

Ocean Disclosure Initiative

MARITIME TRANSPORTATION
INDUSTRY REVIEW

SDA Bocconi
SCHOOL OF MANAGEMENT
SUSTAINABILITY LAB

McKinsey
& Company

 CSIC
CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS



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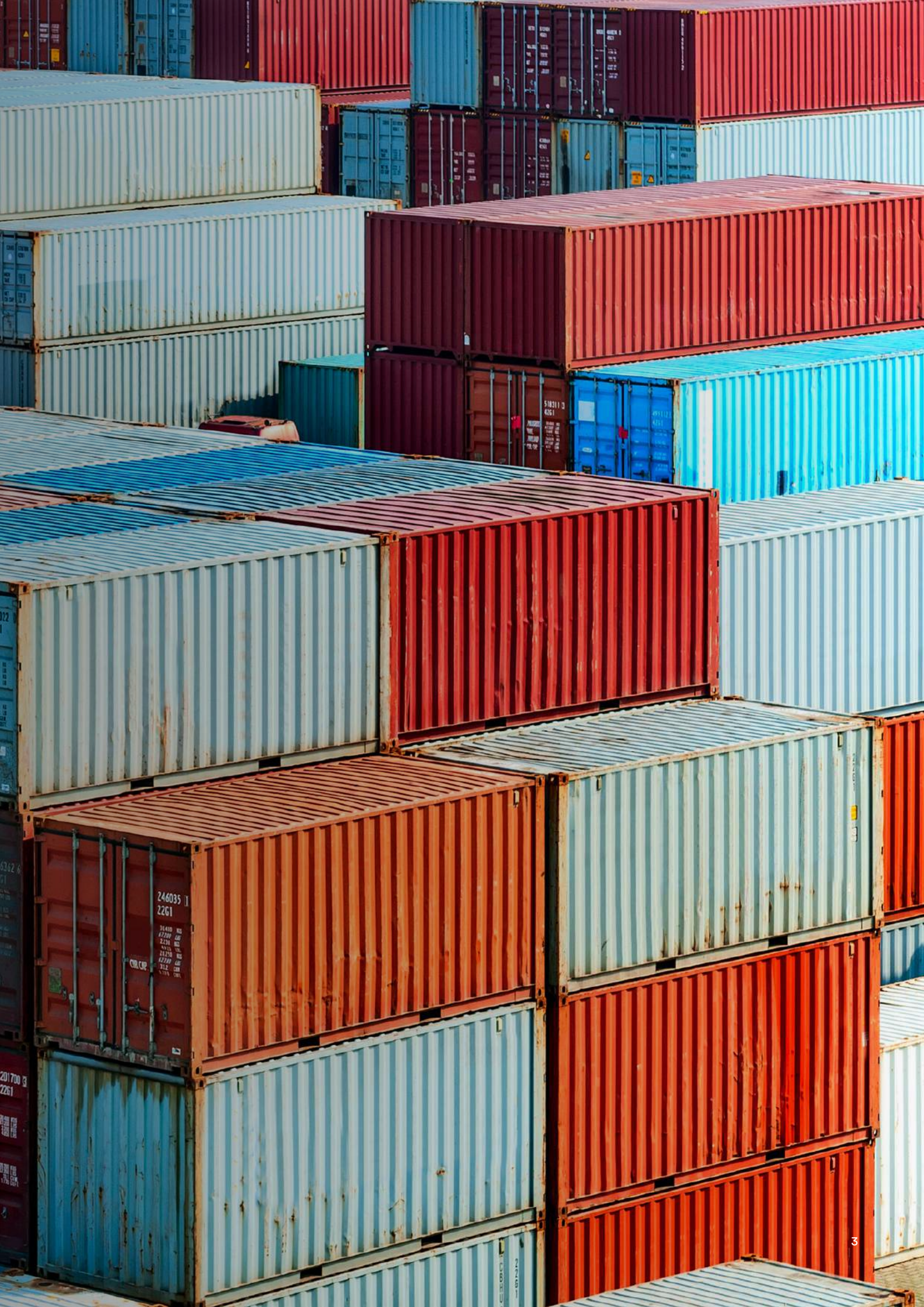
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About One Ocean Foundation

This research is an initiative of the One Ocean Foundation as part of its commitment to the promotion of ocean literacy.

The mission of the Foundation is to accelerate solutions to ocean issues by inspiring international leaders, institutions, companies and people, promoting a blue economy, and enhancing ocean knowledge through ocean literacy. The Foundation intends to develop a leading platform, bringing together and strengthening the voices speaking out on behalf of the ocean around the world.

The distinctive feature of the One Ocean Foundation is its scientific scope and, at the same time, its strong educational drive, with the aim of increasing awareness and establishing constructive relationships between all stakeholders engaged in marine preservation at different levels.

Thanks to its extensive network of partners, the One Ocean Foundation is engaged in numerous unique, innovative, and high added-value projects related to its mission of ocean protection in three main areas: education, environmental research, and the blue economy.

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About the Ocean Disclosure Initiative

The Ocean Disclosure Initiative project is part of the multi-year research “Business for Ocean Sustainability” promoted by the One Ocean Foundation (OOF) in collaboration with SDA Bocconi School of Management Sustainability Lab, McKinsey & Company, and CSIC (Consejo Superior de Investigaciones Científicas) and aimed at building knowledge about the relationship between business activities and the ocean.

The project commenced in 2019 to investigate the role of companies in addressing ocean challenges, focusing on the pressures on marine ecosystems, levels of awareness within the business community and the main responses (technological and organisational) implemented.

The Ocean Disclosure Initiative aims to be a science-based framework and methodology with the objective of supporting businesses from all industries in acting on ocean-related issues, promoting prevention and/or mitigation responses, and favouring disclosure and reporting.

Introduction to the Maritime Transportation Industry

Waterborne transportation, which includes maritime transportation and hydraulic effluvial transportation, is the transport of people or goods via waterways. Nowadays, more than 90% of commercial traffic is conducted by sea¹ through cargo-carrying commercial shipping (e.g. merchant marine), and non-cargo commercial shipping (e.g. ferries, cruise ships). In addition, marine transportation includes military ships, tugs and fishing vessels.

Maritime transportation has been analysed within the framework of the Ocean Disclosure Initiative (ODI) by reviewing relevant material and sectoral publications on the environmental pressures of the industry, along with sustainability reports from the main stakeholders in the sector. The core objective of the analysis is to map and better understand the pressures exerted on marine ecosystems, thus creating the basis for the industry-specific edition of the ODI questionnaire. To this end, the following paragraphs introduce the industry and present its main pressures on the ocean.

Maritime transportation is essential for global trade because, considering the massive quantity of goods transported by sea, it ensures the functioning of the entire economy's supply chains and brings significant economic and social benefits. In fact, the sector is responsible for moving billions of dollars' worth of goods each day². Given these premises and considering the rising demand for resources to be transported by sea, the sector is projected to experience strong growth in the coming years, as it offers the capacity to transport hundreds of thousands of tonnes with limited costs.

MARITIME TRANSPORTATION IS ESSENTIAL FOR GLOBAL TRADE, ENSURING THE FUNCTIONING OF THE WHOLE ECONOMY'S SUPPLY CHAINS AND BRINGING SIGNIFICANT ECONOMIC AND SOCIAL BENEFITS

1. UNCTAD (2022). "Review of Maritime Transport 2022" [online]. Available at: <https://unctad.org/rmt2022> (Accessed: 12 July 2023)

2. Walker, T. R. et al. (2019). "Environmental effects of marine transportation. In World Seas: an environmental evaluation" [online]. Available at: <https://doi.org/10.1016/B978-0-12-805052-1.00030-9> (Accessed: 12 July 2023)

Even though shipping is one of the modes of transport with the lowest carbon dioxide (CO₂) emissions per distance and weight carried³, **shipping movements across the ocean generate a negative impact on both air and water quality as well as on marine and riverine biodiversity**⁴, with stakeholders in the sector having displayed, for the most part, a limited understanding of these factors in the past. Fortunately, the industry has made substantial improvements in terms of preventing and mitigating its impact, mostly thanks to advancements in sector regulations regarding environmental protection.

The 1960s marked an important turning point for the industry when several accidental oil spills occurred, resulting in the pollution of waters and coastal habitats and the demise of a large number of plants and animals. This engendered a significant wave of indignation among the public and a growing awareness of the negative consequences of maritime transportation on the marine ecosystems. The international community responded with the adoption of the “International Convention for the Prevention of Pollution from Ships (MARPOL)”, which is the main international agreement to prevent marine pollution by ships from operational or accidental causes, originally signed in 1973, it was modified by the 1978 Protocol and came into force in 1983. The MARPOL convention was signed at the International Maritime Organization (IMO), the United Nations specialised agency responsible for the safety and security of shipping and the prevention of marine and atmospheric pollution by ships. Under its mandate, the IMO adopts several instruments to protect the marine environment from shipping activities: since its foundation, the organisation has adopted more than 50 international treaties that regulate international shipping, of which 40% focus on environmental protection⁵, increasing attention among the international community to the protection of the environment.

3. EEA & EMSA, (2021). “European Maritime Transport Environmental Report” [online]. Available at: <https://www.eea.europa.eu/publications/maritime-transport> (Retrieved: 12 July 2023)

4. For further information please refer to Walker’s publication as well as to additional scientific literature such as: Lizzette PÉREZ LESPIER, Suzanna LONG, Tom SHOBERG, Steven CORNS. A model for the evaluation of environmental impact indicators for a sustainable maritime transportation system. *Frontiers of Engineering Management*, 2019, and to the European Maritime Transport Environmental Report by the European Environmental Agency mentioned above.

5. EEA and EMSA, (2021). “European Maritime Transport Environmental Report” [online]. Available at: <https://www.eea.europa.eu/publications/maritime-transport> (Retrieved: 12 July 2023)

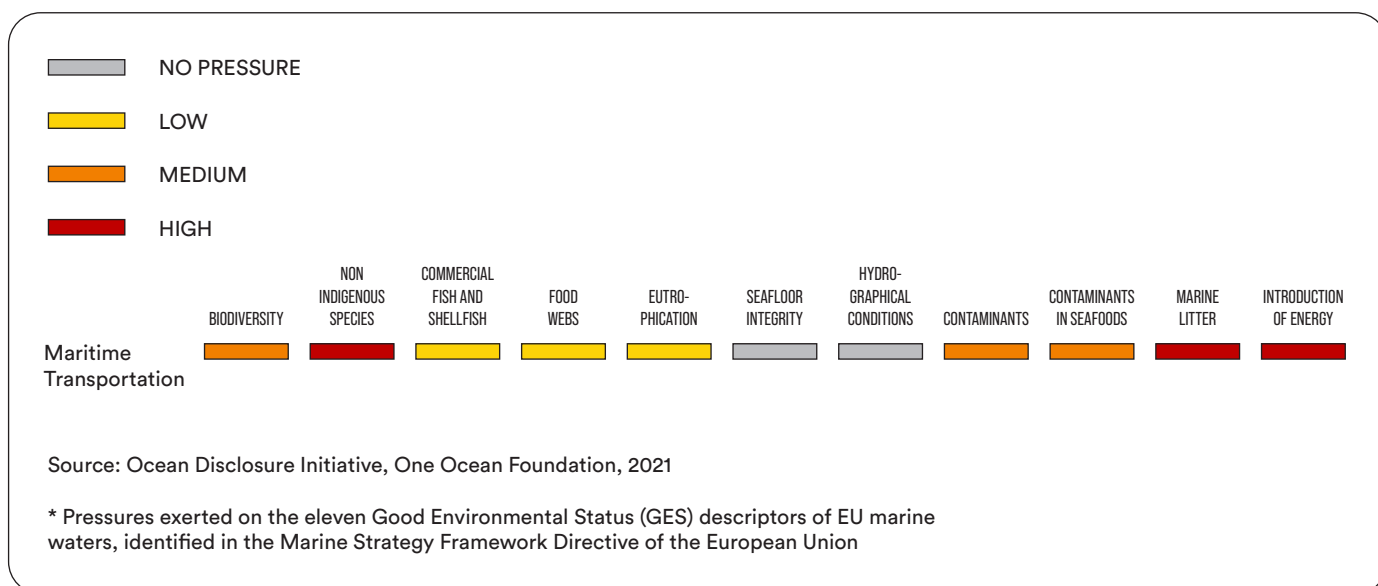
The scientific review conducted as part of the Ocean Disclosure Initiative project⁶, as shown in Figure 1, verified that the most significant potential pressures for ocean health exerted by the maritime transportation sector, highlighted in the orange and red cells, concern:

- Loss of biodiversity
- Introduction of non-indigenous species (NIS)
- Introduction of contaminants
- Introduction of marine litter
- Introduction of energy

Potential damage to seafloor integrity due to anchoring, mostly of high-tonnage ships, and propellers is another element worth discussing with regard to the maritime transportation industry, although with a more limited impact as indicated in the table.

Furthermore, in the following paragraphs, we also discuss how the sector’s emissions of greenhouse gases (GHGs), and other air pollutants cause processes that lead to loss of biodiversity and degradation of marine and coastal ecosystems.

FIGURE 1: Review of negative pressures of the maritime transportation sector*



6. One Ocean Foundation, (2021). “Ocean Disclosure Initiative” [online]. Available at: <https://oceandisclosureinitiative.org/>

The main pressures exerted by the maritime transportation industry

The maritime transportation industry exerts various pressures on the marine environment that may lead to changes in its state and biodiversity. Since shipping covers almost the entire ocean and takes place on a global scale, one of the main concerns is the introduction of non-indigenous species (NIS) through ballast waters. The disturbance to marine fauna from underwater noise emissions is also of significant importance. Moreover, shipping activities have serious implications for both air and water quality through polluting air emissions and the introduction of marine litter and contaminants.

In line with the EU Marine Strategy Framework Directive, the main environmental pressures caused by core activities of the maritime transportation industry with the potential to affect ocean health are listed below, while the loss of biodiversity, which relates to the quality and occurrence of habitats and the distribution and abundance of marine species, is treated in a transversal way across all of the elements below.

Introduction of non-indigenous species (NIS)

**THE MARITIME
TRANSPORTATION INDUSTRY
IS ONE OF THE MAIN DRIVERS
FOR INTRODUCING NON-
INDIGENOUS SPECIES INTO
THE MARINE ENVIRONMENT
DUE TO BALLAST WATERS
AND BIOFOULING**

The maritime transportation industry is one of the main drivers introducing non-indigenous species into the marine environment, especially since the opening of shipping pathways and corridors such as the Suez Canal. Nowadays, the sector is responsible for 60 to 90% of the introduction of non-native species into new areas⁷. Moreover, under suitable environmental conditions and thanks to a high level of resilience and adaptability, non-indigenous species may turn into ‘invasive species’ and proliferate in the marine environment with significant ecological impact on biodiversity, including i) alteration of the presence and abundance of native populations, ii) impact on food web interactions, iii) competition for food, space, and partners, and eventually, iv) replacement of native species.

7. Shipping Pact for People&Nature-SPPaN (2023). “Navigating the Future: Bridging Shipping, Biodiversity, and Decarbonization” [online]. Available at: <https://www.equalroutes.ca/resources/index.html> (Retrieved: 20 December 2023)

The two main vectors for the introduction of NIS are ballast waters and biofouling⁸, the former being associated with about one-third of documented species invasions globally⁹:

— **Ballast waters** are essential for ensuring and maintaining stability as well as reinforcing ships during loading and unloading operations, especially tankers and container vessels; however, discharges of untreated waters represent a significant threat to marine biodiversity. The water picked up near the port of departure is full of free-living and floating life stages of various species (e.g. larvae, eggs, etc.) that are pumped into tanks and, if improperly discharged at the destination port¹⁰, far from the native environment, could become non-indigenous species.

— **Biofouling** refers to the accumulation of sessile organisms and microorganisms, such as algae and molluscs, on ship's hulls (hull fouling), and in general on submerged structures, which travel long distances in the ocean along international and national marine routes before being released, spread, and proliferating in a new water environment as NIS. Moreover, having such organisms attached to ships' hulls slows the cruising speed. The European Maritime Transport Environmental Report 2021 indicates that, at the global level, more than 50% of NIS may have been transported through biofouling.

Best practices. To reduce and control the risks of spreading invasive species, ship owners and operators must adhere to international regulations and adopt specific management plans, including procedures and guidelines for managing ballast waters. An example is the International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM Convention) adopted by the IMO. Moreover, implementing innovative technologies could mitigate the introduction of NIS, such as installing specific systems on board to treat ballast waters through physical filtration and chemical disinfection before being discharged to the ocean. With regard to ship biofouling, or hull fouling, the IMO has recognised this as a threat, and specific guidelines for control and management of the issue have been developed to minimise the transport of invasive aquatic species.

8. Costello, K, et al. (2022). "Assessing the potential for invasive species introductions and secondary spread using vessel movements in maritime ports" [online]. Available at: <https://doi.org/10.1016/j.marpolbul.2022.113496> (Retrieved: 12 July 2023)

9. Davidson, I. C., & Simkanin, C. (2012). "The biology of ballast water 25 years later" [online]. Available at: [10.1007/s10530-011-0056-1](https://doi.org/10.1007/s10530-011-0056-1) (Retrieved: 12 July 2023)

10. EEA and EMSA, (2021). "European Maritime Transport Environmental Report" [online]. Available at: <https://www.eea.europa.eu/publications/maritime-transport> (Retrieved: 12 July 2023)

Introduction of contaminants

Contamination of waters from the maritime transportation industry may be caused by various sources and types of ship operations, including the use of antifouling biocides on hulls and accidents resulting in acute pollution events.

EVEN THOUGH THE NUMBER OF ACCIDENTS IS DECLINING, OIL SPILLS FROM MARITIME TRANSPORTATION REMAIN ONE OF THE MOST DANGEROUS SOURCES OF MARINE POLLUTION

Oil spills from marine transportation are, in fact, one of the most dangerous sources of marine pollution, as they are difficult to clean up and can persist for extended periods in the marine environment. Oil can severely pollute marine and coastal habitats, causing severe damage to plants and animals, in particular seabirds and marine mammals. The extent of the pollution may depend on various factors; for example, waves incorporate oils into the water column, whereas calm conditions allow oil slicks to spread over surface water and shorelines. Oil spills can originate from deliberate operational discharges, from negligence, such as poor maintenance of equipment, or as the result of an accident or incident. Even though the amount of oil transported by sea is constantly growing, the number of accidents is declining¹¹, thanks also to the international regulations put in place. Specifically, Annex I of the MARPOL convention provides measures to ensure that crude oil and oil products are transported and managed safely. At around the same time, in 1990, the IMO adopted the International Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC Convention), which provides the framework for international cooperation and assistance among countries in the event of major oil spills.

In terms of antifouling paints, these could be harmful to the marine environment because of the concentration of biocides and chemical substances used to control harmful organisms that can multiply on the hulls of ships. To manage this source of pollution, the International Convention on the Control of Harmful Anti-Fouling Systems (AFS Convention) came into force in 2008 and banned the use of organotin compounds.

11. IMO (2019) "International Convention for the Prevention of Pollution from Ships (MARPOL)" [online]. Available at: [https://www.imo.org/en/about/Conventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-\(MARPOL\).aspx](https://www.imo.org/en/about/Conventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-(MARPOL).aspx) (Accessed: 12 July 2023)

For this reason, copper-based compounds containing organic booster biocides started to be used. However, copper oxide and zinc oxide may be toxic to the marine environment and marine organisms at high concentrations. In fact, cybutryne, a booster biocide commonly utilised as an additive in anti-fouling paints for “soft fouling,” has been banned from use in ships’ antifouling systems internationally, effective since January 2023, after Member States and the European Commission included it in the 2017 AFS Convention¹². This was the result of research findings having shown that cybutryne can lead to adverse effects on non-target organisms, such as corals. Alternative solutions have therefore been explored.

Finally, the most frequent discharges are from exhaust gas cleaning systems (EGCSs) operations, followed by grey waters and sewage, bilge waters and others¹³. Bilge water is untreated oily wastewater produced by vessels and discharged into the ocean, containing not just oil but also hazardous metals and chemicals. To cut down on operational costs, some ships simply dump it directly into the ocean, where it can pose a serious threat to marine life. Unlike large oil spills, bilge dumps are smaller in scale and less visible, but the frequency at which they are happening demands serious attention.

Sewage contains nitrogen, a nutrient that contributes to eutrophication, leading to increased plant and algae growth, changes in the balance of organisms and water quality degradation. Sewage discharges are regulated by Annex IV of the MARPOL convention, which prohibits their displacement into the ocean within a specified distance from the nearest land. It also includes standards related to equipment, control systems, requirements for surveys and certifications and provisions for port reception facilities. Finally, the carriage of noxious liquid substances in bulk, chemicals and hazardous substances by ships is regulated by Annex II and III of MARPOL and by the International Convention for the Safety of Life at Sea (SOLAS).

12. EMSA (2021) “Adding cybutryne to the guidelines supporting the IMO’s AFS Convention” [online] Available at: <https://www.emsa.europa.eu/protecting-the-marine-environment/anti-fouling/download/6893/4505/23.html> (Accessed: 21 September 2023)

13. EEA and EMSA, (2021). “European Maritime Transport Environmental Report” [online]. Available at: <https://www.eea.europa.eu/publications/maritime-transport> (Retrieved: 12 July 2023)

Best practices. For the most part, when dealing with the correct handling of any kind of wastewater and harmful substance, the implementation of specific management plans and the guidance set out by MARPOL and other international conventions must be followed by both shipowners and operators onboard, as well as by governments, which must ensure the provision of adequate facilities at ports and terminals for reception of the discharges. To specifically reduce the negative consequences of anti-fouling paints, alternative technologies that can be employed nowadays include using hard coatings, ultrasonic systems, self-cleaning and repellent surfaces, and surfaces with spikes.

Introduction of marine litter

THE MARITIME
TRANSPORTATION
INDUSTRY GENERATES
SEVERAL TYPES OF WASTE,
WHICH COULD END UP
IN THE OCEAN MAINLY
THROUGH ILLEGAL
OR ACCIDENTAL DUMPING,
THUS POLLUTING
THE OCEAN

The maritime transportation industry generates several types of waste, which could end up in the ocean mainly through illegal or accidental dumping, thus polluting the ocean. Ship-generated waste includes plastic, metal, glass, and other packing materials, organic waste, paper products, cargo residues, and wastewater and hazardous materials. For instance, lost containers are a source of marine litter, and they may contain toxic and dangerous materials and waste of diverse sizes and varieties. Similarly to the goods they transport, ships can be considered a source of marine litter if disposed of at sea, as their structures can contain various amounts of hazardous materials, such as asbestos and heavy metals, which may contribute to water contamination during dismantling.

The **disposal of garbage** into the ocean is prohibited by several regulations since it may have detrimental effects on the environment through, among other things, reducing water and sediment quality, affecting marine species, increasing turbidity, and altering nutrient levels. Part of the waste produced by vessels can be adequately treated and reused on board, or even legally discharged in the ocean under specific conditions and regulations. Instead, most of the garbage generated on vessels is usually stored until it is delivered and disposed of onshore at port reception facilities.

This practice is compliant with the international standards and requirements set by IMO in the MARPOL convention, in particular Annex V of the International Convention for the Prevention of Pollution from Ships.

Nevertheless, the sufficiency and operation of port reception facilities are, in some cases, inadequate and constitute a pain point in the garbage disposal process¹⁴. Plastic pollution is one of the issues related to the production of marine litter during onboard operations. It has been proved that its presence in ocean layers, in the form of macro, micro and nano plastics, contributes to environmental degradation¹⁵. According to the UN, the amount of plastic in the oceans could be around 75-199 million tons¹⁶. Plastic can have a negative impact on marine fauna, especially on marine vertebrates like sea turtles, sea birds and mammals, through entanglement and ingestion.

Best practices. It is fundamental to implement appropriate waste management plans and follow specific regulations to address the impacts of introducing the large volumes of waste generated by the maritime transportation industry into the marine environment. The IMO has developed various instruments for the handling and disposal of waste to limit the pressures exerted on the ocean. For example, the dismantling of ships is regulated by the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, the last environmental agreement adopted by IMO in 2009. The standards included in the MARPOL convention, particularly in Annex V – Prevention of Pollution by Garbage from Ships, seek to eliminate and reduce the amount of garbage discharged into the ocean from ships¹⁷. Requirements include, among other things, the implementation of a Garbage Management Plan and a Garbage Record Book displaying instructions and recording data on the collection, processing and disposal of garbage generated on board. It is also fundamental to train personnel, the ship's crew, and passengers on these requirements. Action plans set out by IMO are also specifically tailored to managing marine plastic litter and microplastics, promoting circularity through reducing, reusing, and recycling the materials on board.

Moreover, the presence of correctly installed and functioning waste reception facilities at ports plays an essential role in this context, assisting and incentivising shipowners and operators in properly disposing of waste ashore.

14. For additional information, please refer to the IMO at the page "Reception facilities". Available at <https://www.imo.org/en/OurWork/Environment/Pages/Port-Reception-facilities.aspx>

15. As an example of a recent publication, please see: Sina Pourebrahimi, Majid Pirooz (2023). "Microplastic pollution in the marine environment: A review" [online]. Available at: <https://www.sciencedirect.com/science/article/pii/S2772416623000980> (Accessed: 12 February 2024).

16. UN Environmental Programme (2021). "From Pollution to Solution: A Global Assessment of Marine Litter and Plastic Pollution" [online]. Available at: https://www.gdr-po.cnrs.fr/docs/UNEP_2021.pdf (Accessed: 12 July 2023).

17. IMO (2019) "International Convention for the Prevention of Pollution from Ships (MARPOL)" [online]. Available at: [https://www.imo.org/en/about/Conventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-\(MARPOL\).aspx](https://www.imo.org/en/about/Conventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-(MARPOL).aspx) (Accessed: 12 July 2023)

Introduction of energy

MARITIME
TRANSPORTATION IS
AMONG THE MAIN
ANTHROPOGENIC
SOURCES OF UNDERWATER
NOISE DUE TO VESSELS'
PROPULSION, WHICH
MIGHT HAVE A SERIOUS
IMPACT ON MARINE
ANIMALS

Energy use, such as heating and electricity systems, artificial lighting, noise, electromagnetic radiation, radio waves or vibrations, can also exert pressure on the marine environment.

Maritime transportation is among the main anthropogenic sources of underwater noise after explosions, seismic surveys for the oil and gas industry, and sonars¹⁸. According to data collected in the last 50 years, noise in the ocean is rapidly increasing¹⁹. Vessels generate different noise levels, lower to medium levels of continuous sound emissions, depending on factors such as design, speed, type and size of ship, and maintenance of the hull and propellers²⁰. The highest noise emissions are generated by the use of propellers from commercial ships including containers, tankers, and general cargo ships, followed by the use of machinery and movement of the hull. In particular, propeller cavitation - meaning the formation and consequent rapid collapse of bubbles due to the difference in pressures generated by the propeller movement in the water - accounts for about 85% of the noise a ship produces²¹. Normally, vessels that travel at high speeds increase cavitation and produce more underwater noise emissions than low-speed vessels. In addition, the effects of propeller-induced jets can lead to coastal erosion and sediment deposition near port basins, potentially causing substantial changes to the seabed topography²².

Considering that sound travels more than four times faster in water than in air, background noise – low frequencies between 5 to 500 Hz – can significantly affect marine life over long distances, with threats varying based on the intensity and duration of the emissions. Exposure to underwater sounds could lead to changes in both physical and acoustic behaviour, hearing loss, stress, and the masking of communication and echolocation sounds in many marine species, especially marine mammals²³. Indeed, ship noise may extend to and overlap with frequencies used by cetaceans to communicate, navigate, reproduce, detect predators, and find food, thus leading to behavioural disturbances that could also result in the animal's death.

18 Slabbekoorn, H. et al. (2010). A noisy spring: the impact of globally rising underwater sound levels on fish [online]. Available at: <https://doi.org/10.1016/j.tree.2010.04.005> (Retrieved: 12 July 2023)

19. Southall, B. L., et al. (2017). "Underwater noise from large commercial ships—international collaboration for noise reduction" [online]. Available at: https://sea-inc.net/wp-content/uploads/2019/10/Southall-et-al_2017_Vessel-noise-quieting_EMOE.pdf (Retrieved: 12 July 2023)

20. IMO, 2013. Noise from commercial shipping and its adverse impacts on marine life.

21. Bach, N. H. et al. (2021). "Classification of Surface Vehicle Propeller Cavitation Noise Using Spectrogram Processing in Combination with Convolution Neural Network" [online]. Available at: <https://doi.org/10.3390/s21103353> (Accessed: 12 July 2023)

22. Guarnieri, A., Saremi, S., Pedroncini, A., Jensen, J. H., Torretta, S., Vaccari, M., and Vincenzi, C. (2021). "Effects of marine traffic on sediment erosion and accumulation in ports: a new model-based methodology" [online]. Available at: <https://doi.org/10.5194/os-17-411-2021> (Accessed: 20 December 2023)

23. Erbe, C., et al. (2019). "The effects of ship noise on marine mammals—a review" [online]. Available at: <https://doi.org/10.3389/fmars.2019.00606> (Accessed: 12 July 2023)

Best practices. Effective measures to manage and mitigate the impacts of underwater noise pollution on marine species mainly involve the design, operation and maintenance of ships, and the application of new and developing technologies. Regular maintenance and cleaning of propellers can, in fact, contribute to reducing cavitation, together with the implementation of noise-reducing systems and regulation of vessel speed. It is estimated that a 10% reduction in global fleet speed could decrease underwater noise by 40%²⁴. Overall, it is fundamental to respect geographic and seasonal restrictions, to divert vessel traffic and reduce the speed of ships to below 10 knots in specific areas where the frequent presence of cetaceans has been previously reported, including Marine Protected Areas (MPAs), Important Marine Mammal Areas (IMMAs), critical habitats and migratory pathways, rerouting shipping lanes if necessary. Guidelines and restrictions are set by international organisations, above all the IMO, which have also developed noise measurement standards to be followed by shipowners and operators.

In addition to the pressures described above, which are related to the Global Environmental Status Descriptors identified by the EU Marine Directive, it is worth mentioning the contribution of the maritime transportation sector to GHG emissions and air pollution, with consequences on the environmental status of marine waters.

GHG emissions and air pollution

The ocean is by far the largest carbon sink on the planet, storing some 30% of carbon dioxide and 93% of all greenhouse gases²⁵. Nevertheless, increased human activity is generating such high levels of emissions that these are severely harming marine ecosystems, contributing to biodiversity loss.

According to the Fourth IMO GHG Study 2020, the maritime transportation sector emitted 1,056 million tonnes of CO₂ in 2018, accounting for about 2.89% of that year's total global anthropogenic CO₂ emissions²⁶.

24. Shipping Pact for People&Nature-SPPaN, (2023). "Navigating the Future: Bridging Shipping, Biodiversity, and Decarbonization" [online]. Available at: <https://www.equalroutes.ca/resources/index.html> (Retrieved: 20 December 2023)

25. UNEP (2019), Greenhouse gases are depriving our oceans of oxygen [online]. Available at: <https://www.unep.org/news-and-stories/story/greenhouse-gases-are-depriving-our-oceans-oxygen#:~:text=Nitrogen%20deposition%20from%20atmospheric%20emissions,oysters%20and%20other%20aquatic%20animals>. (Accessed: 21 December 2023)

26. IMO (2020) Fourth IMO GHG Study 2020 [online] Available at: <https://www.imo.org/en/OurWork/Environment/Pages/Fourth-IMO-Greenhouse-Gas-Study-2020.aspx> (Retrieved: 12 July 2023)

SHIPPING CAN BE CONSIDERED ONE OF THE MODES OF TRANSPORT WITH THE LOWEST CO₂ EMISSIONS PER DISTANCE AND WEIGHT CARRIED, ALTHOUGH DIFFERENT VESSEL TYPES AND SIZES MAY OPERATE IN SIGNIFICANTLY DIFFERENT CARBON INTENSITY RANGES

Considering that, as mentioned above, about 90% of world trade is transported by sea, shipping can be considered one of the modes of transport with the lowest carbon dioxide (CO₂) emissions per distance and weight carried, although different vessel types and sizes may operate in significantly different carbon intensity ranges. In any case, at the moment, the sector is reliant on fossil fuels, which have severe consequences on ocean health and biodiversity because of the pollutants emitted. To tackle this issue, in June 2023 the IMO released the **Strategy on Reduction of GHG Emissions from Ships by 2050**, which aims to reduce ship emissions by 20-30% by 2030 and 70-80% by 2040, with a 5-10% uptake of zero or near-zero GHG tech, fuels, and energy sources by 2030²⁷. The new strategy represents a significant improvement over the previous 2018 IMO plan which aimed to reduce emissions by 50% by 2050²⁸. Thorough impact assessments will be implemented, guaranteeing an efficient decrease in emissions in the industry and supporting a fair and equal transition without leaving anyone behind.

Greenhouse gas (GHG) emissions from ships are primarily composed of carbon dioxide (CO₂) but also include methane (CH₄) and nitrous oxide and other gases. In particular, CO₂ is generated by the combustion of fossil fuels in the ship's combustion machinery. At the same time, methane (CH₄) can derive from ships using gas or dual fuel engines, or from the cargo tanks in liquefied natural gas carriers. Moreover, other gases such as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF₆) are used to run onboard air conditioning and cargo cooling processes.

In terms of air pollutants, the main ones emitted by marine shipping include sulphur oxides (SO_x), nitrogen oxides (NO_x), particulate matter (PM) and carbon monoxide (CO). NO_x contributes to the eutrophication of the waters, which entails a proliferation of algal blooms and oxygen depletion (anoxia). MARPOL Annex VI, which entered into force in 2005, relates to the Prevention of Air Pollution from Ships, and establishes limits on airborne emissions, including SO_x, NO_x, and volatile organic compounds (VOCs) from shipboard incineration, as well as prohibiting the deliberate emission of ozone-depleting substances (ODS).

27. IMO (2023) Draft resolution-2023 IMO Strategy on Reduction of GHG Emissions from Ships [online] Available at: https://www.wcdn.imo.org/localresources/en/MediaCentre/PressBriefings/Documents/2023%20Strategy%20on%20Reduction%20of%20GHG%20emissions%20from%20ships%20as%20adopted%20subject%20to%20any%20final%20editorials_.pdf (Retrieved: 12 July 2023)

28. IMO (2018) Initial IMO Strategy on reduction of GHG emissions from ships [online] Available at: <https://www.imo.org/en/MediaCentre/HotTopics/pages/reducing-greenhouse-gas-emissions-from-ships.aspx>

The release of these pollutants could cause two serious issues that affect the ocean: ocean acidification and water eutrophication. Nevertheless, between 2020 and 2021, total greenhouse gas emissions from the world fleet increased by 4.7%, with most of the increases coming from container ships, dry bulk carriers, and general cargo vessels. This trend is set to continue if stringent measures are not taken²⁹.

Best practices. The first elements to consider to cut emissions from GHG and other pollutants are the implementation of energy efficiency measures and the adoption of shore power³⁰ whenever available, in order to reduce traditional fuel consumption and facilitate the adoption of alternative, more sustainable fuels. Indeed, employing alternative fuels and energy sources represents an important measure in tackling emissions. Innovative solutions include electric propulsion systems in battery-powered (or hybrid) vessels, hydrogen, e-methanol, bio-LNG and synthetic LNG or e-ammonia-powered vessels, to name but a few. Nevertheless, their limited availability and the lack of adequate infrastructure and onboard technology often represent a barrier to increasing the adoption of alternative fuels, therefore additional efforts at policy level to incentivise production, distribution, and utilisation would be valuable.

Equipping vessels with filters that capture particles and fumes and reduce emissions represents another effective solution. In this regard, it is paramount that the vessel's crew and ground staff are trained on ship waste treatment. In addition to reducing underwater noise and lowering vessel collisions, limiting the speed of ships may also decrease emissions of greenhouse gases and other air pollutants as ships burn less fuel when they travel more slowly³¹. It is estimated that slowing down the global fleet by 10% could result in a 13% reduction in greenhouse gas (GHG) emissions and increase the likelihood of reaching GHG targets by up to 23%³². Decarbonisation in this sector is not a fast process and requires innovative technologies, capital, and clear targets and policies.

29. UNCTAD (2022). "Review of Maritime Transport 2022" [online]. Available at: <https://unctad.org/rmt2022> (Accessed: 12 July 2023)

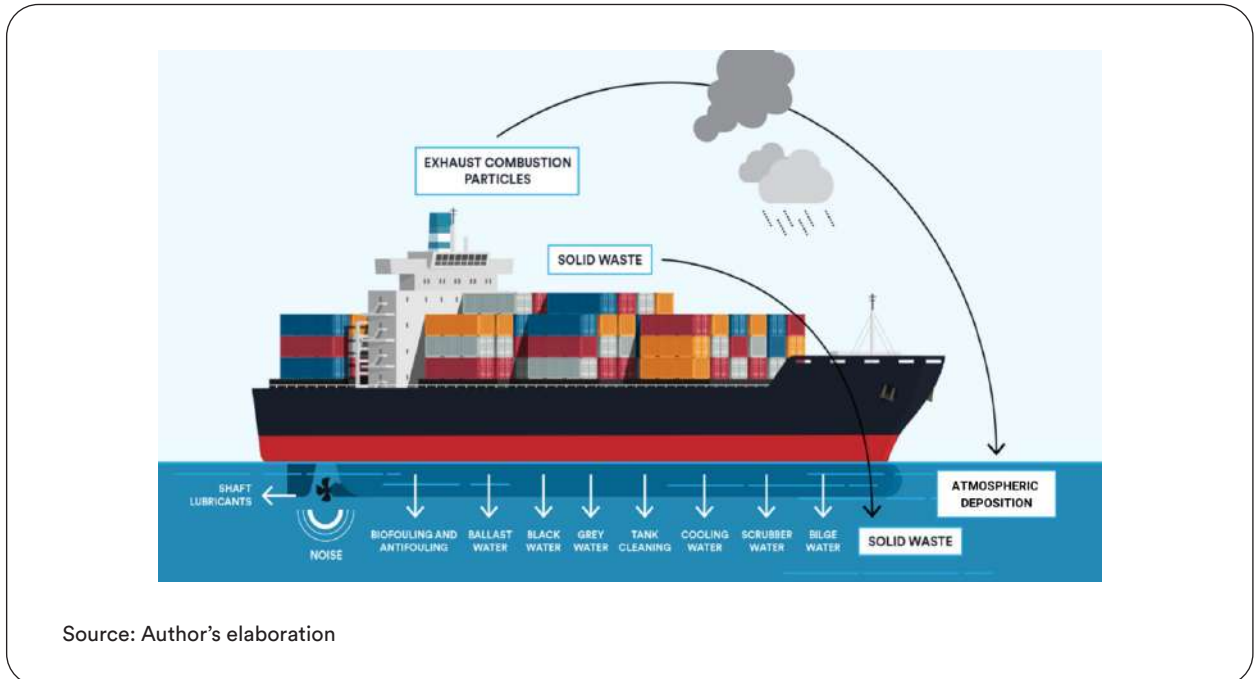
30. Shore power is the provision of shoreside electrical power to a ship at berth while its main and auxiliary engines are shut down.

31. GL Reynolds Environmental Sustainability Consultants (2019). "The multi-issue mitigation potential of reducing ship speed" [online]. Available at: <https://seas-at-risk.org/wp-content/uploads/2021/03/2019.6.11.-Mitigation-ship-speeds.pdf> (Retrieved: 12 July 2023)

32. Shipping Pact for People&Nature-SPPaN, (2023). "Navigating the Future: Bridging Shipping, Biodiversity, and Decarbonization" [online]. Available at: <https://www.equalroutes.ca/resources/index.html> (Retrieved: 20 December 2023)

However, by starting to implement new technological innovations and more sustainable and environmentally friendly practices, maritime transportation companies could significantly contribute to the reduction of emissions and achievement of the targets set by IMO.

FIGURE 2: Sources of water pollution from a ship



Source: Author's elaboration

THE COLLISION OF VESSELS WITH MARINE SPECIES IS A REMARKABLE ISSUE FOR THE MARITIME TRANSPORTATION INDUSTRY WHICH AFFECTS MARINE LIFE

The risk of **collision of vessels with marine species** is another significant issue linked to the pressure exerted by the maritime transportation industry on biodiversity. Ship strikes can happen both directly and as a consequence of other pressures exerted on marine life, including the effects of the introduction of underwater noise in the marine environment. Collisions often result in injuries, strandings, or death of the animals. Vulnerable species include marine mammals and sea turtles, large animals which need to come up to the surface to breathe³³. Decreasing vessel speed below 10 knots and changing maritime routes are good practices to be implemented where marine fauna is present and close to specific sensitive areas to avoid possible collisions, in addition to ad hoc training of crew on the most appropriate behaviours when encountering marine mammals.

33. GL Reynolds Environmental Sustainability Consultants (2019). "The multi-issue mitigation potential of reducing ship speed" [online]. Available at: <https://seas-at-risk.org/wp-content/uploads/2021/03/2019.6.11.-Mitigation-ship-speeds.pdf> (Retrieved: 12 July 2023)

Additional considerations

Furthermore, **the maritime transportation sector exerts a substantial impact on seafloor integrity**, mainly when ships lie at anchor while waiting to access port facilities. Physical damage by anchors often goes unreported, however, it could destroy benthic habitats and modify both ecosystem processes and the seafloor topography. Moreover, ships' primary propellers are responsible for generating intense current jets, leading to high velocities that exert shear stresses on the ocean bottom and could potentially cause sediment resuspension with consequences for marine biodiversity.

As global maritime traffic continues to increase, it is crucial to find more sustainable ways to manage maritime transportation, focusing on innovations and emerging technologies, which represent a promising pathway towards addressing pressing environmental challenges while fostering economic growth.

The importance of disclosing the business pressures on the ocean

The industry-specific edition of the Ocean Disclosure Initiative tool dedicated to the shipping sector, developed by One Ocean Foundation in collaboration with its partners, reflects the main pressures exerted by this sector. The objective is to support companies in becoming aware of their potential impacts on marine ecosystems, assessing the related risks, and disclosing key information and strategic responses on the significant issues related to maritime transportation activities.

As identified in our research and reflected in the industry-specific tool, these pressures include i) loss of biodiversity; introduction of non-indigenous species mainly through ballast waters; ii) release of hazardous substances or contaminants into water bodies, with particular focus on oil spillages; iii) introduction of marine litter due to poor waste management; iv) introduction of energy, mainly related to underwater noise, as well as GHG emissions linked to vessels' propulsion and collisions with marine fauna.

The importance of the Ocean Disclosure Initiative lies in the fact that, for the first time, companies, scientific and financial communities, and civil society can rely on a common language to measure, address, and mitigate the most relevant pressures that humanity exerts on the marine environment, sector by sector, with significant advantages for the health of the ocean.



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