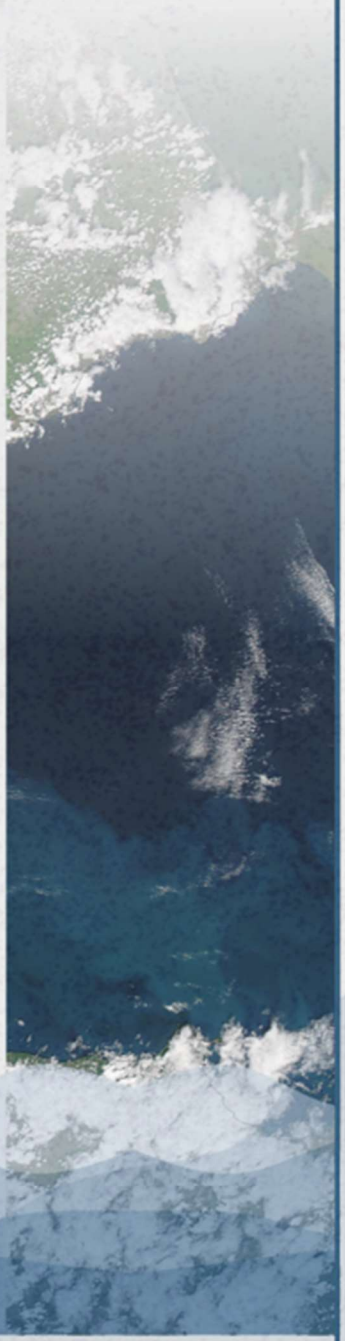
RESPONSE

Building Response Frameworks under existing & new Marine Pollution Challenges in the Black Sea



Milestone 2

Monitoring and assessment framework on Marine pollution types elaborated

Co-funded by the European Union

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Executive Summary

Marine pollution is a growing global threat, harming ecosystems and human health. Effective monitoring and assessment are crucial for understanding the scope of the problem and guiding mitigation efforts.

Project background and context

The RESPONSE, supported by the European Union EMFAF, under Grant Agreement no 101124661 has duration of 36 months, starting from 01.10.2023. The project consortium involves six partners from five different countries: Greece, Bulgaria, Romania, Ukraine and Georgia. Five of the participants are based in countries bordering on the Black Sea, and the lead beneficiary, the Aristotle University of Thessaloniki (AUTH), has a long history of working with the region and with members of the consortium. The partnership includes one university, two research institutes and three environmental NGOs: the Black Sea NGO Network (BSNN) regional NGO network based in Varna, Bulgaria; the National Institute of Marine Research and Development (NIMRD), based in Constanta, Romania, leading research institute for the Black Sea; the Institute of Market Problems and Economic-Ecological Research (IMPEER), Odesa, a public institution, part of the National Academy of Sciences of Ukraine; the Black Sea Branch of Ukrainian Environmental Academy of Sciences (BSBUEAS) is Odesa-based NGO with a team of professional researchers; and the Greens Movement of Georgia / Friends of the Earth (GMG/FoE) – Georgia, an NGO, part of the international environmental network. All three beneficiaries from EU Member States have extensive experience in marine pollution projects under the Horizon 2020 and Horizon Europe programmes.

RESPONSE aims to identify and promote the development and establishment of new-generation advanced training schemes and curricula to support early warning, region-wide mechanisms for monitoring natural and man-made disasters. Various training programs, platforms and curriculum have been implemented to monitor marine pollution and ensure knowledge integration and dissemination. Still, training material, best practices, standards and protocols often differ among platforms and programs, hindering progress towards implementing an integrated, transdisciplinary and multidisciplinary marine pollution training system. Peculiar events, such as armed conflicts, create new environmental and societal challenges that call for international, coordinated responses.

RESPONSE acknowledges the importance of deeper understanding of marine ecosystems and river-delta-sea connections, the need for development of harmonized procedures, standards and methodologies in marine monitoring across the Black Sea countries to support healthy and resilient seas and foster integrated marine governance. The sustainable changes that are required for the establishment of efficient, advanced training schemes that would be integrated with the challenges, goals and specificities of the scientific and social context and make the most of the untapped capacity of stakeholders to promote regional awareness in the field.

In view of the background and context described above, the four overarching objectives of RESPONSE are: 1) IDENTIFY and UNDERSTAND the institutional and societal gaps and needs for effective, integrated, transdisciplinary and multidisciplinary marine pollution training systems; 2) DEVELOP effective training programs by assembling, integrating, and improving the most promising approaches and results into a comprehensive framework that consists of a set of methodological training tools, databases, policy recommendations, and background information; 3) SUPPORT the implementation of the EU and Regional Strategies, by developing operational guidelines for effective application, updating, monitoring and management of training programs on marine pollution; 4) EMPOWER marine pollution training, monitoring and mitigation by involving, inspiring and influencing stakeholders through *a broader vision of co-design, co-creation, co-*

establishment, co-implementation and co-assessment of the training programs.

Table of Contents

Aim of the Milestone

This framework outlines a comprehensive approach to monitoring and assessing different types of marine pollution. By providing a clearer picture of pollution sources and their impacts on humans, organisms, ecosystems, and the services they provide, this approach will empower us to develop more effective responses. The framework addresses major marine pollution categories, including: chemical pollution (e.g.,heavy metals, polycyclic aromatic hydrocarbons, persistent organic pollutants), nutrient pollution (eutrophication, oil spills (total petroleum hydrocarbons), maritime traffic, offshore activity. A deeper understanding of the marine ecosystems and the critical connections between rivers, deltas, and the sea is essential. Developing harmonized procedures, standards, and methodologies for marine monitoring across Black Sea countries is crucial. This will not only support healthy and resilient seas but also foster integrated marine governance.

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Table 1 Names and roles of contributors to this deliverable.

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Introduction

Marine pollution is a major global issue, because oceans cover a vast majority of the Earth's surface and connect all continents. Pollutants don't respect borders and can travel long distances, contaminating entire ecosystems. Pollution disrupts delicate food webs, causing harm to marine animals through entanglement, ingestion, and habitat destruction. This can have cascading effects throughout the marine ecosystem. Also, pollution damages coastal ecosystems and fisheries, impacting tourism and livelihoods that depend on healthy oceans. The conversation around marine pollution acknowledges the sheer volume and diversity of contaminants. Plastic waste is a major focus, but it's just the tip of the iceberg. Estimates suggest millions of tons of plastic enter the oceans annually, causing harm to marine life and ecosystems. Chemical runoff from land, raw sewage discharge, and even noise pollution all contributes to the growing problem. Main types of marine pollution are around land-based sources, highlighting the need for improved waste management practices and pollution control measures upstream. Excess fertilizers and manure from agriculture can create algal blooms, depleting oxygen and harming marine ecosystems. Also, untreated sewage introduces harmful bacteria, viruses, and chemicals, posing risks to human health and disrupting marine life**.** Industrial waste as chemicals, heavy metals, and oil discharges from factories can have toxic effects on marine organisms and disrupt food webs. These pollutants travel from our cities, farms, and industries, highlighting the critical need for improved waste management practices at the source. We need better systems for collecting and treating wastewater, reducing agricultural runoff, and implementing stricter controls on industrial discharges.

The Black Sea is unfortunately one of the world's most polluted seas, suffers from a multitude of pollutants, with some estimates ranking it as Europe's most contaminated sea. The Black Sea main types of pollution are related to land-based sources are the primary culprits, with rivers like the Danube, carrying pollutants from agriculture, industry, and untreated sewage. Additionally, oil spills and discarded fishing gear further contribute to these problems. The Black Sea's restricted water exchange with the Mediterranean Sea due to its geography traps pollutants within the basin, hindering natural dispersal. The Bucharest Convention (Convention on the Protection of the Black Sea Against Pollution), a regional agreement, aims to protect the Black Sea from pollution. However, continued international cooperation and stricter waste management practices in surrounding countries are crucial to improve the situation.

1. Bulgaria

The evaluation of the monitoring and assessment framework on marine pollution in Bulgaria is mainly based on the Updated Assessment of the State of the Marine Environment (2021), which is part of the Marine Strategy of Bulgaria.

Regarding **eutrophication** there is a relatively good understanding of the developments in the coastal waters and the shelf area. This is based on regular monitoring of all eight indicators established by Commission Decision (EU) 2017/848 of 17 May 2017. Concentrations of dissolved inorganic nitrogen (DIN) and dissolved inorganic phosphorus (DIP) are monitored in coastal waters, the shelf area and the open sea during spring and summer. The spatial coverage of chlorophyll monitoring is sufficient for a reliable assessment of the state of the marine environment in coastal waters and on the shelf. The number of sampling stations in the open sea is limited and does not allow an assessment of this parameter in this zone.

Standardisation and extension of metabarcoding-based methods are necessary for accurate monitoring of potentially toxic phytoplankton species and assessment of the state of the marine environment. The accumulation of regional toxicity data and an integrated approach with other analyses is recommended. Water transparency is monitored regularly during the spring and summer seasons, and the results allow an assessment of the photic limit for the coastal waters and the shelf.

Oxygen saturation is monitored in the coastal area. The indicators of nutrient concentration, chlorophyll *a* and oxygen saturation are used to calculate the trophic index TRIX, which provides an integrated assessment of eutrophication. TRIX is determined for the Bulgarian coastal waters on the basis of the available data.

At this stage, the threshold between good and poor condition in terms of the abundance of opportunistic macroalgae is subject to reassessment and further validation. There is recent data and pilot studies on the composition and abundance of macroalgae communities and seagrasses, which is not sufficient for conclusive assessment of the state of the marine environment.

Impacts on macrozoobenthos communities are assessed for coastal waters and the shelf area using the EQR M-AMBI(n) index based on monitoring data and project inputs. Uncertainties remain due to lack of confidence in the maps of the modelled major benthic habitat types in the Black Sea, lack of local data for some habitats with limited range, and lack of distinction between natural factors causing hypoxia in areas of the shelf edge and eutrophication effects.

The monitoring of **contaminants** in the marine environment follows the distinction between ubiquitous, persistent, bioaccumulative, toxic (uPBT) substances and non-uPBT pollutants. The spatial coverage of the monitoring network allows for assessment of the state of the marine environment for chemical pollutants in matrix water and matrix biota. The uPBT in matrix water include mercury (Hg), benzo(a)pyrene (BaP) and tributyltin (TBT) compounds), and for matrix biota: mercury (Hg), dioxins and polybrominated diphenyl ethers (PCB), polybrominated diphenyl ethers (PBDE), benzo(a)pyrene (BaP). A larger group of non-uPBT pollutants is included in the regular monitoring: Al, As, Cd, Cr, Cu, Ni, Pb, Zn, Bisphenol A, Anthracene, Naphtalene, Atrazine,

Hexachlorobenzene, Pentachlorobenzene, PCBs and others.

There are no environmental quality standards for marine sediments that can be used to assess the status of contaminants in the marine environment. The results obtained for contaminants in matrix sediments do not participate in the assessment but are indicative and serve to aggregate data in order to infer trends in their distribution.

The scope of the beach macro and micro **marine litter** monitoring programme includes the monitoring of 10 unprotected beaches or coastal strips along the northern and southern coasts of Bulgaria. In marine waters, the monitoring includes observations of litter floating on the sea surface in Bulgaria's coastal, shelf and open sea waters, as well as litter deposited on the seabed in these areas.

The available data on the distribution and abundance of marine litter on the sea surface and on the seabed are insufficient to assess the pressure. Additional data from regular monitoring are needed to derive thresholds and to assess the situation both in the coastal assessment areas and in the shelf area.

The data on microliter is insufficient for the assessment of its impact on the beach, sea surface and seabed. The expectation is that the regular implementation of the existing monitoring programme will provide reliable information at the end of the third assessment cycle of the MSFD.

The impact of marine litter on the state of the environment is better understood as a result of a series of national and transborder projects, as well as the implementation of regular monitoring activities. The adoption of the Black Sea Marine Litter Regional Action Plan in 2018 provides a framework for transboundary cooperation.

Underwater noise is defined as anthropogenic sound that has the potential to cause negative impacts on the marine environment, including marine biota. The effects of underwater noise on marine organisms can range from behavioural disturbance to hearing loss and, in the worst cases, mortality. The MSFD recognises underwater noise as an important pressure on the marine environment that should be assessed with a view to achieving good environmental status.

Existing data on impulse sound and low frequency noise provide only baseline information. They describe the current state of Bulgarian marine waters in terms of introduced underwater noise. The available results do not provide a status or trend assessment, as thresholds for the impact of these pressures on marine animal populations have not yet been established due to a lack of data.

The introduction of **invasive species** through **ballast waters** has grave implications for the state of the marine environment. Biological invasions are among the most important drivers of the loss of native biodiversity and natural resources in marine ecosystems. Non-native species can affect the new environment by altering communities, habitats and ecosystem functioning as a whole through a range of mechanisms such as competition, predation, strong grazing pressure, algal blooms, toxin release, hybridization, disease transmission, habitat modification and ecosystem engineering. The extent to which alien species alter the environment and associated ecosystem services also depends on their degree of invasiveness.

The analysis of the distribution and abundance of invasive species allows for partial assessment of the state of the Bulgarian Black Sea waters. The recommendations for improving the monitoring of invasive species include achieving better spatial and temporal coverage; prioritising monitoring at the required frequency in 'hotspots' in ports and marinas; using genetic, molecular studies to identify

alien species; conducting regional inventories of alien species every 5 years to determine their status and degree of invasiveness.

Atmospheric deposition of NOx, PAH, heavy metals and particulate matter can add to the adverse effects of eutrophication and the introduction of pollutants into the marine environment. There is no specific monitoring of air pollution over the Black Sea. Data from coastal air quality monitoring, satellite observations and modelling results can be used as a rough estimate of the deposition of atmospheric pollutants to the sea.

In summary, the existing Bulgarian monitoring and assessment framework comprehensively covers parameters such as eutrophication, chemical contaminants and invasive species. There is a growing database on marine litter, which should make it possible to assess the state of its impact in the near future. There are separate observations on underwater noise, but no consistent monitoring, while atmospheric deposition in the marine environment is not currently part of the monitoring effort.

Bulgaria has been working consistently to address the challenges of marine pollution. The Updated Assessment of the State of the Marine Environment (2021), part of the Marine Strategy of Bulgaria, provides information for the evaluation of the monitoring and assessment framework on marine pollution in the Bulgarian waters of the Black Sea. Regarding eutrophication there is a relatively good understanding of the developments in the coastal waters and the shelf area. This is based on regular monitoring of all eight indicators established by Commission Decision (EU) 2017/848 of 17 May 2017. The indicators of nutrient concentration, chlorophyll *and* oxygen saturation are used to calculate the trophic index TRIX, which provides an integrated assessment of eutrophication. TRIX is determined for the Bulgarian coastal waters based on the available data. The monitoring of contaminants in the marine environment follows the distinction between ubiquitous, persistent, bioaccumulative, toxic (uPBT) substances and non-uPBT pollutants. The spatial coverage of the monitoring network allows for assessment of the state of the marine environment for chemical pollutants in matrix water and matrix biota. The results obtained for contaminants in matrix sediments do not participate in the assessment but are indicative and serve to aggregate data to infer trends in their distribution. The scope of the beach macro and micro marine litter monitoring programme includes the monitoring of 10 unprotected beaches or coastal strips along the northern and southern coasts of Bulgaria. In marine waters, the monitoring includes observations of litter floating on the sea surface in Bulgaria's coastal, shelf and open sea waters, as well as litter deposited on the seabed in these areas. The available results for underwater noise do not provide a status or trend assessment, as thresholds for the impact of these pressures on marine animal populations have not yet been established due to a lack of data. The analysis of the distribution and abundance of invasive species allows for partial assessment of the state of the Bulgarian Black Sea waters. There is no specific monitoring of air pollution over the Black Sea though atmospheric deposition of NOx, PAH, heavy metals and particulate matter can add to the adverse effects of eutrophication and the introduction of pollutants into the marine environment.

The existing Bulgarian monitoring and assessment framework comprehensively covers parameters such as eutrophication, chemical contaminants and invasive species. There is a growing database on marine litter, which should make it possible to assess the state of its impact in the near future. There are separate observations on underwater noise, but no consistent monitoring, while atmospheric deposition in the marine environment is not currently part of the monitoring effort.

2. Georgia

The Georgian sector of the Black Sea faces significant challenges due to various sources of pollution, impacting marine ecosystems and human health. The primary sources of pollution in this area include sewer discharges, industrial activities, agricultural runoff, marine litter, operational oil spills, and the introduction of non-indigenous species via ballast water discharge. These sources contribute to multiple types of pollution, including eutrophication, contaminants, marine litter, noise pollution, and atmospheric pollution.

Eutrophication is an issue in the Georgian Black Sea sector. Nutrients, mainly from agricultural runoff and untreated sewage, sometime lead to algal blooms that deplete oxygen levels in the water. The process, known as hypoxia, can impact marine life, and may lead to the death of fish and other aquatic organisms. The primary sources of these nutrients are rivers such as the Rioni, Enguri, Supsa, Chorokhi, Kodori and others, which carry pollutants from agricultural areas and settlements. Urbanization along the coast exacerbates the problem, as insufficiently treated wastewater is in many places discharged directly into the sea. The effects of eutrophication include reduced water transparency, the decline of benthic communities, and the disruption of the marine food web.

Contaminants such as heavy metals (e.g., mercury, cadmium, lead), persistent organic pollutants (e.g., PCBs, DDT), and hydrocarbons pose risks to the marine environment. These pollutants may enter the sea through industrial discharges, urban runoff, and atmospheric deposition. They accumulate in sediments and biota, leading to bioaccumulation and biomagnification through the food chain. This not only can affect marine life but also can pose health risks to humans who consume contaminated seafood. Regular monitoring and stricter enforcement of regulations are needed to address this issue effectively.

Marine litter, including macrolitter and microplastics, is another pervasive and significant problem in the Georgian Black Sea sector. Improper waste disposal, coastal tourism, and shipping activities contribute to the accumulation of plastic waste in the sea. Marine animals often ingest plastic debris, leading to physical harm and exposure to toxic substances. Recreation, tourism and coastal amenities suffer strongly from this type of pollution. Entanglement in marine litter can also cause injury or death to marine animals. Microplastics, which are small plastic particles, enter the food web and can potentially impact human health. Efforts to improve waste management practices and public education campaigns are essential to reduce marine litter.

Noise pollution from shipping, industrial activities, and offshore construction disrupts marine animal communication, leading to stress and behavioral changes. Impulsive and continuous noise can interfere with the ability of marine animals to find food, navigate, and reproduce. Chronic exposure to noise can cause hearing damage and even death in severe cases. Developing baseline noise level data and implementing noise reduction measures are crucial to mitigate these impacts.

Invasive species introduced through ballast water discharge are a significant threat to the marine ecosystem. Species such as Mnemiopsis leidyi, Beroe ovata, and Rapana venosa have already caused considerable disruption in the Black Sea. These invasive species outcompete native species, alter habitats, and impact fisheries and tourism. Effective ballast water management practices and increased monitoring are essential to control the spread of invasive species. Oil

majors such as Chevron, BP operating in Georgia and SOCAR should significantly improve ballast water management and treatment.

Atmospheric pollution, including sulfur oxides (SOx), nitrogen oxides (NOx), and particulate matter (PM), contributes to the acidification of marine waters, as well as eutrophication. These pollutants, primarily from industrial emissions and vehicle exhaust, affect the health of marine ecosystems and pose risks to human health. Enhancing air quality monitoring and implementing stricter emissions controls are necessary to address this issue.

The transnational nature of marine pollution in the Black Sea necessitates international cooperation. Pollutants from one country can easily affect neighboring countries due to the interconnectedness of marine ecosystems. The Bucharest Convention and other regional agreements aim to protect the Black Sea from pollution, but effective implementation requires harmonized procedures and standards across all Black Sea countries. Georgian should drastically improve its efforts to comply with Bucharest Convention and other marine conventions such as those under auspices of IMO, and UNCLOS.

In conclusion, the Georgian sector of the Black Sea faces significant pollution challenges that require comprehensive monitoring, stringent regulations, and international cooperation. By addressing these issues collaboratively, the Black Sea countries can protect marine ecosystems and ensure a healthy environment for future generations.

It is worth quoting diagnostics of the Proposal for a National Marine Environment Strategy and Action Programme (Final Draft, July 2020), a report developed for the Ministry of Environmental Protection and Agriculture of Georgia by the Transtec-GIZ Consortium with support of the EuropeAid/138778/DH/SER/multi EU-funded project 'Support to the implementation of the environmental provisions of the EU – Georgia Association Agreement' that started in March 2019.[1] EU-funded project 'Support to the implementation of the environmental provisions of the EU – Georgia Association Agreement' that started in March 2019.

The following general conclusions were made in the Final Daft NMESAP with regard to environmental status of MSFD Descriptors in Georgia:

"**Descriptors 1 and 4 – Marine Environment**. Insufficient information is available on all habitats and species. The information gap needs to be further specified. Only indicative information is available; more research is needed. At this stage a decision on the full extent of the GES is not possible.

Descriptor 2 – Non-Indigenous Species. Only an indicative status could be defined. Multiple species, in extensive numbers, are present. However, the magnitude of their abundance is not sufficiently known. Regarding the GES, only indicative information is available. More research is needed. As a consequence, no decision on GES is possible yet.

Descriptor 3 – Populations of all Commercially Exploited Fish and Shellfish. Quota for sustainable fish stocks are scientifically determined and applied on an annual basis. However, a considerable number of fish species, including several anadromous and catadromous species have declined and/or are endangered; actions for these are needed. Insufficient information is currently available on all species; this needs to be further determined. First, the existing research and monitoring programmes need to be in line with the MSFD, next the GES that could be defined accordingly.

Descriptor 5 – Eutrophication. According to the assessment with the Black Sea Eutrophication Assessment Tool, most of the upper mixed layer of the Georgian shelf waters was in GES. In the lower photic zone (depth of 18 - 42 m) the assessed status also corresponds to the GES. Most of the upper mixed layer of the Georgian shelf and the low photic zone are in GES.

Descriptors 6 and 7 – Seafloor Integrity and Hydrographical Condition. A lack of sediment input from rivers into the sea is a severe threat to the coastline. River mouths will be affected and on the longer term the seabed as well. In general, GES is currently present for benthic habitats, apart from ports (Poti, Batumi, Kulevi, Supsa Terminal, Anaklia) and the Paliastomi Lagoon. Research to the root causes of the problems and development of measures is needed. The situation of Paliastomi Lagoon is not good; further research and measures are needed.

Descriptors 8 and 9 – Contaminants of the Marine Environment. Only indicative information on pollution is available. However, more research on the nature and its extent is needed. Therefore, it is currently not possible to make a decision on the current status or the GES.

Descriptor 10 – Marine Litter. Litter is present along Georgia's entire coastline and in rivers. Only indicative information is available on its amounts and composition. The available information mainly focuses on macro litter. Information on micro litter and nano litter, and litter present in animals, is non-existent or scarce at best. More research is needed. A decision on the current status or the GES is not possible.

Descriptor 11 – Energy/Noise in the Marine Environment. Because of the limited number of coastal development projects, the absence of extensive and large numbers of marine installations (including windfarms and oil or gas rigs) most of the noise at sea is likely caused by shipping. It is assumed that the Current Environmental Status of energy in the marine environment is at safe levels, thus GES."

3. Romania

The Black Sea suffers most from pollution originating on land. Major rivers, like the Danube, act as channels for pollutants from farms, factories, and raw sewage. Oil spills and lost fishing gear add to the environmental problems the Black Sea faces. The main types of Black Sea pollution categories, include eutrophication (nutrients), contaminants pollution (e.g., heavy metals, polycyclic aromatic hydrocarbons, persistent organic pollutants), oil spills (total petroleum hydrocarbons), maritime traffic, offshore activity, noise pollution (impulsive and continuous noise), marine litter pollution (macrolitter and microplastics), balast water (invasive species).

Overall, these pollutants disrupt the delicate balance of marine ecosystems, impacting everything from plankton at the base of the food web to marine mammals at the top.

Excess nutrients act like fertilizer, triggering massive algal blooms. When these algae die and sink, their decomposition sucks up oxygen in the water. This creates vast oxygen-depleted zones, also known as dead zones, where most marine life cannot survive. Fish suffocate, and the entire food web becomes disrupted. With oxygen depletion and changes in the food web, many species struggle to survive. This can lead to a decline in overall biodiversity, which is the variety of life in the sea. Harmful algal blooms, triggered by eutrophication, can release toxins that contaminate the water. This can pose health risks to humans and marine life alike.

The impact of TPH (Total Petroleum Hydrocarbons), **POPs** (Persistent Organic Pollutants), **HMs** (Heavy Metals), and **PAHs** (Polycyclic Aromatic Hydrocarbons) on the marine environment (water, sediment, biota) is quite significant and poses a serious threat to marine ecosystems**. In seawater** TPH can form oil slicks that reduce oxygen availability, harming marine life. PAHs are slightly soluble in water and can harm organisms directly or accumulate in sediments. HMs can dissolve in water, directly harming organisms or accumulating in sediments. POPs (OCPs and PCBs) are highly persistent and can accumulate in water, entering the food chain. **In sediments,** TPH contamination can smother benthic organisms and alter sediment composition. PAHs and HMs can persist in sediments for long periods, contaminating the benthic environment. POPs tend to bind to sediments, creating reservoirs that release pollutants slowly. Marine animals can accumulate TPH, PAHs, HMs through ingestion or absorption, leading to health problems, biomagnification in food webs, and reproductive issues, leading to DNA damage, cancer, and reproductive problems. POPs bioaccumulate in fatty tissues of marine organisms, reaching harmful levels in top predators. This disrupts hormones, weakens immune systems, and reduces reproductive success. Sounds created by human activities (anthropogenic sounds) can be either brief and intense (like impulsive sounds from seismic exploration, pile driving for wind farms or platforms, and explosions) or constant and long-lasting (like continuous sounds from dredging, shipping, and energy facilities). These different types of **noise pollution** have varying impacts on organisms.

The Black Sea is a semi-enclosed body of water highly vulnerable to **plastic pollution**. Factors such as limited vertical mixing, dynamic surface circulation, anthropogenic pressure from river and canal discharges, shipping, fishing, coastal waste disposal, tourism and recreational activities contribute to marine litter pollution. The Danube Delta and other rivers contribute significantly to marine litter pollution along the Romanian Black Sea coast. The amount of plastic in all marine compartments,

such as the sea surface, water column, seabed and shoreline, is increasing. As they decompose over time, macroplastics break down and produce a significant amount of microplastics. Macroplastics, like their smaller counterparts, can carry various toxic chemicals. The increasing accumulation of floating and seabed plastics leads to habitat loss and biodiversity degradation, entanglement, ingestion and even mortality of marine species. Ingestion of microplastics can cause physical harm and disrupt various physiological functions of different marine organisms. However, there is still no consensus on the extent of the environmental damage caused by microplastics. The impact depends on factors such as the plastic size, environment, organisms and exposure level. Several surveys have been carried out to assess plastic pollution on beaches, floating plastics, the water column and sediments along the Romanian Black Sea coast, revealing high levels of marine debris. However, there is a lack of studies on the impact of marine litter on marine organisms. **Ballast water** discharge is a major contributor to the introduction of invasive species. Marine invasive alien species can alter marine food webs and cause degradation of marine biodiversity, adverse impacts on fisheries (e.g. reduction of fish stocks), tourism, loss of environmental and social benefits of marine ecosystems. Such impacts have been observed due to the introduction of invasive species like Mnemiopsis leidyi, Beroe ovata and Rapana venosa.

All the multiple forms of pollution associated with certain descriptors, which express what the marine environment will look like when good environmental status is achieved, are subject to a national monitoring programme and specific environmental targets, which are included in a "Programme of Measures" (PoM), developed as a set of measures to achieve or maintain good environmental status (GES), based on Article 13 of the Marine Strategy Framework Directive (MSFD - 2008/56/EC). All "measures" are specific actions taken at national, regional, EU or international level that contribute to the achievement or maintenance of GES and the associated environmental objectives. In the present second cycle of implementation, the POM include "existing measures", i.e. the measures considered relevant for the achievement or maintenance of the GES of the marine environment, which have already been adopted under other European Directives (Water Framework Directive, Birds, Habitats, Nitrates Directive, etc.) and international conventions to which Romania has acceded or regional policies (Strategic Action Plan for the Black Sea - Bucharest Convention), implemented or not yet implemented, but also "New measures", which are the measures identified as necessary to achieve or maintain the Good ecological status (GES) of the marine environment, in the conditions where the existing measures are not sufficient. These can be measures that complement existing ones (strengthen them, optimize them or extend their geographical scope) or be completely new, periodically approved in the national legislation, but considering a differentiated implementation of Measures with cross-border impact (60% of Measure are common with Bulgaria, after large public consultations of both parties).

In the annual actualization of the national monitoring plan, the provisions of art. 11, annex V of the Strategy Framework Directive for the marine environment are considered, as well as the increase obtained in the first reporting of the ecological state of the marine environment, respectively the initial assessment of the ecological state of the marine environment (art.8), determining the good ecological status of the marine environment (art.9), as well as the stability of the environmental objectives for achieving the good ecological status of the marine environment (art.10). At the same time, the recommendations of the European Commission were considered in the process of updating the monitoring program.

The results evaluations of the national monitoring program for marine pollution are included in the

annual national reports to the Permanent Secretariat of the Black Sea Commission (BSC-PM), despite regional war disruptions. Foa all type of pollution there is a monitoring developed in the field (in situ) with specific instrumentation of recording or sampling and laboratory quantitative analysis, but also a remote-sensing monitoring based on satellite or aerial technology. Satellite monitoring has been developed for synoptic scale since the 60s, but in the present time certain specific downstream services were developed based on the Copernicus Marine Environment Monitoring System (CMEMS) developed for the Black Sea. Certain specific services were developed for the monitoring of the western basins of BlackSea, including eutrophication, marine front identification and mesoscale circulation in relation of macroplastics trajectories/areas of accumulation, identification of the route of oil tankers in relation of the identification and monitoring of accidental oil spills, encompassing the high-resolution monitoring of water quality in anchorage/coastal areas.

4. Ukraine

A baseline assessment of the environmental state of the marine environment was carried out as part of the Marine Environmental Strategy of Ukraine for the period up to 2036.

According to geomorphological features, the Black Sea is divided into eastern, western and north-western (shelf) parts. The North-Western Black Sea (NWBS) is influenced by the flow of the three major rivers Danube, Dnipro and Dniester, whose runoff totals about 260 km3 and significantly affects the formation of surface water masses and the biochemical regime of the waters of both the sea shelf and the sea as a whole. Relatively uniform zones are combined into marine water massifs of different typology for 1) coastal waters, 2) offshore areas and 3) stretch of high seas.

Descriptor 1: Marine biodiversity

Diversity and total biomass of phytoplankton. There is a *general trend towards an improvement in the ecological state of the Black Sea waters*, which at the level of the microalgae community is reflected in a decrease in total biomass, an increase in species diversity, and a decrease in the number and intensity of «blooms».

Chlorophyll-a content. According to long-term observations, a weak downward trend in the average annual chlorophyll-a content was observed in all areas of the Black Sea and the Sea of Azov.

Diversity, functional indicators and total biomass of zooplankton. In general, the zooplankton communities of the Black Sea coastal zone are in a depressed state. In most water areas, the biomass index shows unsatisfactory values compared to the period of «ecological norm», and diversity is low.

Diversity of macrozoobenthos. In general, for the coastal zone, the number of macrozoobenthos species per station was lower than at the shelf stations, indicating an unstable state of this water area. In coastal areas, 40% of macrozoobenthos communities were in «good» ecological condition, 50% in «average» and 10% in «satisfactory». In the NWFP, 60% of the macrozoobenthos communities correspond to the GES, and 40% were not characterized by the GES.

Diversity of macrophytobenthos. The macrophyte biodiversity has almost reached the reference level (32 species - 27 species, respectively), but there have been significant changes in diversity, their status is in flux, so the ecological status of the water area is classified as «satisfactory».

The state of marine mammal populations. The status of the porpoise population in the Sea of Azov does not correspond to good ecological status (GES), and its numbers are declining. The most important factor in the death of porpoises in the Azov population is excessive incidental mortality in fishing gear. The ranges of all three cetacean species and the distribution within them in Ukrainian waters are in line with the GES. In most large water areas in the north-western part of the Black Sea, the density of all cetacean species is relatively low, and its compliance with the status of the GES needs to be clarified.

Descriptor 2: Non-indigenous species

Some human-related introductions are already regulated at EU level to assess and minimise their potential impacts on aquatic ecosystems, and that some non-indigenous species have been used in aquaculture for a long time and are already subject to special licensing under existing regulations.

Descriptor 3: Commercial fish and shellfish

Currently, there are no reliable assessments of the state of commercial fish stocks, and no scientific surveys are conducted at all.

Descriptor 4: Food webs

In all hydrobiological communities of the pelagic zone, species dominant in terms of seasons and succession changes were identified. For bottom dwellers, it is a community with a distribution of trophic groups and changes in the number of functionally important groups.

Results of macrophytobenthos assessment. The average biomass of the dominant species in the coastal areas is significantly lower than the biomass during the reference conditions. In terms of biomass/number, the coastal areas correspond to the ecological status of «satisfactory». In the area of the Phyllophora cereal field (PCF), the average biomass of the dominant Phyllophora crispa (with the existing projected cover of 5 % to 10 %) increases from spring to autumn and is 0.029 - 0.045 - 0.104 kg·m-2. These values for the second dominant species, Coccotylus truncatus, are slightly lower - 0.024 - 0.031 - 0.077 kg·m-2. Under the reference conditions, the average biomass of phyllophores ranged from 0.010 kg·m-2 to 2.56 kg·m-2, with a maximum of 10.8 kg·m-2. Thus, according to the indicators of number/biomass, % of projected macrophyte coverage, the PCF area can be classified as having a "bad" ecological condition. However, there are currently no assessments of the status of fish, birds and reptiles, and no scientific surveys are carried out at all.

Descriptor 5: Eutrophication

In general, it should be noted that the quality class of the coastal water bodies of the north-western Black Sea shelf according to the baseline assessment corresponds to «satisfactory», «average» and «bad» condition. The bad condition is observed in the water bodies directly affected by river runoff, such as the transit waters of the Danube estuary and coastal waters adjacent to the Dnipro-Bug estuary.

Descriptor 6: Seabed integrity

The analysis of the macrozoobenthos monitoring data of the coastal and shelf zones of the NWBS during 2012-2018, based on the integrated environmental quality assessment indicators, showed that in the offshore part of the exclusive maritime economic zone of Ukraine, the state of bottom biocenoses mostly corresponds to the «good» state, while in the coastal parts - in the Danube and Dnipro-Bug regions - it corresponds to the «satisfactory» assessment. Most of the bottom biocenoses are in «good» condition (75%).

Descriptor 7: Hydrographical conditions

Seasonal fluctuations in the water temperature of the upper layer even in its central part reach 20°C. Variability of the salinity field occurs all year round within mesohaline waters and is determined by the intensity of river and sea water mixing processes, especially during floods. The speed and direction of surface currents, and therefore the direction of migration of phytoplankton and zooplankton, generally depends on the variability of the speed and direction of the driving wind. Similarly, the development of upwelling and the intensity of wind disturbance caused by coastal currents also depend on the wind.

Descriptor 8: Contaminants

The ecological state of marine water bodies (MWBs) is assessed by pollutants such as toxic metals (TMs), organochlorine pesticides (OCPs), polychlorinated biphenyls (PCBs) and polyaromatic hydrocarbons (PAHs), and bottom sediments are additionally assessed for phenols. To assess the ecological state of the marine water bodies, the pollution coefficient (Pk) for each of the individual groups of pollutants are considered. The ecological status of a MWBs is determined by the worst Pk value for any of the assessed groups.

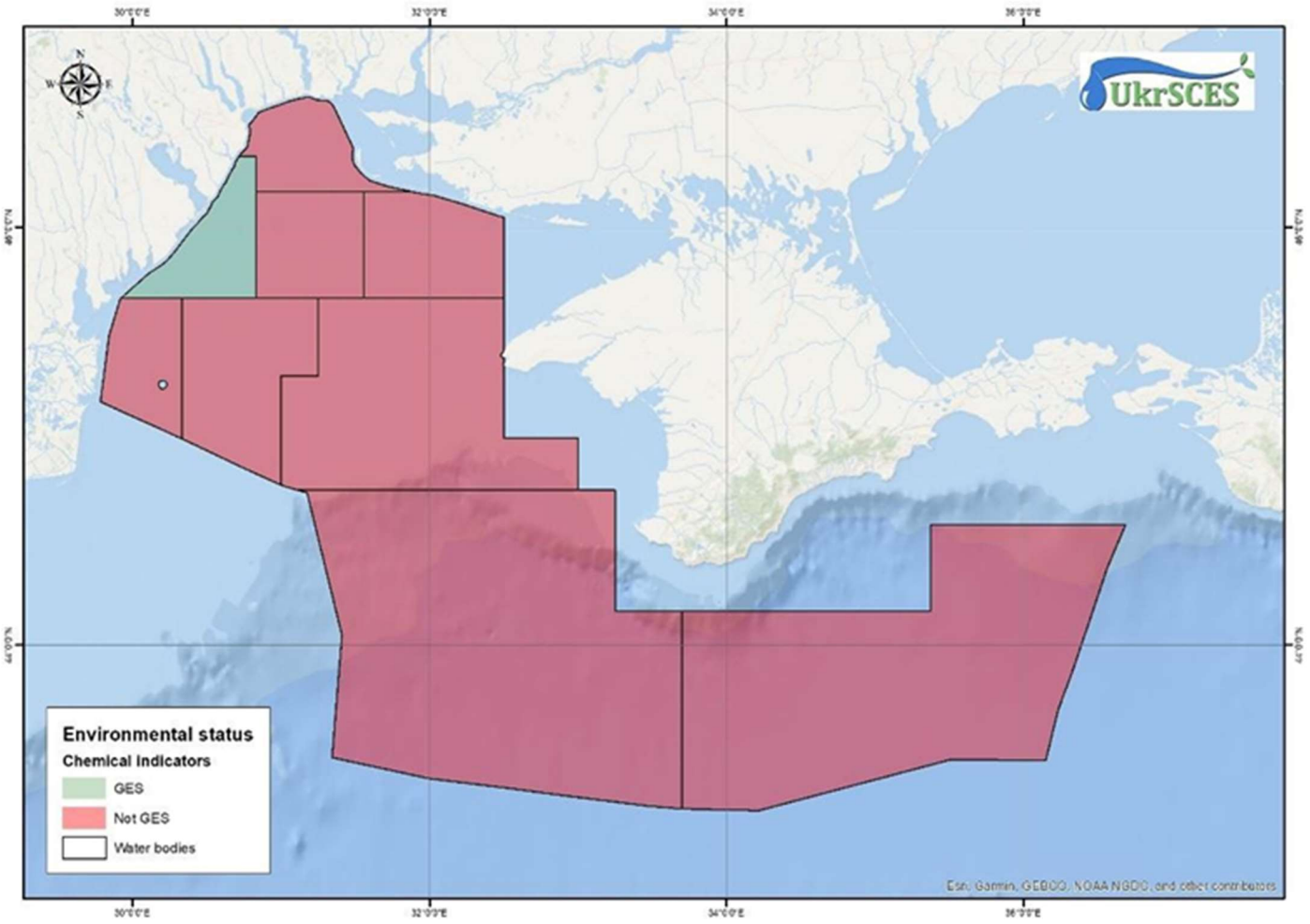

Figure 1 – Baseline assessment of the ecological condition (a) and ecological status (b) of the Black Sea water bodies according to the criteria of chemical pollution

The source: Ukrainian scientific centre of ecology of the sea

Descriptor 9: Contaminants in seafood

For fish, data are available only for the coastal areas influenced by the Danube River runoff. The

bodies of fish are most contaminated with heptachlor and organochlorine pesticides, which were found at abnormally high levels. Mercury contamination is also a concern. The bodies of fish are moderately contaminated with surfactants and benzo(a)pyrene, while the concentrations of hexachlorobenzene and fluoranthene meet the requirements of the GES.

Descriptor 10: Marine litter

The average concentration of marine litter in the western part of the Black Sea in 2016-2017 was 23.0 items/km². In comparison, the concentration of litter in the eastern part of the sea is much higher, at 138.6 items/km².

Descriptor 11: Energy, including underwater noise

Observations of the level of anthropogenic underwater noise in order to identify its impact on the ecological state of the marine environment in the seas of Ukraine have not been carried out.

In addition to the previously mentioned descriptors, it's important to consider the impact of the war. Numerous mammals, fishes and other species were killed or injured as a result of weapon use. There is very heavy noise and chemical pressure on water, on the ecosystem. Numerous explosions and blast waves killed mammals, fish, destroyed elements of an eco-system, caused to human casualties near the seashore and their home's destruction. The assessment methods are being developed; only expert evaluations can be used at the moment. Most of the information about the military influence is restricted from sharing.

5. Conclusions

The Black Sea faces a significant challenge from pollution, and it's an issue that transcends national borders. Six countries surround the Black Sea, all contributing to the pollution problem in one way or another. The countries bordering the Black Sea (Bulgaria, Georgia, Romania, Russia, Turkey, and Ukraine) are all sources of pollutants. Activities like agriculture, industry, martime traffic, off-shore activity, waste disposal generate various contaminants that end up in the sea through rivers and direct discharges. The main types of pollution at the Black Sea included agricultural runoff (fertilizers and pesticides used in agriculture are carried by rivers into the Black Sea, leading to excessive nutrient levels and eutrophication), industrial waste(untreated or poorly treated industrial waste introduces harmful chemicals and heavy metals into the water), oil spills (accidents involving oil tankers or offshore drilling can cause devastating oil spills that coat coastlines and harm marine life), plastic pollution (plastic debris from land-based sources ends up in the Black Sea, posing a threat to marine animals and ecosystems).

The Black Sea's unique geography plays a role in pollution. Being a semi-enclosed sea, it has limited water exchange with the Mediterranean Sea. This restricted flow allows pollutants to accumulate, intensifying their effects. The transnational nature of the Black Sea's pollution problem necessitates international cooperation. Countries bordering the Black Sea need to work together to implement stricter regulations, improve waste management practices, and reduce agricultural runoff. By addressing these issues collaboratively, they can protect the Black Sea's delicate ecosystem and ensure its health for future generations.

In the Black Sea marine pollution has been confirmed as a critical issue aggravated by territorial challenges such as the sea's very large catchment basin, extremely limited exchange with the world ocean, densely populated coast, pollution from land-based sources, industries, busy maritime traffic and various additional inputs from rivers, discharges from numerable coastal ports, and urban areas. The sea area is about 426 thousand square km, while its catchment basin is over 2 million sq. km, equal to a third of the territory of continental Europe, with major parts of territories of over 20 countries. Three of Europe's largest rivers the Danube, the Dnepr and the Dniester discharge waters and waste into the sea. The exchange of Black Sea waters through the narrow winding Bosphorus Straits is very slow. In addition, the Black Sea has a positive water balance, which means it receives more water through river inflows and precipitation than it loses through evaporation or flow to other water bodies. The waters of the upper sea layer leave the Black Sea to travel further to the Marmara Sea and the Aegean, another factor for transport of pollution.

The ongoing war in Ukraine poses additional challenges with new types of pollution sources from armed conflicts from fires, bombing, chemical pollution from arms, floating and sunken armaments and vessels, naval activities, pollution from the destruction of the hydroelectric power plant and dam of Kahovka in Ukraine etc.

The Danube River has the most advanced system of management, on the principle of river basin management and the monitoring is conducted. This is not the situation with the other big rivers. Bulgaria and Romania also apply river basin management and the related monitoring procedures. The ICPDR, governing body of the Danube Convention, cooperates with the Black Sea Commission on pollution monitoring and other issues.

The Black Sea littoral countries are to varied extent involved in marine pollution monitoring and assessment. Those are mostly the EU members applying waters related EU directives, the most comprehensive of which is the MSFD. Turkey, Ukraine, and Georgia are making progress in aligning their procedures with EU and international waters management. The only legally binding instrument for the six littoral Black Sea countries is the Convention on the Protection of the Black Sea against Pollution (1992), with its 4 protocols, which does not provide for monitoring. For some basin wide monitoring and assessment, the Black Sea Commission is granted support from international sources.

Marine pollution has cross-border characteristics as it is generated inland, on the coast and at sea; it is transported by force of nature – winds, waves, currents/water circulation – or human action. It often travels long distances and this often results in blaming neighbouring countries as sources of pollution and ignoring one's own contribution to marine pollution load/input. Marine pollution is a recognized worldwide and regional challenge to be addressed only by joint regional efforts.

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Appendix I

It includes the tables encompassing the type of pollution and its impact on the main Black Sea sectors.

Country	*BS area/Sub-basin*	*Pollution sources(expert opinion /literature)*	*Type of pollution (expert opinion/literature)*	*Type of pollution - details*	*Ecosystem affected (mainly)*	*Impacts*	*Impacts - details*	*Impact Assessment (expert opinion/literature) (High, Medium, Low)*					*Regulation of pollution types (Legislation/ Law enforcement/ mitigation measures etc.)*	
								Index	**Water**	**Sediment**	**Biota**	**Overall Impact**		
Bulgaria	Bulgarian EEZ Subdivided into 5 coastal zones (Cape Sivriburun - Cape Kaliakra; Cape Kaliakra - Cape Galata; Cape Galata - Cape Emine; Cape Emine - Cape Maslen nos; Cape Maslen nos - Rezovo), shelf and open sea	Land-based sources, rivers, maritime traffic, off-shore activity, atmospheric inputs (land-based/ concentred, or sea-based/ diffuse sources)												**Global conventions** to which Bulgaria is party include: United Nations Convention on the Law of the Sea (UNCLOS 1982) is the main international framework agreement regulating ocean related issues; it requires contracting parties to protect the marine environment and address land-based and sea-based sources of pollution; International Convention for the Prevention of Pollution from Ships (MARPOL 73/78), Annex I-VI; Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention, 1975), as replaced by the "London Protocol" (1996; entered into force in 2006); and the Stockholm Convention on Persistent Organic Pollutants (POPs) 2001; Basel Convention (Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal) 1989; CLC International Convention on Civil Liability for Oil Pollution Damage 1992; OPRC International Convention for the Preventing, Combating and Compensation of Marine Pollution 1990; Bunkers Convention (International Convention on Civil Liability for Bunker Oil Pollution Damage from Ships) 2001; Ballast Water Management Convention (International Convention for the Control and Management of Ships' Ballast Water and Sediments) 2004.
			Eutrophication	Nutrients	Pelagic and benthic habitats	The increased concentration of nutrients and the input of organic matter leads to lower water transparency, lower levels of dissolved oxygen, potentially harmful algal blooms, and changes in communities of benthic habitats.	TRIX and EQR M-AMBI(n) ecological indices are used to integrate eutrophication indicators in the coastal areas. The trophic index TRIX encompasses causes (nutrients: DIP and DIN) and effects (chlorophyll-a and oxygen saturation), and EQR M-AMBI(n) evaluates habitat conditions based on the benthic macrofauna biodiversity status.	TRIX	Medium-High			Medium-High	Water Act and Ord. No 4,5,7 etc., Environment Protection Act, Biodiversity Act, Marine Strategy of the Republic of Bulgaria, Law on Maritime Areas, Inland Waterways and Ports of the Republic of Bulgaria, MARPOL Annex IV	**Regional and EU legal framework:** Bulgaria is signatory of the main regional legally binding instrument the Convention on the Protection of the Black Sea against Pollution (1994) and its four protocols: Protocol on Protection of the Black Sea Marine Environment against Pollution from Land Based Sources; Protocol on Cooperation in Combating Pollution of the Black Sea Marine Environment by Oil and Other Harmful Substances in Emergency Situations (Emergency Protocol); and Protocol on the Protection of the Black Sea Marine Environment against Pollution by Dumping (Dumping Protocol). A detailed Black Sea Emergency Plan to the Emergency Protocol has been adopted in 2006 as a response to oil spills. The country is active in all initiatives developed in the context of the Black Sea Convention. Bulgaria is party to the Convention on Cooperation for the Protection and Sustainable Use of the River Danube (Danube River Protection Convention) 1998 and active in its implementation.
								EQR M-AMBI(n)			Medium-High	Medium-High		
			Contaminants	uPBT, non-uPBT	Water, sediments, biota	Chemical contaminants may be grouped in two large classes: ubiquitous, persistent, bioaccumulative, toxic (uPBT) substances and non-uPBT. UPBT	In water: TPH can form oil slicks that reduce oxygen availability, harming marine life. PAHs are slightly soluble in water and can harm organisms directly or	uPBT	High		High	High	Water Act, Biodiversity Act, Soils Act, Environmental Protection Act (EPA), Clean Air Act - Ordinance No 11 and 12, National Air Pollution Control Programme (2020-2030), Law on Maritime Areas, Inland Waterways and Ports of the Republic of Bulgaria - Ord. no 18 on prevention of pollution from ships, Waste Management Act, MARPOL Annex I,II,III; Disaster Protection Act (DPA) and related	**EU Directives related to the state of the Black Sea environment** transposed in Bulgarian legislation are: Marine Strategy Framework Directive (MSFD) (Directive 2008/56/EC); Water Framework Directive (WFD) (Directive 2000/60/EC); Bathing Water Directive (Directive 2006/7/EC); Urban Waste Water Treatment Directive (Directive 91/271/EEC); Nitrates Directive (Directive 91/676/EEC); Port Reception Facilities Directive (Directive 2019/883/EU); Ship-Source Pollution Directive (Directive 2005/35/EC, as amended by Directive 2009/123/EC; Single-Use Plastics Directive (Directive 2019/904/EU); European Maritime and Fisheries Fund (EMFF) Regulation. **National legislation**: Water Act (1999) aims to ensure integrated water management in Bulgaria, taking into account the principles of the EU

						pollutants disrupt the delicate balance of marine ecosystems, impacting everything from plankton at the base of the food web to marine mammals at the top. They include diverse categories, such as POPs (Persistent Organic Pollutants), HMs (Heavy Metals), TPH (Total Petroleum Hydrocarbons), and PAHs (Polycyclic Aromatic Hydrocarbons). They have adverse effects on the marine environment (water, sediment, biota) and pose a serious threat to marine ecosystems.	accumulate in sediments. HMs can dissolve in water, directly harming organisms or accumulating in sediments. POPs (OCPs and PCBs) are highly persistent and can accumulate in water, entering the food chain. In sediments : TPH contamination can smother benthic organisms and alter sediment composition. PAHs and HMs can persist in sediments for long periods, contaminating the benthic environment. POPs tend to bind to sediments, creating reservoirs that release pollutants slowly. In biota: Marine animals can accumulate TPH , PAHs, HMs through ingestion or absorption, leading to health problems, biomagnification in food webs, and reproductive issues, leading to DNA damage, cancer, and reproductive problems. POPs bioaccumulate in fatty tissues of marine organisms, reaching harmful levels in top predators. This disrupts hormones, weakens immune systems, and reduces reproductive success.	non-uPBT	Medium-High		Medium-High	Medium-High	subordinate acts, National Black Sea Oil Spill Emergency Plan.	Water Framework Directive, such as precaution, prevention and sustainability; linked to National Black Sea Programme, strategic document promoting cooperation Black Sea countries under the Convention on the Protection of the Black Sea against Pollution (BSC), the related monitoring programme BSNMP, the National Waste Management Programme (NWMP), setting the objectives for surface and ground waters thus related to the state of the Black Sea environment. Marine Strategy of the Republic of Bulgaria outlines the vision, objectives and actions for the sustainable development and use of marine and coastal resources in accordance with EU MSFD Directive. It aims to ensure the long-term protection and improvement of the quality of the marine environment. Introduces ecosystem approach and addresses all listed types of pollution. Environmental Protection Act (2002) addresses EIA, remediation and clean up measures after accidents. Bathing waters protection is reflected in the Water Act and in Ordinance No 5 of 2008 on bathing water quality management. Requirements for the quality of wastewater are laid down in the Water Act, in particular in Ordinance No. 4 of 2006 on the characterisation of surface waters and Ordinance No. 7 of 2000 on the conditions and procedures for the discharge of industrial wastewater into the sewerage systems of settlements.
			Marine litter	Macrolitter,		Marine litter consists of	Marine litter can lead to	Macrolitter	Medium	Medium		Medium	Waste Management Act, Ordinance on reducing the environmental impact of	

				microplastics	Water, sediments, biota	different materials and is found in sizes from over a meter to less than a micron. It is found on the beaches and on the shoreline, floating on the sea surface or in the water column. Most items eventually sink to the seafloor because they lack buoyancy or are transported by natural processes. The majority of marine litter consists of artificial polymer materials or various types of plastics.	entanglement of organisms, ingestion and increased morbidity and mortality. Ghost fishing is a well-known adverse effect of lost fishing gear at sea. Microplastics (particles less than 5 mm) pose the risk of bioaccumulation in the food web.	Microplastics	Medium-High	Medium-High	Medium-High	Medium-High	certain plastic products PM No 354 of 26.10.2021, Law on Maritime Areas, Inland Waterways and Ports of the Republic of Bulgaria (LMAIWPRB) , Ordinance No 16, LMAIWPRB, on Conditions and Procedures for Disposal of Waste in Port Areas, MARPOL Annex V	
			Noise	Impulsive and continuous noise	Water, biota	Anthropogenic sounds may be of short duration (e.g. impulsive such as from seismic surveys and piling for wind farms and platforms, as well as explosions) or be long lasting (e.g. continuous such as dredging, shipping and energy installations) affecting organisms in different ways.	Anthropogenic noise affects all the marine environment where it's produced and depending on the type (impulsive – short or continuous – long) it can affect a bigger or a smaller part of the ecosystem. Most of the available data about effects of sound on the marine environment describes effects on marine mammals; these animals are dependent on using sound, and many species of marine mammals are known to be sensitive to sound. Nonetheless, fish species and other marine animals can also suffer from noise exposure, being forced to relocate to find food or to reproduce, thus, affecting the ecosystem.	Impulsive sound	High		High	High	Environmental Protection Act (EPA), Marine Strategy of the Republic of Bulgaria	
								Continuous low frequency sound	Medium-High		Medium-High	Medium-High	

			Ballast water / Invasive species	Invasive species	Biota	The introduction of non-native species through ballast waters may lead to substantial harm to the local environment, habitats and competition with indigenous species.		Invasive species			Medium	Medium	Water Act, Biodiversity Act, Ordinance on the Prevention and Control of the Introduction and Spread of Invasive Alien Species, 2011; Ballast Water Management Convention 2004	
			Atmospheric pollution / depositions	Nutrients, uPBT	Water, sediments, biota	The atmospheric deposition of NOx, PAH, heavy metals, particulate matter may compound to the adverse effects from eutrophication and introduction of contaminants in the marine environment.	There is no monitoring of atmospheric pollution over the Black Sea. Data from monitoring of air quality in the coastal area and modelling results may serve as a rough estimate of the deposition of pollutants to the sea transported in the atmosphere.						Environmental Protection Act (EPA), Clean Air Act and its Ordinance No 11 of 14 May 2007 on standards for arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air and Ordinance No 12 of 15 July 2010 on standards for sulphur dioxide, nitrogen dioxide, fine particulate matter, lead, benzene, carbon monoxide and ozone in ambient air, National Air Pollution Control Programme (2020-2030) MARPOL Annex VI, Marine Strategy of the Republic of Bulgaria	Convention on Long-range Transboundary Air Pollution (CLRTAP) and Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (Gothenburg Protocol) to CLRTAP Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants Directive 2008/50/EC on ambient air quality and cleaner air for Europe Directive 2004/107/EC relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air

Country	Pollution sources (expert opinion /literature)	Type of pollution (expert opinion/ literature)	Type of pollution - details	Ecosystem affected (mainly)	Impacts	Impacts - details	Impact Assessment (expert opinion/literature) (High, Medium, Low)					Regulation of pollution types (Legislation/ Law enforcement/ mitigation measures etc.)	
Romania	Maritime traffic, rivers, off-shore activity, land-based sources, atmospheric inputs (lanbase/concentred, or seabase/diffuse sources)	Eutrophication	Nutrients	Pelagic habitat	Nutrients in seawater, such as nitrogen, phosphorus, play a crucial role in marine ecosystems. They act as fertilizers, promoting the growth of phytoplankton, which forms the base of the oceanic food web. This growth supports a diverse range of marine life, from tiny zooplankton to large fish and mammals. However, an excess of these nutrients, often due to agricultural runoff or untreated wastewaters, can lead to harmful algal blooms, depleting oxygen levels and creating dead zones where marine life cannot survive. Thus, while nutrients are essential for sea health, their balance is delicate, and disruption can have significant ecological consequences.	introduction of nutrients is a significant pressure in the Black Sea. In the transitional waters, the main source is the Danube river and other major rivers from Northern area (Dnieper, Dniester, Bug). In the coastal waters the urbanization led to incresing nutrients levels due to untreated or insufficient treated waters discharge. The effects of increased nutrients concentrations are direct - algal blooms and increasing chlorophyll concentrations, and indirect - decreasing of transparency and oxygen levels which affect the benthic communities - both of macroalgae and zoobenthos.	Inorganic phosphorus (phosphate), Inorganic nitrogen (nitrate, nitrite, ammonium)	Water - high				In Romania, the regulation of nutrient pollution and eutrophication involves a combination of national legislation, European Union (EU) directives, and various mitigation measures. Below are the key components: National Legislation Water Law (No. 107/1996, with subsequent amendments): This law is the fundamental legislative act regulating water management in Romania. It aims to prevent and control pollution, including nutrient pollution, and aligns with EU directives. Government Decision No. 964/2000: This decision sets the norms for the classification of surface water quality to determine the ecological status of water bodies. Order No. 161/2006: This order approves the Normative on surface water quality classification to establish the ecological status of water bodies, incorporating standards for nutrients. Law No. 458/2002 on Drinking Water Quality: This law sets the quality standards for drinking water, including limits for nutrient concentrations. European Union Directives Water Framework Directive (2000/60/EC): This directive establishes a framework for the protection of inland surface waters, transitional waters, coastal waters, and groundwater. It aims to achieve good ecological and chemical status for all water bodies, including controlling nutrient pollution and addressing eutrophication. Nitrates Directive (91/676/EEC): This directive aims to protect water quality across Europe by preventing nitrates from agricultural sources from polluting ground and surface waters and by promoting the use of good farming practices. Urban Waste Water Treatment Directive (91/271/EEC): This directive aims to protect the environment from the adverse effects of urban wastewater discharges and discharges from certain industrial sectors. It includes requirements for reducing nutrient loads in wastewater. Marine Strategy Framework Directive (2008/56/EC): This directive aims to protect the marine environment across Europe, including measures to prevent and reduce inputs of nutrients to the marine environment. Mitigation Measures Action Programs under the Nitrates Directive: Romania has designated Nitrate Vulnerable Zones (NVZs) and implemented action programs to reduce nitrate pollution from agricultural sources. These programs include measures like crop rotation, proper fertilizer application, and buffer zones. Implementation of Good Agricultural Practices (GAP): Promoting GAP among farmers to minimize nutrient runoff, including precision farming techniques, soil testing, and controlled use of fertilizers. Wastewater Treatment Improvements: Upgrading and building new wastewater treatment plants to ensure they meet the requirements of the Urban Waste Water Treatment Directive, particularly in reducing nutrient loads. Public Awareness and Education Programs: Increasing public awareness about the impact of nutrient pollution and eutrophication, and educating farmers and industries on best practices to reduce nutrient discharge. Monitoring and Reporting: Establishing comprehensive monitoring networks to track nutrient levels in water bodies and report the data to ensure compliance with both national and EU regulations. Integrated River Basin Management Plans (RBMPs): Developing and implementing RBMPs under the Water Framework Directive to manage water resources at the river basin level, incorporating measures to control nutrient pollution and mitigate eutrophication.	

		Contaminants	TPH, PAHs, HMs, POPs(OCPs , PCBs)	Water, sediments, biota	Overall, these pollutants disrupt the delicate balance of marine ecosystems, impacting everything from plankton at the base of the food web to marine mammals at the top. The impact of **TPH** (Total Petroleum Hydrocarbons), **POPs** (Persistent Organic Pollutants), **HMs** (Heavy Metals), and **PAHs** (Polycyclic Aromatic Hydrocarbons) on the marine environment (water, sediment, biota) is quite significant and poses a serious threat to marine ecosystems.	**In water:** TPH can form oil slicks that reduce oxygen availability, harming marine life. PAHs are slightly soluble in water and can harm organisms directly or accumulate in sediments. HMs can dissolve in water, directly harming organisms or accumulating in sediments. POPs (OCPs and PCBs) are highly persistent and can accumulate in water, entering the food chain. **In sediments :** TPH contamination can smother benthic organisms and alter sediment composition. PAHs and HMs can persist in sediments for long periods, contaminating the benthic environment. POPs tend to bind to sediments, creating reservoirs that release pollutants slowly. **In biota:** Marine animals can accumulate TPH , PAHs, HMs through ingestion or absorption, leading to health problems, biomagnification in food webs, and reproductive issues, leading to DNA damage, cancer, and reproductive problems. POPs bioaccumulate in fatty tissues of marine organisms, reaching harmful levels in top predators. This disrupts hormones, weakens immune systems, and reduces reproductive success.	**Pollutant**	**Water**	**Sediment**	**Biota**	**Overall Impact**	**International Agreements:** International maritime regulations, like MARPOL (International Convention for the Prevention of Pollution from Ships), set standards for waste disposal and emissions from ships, reducing discharges of pollutants like TPH and PAHs. **National Laws:** Countries enact environmental laws that set limits on pollutant discharges from industries and agriculture, restricting the release of HMs and POPs. **Enforcement Actions**: Violations of regulations can result in penalties, fines, or even shutdowns for repeat offenders. **Mitigation measures:** Improved Industrial Practices: Industries can adopt cleaner production processes and wastewater treatment technologies to minimize pollutant releases. **Spill Prevention and Response:** Having robust plans for accidental spills of oil or hazardous materials helps minimize environmental damage from TPH and POPs. **Bioremediation**: Utilizing microorganisms to break down pollutants in contaminated areas can be a viable option for remediating TPH and PAH spills. **Public Awareness**: Educating the public about the dangers of pollution encourages responsible behavior and support for stricter regulations. **Technological Advancements**: Investing in research and development of new technologies for cleaner energy sources, more efficient waste treatment, and improved pollution monitoring can significantly reduce the impact on the marine environment.	***National laws, Enforcement Actions, Mitigation measures:*** Government Emergency Ordinance 71/2010 regarding the establishment of the strategy for the marine environment and adopted by Law 6/2011 for the approval of the Government Emergency Ordinance no. 71/2010 regarding the establishment of the strategy for the marine environment and by Law 205/2013 for the modification of GEO 71/2010 regarding the establishment of the strategy for the marine environment; LAW No. 98 of 16 September 1992 for the ratification of the Convention on the Protection of the Black Sea against Pollution, signed in Bucharest on 21 April 1992; HG. 587/2021 for amending and supplementing the annex to GD 964/200 on the approval of the Action Plan for the protection of waters against pollution with nitrates from agricultural sources published in O.M. 571 of June 4, 2021. GD 79/2024 for amending the annex to Government Decision no. 432/2020 on the approval of the Program of measures to achieve the good ecological status of the Black Sea marine region; Water Law no. 107 of 25 September 1996, as subsequently amended and supplemented; DECISION no. 859 of 16 November 2016 for the approval of the updated National Management Plan for the portion of the international hydrographic basin of the Danube River that is included in the territory of Romania; ORDER no. 459/78/2019 for the approval of the Regulation on the management of emergency situations generated by dangerous hydrometeorological phenomena having the effect of producing floods, hydrological drought, as well as incidents/accidents at hydrotechnical constructions, accidental pollution on watercourses and marine pollution in the coastal area; M.M.G.A. Order no. 223/ 07.03.2006 - ORDER of the Minister of Environment and Water Management for the approval of the Regulation on the organization and operation of the alarm system in case of accidental pollution of the waters in Romania (SAPA-ROM) and of the main international alarm center in case of accidental pollution on the Danube in Romania (CIPA-ROM); DECISION no. 202 of February 28, 2002 (updated 2007) for the approval of the Technical Norms regarding the quality of surface waters that require protection and improvement in order to sustain fish life; DECISION no. 893 of July 5, 2006 for the modification of the Government Decision no. 1.593/2002 regarding the approval of the National Plan for Preparedness, Response and Cooperation in Case of Marine Oil Pollution; ORDER no. 1 of April 1, 2004 for the approval of the Regulation on the organization and functioning of the Operational Command for Marine Depollution; ORDER no. 828 of 4 July 2019 regarding the approval of the Procedure and powers for issuing, amending and withdrawing the water management permit, including the procedure for assessing the impact on water bodies, the Normative for the content of the technical documentation subject to approval, as well as the Framework Content of the Impact Assessment Study on water bodies; ORDER no. 828 of 4 July 2019 regarding the approval of the Procedure and powers for issuing, amending and withdrawing the water management permit, including the procedure for assessing the impact on water bodies, the Normative for the content of the technical documentation subject to approval, as well as the Framework Content of the Impact Assessment Study on water bodies;LAW no. 292 of 3 December 2018 on the assessment of the impact of certain public and private projects on the environment; DECISION no. 188 of 28 February 2002 (updated 2007) for the approval of some norms regarding the conditions of discharge of wastewater into the aquatic environment; LAW no. 17 of 7 August 1990 (republished 2014) on the legal regime of the inland maritime waters, the territorial sea, the contiguous zone and the exclusive economic zone of Romania; DECISION no. 328 of 31 March 2010 regarding the updating of the amount of the specific contributions for the management
							TPH (Total Petroleum Hydrocarbons)	High	High	High	High		
							PAHs (Polycyclic Aromatic Hydrocarbons)	Medium-High	High	High	High		
							POPs (Persistent Organic Pollutants)	Medium-High	High	High	High		

							HM (Heavy Metals)	Medium-High	High	High	High		of water resources, tariffs and penalties with the inflation index; Government Decision no. 570/2016 on the approval of the Program for the gradual elimination of discharges, emissions and losses of priority hazardous substances and other measures for the main pollutants; Government Decision no. 100/2002 with amendments and completions, for the approval of the Quality Norms that surface waters used for drinking water must meet and the Norm regarding the methods of measurement and frequency of sampling and analysis of surface waters intended for the production of drinking water; Government Decision no. 53/2009 with amendments and completions, for the approval of the National Plan for the Protection of Groundwater against Pollution and Deterioration; Law 293/2018 on the reduction of national emissions of certain air pollutants (NEC); Government Decision no. 140/2008 with amendments and completions regarding the establishment of measures for the application of the provisions of Regulation (EC) of the European Parliament and of the Council no. 166/2006 on the establishment of the European Register of Pollutants Emitted and Transferred (EPRTR); EMERGENCY ORDINANCE no. 195 of 22 December 2005 on environmental protection;
		Marine litter	Macrolitter, microplastics	Water, sediments, biota	They have adverse health impacts in marine ecosystems and organisms resulting from microplastic and nanoplastics exposure, ingestion and contamination. Marine biodiversity is readily affected by plastic pollution and coastal communities strongly relying on traditional seafoods and commercial fishing for subsistence are particularly susceptible to the plastic pollution.	The ingestion of **microplastics** can result in physical damage to marine organisms. Concerns have also been raised surrounding the toxicity of plastic ingestion, as plastic can carry possible harmful chemicals (either through absorption or leaching). Finally, as pathogens and parasite vectors have also been identified on microplastics, there is an increased risk for ecosystems. However, there is still no consensus on how damaging microplastics are to the environment, and their impact depends on the plastic size, environment, organisms, and level of exposure. Floating **macroplastics** also have apparent impacts on marine megafauna through ingestion or entanglement. As they degrade over time, they can generate large numbers of microplastics – and like their smaller counterparts, macroplastics can carry chemicals and invasive species. The increasing accumulation of floating plastic 'rafts' on the ocean surface provides a gateway for species to move from one continent to another like never before, representing a real risk for biodiversity due to species invasion.	Macrolitter	High	High	High	High	**National legislation:** Government Emergency Ordinance no. 195/2005 on environmental protection, as subsequently amended and supplemented, and Directive 2008/98 / EC on waste, transposed into national law by Law no. 211 / 2011 on waste management, presents the waste hierarchy that "applies as an order of priority in the legislation and policy on waste generation and management, as follows: prevention, preparation for reuse, recycling, other waste management operations. recovery, for example energy recovery and disposal". Law no. 249/2015 regulates the management of packaging and packaging waste in order to prevent or reduce the impact on the environment. Law no. 22/2001 (MARPOL – Annex 5 - Regulations for the Prevention of pollution by garbage from ships). Governmental Ordinance no. 20/2012 (Directive 2000/59/EC on port reception facilities, with the aim of substantially reducing discharges of shipgenerated waste and cargo residues into the sea). Government Emergency Ordinance no. 6/2021 (GEO 6/2021) implementing in the national legislation the EU Directive 2019/904 on the reduction of the impact of certain plastic products on the environment.	

							Microplastics	High	High	High	High	
		Noise	Impulsive and continuous noise	Water	Anthropogenic sounds may be of short duration (e.g. impulsive such as from seismic surveys and piling for wind farms and platforms, as well as explosions) or be long lasting (e.g. continuous such as dredging, shipping and energy installations) affecting organisms in different ways.	Anthropogenic noise affects all the marine environment where it's produced and depending on the type (impulsive – short or continuous – long) it can affect a bigger or a smaller part of the ecosystem. Most of the available data about effects of sound on the marine environment describes effects on marine mammals; these animals are dependent on using sound, and many species of marine mammals are known to be sensitive to sound. Nonetheless, fish species and other marine animals can also suffer from noise exposure, being forced to relocate to find food or to reproduce, thus, affecting the ecosystem.	Impulsive noise	High			High	International agreements: Through the Marine Strategy Framework Directive (MSFD) - Commission Decision (EU) 2017/848 and with the help of the Technical Group on Underwater Noise, member states have agreed to use threshold values to ensure that levels of anthropogenic noise do not exceed levels that adversely affect populations of marine animals. Under the guidance of the Technical Group on Underwater Noise (TG Noise), Romania has made several measurements, to determine the underwater background noise level for different scenarios, and its working on establishing a fish species as an indicator. Mitigation measures: The International Maritime Organization (IMO) has produced guidelines on continuous noise reduction from shipping through technical measures, such as hull and propeller design or by operational measures, to reduce the speed or spatial restriction. At Romanian level there are no publicly available recorded mitigation measures when it comes to pile driving, but when it comes to geophysical surveying there are several measures that are taken to reduce the risk of adverse effects on marine animals, such as acoustic deterrent devices and the use of marine mammal observers to search the area of operations and near it.	
							Continuous noise	Medium-HIgh			Medium-HIgh		
		Balast water/Invasive species	Invasive species (*Mnemiopsis leidyi, Beroe ovata, Rapana venosa*)	Pelagic and benthic habitat	Marine invasive alien species can alter marine food-webs and cause degradation of marine biodiversity, adversely impact fishing (e.g. reduncing the fish stock) and tourism, loss of environmental and social benefits of the marine ecosystems	**Ecological impact:** invasive species can compete with native species for food and habitat, leading to decline in native population; they can alter the physical and chemical properties of water. **Social impact:** can have a major impact on fishing industry, affect recreational activities such as swimming, boating, and fishing. **Economic impact:** can affect commercial and recreational fishing, reduce property values and may require costs to mantain their population under control and reduce their rate of spread.	Invasive species	Medium-HIgh		Medium-HIgh	Medium-HIgh	**International legislation:** Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive); Directive 92/43/EC regarding the conservation of natural habitats and species of wild fauna and flora as amended by Directives 97/62/EC, 2006/105/EC, 2013/17/EU and Regulation (EC) no. 1882/2003 adapting to Council Decision 1999/468/EC the provisions on the committees assisting the Commission in the exercise of the executive powers provided for by the acts which are subject to the procedure referred to in Article 251 of the EC Treaty; International Convention for the Control and Management of Ballast Water and Sediments from Ships (London Convention, 2004); Regulation (EC) no. 708/2007 of the Council regarding the use in aquaculture of exotic species and species absent locally, amended by Regulation (EC) no. 506/2008; Regulation (EU) no. 1143/2014 on the prevention and management of the introduction and spread of invasive alien species; IMO Guidelines for the Control and Management of Marine Biodeposits to Minimize the Transfer of Aquatic Invasive Species (MEPC Resolution 207/62). **National legislation:** Order of the Ministry of Environment 979/2009 regarding the introduction of non-indigenous species, interventions on invasive species, as well as the reintroduction of indigenous species provided for in annexes no. 4A and 4B of the Government Emergency Ordinance no. 57/2007 regarding the regime of natural protected areas, conservation of natural habitats, flora and fauna, on the national territory.	

<table>
<tr><th>Country</th><th>BS area/ Sub-basin</th><th>Pollution sources (expert opinion/literature)</th><th>Type of pollution (expert opinion/literature)</th><th>Type of pollution - details</th><th>Ecosystem affected (mainly)</th><th>Impacts</th><th>Impacts - details</th><th>Impact Assessment (expert opinion/literature) (High, Medium, Low)</th><th>Regulation of pollution types (Legislation/ Law enforcement/ mitigation measures etc.)</th><th></th></tr>
<tr><td rowspan="5">Ukraine</td><td rowspan="5">NW Black Sea</td><td rowspan="5">Maritime traffic, rivers, off-shore activity, land-based sources, atmospheric inputs (lanbase/concentrated, or seabase/diffuse sources), millitary impact, caused by the war against Ukraine</td><td rowspan="5">Eutrophication</td><td rowspan="5">Nutrients, Chlorophyll in the water column,Harmful algal blooms, Macrophyte communities, Macrofauna communities</td><td rowspan="5">Water, sediments, biota</td><td rowspan="5">In accordance with the Marine Strategy Framework Directive 2008/56/EU and the Decision of the European Commission 2017/848/EU on establishing criteria for methodological standards of appropriate ecological quality of marine water bodies, their assessment is carried out in accordance with descriptor D5 (eutrophication), according to the following primary and secondary criteria:
D5C1 – primary criterion- Nutrients in the water column; dissolved inorganic nitrogen (DIN), total nitrogen (TN), dissolved inorganic phosphorus (DIP), total phosphorus (TP);
D5C2 - the primary criterion - Chlorophyll in the water column;
D5C3 is a secondary criterion - Harmful algal blooms (for example, cyanobacteria) in the water column; D5C4 - secondary criterion - Photic limit (transparency) of the water column;
D5C5 - primary criterion (can be replaced by D5C8) - Dissolved oxygen in the lower part of the water column;
D5C6 - secondary criterion - Opportunistic macroalgae of benthic habitats;
D5C7 - secondary criterion - Macrophyte communities (perennial seaweeds and seagrasses such as fucoides, eels and Neptune grass) of benthic habitats;
D5C8 - secondary criterion (except when used as a substitute for D5C5) - Macrofauna communities of benthic habitats.
The content of phosphate phosphorus in coastal water bodies CW4-CW7 of the Odesa region in 2022 varied in the range from analytical zero (< 5 µg/dm3) to 7.3 µg/dm3, with an average value of 0.7 µg/dm3. The maximum values of phosphate phosphorus were observed in February and March, but they corresponded to the "excellent" quality status and "good" ecological condition in water bodies CW4 - CW7 of the Odesa region.</td><td rowspan="5">The current level of biogenic load and the spatial variability of the BR content in sea waters along the coast of the Odesa region in 2022 are characterized by the analysis and forecast data of the physical and biogeochemical state of the ecosystems of the Copernicus marine service. When assessing the state of eutrophication, according to the definition of the European Commission [7], the indicator of the content of oxygen dissolved in water in the lower part of the water column is the primary criterion of eutrophication. The oxygen content and its changes are an indicator of the ratio of the intensity of the primary production of organic matter and the intensity of its biochemical oxidation. The oxygen content (O2) in the coastal waters of the Odesa region (water bodies CW4-CW6) in 2022 varied in the range from 8.0 mg/dm3 to 11.6 mg/dm3, and the relative oxygen saturation was in the range of 83.2 % to 139.4%. The average annual value of oxygen content in water bodies CW4-CW6 was 9.7 mg/dm3 (103.3% saturation). In the spatial distribution by absolute value, the maximum oxygen content in 2022 was noted at the end of February in the CW6 water body - 11.7 mg/dm3, and the maximum saturation of 139.4% - at the end of August in the CW7 water body. Increased values of oxygen content were observed in the winter and autumn periods, and saturation was observed in the summer period, which was caused by intensive processes of phytoplankton photosynthesis. In general, the determined values of oxygen content in coastal waters in 2022 were not lower than the value of the maximum permissible concentration (MPC) (4.0 mg/dm3) in internal sea waters and the territorial sea of Ukraine and by classes of ecological status (CES), water masses corresponded to "excellent" and "good" quality status. The values of the hydrogen indicator in 2022 in the coastal waters of the Odesa region varied in the range from 8.07 units. pH up to 8.37 units. pH with an average of 8.24 units. pH In general, the pH did not exceed the MPC (8.50 units of pH) determined in the internal sea waters and territorial sea of Ukraine, and according to the CES, according to the pH index, the water masses CW4-CW7 of the Odesa region corresponded to the "good" ecological quality status. Transparency values in water bodies CW4-CW7 of the Odesa region varied in the range from 1.3 m to 18.4 m, with an average of 4.0 m. High water transparency was observed at the end of January and the first half of March. In general, the average monthly values of transparency in water bodies of the Odesa region varied in the range from 2.0 m to 6.8 m and corresponded mainly to "satisfactory", "mediocre" and "poor" statuses and did not correspond to "good" ecological status. Nutrient levels determined by the European Commission are the main indicators of the state of eutrophication. Generalized monitoring data on the eutrophication of the world's water bodies convincingly confirm the leading role of phosphorus and nitrogen in this process. An excessive amount of dissolved mineral nutrients, phosphorus, nitrogen and their organic compounds lead to undesirable consequences of eutrophication, including changes in the structure and functioning of the entire marine ecosystem and a decrease in its stability.The content of phosphate phosphorus in coastal water bodies CW4-CW7 of the Odesa region in 2022 varied in the range from analytical zero (< 5 µg/dm3) up to 7.3 µg/dm3, with an average value of 0.7 µg/dm3.</td><td>
<table>
<tr><th>Pollutant</th><th>Water</th><th>Sediment</th><th>Biota</th><th>Overall Impact</th></tr>
<tr><td>Nutrients in the water column</td><td>High</td><td>Medium</td><td>Medium</td><td>Medium</td></tr>
<tr><td>Chlorophyll</td><td>High</td><td>Medium</td><td>Medium</td><td>Medium</td></tr>
<tr><td>Harmful algal blooms</td><td>High</td><td>Medium</td><td>Medium-High</td><td>Medium</td></tr>
<tr><td>Opportunistic macroalgae of benthic habitats</td><td>Medium</td><td>Medium-High</td><td>Medium</td><td>Medium</td></tr>
</table>
</td><td rowspan="5">In accordance with the framework Directive of the marine strategy 2008/56/EC [5] and the decision of the European Commission 2017/848/EC [7] on establishing criteria and methodological standards for the proper ecological quality of marine water bodies, they are evaluated according to the descriptor D5 (eutrophication).</td><td rowspan="5">One of the important and urgent environmental tasks is the implementation of the National Program for the Protection and Revitalization of the Natural Environment of the Black and Azov Seas [2], the State Water Monitoring Program (in terms of diagnostic monitoring of coastal and marine waters of the Black and Azov Seas) [3] and the provision of the Marine Environmental Protection Strategy of Ukraine [4], which was developed in accordance with the Association Agreement between Ukraine and the European Union, in particular in terms of the implementation of Directive 2008/56/EC of the European Parliament and of the Council of June 17, 2008 [5] on establishing the framework of the Community's activities in the field of environmental policy regarding marine environment (Marine Strategy Framework Directive), and taking into account Directive 2000/60/EC of the European Parliament and the Council of October 23, 2000 [6] "On establishing a framework for Community action in the field of water policy" (Water Framework Directive).</td></tr>
</table>

							The maximum values of phosphate phosphorus were observed in February and March, but they corresponded to the "excellent" quality status and "good" ecological condition in water bodies CW4 - CW7 of the Odesa region.							
			Contaminants	TPH, PAHs, HMs, POPs (OCPs, PCBs), Toxic metals, Group of pollutants of agricultural origin (Pk PAO), Group of pollutants of industrial origin	Water, sediments, biota	On the basis of the analysis of the research data of the waters of the Black Sea, an evaluation of the ecological status was given in accordance with the descriptor D8, D9 according to the maximum permissible concentrations in accordance with the EU directive 2013/39/EU (MAC-EQS). Due to analysis of the research the main pollutants where identified: mercury (Hg), cadmium (Cd), lead (Pb), nickel (Ni) and other heavy metals. The analysis of literature allowed to identify other types of the most recently met pollutants, namely: oil products and different forms of Total Petroleum Hydrocarbons , Persistent Organic Pollutants, Polycyclic Aromatic Hydrocarbons. One of the main sources of these pollutants is represented by marine shipments of cargos and oil spillowers. All the mentioned pollutants influence water quality, marine mammals and other marine biotic forms (seaweeds, algae, fish, mollusks and others).	The pollution coefficient (Pk) was used for evaluation. Pk reflects the concentration of all pollutants in a separate time period in a given area. This coefficient is calculated as the sum of the ratios of the concentration of each polluting compound to its maximum permissible concentration in accordance with the EU directive 2013/39/EU (MAC-EQS), or the maximum permissible concentration in accordance with the Ukrainian legislation (MPC), or the environmental normative (standard) for the quality of the marine environment (EN) to the number of measurements carried out in a given period of time. The ecological condition of the area (water body) is determined according to the following algorithm: 1. The average concentration of each measured pollutant is found to the number of its measurements for a specific period of time in the assessed area. 2. The ratio of the average concentration of each measured pollutant to its maximum permissible concentration, according to Ukrainian or European legislation, is found. As the limit concentrations for the pollutant differ, in these legislations, the lower limit is taken according to the indicator. The table shows Pk values for mercury (Hg), cadmium (Cd), lead (Pb), nickel (Ni) and Pk for heavy toxic metals (TM) in the surface and bottom layer of water according to 2021 data by district. The assessment of the ecological state was carried out in accordance with the EU directive 2013/39/EU (MAC-EQS). 3. Polluting substances are divided into three groups for which the Pk is determined: • Group of toxic metals (Pk TM) • Group of pollutants of agricultural origin (Pk PAO) • Group of pollutants of industrial origin (Pk PIO) 4. The procedures are described in clauses 1, 2, 3 is carried out for water, bottom sediments and biological material sampled in the evaluated area for a specific period of time. Ecological status is determined by the worst assessment of any of the three groups of pollutants in water or bottom sediments. The evaluation of biological objects is carried out according to the same principle separately and indicates the ecological state of the area during the time period of the development of this biological object (the age of the biological object), under the conditions that it is settled from.	**For assesment of mercury, cadmium, lead, nickel and toxic metals pollutions the methodology of ratios of the average concentration of each measured pollutant to its maximum permissible concentration is used**	It is established by the European Union, in particular in terms of the implementation of Directive 2008/56/EU of the European Parliament and of the Council of June 17, 2008 [5], a framework for the Community's activities in the field of environmental policy regarding the marine environment (Marine Strategy Framework Directive), and taking into account the Directive 2000/60/EU of the European Parliament and of the Council of October 23, 2000 [6] "On the establishment of a framework for Community activities in the field of water policy" (Water Framework Directive). "Convention on the protection of the Black Sea against pollution," ratified by the Resolution of the Verkhovna Rada of Ukraine on February 4, 1994, No. 3939-XII (entered into force for Ukraine on April 14, 1994). Regulation of pollution types is also provided in Ukraine by "Convention on the protection of the Black Sea against pollution," ratified by the Resolution of the Verkhovna Rada of Ukraine on February 4, 1994, No. 3939-XII (entered into force for Ukraine on April 14, 1994). The Convention aims to protect and preserve the marine environment of the Black Sea.	On the national level the following legislative acts for pollution mitigation are used: "Water Code of Ukraine," brought into force by the Resolution of the Verkhovna Rada of Ukraine on June 6, 1995, No. 214/95-VR. "Ukraine's Marine Conservation Strategy," approved by the Cabinet of Ministers of Ukraine on October 11, 2021, by Decree No. 1240-r. "Rules for ship control to ensure maritime safety," approved by the Ministry of Transport of Ukraine on July 17, 2003, by Order No. 545. "Rules for the protection of internal waters and territorial sea from pollution and littering," approved by the Cabinet of Ministers of Ukraine on February 29, 1996, No. 269. "Rules for the provision of postal communication services," approved by the Cabinet of Ministers of Ukraine on March 5, 2009, No. 270 (as amended by the Resolution of the Cabinet of Ministers of Ukraine on October 10, 2023, No. 1071). "Procedure for water sampling and analysis," approved by the Cabinet of Ministers of Ukraine on August 21, 2019, No. 828. "Methodology for calculating compensation for damage caused to the state as a result of violations of legislation on the protection and rational use of water resources," approved by the Ministry of Environmental Protection and Natural Resources of Ukraine on July 20, 2009, No. 389. "Provision on the procedure for calculating compensation and payment of damages caused by pollution from vessels, ships, and other floating facilities in the territorial and internal waters of Ukraine," approved by Order of the Ministry of Environmental Protection and Natural Resources of Ukraine dated January 16, 2021, No. 16. "Methodology for calculating damages from oil pollution," approved by the Resolution of the Cabinet of Ministers of Ukraine dated April 26, 2003, No. 631. Resolution of the Cabinet of Ministers of Ukraine "On approval of rates for calculating the amount of compensation for damage caused by enterprises, institutions, organizations, and citizens of Ukraine, foreign legal entities, and citizens as a result of pollution from vessels, ships, and other floating facilities in the territorial and internal waters of Ukraine" dated July 3, 1995, No. 484. Resolution of the Cabinet of Ministers of Ukraine "On approval of rates for calculating the amount of damage caused by violations of fisheries legislation as a result of illegal fishing, destruction, or damage to aquatic biological resources, as well as illegal destruction or deterioration of the environment of aquatic biological resources habitat" dated September 29, 2023, No. 1042. "Methodology for assigning a body of surface water to one of the classes of ecological and chemical status of the body of surface water, as well as assigning an artificial or significantly modified body of surface water to one of the classes of ecological potential of artificial or significantly modified bodies of surface water," approved by the Order of the Ministry of Ecology and Natural Resources of Ukraine dated January 14, 2019, No. 5. "Methodology for determining damages caused by pollution and/or contamination of water, unauthorized use of water resources," approved by the Order of the Ministry of Environmental Protection and Natural Resources of Ukraine dated July 21, 2022, No. 252. "Methodology for determining damage and losses inflicted on territories and objects of the nature

reserve fund as a result of armed aggression by the Russian Federation," approved by the Order of the Ministry of Environmental Protection and Natural Resources of Ukraine dated October 13, 2022, No. 424.
"Methodology for determining losses inflicted on the environment within the territorial sea, exclusive maritime (economic) zone, and internal maritime waters of Ukraine in the Azov and Black Seas," approved by the Order of the Ministry of Environmental Protection and Natural Resources of Ukraine dated August 19, 2022, No. 309.

Indicator	$P(PO_4)$	$N(NO_3)$	$P(PO_4)$	$N(NO_3)$
	µg/dm³	µg/dm³	µg/dm³	µg/dm³
Water massif	CW4		CW5	
Average	0.4	101.2	0.6	107.6
Maximum	05-Jun	237.8	06-Feb	266.6
Area	Pk TM	Pk Cd	Pk Hg	Pk Pb
CW4	0.6	Feb-13	0.15	0.11
CW5	0.2	0.43	0.29	0.07
CW6	0.29	0.68	0.35	0.14
CW7	0.32	0.77	0.45	0.07

For assessment of Total Petroleum Hydrocarbons , Persistent Organic Pollutants, Polycyclic Aromatic Hydrocarbons pollutions and total pollution by Heavy metals, according to the literature review and communication with experts the following scale is used:

Pollutant	**Water**	**Sediment**	**Biota**	**Overall Impact**
TPH (Total Petroleum Hydrocarbons)	High	High	High	High
PAHs (Polycyclic Aromatic Hydrocarbons)	Medium	Medium	Medium	Medium
POPs (Persistent Organic Pollutants)	Medium	Medium	Medium	Medium

								HM (Heavy Metals)	Medium	Medium	Medium	Medium		
			Marine litter	Macrolitter, microplastics	Water, sediments, biota	Garbage is waste that enters the marine environment from land and as a result of human maritime activities. The most dangerous waste is plastic waste, since most of it is insoluble and does not decompose in the marine environment. Evaluation criteria 10.1 Characteristics of garbage in the marine and coastal environment. 10.1.1. Trends in the amount of litter washed ashore and/or deposited on shorelines, including an analysis of its composition, spatial distribution and, where applicable, source. 10.1.2. Trends in the amount of debris in the water column (including floating on the surface) and deposited on the seabed, including an analysis of its composition, spatial distribution and, where applicable, source. 10.1.3. Trends in the quantity, distribution and, where applicable, composition of microparticles (in particular microplastics). 10.2 Impact of garbage on marine flora and fauna. 10.2.1. Trends in the amount and composition of waste entering marine animals (e.g. stomach analysis). Marine debris is assessed using the following indicators: beach debris > 2.5 cm that has washed ashore or accumulated on the shoreline), analysis of its composition, quantity and spatial distribution and, where possible, the source of debris > 2.5 cm that floats on the surface, analysis of its composition, spatial distribution and, where possible, the source	Litter washed ashore or accumulated on the beach Monitoring of marine litter along the Ukrainian coast was carried out in accordance with EU MSFD TG10 "Guidelines for monitoring marine litter in European seas" (2013) (which includes monitoring guidelines, protocols and methodologies). The beaches are selected taking into account the recommendations of the "Management". Among the criteria for the selection of monitoring sites is the openness of the coast (absence of breakwaters, traverses, piers), thus marine debris is not shielded by anthropogenic structures. According to the Guidelines, the amount of beach litter > 2.5 cm is determined by category, number of items and weight per 100 meters (m) of coastline. The "Marine LitterWatch" application developed by the European Environment Agency was used for monitoring. The application includes a list of different categories of waste (plastic, rubber, textile, paper/cardboard, wood, metal, glass/ceramic, other). Ukraine, in turn, developed and approved the Resolution "On the Approval of the State Water Monitoring Procedure", which includes the indicators and periodicity of marine debris monitoring (Resolution of the Cabinet of Ministers of Ukraine dated September 19, 2018 No. 758). Monitoring of marine macro-litter on the coastal line covers 3 unprotected beaches along the Black coast of Ukraine, of which 1 beach is located in the city of Odesa - Chornomorka municipal beach, the other 2 hard-to-reach beaches in the Odesa region. The first is located on the spit that separates the Shabolatsky (Budatsky) estuary, located 18 km from the city of Bilhorod-Dniestrovsky, from the Black Sea, the second - on the territory of Karolino-Bugaz, a Black Sea resort located 60 km northwest of Odesa, on the beginning of the sand spit that separates the Black Sea from the Dniester estuary. Thus, about 11 kg of various types of garbage were collected on the beach "Chornomorka". The most common category was, as always, cigarette butts - 1911 units, other types of plastic were found - 902 units, the second position in terms of quantity was taken by paper - 213 units, and the third - metal (100 units). Garbage floating on the surface of the sea The method determines the amount of floating garbage > 2.5 cm in size in the surface layer of the water column by the number of objects of each category per square kilometer (km2). To monitor floating marine debris and riverine debris), the JRC Garbage Monitoring App (app) developed as part of the RIMMEL project is used. Ukraine began monitoring floating marine debris in 2016 as part of the EMBLAS project. Since the monitoring of floating marine macro-litter is based on visual observations from the ship, the frequency of monitoring depends on the availability of resources and funding. The JRC Floating Litter Monitoring Application is a dedicated generic tool for real-time documentation of floating macrolitter data obtained during visual monitoring sessions and facilitates the recording of metadata such as positions, transect information, vessel speed, weather conditions, etc.The application is designed for tablet computers with the Android operating system. Details about the items and the size of the litter sample are recorded along with the GPS position and time in the data files. According to the results of the observations, it was found that the concentrations of floating debris in the Black Sea varied greatly in some areas and very high concentrations were observed. According to Bulgarian scientists, in the northwestern Black Sea region, the concentration ranged from 30 units/km² to 136 units/km², the average concentration on all transects is 90.5 units/km². The average concentration of marine litter in the western part of the Black Sea in 2016-2017 was 23.0 objects/km². In comparison, in the eastern part of the sea, the concentration of garbage is much higher and amounts to 138.6 objects/km². The litter density on the Odesa-							

							Batumi transect varied from 0 items/km² to 810.2 items/km². The average density of garbage was 90.5 objects/km². This is in good agreement with previous studies. According to observations on the Odesa-Batumi transect, the number of plastic objects in the 2.5-5 cm size categories in the first city was 98; 5-10 cm - 61; 10-20 cm – 49; 20-30 cm - 21; 30-50 cm – 4; > 50 cm - 7 items/km². The total number of plastic items was 240 per km². In the second city - items made of foam plastic - 81 items/km², plastic fragments in the third place - 62 items/km². On the return journey from Batumi-Odesa, the data were similar: 2.5-5 cm – 203; 5-10 cm – 59; 10-20 cm - 64; 20-30 cm - 26; 30-50 cm - 7; > 50 cm - 8 items/km². The total number is 367 items/km². Styrofoam items are in second place - 77 items/km², plastic fragments are in third place - 71 items/km². Marine debris monitoring has shown very high variability among areas of the sea, as well as very high maximum concentrations of floating debris. The uneven distribution of floating debris on the surface of the sea may be related to sources of debris in the sea and requires further observations and analyses. Marine debris, particularly plastic, is found in all areas of the Black Sea. Concentrations on the sea surface are highly variable. Monitoring of marine debris still does not cover any sufficient area to draw correct conclusions about its distribution. However, the confirmation of previous results and the achievement of new data allow us to estimate the total density, and sometimes register some spots of garbage in the sea and thus make suggestions about its sources. Based on the results of the observations, a disappointing conclusion should be drawn: the tendency of the predominance of small size categories of various types of marine debris should be noted. These small fragments are more likely to be swallowed by large fish, birds, and mammals living in the Black Sea. Since it is impossible to reach the reference conditions with marine litter (especially for litter in the water column sunk to the bottom of the sea and micro-litter), it is necessary to take measures to reduce its entry into water bodies. Hydroelectric power plant for marine debris: properties and quantities of marine debris areso as not to harm the coastal and marine environment. Threshold values of HPP for Ukraine have not been determined. Environmental goals related to the sources of litter and the consequences of impact on them: Goal 1: Reducing the trend in the amount of marine litter washed ashore and / or washed ashore. Objective 2: The trend in the amount of marine debris floating on the surface of the water, in the water column and settling on the seabed is decreasing.						
			Noise	Impulsive and continuous noise	Water	Evaluation criteria. The ecological condition of marine environment areas according to Descriptor 11 is assessed by such indicators as: Impulse sounds with low and medium frequency; Continuous low-frequency sound (extraneous noise). Main sources of noise: noise from ships; noise during seismic exploration works using pneumatic guns, noise arising from drilling and extraction of marine minerals, including oil and gas; noise from the activities of the navy (explosions, low- and medium-frequency sonars); noise during construction, pile driving (pulse) and dredging.								

			Ballast water /Invasive species		Water, biota	Alien species (inhabitant species, invasive species) are species of animals or plants that, in one way or another, got into their new habitats. This can happen purposefully (for example, when introducing new species) or through natural or accidental migration. Evaluation criteria. The spread of invasive species is assessed according to the following parameters: 1) Number and characteristics of the state of invasive species (trends regarding changes in the number over time and in the spatial distribution of invasive species); 2) Impact of invasive species on the environment (the ratio of invasive to native species in some well-studied taxonomic groups (e.g., fish, macroalgae, molluscs). The level of alien species introduced by human activity does not have a negative effect on the ecosystem. Definition and assessment of pathways and vectors of anthropogenic dispersal of non-native species is a prerequisite for preventing anthropogenic introduction of such species to levels that adversely affect ecosystems and mitigating any impacts of these species.							
			Military pollution	Macrolitter, microplastics, impulsive and continuous noise, Heavy metalls, Toxic metals, Group of pollutants of industrial origin	Water, sediments, biota	Very heavy impact on mammals, fish and other species, on water, ecosystem. Very heavy impact on people living near seashore.	Numerous mammals, fishes and other species where killed or injured as a result of weapon use. Very heavy noise and chemical preasure on water, on ecosystem. Numerous explosions and blast waves killed mammals, fish, destroyed elements of eco-system, caused to human casualties near the seashore and their homes destruction	The assessment methods are being developed, only expert evaluations can be used at a moment. The most of the information about the attacks affects is restricted for sharing						

Country	BS area/Sub-basin	Pollution sources (expert opinion/literature)	Type of pollution (expert opinion /literature)	Type of pollution - details	Ecosystem affected (mainly)	Impacts	Impacts - details	Impact Assessment (expert opinion/literature) (High, Medium, Low)					Regulation of pollution types (Legislation/ Law enforcement/ Mitigation measures etc.)	Summary of laws and regulations related to marine pollution monitoring and control
								Pollutant	Water	sediment	Biota	Overall Impact		
Georgia	Georgian Black Sea coastal area	Maritime traffic, rivers, off-shore activity, land-based sources, atmospheric inputs (lanbase/concentred, or seabase/diffuse sources), more specifically: 1. Sewer discharges: Untreated or partially treated sewage contributing to nutrient loading and eutrophication. 2. Industrial discharges: Release of heavy metals, organic pollutants, and chemical waste from factories and processing plants. 3. Agricultural runoff: Pesticides, herbicides, and fertilizers increasing nutrient levels in the sea. 4. Marine litter: Accumulation of plastic waste and debris impacting marine life. 5. Oil spills and hydrocarbon pollution: Shipping activities and oil terminals causing oil spills and contamination. 6. Non-indigenous species: Introduction via ballast water discharge from ships. 7. Heavy metals and toxic substances: Mercury, cadmium, and lead from industrial discharge and mining activities.	Eutrophication	Nutrients (nitrates, phosphates).	Pelagic habitat	Eutrophication and hypoxia Contamination of marine life and seafood Disruption of marine ecosystems and loss of biodiversity Economic impact on fisheries and tourism Health risks to humans and marine animals Spread of non-native species outcompeting native species	Introduction of nutrients is a significant pressure in the Black Sea. In the transitional waters, the main sources are rivers (Rioni, Enguri, Supsa, Chorokhi, Kodori, and others) and streams. In coastal waters, urbanization leads to increasing nutrient levels due to untreated or insufficiently treated wastewater discharge. The effects of increased nutrient concentrations are direct—such as algal blooms and increasing chlorophyll concentrations—and indirect—such as decreasing transparency and oxygen levels, which affect benthic communities, including macroalgae and zoobenthos.	Inorganic phosphorus (phosphate)	Medium-High	Medium-High	Medium-High	Medium-High	Legislation/Regulations Law on Environmental Protection of Georgia Law on Water Resrouces Management Association Agreement with the EU (Article 309 and 339) Marine Strategy Framework Directive (MSFD) Water Framework Directive (WFD) Black Sea Strategic Action Plan (BS SAP) EU Water Initiative Plus (EUWI+) National Biodiversity Strategy and Action Plans (NBSAPs) Monitoring and Assessment: National Environmental Agency (NEA) conducts monitoring of water quality. Gaps: Insufficient data on specific pollutants, limited monitoring of microplastics, need for more comprehensive data on non-indigenous species, gaps in legislative enforcement. Potential solutions: Enhance monitoring programs, stricter enforcement of regulations, capacity building for laboratories, regional cooperation for data sharing.	Constitution of Georgia (1995.08.24): Article 29 establishes the right to live in a healthy environment and the right of the public to participate in the decision-making related to the environment. Law of Georgia on Environmental Protection (1996.12.10): Provides a framework for the protection of the environment, including the marine environment. Article 54 is dedicated to the protection of the Black Sea from pollution. Law of Georgia on Water Resources Management (2023.06.30): Ensures the implementation of state policy in the fields of protection and use of water resources, including integrated management principles, harmonised with WFD and other EU Directives. The Environmental Assessment Code (2017.06/01): Introduces Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA) procedures. The Law of Georgian on Industrial Emissions (2023.06.29): Prevents emissions from industrial activities into the atmosphere, water, and soil, and controls waste generation. Maritime Code (1997.05.15): Defines the institutional setup regarding maritime transportation and environmental pollution by ships. Law on Maritime Space of Georgia (1998.12.24): Prohibits the pollution of the maritime space and regulates pollution prevention from coastal and riverbank sources. Law on Maritime-Rescue Service (2000.09.29): Regulates the procedures
								Inorganic nitrogen (nitrate, nitrite, ammonium)	Medium-High	Medium-High	Medium-High	Medium-High		
			Contaminants	Heavy metals (e.g., mercury, cadmium, lead), persistent organic pollutants (e.g., PCBs, DDT), hydrocarbons.	Water, sediments, biota	Toxicity to marine life, bioaccumulation in the food chain, health risks to humans.	Contaminants such as heavy metals (e.g., mercury, cadmium, lead), persistent organic pollutants (e.g., PCBs, DDT), and hydrocarbons pose significant risks. These pollutants lead to toxicity in marine life, bioaccumulation in the food chain, and health risks to humans. Heavy metals and persistent pollutants persist in the environment, causing long-term damage to marine ecosystems. The effects include the accumulation of toxic substances in sediments, impacting benthic organisms and higher trophic levels, including fish and marine mammals, ultimately affecting human health through seafood consumption.	Pollutant	Water	Sediment	Biota	Overall Impact	Legislation/Regulations Law on Environmental Protection of Georgia, Law on Water Resrouces Management, Law on Industrial Emissions, MSFD, WFD. Monitoring and Assessment: Regular monitoring by the National Environmental Agency, participation in the EMBLAS project, monitoring of heavy metals, organic pollutants. DOORS H2020 project Cruise June 2024 (water, sediments, eDNA sampling). Gaps: Limited data on specific contaminants, lack of comprehensive monitoring for all potential pollutants, gaps in legislative enforcement. Potentil solutions: Enhance monitoring programs, stricter enforcement of regulations, capacity building for laboratories, regional cooperation for data sharing.	
								TPH (Total Petroleum Hydrocarbons)	High	High	High	High		
								PAHs (Polycyclic Aromatic Hydrocarbons)	Medium-High	High	High	High		
								POPs (Persistent Organic Pollutants)	Medium-High	High	High	High		
								HM (Heavy Metals)	Medium-High	High	High	High		
			Marine litter	Macrolitter, microplastics	Water, sediments, biota	Ingestion by marine animals, entanglement, introduction of toxic substances into the food web. Impact on recreation,	Marine litter, including macrolitter and microplastics, affects water, sediments, and biota. Marine animals often ingest plastic waste, leading to physical harm and	Macrolitter	High	High	High	High	Legislation/Regulations Law on Environmental Protection of Georgia, Law on Water Resrouces Management, MSFD, Law on Waste Management, National Waste Management Strategy and Action Plan.	
								Microplastics	High	High	High	High		

						tourism and coastal ameanities.	exposure to toxic substances. Entanglement in marine litter can cause injury or death to marine animals. Microplastics can be ingested by a wide range of marine organisms, entering the food web and potentially impacting human health. Marine litter also affects recreational activities, tourism, and coastal amenities, reducing the aesthetic value and usability of beaches and coastal areas.					Monitoring and Assessment: Monitoring by the National Environmental Agency, marine litter surveys, beach litter surveys, beach clean-up programs. Gaps: Inadequate waste management infrastructure, insufficient public awareness, limited monitoring of microplastics. Potential solutions: Improve waste management practices, public education campaigns, enhance monitoring for microplastics, regional cooperation on marine litter reduction initiatives.	for providing assistance and eliminating sea pollution from oil and hazardous substances. Law of Georgia on the Education and Certification of Seafarers (2011.12.23): Defines standards for education, training, and certification of seafarers, including marine environment protection. Law on Protected Areas System (1996.03.07): Provides the legal base for establishing protected areas, including marine protected areas. Law on Establishment and Management of Kolkheti Protected Areas (1999): Establishes Kolkheti National Park, which includes coastal wetlands and marine protected areas. Law on Red List and Red Book of Georgia (2003.06.06): Defines the procedures for protecting critically endangered species, relevant for marine environments. Law on Aquaculture (2020.06.24): Regulates aquaculture activities to promote responsible and sustainable practices. Spatial Planning Architecture and Construction Code (2018.07.20): Regulates spatial planning, including maritime spatial planning and coastal development. Decree of the Government of Georgia № 195 April 22 (2016): Approval of the National Marine Oil Spill Response Plan. Decree of the Government of Georgia № 423 December 31 (2013): Defines fisheries regulations in the Black Sea. Decree of the Government of Georgia № 672 December 31 (2019): Harmonizes European rules with
			Noise	Impulsive and continuous noise	Water	Disruption of marine animal communication, stress and behavioral changes in marine life, potential hearing damage.	Noise pollution from shipping, industrial activities, and offshore construction disrupts marine animal communication, leading to stress and behavioral changes. Impulsive and continuous noise can interfere with the ability of marine animals to find food, navigate, and reproduce. Chronic exposure to noise can cause hearing damage and even death in severe cases. Noise pollution impacts the health of marine mammals, fish, and other marine organisms, leading to changes in population dynamics and ecosystem structure.	Impulsive noise	High			High	Legislation/Regulations Law on Environmental Protection of Georgia, Law on Water Resrouces Management, Maritime Code, MSFD. Monitoring and Assessment (most recent, Regular monitoring): Monitoring of underwater noise levels by the National Environmental Agency, participation in international noise pollution studies. Gaps: Limited baseline data on underwater noise, lack of specific regulations on noise pollution in marine environments. Potential solutions: Develop baseline noise level data, implement noise reduction measures in shipping and construction, enhance regulations on underwater noise.	
								Continuous noise	Medium-High			Medium-High	
			Balast water/Invasive species	Invasive species (*Mnemiopsis leidyi, Beroe ovata, Rapana venosa*)	Pelagic and benthic habitat	Displacement of native species, alteration of marine ecosystems, economic impact on fisheries and tourism.	Ballast water discharge from ships introduces non-indigenous species to the marine environment, which can outcompete native species, alter marine ecosystems, and disrupt local biodiversity. Species such as Mnemiopsis leidyi, Beroe ovata, and Rapana venosa have significantly impacted the Black Sea. Invasive species can cause economic damage to fisheries and tourism industries by altering habitats and reducing the populations of commercially important species. Effective ballast water management and monitoring practices are crucial to mitigate these impacts.	Invasive species	Medium-High		Medium-High	Medium-High	Legislation/Regulations Law on Environmental Protection of Georgia, Law on Water Resrouces Management, Ballast Water Management Convention, National Oil Spill Contingency Plan, MSFD. Monitoring and Assessment: Monitoring of ballast water discharge and invasive species by the National Environmental Agency, implementation of ballast water management practices. Gaps: Insufficient monitoring of ballast water, limited data on the spread and impact of invasive species. Potential solutions: Enhance ballast water management practices, increase monitoring of invasive species, regional cooperation for invasive species control.	

			Atmospheric pollution/depositions	Sulfur oxides (SOx), nitrogen oxides (NOx), particulate matter (PM)		Acidification of marine waters, contamination of marine life, health risks to humans, eutrophication.	Atmospheric pollutants such as sulfur oxides (SOx), nitrogen oxides (NOx), and particulate matter (PM) contribute to the acidification of marine waters, affecting the health of marine ecosystems. These pollutants can lead to the contamination of marine life, posing health risks to humans. Acidification can disrupt the balance of marine ecosystems, affecting species composition and productivity. Additionally, atmospheric deposition of pollutants contributes to eutrophication, exacerbating the effects of nutrient pollution.	Atmospheric pollution/depositions	Medium	Medium	Medium	Medium	Legislation/Regulations Law on Environmental Protection of Georgia, Law on Water Resrouces Management, Law on Atmospheric Air, MSFD. Monitoring and Assessment: Air quality monitoring by the National Environmental Agency, participation in international air quality monitoring programs. Gaps: Limited data and odels on atmospheric deposition in marine environments, insufficient regulation of certain pollutants. Potential solutions: Enhance air quality monitoring, implement stricter emissions controls, regional cooperation on air quality improvement initiatives.	Georgian fisheries regulations. Order of the Government of Georgia № 1629 September 7 (2022): The Fourth National Environmental Action Programme of Georgia for 2022-2026, includes provisions for Black Sea protection. Decree of the Government of Georgia № 343 December 31 (2019): National Biodiversity Strategy and Action Plan of Georgia 2014-2020, focuses on reducing eutrophication and nutrient pollution. Decree of the Government of Georgia № 414 December 31 (2013): Methodology for calculating maximum allowed concentration of pollutants in wastewater discharged into surface waters. Decree of the Government of Georgia № 431 August 20 (2018): Sets quality standards for discharged water in sewage systems. Ministerial Order No. 297/n of the Ministry of Labor Health and Social Affairs of Georgia 16 August 2001: Defines environmental quality norms for surface and coastal waters. 2014/494/EU. Council Decision of 16 June 2014: EU-Georgia Association Agreement, includes articles on marine environment management. Proposal for a National Marine Environment Strategy and Action Programme (2020.07.18)