Economic Zone (EEZ), particularly within Turkish territorial waters, as the Bosphorus Strait is the sole passage to and from the Mediterranean Sea **AoI**: The project footprint with a buffer of 10 km on both sides. **Rationale**: Sound speed in the seawater is approximately 1,500 m/s (Pierce, 1989), proportionally increasing with pressure, temperature and salinity and density (Mackenzie, 1981). Any alteration of the ambient acoustics can be detected up to several km far, depending on the sound level emitted by the source (Urick, 1979). A buffer of 10 km is considered as highly precautional for any kind of manmade underwater sound emission.
Data sources	**Primary sources**: Data were gathered in the AoI by DenAr (2024) about the presence of marine mammals in the area. **Secondary sources**: Secondary data from scientific papers, grey literature, and databases.
Sensitivity	**Medium-high**

Methodological approach

Data to describe both the regional context (i.e., RSA) and the local context (i.e., AoI) were collected through literature review (references reported in Chapter 13.0 of the present ESIA).

Regional context (RSA)

Numerous offshore natural physical and biological factors influence sound sources. Key physical factors contributing to underwater ambient noise include wind, breaking waves, raindrop splashes, lightning, and sounds produced by marine fauna and wave interactions (TNO, 2009), while biological sources are primarily associated with the underwater communication of marine fauna and the echolocation of cetaceans (Southall & Nowacek, 2009).

Human activities such as shipping, military operations, construction, and oil and gas extraction increase underwater sound sources in areas where natural sounds would typically dominate, leading to growing concerns about the potential negative impacts of anthropogenic underwater noise on marine life, as behaviors like foraging, migration, and reproduction could be disrupted (Southall et al., 2009).

The typical sound levels of ocean background acoustics at different frequencies as measured by Wenz (1962), also, also referred to as the Wenz curves, are shown in **Figure 6-34**.

In offshore environments, wind-generated wave noise is typically predominant. In the absence of anthropogenic noise sources, this environmental noise can be recorded at frequencies ranging from 1 Hz to 100 kHz. Sound levels may however vary depending on the source; for instance, rain can increase environmental noise by up to 35 dB within the 100 Hz to 20 kHz frequency range (Wenz, 1962).

Due to the presence of the Bosphorus strait, the RSA is crossed by several maritime routes, navigating back and forth the Mediterranean Sea, highly contributing to the underwater ambient noise of the area.

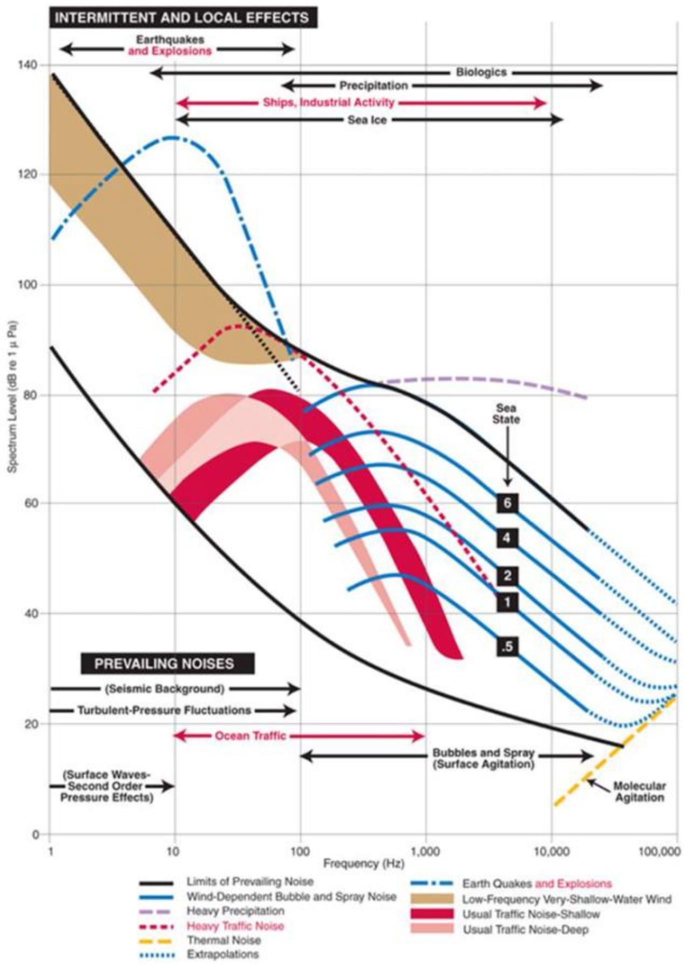


Figure 6-34: Wenz curves, showing prevailing ocean noises and sounds (source: dosits.org).

It should be noted that the United Nations Convention on the Law of the Sea (UNCLOS) includes the introduction of energy (including sound) into the marine environment under the definition of pollution in Article 1 (4). The whole Black Sea and consequently the AoI is under the ACCOBAMS (Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Area) that is a regional international treaty that binds its States Parties on the conservation of Cetacea in their territories. The agreement has been ratified by Türkiye that has been party of the agreement since 2018.

Local context (AoI)

No specific information on underwater acoustics is available for the AoI. However, based on known baseline conditions previously mentioned, some considerations can be made. Apart from natural physical sources due to weather and oceanography, the underwater acoustics of the AoI may be primarily influenced by anthropogenic (i.e., marine traffic) and natural biological sources (i.e., marine fauna).

The AoI is crossed by several maritime routes, some of which follow the AoI for its whole length (see **Figure 6-35**), being probably the working vessels of the Sakarya Gas Field.

The outermost part of the project area is characterized by a higher number of routes, with over 1200 routes per square kilometre per year. Conversely the near-shore portion of the project area appears to be characterized by a lower number of routes, ranging between 0 and 60 routes per square kilometre per year (see **Figure 6-35**).

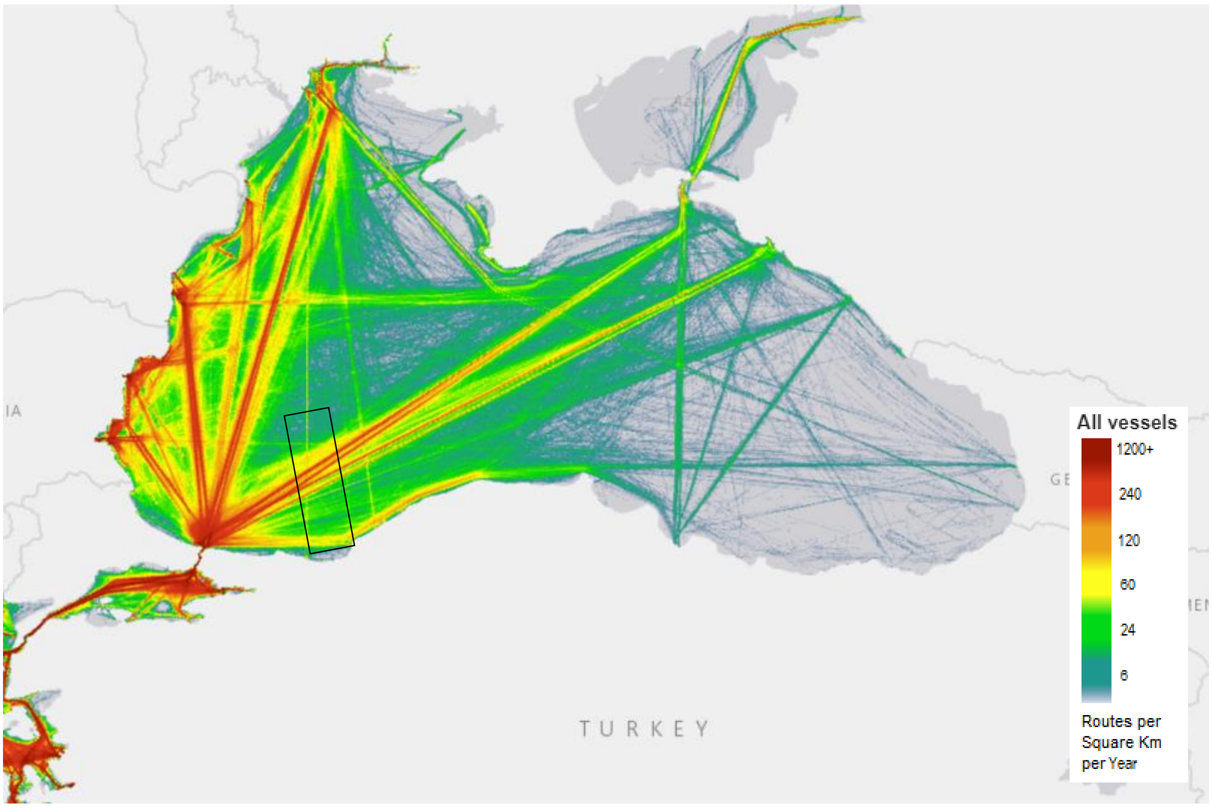


Figure 6-35: Maritime routes in the Black Sea (source: emodnet.com) from 2019 to 2023. The black rectangle indicates the routes most likely to be linked to the development of the Sakarya Gas Field (Phase 2).

Maritime traffic is a low-frequency source of sound (< 300 Hz). Large commercial vessels generally produce relatively loud, low frequency sounds. Main noise sources include propellers cavitation, vibration of engines and related facilities and water displacement caused by the moving hull. The source noise levels may range 180 dB to 195 dB re 1 µPa at 1 m with peak levels in the 10 Hz - 50 Hz frequency band. At frequencies lower than 200

Hz, the propeller systems mostly contribute to the underwater noise. Large cargo vessels may emit high frequency sounds with sound levels over 150 dB re 1 µPa at 1 m around 30 Hz.

Additional noise sources may be generated by on-board equipment (e.g., equipment in the machine room or auxiliary systems) and the hydrodynamic flow around the vessel hull. Noise also increases with an increase in the vessel speed and the sound pressure levels depend on the vessel propeller system (McKenna et al., 2013).

Biological sources of underwater sounds are mainly linked to marine animals, particularly cetaceans. Cetaceans produce in fact sounds for communication, orientation, and navigation purposes. These sounds may range from a low frequency value of about 10 kHz of some whales, absent in the Black Sea, to a high frequency value of over 100 kHz for some dolphins.

According to both primary and secondary data, the AoI hosts three subspecies of cetaceans, namely the Black Sea common dolphin (Delphinus delphis ponticus), the Black Sea Harbour Porpoise (Phocoena phocoena relicta) and the Black Sea bottlenose dolphin (Tursiops truncatus ponticus).

Delphinids generate both tonal whistles and echolocation clicks. Clicks have frequencies ranging from 30 to 100 kHz (Norris, 1969; Au, 1993), with durations of approximately 80 µs for LF clicks and around 60 µs for train clicks, with an inter-click interval of 80 ms (Buscaino et al., 2015).

Whistle frequencies can range from 2 to 30 kHz (Gannier et al., 2010; Azzolin et al., 2014). The Black Sea common dolphin's whistle frequencies vary between 1.6 and 33.2 kHz, with durations ranging from 0.16 to 2.94 seconds (Panova et al., 2020), while bottlenose dolphin whistle frequencies range from 0.8 to 24 kHz, with durations varying between 0.09 and 2.75 seconds (Azzolin et al., 2014).

Harbour porpoises are non-whistling toothed whales that emit directional, narrowband, high-frequency (NBHF) echolocation clicks. These NBHF signals, characteristic of the Phocoenidae family, span from 0 Hz to 150 kHz (Verboom and Kastellein, 1995) and typically last around 100 µs (ranging from 75 to 150 µs). The inter-click intervals vary between 20 and 80 ms, reducing to as low as 2 ms during feeding.

All three subspecies were observed during a visual monitoring campaign carried out between June 13 to June 16, 2024. Furthermore, during a passive acoustic monitoring campaign conducted from June 13 to June 17, 2024, within the study area's boundaries, cetacean acoustic activity was detected, although in only one out of seven the recorded stations.

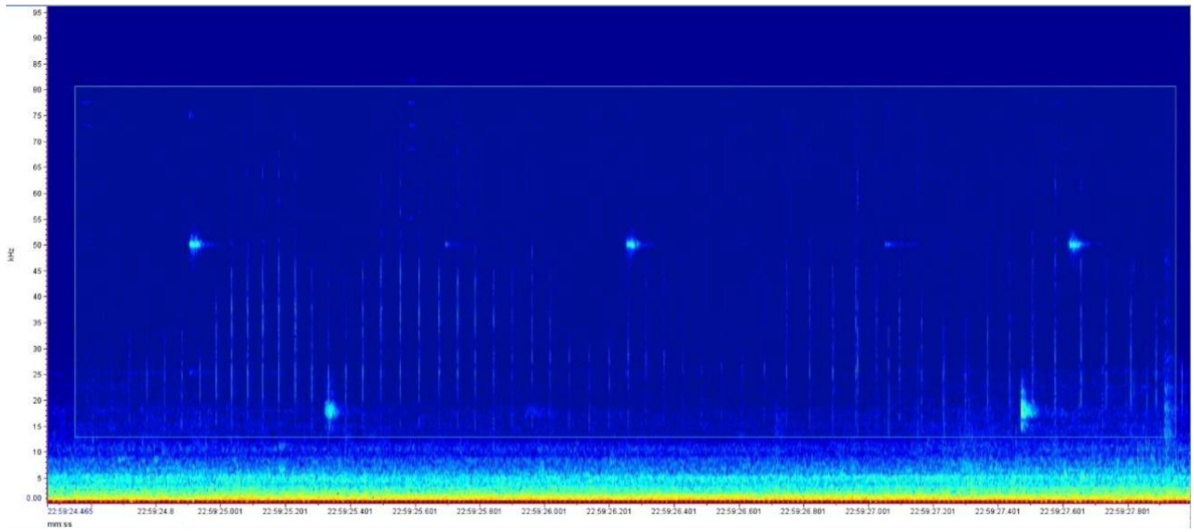


Figure 6-36: Click sequence with 40 to 70 ms interclick interval.

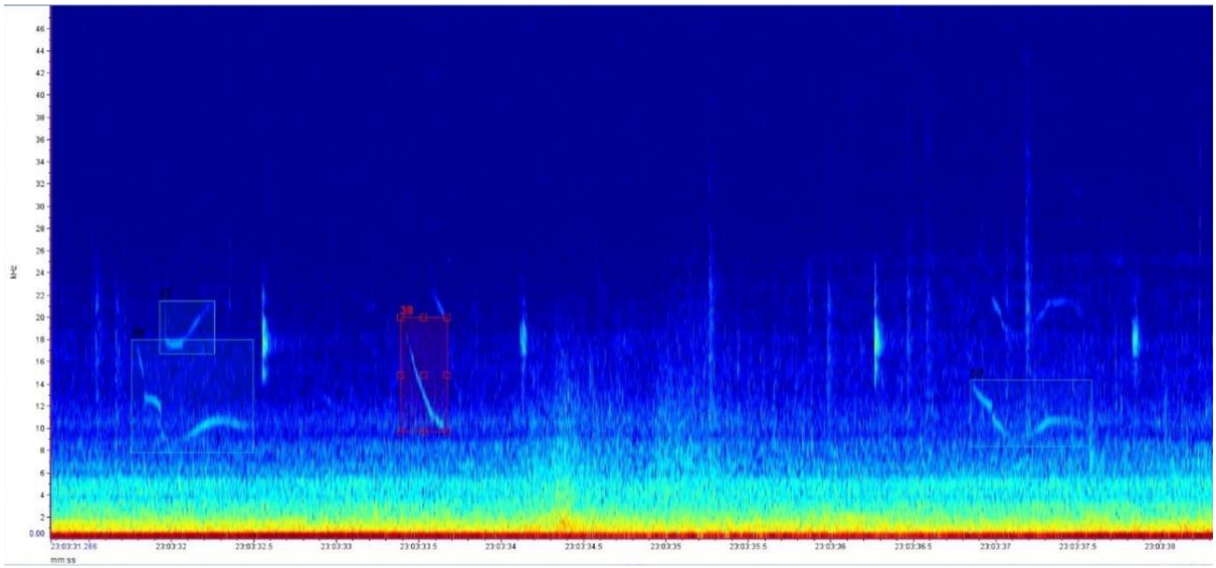


Figure 6-37: spectrogram of the observed whistles.

Based on the above, it is possible to assume that the underwater ambient noise of the AoI may be currently dominated by low frequency anthropogenic noises generated by vessels and high to very high frequency biological vocalizations.

Sensitivity Assessment

Sensitivity features	Supported by	Sensitivity value
Presence of cetaceans High number of maritime routes (primarily in the outermost part of the project area)	Primary and secondary data	**Medium-High**

6.3.2 Biological Environment

This section describes the offshore biological environment, including the components not considered to be affected by the project as evaluated in Chapter 5 (ESIA Methodology). Such components are the following:

Plankton (phyto- and zooplankton);

- Benthic communities (phyto- and zoobenthos);
- Fish;
- Marine mammals;
- Marine habitats;
- Legally Protected Areas and Internationally Recognized Areas; and
- Critical Habitats assessment.

However, it is to note that, according to literature review, there are no sea turtles inhabiting the Black Sea (when spotted, they are only considered as occasional visitors) (IUCN, 2012; Zinenko et al., 2021). According to Zinenko et al. (2021), from 1922 to 2021 only 11 specimens of *Caretta caretta* have been sighted in the Black Sea. Regarding Green Turtles (Chelonia mydas), while nesting sites can be found in the Mediterranean side of Türkiye (in addition to Syria and Cyprus), the species has only once been found in the Black Sea: Nanakinov (1998) found only one Green Turtle record from Bulgaria, no records are available from Romania (Nanakinov, 1998), and according to Valkanov et al. (1978) there are no reports of sea turtles from the former Soviet coasts (Öztürk et al., 2013). For such reason, sea turtles are not described in this baseline. Also, considering their ecological habits, linked both to the terrestrial and marine environments, seabirds are described in the onshore biological baseline only (Chapter 6.2 'Onshore Biological Baseline' of the present ESIA, at section 6.2.6).

6.3.2.1 Plankton

Table 6-16: General overview of the plankton component.

Definition	Plankton are all those organisms that cannot contrast water circulation and are horizontally moved by currents. The group is usually divided into: (i) phytoplankton, which groups the autotrophic cells, (ii) zooplankton, which groups the heterotrophic cells and organisms, and (iii) ichthyoplankton, which is a particular subgroup of the zooplankton, composed by only fish eggs and larvae. Although these organisms are subjected to even hourly vertical migrations in the water column, plankton is considered an important indicator of the water quality being the base of the marine food chain.
Study Area	**RSA:** The Black Sea **Rationale**: A basin-wide gyre called Rim Current cover all the Black Sea, which is also characterized by a strong freshwater input, causing also a permanent halocline and anoxic zone and limited input of saltwater from the Mediterranean Sea at about 100-150 m of depth (Tuğrul et al., 2014). **AoI:** The project footprint plus a buffer of 500 m per side along the new pipeline, and a 5 Km buffer around the FPU. **Rationale:** Plankton is rather affected by natural environmental factors (i.e., rain) and, considering the dilution power of water, it is unlikely that limited pressures introduced may alter the plankton communities and mid and long distance. A buffer of 500 m is considered as highly precautional for the pipeline laying. The activity of the FPU, in its operational phase, implies the discharge of cooling waters and production waters, which could affect pelagic ecosystems, for this reason a buffer of 5 Km was set to describe plankton communities of the AoI and their sensitivity.
Data sources	**Primary sources:** Data from the specialistic investigations for the baseline of Phase 2 (June 2024, see report in APPENDIX H, section 2.2.4.1 and 2.2.4.2). **Secondary sources:** Secondary data from scientific papers, grey literature and database, plus data from the monitoring of Phase 1 (August 2023, see report in APPENDIX G, section 2.2.1.1.1 and 2.2.2.2).
Sensitivity	**High**

Methodological approach

Data to describe the regional context (i.e., RSA) were collected through literature review (references reported Chapter 13.0 of the present ESIA), whereas the local context (i.e., AoI) was assessed by both literature review and the gathering of field data. Primary data were collected as follows for the two subcomponents phytoplankton and zooplankton.

Phytoplankton

For the determination and analysis of phytoplankton in the AoI, surface water samples were collected from 11 stations (Figure 6-38 and Table 6-17). Water samples for analysis of phytoplankton were collected using a Nansen bottle. Phytoplankton quantitative samples were placed in jars with a capacity of 1 l, and immediately fixed with formaldehyde solution in situ. Sub-samples (5-10 mL) were allowed to settle for 24 h in HydroBios chambers and then counted and identified at X100, X200 and X400 magnifications with a Nikon TE2000U inverted microscope according to size fractions of the species. Total phytoplankton density was calculated as cells/l (Utermohl, 1958). Densities of taxa *Scenedesmus spp.*, *Pediastrum* spp. and *Coelastrum spp.* from Chlorophyceae were given as colony. Identification was carried out according to Cupp (1943), Hendey (1964), Komárek and Fott (1983), Kramer and Lange-Bertalot (1986), Tomas (1995). The currently accepted taxon nomenclature has been updated according to Guiry and Guiry (2023). Changes in phytoplankton dynamics were also examined using Shannon diversity index (H') (Zar, 1984). The number of species was referred to as species richness.

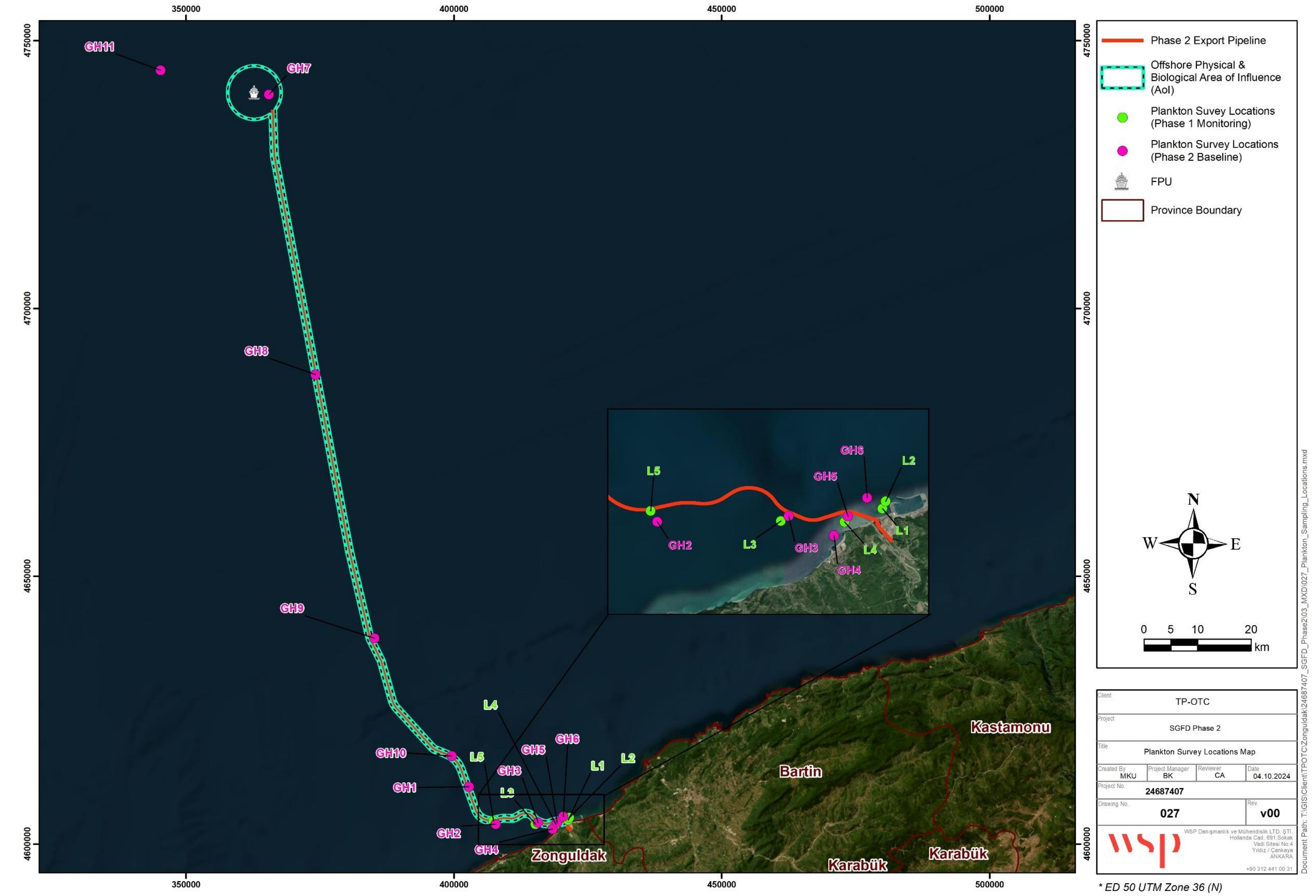


Figure 6-38: Phytoplankton and zooplankton survey stations (GH1-GH11), June 2024.

Table 6-17: Coordinates and depths of biological sampling stations.

Id	Easting(m)	Northing(m)	Depth (m)
GH1	402827.75	4610677.73	-1619.5
GH2	407813.64	4603703.90	-1150
GH3	415717.01	4604043.00	-106
GH4	418434.36	4602864.79	-13
GH5	419275.72	4604023.66	-20
GH6	420434.72	4605150.79	-97
GH7	365477.78	4739960.92	-2117
GH8	374174.05	4687653.14	-2166
GH9	385165.41	4638433.06	-2043
GH10	399605.89	4616441.35	-1805
GH11	345249.21	4744493.82	-2153
F1	420241.14	4603753.13	-7
F2	417242.60	4601177.45	-50
F3	417548.33	4601924.86	-20
a1	417619.66	4601164.04	-
a2	419123.01	4603004.39	-
a3	420428.40	4603532.38	-
a4	416500.46	4602461.88	-

Zooplankton

In June 2024, zooplankton samples (including jellyfish species) were collected vertically using a WP2 closing net (with a 0,5 m diameter and a 200 mm mesh size) at 11 stations (Figure 6-38 and Table 6-17). The collected samples were transferred into 250 ml plastic bottles and fixed by adding a 4% formaldehyde solution buffered with borax. The species identification of samples was carried out under a stereo-binocular microscope using a zooplankton counting chamber, and their total abundance was calculated.

Figure 6-39: Zooplankton sampling.

Given the geographical proximity of the Phase 1's and Phase 2's pipelines, also the data collected in the scope of the monitoring of Phase 1 (August 2023) are considered in the present ESIA to provide integrative information to describe phytoplankton and zooplankton communities in the AoI (the 500 m buffer set for the AoI covers also the operative pipeline of Phase 1 in its nearshore portion). The monitoring was operated in 5 survey locations

(Figure 6-40 and Figure 6-38), plus one additional location (location 6) represented by travelling through the other 5 locations. For the complete methodology see OTC, 2023 (Doc. No. SC26-DNR-PRJ-SU-REP-501211).

Figure 6-40: Phytoplankton and Zooplankton sampling locations (L1-L5) from monitoring of Phase 1 (August 2023).

Regional context (RSA)

The distribution of phytoplankton and zooplankton (including ichthyoplankton) is interlinked with the presence of sunlight, oxygen, and nutrients in the water. Phytoplankton only occurs in the photic zone as they need sunlight for photosynthesis. The photic zone of the Black Sea is from 0 to 100 m but most of the phytoplankton is located between 0 and 60 m. Zooplankton organisms don't depend on sunlight to survive, however, they feed mostly on phytoplankton. Therefore, the zooplankton distribution in the water column is usually similar to the one of phytoplankton.

Because of their dependence to environmental light, sea surface temperature and trophic conditions of the sea water (e.g., eutrophication), it is not rare plankton to show blooms in particular locations throughout the year.

Plankton blooms, in fact, are huge phenomena happening around the world which occur when all the ideal living parameters of plankton align. In the Black Sea, they are known to occur mainly during mid-spring and limitedly in autumn. **Figure 6-41** shows a bloom of coccolithophores (i.e., phytoplankton) occurred in the RSA in spring 2022 (lighter colours).

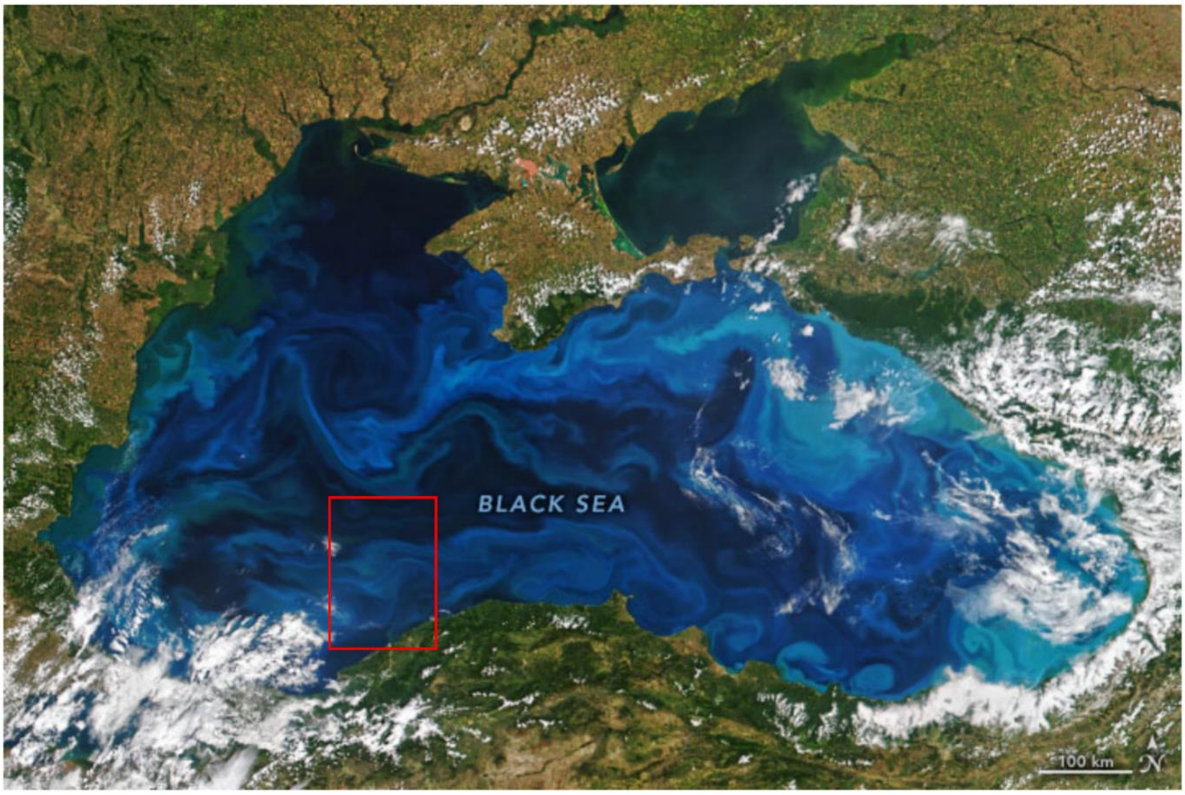


Figure 6-41: Coccolithophore bloom in the Black Sea (Spring 2022) (source: NASA 2022). The red square identifies the Project Area, and the turquoise swirls indicate the presence of phytoplankton tracing the flow of water currents and eddies.

The portion of gelatinous plankton is unusually high in the Black Sea, mainly because of overfishing (but also the introduction of the invasive ctenophore *Mnemiopsis leidyi* largely contributed). In fact, the biomass of scyphozoans (i.e., true jellyfishes) and ctenophores account for more than 90% of total zooplankton biomass in coastal Black Sea waters during the warm period of year (Living Black Sea, 2016).

The most common phytoplankton taxa in the Black Sea are:

- Dinoflagellates (*Ceratium furca*, *Prorocentrum micans*, and *Gonyaulax spinifera*).
- Diatoms (*Chaetoceros compressus*, *Achnantes brevipes*, *Licmophora gracilis* and *Pleurosigma elongatum*).
- Coccolithophores (*Syracosphaera spp.* and *Emiliana huxleyi*).

The most common zooplankton taxa in the Black Sea are:

- Jellyfishes (*Aurelia aurita* and *Rhizostoma pulmo*).

- Ctenophores (*Pleurobrachia rhodopis*, *Mnemiopsis leidyi*, and *Beroe ovata*).
- Copepods (*Oithona spp.*, *Calanus spp.* and *Acartia spp.*).
- Ciliates.
- Rotifers.

In addition, there are multiple coastal upwelling zones reported in the Black Sea. These are the Russian coast of Gelendzhik (Silvestrova, Zatsepin, & Myslenkov, 2017), the South Crimea, the Bulgarian and Romanian coasts, and the Western part of the Turkish coast (Stanichnaya, Davidov, Stanichny, & Soloviev, 2004), where the project is located.

Local context (AoI)

Phytoplankton

As a result of the June 2024 surveys, 45 phytoplankton taxa were recorded, six different classes were identified including Dinophyceae (49% of the total), Bacillariophyceae (36%), Coccolithophyceae (2%), Cryptophyceae (2%), Chlorophyceae (9%) and Zygnematophyceae (2%). The phytoplankton composition of the AoI was mostly from marine species, but in several occasions, typical freshwater taxa (*Scenedesmus spp*., *Pediastrum spp.* and *Coelastrum spp.* from Chlorophyceae and *Cosmarium sp*. from Zygnematophyceae) were also found, especially at Stations GH1, GH2 and GH4 affected by freshwater inputs. In terms of species richness, Bacillariophyceae (diatoms) and Dinophyceae (dinoflagellates) were the most important groups. The following group was Chlorophyceae with four taxa. Coccolithophyceae, Cryptophyceae and Zygnematophyceae were represented by only one species.

The phytoplankton taxa are listed in Table 6-18, while the relative abundances and the species richness of each group, is given in Figure 6-43. Total phytoplankton density ranged from 63.360 cells/l (in Station GH2) to 405.434 cells/l (in Station GH5) with an average of 191.804±122684 cells/l. Overall, phytoplankton species composition revealed variations between stations. Spatial phytoplankton density in the area was often dominated by diatoms but a shift to coccolithophores dominance was observed in some stations (Figure 6-42).

Diatoms, which constitute 39% of total phytoplankton density, reached to their highest density (287.937 cells/l) in Station GH5. *Pseudonitzschia gr. delicatissima*, *Pseudonitzschia gr. seriata*, *Pseudosolenia calcar-avis* and *Dactiliosolen fragilissimus* from diatoms were common at all stations. Of these, *Pseudonitzschia spp*. was present with the highest values in term of density in Stations GH5, GH7, GH9 and GH11. *Dactyliosolen fragilissimus* and *Pseudosolenia calcar-avis* did not develop high numbers (average density <5.000 cells/l). *Leptocylindrus danicus* (in Stations GH1, GH2, GH4) and *Cyclotella spp.* (in Station GH1 and GH7), which have relatively high values in terms of density at some stations, were occasionally recorded.

Dinoflagellates were the group that most contributed to the species richness, but its density was low. *Prorocentrum minimum* played an important role in this group: this species, whose approximate density reached 50.000 cells/l in Station GH 5, was also recorded at relatively high values in Stations GH7, GH9 and GH10. The most frequently occurring dinoflagellates in survey area, *Tripos furca*, *Tripos fusus*, *Tripos muelleri* (ex *Ceratium tripos*), *Tripos pulchellus* did not develop high number (<270 cell/l) and its contribution to the total phytoplankton density was low. Additionally, *Gonyaulax polyedra*, *Gyrodinium fusiforme*, *Prorocentrum micans*, *Protoperidinium sp.* were recorded commonly, but they did not play an important role in terms of density (<5000 cell/l in maximum).

Coccolithophorids were represented by only one species (*Emiliania huxleyii*), recorded in all the stations. *E. huxleyii* reached its highest values in Station GH6 and GH8, constituting 99% of the total phytoplankton at these stations.

Chlorophyceae, which constitute 1% of the total phytoplankton density, ware represented by 4 species. This group, which was recorded at low density values, was found only in Stations GH1, GH2 and GH4.

Other phytoplankton groups represented by only one species were: small photosynthetic flagellate Hillea fusiformis from Cyptophyceae and Cosmarium sp. from Zygnematophyceae. These ones always had low density values, with a maximum as 5,034 cells/l (in Station GH5) and 14 cells/l (in Station GH5), respectively. The spatial distribution of total phytoplankton density according to groups is given in Figure 6-43.

The highest value for the Shannon diversity index was recorded in Station GH1 (H'=2.9), while the lowest value (H'=0.1) was recorded in Station GH8. The average species diversity in the study area was determined as H'=1.75±1.04. The low diversity values (H'<1) in Stations GH3, GH6 and GH8 showed that the increased coccolithophores *Emiliania huxleyii* dominance at these stations suppressed the richness of the phytoplankton community.

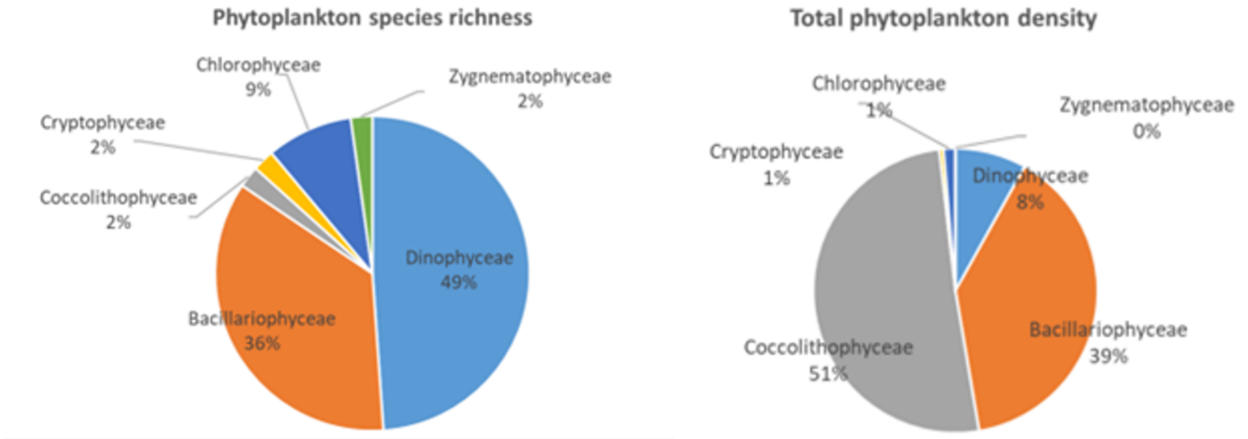


Figure 6-42: The relative contribution of different phytoplankton groups to total abundance and species.

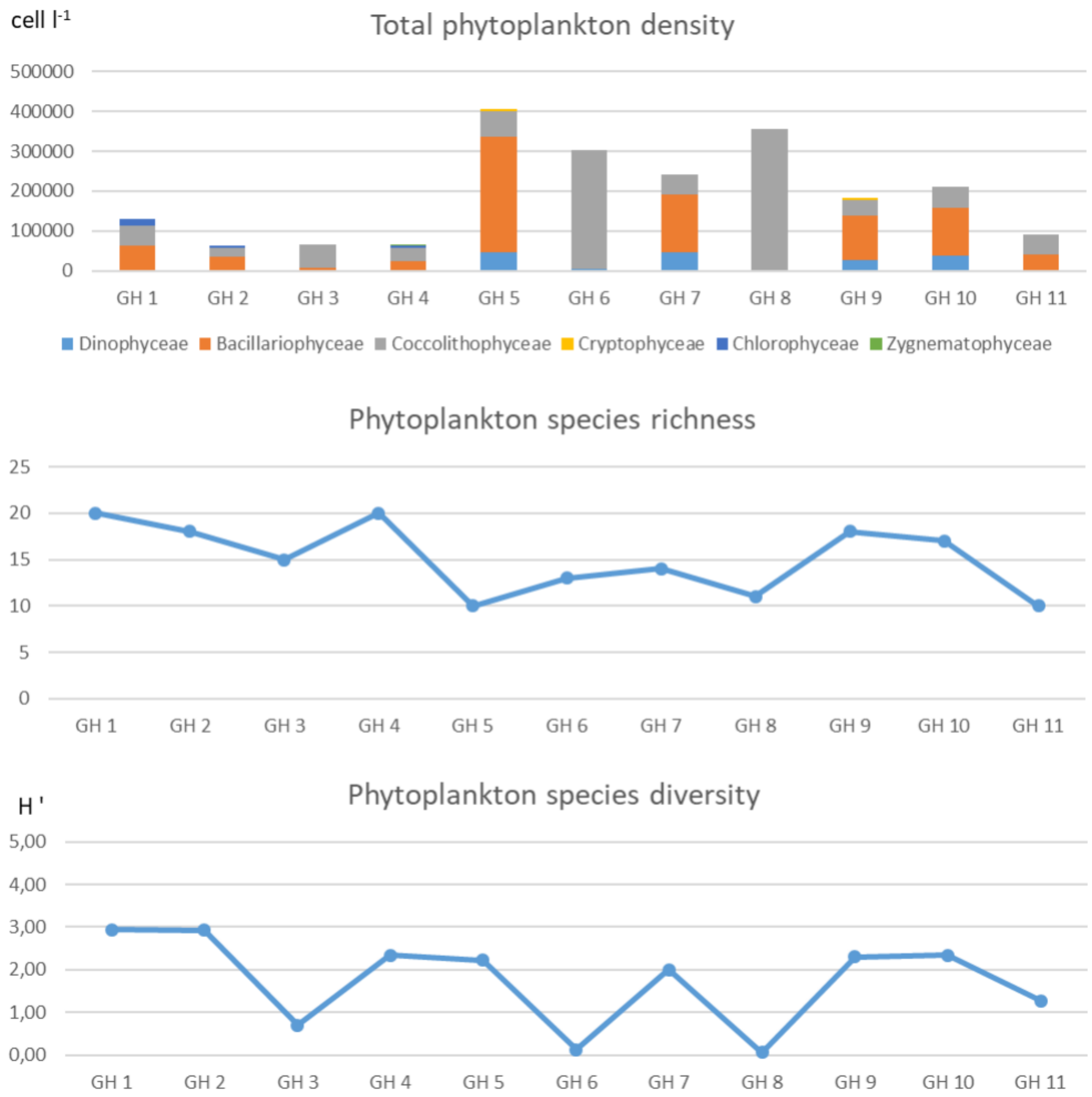


Figure 6-43: Total phytoplankton density, species richness and diversity (Shannon diversity index, H') at sampling stations.

Table 6-18: List of phytoplankton taxa recorded in the study area (for the specific abundance of each taxa see Appendix H, section 2.2.5.1).

Taxa	GH1	GH2	GH3	GH4	GH5	GH6	GH7	GH8	GH9	GH10	GH11
Dinophyceae											
Dinophysis acuminata Claparède & Lachmann	-	-	-	-	-	+	+	-	-	-	-
Gonyaulax sp. Diesing 1866	+	-	-	+	-	-	-	+	-	-	-
Gonyaulax digitalis (Pouchet) Kofoid	-	-	-	-	-	+	-	-	-	-	-
Gonyaulax spinifera (Claparède & Lachmann) Diesing	-	-	-	-	-	+	-	-	-	-	-
Gonyaulax polyedra F.Stein	+	+	+	+	-	-	+	-	-	+	-
Gotoius abei K.Matsuoka	-	-	-	-	-	-	-	-	+	-	-
Gyrodinium fusiforme Kofoid & Swezy	-	-	+	-	-	+	+	+	+	+	+
Noctiluca scintillans (Macartney) Kofoid & Swezy	-	-	-	+	-	-	-	-	+	+	-
Phalacroma rotundatum (Claparéde & Lachmann) Kofoid & J.R.Michener	-	-	+	-	-	+	-	+	-	-	-
Protoperidinium sp. Bergh 1881a	-	-	-	+	+	-	-	+	+	+	+
Protoperidinium leonis (Pavillard) Balech	-	-	-	-	-	+	-	+	-	-	-
Protoperidinium stenii (Jørgensen) Balech	-	-	+	-	-	-	-	+	+	-	-
Prorocentrum compressum (Bailey) Abe'	-	-	-	+	-	-	-	-	-	-	+
Prorocentrum gracile F.Schütt	-	-	+	-	-	-	-	-	-	-	-
Prorocentrum micans Ehrenberg	+	+	-	+	-	+	+	+	+	+	-
Prorocentrum minumum (Pavillard) Schiller	-	-	-	-	+	+	+	-	+	+	+
Pyrophacus steinii (Schiller) Wall & Dale	-	-	-	-	-	-	-	-	-	+	-

Taxa	GH1	GH2	GH3	GH4	GH5	GH6	GH7	GH8	GH9	GH10	GH11
Scaphodinium mirabile Margalef	-	-	+	+	-	-	-	-	+	-	+
Tripos furca (Ehrenberg) F. Gomez	+	-	+	-	+	+	+	+	+	+	+
Tripos fusus (Ehrenberg) F.Gómez	-	+	+	+	-	+	+	+	+	+	-
Tripos muelleri Bory (=Ceratium tripos (O.F.Müller) Nitzsch)	-	+	+	-	+	+	+	+	+	+	+
Tripos pulchellus (Schröder) F.Gómez	-	-	+	-	-	+	+	-	+	+	-
Bacillariophyceae											
Chaetoceros sp. Ehrenberg 1844	-	-	+	-	-	-	-	-	-	-	-
Cyclotella sp.	+	+	+	+	-	-	-	-	-	-	-
Cylindrotecha closterium (Ehrenberg) Reimann & Lewin	+	+	-	-	-	-	-	-	-	-	-
Dactyliosolen fragilissimus (Bergon) Hasle	+	+	-	-	+	-	+	-	+	+	+
Leptocylindrus danicus Cleve	+	-	-	-	-	-	+	-	-	-	-
Leptocylindrus minimus Gran	+	-	-	-	-	-	-	-	-	-	-
Lichmophora abbreviata C.Agardh	+	+	-	-	-	-	-	-	-	-	-
Melosira varians C.Agardh	-	+	-	-	-	-	-	-	-	-	-
Nitzschia sp.	+	+	-	+	-	-	-	-	-	-	-
Proboshia alata (Brightwell) Sundström	-	-	-	-	-	-	-	-	-	+	-
Pseudo-nitzschia delicatissima (Cleve) Heiden	-	+	+	+	+	-	+	-	+	+	+
Pseudonitzschia gr. Seriata (Cleve) H.Peragallo	+	+	-	+	+	-	-	-	+	+	-
Pseudosolenia calcaravis (Schultze) Sundström	+	+	+	+	+	-	+	-	+	+	-

Taxa	GH1	GH2	GH3	GH4	GH5	GH6	GH7	GH8	GH9	GH10	GH11
Skeletonema costatum (Greville) Cleve	+	+	-	+	-	-	-	-	-	-	-
Synedra ulna (Nitzsch) Ehrenberg	+	+	-	+	-	-	-	-	-	-	-
Thallassionema nitzschoides (Grunow) Mereschkowsky	-	-	-	-	-	-	-	-	-	+	-
Coccolithophyceae											
Emiliania huxleyi (Lohmann) W.W.Hay & H.Mohler	+	+	+	+	+	+	+	+	+	+	+
Cryptophyceae											
Hillea fusiformis (J.Schiller) J.Schiller	-	-	-	-	+	-	-	-	+	-	-
Chlorophyceae											
Coelastrum microporum Nägeli	+	-	-	+	-	-	-	-	-	-	-
Pediastrum boryanum (Turpin) Meneghini	+	+	-	+	-	-	-	-	-	-	-
Scenedesmus sp.	+	+	-	+	-	-	-	-	-	-	-
Scenedesmus quadricauda (Turpin) Brébisson	+	-	-	-	-	-	-	-	-	-	-
Zygnematophyceae											
Cosmarium sp.	-	-	-	+	-	-	-	-	-	-	-

Data from the 2023 monitoring report (OTC, 2023, see APPENDIX G section 2.2.2.2) confirms the dominance Bacillariophyta and dinoflagellates in species richness, but with a substantial difference both in total abundance and in abundance distribution of the different taxa (see Table 6-19 and Figure 6-43).

Concerning total abundance, the monitoring of August 2023 reported a mean of 63,666 cell/l for sampling station, while the present survey recorded a mean of 191.804 cell/l per station. Similarly, the abundance distribution saw Bacillariophyta and dinoflagellates as the most abundant taxa (respectively 40,756 cell/l and 20,315 cell/l), while in the 2024 survey campaign the coccolithophore *E. huxleyi* represented the 51% of phytoplankton density.

Table 6-19: Abundance of phytoplankton taxa in 2023 sampling locations (L1-L5).

	Bacillariophyceae	Cryptista	Euglenozoa	Dinophyceae	Ochrophyta	Total
Location 1	42,433	456	453	20,891	1,281	66,514
Location 2	48,965	662	989	18,561	1,301	71,478
Location 3	34,683	138	654	23,545	2,089	62,109
Location 4	36,789	341	801	19,846	1,019	59,796
Location 5	41,324	719	651	17,963	1,501	63,158
Location 6	40,344	185	258	21,087	967	63,841
Mean±SD	40,756±4966	600±93	634±256	20,315±2009	1,359±407	63,666±3957

Both the facts could be explained by the difference in the sampling season (end of the spring in 2024 and end of the summer in 2023). In fact, it is probable that the 2024 survey occurred during the end of the spring bloom (June), in which one of the main protagonists is indeed *E. huxleyi*.

E. huxleyi blooms in the open Black Sea are observed regularly twice a year: in May–July and October–February, moreover both periods are characterized by considerable year-to-year variability in bloom patterns, in fact, in some years late spring-summer blooms can cover the entire open sea, last up to three months, and *E. huxleyi* abundance can be as high as 10–20 × 106 cells/l (Junev et al., 2024). On the other hand, the monitoring of August 2023 reported a decreasing in phytoplankton abundance, which could be correlated to the natural phenomenon of the progressive stabilisation of the thermocline during summer, and the increasing stratification of water column. This process quickly leads to the consumption of the nutrients by the phytoplankton and the consequent decrease of phytoplankton communities.

Concluding, the surveys describe the AoI in two different period of the year, identifying the area and (more widely) the context of the Black Sea Basin as highly productive both offshore and nearshore.

Zooplankton

The samplings conducted in the 11 stations reported a total of 26 taxa, including 10 species of Copepoda and 3 species of Cladocera (Table 6-20). Station GH5 was excluded from the evaluation as no species were found there. Station GH7 was the location identified as the richest in number of species (18 species reported), while the lowest number of species (9) was found at station GH4.

The highest value in zooplankton abundance was recorded in station GH6 with 102 individuals/m^3, while biomass values were found to be high at station GH9 and GH10 (respectively 174,726 mg/m^3 and 58,222 mg/m^3) (see figures below). These exceptional biomass values are caused by the presence of jelly plankton, in particular *A. aurita*. This taxon was reported with a biomass of 174,657.17 mg/m^3 in GH9 and 58,219. 057 mg/m^3 in GH10 (see Appendix H, section 2.2.5.2 for the biomass values and relative abundance of the other taxa). In the survey area, the dominant species were *Paracalanus parvus* (147 individuals per m^3), *Acartia clausi* (77 individuals per m^3), *Parasagitta setosa* (56 individuals per m^3), and *Pleopis polyphemoides* (65 individuals per m^3).

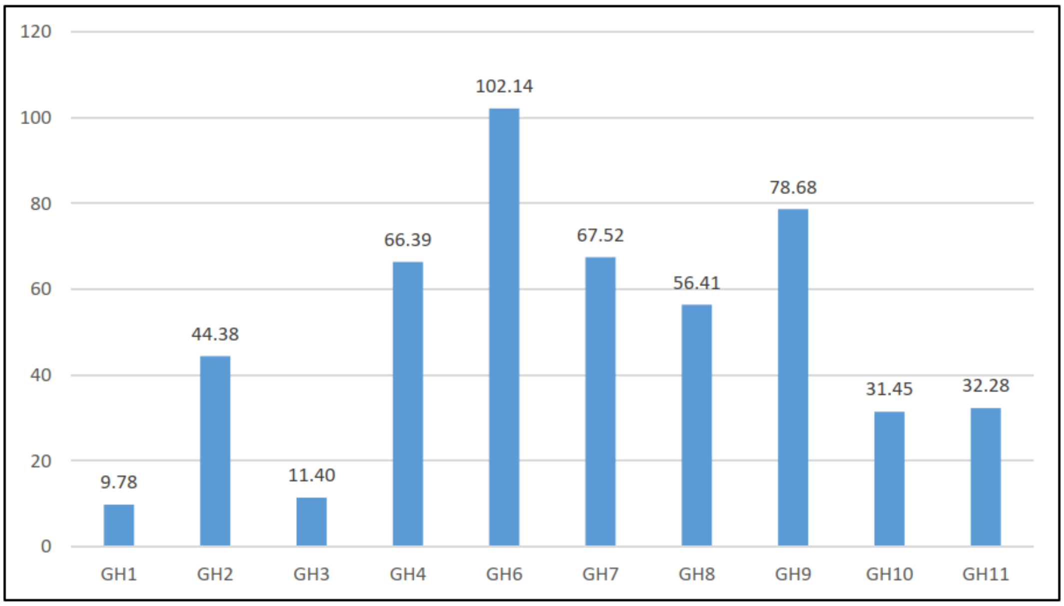


Figure 6-44: Total zooplankton abundance (ind/m^3) in the stations.

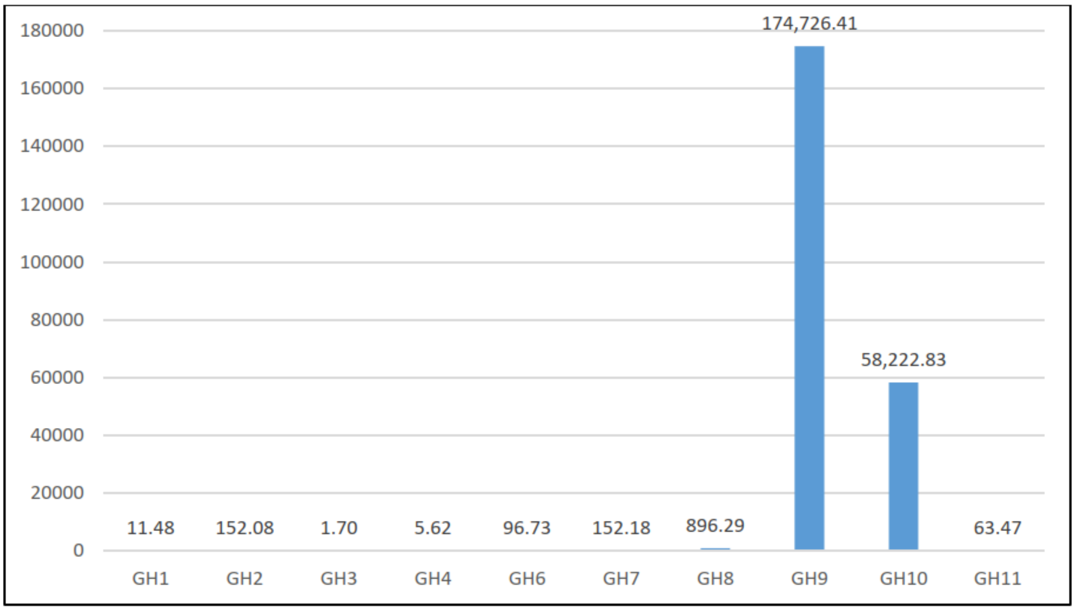


Figure 6-45: Total zooplankton biomass (mg/m^3) in the stations.

In June 2024, *Noctiluca scintillans*, which is taxonomically included in phytoplankton but is effectively sampled with a zooplankton net due to its cell size and shares the same food with zooplankton due to its heterotrophic feeding feature, was also evaluated in zooplankton. It was recorded at the highest value of 261 individuals/m^3 at station GH4 (see figure below).

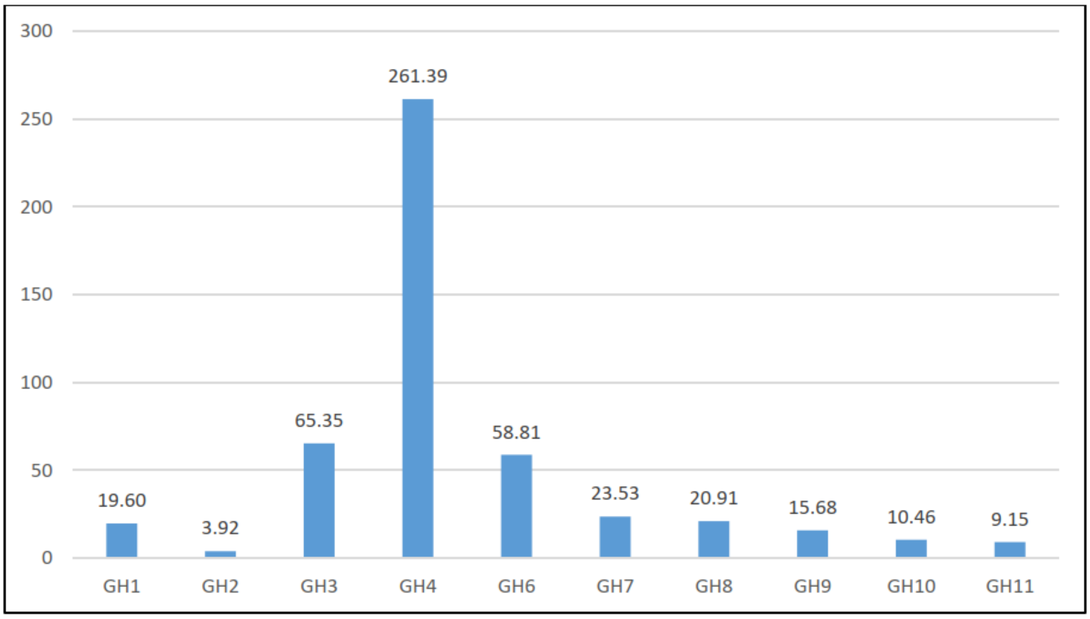


Figure 6-46: Total abundance of Noctiluca scintillans at the stations (ind/m^3).

Lastly, in the area was also recorded the presence of fish eggs, larvae of fish, Bivalvia, Cirripedia, Decapoda, Phoronidae, Gastropoda and Polychaeta, and jelly plankton organisms such as the jellyfish *Aurelia aurita* (Figure 6-47) and the ctenophore *Pleurobrachia pileus.*

Table 6-20: List of zooplankton taxa recorded in study area., see Appendix H, section 2.2.5.2 for the biomass values and relative abundance of taxa.

Taxon	GH1	GH2	GH3	GH4	GH5	GH6	GH7	GH8	GH9	GH10	GH11
Copepoda											
Acartia clausi	+	+	+	+	-	+	+	+	+	+	+
Acartia tonsa	-	+	-	-	-	+	+	-	-	-	-
Calanus euxinus	-	-	-	-	-	+	+	+	+	+	+
Centropages ponticus	+	+	-	-	-	+	+	+	-	+	+
Oithona davisae	-	-	-	-	-	+	+	-	-	+	-
Oithona nana	-	-	-	-	-	+	+	+	+	+	-
Oithona similis	+	+	-	+	-	+	+	+	+	+	+

Taxon	GH1	GH2	GH3	GH4	GH5	GH6	GH7	GH8	GH9	GH10	GH11
Paracalanus parvus	+	+	+	-	-	+	+	+	+	+	+
Pseudocalanus elongatus	-	+	-	-	-	+	+	-	-	+	+
Copepoda nauplii	+	+	-	-	-	+	+	+	+	+	+
Cladocera											
Pseudevadne tergestina	+	-	-	+	-	-	-	-	-	-	-
Penilia avirostris	-	-	+	-	-	-	-	-	-	-	+
Pleopis polyphemoides	+	+	+	+	-	+	+	+	+	+	+
Appendicularia											
Oikopleura dioica	+	+	-	+	-	-	-	-	-	+	-
Chaetognatha											
Parasagitta setosa	+	+	+	-	-	+	+	+	+	+	+
Meroplankton											
Fish larvae	+	+	-	-	-	-	+	+	-	-	-
Fish egg	-	+	+	+	-	-	+	-	+	+	-
Bivalvia larvae	+	+	+	+	-	-	-	-	-	-	-
Cirripedia larvae	+	+	-	-	-	-	-	-	-	-	-
Decapoda larvae	+	+	+	-	-	-	-	-	-	-	-
Phoronidae larvae	-	-	+	-	-	-	-	-	-	-	-
Gastropoda larvae	-	+	-	-	-	-	-	-	-	-	-
Polychaeta larvae	-	-	-	+	-	-	+	-	+	-	-
Other groups and species											
Aurelia aurita	-	-	-	-	-	-	+	+	+	+	-
Pleurobrachia pileus	-	-	+	-	-	+	+	+	+	-	+
Noctiluca scintillans	+	+	+	+	-	+	+	+	+	+	+
Total number of species	14	17	11	9	0	14	18	13	13	15	12

Figure 6-47: The jellyfish *Aurelia aurita* recorded during 2024 surveys.

The comparison with monitoring of Phase 1 (August 2023, APPENDIX G section 2.2.2.2) reported a similar taxa composition (27 taxa identified): *Acartia, Calanus, Centropages, Paracalanus, Pseudocalanus, Oithona, Penilia, Pleopis, Oikopleura and Parasaggita* genres were recorded in both surveys, as well fish eggs and larvae of fish, Bivalvia, Cirripedia, Decapoda, Phoronidae, Gastropoda and Polychaeta. However, no data of biomass or abundance were reported in 2023 monitoring report, nor information about the presence of jelly zooplankton.

Sensitivity Assessment

Considering the information reported in the previous paragraphs and the most important deriving features, listed in the following table, a high sensitivity value was assigned to the plankton component.

Sensitivity features	Supported by	Sensitivity value
Presence of highly productive waters	Primary data and secondary data	**High**

6.3.2.2 Benthic communities (phyto- and zoobenthos)

Table 6-21: General overview of the benthic component.

Definition	Benthos is a category that encompasses different taxonomical groups, vegetal or animal, both sessile and motile. All the species belonging to this category are characterized by living in close contact with the substrate or settled down on it, either soft or hard (Wetzel, 2001). The animal organisms belonging to this group show all the existing feeding habits, including filter feeders, detritus feeders, grazers, scavengers, and carnivores (Versar, 2006).
Study Area	**RSA:** Western Black Sea basin with focus on the Turkish continental shelf, slope and abyssal plain. **Rationale:** The Andrusov Ridge and Archangelsky Ridge extending south from the Crimean Peninsula divide the Black Sea into two depositional basins: the Western Black Sea and the Eastern Black Sea (Shillington et al., 2008). **AoI:** The project footprint plus a buffer of 500 m per side. **Rationale:** The activity of pipeline laying onto the seafloor may resuspend a limited amount of sediments with scarce possibility to be transported through long distances. A buffer of 500 m is considered as highly precautional even for the activities of dredging and deposition of the sediments at the temporary storage area.
Data sources	**Primary sources:** Biodiversity Monitoring Surveys of the “Sakarya Gas Field Development Project” Phase 2 marine section, performed in June 2024. (APPENDIX H – section 2.2.4.3 and section 2.2.5.3). **Secondary sources:** Secondary data were gathered from scientific papers, grey literature, and databases. Additionally, data from field studies and literature used during EIA Phase 1, as well as the monitoring of Phase 1 (APPENDIX G – section 6.3.2.2), were considered for the assessment.
Sensitivity	**Medium-high**

Methodological approach

To describe the regional context (RSA), data were collected through a literature review (Chapter 13.0 of the present ESIA). For the local context (AoI), data were assessed using both literature review and previous field survey data. Specifically, observations were gathered during the 2022 ESIA Phase 1 and the 2023 monitoring survey for the ESIA operational Phase 1.

Macro invertebrate sampling was carried out at 11 stations (Figure 6-48 and Table 6-17). Between 150-2200 m, a box core sample (0.5 m^2) was collected (GH1, GH2, GH3, GH7, GH8, GH9, GH10, GH11), while other samples were collected from the shore surface with a polyp grab (GH4, GH5, GH6). The collected samples were sieved through a 1 mm mesh sieve on board and stored in 4% buffered formaldehyde for later analysis in the laboratory. Macrobenthic organisms were identified to species level where possible.

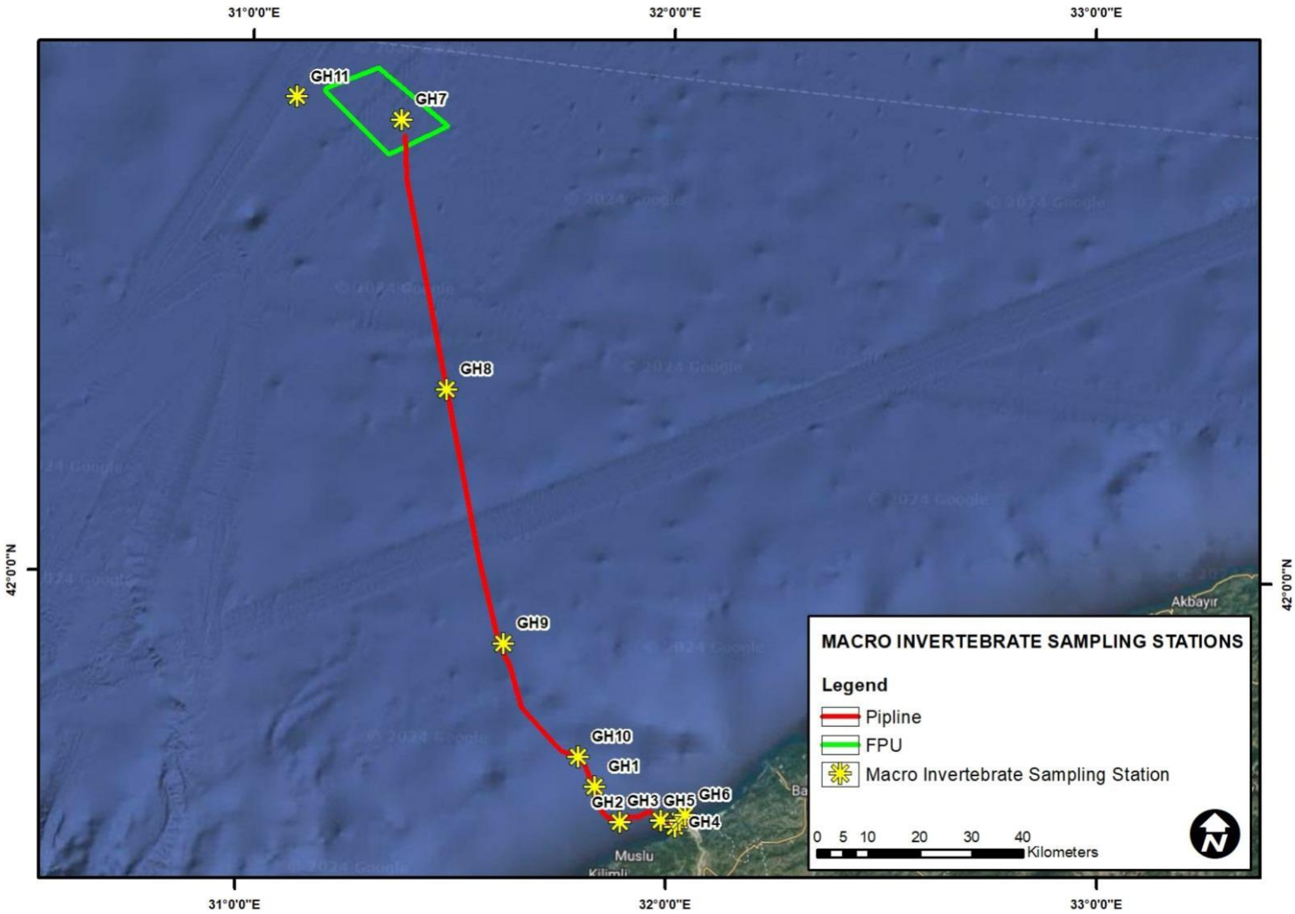


Figure 6-48. Macro invertebrate sampling stations.

Figure 6-49: Box corer.

Regional context (RSA)

The Black Sea represents the largest land-locked basin in the world and it has a unique marine environment, with over 90% of its water lacking dissolved oxygen (Zaitsev, 2008). It is marked by a permanent halocline separating oxic and anoxic waters, with a dynamic O2/H2S-transition region characterized by varying concentrations of oxygen and hydrogen sulfide (Oğuz et al., 1993). Dissolved oxygen drops to zero at around 200 m, and hydrogen sulfide is present at all greater depths. The Black Sea's water exchange with the Mediterranean is restricted through the Bosporus Strait, resulting in the mixing of freshwater and seawater primarily within the upper 150 m. Freshwater from rivers, being less dense than seawater, causes this stratification. Consequently, oxygenated water is found only in the upper layers, while below the pycnocline, the water remains entirely anoxic down to depths of 2000 m. It is suggested that the Black Sea's current anoxic conditions developed relatively recently, around 5600 B.C., when an influx of Mediterranean seawater broke through the Bosporus Strait, flooding what was once a freshwater lake. This event raised the water level by approximately 150 m and created a significant density difference that prevented the mixing of water layers (Laurence, 2006). As a result, the Black Sea developed this unique ecological scenario, further characterized by deep stagnation zones that contribute to its anoxic conditions, making it inhospitable for most marine life except for thiobacteria (Zaitsev, 2008).

Due to these peculiar conditions, benthic communities are categorized into three types: those living in the oxygenated layer above 100-150 m, those that tolerate anoxic conditions, and those that inhabit the fully anoxic layers. Previous studies have focused on the distribution of meiobenthic taxa in the Black Sea under varying environmental, specifically in oxic and anoxic conditions (Sergeeva et al., 2017, 2021; Sergeeva and Mazlumyan, 2015). However, the Turkish coast of the Black Sea has been relatively underexplored regarding macrozoobenthic species, with current studies identifying 788 species across 12 phyla, including Platyhelminthes, Nematoda, Nemertea, Porifera, Cnidaria, Bryozoa, Sipuncula, Annelida, Arthropoda, Mollusca, and Echinodermata (Sezgin and Kurt-Şahin, 2017).

Regarding the oxygenated layer, the RSA is primarily characterized by soft bottoms, making the presence of hard bottom communities unlikely. However, biogenic substrates formed by *Ficopomatus* reefs, a euryhaline species commonly found in estuaries, are present (Micu & Micu, 2004). The most significant habitat-forming species in the RSA are the seagrasses *Zostera marina* and *Z. noltii*. Other notable species include *Cymodocea nodosa*, *Ruppia maritima*, and various brackish water vascular plants such as *Stuckenia pectinata*, *Zannichellia palustris*, and *Potamogeton gramineus* (Karacuha and Okudan, 2017). The algae Cystoseira crinita and *C. barbata* are recognized as the most ecologically important species in the region.

Similar to other oxygenated soft-bottom environments, the RSA's sediments are primarily colonized by infaunal organisms, including bivalves, polychaetes, and nematodes, as well as epifaunal species such as echinoderms, crustaceans, and both errant and sessile polychaetes. At the oxic/anoxic interface, when sediment type permits (e.g., low clay content), communities are often dominated by nematodes and oligochaetes, with the occasional presence of polychaetes and harpacticoids. Only a few nematodes can be found in the upper anoxic zone around 200 m (Luth, 2004), while below 200 m, only anaerobic microbial assemblages are observed.

Surveys conducted in the AoI during 2022 and 2023 showed similar results to regional patterns, with consistent species richness across both years. Specifically, in February 2022, 20 species were found along the pipeline corridor, including anthozoans, polychaetes, gastropods, bivalves, and crustaceans. Although species richness was low, it was characterized by high individual densities, particularly in surface waters. In 2023, 22 species were identified, totaling 5,680 individuals across five main groups. The most diverse groups were Mollusca, Polychaeta, and Crustacea, with Mollusca being the most dominant. No marine phanerogams or algae were observed in either year, though woody debris found in 2022 suggests nearby phanerogam meadows presence. Visual surveys conducted in 2022 showed limited bioturbation and no epibenthic macro-organisms. The most common species in both years were the bivalve *Chamelea gallina*, and in 2022, *Lentidium mediterraneum*, along with the invasive barnacle *Amphibalanus improvisus*, which was also recorded in 2023. Generally, species richness and abundance decreased with depth, while individual sizes increased.

Local context (AoI)

No living organisms were detected, as expected, in the AoI at stations GH1, GH2, GH7, GH10, and GH11. Core samples from the anoxic zone above 300 meters consisted of mud shading from dark grey to black (Figure 6-50). Although station GH9 is located in the anoxic zone at a depth of 1900 meters, dead shells were found there (**Figure 6-51**). To explain this, the simplest assumption is that the sea-bottom profile is a steep precipice, allowing dead shells to fall to great depths. *Polititapes aureus* and *Chamelea gallina* were the dominant taxa at the deep station. As a result of the samples' examination, a total of 17 species and 210 individuals belonging to 2 systematic groups (Polychaeta and Mollusca) were identified and listed in Table 6-22,for a total of 210 individuals, including *Anadara kagoshimensis*, an alien species. Living organisms were found in stations up to 106 meters. Specifically, *Anadara kagoshimensis* was found alive in GH5 station, *Magelona rosea* in GH4 and

GH6 stations, *Flexopecten glaber* in GH3 station, *Chamelea gallina* in GH4 station, and only dead shells in other stations. The previous reports mentioned approximately 20 species in both surveys. The difference in species numbers can be explained by the varying depths and number of samples.

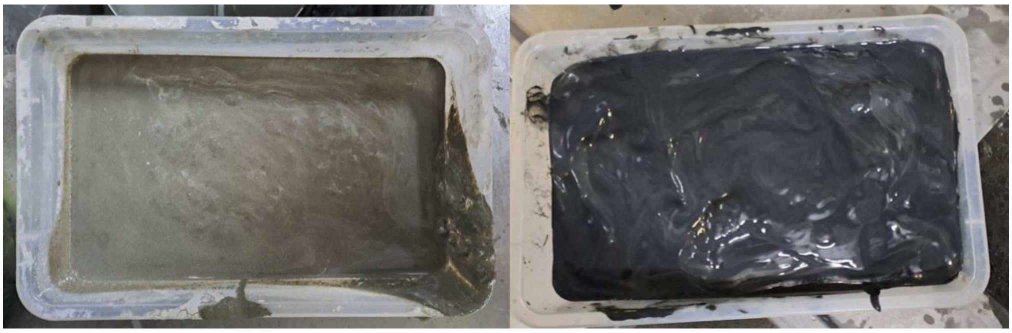


Figure 6-50: The core samples.

Figure 6-51: Sampling species at stations GH9.

Table 6-22: List of macro invertebrate taxa recorded in study area.

Species	GH 1	GH 2	GH 3	GH 4	GH 5	GH 6	GH 7	GH 8	GH 9	GH 10	GH 11
*Anadara kagoshimensis (Tokunaga, 1906) **	-	-	-	-	+	-	-	-	-	-	-
Bittium reticulatum (Da Costa, 1778)	-	-	+	-	-	-	-	-	-	-	-
Calyptraea chinensis (Linnaeus, 1758)	-	-	-	-	-	-	-	-	+	-	-
Cyclope neritea (Linnaeus, 1758)	-	-	+	-	-	+	-	-	-	-	-
Donax trunculus (Linnaeus, 1758)	-	-	-	+	+	-	-	-	-	-	-
Flexopecten glaber (Linnaeus, 1758)	-	-	+	-	-	+	-	-	+	-	-
Gibbula albida (Gmelin, 1791)	-	-	-	-	+	-	-	-	-	-	-
Magelona rosea (Moore, 1907)	-	-	-	+	-	+	-	-	-	-	-
Mytilaster lineatus (Gmelin, 1791)	-	-	-	+	+	-	-	-	-	-	-
Mytilaster minimus (Poli, 1795)	-	-	-	+	+	-	-	-	-	-	-
Mytilus galloprovincialis (Lamarck, 1819)	-	-	-	+	+	-	-	-	+	-	-

	GH 1	GH 2	GH 3	GH 4	GH 5	GH 6	GH 7	GH 8	GH 9	GH 10	GH 11
Species											
Parvicardium scabrum (R. A. Philippi, 1844)	-	-	+	-	+	-	-	-	+	-	-
Polititapes aureus (Gmelin, 1791)	-	-	-	-	-	+	-	-	+	-	-
Rissoa splendida (Eichwald, 1830)	-	-	-	-	-		-	-	+	-	-
Tricolia pullus pullus (Linnaeus, 1758)	-	-	-	-		+	-	-	-	-	-
Spisula subtruncata (da Costa, 1778)	-	-	-	-	+		-	-	-	-	-

* Non-native species

Table 6-23: List of macroinvertebrate species recorded in the study area with number of individuals and sampling methods. In green, living samples are reported.

Species	GH 1	GH	GH 3	GH 4	GH 5	GH 6	GH 7	GH 8	GH 9	GH 10	GH 11
Anadara kagoshimensis (Tokunaga, 1906)	-	-	-	-	7	-	-	-	1	-	-
Bittium reticulatum (Da Costa, 1778)	-	-	13	-	-	-	-	-	-	-	-
Calyptraea chinensis (Linnaeus, 1758)	-	-	-	-	-	-	-	-	5	-	-
Chamelea gallina (Linnaeus, 1758)	-	-	-	-	-	-	-	-	25	-	-
Cyclope neritea (Linnaeus, 1758)	-	-	3	-	-	2	-	-	-	-	-
Donax trunculus Linnaeus, 1758	-	-	-	15	9	-	-	-	-	-	-
Flexopecten glaber (Linnaeus, 1758)	-	-	3	-	-	3	-	-	1	-	-
Gibbula albida (Gmelin, 1791)	-	-	-	-	4	-	-	-	-	-	-
Magelona rosea Moore, 1907	-	-	-	1	-	3	-	-	-	-	-
Mytilaster lineatus (Gmelin, 1791)	-	-	-	9	11	-	-	-	-	-	-
Mytilaster minimus (Poli, 1795)	-	-	-	3	9	-	-	-	-	-	-
Mytilus galloprovincialis Lamarck, 1819	-	-	-	11	6	-	-	-	16	-	-
Parvicardium scabrum (R. A. Philippi, 1844)	-	-	5	-	4	-	-	-	12	-	-
Polititapes aureus (Gmelin, 1791)	-	-	-	-	-	11	-	-	5	-	-
Rissoa splendida Eichwald, 1830	-	-	-	-	-	-	-	-	7	-	-
Tricolia pullus pullus (Linnaeus, 1758)	-	-	-	-	-	6	-	-	-	-	-

	GH 1	GH	GH 3	GH 4	GH 5	GH 6	GH 7	GH 8	GH 9	GH 10	GH 11
Spisula subtruncata (da Costa, 1778)	-	-	-	-	-	-	-	-	-	-	-
Sum	0	0	24	39	50	25	0	0	72	0	0

* Non-native species

Sensitivity Assessment

The macrobenthic fauna identified in the AoI (Area of Interest) is consistent with what has been documented in the literature regarding RSA and in previous investigations conducted in the AoI, both in terms of individual abundance and species richness. Specifically, compared to earlier studies within the AoI, it is observed a coherence in the number of species present. However, differences in species composition have emerged, likely due to environmental and seasonal fluctuations, as well as variable activity regimes that may influence the numerical variability of organisms. Varying depths and number of samples might also have influenced the outcome.

Among the species recorded across all three monitoring campaigns are *Donax trunculus*, *Spisula subtruncata, Chamelea gallina* and the non-native species *Anadara kagoshimensis*. Other species have only been observed in one survey, while others were noted in only two campaigns out of three. Notably, several commercially significant species were present in each survey, including the one conducted in the scope of Phase 2, indicating the area's potential ecological importance. This is particularly demonstrated by the presence of *Donax trunculus* (wedge clam) and *Chamelea gallina* (striped venus clam), which is as a fishery resource in the Black Sea. The comparative analysis of data from the three campaigns highlights a strong dominance of *Donax trunculus* and *Chamelea gallina*, with the latter being the most numerous species in the latest survey, within the sampled benthic communities.

Furthermore, the simultaneous presence of juvenile and adult individuals of various bivalve species suggests that the shallower regions of this habitat may serve as nursery areas for these organisms. The commercial value of *Donax trunculus* and *Chamelea gallina*, coupled with these factors, makes the area ecologically significant, justifying a precautionary approach in its assessment. However, since none of the observed species (registered in previous and present survey) are included in the Turkish evaluation list or the IUCN Red List and considering the absence of significant specific sources documenting bivalve fisheries in AoI, the area has been reconfirmed a **medium-high** sensitivity value.

Sensitivity features	Supported by	Sensitivity value
Absence of protected, endemic or threatened species Presence species of economical importance	Primary data and secondary data	**Medium-high**
Potential presence of nursery area	Primary data	

6.3.2.3 Fish

Table 6-24: General overview of the fish component.

Definition	Fish are gill-bearing aquatic animals that can be found in almost all aquatic environments and have a great diversity. It's an informal group, universally recognized by some common features, resulted from convergent evolutionary processes (such as scales, fins, gills and shape) lampreys, hagfish, bony fish, and cartilaginous fish (Castro & Hubert, 2012).
Study Area	**RSA**: The Black Sea **Rationale**: Fish are highly motile organisms, able to cover long distances and some species are migrant, but the Black represents a closed basin with similar characteristics. **AoI**: The project footprint with a buffer of 5 Km per side **Rationale**: This component includes both highly vagile species, able to move for long distances in a day, and demersal species, more linked to the sea bottom. A 5 Km buffer is considered appropriate and highly precautional also considering that demersal species become inexistent beyond the continental shelf (because of anoxic conditions).
Data sources	**Primary sources:** Data from the specialistic investigations for the baseline of Phase 2 (DenAr, 2024 in APPENDIX H, sections 2.2.4.4. and 2.2.5.4). **Secondary sources:** Secondary data from scientific papers, grey literature, and databases, plus the confront with data from the monitoring of Phase 1 (August 2023, see APPENDIX G, sections 2.2.1.1.4 and 2.2.2.4), and data form the baseline of Phase 1 (2021-2022, consisting in interviews to local fishermen).
Sensitivity	**High**

Methodological approach

Data to describe the regional context (i.e., RSA) were collected through literature review, whereas the local context (i.e., AoI) was assessed by both literature review and the gathering of primary data.

In the scope of the present ESIA, fish sampling was carried out at 3 stations (F1, F2, F3) (Figure and Table), using 2 coastal gillnets, 1000 m long, woven from fishing line with a mesh size of 40 mm.

The 100 m depth contour in the project area is only around 7.5 km away from the shore. Therefore, fishing was carried out in this narrow area due to the narrow continental shelf and the anoxic environment at the bottom. Three samples were considered to be sufficient to represent this narrow area. In addition, sampling was carried out with professional fishermen who know the area well. Since the FPU area is about 170 km from the coast and deeper than 2000 m, there are no fishing operations in this area.

Given the geographical proximity of the Phase 1's and Phase 2's pipelines, also the data collected in the scope of the monitoring of Phase 1 (August 2023, see APPENDIX G section 2.2.2.4) are considered in the present

ESIA in order to provide integrative information to describe fish biodiversity in the AoI. In this case, sampling was carried out with 8 pieces of 15 mm fishing line nets used to catch economically important species and 2 multi-mesh nets with 12 different mesh openings (in accordance with the standards within the scope of the European Union Water Frame Directive to determine diversity). The fish caught within the scope of the study were taken ashore and their detection and measurements were carried out.

Regional context (RSA)

In the Black Sea, the fish population is distributed according to the water depth. In fact, as already described in 6.3.2.2, the oxygen dissolved in water decrease with the depth, becoming depleted at around 100-150 m depth. The water column is therefore completely inhabitable for fish after that depth (Living Black Sea, 2016). Based on the available checklists, there are 165 species and subspecies living in the Black Sea, composed as follows:

- Marine species (119).
- Anadromous[2] and semi-anadromous species (24); and
- Freshwater species[3] (22).

This datum is consistent with Keskin (2010), which reported, based on the most recent records and observations, the Turkish Black Sea biodiversity consisting of 161 species, categorized as follows:

- Atlanto-Mediterranean species make up the majority at 62.73%.
- Cosmopolitan species constitute 6.83% of the total.
- Endemic species, accounting for 28.57%, are further divided into 18.01% Black Sea endemics and 10.56% Mediterranean endemics.

Introduced species originating from the Indo-Pacific and Atlantic regions represent 1.86% of the total.

The information on their distribution, especially in the waters of the central Black Sea, is limited. However, considering the lack of fishing areas and the low level of plankton productivity in such area (i.e., the central Black Sea), it can be stated that the fish species in the central Black Sea is limited to the pelagic species which use the area to travel, such as the Black Sea sprat (*Clupeonella cultriventris*), the European anchovy (*Engraulis encrasicolus*), and Black Sea horse mackerel (*Trachurus mediterraneus*). Most fish species distribution in the Black Sea are located close to the shoreline (Yankova, et al., 2014), where most of the fisheries are also found.

Local context (AoI)

The Area of Influence was investigated through the acquisition of primary data.

In July 2024, 8 fish taxa were identified as the result of sampling at 3 stations (Figure 6-52 and Table 6-26). Obtained fish species are listed from the most abundant to the least abundant: *Merlangius merlangus* 42 small individual (3.25 kg), *Mullus barbatus* 36 individual (1.280 kg) and one *Scorpaena porcus* (30 g), one *Serranus scriba* (20 g), one *Trachinus draco* (19 g) one *Callionymus risso* (12 g) and one *Uranoscopus scaber* (32 g).

2 Born in freshwater, living in saltwater and spawning in freshwater.

3 Living at the large river mouths of the basin.

Additionally, 9 body parts of *Raja clavata* with their fins cut off and thrown away by other fishermen were also observed.

The results of the monitoring of Phase 1 (conducted in 12 sampling stations during August 2023) are reported as well in Table 6-26, while the position of the 12 sampling locations is represented in Figure 6-53. The most abundant species both in frequency and in caught individuals were: *Trachurus trachurus* (133 individuals in 7/12 sampling locations), *Engraulis encrasicolus* (206 individuals in 8/12 sampling locations), *Merlangius merlangus* (166 individuals in 7/12 sampling locations), *Pomatomus saltatrix* (63 individuals in 6/12 sampling locations) and *Mullus barbatus* (72 individuals in 8/8 sampling locations). Of this species only *Pomatomus saltatrix* is listed as 'nearly threatened' in IUCN European Red List (and as 'Vulnerable' in the rest of the world).

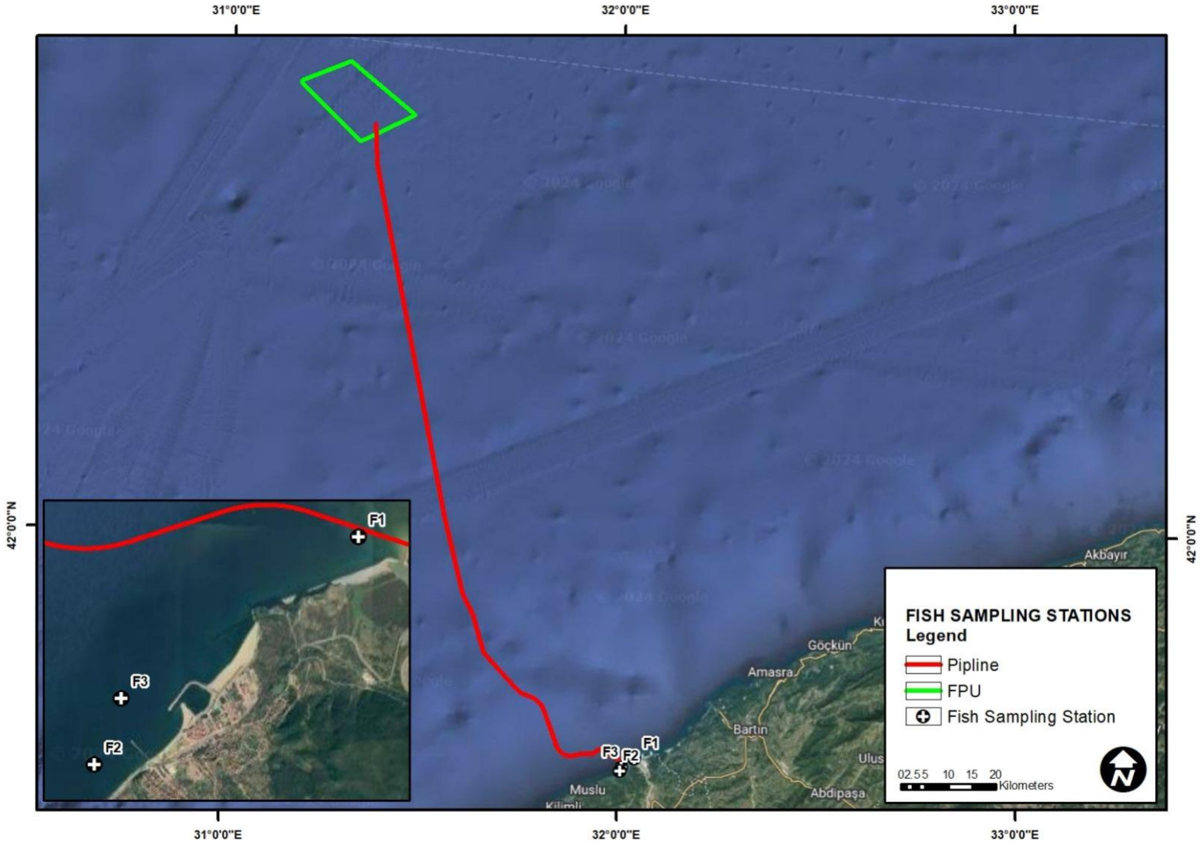


Figure 6-52: 3 fish sampling stations of the 2024 survey.

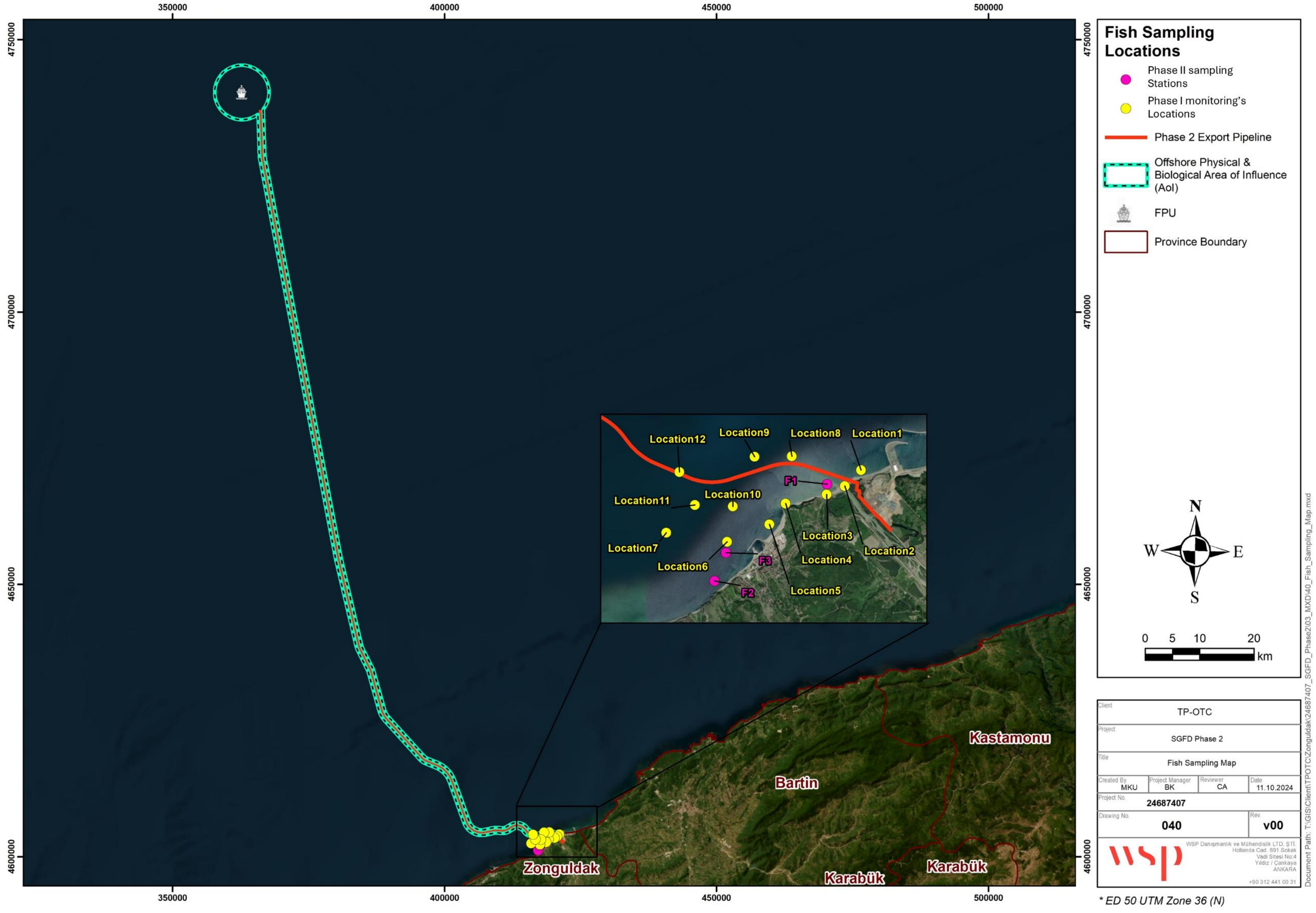


Figure 6-53 Localization of the 12 sampling locations for the 2023 campaign (monitoring of Phase 1) in relation with the 3 sampling sites of 2024 surveys and the position of the Phase 2 pipeline.

In Table 6-27 the diversity indexes are presented for the 8 of the 12 locations (in 4 of these no catches occurred).

The ecological status of the fish sampling points was evaluated based on the Shannon diversity index (see Table 6-27), population parameters and expert opinion (OTC, 2023, see APPENDIX G section 2.2.2.4). The assessment was carried out by converting the five criteria recommended by the Water Framework Directive (WFD) into three criteria. Classification criterion is summarized in **Figure 6-54**, and the sampling points' evaluation, according to the criterion, is presented in **Figure 6-55**, identifying the AoI as in a good-moderate ecological status regarding its fish communities (OTC, 2023, see APPENDIX G section 2.2.2.4).

Shannon diversity index value	Accepted condition	Colour
2 < x	Good	Green
1 < x ≤ 2	Moderate	Yellow
x ≤ 1	Bad	Red

Figure 6-54: Criterion used in classification (monitoring of Phase 1, August 2023).

Station	Shannon diversity index value	Accepted condition	Colour
Location 1	1.65	Moderate	Yellow
Location 2	2.10	Good	Green
Location 4	2.53	Good	Green
Location 5	2.36	Good	Green
Location 7	2.1	Good	Green
Location 8	1.83	Moderate	Yellow
Location 10	1.62	Moderate	Yellow
Location 12	1.51	Moderate	Yellow

Figure 6-55: Status of sampled points according to the Shannon diversity index value (monitoring of Phase 1, August 2023).

The investigation conducted in July 2024 in the scope of the preset ESIA did not result in the same abundance and species richness of the previous year (although the season of the monitoring was the same). However, this could be considered a coherent datum, taking in account the large variability between the 12 sampling sites of 2023. Moreover, two of the species found as dominant in abundance in 2023 monitoring are reconfirmed as such in 2024: *Mullus barbatus* (36 individual in 2024 monitoring) and *Merlangius merlangus* (42 individual in 2024 monitoring).

Fish reported to be mostly caught by fishermen interviewed in 2021 and 2022 are reported in Table 6-26.

As it can be noted, species listed are not always the same of 2023 and 2024 monitoring, especially for taxa *Alosa fallax, Arnoglossus kessleri, Trachurus mediterraneus, Dicentrarchus labrax, Sarda sarda* and *Pegusa nasuta*, which are not reported in 2023-2024 samplings, although described as 'most frequently caught' by fishermen. This can be explained by the different survey's seasons: questionary investigation was proposed during winter-spring, while active sampling was conducted in midsummer.

Moreover, in 2021, Tagem (General Directorate of Agricultural Research and Policices) provided a comprehensive assessment of the fisheries situation in Filyos. The study included an analysis of fishing capacity, catch diversity, current status of economically important fish species and Marine Ecosystem Characteristics in Filyos and the Central Black Sea basin. The report also assessed the potential impacts of natural gas activities on the ecosystem and fish populations.

According to Tagem's report and depending on the fishing season, the most caught fish species by coastal fishermen are turbot (*Scophthalmus maximus*), red mullet (*Mullus barbatus*), haddock (*Merlangius merlangus*), mackerel (*Trachurus mediterraneus*), bluefish (*Pomatomus saltatrix*), mullet (*Mugil* sp.), bonito (*Sarda sarda*) and scorpionfish (*Scorpeana porcus*).

In 2023 official records from the Filyos fisheries cooperative were released, documenting a total of 150 kg of economically important species (red mullet, haddock and mackerel) caught in April 2023, 100 kg in May and 200 kg in June. The distribution amounts of these species are given in Table 6-25.

Table 6-25: Official fishery records for 2023 from Filyos Fisheries Cooperative

Species	April	May	June	Total
Barbunya (red mullet)	50 kg	80 kg	85 kg	215 kg
İstavrit (mackerel)	100 kg	150 kg	100 kg	350 kg
Mezgit (haddock)	150 kg	100 kg	200 kg	450 kg

These data are in line with what has been reported in Table 6-26 (primary data for the present ESIA), specially for the species *Mullus barbatus* and *Merlagius merlagius*, which were recorded in each year (baseline of Phase 1, monitoring of Phase 1 and specialist reports for Phase 2).

Lastly, CR and EN fish species, which were identified in literature for the Critical Habitat Screening (reported in Table 6-28) were not detected during any of the 2023-2024 surveys, nor reported by fishermen in 2021-2022. However, some of the species listed in Table 6-26 are inserted in European and Global IUCN red lists: *Trachurus trachurus* (LC in European IUCN and VU In Global IUCN), *Pomatomus saltatrix* (NT in European IUCN and VU In Global IUCN), *Raja clavata* (NT in European IUCN and NT In Global IUCN), *Umbrina cirrosa* (VU in European IUCN and NT In Global IUCN), *Scophthalmus maximus* (VU in European IUCN and not evaluated in In Global IUCN).

Table 6-26: List of species and species' abundance/presence collected from the survey locations (August 2023, monitoring of Phase 1 – APPENDINX G), specialistic investigation for baseline of Phase 2 (July 2024 – APPENDIX H) and reported in baseline of Phase 1.

Family	Taxon	European IUCN Status	Global IUCN Status	CITES	BERN	Baseline of Phase 1 (presence/absence)	Monitoring of Phase 1 (number of caught individuals per location)												Specialistic investigation for baselines of Phase 2 (number of caught individuals per location)		
							L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	F1	F2	F3
Alosidae	*Alosa fallax*	LC	LC		Ann-I-III	+															
Atherinidae	*Atherina boyeri*	LC	LC			-	0	2	0	4	2	0	0	0	0	0	0	0			
Bothidae	*Arnoglossus kessleri*	DD	DD			+															
Callionymidae	*Callionymus risso*	LC	LC			-													1		
Carangidae	*Trachurus trachurus*	LC	VU			-	26	3	0	0	2	0	15	22	0	9	0	56			
Carangidae	*Trachurus mediterraneus*	LC	LC			+															
Centracanthidae	*Spicara smaris*	LC	LC			-	0	7	0	2	0	0	6	11	0	9	0	0			
Clupeidae	*Alosa maeotica*	LC	LC			-	0	0	0	5	0	0	0	0	0	0	0	0			
Clupeidae	*Clupeonella cultriventris*	LC	LC			-	2	0	0	4	7	0	3	5	0	0	0	2			
Engraulidae	*Engraulis encrasicolus*	LC	LC			+	24	9	0	7	12	0	31	61	0	38	0	24			
Gadidae	*Merlangius merlangus*	LC	LC			+	14	0	0	4	1	0	25	55	0	48	0	19			42
Liparidae	*Not identified liparidae*	-	-			+															
Lotidae	*Gaidropsarus mediterraneus*	LC	LC			-	0	0	0	2	2	0	1	0	0	0	0	0			
Moronidae	*Dicentrarchus labrax*	LC	LC			+															
Mugilidae	*Mugil cephalus*	LC	LC			+	0	3	0	4	2	0	6	1	0	0	0	0			
Mullidae	*Mullus barbatus*	LC	LC			+	4	2	0	3	6	0	8	22	0	18	0	9	36		
Pleuronectidae	*Platichthys flesus*	LC	LC			-	0	0	0	2	0	0	0	0	0	0	0	0			
Pomatomidae	*Pomatomus saltatrix*	NT	VU			+	4	0	0	0	2	0	21	20	0	11	0	5			

Family	Taxon	European IUCN Status	Global IUCN Status	CITES	BERN	Baseline of Phase 1 (presence/absence)	Monitoring of Phase 1 (number of caught individuals per location)												Specialistic investigation for baselines of Phase 2 (number of caught individuals per location)		
							L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	F1	F2	F3
Rajidae	*Raja clavata*	NT	NT			-	0	0	0	0	0	0	0	1	0	2	0	0			9*
Sciaenidae	*Umbrina cirrosa*	VU	VU		Ann-III	-	0	1	0	3	0	0	2	6	0	0	0	0			
Scombridae	*Sarda sarda*	LC	LC			+															
Scophthalmidae	*Scophthalmus maximus*	VU	NE			+	0	3	0	1	2	0	0	0	0	0	0	0			
Scorpaenidae	*Scorpaena porcus*	LC	LC			+	0	0	0	0	2	0	0	0	0	0	0	0		1	
Serranidae	*Serranus scriba*	LC	LC			-														1	
Soleidae	*Pegusa nasuta*	NE	NE			+															
Soleidae	*Solea solea*	LC	DD			-	2	2	0	2	4	0	1	0	0	0	0	0			
Sparidae	*Diplodus annularis*	LC	-			-	3	7	0	6	2	0	17	0	0	0	0	4			
Sparidae	*Not identified sparidae*	-	-			+															
Trachinidae	*Trachinus draco*	LC	LC			-	0	0	0	0	2	0	0	0	0	0	0	1	1		
Uranoscopidae	*Uranoscopus scaber*	LC	-			-													1		

* 9 body parts of *Raja clavata* with their fins cut off and thrown away by other fishermen.

Table 6-27: Index values of the diversity analyses (sampling locations of monitoring of Phase 1).

	Location 1	Location 2	Location 3	Location 4	Location 5	Location 6	Location 7	Location 8	Location 9	Location 10	Location 11	Location 12
Taxa_S	8	10	-	14	14	-	12	10	-	7	-	8
Individuals	79	39	-	49	48	-	136	204	-	135	-	120
Dominance_D	0.2399	0.144	-	0.08705	0.1224	-	0.1455	0.1994	-	0.2392	-	0.2917
Simpson_1-D	0.7601	0.856	-	0.913	0.8776	-	0.8545	0.8006	-	0.7608	-	0.7083
Shannon_H	1647	2098	-	2.53	2367	-	2.1	1827	-	1621	-	1518
Evenness_e^H/S	0.6488	0.8148	-	0.8965	0.7616	-	0.6808	0.6213	-	0.7225	-	0.5701
Margalef	1602	2457	-	3.34	3358	-	2239	1692	-	1223	-	1462

Table 6-28: Fish species identified for Critical Habitat Screening and their conservation status in European and Global IUCN red lists and other conventions.

Family	Species	Europe IUCN Status	Global IUCN Status	CITES	BERN
Anguillidae	*Anguilla anguilla*	CR	CR	Ann-II	Ann-II
Dasyatidae	*Dasyatis pastinaca*	VU	VU		
Labridae	*Labrus viridis*	VU	VU		
Sciaenidae	*Sciaena umbra*	VU	NT		Ann-III
Sparidae	*Dentex dentex*	VU	VU		
Acipenseridae	*Acipenser gueldenstaedtii*	CR	CR	Ann-II	
Acipenseridae	*Acipenser stellatus*	CR	CR	Ann-II	
Acipenseridae	*Huso huso*	CR	CR	Ann-II	

Sensitivity Assessment

Considering the information reported in the previous paragraphs and the most important deriving features, listed in the following table, a high sensitivity value was assigned to the fish component.

Sensitivity features	Supported by	Sensitivity value
Abundance of pelagic fish targeted by fisheries. Presence of species of economic interest. Possible presence of species cited as VU -EN -CR in IUCN red lists.	Primary data and secondary data.	**High**

6.3.2.4 Marine mammals

Table 6-29: General overview of the marine mammal component.

Definition	Marine mammals are aquatic mammals that depend on the sea and other marine ecosystems for their existence (Castro & Hubert, 2012). They are considered an informal group, unified only by their reliance on marine environments for feeding (Jefferson et al., 1993). This group includes cetaceans, pinnipeds, sirenians, and marine fissipeds (such as polar bears and sea otters). In the Black Sea, however, only cetaceans and pinnipeds are found. All cetaceans are protected in the Black Sea by the international Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Area (ACCOBAMS).
Study Area	**RSA:** The Black Sea **Rationale:** The Black Sea hosts three endemic subspecies of cetaceans in the basin, which migrate throughout it. **AoI:** The project footprint with a buffer of 10 km per side **Rationale:** Marine mammals are highly skilled swimmers, capable of covering long distances in a short amount of time (Berta et al., 2015), and that heavily rely on underwater acoustics. Given that, any acoustic alteration can be detected up to several kilometres away (Urick, 1979). Therefore, a buffer zone of 10 km is considered appropriate as a highly precautionary measure.
Data sources	**Primary sources:** Biodiversity Monitoring Surveys of the “Sakarya Gas Field Development Project” Phase 2 marine section, performed in June 2024. (APPENDIX H – section 2.2.4.5 and section 2.2.5.5). **Secondary sources:** Secondary data were gathered from scientific papers, grey literature, and databases. Additionally, data from field studies and literature used during EIA Phase 1, as well as the monitoring of Phase 1 (APPENDIX G – section 2.2.2.5), were considered for the assessment.
Sensitivity	**High**

Methodological approach

Secondary data:

Data describing the regional context (i.e., RSA) were collected through a literature review (Chapter 13.0 of the present ESIA). For the local context (i.e., AoI), data were assessed through both literature review and previous field survey data collection. Specifically, data were gathered from observation sessions conducted in 2022 during the ESIA Phase 1 and from the monitoring survey for the ESIA operational Phase 1 in 2023.

Field data:

Visual line transect surveys and acoustic surveys were conducted in June 2024 to assess cetacean populations in the area.

Visual observation

Visual line transect surveys were conducted on board ORUÇ REİS and ZEKİ (small fishing vessel). The observation was conducted by a team of two observers, one positioned on the port side and the other on the starboard side of the vessel, while a third person was responsible for recording all the information on the datasheets. The track line of the vessel were continuously recorded with the hand-held GPS. At the beginning of the each transect, the date, time, coordinates, observers and sea conditions were recorded. The port and starboard observers scanned a total area of 100°, ranging from 0° at the ship's bow to 10° beyond the opposite side, using both binoculars and the naked eye. This provided additional observation effort for the 20° angle, directly along the transect line. When a cetacean group was encountered, the initial position of the vessel, the observer who made the sighting, the angle between the group and the transect line, and the radial distance to the group were recorded in the datasheet. Additionally, opportunistic observations during transfers from the offshore ship to the port were recorded as off-effort (Figure 6-56). The first survey was conducted between June 13 and 16, 2024, and the second on June 25, 2024. A total of 50 nautical miles 14 hours were covered in both surveys (**Figure 6-57**). It is important to highlight that the investigated area encompassed both the corridor and the designated FPU area, as shown in **Figure 6-57**. Opportunistic observations were also made on the 17th.

Figure 6-56: Cetaceans observation.

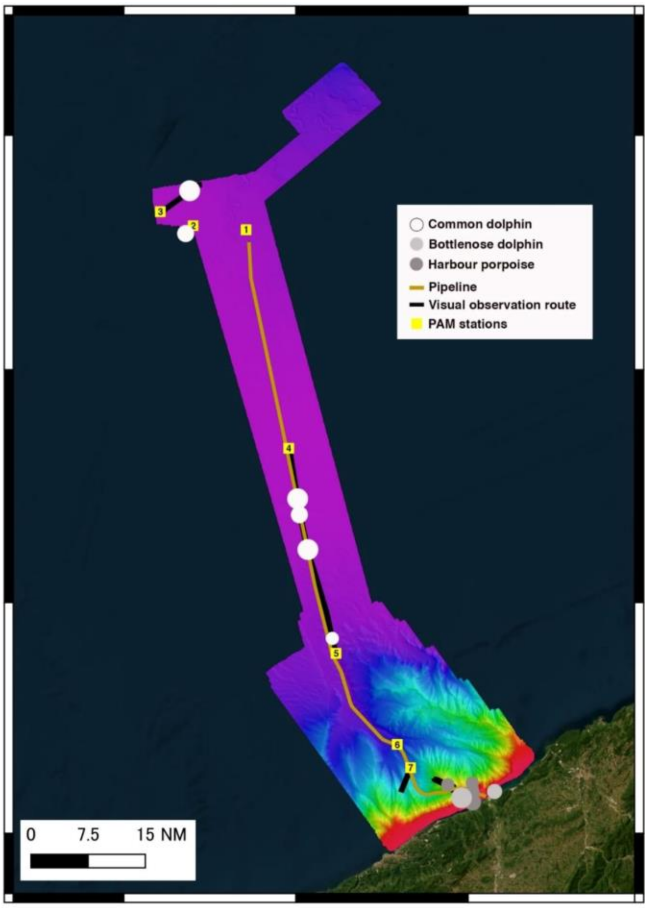


Figure 6-57: Visual observation locations.

Acoustic observations

To understand the presence of cetacean species, stationary underwater passive acoustic recordings were made at seven stations in the study area between June 13 and 17, 2024 (**Figure 6-59**). A single stationary hydrophone and a Soundtrap ST600HF were used, with a sample rate of 96-192kHz/24Bit. The coverage area can reach up to 10 km in calm weather and in areas without noise barriers (Offshore Acoustics Product Manual). The Raven Pro software (Interactive Sound Analysis Software, Center for Conservation Bioacoustics, Cornell Lab of Ornithology) was used for audio file analysis, listening, and generating spectrogram images. Sound recordings in 'wav' format were examined manually and visually using Raven Pro software with spectrogram parameters set to a Hann window, a 3-second time axis, and a 512 FFT/DFT screen resolution. Manual measurements of whistles were made using parameters selected by Oswald et al. (2003), Azzolin et al. (2014), La Manna et al. (2020), and Pace et al. (2022), including: beginning time, ending time, duration (delta time in seconds), minimum and maximum frequency, frequency range (delta frequency in Hz), and the type or pattern of whistle contour (e.g., upsweep, down sweep, sinusoidal, squeak). For clicks or click trains, only the click sequence was captured. For the sound/signal specifications to discriminate between Delphinids such as bottlenose dolphins, common dolphins, and harbour porpoises, there are numerous published articles from the Black Sea and Mediterranean. The presence of both cetacean families in the desired study area was analysed with the help of selected published materials.

Delphinids produce both tonal whistles and echolocation clicks. These clicks are short broadband pulses with frequencies ranging between 30 and 100 kHz (Norris, 1969; Au, 1993). Their duration is around 80 µs for LF clicks and around 60 µs for train clicks, with an interclick interval of 80 ms (Buscaino et al., 2015). Most delphinids produce frequency-modulated whistles. The fundamental frequency of most whistles ranges from 2 to 30 kHz (Gannier et al., 2010; Azzolin et al., 2014). For example, Black Sea common dolphin whistles have frequencies between 1.6 and 33.2 kHz and durations of 0.16 to 2.94 seconds (Panova et al., 2020), while bottlenose dolphin whistles have frequencies between 0.8 and 24 kHz and durations ranging from 0.09 to 2.75 seconds (Azzolin et al., 2014), or between 50 ms and 3 seconds (Ding et al., 1995).

Harbour porpoises are non-whistling toothed whales that produce directional, narrowband, high-frequency (NBHF) echolocation clicks. These Phocoenidae family's NBHF signals cover a very broad frequency range from 40 Hz to 150 kHz (Verboom and Kastellein, 1995) and have durations around 100 µs (ranging from 75 to 150 µs), with interclick intervals of 20 to 70 ms, and as short as 2 ms during feeding. Their center frequencies are around 130 kHz, and source levels are generally below 200 dB re 1 µPa. Four components are also indicated for porpoise signals: low frequency (1.4-2.5 kHz), mid frequency (30-60 kHz), broadband mid frequency (10-100 kHz), and high frequency (110-150 kHz) (Au, 1993; Madsen et al., 2005; Villadsgaard et al., 2007).

Figure 6-58: Acoustic observations.

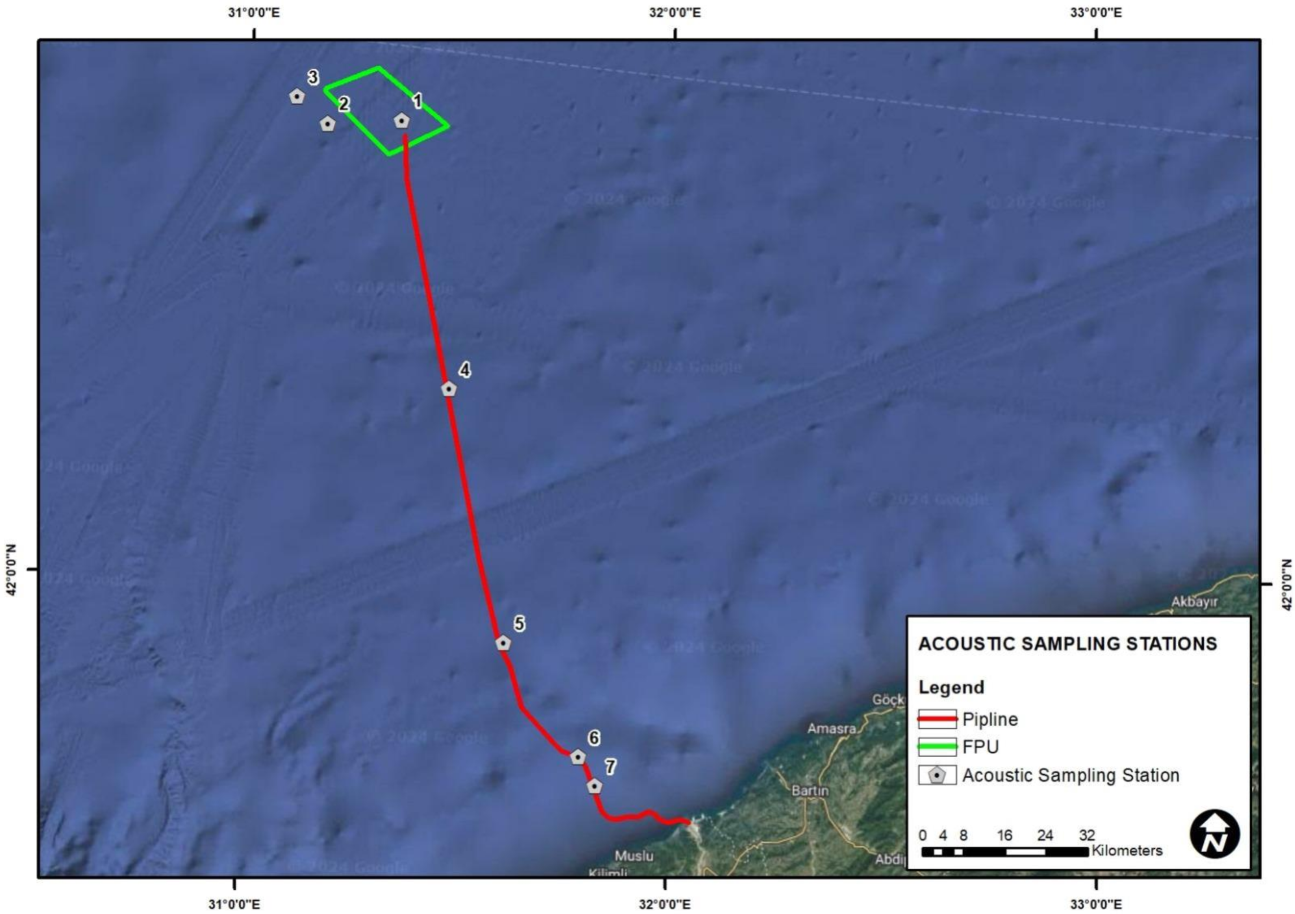


Figure 6-59: Acoustic observation locations.

Regional context (RSA)

The Black Sea is an isolated basin connected to the Mediterranean Sea only through the narrow Istanbul Strait. This isolation, combined with the nutrient-rich inflow from some of Europe's largest rivers, results in a low salinity level of 14-18% and high eutrophication. Waters below 100-150 meters are characterized by a high H2S content, making it the world's largest anoxic water mass. These characteristics make it a fragile and highly sensitive ecosystem (Borysova et al., 2005).

There are three cetacean species in the Black Sea: the harbour porpoise (*Phocoena Phocoena*, Linnaeus, 1758), the bottlenose dolphin (*Tursiops truncatus*, Montagu, 1821), and the common dolphin (*Delphinus delphis*, Linnaeus, 1758) (Öztürk, 1999; Ben Chehida et al., 2020). All three species mentioned are scientifically recognized as endemic subspecies in the Black Sea (IUCN, 2012; Akkaya Bas et al., 2017; Notarbartolo di Sciara and Tonay, 2022):

- *Phocoena phocoena relicta* (Abel 1905),
- *Tursiops truncatus ponticus* (Barabash-Nikiforov 1940),
- *Delphinus delphis ponticus* (Barabash, 1935).

The bottlenose dolphin and harbour porpoise are known to inhabit shallow areas but can sometimes be seen far from the shore. Conversely, the common dolphin is mostly observed in offshore waters but can also be seen near the shore (Birkun et al., 2016).

Indeed, according to Sanchez-Cabanes et al. (2017), prediction models for Black Sea cetaceans indicate that depth may play a significant role in determining their distribution. Specifically, the common dolphin suggests a potential association with greater depths up to 2250 meters, while bottlenose dolphins and harbour porpoises favor depths of 200-250 meters.

One of the first studies in the Zonguldak region (Çanakkale et al., 1989) reported the distribution of the three species as 53% bottlenose dolphin, 24% harbour porpoise, and 23% common dolphin. More recent studies have found seasonal fluctuations in the occurrence of all three species, with peaks in April-May (spring). The largest groups of harbour porpoise and bottlenose dolphin were recorded in late spring and early summer, while the common dolphin had a peak in July (summer) (Uludüz et al., 2020).

During a preliminary photo-ID study in the region, 46 bottlenose dolphins and 8 common dolphins were identified in the coastal area, with six individuals re-sighted (Uludüz et al., 2021). Between April 2018 and December 2021, 38 stranded cetaceans (16 harbour porpoises, 19 common dolphins, and 3 bottlenose dolphins) were recorded in the Zonguldak region (Uludüz et al., 2023). In 2019, during the ASI-CENOBS aerial survey covering 52% of the Black Sea, bottlenose dolphins were seen in the coastal area, common dolphins in offshore areas, and harbour porpoises in both coastal and offshore areas, but not intensively in the Zonguldak area (Paiu et al., 2024).

Other species may occasionally occur in the basin but are not considered resident (BlackSeaWatch).

All three cetacean species are listed under Annex IV of the EU Habitats Directive 92/43/EEC, while the harbour porpoise and bottlenose dolphins are also listed under Annex II. It is believed that several threats, including past direct takes, habitat degradation, depletion of prey stocks, and zoonoses, had already led to drastic declines by the end of the 1980s (Birkun, 2002a; Daskalov, 2003).

Species ecology, IUCN Red List Status, and status for the UNEP Black Sea Protocol of all three cetacean subspecies are reported in Table 6-30.

Table 6-30: List of Marine Mammal species of the Black Sea.

Species	Common Name	Global IUCN Red List Status	UNEP Black Sea Protocol
Phocoena phocoena relicta	Black Sea harbour porpoise	EN	**
The Black Sea harbour porpoise inhabits mainly shallow waters (0 to 200 m deep) on the continental shelf surrounding the Black Sea coast but can also be seen in deep waters, away from the coast. It usually aggregates in large groups, that occasionally may be encountered 200 km offshore, in waters of over 2,000 m deep. Some individuals migrate southwards from the Azov Sea and north-western Black Sea before winter and return in spring. The primary wintering areas are in the southeastern part of the Black Sea. This subspecies suffered from unregulated hunting until 1983, and the decline of this species continues caused by entanglements and bycatch leaving only several thousands of individuals left (IUCN, 2012).			

Species	Common Name	Global IUCN Red List Status	UNEP Black Sea Protocol
Delphinus delphis ponticus	Black Sea common dolphin	VU	**
The Black Sea common dolphin is primarily found in the open sea, where it migrates from for seasonal feeding. If it is found in shallow coastal waters it's usually to pursue preys. The annual winter aggregations of anchovies (the dolphin's main prey) in the southeastern Black Sea and in the south of the Crimean Peninsula create the ideal conditions for the winter aggregations of dolphins. Summer foraging is rather made of sprat in the northwest, northeast and central Black Sea. The Black Sea common dolphin used to be target of deliberate catches in such large numbers that they came close to extinction. Nowadays, the population went back up to tens of thousands of individuals (IUCN, 2012).			
Tursiops truncatus ponticus	Black Sea bottlenose dolphin	EN	**
The Black Sea Bottlehead Dolphin is mostly found on the continental shelf but can also be found far from the coast, especially upon the continental slope, where it usually feeds. The animal is typically found in scattered groups of about 10 to 150 animals at different points around the Crimean Peninsula and in the northern Black Sea. It is also known that there are resident groups in areas close to the Turkish coasts. The subspecies suffered from active catches that drove its population to be less than a thousand (IUCN, 2012).			

*VU: Vulnerable; EN: Endangered; **: Endangered.*

In the 20th century, the abundance of Black Sea cetaceans significantly declined due to large-scale hunting, which continued until 1983. Birkun (2008) suggests that populations did not recover adequately during the following period (1983-2006), and their numbers may have even decreased or shown minimal recovery due to escalating threats such as bycatch, habitat degradation, and mass mortality events. Several Marine Protected Areas (MPAs) important for marine mammals in the Black Sea were proposed by Öztürk (1999) and Öztürk et al. (2013). More recently, several Important Marine Mammal Areas (IMMAs) and the Sakarya Canyon Area of Interest, located about 85 km west of the Filyos study area, have been recognized and approved along the Turkish Black Sea coast (IUCN Marine Mammal Protected Areas Task Force, 2021) (see section 6.3.2.6).

In the Area of Interest (AoI) examined in this study, all three subspecies of cetaceans were observed during surveys conducted in 2022 and 2023. The common porpoise (*Phocoena phocoena relicta*) emerged as the most frequently sighted species in 2022. Its daily presence, often linked to feeding behaviors, along with the sighting of calves, suggests that the AoI may serve as an important feeding area and potentially a breeding ground for this species. Although the porpoise is known for its seasonal migrations within the Black Sea, it is relatively sedentary (Bjorge & Tolley, 2018). Therefore, the regularity of its sightings and feeding activities indicates the possibility of resident populations, implying that the AoI and its surroundings may function as vital area for the subspecies. As for the bottlenose dolphin (*Tursiops truncatus ponticus*), it was observed sporadically in 2022, with only a single group of 4 individuals spotted in transit during sightings. However, in 2023, the presence of 22 individuals in 5 distinct groups, engaging in active behaviors such as feeding, socializing, and traveling, suggests that this subspecies may have a more significant presence than previously noted. By combining these two pieces of information, it appears that the AoI serves as a significant passage and feeding area, particularly under certain conditions or during specific seasons. This is further supported by the partial overlap in the diets of bottlenose dolphins and harbor porpoises. In contrast, the common dolphin (*Delphinus delphis ponticus*) was observed only once, in 2023, resting near the mouth of Filyos river. The absence of sightings in earlier surveys could be attributed to the pelagic nature of this species, which typically prefers deeper waters beyond the continental shelf. Nevertheless, the presence of bluefish (*Pomatomus saltatrix*), its primary prey, in the AoI suggests that it may occasionally visit the area for feeding, even though less frequently than the other two species.

Local context (AoI)

Visual observations

During 12 visual observations, a total of 56 individuals from three different cetacean species were recorded (Table 6-31). The observed species included 37 common dolphins, 10 bottlenose dolphins (including a calf), and 9 harbor porpoises. Photographs of the species identified during these observations are presented in **Figure 6-60** - **Figure 6-65**.

Table 6-31: Marine mammals' visual observations.

Date	Species	Latitude	Longitude	Number of individuals
13.06.2024	*Delphinus delphis ponticus*	42.79065	31.18026	4
13.06.2024	*Delphinus delphis ponticus*	42.88172	31.19436	9
14.06.2024	*Delphinus delphis ponticus*	42.21926	31.50575	13
14.06.2024	*Delphinus delphis ponticus*	42.18874	31.51269	4
14.06.2024	*Delphinus delphis ponticus*	42.1128	31.53378	6
14.06.2024	*Delphinus delphis ponticus*	41.92239	31.60539	1
17.06.2024	*Phocoena phocoena relicta*	41.606003	32.01196	1
17.06.2024	*Tursiops truncatus ponticus*	41.590121	32.0764	2
25.06.2024	*Phocoena phocoena relicta*	41.58989	32.01224	2
25.06.2024	*Phocoena phocoena relicta*	41.60431	31.94066	1
25.06.2024	*Tursiops truncatus ponticus*	41.57998	31.98874	8
25.06.2024	*Phocoena phocoena relicta*	41.56673	32.0127	5
Total number of individuals				56

Figure 6-60: *Delphinus delphis ponticus*.

Figure 6-61: *Delphinus delphis ponticus*.

Figure 6-62:*Delphinus delphis ponticus*.

Figure 6-63: *Tursiops truncatus ponticus* with her calf in Filyos harbour.

Figure 6-64: *Tursiops truncatus ponticus* with her calf in Filyos harbour.

Figure 6-65: *Phocoena phocoena relicta*.

Acoustic observations

After deploying 7 passive acoustic monitoring (PAM) stations and collecting approximately 70 minutes of recordings, cetacean acoustic activity was detected at only station 6 (Table 6-32). In the 40 analysed click sequences, the frequency range was observed to be between 15 and 90 kHz, with inter-click intervals varying from 20 to 80 ms. The whistle frequencies ranged from 8 to 24 kHz, with durations between 0.23 and 1 second. The figures below show sample spectrograms for both the click sequences and whistles (**Figure 6-66** - **Figure 6-68**).

Table 6-32: Passive acoustic monitoring stations and results.

Station	Date	Latitude	Longitude	Event
Filyos 1	12.06.2024	42.79938	31.35534	No detection
Filyos 2	13.06.2024	42.79082	31.18055	No detection
Filyos 3	13.06.2024	42.83724	31.10600	No detection
Filyos 4	14.06.2024	42.33173	31.47958	No detection
Filyos 5	14.06.2024	41.88972	31.61685	No detection
Filyos 6	16.06.2024	41.64248	31.83327	25 whistle and 40 click detection.
Filyos 7	17.06.2024	41.69298	31.79413	No detection

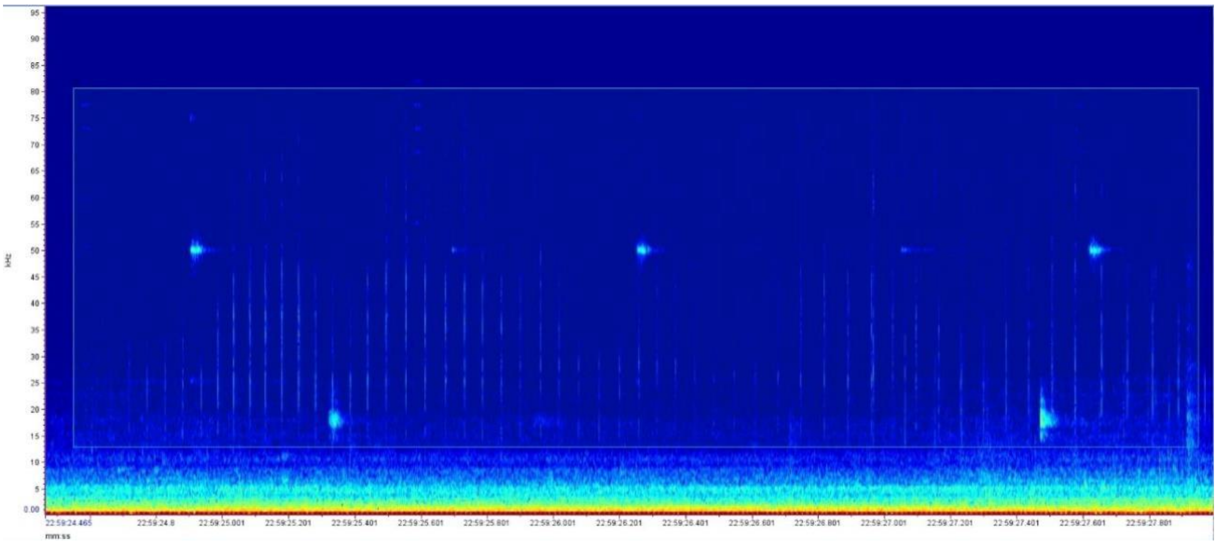


Figure 6-66: Click sequence with 40 to70 ms interclick interval from left to right.

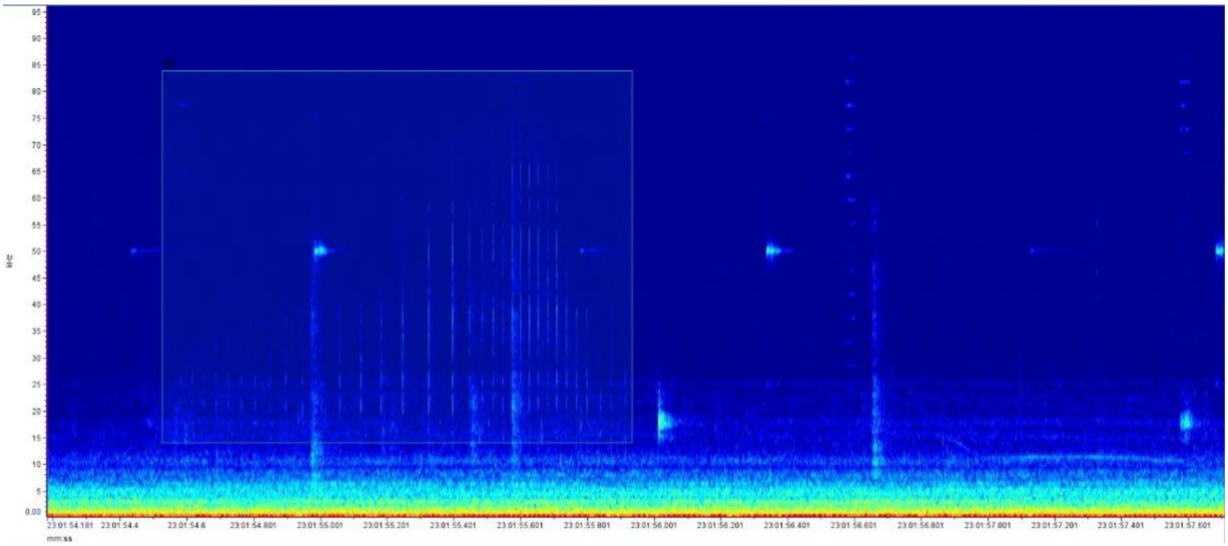


Figure 6-67: Click sequence vary left to right as 35-60-25ms.

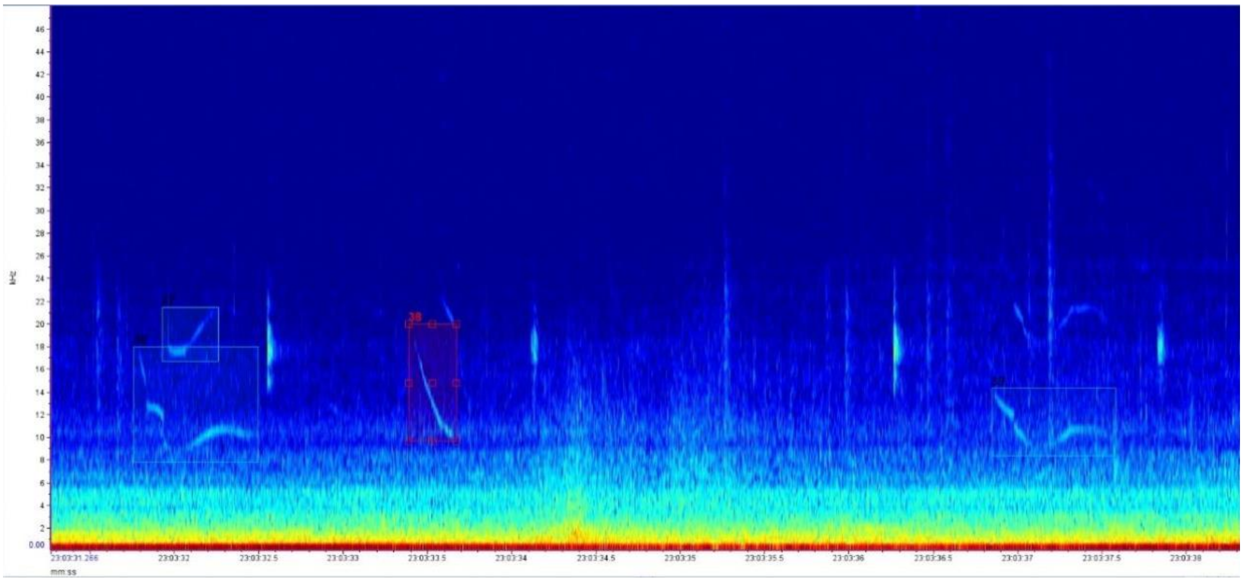


Figure 6-68: Sample spectrogram screen of observed whistles.

Sensitivity Assessment

Over the three-year observation period, all three marine mammal species endemic to the region were detected within the Area of Interest (AoI). Comparing the available literature with data from previous and present monitoring efforts, the area appears to be of ecological importance for at least two cetacean species in the Black Sea. The consistent presence of the harbour porpoise, documented since 2021 and confirmed in subsequent years, indicates that the AoI may function as a crucial area for feeding and potentially breeding for this species. Similarly, the bottlenose dolphin has displayed feeding behaviours consistent with a functional use of the AoI, particularly during the last two monitoring surveys, when the number of sighted individuals corresponded with previously reported data in literature. Additionally, the observation of a female with a calf during the most recent monitoring survey implies that the AoI may also serve as a reproductive area for this species as well.

The common dolphin, less frequently observed in previous surveys, was especially recorded during the most recent monitoring session, with a notable group of 37 individuals in mid-June. This suggests a possible seasonal use of the area for feeding, despite its usual preference for deeper waters. This observation aligns partially with the literature, which reports a peak in sightings of this species in July (Uludüz et al., 2020).

Acoustic data collected indicate vocalizations primarily attributable to delphinids, likely excluding the presence of porpoises based on the recorded frequencies. The variety of acoustic signals, including clicks and whistles, suggests that the observed individuals were engaged in multiple activities, including echolocation and social communication.

Overall, the findings, when compared with past surveys and literature, suggest that the AoI facilitates a variety of essential ecological behaviours, including feeding, socializing, and resting. These behaviours affirm the area's role in sustaining vital functions within the biological cycles of local cetacean populations. Additionally, the evaluation by the International Union for Conservation of Nature (IUCN) and the level of protection of such species, under various directives and agreements, further underline its significant ecological importance.

In conclusion, based on the information gathered, a **high** sensitivity has been assigned to the area.

Sensitivity features	Supported by	Sensitivity value
Presence of protected and/or threatened species	Primary data and secondary data	**High**
Presence of feeding grounds	Primary data and secondary data	
Potential presence of breeding ground	Primary data	

6.3.2.5 Marine habitats

Table 6-33: General overview of the marine habitat component.

Definition	Marine habitats are saltwater habitats which sustain marine life (Abercrombie, Hickman, & Johnson, 1966). Because of the tridimensionality of the marine environment, marine habitats are divided into benthic habitats, standing on the substrate, and pelagic habitat, relying on the water column. Both the habitat typologies are highly influenced by the light availability, which is the main limiting factor.
Study Area	**RSA**: Western Black Sea basin with focus on the Turkish continental shelf, slope and abyssal plain. **Rationale**: The Andrusov Ridge and Arkhangelsky Ridge extending south from the Crimean Peninsula divide the Black Sea into two depositional basins: the Western Black Sea and the Eastern Black Sea (Shillington et al., 2008). **AoI**: The project footprint plus a buffer of 500 m per side along the new pipeline, and a 5 Km buffer around the FPU. **Rationale**: The activity of pipeline laying onto the seafloor may resuspend a limited amount of sediments with scarce possibility to be transported through long distances. A buffer of 500 m is considered as highly precautional. The activity of the FPU, in its operational phase, implies the discharge of cooling waters and production waters, which could affect pelagic ecosystems, for this reason a buffer of 5 Km was set to describe the pelagic habitats of the AoI and their sensitivity.
Data sources	**Primary sources:** Data from the specialistic investigations for the baseline of Phase 2 (June 2024, APPENDIX H, sections 2.2.4.6 and 2.2.5.7). **Secondary sources**: Secondary data from scientific papers, grey literature and databases, plus data from the monitoring of Phase 1 (August 2023, APPENDIX G, sections 2.2.1.1.1 and 2.2.2.1).
Sensitivity	**Medium**

Methodological approach

Data to describe the regional context (i.e., RSA) were collected through literature review, whereas the local context (i.e., AoI) was assessed by both literature review and the gathering of field data.

In the scope of the present ESIA benthic habitats were described using the primary data collected during survey campaign of June 2024, which consisted in:

- Box core sampling in 11 stations (GH1-GH11, Figure 6-69 and Table 6-17).
- Underwater ROV surveys in 4 costal stations (a1-a4, Figure 6-69 and Table 6-17), each survey site covered an area of approximately 500 m^2.

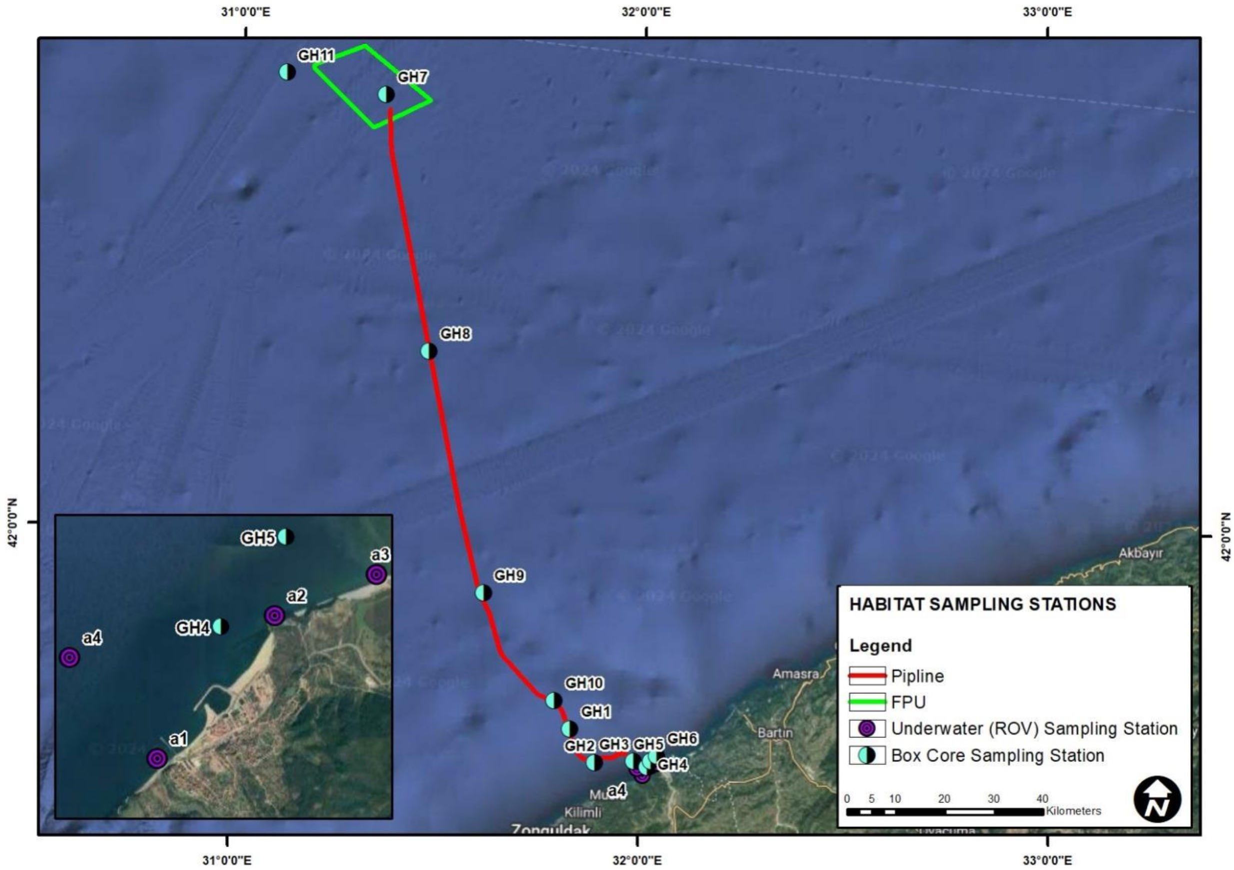


Figure 6-69 Habitat sampling stations (June 2024): ROV survey stations (a1-a4) and Box Core sampling stations (GH1-GH11).

Figure 6-70 Habitat observations by underwater ROV.

Given the geographical proximity of the Phase 1's and Phase 2's pipelines, also the data collected in the scope of the monitoring of Phase 1 (August 2023) are considered in the present ESIA to provide integrative information to describe habitat diversity in the AoI (the 500 m buffer set for the AoI is near to or overlap also the 500 m buffer of the operative pipeline of Phase 1 in its nearshore portion).

In particular, in the context of the of the monitoring of Phase 1, surveys were carried out adopting conservative observation techniques such as Sea Imaging System (i.e., Surface controlled camera, Housing + Canon 600 D SLR + 4000 L Probe) and SCUBA Underwater Visual Counting (SGS) in order to map habitats and monitor their distribution in three costal monitoring sites (Figure 6-71). Also, habitat surveys were conducted as transects, which means a corridor of 100 m was observed during surveys.

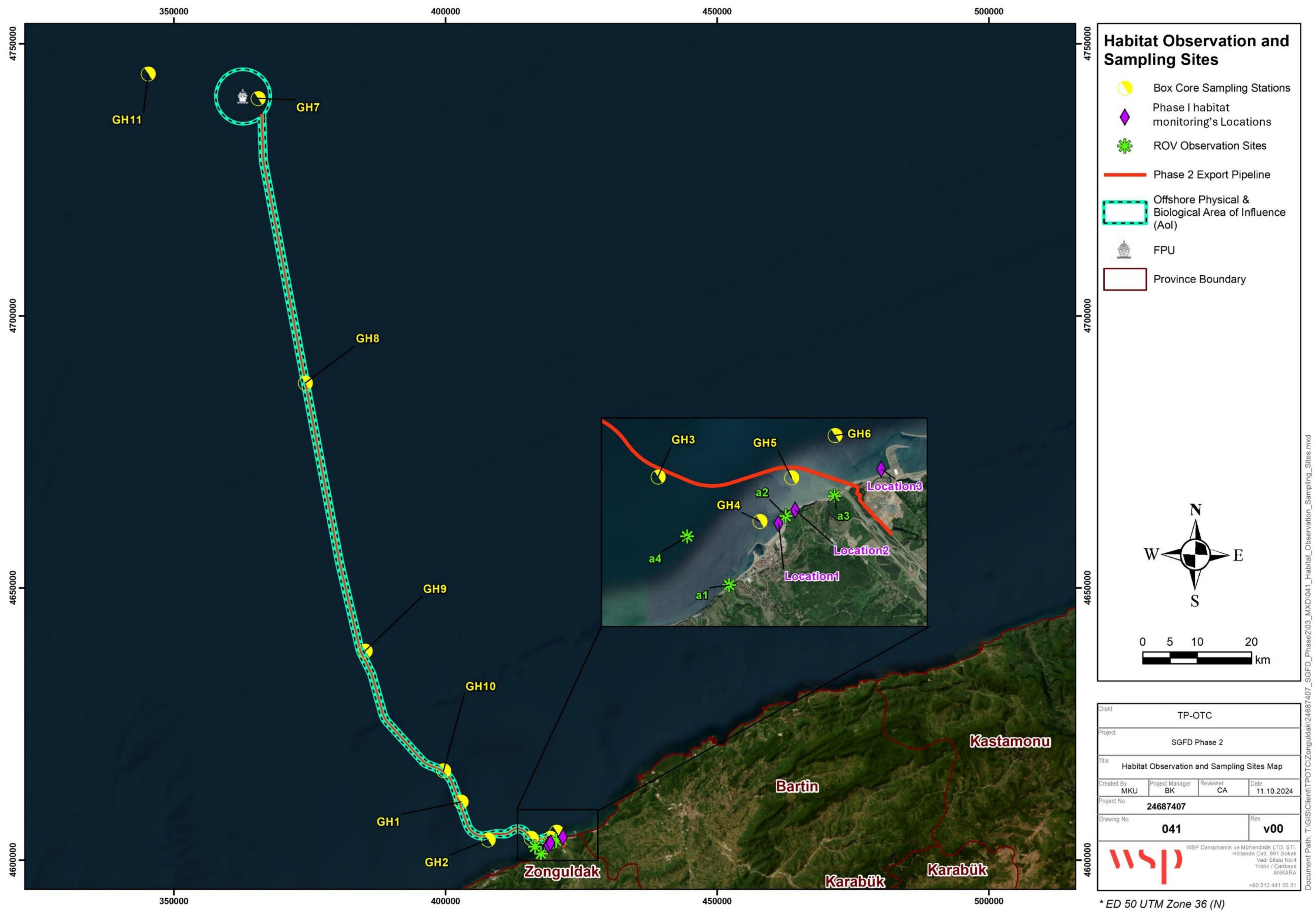


Figure 6-71 Marine Habitat Survey Locations (purple diamonds) (monitoring of Phase 1, 2023) in relation to ROV and Box Core sampling sites (2024) and Phase 2 pipeline position.

Regional context (RSA)

According to the EUNIS database, there are 72 types of benthic habitats in the Black Sea (EUNIS, 2016). The EUNIS classification, is useful in terms of not only relating the national classifications to international level, but in terms of corresponding EUNIS habitats to habitats listed in Annex I of Habitats Directive for "designation of special areas of conservation" and the European Red List of Habitats (Janssen, 2016) for the critical habitat assessment.

Within these habitats, 6 are considered endangered (EN) and 3 are considered critically endangered (CR). However, the distribution of benthic habitats in the Black Sea is strongly correlated with the amount of oxygen in the water. Indeed, as the depth increases, the oxygen concentration decreases until reaching anoxic conditions at around 100-150 m depth (see 6.3.1.1). The general zonation in the Back Sea is the following (EUNIS, 2016).

- 0 to 20 m depth: Bed rock and coarse sediments dominated by algal communities.
- 10 to 25 m: Fine to medium sandy bottom sediments dominated by polychaetes such as Melinna palmata and molluscs (e.g., *Chamelea gallina, Lentidium mediterraneum and Gelidiophycus divaricatus*).
- 25 to 50 m: Substrate becoming a mixture between sand and mud and showing a decrease in the species richness.
- 50 to 80 m: Substrate composed of a mixture of mud, clay and dead seashells, where species diversity is the lowest and mainly dominated by polychaetes and echinoderms.
- Beyond 80 m: The species richness declines until the oxygen is completely depleted.

On the opposite, no information is available for the pelagic habitats of the Black Sea. However, based on what is reported in the previous baseline sections, only the epipelagic zone is actually inhabited by living organisms and may act as pelagic habitat.

Local context (AoI)

The Area of Influence was investigated through the acquisition of primary data. The results of the box core samplings, the same operated for the benthic communities characterization (6.3.2.2), have been analyzed together with the samples' depth and sediment's granulometric description characterizing the study area provided in section (6.3.1.2), thus the consequent habitat type based on EUNIS classification was extrapolated. The results are presented in the following table.

Table 6-34 EUNIS habitat classification in the survey area.

Station	Depth (m)	Sample description	EUNIS Code	Benthic marine habitat type and characterization
GH4-GH5	-13; -20	Infralittoral sand with living polychaetes (*Magelona rosea*), bivalves (*Donax turnculus* and *Anadara kagoshimensis*), and dead mussels (probably form the artificial reefs of the coast). Sand in this location is the predominant	MB54	Black Sea infralittoral sand: Clean medium to fine sands or non-cohesive slightly muddy sands on open coasts, offshore or in estuaries and marine inlets. Such habitats are often subject to a degree of wave action or currents which restrict the silt and clay content to less than 15%. This habitat is

Station	Depth (m)	Sample description	EUNIS Code	Benthic marine habitat type and characterization
		granulometry: sediment sampling in the coastal strip (EN8, EN10, EN33, EN34) recorded a composition of 95% in sand (only exception regarding EN9 constituted in 37% in sand, probably due to Filyos river).		characterised by a range of taxa including polychaetes, bivalve molluscs and amphipod crustacea.
GH6	-97	Infralittoral muddy sand with dead or live polychaetes (*Magelona rosea)* and bivalves (*Polititapes aureus*). Sand is still the main granulometry class, but decreasing in abundance	MB64	Black Sea infralittoral mud: Infralittoral mud and cohesive sandy mud of the Black Sea with polychaete worms and bivalve molluscs.
GH3	-106	Infralittoral muddy sand with dead bivalves and gastropods, and few living *Flexopecten glaber*. Sand is still the main granulometry class, but decreasing in abundance	MB64	Black Sea infralittoral mud.
GH2	-1150	Bathyal anoxic mixed sediment. Sand is still the main granulometry class, but decreasing in abundance	MF64	Black Sea lower bathyal mud: Anoxic predominately muddy substrates in the lower bathyal zone of the Black Sea, this is the most widespread habitat in the lower bathyal zone of the Black Sea.
GH1	-1619.5	Bathyal anoxic mixed sediment. Sand is still the main granulometry class, but decreasing in abundance	MF64	Black Sea lower bathyal mud
GH10	-1805	Bathyal anoxic mixed sediment. Sand is still the main granulometry class, but decreasing in abundance	MF64	Black Sea lower bathyal mud
GH9	-2043	Mixed sediment with dead bivalves and gastropods. Sand is still the main granulometry class, but decreasing in abundance	MD44	Black Sea offshore circalittoral mixed sediment: Offshore (deep) circalittoral habitats in the Black Sea with slightly muddy mixed gravelly sand and stones or shell.
GH8	-2166	Bathyal anoxic mixed sediment. Sand is still the main granulometry class, but decreasing in abundance	MF64	Black Sea lower bathyal mud

Station	Depth (m)	Sample description	EUNIS Code	Benthic marine habitat type and characterization
GH11-GH7	-2153; -2117	Bathyal anoxic muddy sand. Sand is still the main granulometry class, but decreasing in abundance	ME64	Black Sea upper bathyal mud: Predominately anoxic muddy substrates in the upper bathyal zone of the Black Sea. Fine mud is the most widespread habitat in the bathyal zone of the Black Sea.

ROV surveys (operated in the same scope of this ESIA, **Figure 6-69**) were instead executed nearer to the shore. For this reason, the characterization resulted in a greater presence of anthropogenic habitat, in particular for those associated to artificial reefs such as *Mytilus galloprovincialis* biogenic reefs in a3 station (EUNIS MA14 facies with Bivalvia).

The monitoring of Phase 1 (OTC 2023, see APPENDIX G section 2.2.2.1) reconfirmed the characterizations identified in the scope of the Phase 1 baseline (OTC 2022, Doc. No. SC26-OTC-PRJ-EN-REP-000007). In particular, the zones in proximity of the AoI investigated for this ESIA (the survey areas of the Phase 1, see OTC 2022, Doc. No. SC26-OTC-PRJ-EN-REP-000007), identified the presence of four characteristic species (*Donax trunculus, Chamelea gallina, Lentidium mediterraneum,* and *Modiolus adriaticus*), in the nearshore area; for this reason, the habitat was attributable to the EUNIS A5.237 (Pontic infralittoral sands and muddy sands without macroalgae). This habitat is characterized by low species richness and high biomass (expressed, in this case, by the density of individuals). This is particularly reflected in the benthic communities sampled (OTC 2022, Doc. No. SC26-OTC-PRJ-EN-REP-000007), where a strong dominance of two species (*D. trunculus* and *Chamelea gallina*) was observed. Such simple communities (i.e., characterized by a low species richness and high dominance) are known to be highly resilient to disturbance. This association was recorded also in the benthos monitoring of Phase 1 (OTC 2023, see APPENDIX G section 2.2.2.1).

The continental shelf's habitats appear, in this survey, poorer than what previously found (OTC 2022 and OTC 2023), and the characterization is mainly dependent on the sediment, since the associations described (Table 6-34) are for the most part thanatocoenosis.

As far as what concerns the pelagic habitats of the AoI, no information is available and, for such reason, assumptions are made in order to identify them.

Based on the data reported in the previous baseline sections, the AoI may be characterized by the pelagic habitats described here below.

Estuarine-influenced neritic waters facing the Filyos river mouth. The always illuminated water layer upon the continental shelf, characterized by high primary production, as indicated by the greenish water (see 6.3.2.1). Because of the water circulation of the area (see 6.3.1.4), this may not be considered as a true estuarine area characterized by brackish water, but only influenced but the river mouth. Because of these features, such habitat may be potentially frequented by all the biological components considered in this baseline (except for benthos), as indicated by the presence of cruising Black Sea harbour porpoises (see 6.3.2.4).

Sakarya epipelagic zone. The illuminated water layer at the surface of the sea where enough light is available for photosynthesis (Talley et al., 2012), located beyond the continental shelf and characterized by high primary production. It is the most biodiverse pelagic habitat of the AoI, inhabited by all the biological components considered in this baseline (except for benthos) (Miller, 2004). As indicted by the constant presence of cetaceans (see 6.3.2.4) and birds (Chapter 6.2 'Onshore Biological Baseline' of the present ESIA, at section 6.2.6), such habitat is rich in halieutic resources. In fact, because of its features and the organisms inhabiting it, this habitat takes on great importance to humans (see 6.3.2.3). The zone extends from the sea surface to the depth where 1% of the sunlight is found (i.e., generally identified as 100 m in the Black Sea).

Nevertheless, even if the AoI reaches the depth of 2,200 m, because of the total anoxic conditions of the Black Sea below 100-150 m of depth, including the AoI, no living organism could be found beyond that depth. For those reason, it can be safely stated that no other pelagic habitat may be found within the AoI.

Sensitivity Assessment

Because of their diversity and ecosystem functioning the benthic habitats and pelagic habitats are here assessed separately.

Considering the features listed in the following table, a **medium** sensitivity value was assigned to the marine habitats' component.

Sensitivity features	Supported by	Sensitivity value
Benthic habitats		
Simple communities dominated by one species. Absence of bioconstructions and seagrasses.	Primary Data	**Low**
Pelagic habitats		
Productive pelagic habitats highly rich in species Probable feeding area. Presence of protected species.	Primary and secondary data	**High**

6.3.2.6 Legally Protected Areas and Internationally Recognized Areas

Table 6-35: General overview of legally protected areas and internationally recognized areas.

Definition	Legally protected areas are clearly defined geographical spaces, nationally or internationally recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values (IUCN, 2008). Internationally recognized areas are important areas for biodiversity identified and designated because their particular features have the potential to support global biodiversity. Officially, they are non-legally protected areas and are usually defined by networks of internationally recognized environmental NGOs and Institutions (e.g., IUCN; Conservation International; Birdlife International, etc.) based on solid standardized scientific criteria. Some of the important areas for biodiversity may also overlap with legally protected areas, while others remain with no legal protection for a period of time until they are eventually recognized as such by the local authorities.
Study Area	**RSA**: Turkish EEZ of the Black Sea **Rationale**: Türkiye is the nation the Project belong to and, for this reason, the Black Sea waters under its jurisdiction are taken as reference. **AoI**: The project footprint with a buffer of 10 km per side. **Rationale**: Türkiye does not have regulations on distances from the boundaries of a protected area where a project can be implemented. Therefore, using a precautionary approach, a 10-km buffer is considered as appropriate.
Data sources	**Secondary sources**: Secondary data from scientific papers, grey literature and databases.
Sensitivity	**Medium-High**

Methodological approach

Data to describe the regional context (i.e., RSA) and the local context (i.e., AoI) were collected through literature review (see Chapter 13.0 of the present ESIA).

Due to the typology of this project (see Chapter 3.0 of the present ESIA), having both an offshore and an onshore part, this offshore baseline includes only the legally protected areas and internationally recognized areas that are totally or partially marine (i.e., coastal areas embedding also offshore within their boundaries).

All the other areas that are considered totally terrestrial (i.e., even coastal, but not having a marine part inside their boundaries), as well as the onshore description of the mixed areas (terrestrial and marine) are listed and described in the onshore baseline (see Chapter 6.2 'Onshore Biological Baseline' of the present ESIA, at section 6.2.8).

The typologies of legally protected areas here considered are the same already presented in the onshore baseline (see Chapter 6.2 'Onshore Biological Baseline' of the present ESIA, at section 6.2.9), being either marine or terrestrial, whereas, besides the internationally recognized areas already presented in in that section, the ones listed below are exclusively marine.

Ecologically or Biologically Significant Marine Areas (EBSAs): EBSAs are areas of the ocean carrying special importance in terms of ecological and biological characteristics: for example, by providing essential habitats, food sources or breeding grounds for particular species. They are designated under the CBD, but their designation does not bring any management measures or restriction of activities. However, it can be of support for the identification of new areas to be legally protected.

Important Marine Mammal Areas (IMMAs): Areas defined as discrete portions of habitat, important to marine mammal species, that have the potential to be delineated and managed for conservation. IMMAs consist of areas that may merit place-based protection and/or monitoring. They are not legally protected or managed and have usually the aim of supporting existing EBSA and KBA designations as a basis for promoting environmental protection and developing management plans for specific areas in the world's oceans.

Cetacean Critical Habitats (CCHs): These are parts of a cetacean range within the ACCOBAMS area (i.e. Mediterranean and Black Seas, and the Atlantic area contiguous to the Gibraltar Strait), either a whole species or a particular population of that species, that are essential for day-to-day survival, as well as for maintaining a healthy population growth rate. CCHs can include both areas that are regularly used for feeding, breeding and raising calves, as well as, sometimes, migrating, and areas where cetaceans are known to under direct threats (ship strike, by-catch, impulsive noise, harassment from whale-watching or pleasure boating, etc.). As of today, however, no CCH has been defined within the boundaries of the Turkish EEZ (Protected Areas | Accobams).

Regional context (RSA)

According to the available data, there are no exclusively offshore legally protected areas in the RSA, which, however, partially overlaps with 9 legally protected coastal areas. Based on the available georeferenced data, none of the abovementioned areas is located within or in proximity of the AoI. The nearest protected area (represented by Sakaraya Delta Wetland) is in fact located at a distance of 103 km from the Project AoI.

Table 6-36: Legally protected areas located within RSA borders.

Name	Typology	Distance from the AoI
Igneada Longozu	Wetlands (Nationally Important Area)	> 100 km
Firtina Deresi	Wetlands (Nationally Important Area)	> 100 km
Gölardi Simenlik	Wildlife Enhancement Area	> 100 km
Karadere	Wetlands (Nationally Important Area)	> 100 km
Kizilirmak Deltasi	Ramsar site, Wetland of International Importance (1998)	> 100 km

Name	Typology	Distance from the AoI
Kizilirmak Deltasi	Wildlife Enhancement Area	> 100 km
Kizilirmak Deltasi	Wetlands (Nationally Important Area)	> 100 km
Sakarya Deltasi	Wetlands (Nationally Important Area)	> 100 km
Sarikum Golu	Wetlands (Nationally Important Area)	> 100 km
Yesilirmak Deltasi	Wetlands (Nationally Important Area)	> 100 km

As far as what concerns the exclusively offshore internationally recognized areas, 4 IMMAs and 4 EBSAs partially overlap with the RSA. They are however located farther than 200 km from the project location (Table 6-37).

All the aforementioned IMMAs have been designated due to the presence of the three threatened and endemic marine mammal subspecies (namely: *Delphinus delphis ponticus, Phocoena phocoena relicta, Tursiops truncatus ponticus*), while the EBSAs are established according to their role in supporting the healthy functioning of oceans and the many services that it provides (Ecologically or Biologically Significant Marine Areas (EBSAs) (cbd.int)).

Table 6-37: Legally protected areas located within RSA borders.

Name	Typology	Rationale for designation	Distance from the AoI
Western Black Sea	IMMA	Criteria A, B, C for *Phocoena phocoena relicta*	> 200 km
Turkish Straits System and Prebosphoric	IMMA	Criteria A, B, C *for Delphinus delphis ponticus, Phocoena phocoena relicta, Tursiops truncatus ponticus*	> 200 km
Sinop	IMMA	Criteria A, B, C for *Delphinus delphis ponticus, Phocoena phocoena relicta, Tursiops truncatus ponticus*	> 200 km
Black Sea Eastern Anatolian Coast	IMMA	Criteria A, B, C both for *Phocoena phocoena relicta and Delphinus delphis ponticus*	> 200 km

Name	Typology	Rationale for designation	Distance from the AoI
Giresun – Tirebolu	EBSA	Criteria C1 (medium), C2 (high), C3 (medium), C4 (medium), C6 (medium), C7 (medium).	> 550 km
Trabzon-Arsin	EBSA	Criteria C1 (medium), C2 (high), C3 (high), C4 (medium), C5 (medium), C6 (medium), C7 (medium).	> 650 km
Trabzon-Sürmene	EBSA	Criteria C1 (medium), C2 (high), C3 (high), C4 (high), C5 (medium), C6 (medium), C7 (low).	> 650 km
Artvin-Arhavi	EBSA	Criteria C1 (medium), C2 (high), C3 (high), C4 (medium), C6 (medium), C7 (high).	> 800 km

*The AOI may be reassessed by experts at regional workshops and determined as future candidate IMMA.

IMMA criteria
A: Species or population vulnerability
B: Distribution and abundance
C: Key life cycle activities

EBSA criteria
C1: Uniqueness or rarity
C2: Special importance for life-history stages of species
C3: Importance for threatened, endangered or declining species and/or habitats
C4: Vulnerability, fragility, sensitivity, or slow recovery
C5: Biological productivity
C6: Biological diversity

The RSA also includes 15 coastal internationally recognized areas (see Table 6-38), and, based on the available georeferenced data, one partially overlaps with the AoI.

Table 6-38: Internationally recognized areas located within RSA borders

Name	Typology	System	Rationale for designation	Distance from the AoI
Akkuş Island	KBA, IBA	Terrestrial, Marine	IBA criterion: B3 (2004) KBA criterion: -* (2004)	> 100 km
Amasra Coast	KBA, IBA	Terrestrial, Marine	IBA criterion: B3 (2004) KBA criterion: -* (2004)	Overlapping

Name	Typology	System	Rationale for designation	Distance from the AoI
Bosphorus	KBA, IBA	Terrestrial, Marine	IBA criterion: A1, A4i, A4ii, A4iii, A4iv, B1i, B1ii, B1iv (2016) KBA criterion: A1b, A1d, B1, D1a (2016)	> 100 km
Eastern Black Sea Mountains	KBA, IBA	Terrestrial, Marine	IBA criterion: A1, A2, A3, B1i, B1iii, B1iv, B2 (2004) KBA criterion: A1c (2004)	> 100 km
Giresun Island	KBA, IBA	Terrestrial, Marine	IBA criterion: B1i (2004) KBA criterion: -* (2004)	> 100 km
Harsit Vadisi	KBA	Terrestrial, Marine	KBA criterion: -* (2004)	> 100 km
İğneada Forests	KBA, IBA	Terrestrial, Marine	IBA criterion: A4i, B1i, B1iv (2004) KBA criterion: D1a (2004)	> 100 km
Kızılırmak Delta	KBA, IBA	Terrestrial, Marine	IBA criterion: A1, A4i, A4ii, A4iii, B1i, B1ii, B2, B3 (2004) KBA criterion: A1a, A1b, A1c, A1d, B1, D1a (2004)	> 100 km
Kozlu coast	KBA, IBA	Terrestrial, Marine	IBA criterion: B3 (2004) KBA criterion: -* (2004)	~ 24 km
Küre Mountains	KBA, IBA	Terrestrial, Marine	IBA criterion: B3 (2004) KBA criterion: -* (2004)	~ 34 km
Sakarya Delta	KBA, IBA	Terrestrial, Marine	IBA criterion: B1i (2004) KBA criterion: -* (2004)	> 100 km
Şile Coast	KBA, IBA	Terrestrial, Marine	IBA criterion: B1i, B3 (2004) KBA criterion: -* (2004)	> 100 km
Sinop Peninsula	KBA, IBA	Terrestrial, Marine	IBA criterion: A1, A4iii (2004) KBA criterion: -* (2004)	> 100 km
Terkos Basin	KBA, IBA	Terrestrial, Marine	IBA criterion: A1, B2 (2004) KBA criterion: A1d (2004)	> 100 km
Yeşilırmak Delta	KBA, IBA	Terrestrial, Marine	IBA criterion: B1i, B2 (2004) KBA criterion: -* (2004)	> 100 km

*Key Biodiversity Area of international significance was identified using previously established criteria and thresholds and for which available data indicate that it does not meet the new global KBA criteria and thresholds set out in the Global Standard.

KBA criteria

A1: Threatened species

- A1a: >0.5% of global population size and 25 reproductive units (RU) of a CR/EN species
- A1b: ≥1% of global population size and ≥25 reproductive units (RU) of a VU species
- A1c: ≥0.1% of global population size and ≥5 RU of a species listed CR/EN due only to past/current decline
- A1d: ≥0.2% of global population size and ≥10 RU of a species listed VU due only to past/current decline

B1: Geographically restricted biodiversity

D1: Biological process

- D1a: ≥1% of global population size of a species, over a season and during ≥1 key stage in life cycle

Global IBA criteria

A1. Globally threatened bird species

A2. Restricted- range bird species

A3. Biome- restricted bird species

A4. Congregations of bird species/individuals

Regional IBA criteria

B1: Bird species of conservation concern

B2: Bird species with most of their range restricted to a region

- B2a: Bird species with a favorable conservation status but concentrated in the region+

B3: Regionally important congregations of bird species/individuals

- B3a: Regionally important bird congregations – biogeographical populations; this criterion is a unification of former criteria A4i, B1i & B1ii, B1iii (Europe), B1i & B1ii (Middle east)

Local context (AoI)

Based on the available georeferenced data, the Area of Interest (AoI) is not situated within or near any legally protected area. However, the offshore pipeline, and consequently the AoI, partially intersects the internationally recognized 'Amasra Coasts' KBA/IBA for approximately 1.5 km in length.

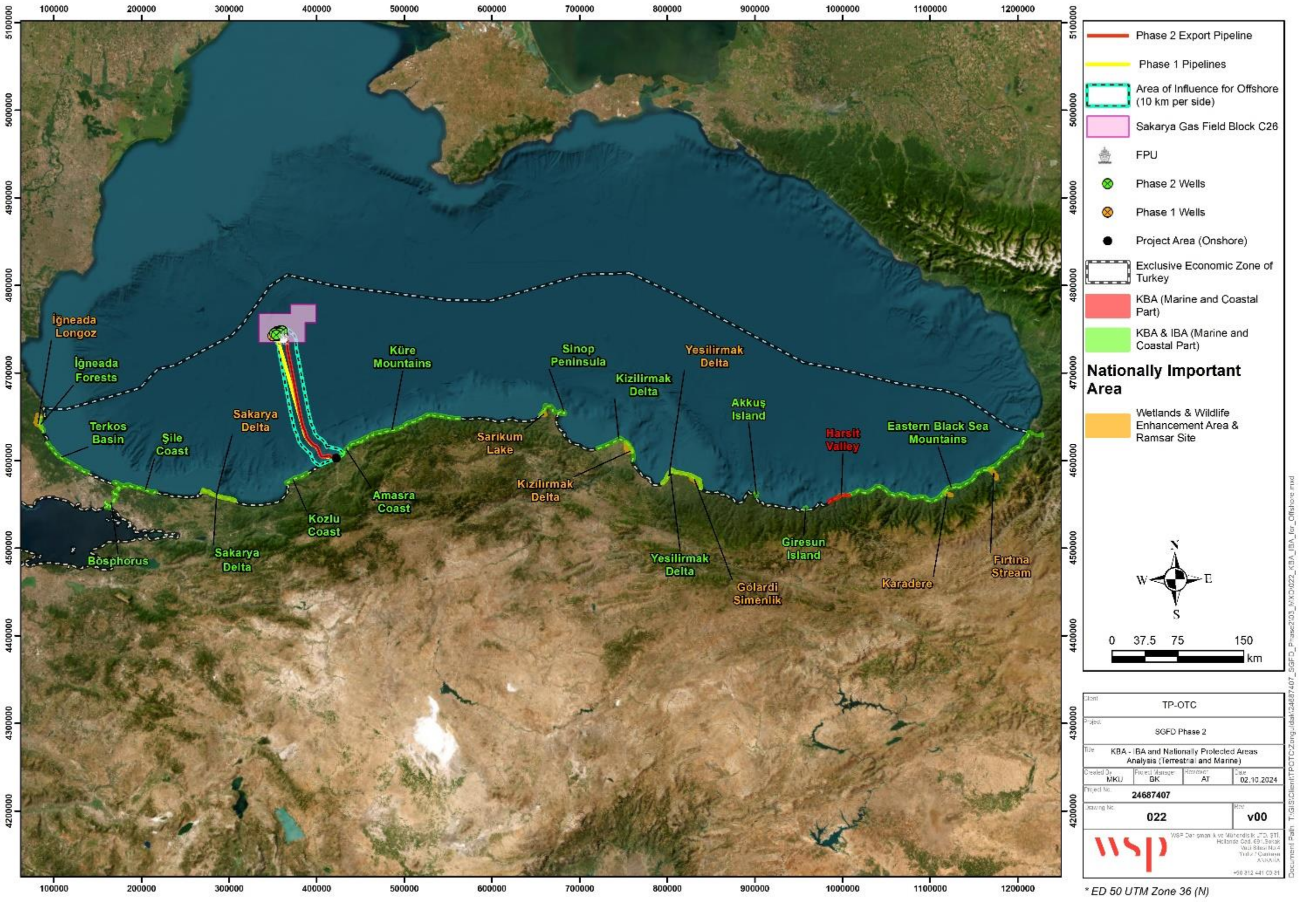


Figure 6-72: IBA/KBA and Legally Protected Area included in RSA (Turkish Exclusive Economic Zone, EEZ).

The Amasra Coasts IBA/KBA extends from shores starting from the Amasra district in the western Black Sea region and developing southwestwards to the Filyos river mouth at the western border of the Bartin province.

While its terrestrial portions are described in Chapter 6.2 (‘Onshore Biological Baseline’ of the present ESIA) at section 6.2.9 based on the available bibliographic data, the shores of Amasra, which has small well-preserved beaches and steep rocky slopes, are an important wintering area for blackwater divers (Gavia arctica) in the region. Moreover, it is known that otters (Lutra lutra) live in significant numbers in the region and, until the mid-1990s, Mediterranean monk seals (Monachus monachus) were also reported to live in the KBA/IBA.

Both the KBA and IBA have been designated by the presence of the European shag (Phalacrocorax aristotelis), which is the primary bird species breeding in the area (Amasra Coast (Türkiye) - BirdLife IBA factsheet).

However, while the IBA has been designated according to the criterion B3 “Regionally important congregations”, it should be noted that the KBA designation was based on criteria and thresholds previously established and for which available data indicate that it does not meet the new criteria and thresholds set out in the Global Standard anymore. In addition, no legal protection tool is reported for this internationally recognized area.

Sensitivity Assessment

Sensitivity features	Supported by	Sensitivity value
Absence of legally protected areas Presence of internationally recognized coastal areas	Secondary data	**Medium-High**

Given that no Legally Protected Areas and Internationally recognized areas (apart from a limited shallow water section of the Amasra Coast IBA/KBA) is located within the Project's AoI boundaries, the component will be included only in the terrestrial/coastal impact assessment. (please refer to chapter 7.2)

6.3.2.7 Critical Habitats Assessment

As stated by PS6, habitats constitute "a terrestrial, freshwater or marine geographical unit or airway that supports assemblages of living organisms and their interactions with the non-living environment". To meet PS6 requirements, clients would have different obligations for different kinds of habitats. This enables to provide a better understanding of particular species and habitat requirements and establish meaningful management units to define a mitigation strategy.

Critical habitat criteria as put forward by ESS6, that forms the basis of critical habitat assessment, are as follows:

- Criterion 1: Critically Endangered (CR) or Endangered (EN) species.
- Criterion 2: Endemic or restricted-range species.
- Criterion 3: Migratory or congregatory species.
- Criterion 4: Highly threatened and/or unique ecosystems.
- Criterion 5: Key evolutionary processes.

Based on the information reported in the sections above, three species (and no habitats) are considered eligible to potentially trigger Critical Habitat (CH) according to the definitions, criteria and thresholds provided by IFC Performance Standard 6 (PS6, 2019). Such species (*Phocoena phocoena relicta, Tursiops truncatus ponticus, Delphinus delphis ponticus*) are reported in Table 6-39 and, thus Critical Habitat Determination under IFC PS6 was conducted only for those ones.

In fact, other species initially identified as possible CH triggers were only reported in literature (so not directly observed during all the 2021-2024 surveys), or, if actually recorded, are cited as 'VU' in IUCN global red list. In particular:

- *Trachurus trachurus, Pomatomus saltatrix* and *Umbrina cirrosa* were recorded during the 2023 monitoring (as reported in 6.3.2.3, see APPNEDIX G section 2.2.2.4) and are actually listed as 'VU' (IUCN global), thus they could potentially be evaluated under criterion 1b: "Areas that support globally important concentrations of an IUCN Red-listed Vulnerable (VU) species, the loss of which would result in the change of the IUCN Red List status to EN or CR and meet the thresholds in GN72(a)". However, it is deemed that this criterion is not applicable, considered the wide distribution range of the species and their high fecundity together with the actual fishery management policies.
- The European eel (*Anguilla Anguilla*) and the sturgeons *Acipenser gueldenstaedtii* (Russian sturgeon), *Acipenser stellatus* (Common sturgeon) and *Huso huso* (Beluga) are all assessed as 'CR' species (as reported in 6.3.2.3, APPENDIX G section 2.2.2.4), and they're reported to be present along the Turkish nearshore waters (Memiş et al., 2020). However, none of these has ever been recorded during all the surveys operated for the Sakarya Gas Field Project, and they were never reported by the local fishermen. Moreover, based on the ecology of sturgeon species, Filyos River is not a suitable habitat for sturgeons, preferring deltas of larger rivers, such as Sakarya, Don and Danube (Memiş et al., 2020).

Table 6-39: Eligible species for the Critical Habitat Determination under IFC PS6.

Species/ subspecies	Common name	Global IUCN Red List Status	Endemic/ Restricted Range [Y/N]	Congregatory/ Migratory [C/M]	IFC PS6 Criteria of eligibility
Phocoena phocoena relicta	Black Sea harbour porpoise	EN	N*	C**	C1a; C3
Tursiops truncatus ponticus	Black Sea bottlenose dolphin	EN	N*	C**	C1a; C3
Delphinus delphis ponticus	Black Sea common dolphin	VU	N*	C**	C1b; C3

*The subspecies is endemic to the Black Sea, but is not considered as locally endemic

**The subspecies make seasonal feeding migrations in the Black Sea not considered to be true migrations sensu stricto

Considering the fact that all the three species selected (*Phocoena phocoena relicta, Tursiops truncatus ponticus* and *Delphinus delphis ponticus*) are marine mammals, the Critical Habitat Determination was conducted within the AoI as defined in 6.3.2.4.

Criterion 1: Habitats of significant importance to Critically Endangered and/or Endangered

All the three subspecies meet Criterion 1 standards (GN72, IFC GN6 2019):

- *Phocoena phocoena relicta* (Black Sea harbour porpoise) and *Tursiops truncatus ponticus* (Black Sea bottlenose dolphin), evaluated under Criterion 1a "Areas that support globally important concentrations of an IUCN Red-listed EN or CR species (≥ 0.5% of the global population AND ≥ 5 reproductive units GN16 of a CR or EN species)" as Endangered (EN) species; and
- *Delphinus delphis ponticus* (Black Sea common dolphin), assessed with a precautionary approach under Criterion 1b "Areas that support globally important concentrations of an IUCN Red-listed Vulnerable (VU) species, the loss of which would result in the change of the IUCN Red List status to EN or CR and meet the thresholds in GN72(a)" as a VU species having a distribution range limited to the Black Sea, Bosphorus Strait and Marmara Sea (IUCN, 2022).

In order to apply the Criterion 1a threshold, an Ecologically Appropriate Area of Analysis (EAAA) has been identified for each species and used to determine the presence of CHs, since an exact numerical estimation of the local populations of the abovementioned species does not exist.

The EAAA was then compared with the Extent of Occurrence (EOO) of each species, which represents the global population distribution, in order to identify if that area could potentially meet Criterion 1a threshold: if the EAAA is ≥ 0.5% of the EOO, the area is defined as triggering Critical Habitat (CH). The EAAA identification for each species is reported below:

- For the Black Sea harbour porpoise (*Phocoena phocoena relicta*), being typically a neritic species that inhabits mainly shallow waters (0–200 m deep) over the continental shelf, the EAAA (Figure 6-73) has been identified as the continental shelf present within its EOO, corresponding to the Black and Azov Seas (with the related Kerch Strait), and the Marmara Sea (no confirmed information from the Dardanelles Straits is known) (IUCN, 2022);
- For the Black Sea bottlenose dolphin (*Tursiops truncatus ponticus*), being typically a neritic species that sometimes may occur far offshore on the continental slope, the EAAA (Figure 6-74) has been identified as the continental shelf and the slope present within its EOO, corresponding to the Black Sea, the Kerch Strait along with the adjoining part of the Azov Sea, and the Turkish Straits System (TSS) (IUCN, 2022);
- For the Black Sea common dolphin (*Delphinus delphis ponticus*), having typically more oceanic habits and inhabiting offshore waters over the continental slope and deep-sea depression, the EAAA (Figure 6-75) has been identified as the abyssal plane present within its EOO, corresponding to the Black Sea, the Bosphorus Strait and Marmara Sea (IUCN, 2022).

All the EAAAs identified as mentioned above correspond to >0.5% of the EOO, therefore *Phocoena Phocoena relicta, Tursiops truncatus ponticus* and *Delphinus delphis ponticus* are determined to trigger Critical Habitat since they were directly observed in the AoI, The results of the CH Determination are detailed in Table 6-40.

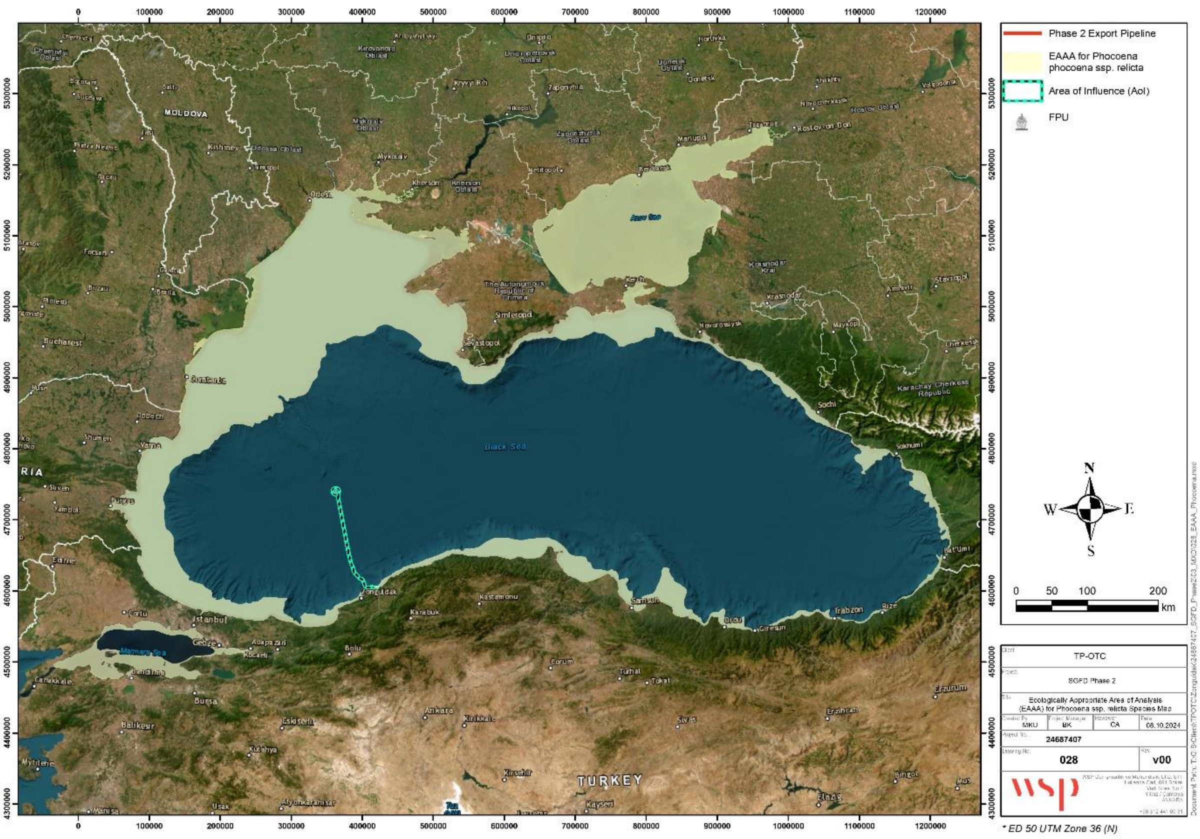


Figure 6-73: Ecologically Appropriate Area of Analysis for the Black Sea harbour porpoise (*Phocoena phocoena relicta*).

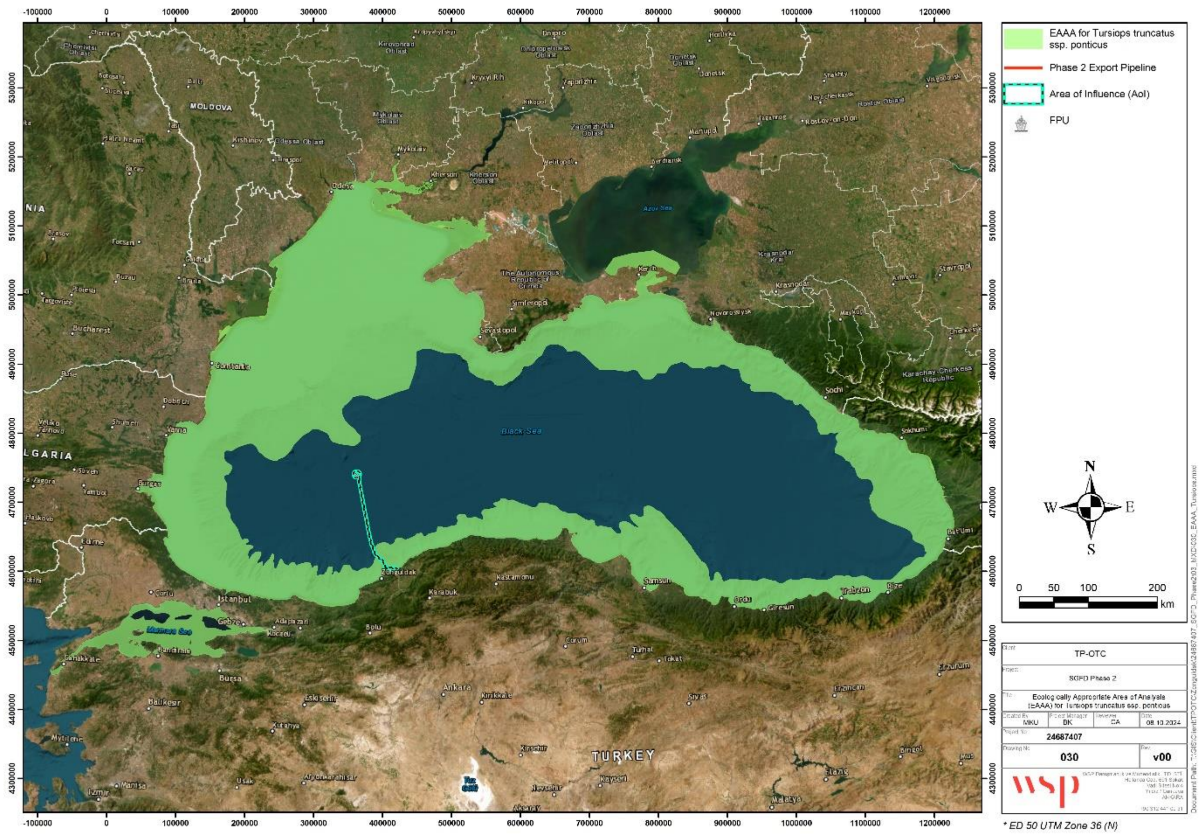


Figure 6-74: Ecologically Appropriate Area of Analysis for the Black Sea bottlenose dolphin (*Tursiops truncatus ponticus*).

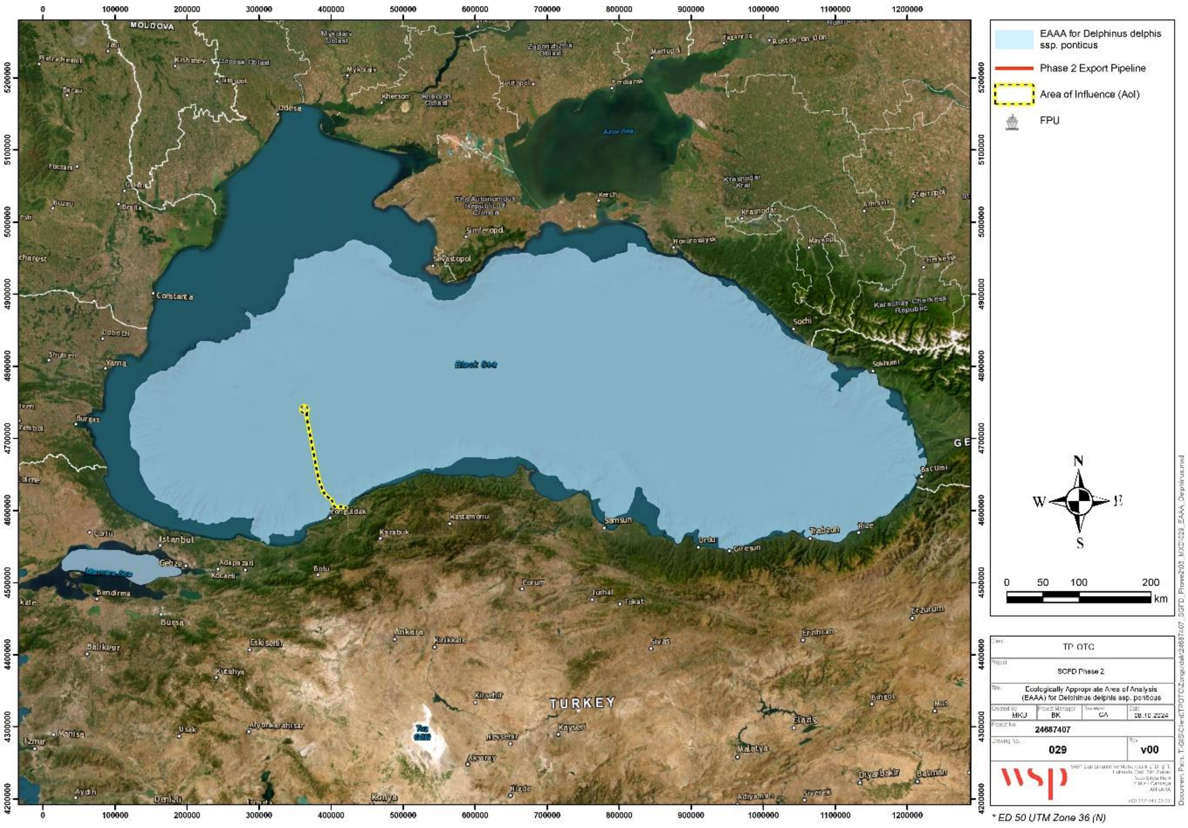


Figure 6-75: Ecologically Appropriate Area of Analysis for the Black Sea common dolphin (*Delphinus delphis ponticus*).

Table 6-40: CH Determination for the species eligible to trigger Critical Habitat according to Criterion 1 (IFC PS6, 2019).

Species/ Subspecies	Common name	IUCN Global Red List Status	Potentially Present/ Observed [P/O]	EOO (km^2)	0.5% of EOO (km^2)	EAAA (km^2)	EAAA is ≥ 0.5% of EOO [Y/N]	Trigger Critical Habitat [Y/N]
Phocoena phocoena relicta	Black Sea Harbour Porpoise	EN	O	496,636	2,483	153,847	Y	Y
Tursiops truncatus ponticus	Black Sea Bottlenose Dolphin	EN	O	437,321	2,187	225,983	Y	Y
Delphinus delphis ponticus	Black Sea Common Dolphin	VU	O	434,194	2,171	316,504	Y	Y

Criterion 2: Habitats of significant importance to Endemic and/or Restricted-range species Local context (AoI)

No species meets the endemic and restricted range standards of Criterion 2 (GN74, IFC 2019); therefore, no species were identified as Endemic and/or Restricted-range.

As a result, no species are determined as triggering Critical Habitat or potentially CH for Criterion 2 (GN75, IFC 2019).

Criterion 3: Habitats supporting globally significant concentrations of Migratory and/or Congregatory species

All the three subspecies meet Criterion 3 standards (GN76 and GN77, IFC GN6 2019), being identified as congregatory, as follows.

- *Phocoena phocoena relicta* is known to form dense aggregations of some hundreds of individuals during its seasonal migration every year (IUCN, 2022).
- *Tursiops truncatus ponticus* is known to form aggregations close to the Turkish coast (Sergey Krivokhizhin pers. comm., 2005; IUCN, 2022).
- *Delphinus delphis ponticus* is known to be a highly social animal that lives in groups ranging from a few tens to several thousands of individuals (Perrin 2018, Saavedra et al. in press; IUCN, 2022).

All the subspecies have been assessed according to Criterion 3a threshold "areas known to sustain, on a cyclical or otherwise regular basis, ≥ 1 percent of the global population of a migratory or congregatory species at any point of the species' lifecycle". Within this scope, since an exact numerical estimation of the local populations of these species does not exist, the same EAAAs presented in section "Criterion 1: Habitats of significant importance to Critically Endangered and/or Endangered species" have been compared with the EOO of each species, which represents the global population estimate, in order to identify if that area could potentially meet Criterion 3 threshold: if the EAAA is ≥ 1% of the EOO, the area is defined as potentially Critical Habitat.

All the EAAAs identified correspond to >1% of the EOO, therefore *Phocoena phocoena relicta, Tursiops truncatus ponticus* and *Delphinus delphis ponticus* are determined to trigger Critical Habitat since they were directly observed in the AoI. The results of the CH Determination are detailed in Table 6-41.

Table 6-41: CH Determination for the species eligible to trigger Critical Habitat according to Criterion 3 (IFC PS6, 2019).

Species/ Subspecies	Common name	IUCN Global Red List Status	Potentially Present/ Observed [P/O]	EOO (km2)	1% of EOO (km2)	EAAA (km2)	EAAA is ≥ 1% of EOO [Y/N]	Trigger Critical Habitat [Y/N]
Phocoena phocoena relicta	Black Sea Harbour Porpoise	EN	O	496,636	4,966	153,847	Y	Y
Tursiops truncatus ponticus	Black Sea Bottlenose Dolphin	EN	O	437,321	4,373	225,983	Y	Y
Delphinus delphis ponticus	Black Sea Common Dolphin	VU	O	434,194	4,342	316,504	Y	Y

Criterion 4: Highly Threatened and/or Unique Ecosystems

The Criterion 4 application (GN79, IFC 2019) foresees the use of the "Red List of Ecosystems (RLE)" where formal IUCN assessments have been conducted, however no evaluation were performed within the Black Sea area as shown in the IUCN RLE Database9. The "European Red List of Habitats – Part 1. Marine habitats" was used instead.

None of the EUNIS habitats identified in 6.3.2.5 is considered as unique ecosystem and/or highly threatened. Therefore, no Critical Habitat is expected to be present in the AoI according to Criterion 4 (GN80, IFC GN6 2019).

Criterion 5: Areas associated with Key Evolutionary Processes

The AoI is not known to contain landscape features that may influence evolutionary processes, as described in 6.3.1.1, giving rise to regional configurations of species and ecological properties. In fact, no species and/or subpopulations of species is characterized by a particular level of isolation10, spatial heterogeneity, and wealth of environmental gradients or edaphic interfaces. Moreover, the areas are not considered to be of demonstrated importance as to climate change adaptation or as biological corridor. These considerations suggest that the AoI does not support any key evolutionary processes. Thus, no Critical Habitat is triggered under Criterion 5.