

ONE OCEAN Foundation

BUSINESS FOR OCEAN SUSTAINABILITY

FOURTH EDITION — GOOD PRACTICES IN THE OCEAN ECONOMY

Foreword

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Recent scientific studies and global assessments portray an ocean increasingly under pressure. Human activities, from industrial production and resource extraction to consumption and waste, are altering the physical, chemical and biological conditions on which marine life depends. Ocean heat content reached another record in 2025,[1] while observations show that warming, acidification, oxygen loss and changes in salinity increasingly occur together, extending well below the surface.[2] A reassessment of ocean acidification indicates that, by 2020, average global conditions had already entered the uncertainty range of this planetary boundary, with substantial reductions in suitable habitats for sensitive marine organisms.[3]

The United Nations' Third World Ocean Assessment places these findings in a broader context, highlighting how the cumulative effects of climate change, pollution and overexploitation are degrading marine ecosystems and putting the livelihoods, human well-being and economic activities they support at risk.[4] Addressing these pressures requires action on both climate change and the direct causes of marine ecosystem degradation. For companies, this means understanding how their activities contribute to these changes and identifying where they can intervene, within their operations and along their value chains.

[1] Pan, Y., Cheng, L., Abraham, J., Trenberth, K. E., Reagan, J., Du, J., Wang, Z., Storto, A., Von Schuckmann, K., Zhu, Y., Mann, M. E., Zhu, J., Wang, F., Yu, F., Locarnini, R., Fasullo, J., Huang, B., Graham, G., Yin, X., … Chen, L. (2026). Ocean heat content sets another record in 2025. *Advances in Atmospheric Sciences, 43*, 2019–2041. https://doi.org/10.1007/s00376-026-5876-0

[2] Tan, Z., von Schuckmann, K., Speich, S., Bopp, L., Zhu, J., & Cheng, L. (2026). Observed large-scale and deep-reaching compound ocean state changes over the past 60 years. *Nature Climate Change, 16*(1), 58–68. https://doi.org/10.1038/s41558-025-02484-x

[3] Findlay, H. S., Feely, R. A., Jiang, L.-Q., Pelletier, G., & Bednaršek, N. (2025). Ocean acidification: Another planetary boundary crossed. *Global Change Biology, 31*(6), Article e70238. https://doi.org/10.1111/gcb.70238

[4] United Nations. (2026). *Third World Ocean Assessment: Overall summary*. https://woa.un.org/third-world-ocean-assessment/section-1-overall-summary

For the business community, ocean sustainability is emerging as a new challenge comparable to the growing recognition of global warming and climate change some thirty years ago. Companies need to understand these changes and their implications for investment and management decisions. Today, we also have a clearer understanding of how environmental challenges are intertwined and how profoundly they affect societies and economies. Protecting marine biodiversity, maintaining ecosystem functions and addressing climate change are interdependent objectives, with entire communities relying on a healthy ocean for their livelihoods and well-being. These dependencies make ocean health relevant to business resilience, competitiveness and long-term value creation.

Since 2019, the Business for Ocean Sustainability research program has investigated the relationship between business activities and marine ecosystems. Developed by One Ocean Foundation in collaboration with SDA Bocconi School of Management, McKinsey & Company and CSIC, this work combines natural sciences and economics through an integrated and innovative approach to examine both the pressures businesses exert on marine ecosystems and their dependence on them, and the responses available to address these challenges. Its scope extends across industries, supply chains and geographical boundaries, acknowledging the interdependence between business and ocean health.

This new edition of Business for Ocean Sustainability, "Good Practices in the Ocean Economy", takes a further step by examining the initiatives that companies report having implemented to address their pressures on marine ecosystems. Drawing on the 2024 sustainability and annual reports of 70 companies across four ocean economy industries - shipbuilding, maritime transportation, ports and warehousing, and fishing and aquaculture - the report documents technological, operational and organisational solutions that can help prevent, mitigate and remediate these pressures. The assessment combines sector-specific scientific frameworks with generative AI-assisted analysis and human verification, providing a concrete basis for learning, knowledge exchange and wider adoption.

The findings reveal some progress, but substantial gaps remain in corporate awareness of ocean pressures and in the actions taken to address them. The report examines four areas of action to protect marine ecosystems: emissions, contaminants, marine litter and biodiversity loss. Most companies focus on climate change, which remains the main entry point for corporate environmental action. Only 39% report practices across all four areas. Some critical issues, particularly seabed protection, remain largely outside the scope of corporate action. These findings highlight the need to develop a broader understanding of ocean sustainability and to translate this knowledge into business priorities.

Many solutions are already available. Their wider adoption depends on how companies allocate resources, define responsibilities and cooperate. Some interventions deliver immediate operational savings; others generate shared ecological benefits while their costs fall on individual operators. The findings suggest that good practices are more widely adopted where a clear business case exists. However, trade-offs and returns that materialise over longer periods mean that internal economic incentives alone are often insufficient to address the full range of marine pressures.

This is particularly relevant to biodiversity and ecosystem conservation, where companies may struggle to capture the benefits of their environmental investments. An individual operator bears the cost, while the benefits accrue to other businesses, communities and society more broadly. This limited ability to appropriate returns can discourage investment, even when the collective benefits are substantial. Regulation, incentives, standards and coordination therefore have an important role in rebalancing costs, risks and opportunities, helping companies address trade-offs and supporting the wider adoption of effective solutions.

We also need to understand whether the practices adopted deliver the expected environmental benefits by measuring their effects on marine ecosystems. This report examines what companies disclose, providing a foundation for that next step. Connecting corporate information with environmental monitoring remains particularly challenging in the ocean, where pressures can be indirect, interact with other drivers and produce effects beyond the locations and time horizons of individual operations. Artificial intelligence can strengthen analytical capabilities and help connect different sources of information, supported by scientific expertise and human verification.

For One Ocean Foundation, the purpose of this research is to help translate knowledge into decisions and actions. The report provides a practical foundation for extending corporate action beyond decarbonization towards the broader protection of ocean health. We hope these findings will encourage companies to integrate ocean health into strategy and operations, investors to support effective solutions, and institutions to enable their wider adoption. Protecting marine natural capital is a shared responsibility and a vital investment in our long-term resilience and prosperity. **Now more than ever, we need companies and leaders willing to step up to the challenge and have the courage to drive this transformation.**

Table of contents

	One Ocean Foundation	**7**
	Business for Ocean Sustainability (B4OS)	**8**
	Ocean Impact Initiative (OII)	**9**
1	**Executive summary**	**11**
2	**Introduction**	**16**
2.1	Why good practices	17
2.2	Objectives of the report	18
3	**Methodology**	**20**
3.1	Defining "good practice"	20
3.2	Verdicts and supporting evidence	21
3.3	Scope: ocean economy sectors and company sample	21
3.4	Data sources	22
3.5	Analytical process	23
3.6	Limitations and how they were addressed	24
4	**Maritime transportation**	**27**
4.1	Sample description	28
4.2	The practices assessed	29
4.3	Adoption of good practices	30
	In depth: Underwater noise: recognising the biodiversity impact of speed reduction	40
4.4	Sector synthesis	41
5	**Shipbuilding and repairs**	**43**
5.1	Sample description	44
5.2	The practices assessed	45
5.3	Adoption of good practices	46
	In depth: Ship recycling and design for end-of-life	55
5.4	Sector synthesis	56

Table of contents

6	**Ports and warehousing**		**58**
	6.1	Sample description	60
	6.2	The practices assessed	60
	6.3	Adoption of good practices	62
		In depth: Port dredging and its impact on the seabed	72
	6.4	Sector synthesis	73
7	**Fishing and aquaculture**		**76**
	7.1	Sample description	78
	7.2	The practices assessed	79
	7.3	Adoption of good practices	81
		In depth: Integrated multi-trophic aquaculture (IMTA)	93
	7.4	Sector synthesis	96
8	**Cross-sector analysis**		**98**
	8.1	Why look across sectors	98
	8.2	Emissions are addressed everywhere, other pressures only in part	99
	8.3	Areas for action available to all the companies	100
	8.4	Common gaps across the four sectors	102
	8.5	Conclusion	103
9	**Commitment to SDG 14 (Life Below Water)**		**105**
	9.1	What was assessed	105
	9.2	Named, linked or measured: how deep the commitment goes	106
	9.3	Why companies do not name SDG 14	107
10	**Engagement with NGOs and conservation partnerships**		**109**
	10.1	Why ocean conservation partnerships matter	109
	10.2	What companies do: from beach clean-ups to habitat restoration	110
	10.3	Final considerations	112
11	**Comparing the 2024 and 2025 reports**		**114**
	11.1	Why did the verdicts change?	114
	11.2	How critical are these differences?	115

One Ocean Foundation

At One Ocean, we believe that protecting the ocean goes beyond mitigating existing damage - it involves addressing the root causes of the pressure. Our approach extends conservation efforts: we actively collaborate with businesses, finance and policymakers to drive systemic change, ensuring a sustainable future for marine ecosystems. The One Ocean Foundation is dedicated to promoting a nature-positive economy that balances resource use with the urgent need to protect and restore marine ecosystems and their biodiversity.

The distinctive feature of the One Ocean Foundation is that every project we undertake is rooted in science and designed to create measurable, long-term impact. Our initiatives are carried out under the guidance of our international scientific committee and through continuous collaboration with cutting-edge research centres and universities. Through collaboration with companies, we help them understand and reduce their environmental footprint while fostering policies that safeguard the ocean.

Business for Ocean Sustainability (B4OS)

This report has been developed within the framework of the Business for Ocean Sustainability (B4OS), research project, a multi-year project developed by One Ocean Foundation in collaboration with SDA Bocconi School of Management Sustainability Lab, McKinsey & Company and the Consejo Superior de Investigaciones Científicas (CSIC). Its scientific basis, developed in 2019, is a review of the direct and indirect pressures each industry exerts on the ocean. That review was carried out by a panel of natural and social scientists from research institutions across Europe, North and South America and Australia.

The project has produced four reports:

2019 – Focus on the Mediterranean Sea. The first edition, which sets out how business activities exert pressure on marine ecosystems.

2021 – Focus on the Fashion Industry. A deep dive into a single land-based sector, highlighting good practices along the whole value chain.

2021 – A Global Perspective, Second Edition. Extended the analysis to a global sample and first presented the Foundation's ocean disclosure framework.

2023 – Third Edition, Capturing the Blue Opportunity. Analysed the reports of about 2,500 companies, representing more than 70% of world market capitalisation, using Natural Language Processing and Generative AI. It put forward Blue Natural Capital as the guiding principle of a nature-positive ocean economy and introduced the concept of Blue Business Opportunities.

Further, validating the scientific approach adopted, the findings have been consistent across editions. Awareness is growing but still limited. In 2023, 52% of companies acknowledged at least one of the pressures their sector exerts on the ocean, and only 9% referred to SDG 14 "Life Below Water". Action on ocean-related pressures is lower still, with an average activation score of 20%. And there is no reporting framework for the private sector specifically designed for the ocean.

Ocean Impact Initiative (OII)

The findings of the "Business for Ocean Sustainability" research have led to the development of the Ocean Impact Initiative (formerly known as Ocean Disclosure Initiative), which aims to address the urgent need for dedicated initiatives to promote the disclosure of businesses' impacts and pressures on the ocean.

The project commenced in 2020 with the goal of investigating the role of companies in addressing ocean challenges, focusing on the pressures on marine ecosystems, the level of awareness within the business community and the main responses (technological and organisational) implemented.

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

Within the Ocean Impact Initiative, the Foundation develops a series of industry reviews, each focusing on a specific economic sector. Drawing on scientific literature, the reviews identify the main pressures that each sector exerts on marine and coastal ecosystems and outline good practices that companies can adopt to prevent, mitigate or remediate these impacts. The reviews cover both sectors that operate directly at sea, such as maritime transportation, shipbuilding and repairs, fishing and aquaculture, and land-based sectors whose activities can affect the ocean indirectly, including textiles and apparel, agriculture, chemicals and pharmaceuticals. The Foundation has completed reviews of 15 economic sectors originally identified within the Business for Ocean Sustainability framework. Building on this work, the Foundation will continue expanding the series to include additional industries whose activities are relevant to ocean health and sustainability.

SDA Bocconi SCHOOL OF MANAGEMENT

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CSIC Consejo Superior de Investigaciones Científicas



Executive summary

The present edition of the report “Business for Ocean Sustainability” builds on the research outcomes of this multi-year project promoted by One Ocean Foundation, and on the industry reviews developed under the Ocean Impact Initiative framework, to provide an overview of the good practices that companies of the ocean economy report in order to reduce their pressures on the ocean.

Previous editions focused primarily on raising corporate awareness by assessing whether companies recognise the pressures they exert on marine and coastal ecosystems, how they disclose these impacts, and, in the Third Edition, the extent to which they have translated awareness into action. However, a comprehensive catalogue of reported good practices was still missing. This edition moves the focus from awareness and activation to good practices, meaning the specific technologies and techniques that companies report as already in use.

For this purpose, **a good practice** is defined as an innovative, technology-driven action, technique or operational solution that a company is implementing, or has already implemented, to prevent, mitigate and/or remediate its direct and indirect pressures on marine ecosystems. Good practices are therefore concrete and replicable interventions, such as the use of alternative fuels, advanced onboard waste treatment, innovative antifouling coatings or selective fishing gear. General environmental commitments and policy statements are not considered good practices.

The study was conducted across four sectors of the ocean economy that exert direct pressures on marine ecosystems: shipbuilding, maritime transportation, ports and warehouses, and fishing and aquaculture. The final sample consists of **70 companies**: 16 in shipbuilding, 29 in maritime transportation, 14 in ports and warehouses, and 11 in fishing and aquaculture. Companies were selected from the database compiled under the Third Edition of the Business for Ocean Sustainability project, which identifies the largest and most relevant companies of each sector by revenue and market presence. For each company, the sustainability report covering the 2024 financial year, or the annual report where a sustainability report was not available, was analysed. Only publicly available information was used.

Since each sector interacts with the ocean in a different way, a specific list of good practices was built for each sector, based on the solutions identified in the Foundation's earlier industry reviews. The practices are grouped by the main pressure they address, namely greenhouse gas (GHG) emissions and air pollution, contaminants, marine litter, and biodiversity loss, which includes underwater noise, collisions with marine mammals, non-indigenous species and damage to the seafloor. Each sector is first analysed in its own chapter. A cross-sector chapter follows, which looks at the ocean economy as one system. It compares the four sectors across the same four pressures to show where they are similar and where they differ. This matters because, in the broad category of the ocean economy, one sector's practices can affect what is possible in another.

Two further aspects were assessed separately, as they are commitments rather than technologies, and are presented in dedicated sections of the report. The first is engagement with Non-Governmental Organisations (NGOs) and support for ocean conservation, whether through partnerships or the company's own initiatives. This section also looks at the type of activity companies report, such as coastal clean-ups, species protection, habitat restoration, and research and monitoring. The second is the reference to Sustainable Development Goal (SDG) 14, Life Below Water, and how closely companies link it to concrete actions or targets.

The assessment was conducted using generative artificial intelligence (GenAI), with the oversight and expert input of the Foundation's analysts. A dedicated GenAI tool first read each report against the sector list. It gave a Yes or No answer for every practice, supported by a quotation and page reference. An analyst then checked every answer against the original report. A practice was counted only when from the report it was possible to confirm that it is actually in use, so intentions and future plans were not counted. A final review made sure the same standard was applied to every company. Each confirmed practice was also checked for supporting evidence, such as quantitative data, third-party verification or multi-year trends. This shows how well the practice is documented.

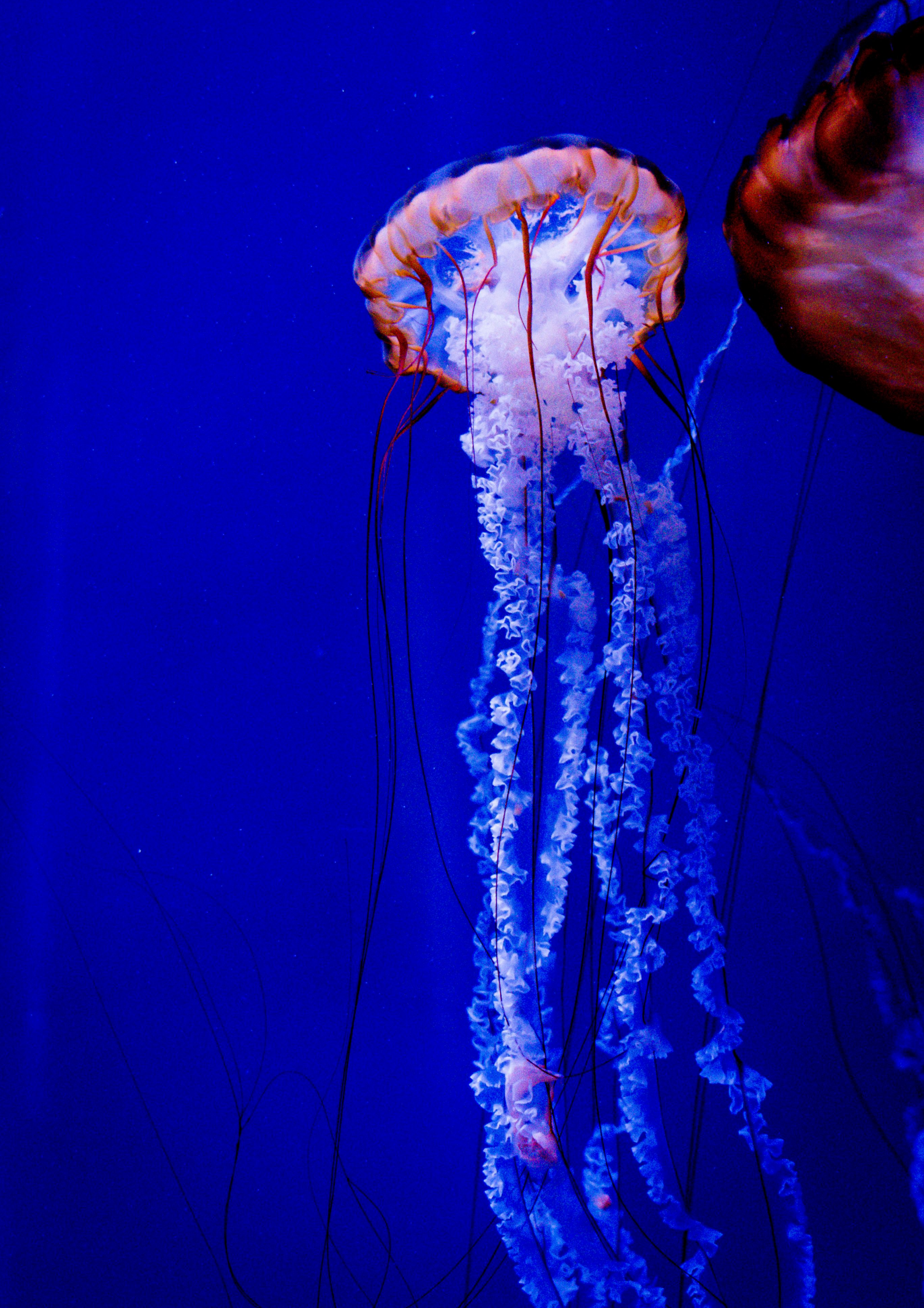
It is important to note that the analysis is based on what companies disclose in their reports. As in the third edition of the Business for Ocean Sustainability report, disclosure is used here as a proxy for performance. It is the best available indication of what companies do, but it is not a direct measurement of their environmental performance. A company may apply a practice without reporting it, and reports differ widely in length, level of detail and structure. In line with the Foundation's approach, the results are presented at sector level, and no company is named.

Specific findings intersect across the four sectors and draw a cross-sectoral picture of the good practices companies report:

- **Climate action is almost universal.** 97% of companies report at least one practice to reduce GHG emissions, such as energy efficiency, shore power, alternative fuels or on-site renewable energy;
- **GHG practices dominate the results.** They represent about one quarter of all practices assessed (26%) but almost half of all positive answers (47%);
- **Other pressures receive less attention.** Fewer companies report practices against marine litter, biodiversity loss and contaminants, and only 39% of companies address all four topics;
- **Seabed protection is almost absent.** Only 3 of the 54 companies in maritime transportation, ports, and fishing and aquaculture report a practice that limits physical damage to the seafloor;
- **Companies support biodiversity more outside their operations than within them.** 77% of companies support ocean conservation through NGOs or their own projects, while only 37% report good practices that directly reduce their own pressure on marine life;
- **Evidence is limited.** Only one in four positive answers (25%) is supported by third-party verification, and most of these concern GHG emissions. More than half of the practices in other topics are reported without any supporting evidence;
- **Digital tools are adopted mainly for efficiency, rather than the environment.** Many companies already use digital twins and AI to manage operations, but few apply them to monitor or reduce pressures on marine ecosystems.
- **SDG 14 is widely referenced but rarely linked to measurable targets.** 60% of companies refer to SDG 14, but only 7% link it to specific targets or measurable company goals.

Overall, these results suggest that companies adopt good practices most readily when they save fuel or energy and for compliance, meaning when an existing regulation or reporting framework already measures them. **Practices against underwater noise, introduction of non-indigenous species, seabed damage and marine litter bring no direct savings and are rarely measured, and therefore remain at the bottom of the ranking.** Nevertheless, most of these practices are already applied by at least one company in the sample, which indicates that technology is not the main barrier.

In conclusion, the analysis shows a positive signal: most companies across the ocean economy are taking concrete action, and a wide range of technologies is already in use. By documenting what the largest companies are already doing, this report aspires to bridge the gap between awareness and the adoption of good practices, and to offer companies a practical reference for extending good practices from carbon to the full range of pressures on the ocean.



Introduction

The ocean is essential to the stability and prosperity of our planet. Covering more than 70% of the Earth's surface, it regulates the global climate, produces a substantial share of the oxygen we breathe, absorbs excess heat and carbon emissions, and supports biodiversity and human well-being. While the ocean economy is estimated to generate trillions of dollars in value every year, the value of the ecosystem services provided by healthy marine ecosystems is even greater, underpinning many of the economic and social systems on which we depend, but this role is not yet fully recognised.

For this reason, ocean protection should not be viewed only as an environmental responsibility. It is also a prerequisite for long-term economic growth and societal resilience. Economic development and environmental protection must go hand in hand, as businesses and industries ultimately depend on the health of natural ecosystems. From food production and tourism to shipping, finance, fashion and manufacturing, virtually every sector is connected to the ocean either directly or indirectly. The degradation of marine ecosystems therefore represents not only an environmental risk but also an economic one.

This is why One Ocean Foundation actively works to engage the private sector alongside institutions, researchers and civil society. Since its establishment, the Foundation has promoted a vision in which companies become part of the solution by understanding, measuring and reducing their impacts on marine ecosystems, while also contributing to conservation, restoration and sustainable blue economy initiatives.

In this context, this report represents an important step forward. It marks the evolution from a traditional "pressure-based" approach, focused primarily on identifying and reporting environmental impacts, towards a "good-practice" approach that highlights solutions, successful experiences and replicable actions. By showcasing concrete examples of leadership and innovation, the report aims to inspire broader engagement and accelerate positive changes across sectors.

As a science-based platform, One Ocean Foundation seeks to facilitate the exchange of knowledge and the dissemination of good practices among businesses, institutions and stakeholders. The ultimate objective is to create a community of actors committed to safeguarding marine ecosystems while fostering a sustainable and resilient blue economy, demonstrating that ocean protection and economic prosperity can and must advance together.

The ocean economy plays a key role in global economic development. For this reason, we decided to begin our analysis of good practices within ocean-based sectors, namely those industries that operate in and on the ocean and whose activities are closely linked to the health of marine ecosystems. Shipbuilding, maritime transportation, ports, fishing and aquaculture provide food, jobs and the transport of goods on which people and businesses around the world depend. At the same time, these activities exert significant direct and indirect pressures on marine and coastal ecosystems, including greenhouse gas (GHG) emissions, underwater noise, marine litter, contaminants and the introduction of non-indigenous species. Over the previous editions of Business for Ocean Sustainability, One Ocean Foundation has analysed how companies recognise and disclose these pressures. Our research showed that awareness is growing. However, the link between business activities and ocean health is often not acknowledged, and the actions companies take to address it are rarely described in a clear and comparable way.

2.1 Why good practices

Awareness is the starting point, but it is not enough to protect the ocean. What makes the difference is action. For this reason, as mentioned above, this edition moves from measuring pressures to documenting solutions. In broad terms, good practices are more than actions. They are structured solutions that companies implement to reduce their pressures on the ocean in a measurable and lasting way. Good practices move beyond isolated initiatives, demonstrating how sustainability can be integrated into core business activities and replicated by others.

The precise definition used in this report, and the criteria applied to identify them, are presented in the Methodology section. Focusing on good practices offers two main advantages. First, it shows what is already possible today, through solutions that are available and working in real operations. Second, it creates a shared reference that companies in the same sector, and in other sectors, can learn from and replicate.

2.2 Objectives of the report

The analysis is based on what companies disclose in their sustainability and annual reports, not on a direct measurement of their performance. Within this scope, the report aims to:

- **Map good practices.** Identify which good practices the largest companies in ocean economy sectors (shipbuilding, maritime transportation, ports and warehouses, and fishing and aquaculture) report having in place.
- **Assess the quality of evidence.** Examine how clearly each practice is supported in company reports, for example through quantitative data, concrete results or third-party verification.
- **Compare sectors.** Examine how the activation towards ocean sustainability differs between the four sectors, and which topics are most relevant for each of them. Beyond this comparison, the report takes a broader view and treats the sectors as parts of one system: each sector acts on its own specific activities, from building and operating ships to managing ports and harvesting marine resources, and together these actions move ocean sustainability forward.
- **Support action.** Offer businesses, investors and policymakers a practical reference to accelerate the adoption of ocean-positive solutions, including those already working in one sector that could be transferred to another.

Beyond the sector-by-sector comparison, the report treats the four sectors as parts of a single system. Each acts on its own activities, from building and operating ships to managing ports and harvesting marine resources, and together these actions move ocean sustainability forward. In doing so, the report seeks to show that many of the good practices the ocean needs are already available, and that their wider adoption is within reach.

This approach forms part of One Ocean Foundation's efforts to strengthen the relationship between marine ecosystems and the business world. It is intended to be extended to further ocean economy sectors and to future reporting years, so that the evolution of practices can be followed over time. In line with the Foundation's mission, it seeks to help businesses, investors and policymakers work together to preserve the ocean, its resources and its ecosystem services for current and future generations.



Methodology

This chapter describes how the analysis behind this report was carried out. It explains how a good practice was defined, which ocean economy sectors and companies were included, and which data sources were used. It then sets out the step-by-step process through which company reports were assessed, combining desk research, a purpose-built AI tool, and the verification of every answer by the Foundation's analysts. Finally, it presents a year-on-year comparison, in which the assessment was repeated on the 2025 reports of a subset of companies, and the main limitations of the approach.

3.1 Defining "good practice"

The analysis is built around a single definition of **good practice**, applied in the same way to every sector and every company. For the purpose of this report, a good practice is defined as an **innovative, technology-driven action, technique or operational solution** that a company is implementing, or has already implemented, to **prevent, mitigate and/or remediate** its direct and indirect pressures on marine and coastal ecosystems. Good practices are therefore concrete and replicable interventions, such as new technologies, specialised techniques, or operational and process innovations. General environmental commitments, policy statements, and aspirational sustainability language do not qualify (e.g., "we aim to," "we are exploring," or "we are committed to developing").

The good practices lists used in this analysis were derived from the **industry reviews previously published by One Ocean Foundation** under the Ocean Impact Initiative, which had already identified, sector by sector, the technologies, innovations and operational solutions available to companies to prevent, mitigate or remediate their pressures on the ocean. The lists used in this analysis consolidate that research into a defined and auditable checklist for each sector, together with the definition and the evidence rules set out in Sections 3.1 and 3.2.

3.2 Verdicts and supporting evidence

For each company and each practice, the assessment produced a verdict. The final dataset uses two verdicts, applied in the same way across all sectors and companies:

- **Yes.** The report confirms that the specific good practice is in use.
- **No.** The report explicitly indicates that the good practice is absent or does not address it.

During the first reading of the reports, a third label, **Unclear**, was used for cases in which the report was ambiguous or contained only a stated intention without confirming that the practice had been implemented. Wherever genuine doubt remained, the first reading defaulted to Unclear rather than Yes, since a false positive was considered a more serious error than a case flagged for a second look. Each Unclear case was then reviewed by an analyst against the source report and resolved as either Yes or No (see Section 3.5), so that the final dataset contains only these two verdicts.

In addition, every practice marked Yes was checked against four types of supporting evidence: i) a quantitative metric; ii) a concrete qualitative outcome; iii) third-party verification; and iv) multi-year trend data. Each type of evidence was counted only if the report explicitly tied it to that specific practice, through a direct quote and a page reference. General company-wide statistics and unverifiable claims of success were not accepted. These evidence types have some limits. Trend data cannot yet exist for practices introduced recently, so the absence of a trend does not mean that a practice is weak. This is especially true for innovative solutions. In any case, this evidence was not used to decide whether a practice was accepted as a good practice; it was collected only as additional information. It shows how solidly each Yes is supported in the company's own reporting.

3.3 Scope: ocean economy sectors and company sample

The analysis focuses on four sectors, generally classified as part of the ocean economy and part of sectors analysed in the framework of One Ocean Foundation's Ocean Impact Initiative: **Fishing and aquaculture**, **Maritime transportation**, **Shipbuilding and repairs**, and **Ports and warehousing**. These sectors were selected because they exert direct operational pressures on marine ecosystems and publish sufficiently comparable public reports. However, they interact with the ocean in structurally different ways. For example, the pressures of fishing and aquaculture relate largely to biodiversity and bycatch, while those of ports and shipbuilding relate more to emissions, discharges and industrial waste. For this reason, a separate good practices list was built for each sector, rather than applying a single generic list to all companies (see Section 3.5).

In total, **70 companies** were analysed across the four sectors. Table 3.1 shows how the sample is distributed.

TABLE 3.1 · Company sample by ocean economy sector

Ocean economy sector	Number of companies	Share of sample
Fishing and aquaculture	11	16%
Maritime transportation	29	41%
Ports and warehousing	14	20%
Shipbuilding and repairs	16	23%
Total	**70**	**100%**

The sample was drawn from the database compiled under the 2023 **Business for Ocean Sustainability (B4OS)** research.[1] Each sector is represented by its largest and most relevant companies by revenue and market presence. Using this existing, independently compiled database as the sampling frame, rather than selecting companies case by case, keeps the sample representative of the largest operators in each sector and consistent with the Foundation's wider body of ocean economy research.

3.4 Data sources

The analysis relies exclusively on **publicly available company disclosures**. No proprietary, confidential or third-party data was used to assess whether a company applies a given practice. For each of the 70 companies, the **sustainability report covering financial year 2024** was collected or, where no standalone sustainability report was published, the **annual report** for the same year. The majority of the files analysed (76%) were sustainability reports, while the remaining 24% were annual or integrated reports. These documents were the single source for the assessment of that company. Financial year 2024 was chosen because, at the time of the assessment, not all companies in the sample had yet published their 2025 reports. Using the same reporting year across the whole sample keeps the comparison between companies, and between sectors, on a consistent basis. In addition, the 2025 reports of a subset of 20 companies, published in time for this analysis, were used for two purposes: to ensure that the analysis draws on the most recent data available, and to show how the disclosure of good practices changed between the two years (see Section 3.5).

[1] One Ocean Foundation (2023) "Business for Ocean Sustainability: Third Edition- Capturing the Blue Opportunity. https://cdn.1ocean.org/64f6e66abe822f04fd9af30a_Business_20for_20_Ocean_20_Sustainability_Third_20_Edition_17aca47c99.pdf

3.5 Analytical process

The assessment of all 70 companies followed a five-step process, which combined a purpose-built AI-assisted reading tool with structured human verification. The process was designed so that results would be consistent and defensible across every sector and every company, regardless of who, or what, performed the first reading.

1. **Report collection and list-building:** the 2024 sustainability or annual report of each of the 70 companies was collected. In parallel, a good practices list was built for each of the four sectors, drawing on the industry reviews. Because each sector affects the ocean in different ways, the practices on each list, and in some cases their number, differ from one sector to another.

2. **First-pass reading with Claude:**[2] a standalone Claude Project (a dedicated workspace that keeps all the information needed for a task in one place) was created for this analysis. It brings together all the instructions, materials and references used in the assessment: the good practices list of each sector, the industry reviews they come from, and the rules set out in Sections 3.1 and 3.2. The goal of the Project was to make sure that every company report was read with the same context and the same rules. Within the Project, a dedicated Claude skill (a set of written instructions that guides the AI model through a specific task) was created. It encodes the good practice definition, the verdict rules, the four evidence types and the citation requirement. Using a structured prompt built on these rules and on the sector list, Claude read each company's 2024 report and produced, for every practice, a verdict, an evidence assessment, and the supporting quotation and page reference.

3. **Analyst verification:** every answer produced by Claude was then reviewed by an analyst of the Foundation, who checked the verdict and the supporting quotation against the original report. This step confirmed that no fabricated evidence, quotation or page reference had been introduced, and resolved every Unclear case as Yes or No. Wherever the automated reading did not match the source document, the analyst corrected the answer.

4. **Consolidation and consistency check:** once verified answers were available for every company in a sector, they were consolidated into a single sector dataset. A second Claude-assisted check was then run across the consolidated answers to test whether the same standard of judgement had been applied to every company in the sector. Any inconsistencies were flagged for a further analyst review.

5. **Visualisation and reporting:** once the dataset was finalised for all four sectors, it served as the basis for generating the graphs presented in this report and developing initial descriptions of the data disclosed in the sustainability reports.

[2] Claude is a large language model (an artificial intelligence system that understands and generates text) developed by Anthropic, which was used in this report to support the screening and analysis of company sustainability reports.

Claude was used as an assisting tool for both tasks, supporting the creation of sector-specific graphs and cross-sector comparisons, as well as the preparation of preliminary text describing the reported data. After that, the analysts wrote and edited each chapter, identifying the key findings and outcomes and shaping the final narrative of the report.

6. **Comparing the 2024 and 2025 reports:** The analysis uses the 2024 reports as its baseline, since not all companies in the sample had published their 2025 reports at the time of the assessment. To include the most recent data available and to observe how the disclosure of good practices is evolving, the assessment was repeated on the sample of 20 companies from 2025 reports, five in each sector. For each company, the 2025 verdicts were compared with the 2024 verdicts for the same practices, using the same rules. The results of this comparison are presented in Chapter 11.

This combination of a rule-based automated first reading with mandatory human verification makes the analysis both scalable, across 70 companies and four sectors, and defensible. Every positive verdict and every piece of supporting evidence in the dataset can be traced back to a quote and page number in the company's own 2024 report, and was checked twice: once by an analyst reading against the source, and once through the cross-company consistency review.

3.6 Limitations and how they were addressed

This approach has limitations that the reader should keep in mind before reading the results. The main ones, and the way each was addressed, are summarised below.

- **Disclosure is not performance.** The analysis assesses what companies report, it does not verify what they do. A company may apply practices that it does not report, or describe practices that are only partially implemented. To address this, results are described throughout in terms of disclosure, and differences between the 2024 and 2025 reports are read as changes in what companies disclose, not necessarily in their actual practices.
- **Different practice lists for each sector.** Each sector has its own list, and the lists differ in length and content. For this reason, adoption rates cannot always be compared directly from one sector to another. To address this, comparisons across sectors are made only for practices or themes that are relevant to more than one sector.
- **Differences between reports.** Company reports vary in length, level of detail, structure, reporting standard and language. To address this, every report was assessed against the same definition and verdict rules, every Yes required a written quote and page reference, and a cross-company consistency check was run in each sector.

– **Use of AI.** An AI model can misread a passage or produce a quotation that does not exist in the source. To address this, every answer produced by Claude was reviewed by an analyst against the original report, and no answer entered the final dataset without this verification.

With these considerations in mind, the following chapters present the results of the analysis, sector by sector, and then compare the four sectors to highlight the main trends in good practices across the ocean economy sectors.



Maritime transportation

Maritime transportation is the movement of goods and people by sea, from container ships, bulk carriers and tankers to ferries and cruise vessels. It carries more than 90% of global commercial traffic[1] and is projected to keep growing at an average annual rate of around 2% over 2026–2030.[2] Shipping is the lowest-carbon transport mode per tonne-kilometre carried, but its scale and constant presence at sea make it a significant source of pressure on marine ecosystems.

Those pressures come from the ordinary operation of a vessel: ballast water and hull biofouling make the sector responsible for 60–90% of introductions of non-indigenous species; oil spills, antifouling biocides, scrubber wash water, bilge water and sewage release contaminants; waste reaches the sea through accidental dumping; propeller cavitation generates around 85% of a ship's underwater noise, masking the frequencies cetaceans depend on; ships strike marine mammals and turtles, disturb the seabed at anchor, and emitted 1,056 million tonnes of CO_2 in 2018, about 2.89% of the global total.[3]

ALTHOUGH SHIPPING IS THE MOST CARBON-EFFICIENT MODE OF TRANSPORT, ITS SCALE MAKES IT A SIGNIFICANT PRESSURE ON THE SEA

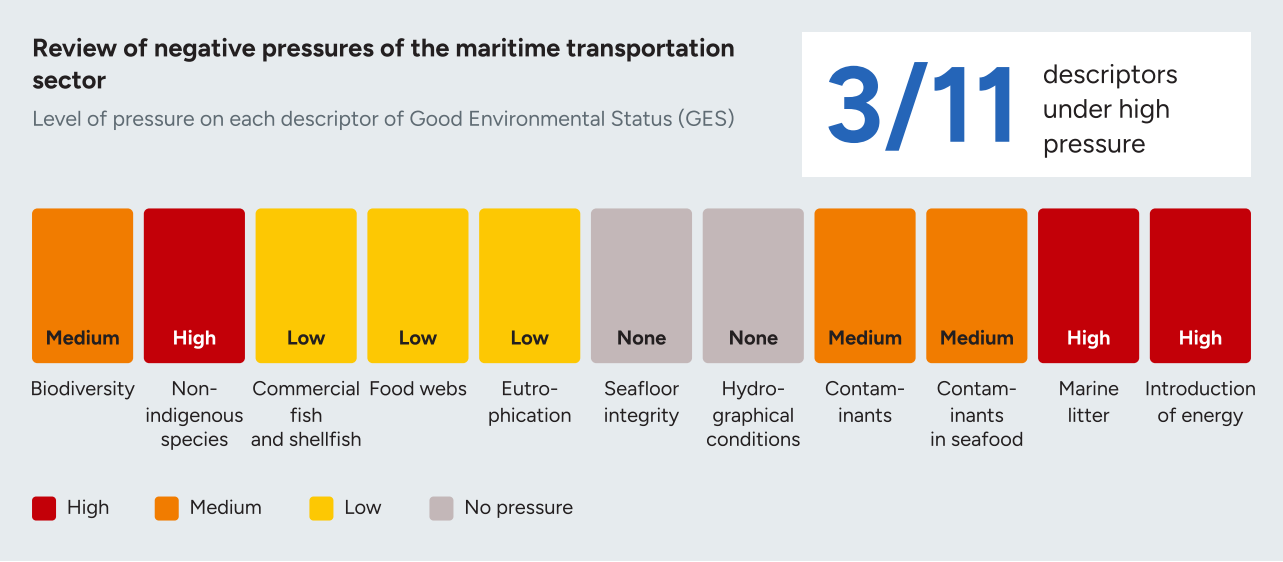
The scientific review conducted as part of the Ocean Impact Initiative (OII) project, shown in Figure 4.1, identified the most significant potential pressures the sector exerts on ocean health.

[1] One Ocean Foundation. (2024). "Maritime Transportation Industry Review". Available at: https://www.1ocean.org/news/the-impact-of-maritime-transportation-on-the-ocean-analysis-and-solutions

[2] UNCTAD. (2025). "Review of Maritime Transport 2025". Available at: https://unctad.org/publication/review-maritime-transport-2025

[3] One Ocean Foundation. (2024). "Maritime Transportation Industry Review". Available at: https://www.1ocean.org/news/the-impact-of-maritime-transportation-on-the-ocean-analysis-and-solutions

FIGURE 4.1 · Pressures of maritime transportation[4]



Source: Maritime Transportation Industry Review, One Ocean Foundation, 2024.

On this basis, the scientific review also identified, for each pressure, several good practices that companies in the sector can apply to prevent and/or mitigate it, as evidenced in the relevant scientific literature. These good practices, identified within the framework of the OII project, are presented in Table 4.1 below.

4.1 Sample description

Twenty-nine maritime transportation companies were assessed against a sector list of seventeen good practices, on the basis of their 2024 sustainability and annual reports. A practice was recorded as applied only where the company described a specific technological or innovative solution actually in use: naming the pressure or stating an intention to address it was not counted.

29

maritime transportation companies assessed

17

good practices in the sector list

[4] One Ocean Foundation. (2024). "Maritime Transportation Industry Review". Available at: https://www.1ocean.org/news/the-impact-of-maritime-transportation-on-the-ocean-analysis-and-solutions

4.2 The practices assessed

TABLE 4.1 · Good practices in the maritime transportation industry

Good practice	Definition
GHG EMISSIONS AND AIR POLLUTION	
Energy-efficiency measures and shore power at berth	Measures that cut fuel burn per unit of transport work — hull and propeller optimisation, air lubrication, waste-heat recovery, weather routing, fleet-performance software — plus cold ironing, which lets a vessel shut down auxiliary engines and draw grid electricity in port. Less fuel burned means proportionally less CO_2, SOx, NOx and particulate matter.
Alternative marine fuels	Substitution of fossil fuel with hydrogen, e-methanol, e-ammonia, bio-LNG or synthetic LNG, through dual-fuel engines or drop-in blends. Displaces combustion emissions at source rather than reducing the quantity combusted.
Real-time air-emissions monitoring	Sensor- or platform-based tracking of GHG and other air pollutants, so emissions can be managed within a voyage rather than reconstructed after it.
Electric and hybrid propulsion and terminal electrification	Battery-electric and hybrid drivetrains on vessels and on the landside fleet — terminal tractors, cranes, straddle carriers, trucks. Removes combustion emissions from the port airshed, which is coastal and typically populated.
UNDERWATER NOISE	
Vessel speed regulation and reduction	Fleet-wide slow steaming, or a mandated or voluntary limit inside a defined zone. Radiated noise rises steeply with speed, so a modest reduction gives a disproportionate acoustic benefit while also cutting fuel burn and strike risk.
INTRODUCTION OF MARINE LITTER	
Onboard waste management technologies	Segregation, compaction, recycling and digital tracking of plastics, packaging and cargo residues generated aboard. Prevents litter from entering the sea and reduces what is landed for disposal.
Litter-capture devices	Onboard filtration or capture systems, typically on a seawater intake line, that remove plastic and microplastic already in the water column.
INTRODUCTION OF CONTAMINANTS	
Alternative antifouling technologies	Non-biocidal or reduced-biocide approaches to hull fouling — silicone foul-release and hard coatings, graphene propeller coatings, ultrasonic systems, robotic and in-transit cleaning. Reduces the continuous leaching of copper and organic biocides, and cuts drag with it.
Bilge, sewage and greywater treatment	Oily-water separators, oil-content monitors, sewage plants and advanced wastewater purification that treat effluent before discharge or hold it for reception ashore. Reduces the hydrocarbon, nutrient and pathogen load entering coastal waters.
Automatic oil-spill detection	Sensor-based or satellite-monitored systems that detect a hydrocarbon release early. Spill volume and damage scale with time to detection, so detection speed is itself a mitigation.
COLLISION WITH MARINE FAUNA	
Marine-mammal encounter training	Bridge-team training in lookout, avoidance manoeuvring and sighting reporting, increasingly supported by app-based tools feeding shared sighting networks. Addresses the detection failure that precedes most strikes.
Acoustic deterrents and species-detection sensors	Technologies that put a whale on the bridge display before the lookout sees it — thermal imaging with AI classification, passive acoustic buoys, forward-looking detection — or that move animals clear of a noisy operation.

TABLE 4.1 · Good practices in the maritime transportation industry

Good practice	Definition
NON-INDIGENOUS SPECIES	
Ballast water treatment systems	Onboard physical filtration combined with UV or chemical disinfection, killing organisms taken up in one biogeographic region before discharge in another. The principal engineering barrier to ballast-mediated species transfer.
Real-time ballast water monitoring	Sensors measuring treatment performance during the operation — residual chlorine, biological load — rather than certifying the system once at type approval.
SEAFLOOR INTEGRITY	
Seabed mapping for anchoring and routing	Sonar, bathymetric survey and GIS layers of sensitive habitat used to decide where a vessel anchors and how it routes, preventing anchor and chain scour on seagrass, maerl and reef.
Eco-moorings and geofenced anchoring	Fixed mooring buoys with elastic risers that hold a vessel without chain sweep, combined with GPS geofencing enforcing no-anchor zones over sensitive habitat.
CROSS-CUTTING	
Sustainability and environmental training	Structured environmental training for employees, suppliers and other stakeholders. Enables every other practice on this list but acts on no pressure directly.

4.3 Adoption of good practices

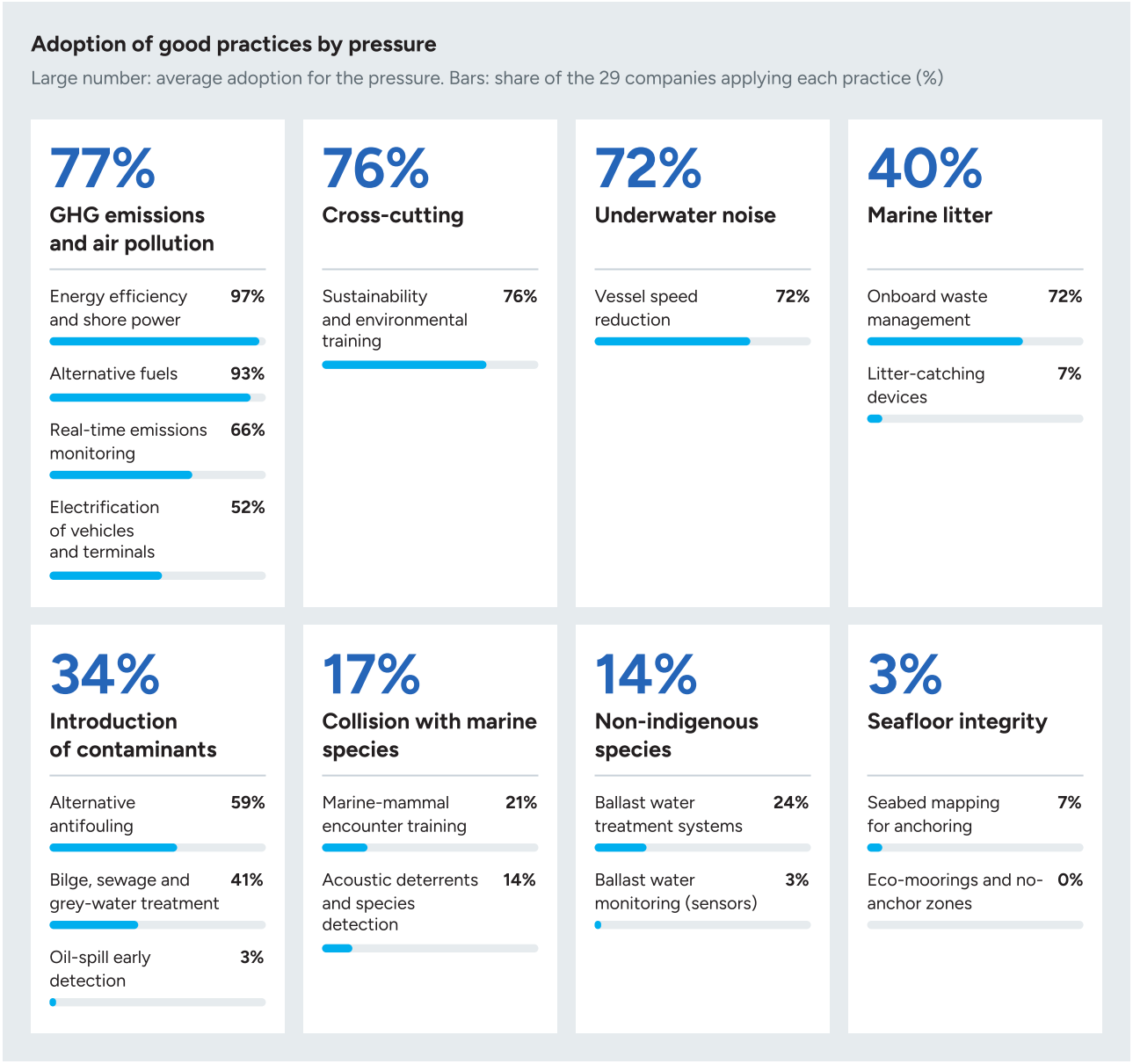
The response is uneven across pressures

ADOPTION IS HIGHEST FOR GHG EMISSIONS AND LOWEST FOR SEAFLOOR INTEGRITY, SHOWING A STRONG IMBALANCE OF ATTENTION TO DIFFERENT PRESSURES

The seventeen identified practices can be grouped according to the ocean pressure they address. See Figure 4.2. The graph highlights a strong imbalance in the sector's response to different pressures. Adoption is highest for GHG emissions and air pollution (77%), followed by cross-cutting practices (76%) and underwater noise (72%). High adoption of speed reduction drives the underwater noise figure, although companies mainly use it to save fuel.

Adoption then falls to 40% for marine litter, with a particularly wide gap between onboard waste management (72%) and the installation of litter-capture devices (7%). Practices addressing the introduction of contaminants reach 34%, while pressures directly affecting marine species receive considerably less attention: 17% for collisions with marine species and 14% for introduction of non-indigenous species. The good practices related to the protection of seafloor integrity are almost entirely unaddressed, at just 3%. Overall, the graph shows that companies tend to prioritise measurable and operational pressures, while more diffuse, ecosystem-level impacts remain largely overlooked.

FIGURE 4.2 · Adoption of good practices by pressure



GHG emissions and air pollution

Energy-efficiency measures and shore power are applied by 97% of companies (28 of 29) — the highest adoption in the sector. This is not a single technology but a long list of improvements to the ship and to the way it is sailed: smoother underwater coatings, better propellers, reshaped bows and waste-heat recovery. Shore power, or cold ironing, is when the ship plugs into the local electricity grid in port so that its engines can be switched off at berth.

NEARLY ALL COMPANIES REPORT ACTIONS TO IMPROVE ENERGY EFFICIENCY AND ADOPT ALTERNATIVE FUELS

One container line has rebuilt parts of more than a hundred of its ships since 2022 — new propellers, redesigned bows and smoother hull coatings. One cruise company uses artificial intelligence to decide how energy is shared between systems on board, and stores heat rather than wasting it. On the shore power side, one cruise operator can now plug in seven ships out of ten, and one terminal group has extended shore power to all of its container berths in its home port.

Alternative fuels are used by 93% of companies (27 of 29). The practice covers fuels that replace conventional heavy fuel oil: LNG and its renewable version bio-LNG, methanol made from renewable sources, biofuels made from waste oils, and, in the longer term, ammonia and hydrogen, which release no carbon dioxide when burned.

One ferry operator runs its older ships on certified biofuel and its trucks on renewable diesel, treating this as the practical option available today; one operator has gone further and installed equipment that captures carbon dioxide from the ship's exhaust while sailing.

This high figure should be read carefully, however: it shows that almost every company has started, not that fleets have changed over. Around half of the positive results rest on biofuel blended into ordinary fuel, single trial voyages, purchased certificates, or ships ordered but not yet delivered.

Real-time emissions monitoring is applied by 66% of companies (19 of 29). The idea is to measure what comes out of the funnel as the ship sails, using sensors and a live dashboard, instead of calculating it once a year from fuel receipts.

One company has fitted meters on more than 200 of its ships that measure fuel flow and engine power continuously, feeding a live digital twin of the vessel that shows its emissions as it sails. Many of the other positive results are advanced annual carbon accounting or exhaust-cleaning equipment rather than live measurement of air pollutants.

Electrification of vehicles and terminal equipment is applied by 52% of companies (15 of 29). However, the reported practices cover two distinct situations.

The first, and by far the more widespread, is landside electrification, which concerns the port ecosystem as a whole rather than maritime transport operations: electric terminal tractors and straddle carriers moving containers around the quay (one terminal group runs eight fully electric straddle carriers on a berth that is itself all-electric), alongside electric shuttle trucks, forklifts, and pilot projects to build local power grids at terminals. Almost all of the 52% is accounted for by practices of this type.

The second is the electrification of the vessels themselves. This is the step that matters for the sector, and it is still rare. Only a few companies have made a start: one put a diesel-electric hybrid towboat into service in 2024, with a battery system expected to cut emissions by up to 80%. No company in the sample operates an electric ocean-going ship. At sea, batteries currently support the engine rather than replace it, and full electrification is viable only for harbour, inland and short-distance craft — which is why the sector's answer for long voyages is alternative fuels rather than electricity.

Underwater noise

Vessel speed reduction is applied by 72% of companies (21 of 29), and it is the only practice addressing a pressure on marine life that reaches the top group. Noise from a ship comes mostly from its propeller and rises very steeply with speed, so taking a few knots off a passage makes the ship much quieter in the frequencies whales use to communicate, and it gives the bridge more time to see and avoid an animal ahead. To learn more about the issue of underwater noise, see the in-depth section below.

SPEED REDUCTION CUTS PROPELLER NOISE AND GIVES CREWS MORE TIME TO AVOID WHALES, BUT MOST COMPANIES THAT USE IT MENTION ONLY THE FUEL IT SAVES

The reports describe several forms of this. One ferry operator slows down and adjusts its route in part of the Mediterranean to avoid disturbing sperm whales. Many companies take part in voluntary slowdown schemes run by port authorities and conservation programmes. In around half the cases, however, the company describes slow steaming purely as a way to save fuel, with no mention of noise or wildlife, suggesting limited awareness of the pressures of operations on biodiversity.

Introduction of marine litter

Onboard waste management is applied by 72% of companies (21 of 29). It covers the equipment and activities that keep waste on board and out of the sea: separating waste into streams, compacting and storing it, and landing it ashore for recycling. The better examples go beyond sorting. One cruise operator separates waste into seven streams and weighs food waste with digital scales to find where it is being generated; another has begun recycling worn-out mooring ropes, among the heaviest and most persistent plastic items a ship can lose. Another company collects plastic bottles from its ships to be turned into clothing.

Litter-capture devices are used by 7% of companies (2 of 29). One passenger ferry has carried a prototype capture system that filters seawater as the ship sails and removes microplastic particles from it; over the reporting year it ran for more than 5,000 hours and captured tens of millions of particles. The second case is a filter at a seawater intake that collects particles for a university to analyse.

Introduction of contaminants

Alternative antifouling technologies are applied by 59% of companies (17 of 29). Any hull left in the water grows a layer of algae and barnacles, which slows the ship, increases fuel use, and carries species from one part of the world to another. The traditional answer is paint that slowly releases copper or other biocides; the alternatives are coatings so slippery that organisms cannot hold on, and cleaning methods that remove growth physically. Reported examples include silicone coatings containing far fewer biocides than conventional paint, an ultrasonic device fitted to a propeller that stops growth without releasing any chemical, and robots that clean the hull between dry dockings. The caution here is about wording: several companies describe only a "high-performance" or "low-friction" coating without specifying a special material or technology.

Treatment of bilge water, sewage and greywater is applied by 41% of companies (12 of 29). Passenger ships report advanced treatment plants that clean sewage and greywater to a standard stricter than the law requires, with the treated water tested daily on board. One inland and coastal operator goes further and forbids any discharge of bilge water overboard at all, even on vessels fitted with the separator equipment to do it legally.

Automatic oil-spill detection is applied by one company only (3%). Several companies report that they had no significant spills during the year, which is good news but not the same thing: reporting an outcome afterwards is different from installing sensors or satellite monitoring that catch a leak in its first minutes, which is exactly when a small spill can still be stopped from becoming a large one.

Collision with marine fauna

When it comes to protection of marine biodiversity, **crew training on marine-mammal encounters** is applied by 21% of companies (6 of 29), and four of those six deliver it with an outside partner — a conservation charity or a national wildlife agency. One cruise operator has its crew trained in how to watch for whales, what to do if a strike happens and how to report it; on some ships, bridge teams report sightings in real time through a public phone app, feeding a shared database other vessel can use.

Acoustic deterrents and real-time species detection are applied by 14% of companies (4 of 29). The technologies are technically advanced and among the least used: thermal imaging cameras with automatic recognition software, fitted to three ships, which send confirmed sightings to a shore-based marine scientist so the crew can slow down or change course; underwater listening buoys funded on a migration route to detect whales by their calls; and, in offshore construction, deliberate underwater sound before piling begins, to move marine mammals clear of the area first.

Non-indigenous species

Ballast water advanced treatment systems are credited to 24% of companies (7 of 29), and this figure needs explaining rather than being taken at face value. Ships take on seawater for stability and release it in the next port, moving living organisms between ecosystems as they do. Treating that water is already compulsory under the International Maritime Organization (IMO) International Convention for the Control and Management of Ships' Ballast Water and Sediments, and nearly every company confirms it complies; compliance alone was not counted here, because the report looks for practices that go beyond the law. By contrast, the companies scored as applying this good practice describe a specific combined technology — filtering the water first, then disinfecting it and neutralising the disinfectant before discharge, or ultraviolet treatment documented across the fleet.

Real-time ballast water monitoring is applied by one company (3%), whose system measures the disinfectant level continuously and adjusts the dose automatically both when water is taken on and when it is released. The remaining companies treat ballast water without measuring the result as it happens.

Seafloor integrity

Seabed mapping to guide routing and anchoring is applied by 7% of companies (2 of 29). The best example is a company that combines its own fleet tracking data with maps of protected and ecologically important marine areas, in order to see where its routes actually cross sensitive habitat and to feed that into its planning.

Eco-moorings and no-anchor zones are applied by no company in the sample — the only practice in the sector that is not in use. When a ship anchors, the anchor and the chain, which sweeps across the bottom as the ship swings with wind and tide, tear up whatever is growing there, and seagrass meadows, coral and maerl beds recover very slowly or not at all. The remedy is neither new nor expensive: fixed buoys a ship can tie to instead of dropping its anchor, and mapped zones where anchoring is not allowed. The gap here begins before the technology, with awareness. Only three of the twenty-nine companies mention anchor damage or seabed disturbance at all, and each names it as a risk without describing a single measure taken against it.

Cross-cutting

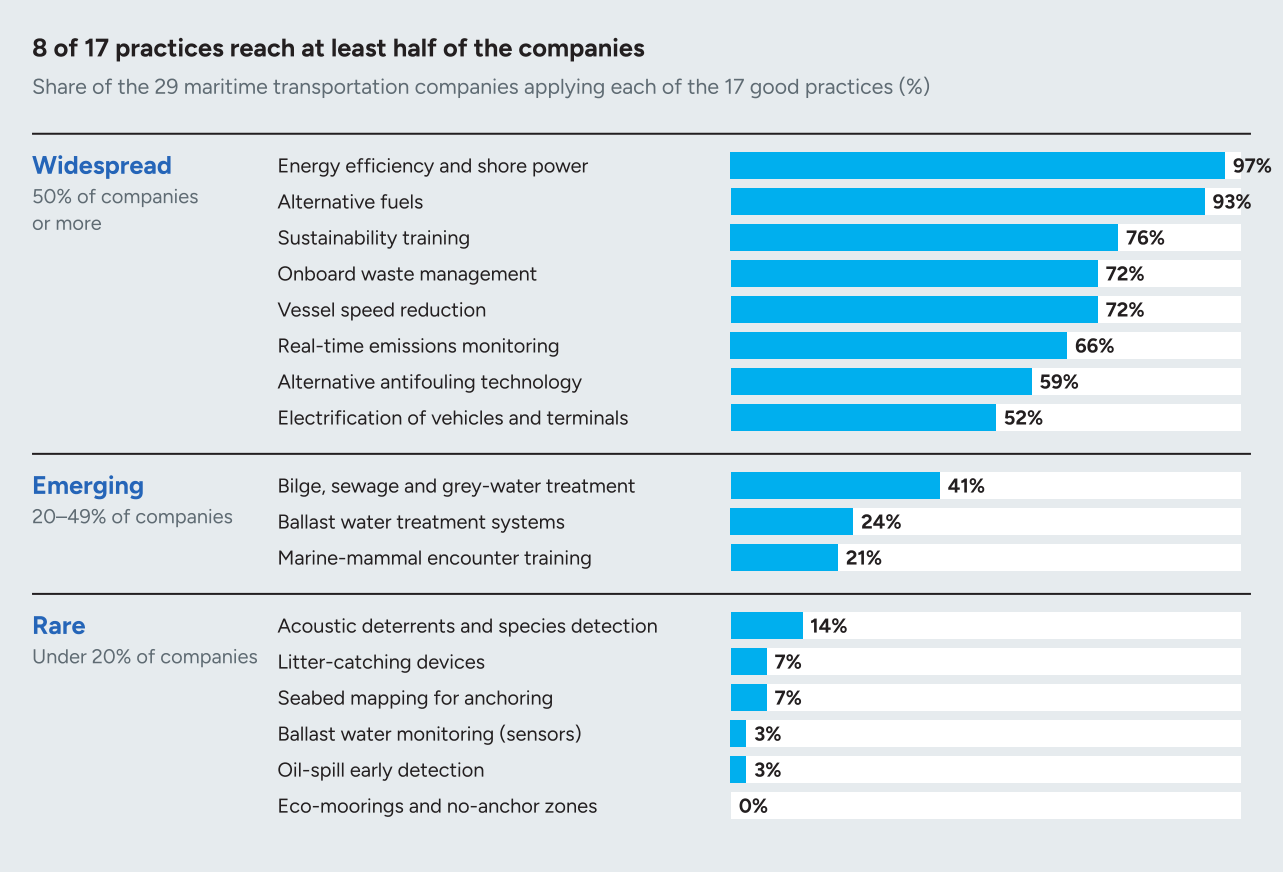
One of the seventeen practices, **sustainability and environmental training**, is reported by 76% of companies (22 of 29). This is worth attention because, unlike the other sixteen, it is not a technology or a solution acting on a specific pressure. Companies report it almost exclusively through input indicators: hours of training delivered, number of courses, share of employees enrolled, which measure how much has been invested in the activity, not what it has changed. For this reason, training should be read as a supporting measure that enables the other practices, rather than as a good practice acting on a pressure in its own right.

Eight practices are widespread, three are emerging, six are rare

Figure 4.3 ranks all seventeen practices by the share of companies applying them. Eight practices are applied by half or more of the sample and are shown in dark blue; three sit in an emerging band between 20% and 49%; six are applied by fewer than one company in five, and one — eco-moorings and geofenced anchoring — by none at all.

EIGHT OF THE SEVENTEEN GOOD PRACTICES ARE APPLIED BY HALF OR MORE OF COMPANIES IN THE SECTOR

FIGURE 4.3 · Adoption of each good practice in maritime transportation



What can be measured gets attention

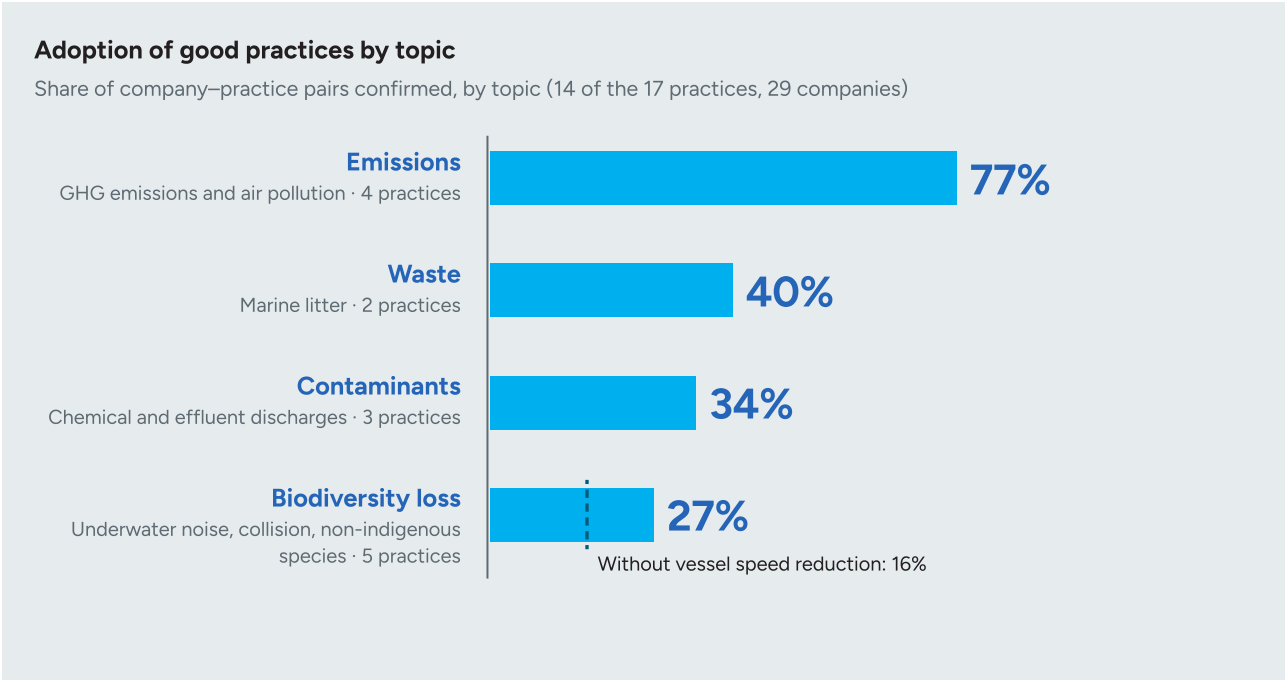
Furthermore, fourteen of the seventeen practices were regrouped into four broader topics, scoring each by the share of all companies' positive answers. There are three practices not shown: sustainability training, which acts on no pressure directly, and the two seabed practices, which fall outside the four topics. The dashed line on the biodiversity bar shows what is left once vessel speed reduction is set aside, since companies adopt it mainly to save fuel rather than to protect marine life. See Figure 4.4.

Grouped into four topics, emissions practices lead by a wide margin: 89 of the 116 company-practice answers in that group, or 77%. Carbon is the one pressure here that can be counted — every tonne of fuel burned appears on a bunker receipt, converts into a carbon figure by a fixed formula, and is checked by an auditor. It is also the pressure on which regulators have acted most strongly and earliest, progressively introducing requirements that set targets, establish monitoring systems and put a cost on emissions. The pressure has a price, a method and an owner, and the sector performs best exactly where all three exist.

EMISSIONS PRACTICES LEAD BECAUSE CARBON IS MEASURED, AUDITED AND PRICED, WHILE BIODIVERSITY PRACTICES, REMAIN LESS ADOPTED, REFLECTING THE DIFFUSE AND UNPRICED NATURE OF IMPACTS

Waste and contaminants sit close together in the middle, at 40% and 34%. Rules explain the floor beneath them: MARPOL (the International Convention for the Prevention of Pollution from Ships) governs garbage, the oil content of bilge water and the treatment of sewage, and a separate convention bans the most harmful antifouling paints.

FIGURE 4.4 · Adoption of good practices by topic



What these rules set is a minimum standard of behaviour rather than a target to improve on. They can be met with basic equipment, and around half of the companies stop at compliance — which is why each of these topics contains one practice that is nearly universal and another that is almost absent.

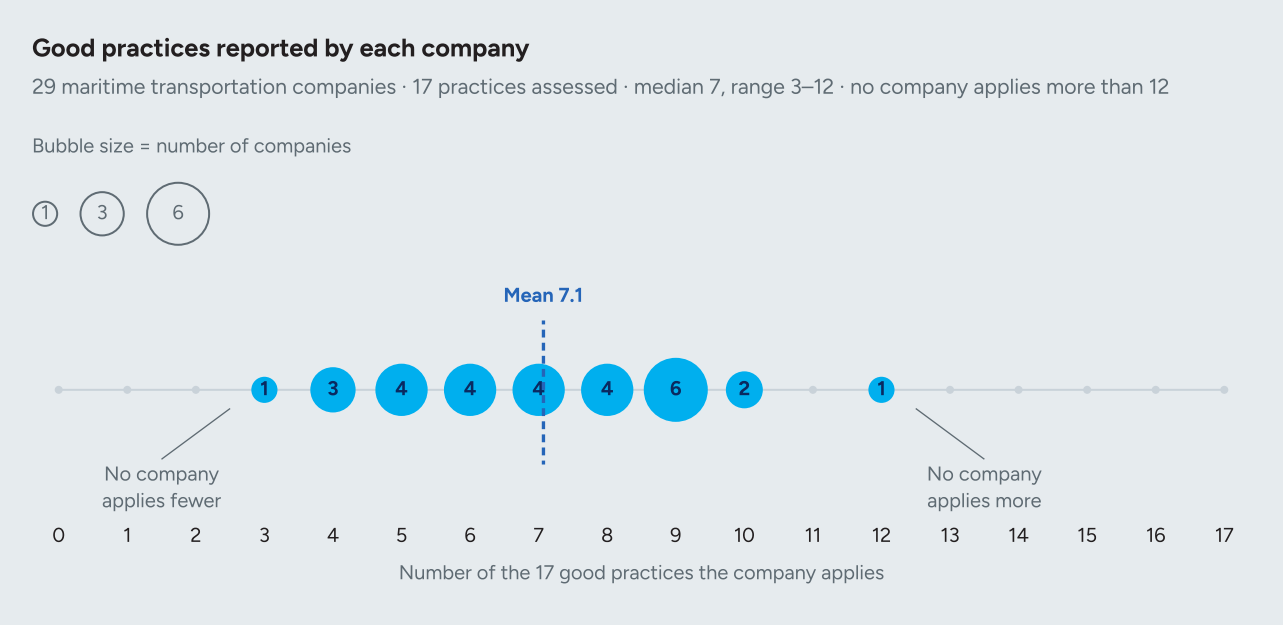
Biodiversity loss comes last, at 27%. The harm is diffuse, delayed and impossible to pin on any one ship among the many using the same waters, so there is little that is routinely measured, audited or priced; the cost is real, but it falls on the ocean rather than on the company. This is compounded by a lack of awareness. Underwater noise, for example, is rarely discussed as a pressure in its own right, and about half the companies that slow their ships down present it purely as a way of saving fuel, apparently unaware that the same decision is one of the most effective things a ship can do for whales.

No company applies more than twelve of the seventeen good practices

Figure 4.5 shows how many of the seventeen assessed good practices each of the twenty-nine companies applies. Each bubble sits at a number of practices on the scale from zero to seventeen, and its size and label give how many companies are at that point.

No company applies fewer than 3, and only one adopts 12, which is the highest result. No company is close to doing everything: the best performer still misses 5 practices, and the whole right side of the chart (13–17) is empty, so even the leaders have clear room to improve. At the same time, nobody is doing nothing — the lowest score is 3, not 0, meaning every company in the sample has at least some ocean-related practices in place.

FIGURE 4.5 · Good practices reported by each company



The distribution shows something closer to a single crowd, with scores packed into a narrow middle band and no small group of leaders far ahead of the rest. Most companies land between 3 and 10. On average, a company uses about 7 practices — fewer than half the list.

In practice, this means the problem is not a few companies lagging behind — it is that some good practices are still rare across the sector, so the goal should be getting more companies to take them up.



IN DEPTH

Underwater noise: recognising the biodiversity impact of speed reduction

Whales use low-frequency sound to communicate, navigate and find food. Ships operate in the same acoustic space. Much of the noise comes from propeller cavitation: vapour bubbles form and violently collapse around the blades, producing broadband noise across frequencies that marine animals rely on. The result is a steadily louder ocean. Background low-frequency noise has been estimated to double roughly every decade over the past 50 years,[5] with merchant shipping the dominant contributor.

SLOWING DOWN BY ONE KNOT CUTS UNDERWATER NOISE BY ABOUT ONE DECIBEL, REDUCING PRESSURE ON WHALES WITHOUT NEW TECHNOLOGY, WHILE ALSO SAVING FUEL

In noisy waters, beaked whales can lose more than half their feeding efficiency, while humpback whales call louder and less often. Right whale calls can be masked at distances where they were once detectable.[6] Yet underwater noise rarely produces a single, visible event that can be attributed to one vessel.

Speed reduction is the most immediate lever. Noise rises sharply with vessel speed, while slowing down requires no new technology or equipment. Studies suggest that reducing speed by one knot can cut underwater noise by roughly one decibel, while also reducing fuel consumption and collision risk. The measure is particularly important in feeding grounds, migration corridors and other sensitive areas. Slower ships are less likely to strike whales, and ship strikes remain a major cause of death for large whales. Shipping routes overlap with about 92% of the ranges of blue, fin, humpback and sperm whales, yet only around 7% of the highest-risk areas have protection in place.[7]

AROUND HALF OF COMPANIES PRESENT SPEED REDUCTION ONLY AS A FUEL-SAVING MEASURE; RECOGNISING ITS BENEFITS FOR BIODIVERSITY COULD REPRESENT A STEP FORWARD

The problem is that companies do not always recognise the biodiversity value of the measure they are already taking. In around half the cases, companies describe speed reduction purely as a fuel-efficiency measure, without mentioning underwater noise or whales. The action is right, but the rationale is incomplete. If the practice is justified only by fuel savings, its environmental value is tied to fuel prices and efficiency targets rather than treated as a deliberate measure to reduce pressure on marine ecosystems.

Underwater noise shows that the right practices can protect the ocean even when they are adopted for other reasons and named differently. Explicitly recognising, measuring and reporting their biodiversity impact is what moves a company further along its sustainability path, towards more deliberate and more effective action.

[5] Erbe, C. et al. (2019). "The Effects of Ship Noise on Marine Mammals — A Review". Frontiers in Marine Science 6:606. Available at: https://www.frontiersin.org/journals/marine-science/articles/10.3389/fmars.2019.00606/full

[6] Ibidem

[7] Nisi, A.C., Welch, H., Brodie, S., et al. (2024). "Ship collision risk threatens whales across the world's oceans". Science. Available at: https://doi.org/10.1126/science.adp1950

4.4 Sector synthesis

1 **Maritime transportation companies strongly prioritise practices linked to fuel savings and regulatory requirements.**

Energy efficiency and shore power are adopted by 97% of companies, alternative fuels by 93%, and electrification of vehicles and terminals by 52%. These practices are widespread because they reduce fuel costs, are increasingly regulated or priced, and can be measured using existing systems.

2 **Adoption of practices addressing marine biodiversity is the weakest in the sector, at roughly one third of the rate for carbon.**

The overall adoption is 27% for practices addressing pressures on marine biodiversity, which include collisions with marine species, spread of non-indigenous species and underwater noise. In comparison with decarbonisation-related practices, marine biodiversity impacts are more diffuse, location-specific and difficult to measure, making them less visible and less systematically integrated into corporate strategies and reporting.

3 **There is no leading group; the whole sector sits in one crowd.**

Companies apply between three and twelve of the seventeen practices, with a median of seven and a mean of 7.1. Adoption of good practices appears to be shaped less by individual company characteristics than by shared sector-wide constraints and comparable barriers to going beyond a baseline level of environmental action.


NO SMOKING
SAFETY FIRST

Shipbuilding and repairs

The shipbuilding and repairs industry includes operators responsible for building, converting, maintaining and dismantling ships in newbuild yards and repair docks. Its global market reached USD 201.4 billion in 2024 and is projected to reach USD 500.63 billion by 2035.[1] The sector is not accountable for a ship's emissions in service or for how it is scrapped, yet ships last thirty years or more, and what the yard builds is what the ocean lives with.

GIVEN THE LONG LIFESPAN OF A SHIP, THE CHOICES A SHIPYARD MAKES AT CONSTRUCTION DETERMINE THE PRESSURES A VESSEL EXERTS ON THE OCEAN FOR DECADES

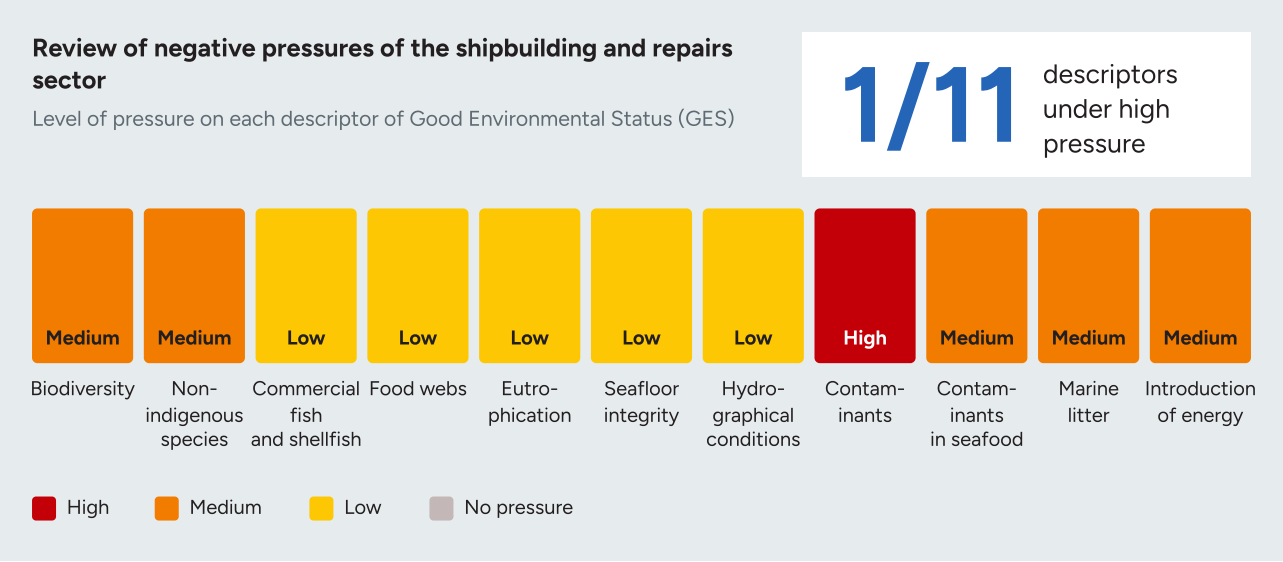
The pressures on the environment from the industry come from what a yard does and from what it designs. Paints and solvents release volatile organic compounds (VOCs), and fossil-fuelled air heaters emit nitrogen oxides, carbon monoxide and particulates. During hull maintenance at shipyards, antifouling paints release biocides into the water. There, they settle into the sediments, together with lead, mercury, polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs) from old coatings, abrasive blasting and fuel residues. Blasting, welding and painting generate large volumes of wastewater. Pneumatic hammers make a yard loud, and the propellers it installs radiate over 180 dB underwater once the vessel is in service. Vessels arriving for repair bring non-indigenous species on fouled hulls. At the end of a ship's life, more than 70% of obsolete ships are beached in South Asia, releasing hazardous materials, heavy metals and microplastics.[2]

The scientific review conducted as part of the Ocean Impact Initiative project, shown in Figure 5.1, identified the most significant potential pressures the sector exerts on ocean health.

[1] Market Research Future. (2026). "Shipbuilding Market 2026". Available at: https://www.marketresearchfuture.com/reports/shipbuilding-market-10314

[2] One Ocean Foundation. (2024). "Shipbuilding and Repairs Industry Review". Available at: https://www.1ocean.org/news/shipbuilding-repairs-industry-and-its-impact-on-the-ocean-analysis-and-solutions

FIGURE 5.1 · Pressures of shipbuilding and repairs[3]



Source: Shipbuilding and Repairs Industry Review, One Ocean Foundation, 2024.

For each of these pressures, this report went on to set out the good practices applied by companies in the sector. Table 5.1 lists the practices identified through the OII project and explains what each one involves.

5.1 Sample description

Sixteen shipbuilding companies were assessed against a sector list of ten good practices, on the basis of their 2024 sustainability and annual reports. A practice was recorded as applied only where the company described a specific technological or innovative solution actually in use: naming the pressure, or stating an intention to address it, was not counted.

The sample deliberately spans the different kinds of business that sit under the shipbuilding heading. This includes large commercial and offshore newbuild yards, naval and defence builders, and recreational boat and marine engine manufacturers.

16

shipbuilding and repairs companies assessed

10

good practices in the sector list

[3] One Ocean Foundation. (2024). "Shipbuilding and Repairs Industry Review". Available at: https://www.1ocean.org/news/shipbuilding-repairs-industry-and-its-impact-on-the-ocean-analysis-and-solutions

5.2 The practices assessed

TABLE 5.1 · Good practices in the shipbuilding and repairs industry

Good practice	Definition
GHG EMISSIONS AND AIR POLLUTION	
Renewable energy for yard operations	On-site generation and procurement of electricity from renewable sources for shipyard operations: rooftop and ground-mounted photovoltaics, power purchase agreements, renewable grid tariffs. Acts on the construction phase rather than the vessel, cutting the yard's own emissions.
Alternative fuels and low-emission propulsion in ship design	Integration of hydrogen, battery-hybrid and dual-fuel propulsion systems, and of alternative fuels such as methanol, ammonia and LNG, into the vessels leaving the yard as well as into the yard's own operations. The builder fixes what a ship can burn for its entire service life, so the emissions profile of decades of operation is decided at construction.
INTRODUCTION OF CONTAMINANTS	
Environmentally responsible coatings and paints	Non-toxic antifouling systems: silicone-based foul-release coatings, novel polymers, nanotechnology-based products and lower-solvent or solvent-free application systems. Reduces both biocide leaching into the water column over the vessel's life and solvent emissions from the paint process.
INTRODUCTION OF MARINE LITTER	
Life cycle assessment (LCA) of materials and processes	LCA is a standardised method for quantifying the environmental impact of a product across the stages of its life, from raw-material sourcing through construction and operation to dismantling. The method covers a broad range of environmental aspects (energy, emissions, water use, waste), but it was assessed here only in its material dimension: whether the company uses it to inform the choice of materials and design, at the point where the downstream consequences of that choice can still be changed.
Waste management technologies and circular design	Advanced recycling systems, waste-to-energy recovery and circular-economy approaches applied to yard waste, end-of-life vessels and the recycled content of construction materials. Addresses the steel, composite, plastic and packaging streams that would otherwise reach the sea as litter and microplastic.
UNDERWATER NOISE AND LIGHT	
Hull and propulsion optimisation	Hull forms modelled with computational fluid dynamics, air-lubrication systems, seawater-lubricated propellers and comparable technologies that reduce resistance and propeller cavitation. Companies mostly report these as energy-efficiency measures, but cavitation is the dominant source of radiated underwater noise, so the same design work acts on both.
NON-INDIGENOUS SPECIES	
Inspection and biofouling maintenance technologies	Autonomous or remotely operated robotic systems, drone-assisted inspection tools and related monitoring technologies for proactive hull inspection, grooming and maintenance. Removing fouling before it establishes prevents the transfer of non-indigenous species between biogeographic regions, and a clean hull also lowers resistance and fuel burn.
CROSS-CUTTING	
Digital twin, simulation and AI	Digital twins, simulation and artificial intelligence applied to vessel design, production processes, planning, supply-chain management and operational decision-making within the company. Testing a design virtually displaces physical prototyping and rework, cutting material and energy consumption before construction begins.

TABLE 5.1 · Good practices in the shipbuilding and repairs industry

Good practice	Definition
Automation and robotics in the shipyard	Automated and robotic systems in yard activities — welding, cutting, painting, material handling — are deployed to optimise operations and reduce the environmental impact of construction. Tighter process control reduces material overuse, paint overspray and energy consumed per unit of output.
Sustainability and environmental training	Structured environmental training for employees, suppliers and other stakeholders. Enables every other practice on this list but acts on no pressure directly.

5.3 Adoption of good practices

Some environmental pressures receive far more attention than others

The ten identified practices can be grouped according to the ocean pressure they address. See Figure 5.2. As in the maritime transportation industry, adoption is highest for GHG emissions and air pollution (78%), followed by cross-cutting practices that include new digital technologies and tools for sustainability and environmental training (69%). Adoption then falls to 47% for prevention of marine litter, where life cycle assessment (50%) sits slightly ahead of the recycling and circular-design technologies it is meant to inform (44%). Practices addressing contaminants and underwater noise both reach 38%, and in each case the figure rests on a single practice that companies report for a reason other than the pressure it acts on. The one practice addressing non-indigenous species — robotic and drone-assisted hull inspection and biofouling maintenance — is applied by no company in the sample.

ADOPTION IS HIGHEST FOR EMISSIONS AND CROSS-CUTTING PRACTICES, WHILE ATTENTION TO THE ISSUE OF NON-INDIGENOUS SPECIES IS LOW

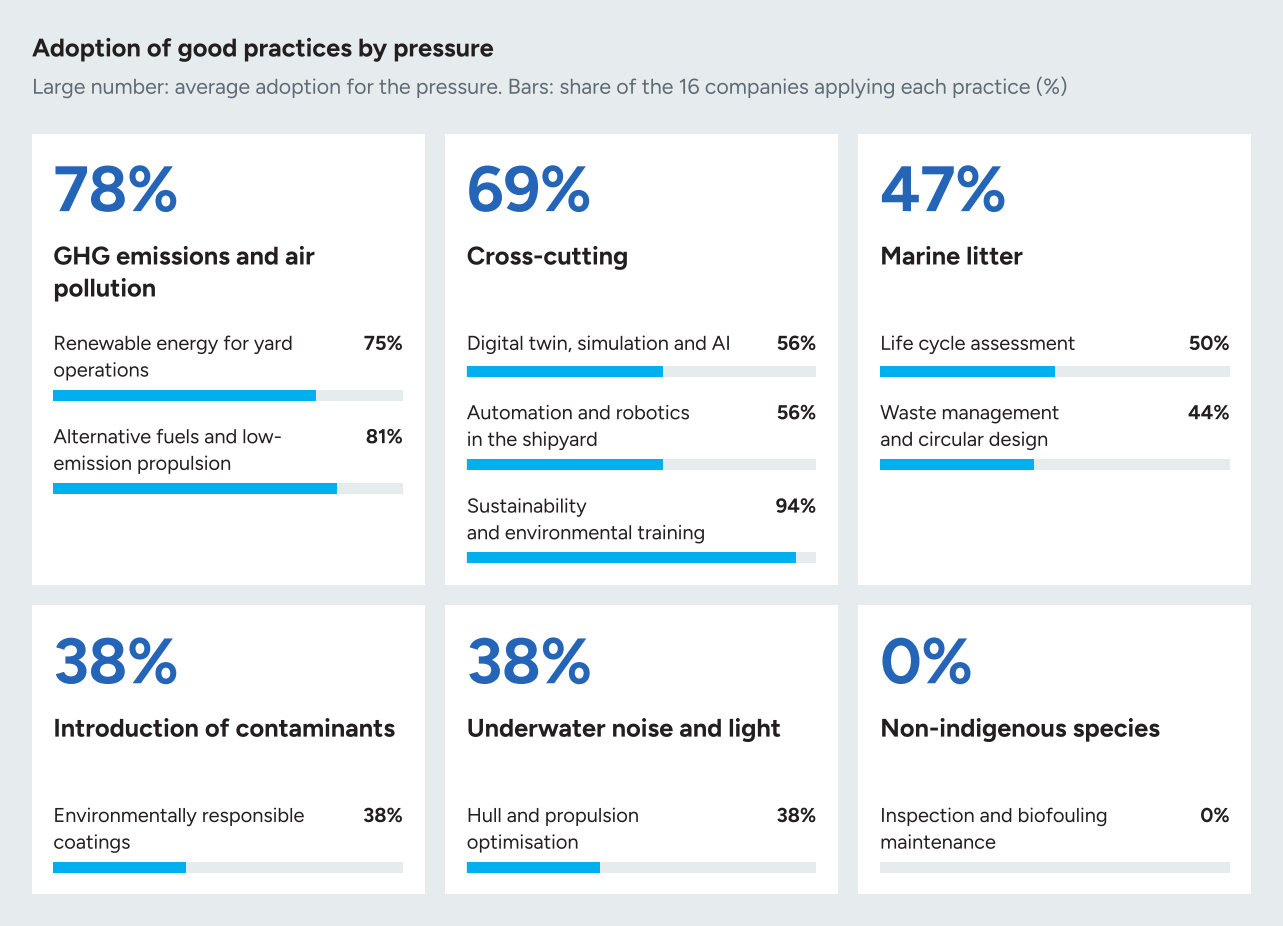
GHG emissions and air pollution

Alternative fuels and low-emission propulsion in ship design are applied by 81% of companies (13 of 16), the second highest adoption in the list of good practices. This is where shipbuilding differs most from every other ocean sector: the builder does not burn the fuel, but it decides what the ship can burn for years to come. At the same time, those decisions are ultimately shaped by shipowners and operators, whose orders drive demand for low-carbon technologies and fuels. The practice covers dual-fuel and hydrogen-ready machinery, methanol, ammonia, LNG and biofuels, and battery-hybrid and fully electric propulsion.

81% OF COMPANIES INTEGRATE ALTERNATIVE FUELS AND LOW-EMISSION PROPULSION INTO THE VESSELS THEY BUILD

One large commercial yard reports that clean-energy vessels rose from 58% to 74% of its order book in a single year. Another company quantifies what its methanol dual-fuel ships change against conventional bunker fuel: 25% less greenhouse gas, 99% less sulphur oxides, 80% less nitrogen oxides.

FIGURE 5.2 · Adoption of good practices by pressure



The recreational segment reaches the practice from the other end: one boat group sells six sailing models in fully electric versions and validated its first low-voltage hybrid drive, lifting the share of its models available with alternative propulsion from 1% to 8% over three years against a target of 100% by 2030.

Renewable energy for yard operations is applied by 75% of companies (12 of 16), and it is one of the most quantified practices in the sector: eleven of the twelve positives carry a number. This is the practice that acts on the yard rather than the ship. One builder has covered several of its shipyards in Italy with solar panels, has more than doubled in a year the share of its electricity generated on site, and has contracted renewable supply for all its yards on top of that. One naval group reports sourcing wind energy alongside solar energy through power purchase agreements and has begun investing in heat pumps and alternatives to gas heating. One recreational manufacturer runs one plant entirely on biomethane.

Introduction of marine litter

Life cycle assessment of materials and processes is applied by 50% of companies (8 of 16). The method itself spans the whole environmental profile of a product, from energy use to emissions and waste; in this analysis, it is assessed only in its material dimension, as a means of reducing marine litter.

What a ship is built from determines what it sheds while in service and what is left when it is dismantled — coatings, composites, plastics and insulation all reach the sea if they are not designed out or recovered. The builder is the only actor that can still change that choice, and the yard is the point at which its downstream consequences become visible.

One large yard assessed a ship across its full-service life and used the findings to change what it builds with, replacing materials in the hull and the interiors with lower-impact alternatives. A recreational boat group has assessed several of its models against ISO standards and had the work reviewed by outside experts. A naval builder has made the assessment a formal stage of its design process, so that material and design options are compared before a decision is taken rather than after.

It is important to note that, across the eight positive answers, only a few companies report quantified results or concrete outcomes, and none provide evidence of external verification or multi-year data. Moreover, life cycle assessment is an assessment practice rather than a mitigation measure: it produces information about environmental impacts but does not in itself reduce them. Positive change depends on whether the findings are subsequently used to inform decisions and drive changes in products, processes or operations.

Waste management technologies and circular design are applied by 44% of companies (7 of 16). This is the best-evidenced practice in the sector — all seven positives carry a quantitative metric, four carry multi-year data and three carry external verification.

One shipbuilding group co-developed a recyclable thermoplastic resin and built the first commercially produced boat to use it, with a small series now in the water; it also uses bio-attributed polyester and hemp fibre, has set up glass-fibre recycling with industrial partners, and runs an end-of-life scheme that has decommissioned thousands of boats since 2019, lifting its recycling and recovery rate steeply over three years. One commercial yard converts waste resin, rubber and wood into solid recovered fuel supplied to power plants as a replacement for coal and now recycles more than twice the volume it did in 2021. Another sells its steel scrap furnace-ready for direct reintroduction into production. A third recycles the polystyrene packaging that arrives around ship equipment into regenerated ingot, specifically to keep it out of the incinerator and out of the microplastic stream. To learn more about the topic, see the in-depth section below.

Introduction of contaminants

Environmentally responsible coatings and paints are applied by 38% of companies (6 of 16). The practice encompasses two approaches: non-toxic antifouling systems and lower-solvent systems. In this sample, however, the majority of reported cases refer to the use of lower-solvent systems rather than non-toxic antifouling coatings.

One Italian shipbuilding company has substituted low-solvent and water-based products across its production sites and reports its volatile organic compound emissions in absolute terms, with emissions per production hour falling against a 2021 baseline in each of the three years since. One recreational boat group has moved to water-based varnishes and low-styrene resins and rolled out closed-mould injections over more than a decade, cutting contact-resin consumption by an order of magnitude and reducing VOC intensity per thousand hours worked by close to a fifth. In addition, one yard completed performance verification of antifouling paints with a very low content of acutely toxic substances. Another states that it is developing and applying low- and non-toxic antifouling paints, with a target to keep eco-friendly paint above a majority share of use from next year.

Underwater noise and light

Hull and propulsion optimisation is applied by 38% of companies (6 of 16) and is a case of the right technology adopted for a different reason: companies present it as a way to improve energy efficiency and cut fuel consumption, not to reduce underwater noise. Propeller cavitation is the dominant source of radiated underwater noise, and the same hull and propeller work that reduces resistance reduces cavitation, so the practice was scored on the technology whether or not the company connects it to noise.

On the bright side, three of the six companies do make the connection, showing a higher degree of awareness. One yard reports reducing radiated noise by using an air-lubrication system and runs acoustic tanks and structural testing alongside it. Another company took part in an EU-funded project that optimised propeller design and built a real-time self-assessment model, stated in its report, to target noise harmful to cetaceans, applicable to newbuilds and refits. A third has developed radiated-noise monitoring and reduction technologies and delivered the first merchant vessel to receive a classification society's silent notation.

The remaining companies describe the same engineering with no reference to the marine environment — air lubrication, shaft generators, rudder bulbs and controllable-pitch propellers presented as propulsion efficiency, and foils and hull architecture that cut drag, and therefore fuel, by nearly 20% on two models.

Non-indigenous species

Inspection and biofouling maintenance technologies are applied by no company in the sample — the only practice on the list with no positive answers. Thirteen of the sixteen reports do not mention biofouling or hull grooming anywhere.

The reason for these results could be linked to the fact that non-indigenous species travel on hulls and in ballast water of vessels in operation, and both fall to the owner once the ship is delivered. Yards treat the issue as a product specification — supplying the coating and ballast treatment system the client orders — rather than as a pressure of their own, and hull maintenance over a vessel's service life sits outside their boundary entirely. Yet the coating and hull-form choices made at the building stage largely determine how much fouling that vessel could carry for decades.

Cross-cutting

Sustainability and environmental training is reported by 94% of companies (15 of 16), the highest adoption in the sector. Some companies record training hours for employees and subcontractors, with a rising number across three years. One naval builder made an eco-design e-learning module compulsory for several thousand employees across marketing, purchasing and design. Every one of these is an input measure — hours delivered, participants enrolled, modules completed. Not one company reports what changed as a result. Training should be read as a supporting measure that enables other practices rather than as a good practice acting on a pressure in its own right.

Digital twin, simulation and AI, and automation and robotics in the shipyard are applied by 56% of companies (9 of 16). One yard completed a digital-twin platform giving full visual coverage of its work sites, blocks and logistics, with machine learning and an autonomous yard set as milestones later this decade. Other companies apply simulation at a single stage of the build — computational fluid dynamics to optimise hull form and appendages, virtual prototyping and clash detection in 3D models that displace physical mock-ups, production simulation for block assembly sequencing and dock scheduling, or vision-based AI for weld defect detection and predictive maintenance on yard equipment.

OVER HALF OF SHIPBUILDERS USE DIGITAL TWINS, AI AND ROBOTICS, YET RARELY HIGHLIGHT THEIR ENVIRONMENTAL BENEFITS

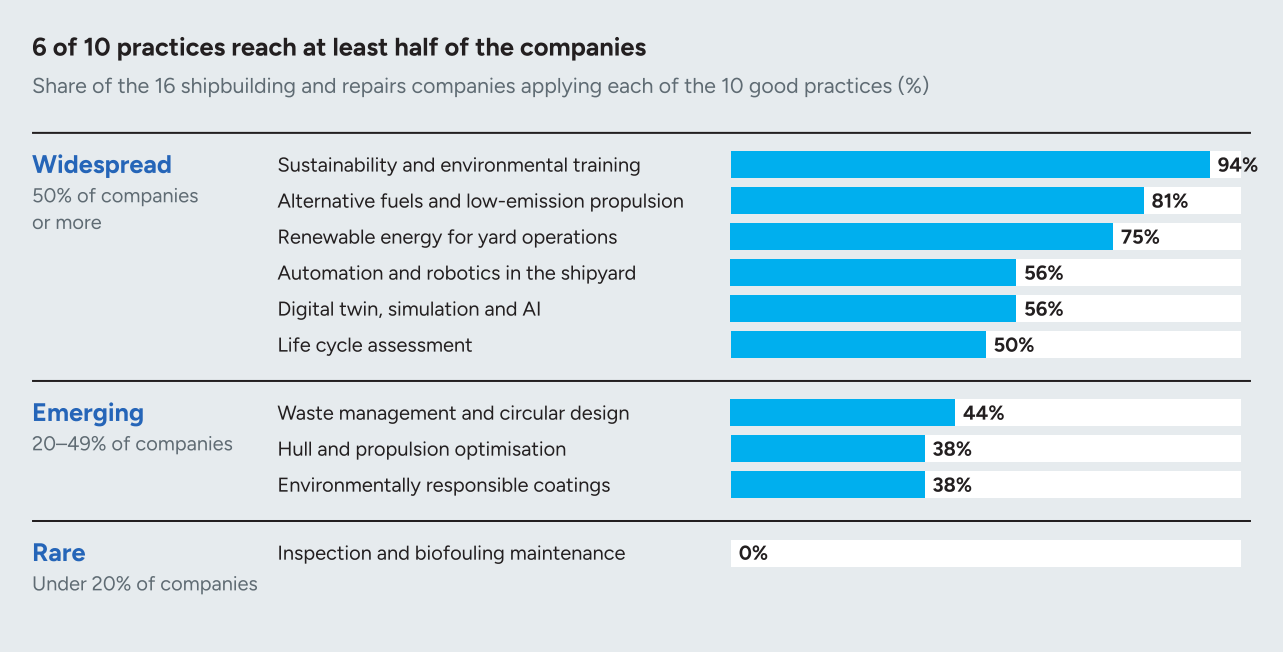
Automation is used at different stages of the shipbuilding process. It is most common in the cutting and welding of steel plates and panels, where companies use automated cutting, robotic welding, and automated marking and edge preparation. One company has developed a small robot that can enter narrow openings and weld inside the closed spaces between the two layers of a double hull. Other companies use magnetic robots that climb on the outside of large hull sections. In surface treatment, robots are used for blasting and spray painting. For heavy work, companies use automated systems to move large hull sections and robots to build pipe sections. Drones and small crawling robots are increasingly used to inspect welds, tanks and the hull, so that workers no longer need to use scaffolding or ropes to reach these areas. One company reports that robotic welding has made its work much more efficient, and it plans to automate almost all of its processes by 2030. Several companies also use exoskeletons (wearable devices that support workers' bodies) and collaborative robots that work safely next to people. However, they present these as measures for worker safety, not for environmental protection.

Six practices are widespread, three are emerging, one has no positive answers

Figure 5.3 ranks all ten practices by the share of companies applying them. Six are applied by half or more of the sample and are shown in dark blue; three sit in an emerging band between 20% and 49%; one is applied by no company. The distribution also reveals a clear concentration of adoption around decarbonisation and operational efficiency, while practices addressing other environmental pressures tend to have lower adoption rates.

ADOPTION OF GOOD PRACTICES IS CONCENTRATED ON DECARBONISATION AND OPERATIONAL EFFICIENCY

FIGURE 5.3 · Adoption of each good practice in shipbuilding and repairs

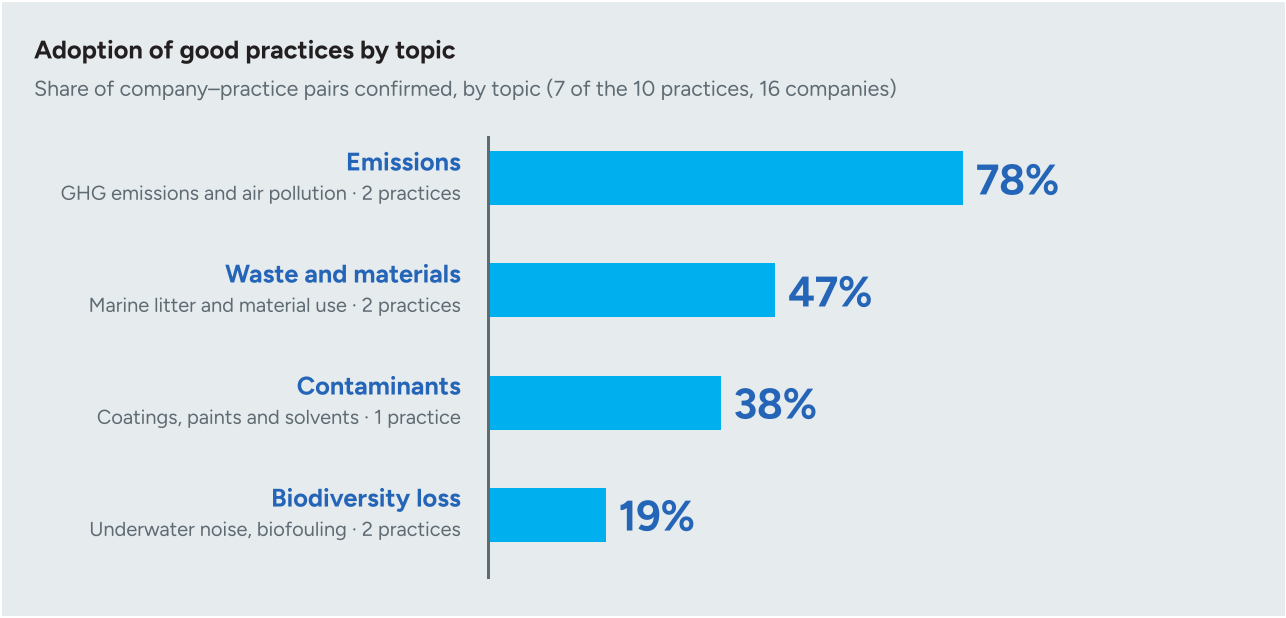


The adoption gap between emissions and biodiversity practices

To offer a view of the results by topic relevant for the protection of the environment, seven of the ten practices were regrouped into four broader topics, scoring each by the share of all companies' positive answers. The three not shown are training, which acts on no pressure directly, and the two shipyard-process practices (digital twin, simulation and AI, and automation and robotics in the shipyard), which do the same. See Figure 5.4.

Emissions lead by a wide margin: 25 of the 32 company-practice answers in that group, or 78%. Their strong position reflects the fact that carbon and air pollutants are comparatively well established in shipbuilding's technical, commercial and regulatory frameworks, with clearer metrics and assessment methods. The builder never burns the fuel, so the savings from an efficient hull or a dual-fuel engine accrue to the buyer over the ship's service life; what returns to the builder is order-book share. Regulation reinforces the demand rather than the supply: efficiency rules, emissions trading and fuel standards apply to the operator, and the operator specifies the ship.

FIGURE 5.4 · Adoption of good practices by topic



The lower adoption of waste and materials practices (47%) suggests that resource efficiency and waste management are recognised issues but are less consistently embedded across companies. Some of these practices are directly connected to shipyard operations and can therefore be addressed through established waste-management systems, material choices and process controls. Contaminants, at 38%, show a similar but somewhat lower level of adoption, with practices such as the use of more environmentally responsible coatings and paints helping to address pollutants released during construction and throughout the vessel's life cycle.

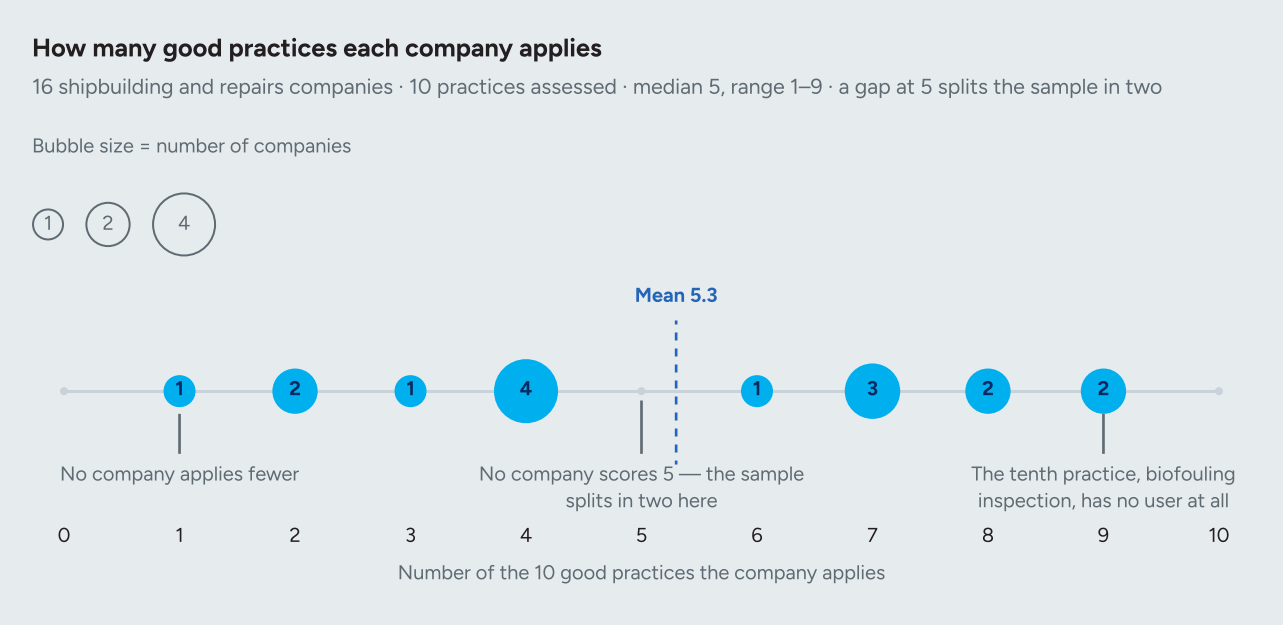
The largest gap is visible for biodiversity loss, where only 6 of the 32 company-practice answers are positive (19%). The practices grouped here address underwater noise and non-indigenous species, impacts that are more closely linked to marine ecosystems than to the shipyard's immediate operational footprint. This makes them harder to translate into conventional production, efficiency or cost metrics. Moreover, many biodiversity impacts materialise after a vessel leaves the shipyard, during its operational life, while responsibility is distributed between shipbuilders, vessel owners, operators and other actors. This can weaken the incentive for shipyards to treat biodiversity as a core design or production priority.

GOOD PRACTICES THAT IMPROVE EFFICIENCY AND REDUCE COSTS TAKE PRIORITY, WHILE THOSE AIMED AT PROTECTING BIODIVERSITY REMAIN LARGELY OVERLOOKED

No leading group, and no company doing nothing

Figure 5.5 shows how many of the ten assessed good practices each of the sixteen companies applies. Each bubble sits at a number of practices on the scale from zero to ten, and its size and label give how many companies are at that point.

FIGURE 5.5 · Good practices per company



The sample is spread fairly evenly across the range rather than bunched at either end. Scores run from one practice to nine, no more than a quarter of the companies sit at any single score, and the mean of 5.3 falls almost exactly at the centre of the scale — with eight companies below it and eight above. The distribution is balanced: there is no leading group pulling away from the rest, and no tail of companies left far behind.

No company scores zero. Every company in the sample applies at least one of the ten practices, so ocean-related practice is nowhere absent. The scope for improvement is therefore distributed across the sector as a whole rather than confined to a small number of underperforming companies: the highest-scoring companies have yet to adopt at least one of the assessed practices, while those at the lower end of the distribution have nonetheless implemented several.



IN DEPTH

Ship recycling and design for end-of-life

Ships have the potential to be entirely recycled after the end of their lifespan. Ship recycling is an important part of sustainable shipbuilding because a vessel's environmental footprint does not end when it leaves service. Ships contain large quantities of valuable materials, particularly steel, as well as equipment, cables, paints, coatings and other substances that can create environmental and safety risks during dismantling. Between 90% and 97% of a vessel's mass leaves the recycling yard as material rather than waste.

ALTHOUGH SHIPS CAN BE FULLY RECYCLED AT THE END OF THEIR LIFESPAN, THEY ARE RARELY DESIGNED FOR DISASSEMBLY, MAKING SAFE AND EFFICIENT DISMANTLING DIFFICULT

The problem has never been whether the material comes back; it is the conditions under which it is extracted, and the fact that almost none of it was ever meant to come apart. Ships are designed for construction and operation. Twenty-five or thirty years later, someone has to reverse that construction with a cutting torch, usually without drawings, often without knowing what is inside the steel they are cutting.

Designing vessels with their eventual dismantling in mind can make materials easier to identify, separate, recover and reuse, while reducing the presence of hazardous substances. A key concept is **design for circularity**: rather than treating recycling as an end-of-life problem, shipbuilders can consider how materials and components will circulate after the vessel is retired. This can increase recovery of steel and other materials, reduce waste and potentially lower the environmental impacts associated with producing new materials.

DESIGN FOR CIRCULARITY IN SHIPBUILDING TREATS RECYCLING AS A DESIGN CHOICE, MAKING MATERIALS EASIER TO IDENTIFY, SEPARATE AND REUSE

Key practices include **material traceability** and maintaining inventories of hazardous substances to ensure that materials can be identified and properly managed throughout the vessel's life cycle. **Modular construction** can facilitate the removal, replacement and recovery of components, while the use of **recycled and recyclable materials** can reduce reliance on virgin resources. Shipbuilders can also minimise hazardous substances in paints, coatings and equipment, and design structures to support efficient **steel recovery and component reuse**. Together, these approaches shift ship recycling from an end-of-life waste issue to a consideration embedded in the vessel's design from the outset.

The important shift is from **"How do we recycle this ship?" to "How do we design the ship so that it can be recycled?"**

5.4 Sector synthesis

1 **The shipbuilding sector has made the strongest progress in decarbonisation and operational efficiency.**

Most companies have adopted alternative fuels, low-emission propulsion systems, renewable energy, and digital technologies to reduce environmental impacts and improve vessel performance. These initiatives are generally driven by regulatory requirements, customer demand, and clear economic benefits.

2 **Sustainability is increasingly being integrated into shipyard operations through technology and new tools.**

Companies widely use digital twins, automation, artificial intelligence, and robotics to improve resource efficiency, reduce waste, and optimise production processes.

3 **Biodiversity considerations are not yet fully embedded in shipbuilding practices.**

Technologies and design solutions that could reduce underwater noise, protect marine habitats, or mitigate ecological impacts are adopted by only a minority of companies. Innovations that do benefit the marine environment are often justified primarily through fuel savings rather than marine conservation benefits.

4 **Future progress will depend on expanding the focus beyond climate change.**

While decarbonisation will remain a priority, shipbuilders have an opportunity to take a broader ocean-health approach by integrating circularity, biodiversity protection, pollution prevention, underwater noise reduction, and non-indigenous species management into vessel design and construction. This would strengthen the sector's contribution to the long-term sustainability of marine ecosystems.



Ports and warehousing

The ports and warehousing industry is the hinge of seaborne trade. Terminals, quays, storage yards, warehouses and inland logistics parks receive, hold and dispatch the cargo that ships carry, and they are where a vessel stops, berths, is loaded and serviced.

The sector is also spatially fixed: a port cannot be moved off the coastline it occupies, and the water it sits in is almost always a sheltered, shallow, biologically productive place — an estuary, a bay, a river mouth — because those are the places that make good harbours. Ports are the place where the sea meets the land. They are closely connected to the cities that grow around them and to the roads, railways and inland waterways that link them to the hinterland, so they can be seen as sea–land ecosystems whose pressures reach both the marine and the land environment.

PORTS CONCENTRATE MULTIPLE PRESSURES, FROM LITTER AND NON-INDIGENOUS SPECIES TO EMISSIONS AND LIGHT POLLUTION

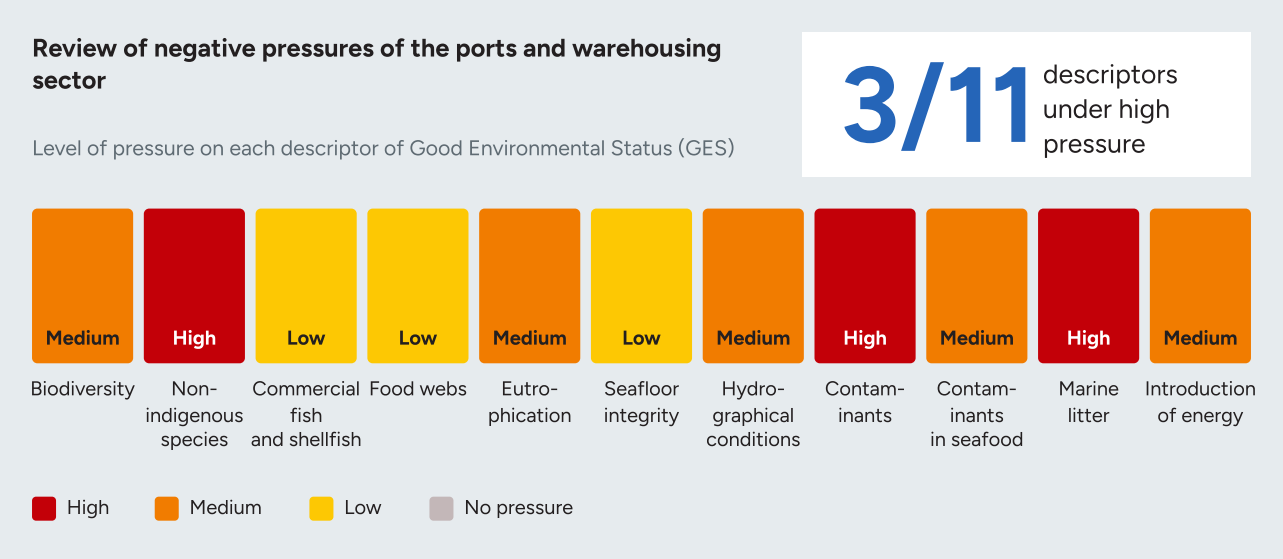
The pressures follow directly from what building and running such a facility requires. Deepening and maintaining an approach channel means dredging: sediment is cut and moved, the benthic community goes with it, fine material is resuspended, and the spoil settles somewhere else on whatever lives there. Expanding a terminal means reclaiming land from shallow water, and driving the piles that carry a quay wall injects some of the loudest impulsive sound that humans make underwater.[1] Day to day, a port is a large impermeable surface draining straight into the basin, so rainfall washes hydrocarbons, tyre and brake particles, metals, bulk cargo dust and nutrients into the water, while wastewater, bilge discharges, hull cleaning and accidental spills add contaminants directly.

[1] One Ocean Foundation. (2024). "Ports and Warehousing Industry Review". Available at: https://www.1ocean.org/news/ports-warehousing-industry-review-its-impact-on-the-ocean-and-possible-solutions

Ports are particularly prone to the accumulation of marine litter, as they intercept waste originating from both land-based sources and maritime activities, and they are also the point of arrival for non-indigenous species travelling on hulls and in ballast tanks. Cargo-handling equipment, heavy vehicles, tugs and hotelling vessels burn fuel continuously in a confined area, and lighting a terminal for night working spills artificial light across the water surface.

The scientific review conducted as part of the Ocean Impact Initiative project, shown in Figure 6.1, identified the most significant potential pressures the sector exerts on ocean health.

FIGURE 6.1 · Pressures of ports and warehousing[2]



Source: Ports and Warehousing Industry Review, One Ocean Foundation, 2024.

Reducing these pressures is the core idea behind the concept of the green port: a port that integrates environmental considerations into its operations and infrastructure to reduce its impacts on the marine and surrounding environment while maintaining efficient economic activity. Becoming a green port does not depend on a single technology. It can be achieved only when several good practices are applied together, such as renewable energy generation, electric cargo-handling equipment, stormwater treatment, marine litter collection, the reuse of dredged material and noise reduction during construction.

For each of the pressures, this report went on to set out the good practices applied by companies in the sector. Table 6.1 lists the practices identified through the OII project and explains what each of them covers.

[2] One Ocean Foundation. (2024). "Ports and Warehousing Industry Review". Available at: https://www.1ocean.org/news/ports-warehousing-industry-review-its-impact-on-the-ocean-and-possible-solutions

6.1 Sample description

Fourteen ports and warehousing companies were assessed against a sector list of fourteen good practices, on the basis of their 2024 sustainability and annual reports. A practice was recorded as applied only where the report describes the company itself using the technology in its own operations; stated ambitions and policies without a described implementation were not counted. Each positive answer was additionally coded for the kind of evidence supporting it: a quantitative metric, a concrete qualitative outcome, third-party verification, and multi-year trend data.

The sample spans the different kinds of business that sit under the ports and warehousing heading: eight port authorities and multi-terminal port groups handling bulk, container and general cargo; three container terminal operators; one integrated port and logistics group that also owns its own dredging fleet; one logistics group whose assets are warehouses and inland parks as well as port terminals; and one regional container shipping line. The list was scored as it stands for every company, including those for which a practice is not part of the business — a warehousing operator does not dredge — so a small number of negative answers reflect the shape of the company rather than a gap in its practice. This is noted where it affects the reading of a result.

14

ports and warehousing companies assessed

14

good practices in the sector list

6.2 The practices assessed

TABLE 6.1 · Good practices in the ports and warehousing industry

Good practice	Definition
GHG EMISSIONS AND AIR POLLUTION	
Renewable energy generation	Generation of electricity from renewable sources within the port or warehouse estate to power operations and reduce reliance on grid and diesel power: rooftop, ground-mounted and canopy photovoltaics, solar arrays integrated into cranes and equipment and wind turbines. Acts on the terminal's own electricity demand, which in an electrified port is the bulk of its energy footprint.
Electric cargo-handling equipment and vehicles	Replacing diesel cargo-handling equipment and road fleets with electric or hybrid alternatives, including cranes, terminal tractors, trucks, forklifts and automated vehicles. Reduces combustion emissions from quay and yard operations closest to the water.
Alternative fuels and more efficient engines	Use of lower-carbon fuels and more efficient propulsion in company vessels, equipment and vehicles, including LNG, ammonia, hydrogen, biofuels, electric and hybrid systems. Reduces emissions from assets that remain in service for decades.
Exhaust filtration and abatement technology	Installation of after-treatment equipment on combustion sources that remain in service: particulate filters, selective catalytic reduction (SCR) and exhaust gas cleaning that reduce NOx, SOx and particulate emissions from combustion sources.

TABLE 6.1 · Good practices in the ports and warehousing industry

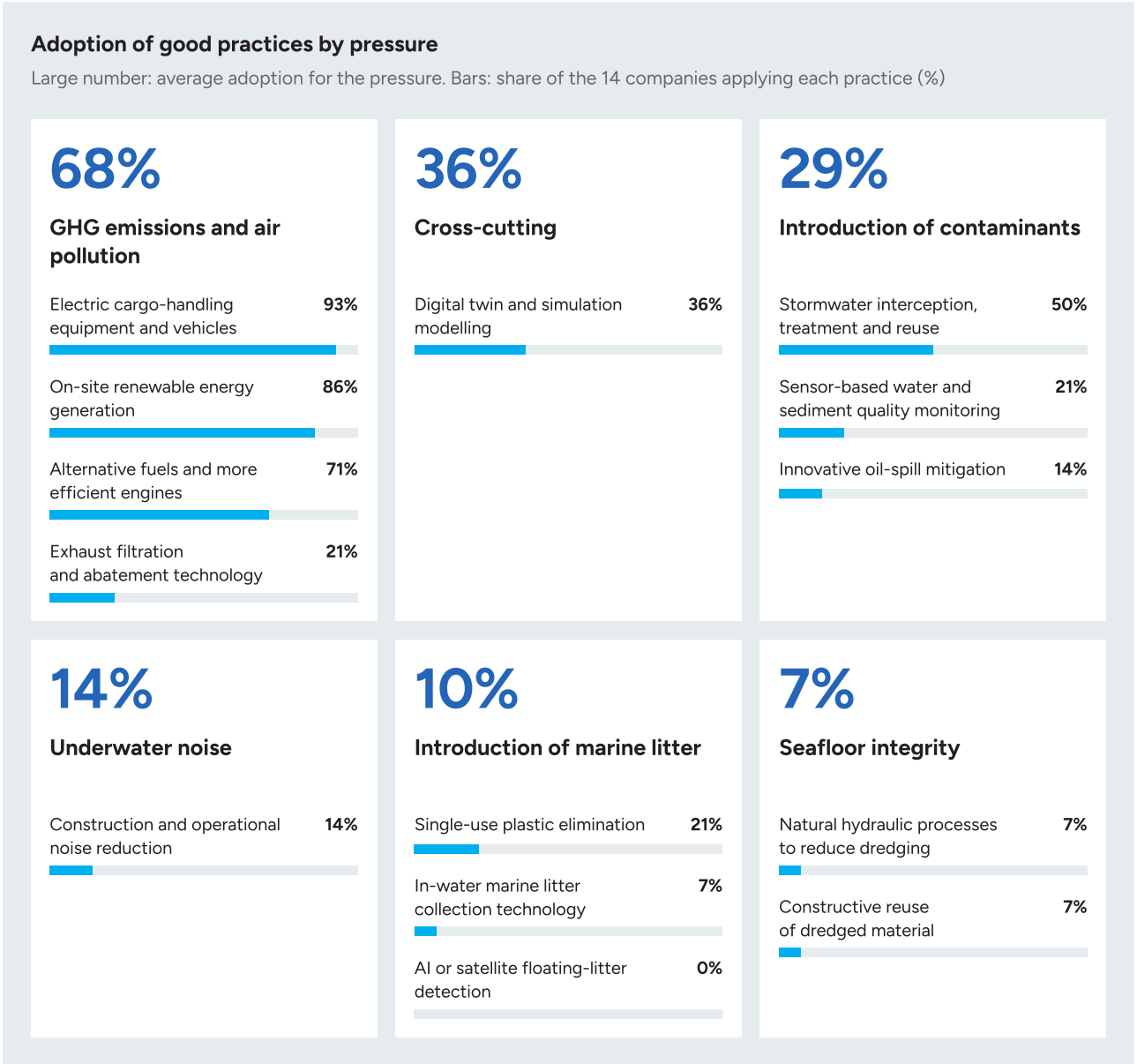
Good practice	Definition
INTRODUCTION OF CONTAMINANTS	
Innovative oil-spill mitigation	Innovative practices for preventing, detecting and containing oil in the water: spill-response hardware such as booms, skimmers and sorbents maintained as a capability, automated or early spill-detection systems, predictive dispersion modelling used to plan response, and technologies for managing chronic oily water from bilges, decks and machinery spaces. Routine oil–water separators are not counted.
Sensor-based water and sediment quality monitoring	Continuous or near-continuous monitoring of marine water, sediment and wastewater quality using sensors and automated leak detection. Measurement is what makes the contaminant practices verifiable.
Stormwater interception, treatment and reuse	Engineered systems that capture runoff from yards, quays and roofs before it reaches the basin and put it back into use: separation and sedimentation devices, smart cisterns and storage tanks, multi-stage treatment, rainwater–sewage separation, and reuse of the treated water. Acts on the first flush, which carries most of the contaminant load.
INTRODUCTION OF MARINE LITTER	
AI or satellite floating-litter detection	Automated detection of floating litter accumulations so that collection can be targeted: AI-powered camera systems on quays, cranes, vessels or drones, satellite and aerial remote sensing. Turns clean-up from an occasional campaign into a measured, repeatable operation.
Single-use plastic elimination	Removal of single-use plastics from port facilities, warehouses and vessels and their replacement with reusable, bio-based or biodegradable alternatives, in packaging, catering, consumables and operational materials. Acts at the point where a port's own consumption becomes the lightweight litter most likely to escape into the water.
In-water marine litter collection technology	Installed technology that removes litter from the water body itself: floating collectors and seabins, eco-barriers and booms placed across watercourses feeding the harbour, microplastic filters, and multi-stage wastewater treatment.
SEAFLOOR INTEGRITY	
Natural hydraulic processes to reduce dredging	Use of hydraulic, hydrodynamic and vegetation-based design to reduce how much sediment has to be removed and how often: water injection and agitation dredging that lets density currents carry material away, training walls and channel geometry that maintain depth by tidal flushing, sediment traps, and vegetated margins that stabilise sediment. Reduces the pressure at source rather than mitigating it afterwards.
Reuse of dredged material	Putting dredged sediment to use for habitat restoration, wetland creation, reclamation, construction or other beneficial purposes instead of sea disposal. Avoids the smothering of benthic communities at a disposal ground and, in its habitat-creating forms, returns some of the ecological function that dredging removes.
UNDERWATER NOISE	
Construction and operational noise reduction	Quieter technology such as bubble curtains, low-noise piling, and scheduling that avoids spawning, migration and other sensitive periods for marine species. Impact piling is the loudest sound a port makes, and it travels far underwater.
CROSS-CUTTING	
Digital twin and simulation modelling	Digital twins and simulations used for environmental planning, dredging and expansion assessment, and for the optimisation of operations and energy use.

6.3 Adoption of good practices

The sector's attention is heavily concentrated on emissions

The fourteen identified practices can be grouped according to the ocean pressure they address. See Figure 6.2. Adoption is highest by a wide margin for GHG emissions and air pollution, where the four practices average 68%, and falls away steeply from there: the cross-cutting digital practice sits at 36%, the three contaminant practices average 29%, underwater noise 14%, marine litter 10% and seafloor integrity 7%. Only one practice outside the emissions group is applied by half the sample.

FIGURE 6.2 · Adoption of good practices by pressure



GHG emissions and air pollution

ELECTRIC CARGO-HANDLING EQUIPMENT IS THE MOST ADOPTED PRACTICE AND THE BEST EVIDENCED, WITH PORTS ELECTRIFYING CRANES, TRUCKS AND CONTAINER-STACKING MACHINES

Electric cargo-handling equipment and vehicles are applied by 93% of companies (13 of 14), the highest adoption in the list and the best-evidenced practice in the sector: twelve of the thirteen cases carry a quantitative metric. One port group in China has electrified the large majority of its annual equipment purchases. It has added several hundred electric container trucks, and almost all of its cranes, container-stacking machines and forklifts now run on electricity. A global operator based in Hong Kong, managing terminals in several countries, now requires all new equipment to be electric, and reports that close to a third of its machines and trucks are already electric or hybrid. One terminal tested a small fleet of electric vehicles for moving and stacking containers over several months, reporting clear greenhouse gas savings compared with diesel vehicles and a fall of about one fifth in total fuel use. One company in Brazil converted part of its cranes to electric power. At a terminal in Australia, another company recovers a meaningful share of its energy from the movement of its cranes: when a crane lowers a container, the energy is captured and reused, in the same way as an electric car recovers energy when braking.

On-site renewable energy generation is applied by 86% of companies (12 of 14); seven mentions carry a metric and three carry multi-year data. The installations vary widely in scale. At the smaller end are distributed rooftop arrays of a few megawatts; at the larger end, solar farms covering several hectares of terminal land, one of them generating enough electricity for shore power, terminal machinery and offices to run on self-generated supply. Several operators have gone beyond roofs and open ground, mounting panels directly on quay and ship-to-shore cranes so that the generation sits on the equipment it powers. The most technically ambitious installation in the sample is a wind–solar–storage–hydrogen integration project developed by one port group. It is fully operational in one of the group's port areas in China, integrating renewable energy generation and storage with a hydrogen refuelling station on the quay.

Alternative fuels and more efficient engines are applied by 71% of companies (10 of 14); four cases carry a metric, one a concrete outcome and one multi-year data. LNG has displaced diesel across the great majority of one operator's in-field container tractors, and another runs a large LNG prime-mover fleet alongside a hydrogen proof-of-concept for horizontal port transport. At a port group in China, hydrogen fuel-cell heavy trucks are moving freight on a dedicated zero-emission corridor. One towage operator in Brazil has delivered a full series of twin-fin hull tugboats whose hull form cuts carbon emissions through greater hydrodynamic efficiency and has begun authorised trials of biodiesel and hydrotreated vegetable oil (HVO). A terminal group reports a sharp rise in ethanol replacing petrol alongside a shift from higher- to lower-sulphur diesel.

At least three of the ten cases rest on pilots, design intent or facilitation rather than fuel the company itself burns. One is a carrier stating that new vessels are designed to accommodate alternative fuels. One is a terminal operator welcoming other companies' LNG-powered vessels to its berths: the first LNG-powered container vessel to dock at its terminal in Manila, the Philippines, and the first LNG-powered box ship to call in Brazil. One is a 50% fee discount offered to LNG-fuelled callers — a real incentive, but the fuel is burned by someone else.

Exhaust filtration and abatement technology is applied by 21% of companies (3 of 14): diesel particulate filters and selective catalytic reduction retrofitted to the engines of conventional equipment at one terminal in Busan, South Korea; mandated organic exhaust gas recovery plus spray suppression, windbreak nets and mist cannons against particulates at a bulk port in Ningbo-Zhoushan, China; and, the best-evidenced example, a company with exhaust gas cleaning systems on a number of its vessels bringing sulphur emissions well below the IMO limit and selective catalytic reduction on several ships rated highly efficient on nitrogen oxides. For terminal operators, the answer to a diesel engine is to remove it, not to filter it, and after-treatment retrofits compete for the same capital as electrification and lose. Abatement therefore concentrates where combustion cannot be designed out and a marine emissions rule applies.

Introduction of contaminants

Stormwater interception, treatment and reuse is applied by 50% of companies (7 of 14) and is the only practice outside the emissions group that half the sample applies; the majority of good practice cases carry a quantitative metric or a concrete outcome, and one carries multi-year data. The engineered systems described are substantial. One bulk port in Qinhuangdao, China, has built a chain of storage and sedimentation tanks in which the black water generated by coal loading passes through multi-stage sedimentation and overflow into a settlement basin, emerging as clear water that is then reused for road spraying; the port reports capturing the runoff of a single heavy rainfall in one event and saving the cost of the recycled water it would otherwise have bought. Another port group in Jingjiang and Nanjing, China, separates rainwater from sewage, runs both through sedimentation and reuse tanks and returns the reclaimed water to greening and firefighting, reporting zero discharge of wastewater from the port area. A terminal operator in Brazil treats and reuses the water from equipment supply and washing and returns treated grey water to its buildings, with total water reuse rising steadily across three years.

Sensor-based water and sediment quality monitoring is applied by 21% of companies (3 of 14). One port in China maintains online monitoring stations for wastewater and has built its own ecological environment control system to collect and analyse the data.

Another has fitted round-the-clock automatic testing at its sewage treatment plants and runs a smart water platform across its supply network, which identified a substantial number of leakage points and led to meters and sections of ageing pipe being replaced; the local ecology and environment bureau and water authority regularly sample those plants' inlets and outlets, which is the verification. The third is a terminal in Salvador, Brazil, monitoring reservoir levels, consumption and leaks remotely. What matters is what these systems watch. All three monitor the pipe: effluent, consumption, reservoir level, leaks, and not the harbour. Ambient marine water and sediment quality sensing is confirmed for no company in the sample.

Innovative oil-spill mitigation is applied by 14% of companies (2 of 14). One operator deployed tugboats, dispersants and booms to arrest and treat a spill following a vessel collision at one of its terminals in Singapore. The other models oil-slick dispersion numerically, using climate and oceanographic variables to map vulnerable areas and plan response: a useful capability, and an important starting point, although it does not detect or collect oil in the water. The sector therefore has response equipment and predictive modelling; however, there is still room for more innovative and technological spill detection tools. Moreover, no report describes a technology for chronic oily water — the everyday bilge, deck drainage and machinery-space oil that cumulatively contributes a larger load to a harbour than the rare catastrophic spill. Routine oil–water separators were excluded from the definition as standard compliance equipment rather than innovative practice.

Introduction of marine litter

Single-use plastic elimination is applied by 21% of companies (3 of 14), with one quantitative metric among them. One terminal group runs a named plastic phase-out across its facilities in Santos, Guarujá and Vila do Conde, replacing plastic cups with biodegradable alternatives and promoting reusable bottles. One warehousing company in Singapore has substituted bio-based for fossil-based plastic packaging materials, worked on biodegradable packaging and replaced plastic bags with paper fillers and gum tape, reporting that one client's order process now uses no plastic at all. The third is a ports division replacing single-use disposables with durable and reusable alternatives through green procurement.

Marine litter collection technology is applied by only one company (7%). The single positive is an eco-barrier installed across the São Jorge river, which feeds an estuary, to intercept floating waste before it reaches the port basin; the company reports both the mass of waste removed and a substantial fall in accumulated waste. It reached the water through a sponsored multi-stakeholder initiative rather than as the company's own port infrastructure.

Another company in Tianjin, China, addresses litter as an activity rather than technology: dynamic clean-up along the coastline, harbour basin and navigation channels, removal of floating garbage near terminals, volunteer beach and seabed clean-ups in Singapore and Jordan. The distinction matters — a campaign removes what has accumulated and stops when the volunteers go home, whereas an installed barrier or filter works continuously and produces a measurable mass.

AI or satellite floating-litter detection is applied by no company in the sample — the only practice on the list with no positive answer at all. Machine vision pointed at a container is routine in this sector; machine vision pointed at the water is nowhere. The obstacle is neither the technology nor its cost, both of which the sector has already absorbed for cargo. The main reason appears to be that no regulator, customer or reporting standard currently requires a port to state how much floating litter passes its quays, and, as a result, no port has yet built a system to produce this figure.

Seafloor integrity

The two good practices linked to seafloor integrity are each applied by only one company in the sample (7%).

The single positive related to **natural hydraulic processes to reduce dredging** is a water injection dredger, operated as part of a company-owned dredging fleet for the regular maintenance dredging of its port at Hazira, India. The technique fluidises sediment in place so that natural density currents carry it away rather than being cut, lifted, transported and dumped. In relation to the **reuse of dredged material**, the company's reuse is quantified and substantial, running to tens of millions of cubic metres of capital dredged material used to reclaim backup area at its ports and to thousands of hectares reclaimed by the fleet to date.

Dredging is the largest recurring physical intervention a port undertakes in the sea, and thirteen of fourteen companies describe no technique for reducing it or for putting its material to use. Four reports do not mention dredging at all. Where it does appear, it appears as something that happens to the company rather than something the company designs: a cost line in a climate-risk table, where heavy rainfall causes siltation and increases dredging costs; a depth figure for a navigation channel; a permit condition accompanied by rescue and monitoring of aquatic biota around the works.

DREDGING, THE LARGEST INTERVENTION A PORT UNDERTAKES IN THE SEA, IS MENTIONED ONLY BY A FEW COMPANIES

Underwater noise

Construction and operational noise reduction is applied by two companies in the sample (14%). One port in China describes a fully enclosed belt-conveyor corridor at its Shenqiu Port, designed to block the noise transmission path, and separately plans construction at its Jingjiang Port to avoid the migration periods of some sensitive species. The other company purchases low-noise equipment, modified gantry crane alarms, vehicle speed limits and replanned yard layout — together with avoidance of peak spawning periods for fish, shrimp and crab during underwater construction.

No bubble curtain, no noise-attenuation sleeve, no soft-start or low-noise piling method appears in the sample of the reports analysed. The seasonal-avoidance component is the sector's only genuine underwater-noise mitigation, and it is a scheduling decision rather than a technology.

Cross-cutting

Digital twin and simulation modelling is applied by 36% of companies (5 of 14); not one of the five cases carries a quantitative metric or a concrete outcome. The five twins are real systems — predictive simulation for operational planning and a second twin optimising truck traffic and waiting time inside a terminal; digital twin technology within an equipment health platform predicting failures; twins embedded in a control platform integrating energy, operations and carbon emissions, and used with AI recognition for safety management at a port group in Tianjin, China; and a smart-product matrix built around a port operating system for terminal production and equipment control. This practice was assessed with a deliberately broadened definition, agreed for this report, admitting twins built for operational and energy optimisation alongside those built for environmental simulation.

Non-indigenous species

Three further practices on the original ports list address the introduction of non-indigenous species — onboard ballast water treatment, modern antifouling hull coatings, and sensor-based biofouling monitoring with robotic hull cleaning. All three were assessed across the sample, and none was confirmed for any company. They are recorded here but excluded from the fourteen practices in Table 6.1 and from the figures, because they are attributes of the visiting vessel rather than of the port, and they are assessed in full in Chapter 4, Maritime transportation. The exclusion should not be read as the pressure being irrelevant to ports: a port is precisely where a hull and a ballast tank arrive, and the sheltered, warm basin they arrive into is where an introduced species establishes. The port's levers are different from the ship's — ballast reception and treatment facilities, in-water cleaning with capture so that removed biofouling is contained rather than released at the berth, monitoring of the basin for new arrivals, and the conditions attached to a berth booking. None of these appears in the fourteen reports either.

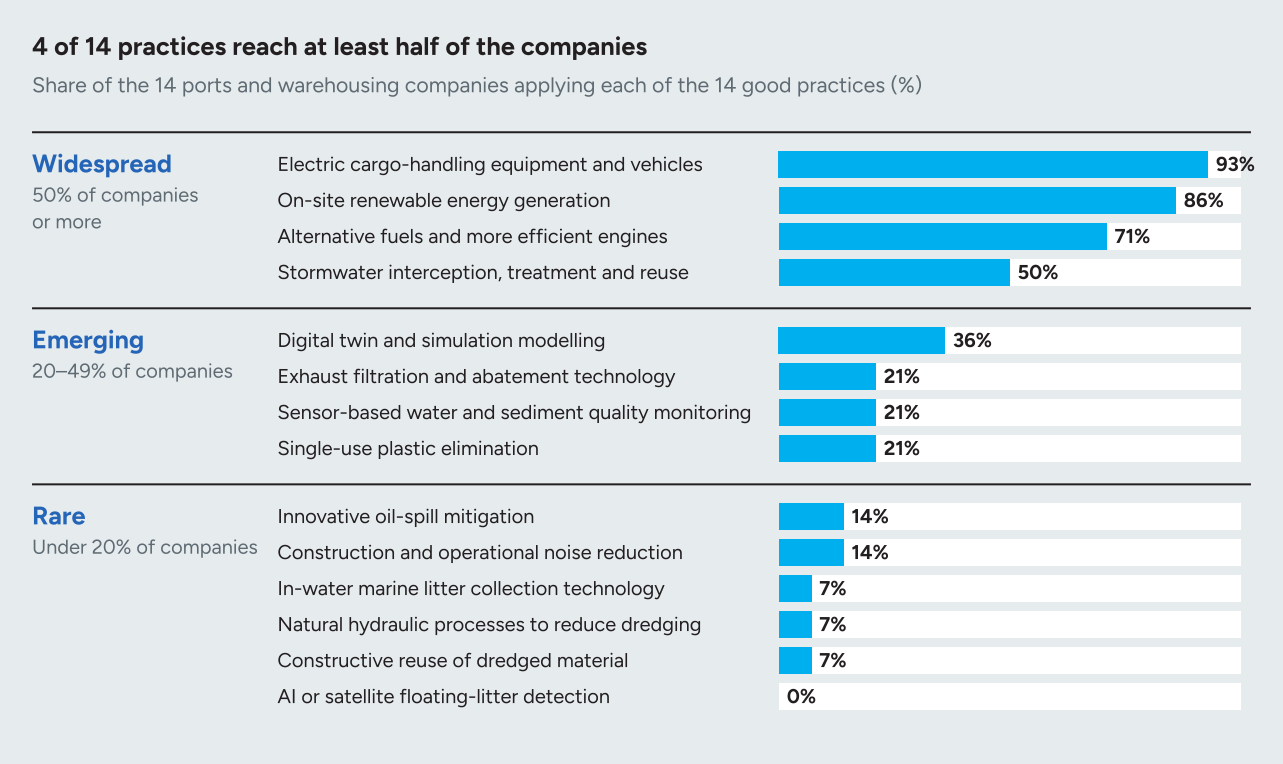
Four practices are widespread, four are emerging, six are rare

Figure 6.3 ranks all fourteen practices by the share of companies applying them. Four are applied by half or more of the sample and are shown in dark blue; four sit in an emerging band between 20% and 49%; six are applied by fewer than one company in five, including one with no user at all. The distribution spans the full range, from 93% to zero.

Relatively mature practices linked to energy, equipment and emissions are already widespread, whereas practices requiring more specialised technologies, monitoring systems or direct intervention in marine impacts remain at an early stage. The absence of adoption for AI/satellite floating-litter detection is particularly notable given that the same sector is already using digital technologies such as digital twins and simulation. This suggests that digitalisation is present, but its application is not yet consistently directed towards monitoring or reducing marine environmental pressures.

ENERGY PRACTICES ARE MATURE AND WIDESPREAD; NEW PRACTICES REQUIRING SPECIALISED TECHNOLOGY OR DIRECT MARINE MONITORING REMAIN FAR BEHIND

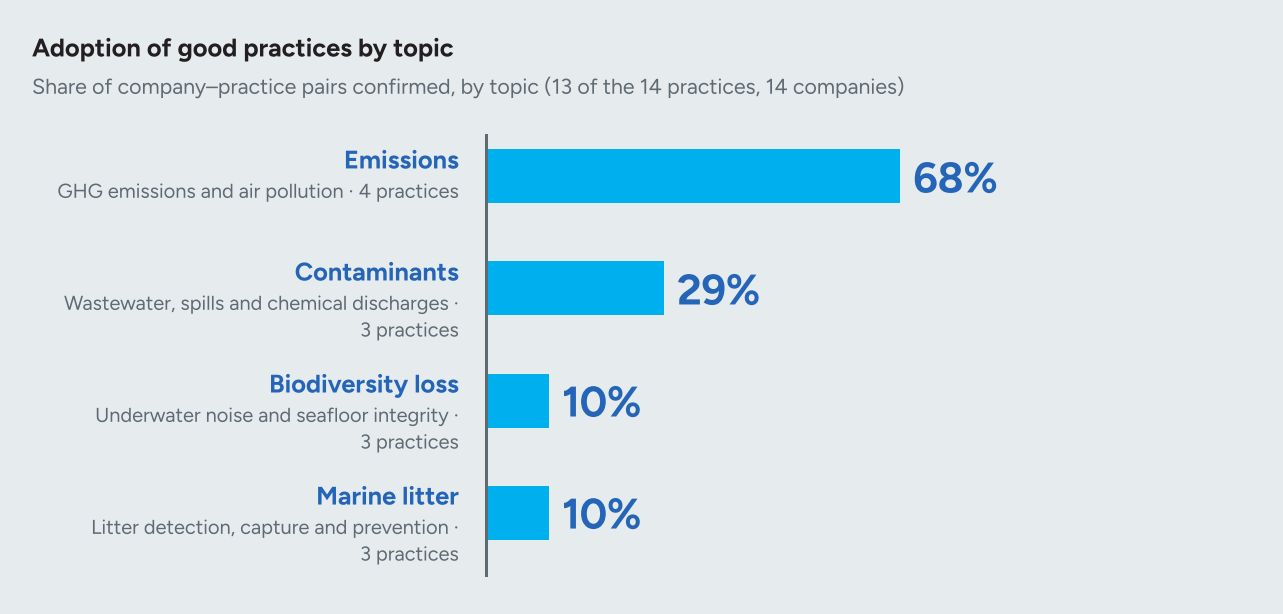
FIGURE 6.3 · Adoption of each good practice in ports and warehousing



The adoption gap between emissions and the physical marine pressures

Thirteen of the fourteen practices were regrouped into four broader topics, scoring each by the share of all companies' good practice cases. The one not shown is digital twin modelling, which acts on no pressure directly. See Figure 6.4.

FIGURE 6.4 · Adoption of good practices by topic



Emissions lead by a wide margin: 38 of the 56 company-practice cases in that group, or 68%. Their position reflects how well established the reporting infrastructure for carbon and air pollutants now is. Emissions therefore appear to be the environmental pressure for which companies have developed the broadest and most established set of responses.

The gap becomes substantial for the other topics. Contaminants, covering wastewater, spills and chemical discharges, are addressed in 29% of cases, less than half the adoption rate of the emissions practices (68%). Contamination from a port is chronic, diffuse and hard to attribute to a single operator sharing a basin with shipping lines, a city and a river catchment, which makes it precisely the kind of pressure no individual company is under pressure to measure.

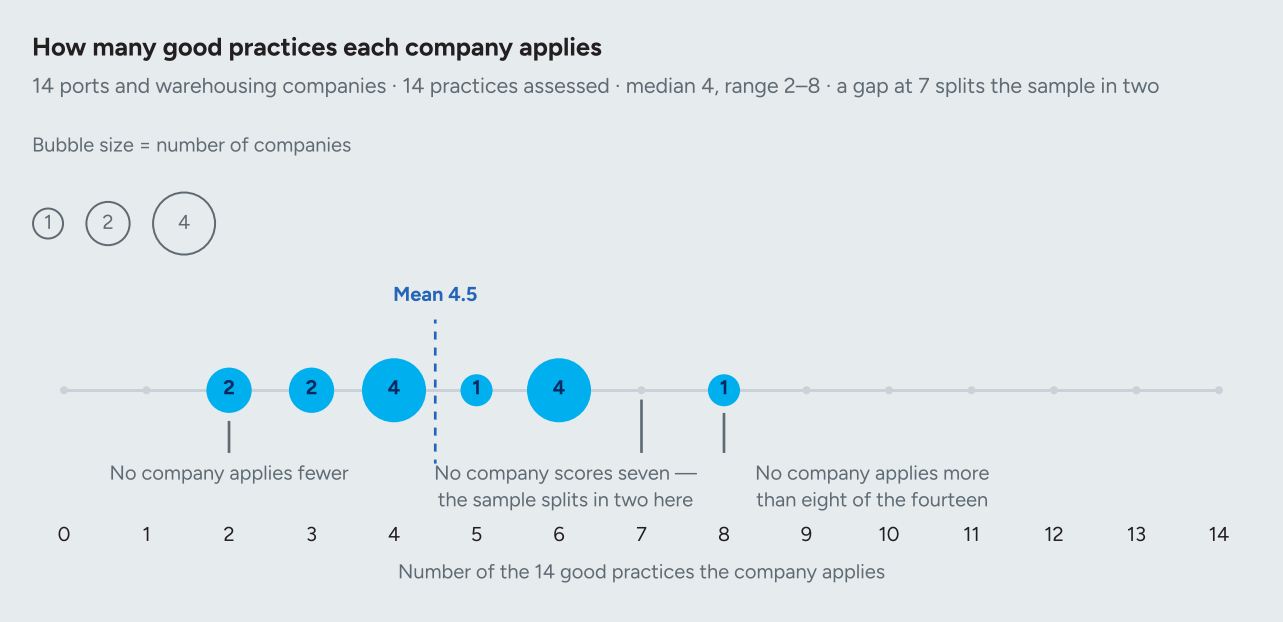
CONTAMINANT PRACTICES LAG BEHIND EMISSIONS, AS BASIN-WIDE POLLUTION IS DIFFICULT TO ATTRIBUTE TO INDIVIDUAL COMPANIES

The largest gaps are on the physical and biological pressures. Seabed and noise practices are confirmed in 4 of 42 cases, or 10%, and marine litter in 4 of 42, or 10%. These are the pressures a port causes most directly and most exclusively — nobody else dredges its channel, drives its piles or lines its quays with the material that becomes floating litter — and they are the ones least addressed. The impacts are often delayed, spatially diffuse, difficult to attribute and, critically, largely unpriced. No established mechanism systematically assigns a cost to a hectare of benthic habitat smothered, an hour of piling-related underwater noise, or a tonne of plastic released from port operations. Where environmental impacts are not priced, incentives to measure them remain weak; and where they are not measured, they are less likely to be identified, managed or reported as sustainability practices.

The sample is divided into two groups

Figure 6.5 shows how many of the fourteen assessed good practices each of the fourteen companies applies. Each bubble sits at a number of practices on the scale from zero to fourteen, and its size and label give how many companies share that score.

FIGURE 6.5 · Good practices per company



Scores run from two to eight, with a mean of 4.5 and a median of four, and the distribution has a clear gap: four companies sit at four, one at five, four at six, then nothing at seven before a single company at eight. The sample divides into a lower group of nine companies applying between two and five practices and an upper group of five applying six or more, and the division tracks how much of the physical port estate a company owns and operates. The upper group are asset-owning port and terminal groups with their own generation, equipment fleets, water infrastructure and, in one case, dredging vessels.

No company scores zero, and no company scores more than eight. Every company applies at least two of the fourteen practices, so ocean-related practice is nowhere absent; equally, the best performer in the sector leaves six of fourteen unaddressed. The scope for improvement is distributed across the whole sample rather than concentrated in a laggard tail, and the practices the leaders are missing are, with few exceptions, the same ones the rest of the sample is missing.



IN DEPTH

Port dredging and its impact on the seabed

DREDGING REMOVES SEABED HABITATS, RESUSPENDS SEDIMENTS AND CAN RELEASE CONTAMINANTS

Dredging is what allows a port to remain accessible to the vessels it serves. As ships have become larger, many ports have had to deepen navigation channels, turning basins and berths beyond the depth that would occur naturally. At the same time, rivers and coastal processes continuously bring sediment back into these areas. Dredging is therefore not a one-time intervention: in many ports, it is a recurring activity that maintains the depth required for navigation and operations.

The environmental implications begin with the seabed itself. Seabed sediments are not simply an inert layer at the bottom of the sea. They provide habitat for organisms living on and within the sediment and form part of wider coastal and marine ecosystems. Dredging removes this material, disturbing or eliminating the habitats present in the area being excavated. The process can also resuspend fine sediments in the water column, temporarily increasing turbidity and potentially transporting contaminants that have accumulated in the sediment over time. The consequences depend heavily on the location, sediment characteristics, dredging method and frequency of the intervention.

What happens to the material once it has been removed is therefore an important part of the environmental footprint of dredging. Depending on its characteristics and local requirements, it may be reused for land reclamation, habitat creation or shoreline nourishment, while unsuitable material may require treatment, confinement or disposal.

This creates a particularly important connection between port infrastructure and the wider coastal environment. A port may report that dredging is carried out safely and in compliance with applicable requirements, while the broader ecological effects of repeated seabed disturbance may remain difficult to capture in conventional sustainability reporting. Physical intervention is clear; its cumulative ecological consequences can be much harder to measure.

Dredging also illustrates a broader challenge in assessing the environmental performance of ports. The depth of a navigation channel is a precise operational parameter, while the ecological condition of the seabed is more complex. Changes in benthic communities, sediment quality, habitat structure or the movement of contaminants may occur over different timescales and across areas extending beyond the immediate dredging site. As a result, the environmental dimension of maintaining navigable waters can be less visible than the operational benefit it enables.

DREDGING PRESSURES CAN BE REDUCED BY AVOIDING CRITICAL PERIODS AND HABITATS, USING LOW-RESUSPENSION METHODS AND MONITORING WATER AND SEDIMENT CONDITIONS

There are several good practices that can help reduce the impact of dredging. These include careful planning to avoid critical periods and habitats, using dredging methods that minimise sediment resuspension, monitoring water and sediment quality during operations, and identifying beneficial uses for suitable dredged material. Post-dredging monitoring can also help assess whether seabed habitats are recovering and whether additional measures are needed.

6.4 Sector synthesis

1 **The sector's response to ocean pressures is concentrated almost entirely on emissions.**

Across the fourteen assessed practices, 63 of 196 company-practice pairs were confirmed, an overall adoption rate of 32%. Within that, the four GHG and air pollution practices account for 38 of 56 cases, or 68%, while the three contaminant practices reach 29%, the seabed and noise practices 12% and the marine litter practices 10%. Ports are decarbonising at a visible and measurable pace and addressing their physical and biological impacts on the sea at a fraction of it.

2 **Dredging, the largest recurring physical intervention a port undertakes in the sea, is addressed by only one company in the sample.**

This company owns its own dredging fleet. Its reuse of 30 million m^3 to 42 million m^3 of dredged material is land reclamation; no company evidences the habitat-creating uses the practice names. Four reports do not mention dredging at all, and where it appears, it appears as a cost or a permit condition rather than a method the company chooses.

3 **Monitoring and digital capabilities are more advanced than marine-specific applications.**

Over a third of companies use digital twins and simulation tools to optimise operations, energy efficiency, and asset management. However, these technologies are rarely applied to monitor marine environmental pressures, with no company reporting the use of AI or satellite-based floating-litter detection.

4 **Contaminant management shows moderate progress but remains focused on operational infrastructure.**

Stormwater treatment and water reuse systems are relatively well established, making them the only non-emissions practice adopted by half of the sample. In contrast, more advanced approaches such as ambient water-quality monitoring and innovative oil-spill technologies remain limited, indicating a focus on compliance and efficiency rather than broader ecosystem monitoring.

5 **Sector leaders are distinguished by ownership and control of physical assets, but substantial gaps remain.**

Companies that own and operate port infrastructure, equipment fleets, energy systems, and water networks generally implement a wider range of good practices. Nevertheless, even the strongest performers address only a portion of the assessed practices, highlighting significant opportunities for the entire sector to expand efforts on marine litter, underwater noise, biodiversity, and seafloor protection.



Fishing and aquaculture

Fishing and aquaculture are the two main activities through which aquatic food is produced: capture fisheries harvest wild populations, while aquaculture farms fish, shellfish and algae in cages, ponds, tanks and on lines, whether offshore, along the coast or inland.

FISHERIES AND AQUACULTURE REACHED RECORD PRODUCTION IN 2024, WHILE THEIR ACTIVITIES HAVE POTENTIAL TO DEPLETE WILD STOCKS, DISTURB SEABED AND RELEASE CONTAMINANTS

According to the latest Food and Agriculture Organization of the United Nations (FAO) data, global fisheries and aquaculture production reached a record 235 million tonnes in 2024, of which 195 million tonnes were aquatic animals and 40 million tonnes were algae.[1] Aquaculture produced 103 million tonnes of aquatic animals, 53% of aquatic animal production, having overtaken capture fisheries.[2] The sector employs about 65 million people in primary production and supports the livelihoods of more than 600 million.[3] The two activities are also tightly linked in the value chain: a large part of the fishmeal and fish oil that feeds farmed fish is made from wild-caught small pelagic species and from the trimmings of fish processing. Moreover, several of the largest seafood groups operate across both wild-capture fisheries and aquaculture. Therefore, in this report, the two are treated as a single industry.

However, the way the sector harvests seafood at sea and farms it shapes the pressures it exerts on the ocean. For fishing, the main pressure concerns the depletion of commercial fish and shellfish stocks: rising demand and increasingly efficient technologies have led to extraction at often unsustainable rates, with consequences that extend across marine food webs.[4]

[1] Food and Agriculture Organization (FAO). (2026). "In Brief to The State of World Fisheries and Aquaculture 2026". Available at: https://www.fao.org/publications/fao-flagship-publications/the-state-of-world-fisheries-and-aquaculture/en

[2] Ibidem

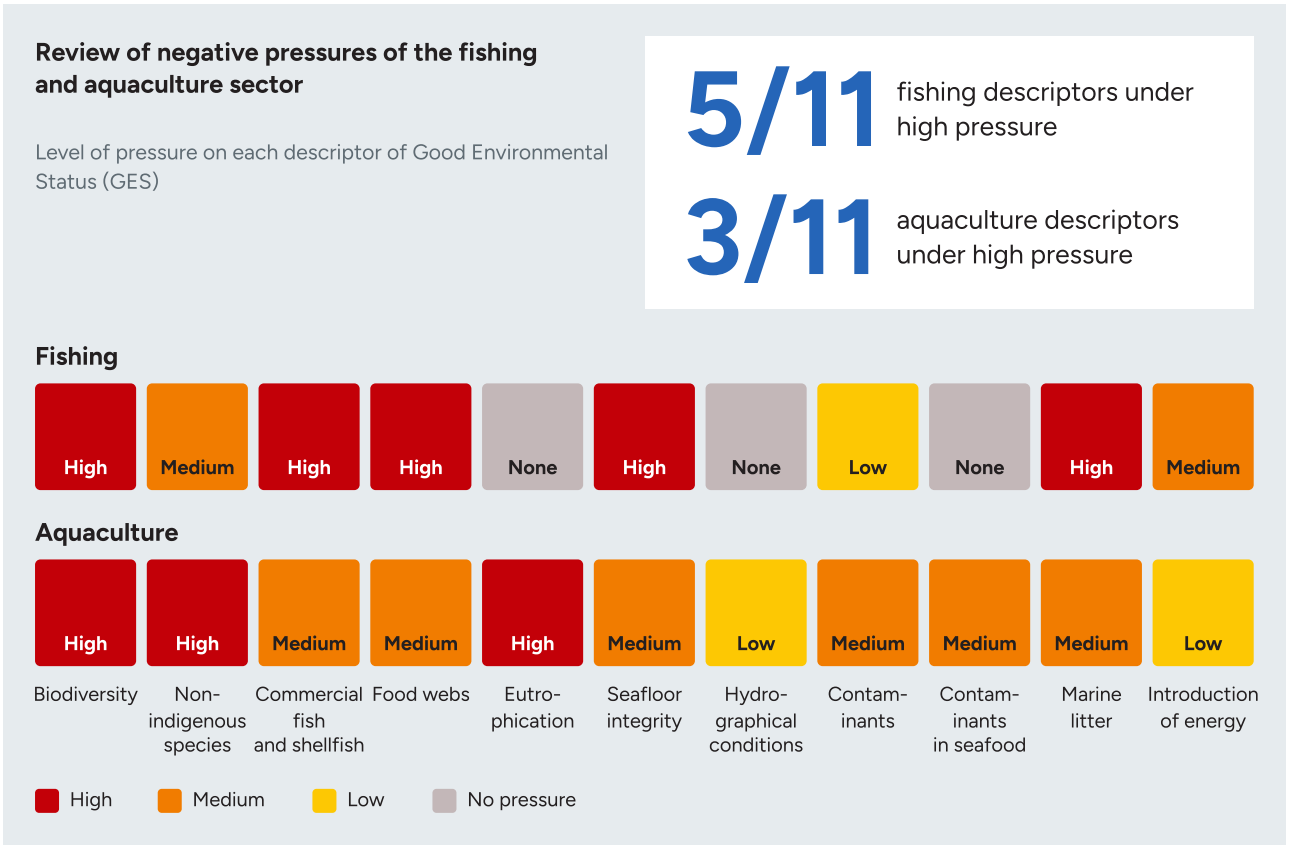
[3] Ibidem

[4] One Ocean Foundation. (2023). "Fishing Industry Review". Available at: https://www.1ocean.org/news/new-industry-review-on-the-fishing-sector-is-out

Furthermore, bottom trawls and dredges compromise seafloor integrity and the communities living on the seabed, while lost and abandoned nets become ghost nets that continue to catch fish, turtles and marine mammals. Bycatch (the accidental catch of species that were not targeted, much of which is thrown back into the sea dead or dying) and the fuel burned by fishing fleets add further pressure. Aquaculture, on the other hand, exerts pressure in a different way, which also depends on whether farms are located offshore, along the coast or inland. The construction of farms can lead to the loss of coastal habitats, and escaped farmed fish can compete with wild populations, spread parasites and diseases, and weaken wild populations genetically through interbreeding. In addition, faeces and uneaten feed release nutrients that can drive eutrophication, while antibiotics and antifouling paints may introduce contaminants that harm marine organisms.[5] Finally, fed aquaculture still relies on fishmeal and fish oil made from wild forage fish, linking its pressures back to the wild stocks targeted by capture fisheries.

The scientific review conducted as part of the Ocean Impact Initiative (OII) project, shown in Figure 7.1, identified the most significant potential pressures the sector exerts on ocean health.

FIGURE 7.1 · Pressures of fishing and aquaculture[6]



Source: Fishing Industry Review, One Ocean Foundation, 2023.
Source: Aquaculture Industry Review, One Ocean Foundation, 2023.

[5] One Ocean Foundation. (2023). "Aquaculture Industry Review". Available at: https://www.1ocean.org/news/new-review-dedicated-to-the-aquaculture-industry-is-out

[6] One Ocean Foundation. (2023). "Aquaculture Industry Review". Available at: https://www.1ocean.org/news/new-review-dedicated-to-the-aquaculture-industry-is-out; One Ocean Foundation. (2023). "Fishing Industry Review". Available at: https://www.1ocean.org/news/new-industry-review-on-the-fishing-sector-is-out

For each of these pressures, this report went on to set out the good practices applied by companies in the sector. Table 7.1 lists the practices identified through the OII project and explains what each of them covers.

7.1 Sample description

Eleven fishing and aquaculture companies were assessed against a sector list of twenty-one good practices, on the basis of their 2024 sustainability and annual reports. A practice was recorded as applied only where the report describes the company itself using the technology in its own operations; stated ambitions and policies without a described implementation were not counted.

The sample spans a range of seafood business models, including salmon farming groups covering the production chain from hatcheries to processing and, in some cases, feed production. It also includes companies combining fishing fleets with aquaculture and fishmeal and fish oil production, alongside a wild-capture fishing and processing group and a diversified seafood company active in deep-water fishing and mussel cultivation. Because fishing and aquaculture are treated as one industry, every company was scored against the full list, including practices that sit outside its own business (e.g. a salmon farmer operates no fishing gear, and a wild-capture group operates no fish cages). Most of the companies are based in three main regions: Northern Europe, South America and Oceania, while one is based in Southern Africa. The analysis is not carried out by region, but regional differences are pointed out where they help to explain the results.

11

fishing and aquaculture companies assessed

21

good practices in the sector list

7.2 The practices assessed

TABLE 7.1 · Good practices in the fishing and aquaculture industry

Good practice	Definition
GOOD PRACTICES IN THE AQUACULTURE INDUSTRY	
GHG EMISSIONS AND AIR POLLUTION	
Deforestation-free and low-footprint feed	Sourcing terrestrial feed ingredients, above all soy, that are certified deforestation- and conversion-free and replacing high-emission inputs with lower-footprint alternatives such as fishery trimmings and by-products. Feed is the main source of greenhouse gas emissions in fed aquaculture, whether fish are farmed at sea or on land, because these emissions come mostly from growing and processing the feed ingredients.
On-site renewable and hybrid energy	Renewable generation and hybrid or battery energy systems at farm sites, feed barges, hatcheries and processing plants: solar panels, small hydropower and connection of sea sites to shore power.
INTRODUCTION OF CONTAMINANTS AND EUTROPHICATION	
Water-quality sensing and remote monitoring	Networks of water-quality sensors, oceanographic buoys, remote sensing, satellite data and dispersion models used to follow the environmental conditions and discharge footprint of a farm site and to select sites where currents disperse organic waste. It makes pressures measurable in time to act on them.
Integrated multi-trophic aquaculture (IMTA)	Farming a fed species, such as finfish, together with species that use its waste: seaweeds that absorb dissolved nitrogen and phosphorus, and filter and deposit feeders such as mussels, sea cucumbers or polychaete worms that consume particulate organic matter, supported where possible by nutrient-flow modelling. Turns part of a farm's nutrient discharge into a harvestable crop.
Precision feeding technology	Camera-, hydrophone- and sensor-based detection of appetite and of uneaten pellets, automated and AI-supported feeding systems and centralised remote feeding centres. Matches feed to the fish's appetite, so that less uneaten feed sinks to the seabed or dissolves into the water.
Aquaponics and automated nutrient cycling	Systems that recover the nutrients in aquaculture wastewater and use them within the same production system: aquaponics, in which plants grow on fish effluent, and sensor-controlled nutrient-recycling units. Close the nutrient loop instead of discharging it.
NON-INDIGENOUS SPECIES	
Digital escape monitoring and contingency tools	Technology for preventing, detecting and responding to escapes from open-water farms: underwater cameras, remotely operated vehicle (ROV) inspections of nets and moorings, acoustic and biomass sensors, and simulation of escape-response plans.
Closed containment and recirculating systems (RAS)	Land-based recirculating aquaculture systems and closed or semi-closed containment at sea, with automated control of water quality. Places a physical barrier between farmed stock and the wild environment, preventing escapes, limiting the exchange of parasites and pathogens and allowing effluent to be collected and treated.
EXPLOITATION OF FISH STOCKS AND FOOD WEBS	
Novel feed proteins and oils	Replacing fishmeal and fish oil from wild forage fish with novel ingredients: insect meal, single-cell proteins from bacteria, yeast or fungi, algal oils and other emerging raw materials. Reduces the dependence of fed aquaculture on the small pelagic fish at the base of marine food webs.
CROSS-CUTTING	
Digital traceability platform	Digital platforms giving lot-level chain of custody from feed ingredients and broodstock through farming and processing to the customer. Makes the origin of marine and terrestrial feed ingredients verifiable and underpins every sourcing commitment.
Life cycle assessment (LCA) tools	Life cycle assessment software, databases and methods used to quantify environmental footprints across production stages, from feed ingredients to the finished product. Shows where in the value chain the environmental load sits and which intervention would reduce it most.

TABLE 7.1 · Good practices in the fishing and aquaculture industry

Good practice	Definition
GOOD PRACTICES IN THE FISHING INDUSTRY	
GHG EMISSIONS AND AIR POLLUTION	
Hybrid and electric vessel propulsion	Hybrid-electric or fully electric propulsion in fishing vessels, workboats and service vessels. Cuts fuel combustion and, with it, emissions of CO_2, nitrogen oxides and particulates, as well as engine noise, in coastal waters.
Route optimisation and fuel tracking	Fuel-reduction technology in transport operations: route-optimisation and logistics-planning software and remote monitoring of vessel fuel use. Reduces the fuel burned per tonne of product moved from the sea to the market.
EXPLOITATION OF FISH STOCKS AND FOOD WEBS	
Selective and low-impact fishing technology	Gear and equipment that target the intended species and size and reduce unwanted catch: species-selective nets, bird-scaring lines and exclusion devices, shoal detection that allows sets to be chosen, and electronic monitoring of catches on board. Lowers the bycatch of juvenile fish, seabirds, marine mammals and other protected species.
Stock assessment models and AI catch forecasting	Data-driven fishery management operated by the company: stock-assessment models, AI-based catch forecasting and analytics on catch and effort data. Helps keep fishing effort within what a stock can sustain.
Acoustic deterrent devices (pingers)	Acoustic pingers fitted to nets to warn marine mammals away from fishing gear. Reduces the entanglement and death of dolphins, porpoises and whales in fishing nets.
SEAFLOOR INTEGRITY	
Low seabed-contact and modified gear	Gear modifications that reduce contact with the seabed: raised footropes, sorting grids, semi-pelagic or float trawls and sensors that monitor seabed contact in real time. Reduces the abrasion and sediment resuspension caused by bottom-towed gear.
Habitat mapping to avoid sensitive areas	Satellite data, geographic information systems and seabed habitat mapping used to identify sensitive and protected habitats, spawning grounds and protected-species areas, so that fishing grounds and farm sites can be kept away from them.
MARINE LITTER AND WASTE	
Waste treatment technology	Named technology for treating waste and effluent on board fishing vessels and at onshore facilities (processing plants and hatcheries), such as wastewater purification, dissolved air flotation, filtration of hatchery wastewater and on-board waste processing. Keeps organic matter, oils and solids out of the sea.
Recycling and circular-economy technology	Technologies that turn discards, by-products and used materials into new inputs: rendering of offcuts, trimmings and mortalities into fishmeal, oil, silage, biogas and fertiliser, and recycling of end-of-life nets, ropes and buoys into new products. Reduces both waste and the demand for new raw materials.
Gear and infrastructure tracking and recovery	Tracking and recovery of fishing gear and farm infrastructure at risk of loss: GPS trackers and smart buoys, equipment registers, traceability of moorings and floating equipment, lost-gear retrieval and escape panels for non-target species.

Feeding practices

Feed is one of the most important sustainability topics for the fishing and aquaculture industry. It connects the two activities, since the fishmeal and fish oil used in fish farming are produced from wild-caught forage fish and from fish processing by-products, and it is the source of several pressures at once: the exploitation of wild fish stocks and of the food webs that depend on them, greenhouse gas emissions from the production of terrestrial feed ingredients such as soy, and the release of nutrients from uneaten feed and faeces. For this reason, the good practices related to feeding do not form a single group in Table 7.1 but are assessed under the pressures they address.

7.3 Adoption of good practices

Escapes and emissions are widely addressed, wild stocks and the seabed are not

ADOPTION IS HIGHEST WHERE ACTION PROTECTS THE COMPANY'S OWN STOCK AND COSTS, SUCH AS PREVENTING FISH ESCAPES IN AQUACULTURE, AND LOWEST FOR WILD FISH STOCKS

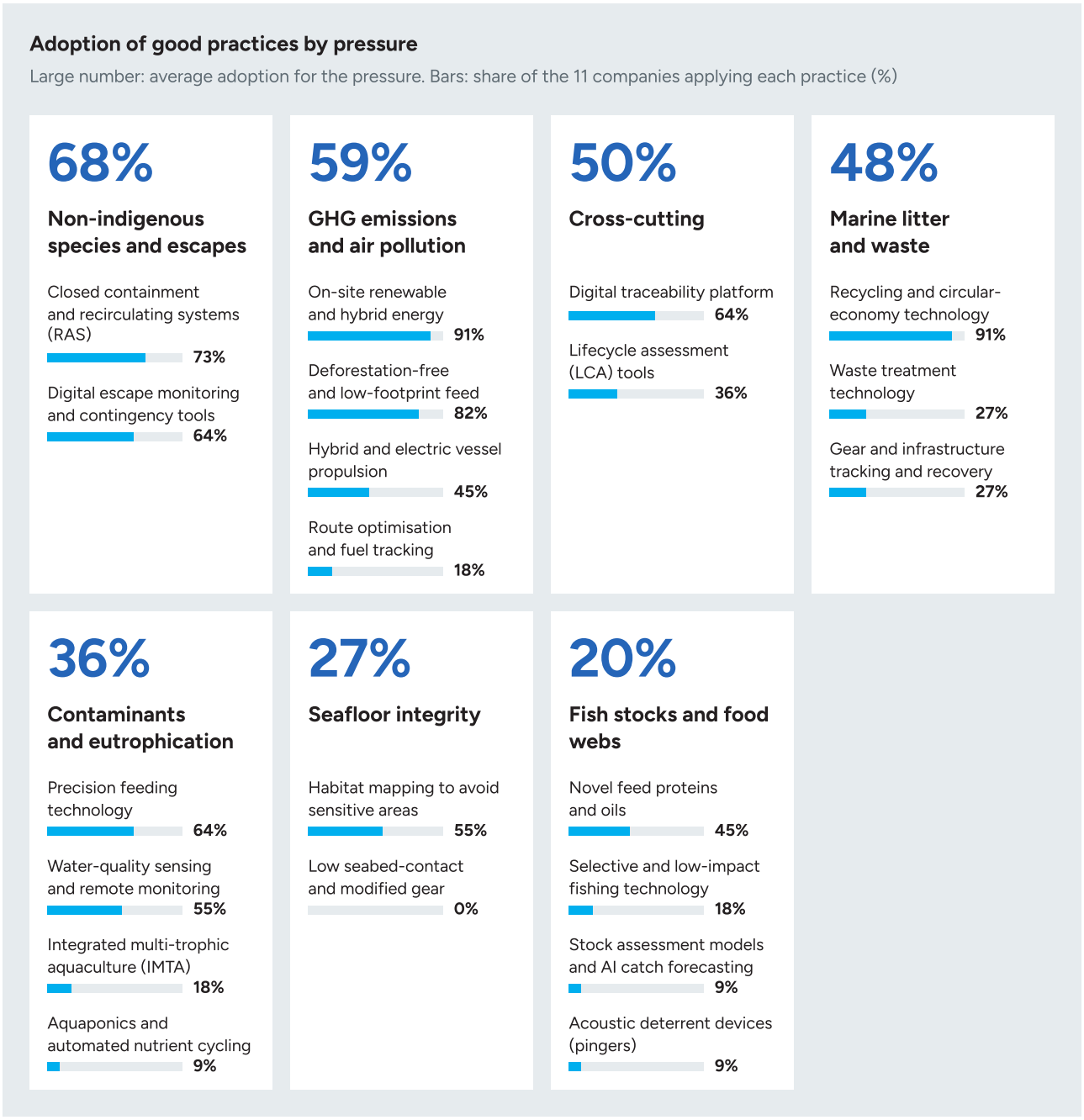
The twenty-one practices can be grouped according to the ocean pressure they address (Figure 7.2). Adoption is highest for non-indigenous species and escapes, where the two practices average 68%, followed by GHG emissions and air pollution at 59%. The two cross-cutting practices have an average adoption rate of 50%, followed by marine litter and waste at 48%, and contaminants and eutrophication at 36%. Adoption is lower for seafloor integrity, at 27%, and lowest for the exploitation of fish stocks and food webs, at 20%.

Unlike the industries discussed earlier, where corporate action tends to concentrate on emissions, the highest adoption in this sector concerns pressures that are also closely tied to production and operational risk. Escaped fish represent both lost stock and a potential licensing risk, while energy efficiency is directly linked to operating costs. At the opposite end of the spectrum are the two pressures most directly associated with the sector's interaction with the wider marine ecosystem: the removal of fish from wild populations and disturbance of the seabed. The pattern suggests that adoption is strongest where environmental action aligns with immediate commercial or operational interests, and weakest where the benefits primarily accrue to the shared marine environment rather than to the individual company.

Non-indigenous species and escapes

Closed containment and recirculating systems (RAS) are applied by 73% of companies (8 of 11); six answers carry a quantitative metric, mostly the share of water that is recirculated or the reduction in freshwater withdrawal. The dominant form is the land-based RAS hatchery producing juvenile salmon, in which the great majority of the water is filtered, treated and reused under automated control of oxygen, temperature and pH.

FIGURE 7.2 · Adoption of good practices by pressure



Several companies also report farming larger juvenile salmon in closed or semi-closed containment at sea, or using submersible and shielded cages, and indicate fewer treatments against sea lice, a common parasite of farmed salmon, as a result. The practice is best understood as a production technology with an environmental co-benefit: a larger juvenile grown on land spends less time in open cages, where it is exposed to parasites and where escapes occur. The qualification is that containment covers the early part of the life cycle. The later growing phase at sea, in which fish are largest and most numerous and escapes matter most for wild populations, still takes place predominantly in open net cages. Recirculating systems are reported by companies in each of the three main regions, but most clearly in Northern Europe and South America, where juvenile production on land in freshwater is the established model.

Digital escape monitoring and contingency tools are reported by 64% of companies (7 of 11). What companies describe is largely physical and procedural: regular net inspections by remotely operated vehicles, reinforced nets and moorings, cage designs chosen with a weather-risk matrix, and escape contingency plans required by regulation. Underwater cameras are widespread; they are used to monitor fish welfare, biomass and parasites such as sea lice. One company's digital tool identifies the farm of origin of an escaped fish only after the event. Escapes continue to be reported by several companies. The mitigation pathway is nevertheless direct: an escape that is detected early can be stopped at a small hole rather than a failed cage, and every fish that stays in the cage is one fewer to interbreed with wild salmon or carry parasites to them. The high score of this pressure family should therefore be read with care, as it reflects containment of juveniles and routine inspection more than a technological answer to escapes from sea cages. The clearest regulatory reference comes from Northern Europe, where escape-proof standards for sea sites and land-based hatcheries are set in national law and verified by independent assessors; the practice is also reported in South America and Oceania.

GHG emissions and air pollution

ON-SITE RENEWABLE ENERGY AND RECYCLING ARE THE MOST ADOPTED PRACTICES IN THE SECTOR

On-site renewable and hybrid energy is applied by 91% of companies (10 of 11), jointly the highest adoption on the list and one of the best evidenced: eight of the ten positive answers carry a quantitative metric and six carry multi-year data. The most common form is the hybrid energy system on a feed barge, in which a battery bank takes over from the diesel generator for much of the day, together with the connection of sea sites to shore power so that the generator is needed only as a back-up. Several companies report that a large and rising share of their active sea sites now run on hybrid systems or on shore power. Other companies report solar panels installed on processing plants on land, feed mills and hatcheries, in one case with battery storage large enough to cover most of a plant's electricity demand; one hatchery is supplied directly by a small hydroelectric plant, which has sharply reduced its diesel use; and one company recovers energy with turbines placed in the seawater return pipes of its facilities. The practice is reported in all three main regions, but the most detailed accounts of installed systems and connected sea sites come from Northern European farming groups, where the connection of sites to shore power is also described.

Deforestation-free and low-footprint feed was confirmed for 82% of companies (9 of 11), and it is the best-verified practice in the sector: seven of the nine positive answers carry third-party verification, because the soy used in feed is certified under external deforestation- and conversion-free standards.

Most farming companies now report that all the soy in their feed is certified in this way, and several also describe replacing whole wild fish with trimmings and by-products from fish processing, lowering the marine-ingredient dependency of their feed and, in some cases, reporting a measured reduction in feed-related emissions over several years. Because feed ingredients are traded globally, the same certification schemes are reported by companies in all three main regions.

Hybrid and electric vessel propulsion is applied by 45% of companies (5 of 11), but the score says more about aquaculture than about fishing. Three of the five positive answers concern the aquaculture service fleet: fully electric and hybrid workboats that travel short distances between a farm base and its sea sites, where short and regular trips are well suited to battery power. One company reports a new fishing vessel with diesel-electric propulsion, which combines a diesel engine with electric motors. Another reports hybrid energy systems at its farm sites and sets electric vessels as a future target. Another fishing group states that there is currently no effective alternative to conventional propulsion for its seagoing vessels, and the boats that transport live fish remain fuel-powered throughout the sample.

Route optimisation and fuel tracking appear in the reports of 18% of companies (2 of 11). One company describes optimised road and air freight routes supported by supply-chain planning tools; another uses remote monitoring of vessel fuel consumption together with logistics changes that cut transhipment. More companies report a modal shift, moving fresh product from air to sea freight or from road to rail. This brings a real and sometimes large emissions benefit but is a change of transport mode rather than a routing technology and was not counted. No company describes route optimisation for fishing trips, where search time and steaming distance determine most of the fuel burned.

Introduction of contaminants and eutrophication

Precision feeding technology is reported by 64% of companies (7 of 11). The systems described are advanced: underwater cameras that detect uneaten pellets and slow the feeders, hydrophones that listen for the sound of feeding activity, AI-supported autonomous feeding, and centralised remote feeding centres from which a team controls feeding across many sea sites. However, six of the seven answers carry no evidence of any type. Feed-conversion ratios (the amount of feed needed to produce one kilogram of fish) are reported, but companies attribute them to feed composition and general management rather than to the feeding technology, and at least two positive answers rest on remote centralised feeding without confirmed sensor-based detection of appetite. The practice acts at the source of the nutrient pressure: feed that is not eaten sinks to the seabed beneath the cages or dissolves into the water, and each pellet saved is organic enrichment avoided. Its adoption can be attributed mainly to economics, since feed is the highest operating cost in the farming of fed fish, such as salmon.

Water-quality sensing and remote monitoring is applied by 55% of companies (6 of 11); three answers carry third-party verification, through independent surveys of the seabed and certification audits. Several companies transmit real-time measurements of oxygen, salinity and temperature from sensors on their cages, at several depths, directly to the environmental regulator. Others deploy oceanographic buoys in the lakes where juveniles are farmed, use hydrodynamic and dispersion models to predict the impact on the seabed and choose sites where currents disperse organic waste, draw on satellite eutrophication data, and monitor effluent at the discharge points of their hatcheries. Much of this monitoring is required by regulation or motivated by fish health, and sampling of the seabed beneath the cages, performed by third parties under national standards, was not counted as a sensor technology. Monitoring is the foundation of every contaminant practice, but on its own it measures the pressure without reducing it.

Integrated multi-trophic aquaculture (IMTA), in which fish are farmed together with seaweed and shellfish that use their waste, was confirmed for two companies in the sample (18%). One company is developing restorative seaweed farming, in partnership with a conservation organisation, in a region where it also farms salmon; the other is investigating the co-farming of salmon and shellfish. Neither describes seaweed or shellfish grown alongside fish cages at commercial scale, and a further company that has explored kelp and mussels for the same purpose, and another that holds seaweed licences linked to its salmon sites, were not counted. Every other farming company in the sample describes single-species farming. The practice is examined in more detail in the in-depth section at the end of this chapter.

Aquaponics and automated nutrient cycling is applied by only one company in the sample (9%). The single positive answer is an aquaponics partnership at a juvenile production facility, in which nutrients extracted from the wastewater are to be used to grow plants before the water returns to the facility. Elsewhere, nutrient recovery takes place away from the farm: sludge, silage and organic waste are sent to biogas plants, composting and fertiliser production. That recovery is counted under recycling below. This contrast is a notable finding in itself: the sector appears to treat nutrients as a waste stream to be valorised elsewhere, not as a resource to be cycled within the production system.

Marine litter and waste

Recycling and circular-economy technology is applied by 91% of companies (10 of 11), jointly the highest adoption on the list; eight cases carry a quantitative metric, and five carry multi-year data. The sector has a long tradition of using the whole fish: offcuts, trimmings and viscera are rendered into fishmeal and fish oil, returned to feed or sold to the pet-food and livestock industries; mortalities are ensiled and converted into biodiesel; and sludge from hatcheries is digested into biogas and fertiliser. The newer and more ocean-relevant part is the recycling of farm and fishing materials.

Several companies report sending large volumes of end-of-life nets to specialised recyclers that turn the nylon into new products, in one case after switching to copper-free nets to make full recycling possible, and others reuse or compost discarded buoys and recover plastics. This high level of adoption can be attributed to the market value of by-products; at the same time, a net that is recycled cannot become ghost gear.

Waste treatment technology was confirmed for 27% of companies (3 of 11). The positive answers describe purification systems at onshore processing plants, dissolved air flotation for wastewater treatment, and filtration of hatchery wastewater before discharge. The score is low because the practice was assessed on named technology only: most companies describe waste-management plans, sorting, recycling rates and licensed disposal, which is sound management but not a specific innovative treatment technology.

Gear and infrastructure tracking and recovery is applied by 27% of companies (3 of 11). One farming company fits GPS trackers to its larger floating equipment and keeps equipment registers and is the only company in the sample that reports a result: a large reduction over several years in the marine debris attributed to its operations. The other two cases rest on a policy of retrieving lost fishing gear and on the pilot of an exclusion device that lets dolphins, whales and sharks escape from nets, delayed during the reporting year. No company describes tracking its fishing gear at sea with smart buoys or acoustic tags. For fishing companies, this is the practice closest to the marine-litter pressure they cause most directly, and it remains largely a matter of policy, denoting significant room for improvement.

Seafloor integrity

Habitat mapping to avoid sensitive areas is reported by 55% of companies (6 of 11). Most of the positive answers concern farm siting: companies screen and map their sites against protected areas, key biodiversity areas and other sensitive habitats using biodiversity assessment tools, map spawning grounds and vulnerable species around potential new sites, and survey seagrass, reefs and sediment fauna with remotely operated vehicles. For fishing, the mapping of sensitive grounds such as seamounts is carried out by the fisheries authority rather than by the company. Five of the six cases therefore come from farming operations, and the practice is applied to the seabed beneath fish cages far more than to the fishing grounds for which it was written. The reference frameworks that companies name are those of their home jurisdictions, such as European protected-area networks and national protected-area law in Northern Europe, so what counts as a sensitive area differs from one region to another, and the results are not directly comparable.

Low seabed-contact and modified gear is reported by no company in the sample, the only practice on the list with no positive answer. One fishing group names the adoption of float trawling to reduce fuel use and seabed impact, but without confirming that it is in use; pelagic purse-seine fleets touch the bottom little by design but describe no modification aimed at the seabed.

Bottom-towed gear is one of the most widespread physical disturbances of the seabed, and the technologies that reduce it, from raised footropes to semi-pelagic doors and contact sensors, are well established. Their absence from every report is one of the clearest gaps identified in this chapter and, since these technologies are well established, also one of the clearest opportunities for improvement.

Exploitation of fish stocks and food webs

Novel feed proteins and oils are reported by 45% of companies (5 of 11); three answers carry a quantitative metric, and two carry third-party verification. The ingredients in use are algal oils that partly replace fish oil, insect meal and oil, single-cell proteins, and other emerging raw materials. In every case, they make up a small share of the feed; one case rests on trials with very low purchased volumes. Most of the reduction in the sector's dependence on wild fish has been achieved by other means: fishery trimmings, and plant and land-animal proteins, which reduce the pressure on forage fish but move part of it to land. The practice matters for the ocean because the small pelagic species used for fishmeal and fish oil feed seabirds, marine mammals and larger fish; every tonne replaced by an ingredient grown outside the sea is a tonne left in the marine food web. Adoption appears to be held back by cost and by supply: novel ingredients remain more expensive than conventional ones and are not yet produced at the volumes the feed industry requires.

Selective and low-impact fishing technology is applied by two companies in the sample (18%). One fishing group reports having fitted bird-scaring lines across its fleet, together with a very large reduction in seabird deaths, the only quantified bycatch result in the sample; another reports operating purse-seine vessels with advanced shoal-detection equipment that allows the target school to be identified before the net is set. No company describes electronic monitoring of catches on board, the technology that makes bycatch visible in the first place.

Stock assessment models and AI catch forecasting were confirmed for only one company in the sample (9%). The single case rests on satellite-based quota management and participation in national fisheries research, supported by an external certification of the fishery. Other fishing companies take part in the scientific working groups of their fisheries authorities, commission reports on the status of the stocks they fish, or review catch and effort data. AI-based catch forecasting appears nowhere in the sample.

Acoustic deterrent devices are applied by one company (9%), and this single case concerns deterrence at fish farms, where lasers and predator nets keep birds and marine mammals away from the cages, rather than pingers on fishing nets. No company describes acoustic pingers on fishing gear. Marine-mammal interactions are reported mainly by farming companies, which manage them with physical exclusion nets, and seabird bycatch by fishing companies, which manage it with bird-scaring lines.

Taken together, the four practices in this pressure group reach 20% (9 of 44 company-practice pairs, i.e. 4 practices × 11 companies), a figure lifted by novel feed ingredients, which are applied by farming companies. The three practices that act directly on wild stocks reach only 12% (4 of 33 answer pairs). Part of this reflects the composition of the sample, since seven farming companies operate no fishing fleet.

Cross-cutting tools: traceability is widespread; life cycle assessment is not

Digital traceability platforms are reported by 64% of companies (7 of 11); five answers carry third-party verification through chain-of-custody certification. Companies trace each product by lot or tracing code back through processing and farming to the broodstock, and in several cases trace every feed ingredient to its origin; one company runs an integrated online system that consolidates all production data, from inputs and treatments to harvest. Several positive answers rest on a certified chain of custody with digital records rather than on a named platform, and no company uses blockchain. Traceability does not reduce pressure by itself, but it is what makes the deforestation-free and marine-ingredient commitments above verifiable.

Life cycle assessment tools are applied by 36% of companies (4 of 11), but none of them reports a measured result of using the tool, such as a change in operations or a smaller footprint after the assessment. The tools in use are water footprints calculated according to the life-cycle-based ISO standard across hatcheries, sea sites, processing plants and feed, and emission factors for feed drawn from life-cycle databases. For most companies, the life-cycle perspective enters through third-party emission factors in a greenhouse-gas inventory rather than through a product LCA of their own. LCA is the tool that would show whether a switch in feed, energy or production system actually lowers the total footprint or merely moves it elsewhere, which makes its limited use significant for a sector whose main footprint lies upstream in feed.

Nine practices are widespread, five are emerging, seven are rare

Figure 7.3 ranks all twenty-one practices by the share of companies applying them. Nine are applied by half or more of the sample and are shown in dark blue; five sit in an emerging band between 20% and 49%; seven are applied by fewer than one company in five. The distribution spans the full range, from 91% to zero.

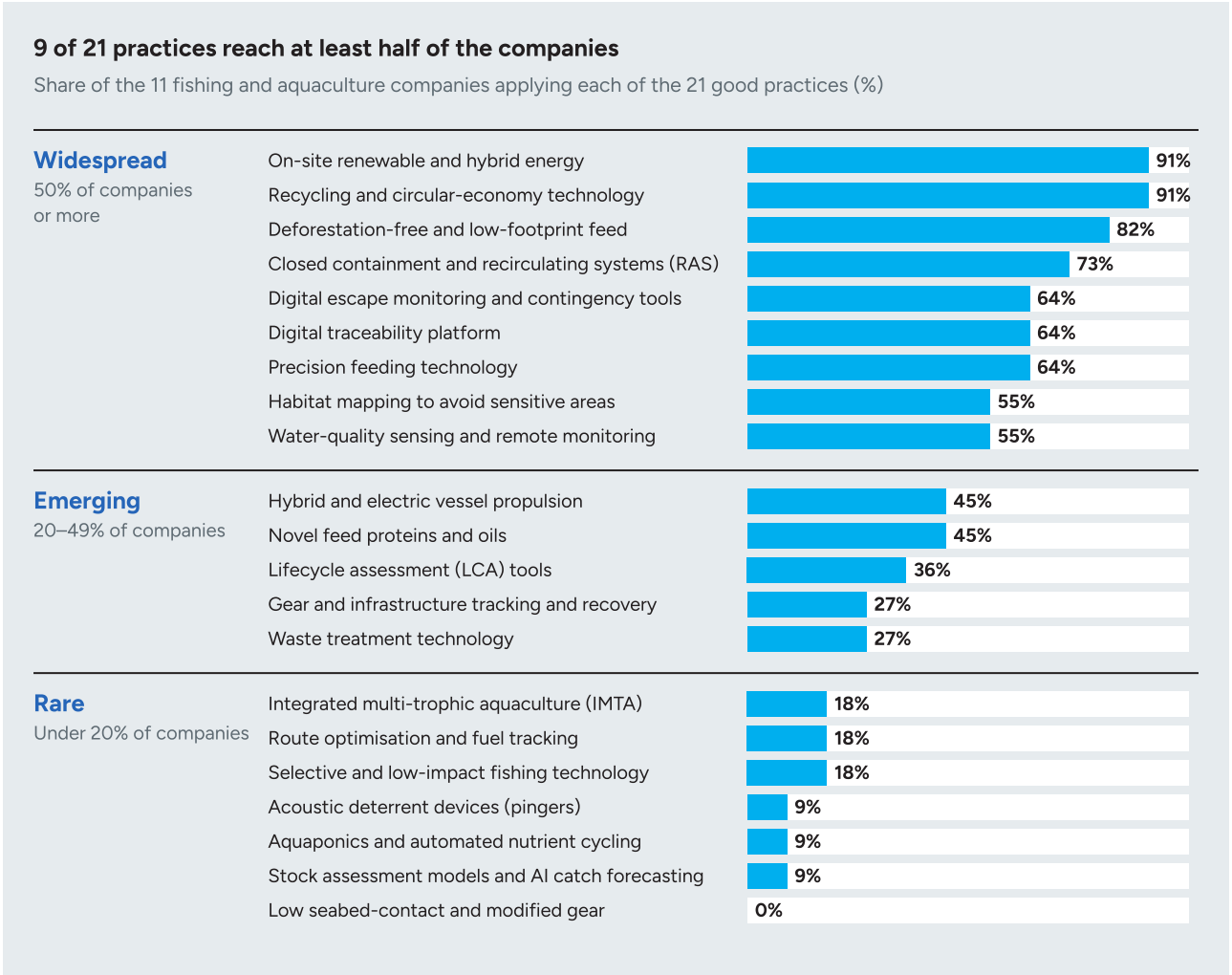
NINE OF THE 21 GOOD PRACTICES HAVE BECOME WIDELY ADOPTED, WHILE SEVEN REMAIN NICHE

The widespread practices have two things in common. Most of them are investments a farm makes for its own production: energy systems that cut fuel costs, juvenile production in controlled systems, precision feeding that saves the most expensive input, and by-product use that turns waste into revenue. The others are responses to buyer and certification requirements, such as certified soy and traceability. The rare practices have the opposite profile.

They either change the production system itself, as integrated multi-trophic aquaculture and aquaponics do, or they act on a wild resource, as selective gear, stock models, pingers and low-contact gear do, where the benefit is shared by everyone who depends on the stock or the seabed and no customer asks for proof, at least for now. This suggests that further progress in this sector is unlikely to come from the business case alone and will likely require regulation, public funding or market recognition that rewards the practices at the bottom of the ranking.

The evidence behind the positive answers points the same way. Of the 99 positive answers, 38 carry a quantitative metric, 25 third-party verification, 24 multi-year trend data and 10 a concrete qualitative outcome, while 46 carry no evidence of any type. Third-party verification is far more common here than in ports and warehousing, but it comes almost entirely from certification schemes for feed ingredients and chains of custody. It verifies where an input came from, not what a practice achieved at sea. Digital escape monitoring, integrated multi-trophic aquaculture, aquaponics and the acoustic deterrent practice carry no evidence of any type across all of their positive answers.

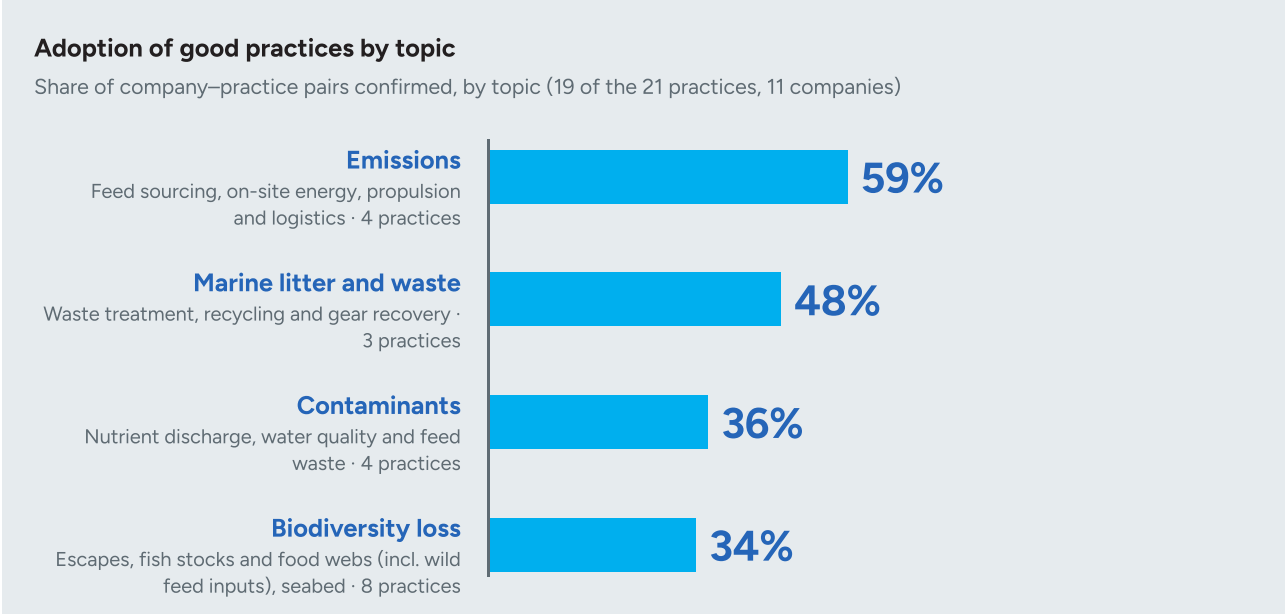
FIGURE 7.3 · Adoption of each good practice in fishing and aquaculture



Emissions lead, and biodiversity is addressed in farming activities but not in wild-capture fishing

Nineteen of the twenty-one practices were regrouped into four broader topics, scoring each by the share of all companies' positive answers. The two not shown are digital traceability and life cycle assessment, which act on no pressure directly. See Figure 7.4.

FIGURE 7.4 · Adoption of good practices by topic



Emissions lead with 26 of 44 company-practice answers confirmed, or 59%, followed by marine litter and waste at 48%, contaminants at 36% and biodiversity loss at 34%. The gap between the first and the last topic is narrower than in other industries, and at first sight the sector appears to address biodiversity almost as often as contaminants. However, a closer look reveals the most important contrast in the data. The biodiversity group mixes two kinds of practice: those that act on the farm by preventing escapes, and those that act on fish stocks, food webs and habitats, covering wild feed inputs, bycatch, stock management and the seabed. The escape-related practices reach 68%; the practices acting on fish stocks, food webs and the seabed reach 23%, and most of those cases come from farming companies, through novel feed ingredients and the mapping of farm sites.

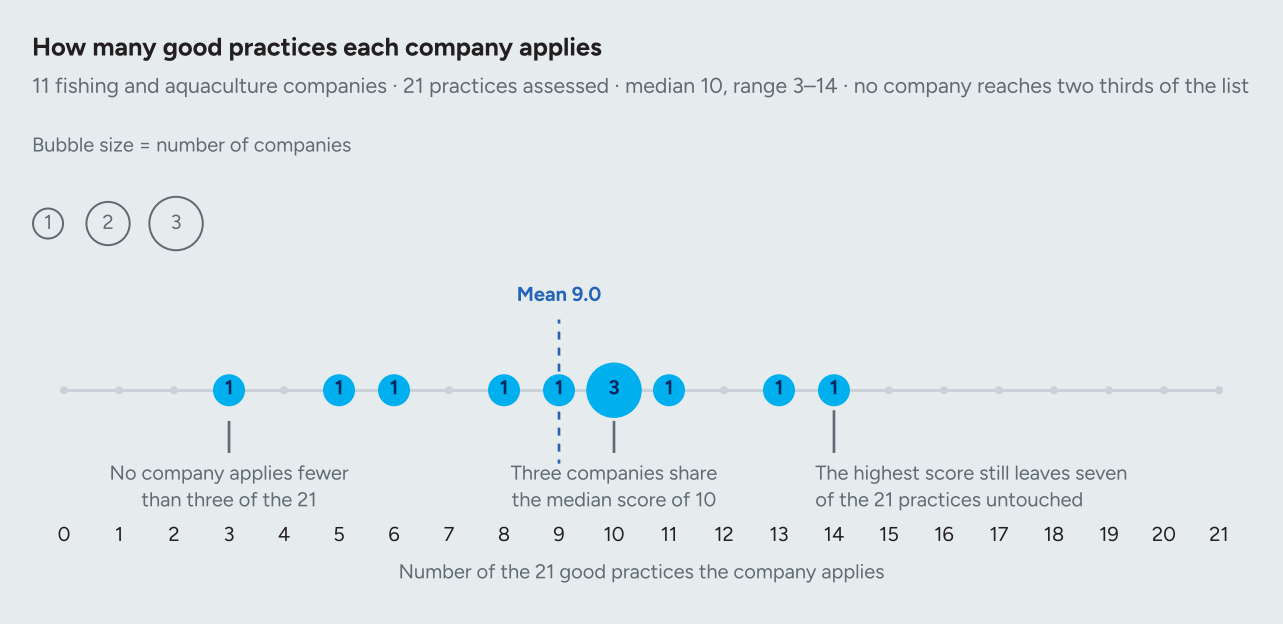
Marine litter and waste scores well because of the commercial value of by-products and of recycled net material, not because lost gear is being tracked. Contaminants sit in the middle: the sector measures its nutrient footprint and feeds more precisely, but has hardly begun to capture nutrients, which is what IMTA and aquaponics would do. Overall, the findings suggest that the sector's biodiversity performance depends on where the pressure occurs. Where the pressure arises inside an asset the company owns, such as a cage, a hatchery or a feed mill, it is managed. Where it falls on the wild stock, the bycatch species or the seabed of a fishing ground, it appears to be left largely to regulators.

PRESSURES INSIDE COMPANY-OWNED CAGES AND HATCHERIES ARE MANAGED, WHILE PRESSURES ON WILD STOCKS, BYCATCH AND FISHING-GROUND SEABED REMAIN OVERLOOKED

No company applies more than two-thirds of the list

Figure 7.5 shows how many of the twenty-one assessed good practices each of the eleven companies applies. Each bubble sits at a number of practices on the scale from zero to twenty-one, and its size and label give how many companies share that score.

FIGURE 7.5 · Good practices per company



Scores run from three to fourteen, with a mean of 9.0 and a median of ten. Apart from three companies sharing the median, every score is held by a single company, so the sample forms a continuous spread rather than distinct groups. The position on the scale follows the business model. The upper half of the distribution is made up mainly of salmon farming groups, which operate the hatcheries, sea sites, feed barges and processing plants to which most of the list applies, while the two lowest scores belong to companies whose business is weighted towards wild capture. The same pattern appears in the two halves of the list: the eleven aquaculture practices reach 55%, the ten fishing practices 30%.

No company scores below three and none scores above fourteen, so every company applies some ocean-related practice, and even the best performer leaves seven of the twenty-one unaddressed. The practices the leaders are missing are largely the same ones the rest of the sample is missing: integrated multi-trophic aquaculture, aquaponics, novel feed ingredients at scale and the practices that act on wild stocks and the seabed. The scope for improvement is therefore shared by the whole sector rather than concentrated in a few laggards, and the list itself shows that fishing companies have fewer technological options on offer than farming companies, which is a gap that future editions of this assessment and the industry's innovation agenda will both need to address.



IN DEPTH

Integrated multi-trophic aquaculture (IMTA)

IMTA FARMS FISH TOGETHER WITH SHELLFISH, SEA CUCUMBERS AND SEAWEED THAT USE THEIR WASTE, TURNING RELEASED NUTRIENTS INTO A SECOND OR THIRD HARVEST

Integrated multi-trophic aquaculture, or IMTA, combines in the same system, and in appropriate proportions, the farming of a fed species, such as finfish or shrimp, with organic extractive species, such as mussels, oysters, sea cucumbers or polychaete worms, which feed on particles, and inorganic extractive species, such as seaweeds, which absorb dissolved nutrients.[7] The idea is as old as pond farming in Asia, but its modern form was defined in the early 2000s as a way of turning the waste of one crop into the feed of another. It is the aquaculture practice that comes closest to the principle of a circular economy: nutrients that a monoculture releases into the sea are instead harvested as a second or third product.

In fed aquaculture, only part of the nitrogen and phosphorus in feed ends up in the harvested fish. A study of Norwegian salmon farming estimated that 62% of the nitrogen and 70% of the phosphorus supplied in feed was released into the environment, partly dissolved in the water and partly as particles of uneaten feed and faeces.[8] Locally, these nutrients can enrich the seabed beneath the cages and, where water exchange is poor, contribute to eutrophication. Extractive species do not need to be fed, and when they are harvested, the nitrogen, phosphorus and carbon they have taken up leave the sea with them.

The best-known large-scale example is Sanggou Bay in northern China, where kelp, scallops, oysters and abalone have been farmed together for decades. The bay produces more than 240,000 tonnes of seafood a year from over 30 species across about 100 km², and research there has traced how carbon and nitrogen move between the farmed species and the surrounding ecosystem.[9] Kelp makes up the large majority of the farmed biomass, and ecosystem studies conclude that the multi-trophic design reduces the pressure of aquaculture on the ecosystem of the bay, for example through the uptake of the nutrients released by the farmed animals, while improving the economic return.

The evidence also shows where the limits lie. In open water, farm effluent is diluted quickly, and filter feeders do not necessarily feed on it: a stable-isotope study at six Mediterranean fish farms found that farm waste was not a major component of the diet of mussels grown next to the cages, and proposed judging IMTA on nutrient budgets at the scale of a bay or region rather than on direct uptake.[10] Seasonality adds a further mismatch, because seaweeds grow and absorb most nutrients at different times of the year from the fish's peak feeding.

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[7] Barrington, K., Chopin, T. & Robinson, S. (2009). "Integrated multi-trophic aquaculture (IMTA) in marine temperate waters"; Food and Agriculture Organization (FAO). (2009). "Integrated mariculture: a global review". FAO Fisheries and Aquaculture Technical Paper. Available at: https://www.fao.org/3/i1092e/i1092e00.htm

[8] Wang, X., Olsen, L.M., Reitan, K.I. & Olsen, Y. (2012). "Discharge of nutrient wastes from salmon farms: environmental effects, and potential for integrated multi-trophic aquaculture". Aquaculture Environment Interactions.

[9] Fang, J. et al. (2016). "Integrated multi-trophic aquaculture (IMTA) in Sanggou Bay, China". Aquaculture Environment Interactions. Available at: https://doi.org/10.3354/aei00179

[10] Sanz-Lazaro, C. & Sanchez-Jerez, P. (2017). "Mussels do not directly assimilate fish farm wastes: shifting the rationale of integrated multi-trophic aquaculture to a broader scale". Journal of Environmental Management.

Deposit feeders beneath the cages help close the other side of the budget: a model analysis found that sea cucumbers could remove up to 86% of the particulate organic carbon reaching the bottom under finfish cages, while providing a valuable additional crop.[11]

Why adoption is still low

IMTA OFFERS ECONOMIC OPPORTUNITIES, BUT LOW PRICES AND SINGLE-SPECIES LICENSING REGIMES REMAIN KEY BARRIERS

The barriers are economic, regulatory and practical rather than technical. Economic studies find that IMTA can be more profitable than monoculture, with one analysis showing a net present value 24% higher, but results are sensitive to the low market prices of seaweed and shellfish. A review of this literature concludes that IMTA will spread in Western aquaculture only when its nutrient-removal service is given a monetary value, for example through nutrient credits, eco-certification or support for demonstration sites.[12] Licensing is typically granted for a single species on a single site, which makes it difficult for a fish farmer and a seaweed or shellfish farmer to share a location. The European Commission's own guidance states that IMTA is promoted by the EU strategic guidelines for sustainable aquaculture but is not yet sufficiently developed for industrial deployment, and notes that EU rules preventing farmed animals from being fed on waste are an obstacle to combining fish with low-trophic species such as bivalves and sea cucumbers.

What the companies assessed are doing

In the sample assessed for this report, IMTA appears only at the margins. One company is developing restorative seaweed farming with a conservation organisation in a region where it also farms salmon; another is investigating the co-farming of salmon and shellfish; a third has explored kelp and mussels to remove organic and inorganic loading; and a fourth holds seaweed licences linked to its salmon sites. None reports seaweed or shellfish grown alongside its fish cages at commercial scale, none quantifies the nutrients removed, and none uses nutrient-flow modelling to size an extractive crop against its fish biomass. Nutrient management relies instead on site selection in strong currents, fallowing and monitoring, which disperse the nutrients rather than recover them.

[11] Cubillo, A.M. et al. (2016). "Role of deposit feeders in integrated multi-trophic aquaculture — a model analysis". Aquaculture.

[12] Knowler, D. et al. (2020). "The economics of integrated multi-trophic aquaculture: where are we now and where do we need to go?". Reviews in Aquaculture 12.

What good practice would look like

The evidence suggests that a credible IMTA practice does not need to place every mussel line next to a fish cage, but it does need to be designed and reported as a nutrient budget. That means sizing seaweed and shellfish production against the nitrogen and phosphorus released by the fed species, at the scale of the farm or the bay; placing deposit feeders where particulate waste settles; reporting the tonnes of nutrients removed at harvest; and working through partnerships between fish farmers, seaweed and shellfish growers and regulators where a single company cannot farm every species. Seen this way, IMTA links the two sides of this chapter: it reduces the contaminant pressure of fed aquaculture, and it expands low-trophic production that needs no wild fish in its feed.

7.4 Sector synthesis

1 **The sector applies the good practices that pay back in its own production.**

Across the twenty-one assessed practices, 99 of 231 company-practice pairs were confirmed, an overall adoption rate of 43%. The most widely applied are on-site renewable and hybrid energy and recycling and circular-economy technology, followed by certified deforestation-free feed and closed containment and recirculating systems. Each of them saves fuel, feed or raw material, or meets a buyer's certification requirement, while also reducing ocean pressures.

2 **The pressures specific to wild capture are the least addressed in the sector.**

The three practices acting directly on wild fish stocks reach 12%. No company uses low seabed-contact gear, operates its own stock model, uses AI catch forecasting or fits acoustic pingers to its nets. Even among the four companies that operate capture fleets, the fishing practices reach only 30%, and half of those positives come from the waste, recycling and gear-loss practices rather than from the stock or the seabed.

3 **Aquaculture pressures are contained and measured rather than designed out.**

Closed containment reaches 73% but covers mainly juvenile production on land, and digital escape monitoring reaches 64% with no evidence of any type behind it. The two practices that would recover the nutrients of fed aquaculture within the production system remain rare: integrated multi-trophic aquaculture at 18% and aquaponics at 9%, neither applied at commercial scale alongside fish cages.

4 **Every company leaves at least a third of the list unaddressed, and the list favours aquaculture.**

Scores run from three to fourteen of twenty-one, with a median of ten. The eleven aquaculture practices reach 55% and the ten fishing practices 30%, and salmon farming groups occupy the upper half of the distribution. Improvement is needed across the whole sample, above all in nutrient recovery, novel feed at scale, gear that reduces bycatch and seabed contact, and the tracking of fishing gear at sea. Closing these gaps will depend on collaboration between companies, investors and policymakers, and on market recognition for the practices that benefit the marine environment.



Cross-sector analysis

8.1 Why look across sectors

Chapters 4 to 7 assessed each industry on its own terms, against a list of good practices built around the pressures that industry potentially exerts on the ocean. However, ships, ports, shipyards, fishing fleets and fish farms do not operate in a separate ocean. They share coastal waters, infrastructure and supply chains, and pressures that one sector leaves unaddressed often become a problem for another. A ship's hull is designed in a shipyard, fouled at sea, and cleaned in a port. In the same way, a ship can switch off its engines at berth only if the port supplies clean electricity, and waste sorted on board stays out of the sea only if it can be landed and treated ashore.

PRESSURES THAT ONE SECTOR LEAVES UNADDRESSED OFTEN BECOME A PROBLEM FOR ANOTHER

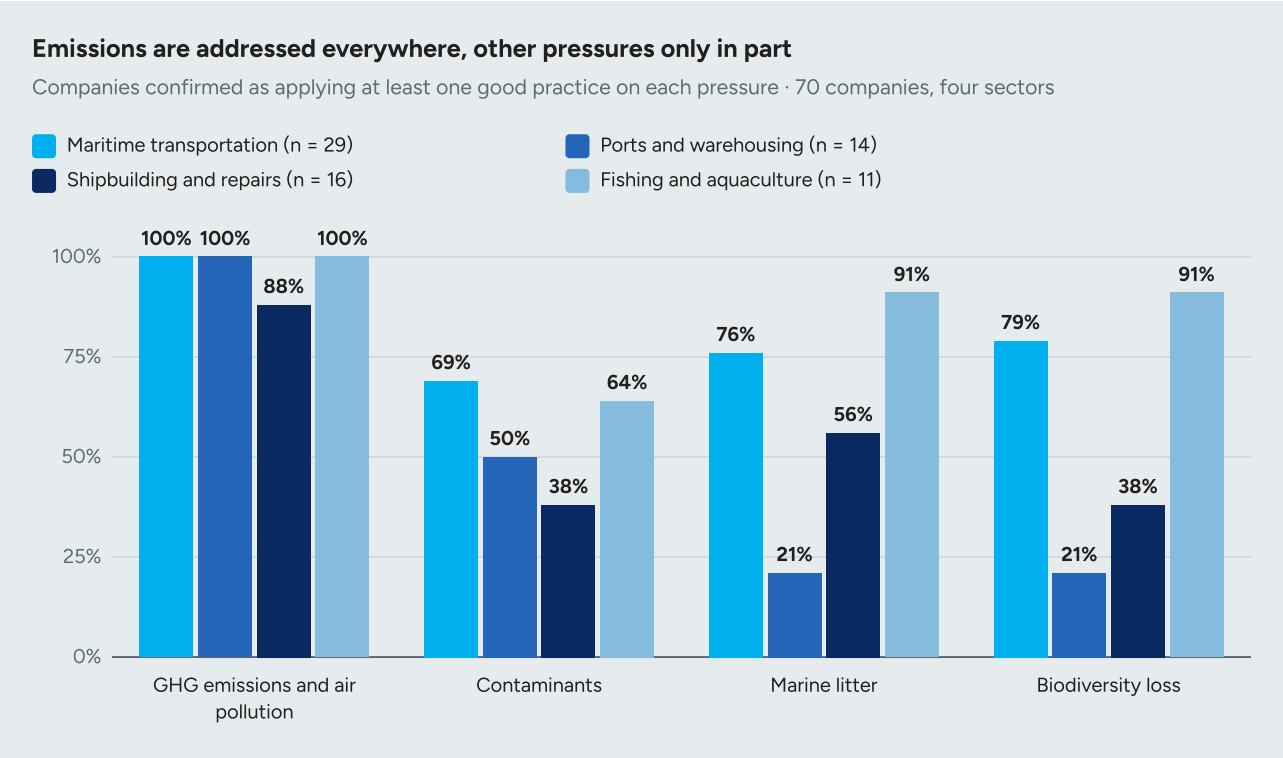
Each sector can act on a different part of the same pressure: the shipyard through the design, fuel and coatings it builds into a vessel, the operator through how fast and where that vessel sails and the port through what it offers at the quay. No single good practice is enough on its own, but together these efforts can add up, and the combined action of all sectors can make a real difference for the ocean.

This chapter therefore reads the 70 companies of the sample as a single system. It compares good practices to mitigate four pressures that all four sectors exert: greenhouse gas emissions and air pollution, contaminants, marine litter and biodiversity loss.

8.2 Emissions are addressed everywhere, other pressures only in part

Figure 8.1 compares the four sectors on one simple measure: the share of companies confirmed as applying at least one good practice for each pressure. It measures scale of engagement, not depth: a company with one practice counts the same as a company with several. For comparability, practices on seafloor integrity, underwater noise, collisions with marine fauna, non-indigenous species and fish stocks are grouped under biodiversity loss in all four sectors.

FIGURE 8.1 · Share of companies addressing each pressure, by sector



GHG emissions are the only pressure addressed by almost every company in the sample: 68 of 70 (97%).

The other three pressures sit far lower: 63% of companies (44 of 70) address marine litter, 60% (42) biodiversity loss and 57% (40) contaminants. These overall shares are close together, but they hide large differences between sectors. Coverage of contaminants ranges from 38% in shipbuilding to 69% in maritime transportation, while for marine litter and biodiversity loss the gap is even wider, from 21% in ports and warehousing to 91% in fishing and aquaculture, a difference of 70 percentage points. Only 27 of the 70 companies (39%) report at least one practice on all four pressures.

ONLY 39% OF COMPANIES REPORT AT LEAST ONE PRACTICE ON ALL FOUR PRESSURES

The data shown for biodiversity should be read with care. Much of it comes from practices that companies report as fuel or efficiency measures, such as slower sailing and optimised hulls and propellers, which can also reduce underwater noise, or from farm practices that protect the company's own stock. If the two practices reported mainly for fuel efficiency are set aside, the share of companies addressing biodiversity falls from 60% to 37% (26 of 70).

The differences between sectors appear to follow one pattern: **companies are most proactive when part of the benefit returns to them, through lower costs, protected stock or customer requirements.** Fishing and aquaculture show the broadest coverage, probably because many of their litter and biodiversity practices also protect stock, feed or the value of by-products. Ports cover marine litter and biodiversity least, although dredging, piling and quayside litter are pressures they cause directly; the impact is delayed, diffuse and unpriced, so nothing returns to the company that reduces it. In shipbuilding, most pressures on biodiversity materialise after delivery, when the vessel belongs to its owner. Maritime transportation sits in between, with wide but shallow coverage of the non-carbon pressures.

COMPANIES ARE MOST PROACTIVE WHEN PART OF THE BENEFIT RETURNS TO THEM, THROUGH LOWER COSTS, PROTECTED STOCK OR CUSTOMER REQUIREMENTS

8.3 Areas for action available to all the companies

The same families of solutions appear in industries that otherwise have little in common. Read by type of action rather than by sector, they show what any company can do.

Technological actions

Electrification is the clearest technology that travels across the ocean economy, and in every sector it works best on short, predictable duty cycles: terminal equipment in ports, harbour craft in shipping, and workboats and feed barges in aquaculture. For long routes, alternative fuels remain the answer, and what a vessel can burn is fixed at the shipyard. The same holds for underwater noise and biocides: hull form, propeller design and coatings are chosen at construction and determine how loud and how toxic a ship will be over a service life of thirty years or more.

Operational actions

Some of the most effective measures require no new equipment, only different planning. Reducing speed, scheduling construction outside breeding and migration periods, feeding fish to appetite and choosing farm sites away from sensitive habitats all reduce pressures on marine life through planning decisions.

OPERATIONAL ACTIONS ARE WITHIN REACH OF EVERY COMPANY, BUT THEY PROTECT THE OCEAN RELIABLY ONLY WHEN THEY ARE PLANNED WITH THE OCEAN IN MIND

Habitat mapping is a clear example of a capability that exists but is not shared across uses: it is applied mainly to choose aquaculture sites, while it is almost absent from decisions on where ships anchor and where fishing gear touches the seabed. Operational actions are within reach of every company, but they protect the ocean reliably only when they are planned with the ocean in mind, and not as a side effect of saving fuel.

Governance and strategy actions

In all four sectors, practices that benefit marine biodiversity are often adopted for another reason and described in other terms. A measure justified only by fuel savings depends on fuel prices and may be weakened when these change. By contrast, naming the ocean pressure in the company's strategy, assigning responsibility for it and setting targets for it would turn these co-benefits into deliberate action. A second strategic action concerns the boundary of responsibility. Coverage is broadest where the company owns the asset in which the pressure arises, and weakest where the pressure falls on a shared space or occurs after the product has left the company. In ports, the groups that own and run their own energy systems, equipment fleets and water networks apply a wider range of good practices than those that do not, while dredging and floating litter in the shared harbour basin remain largely unaddressed. In aquaculture, pressures that arise inside the company's own cages, hatcheries and feed mills are managed and measured, whereas pressures on wild fish stocks and on the seabed of fishing grounds appear to be left mostly to regulators. Companies can widen this boundary by including in their strategy and design the pressures their products cause once in service, and those that arise in the waters they share with other operators, for example through life cycle thinking at the design stage.

Measurement and reporting actions

Digital capability, from digital twins to live emissions dashboards and cameras in fish cages, is present in every sector. However, it is pointed mainly at operations, energy and production, and rarely at the surrounding water. Sensing that monitors the sea itself, such as detecting oil, floating litter or changes in ambient water quality, is close to absent. Yet the same tools could be turned towards environmental problems with little additional investment: the machine vision that already tracks containers on a quay could detect floating litter in the harbour basin, cameras that count fish in a cage could detect escapes as they happen, and digital twins built to optimise operations could simulate the effect of dredging or expansion on the seabed. Redirecting existing technology in this way would allow companies to measure their pressures on the ocean in real time and to act before small problems become large ones, at a fraction of the cost of new systems.

Value-chain and cross-industry cooperation

Many pressures sit at the interface between sectors, where no single company can address them alone. Shore power needs both a ship that can connect and a berth that can supply clean electricity. Waste separated on board stays out of the sea only if it can be landed and treated ashore. Hull biofouling is shaped by the builder's choices, carried by the operator and contained, or released, wherever the hull is cleaned. Trimmings and offcuts from fish processing are rendered into fishmeal and fish oil for aquaculture feed, so that what one activity discards becomes another's input and less wild fish needs to be caught for feed.

8.4 Common gaps across the four sectors

Reading the four sectors together brings out gaps that no single chapter can show on its own.

ACROSS THE 54 COMPANIES IN THESE THREE SECTORS, ONLY 3 REPORT A PRACTICE THAT AVOIDS OR REDUCES THIS CONTACT

Despite its ecological importance, the seabed remains the most neglected ecosystem in ocean economy activities. Three sectors disturb the seabed physically in their daily work: ships through anchors and chains, ports through dredging, and fishing fleets through bottom-towed gear. Across the 54 companies in these three sectors, only 3 report a practice that avoids or reduces this contact. The damage is local, cumulative and slow to recover, and many reports do not mention it at all.

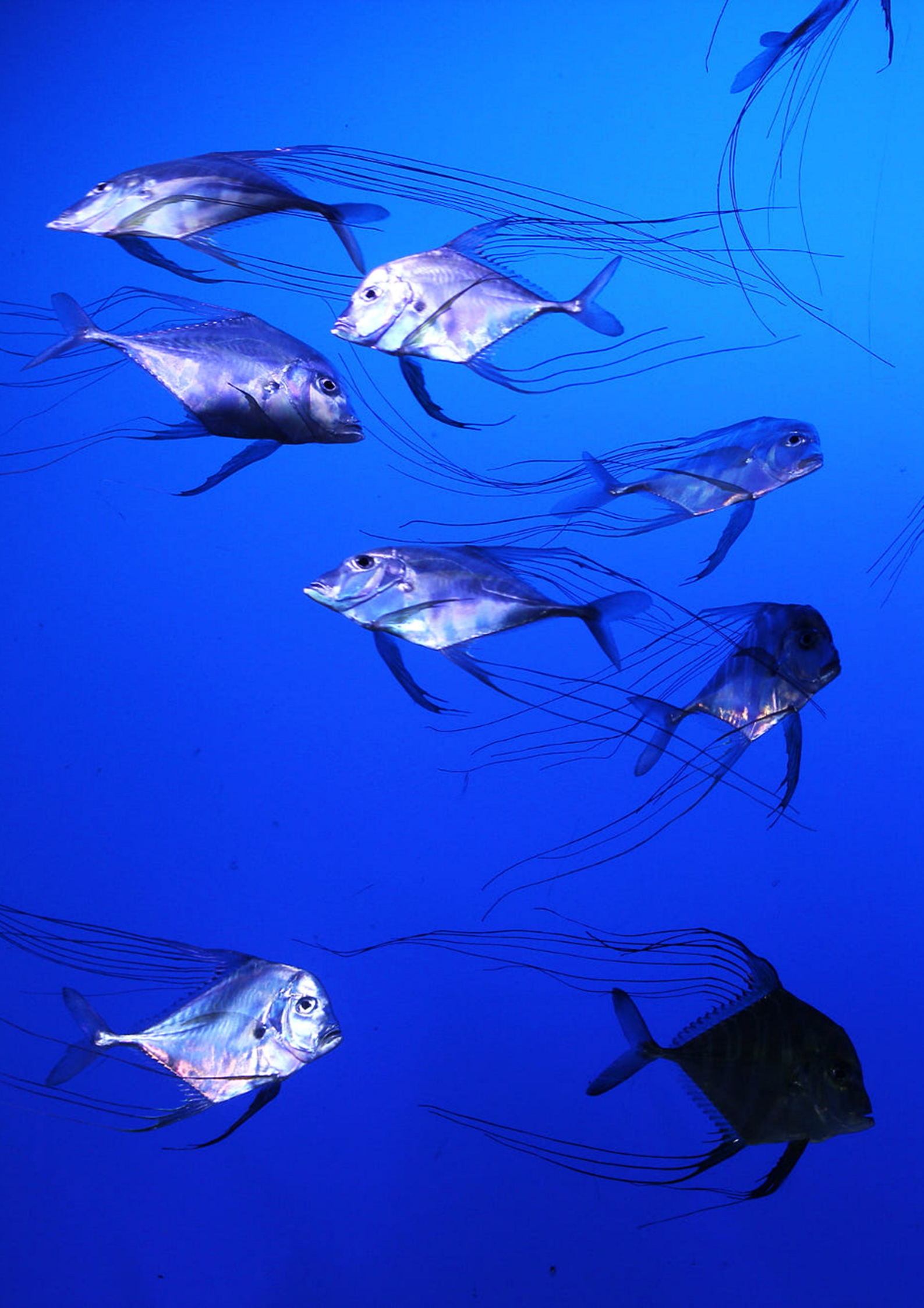
Marine litter is managed inside operations, but rarely where it reaches the sea. Across the sample, 43 of 70 companies (61%) report practices for the waste and materials they generate themselves, such as onboard sorting, recycling, removing single-use plastics or choosing materials at the design stage. In contrast, only 6 of the 54 companies in shipping, ports, and fishing and aquaculture report a practice that removes litter already in the water or tracks fishing gear and farm equipment at risk of being lost. Litter is treated as a waste-management problem within companies' own operations, not yet as a pressure on the marine environment: waste is controlled where it is generated, but not where it ends up.

Biodiversity is protected largely as a side effect. A large part of the action on biodiversity relies on fuel savings or on the protection of farmed stock. Practices designed specifically for wild species, such as real-time detection of marine mammals, low-impact fishing gear and noise reduction during construction, remain rare in every sector in which they were assessed.

Taken together, these gaps point to four priorities for the ocean economy as a whole: i) extend action from carbon to the seabed and to marine life, starting with mature, low-cost measures; ii) close the gaps at the interfaces through cooperation between builders, operators and ports; iii) turn existing digital capability towards resolving environmental issues; and iv) bring the evidence for non-carbon pressures up to the standard already reached for carbon.

8.5 Conclusion

The four sectors analysed have built a shared response to climate change: almost every company in the sample reports at least one practice to reduce its emissions, and much of this effort is measured and verified. However, the response to the pressures that act directly on marine life is narrower, less intentional and less evidenced, and it is weakest exactly where the sectors meet: on the seabed they share, in the ports where their ships arrive, and along the pathways that carry species from one sea to another. The technologies needed are largely known and mature. What is still missing is the decision to apply them for the ocean's sake and for their own, since all four sectors ultimately depend on its health, and the cooperation to apply them together. If businesses, investors and policymakers give the seabed and marine life the same attention they have given to carbon, the ocean economy can continue to grow while keeping the ocean healthy for current and future generations.



Commitment to SDG 14 (Life Below Water)

9.1 What was assessed

Sustainable Development Goal 14, Life Below Water, is the United Nations goal for the protection of the ocean. Its targets ask for less marine pollution (target 14.1), the protection and restoration of marine and coastal ecosystems (14.2), less ocean acidification (14.3) and an end to overfishing (14.4). Every company in this study builds, operates, hosts or harvests at sea. For this reason, a public commitment to SDG 14 was included as a cross-cutting good practice in all four sector samples.

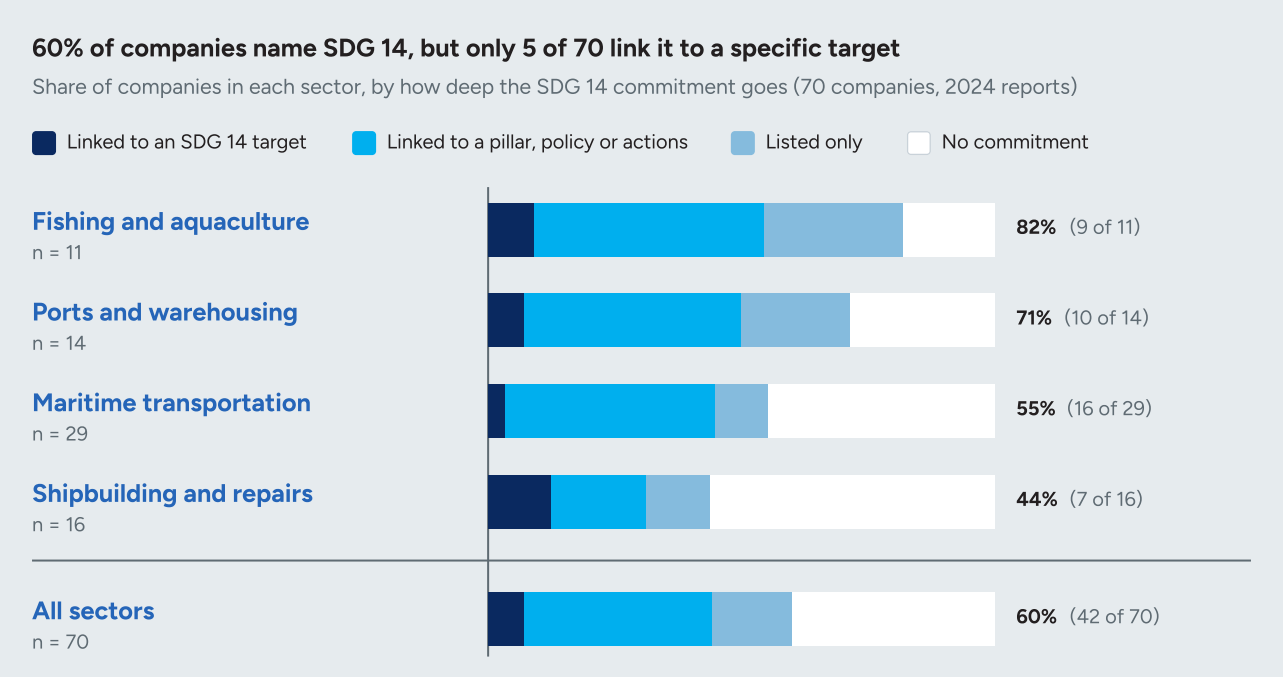
A PUBLIC COMMITMENT TO SDG 14 WAS INCLUDED AS A CROSS-CUTTING GOOD PRACTICE IN ALL FOUR SECTOR SAMPLES

A company was scored positively when its analysed report explicitly names SDG 14 or Life Below Water, whether as a goal it contributes to, in a mapping of its activities, or as an icon in a list of goals. A general reference to the SDGs, or ocean content that is never linked to the goal, was scored No. This criterion therefore captures whether the goal is mentioned, not how far it is acted upon: the depth of each positive case is analysed in the next section.

These findings show that the mention of SDG 14 follows how directly a sector depends on living marine resources. **Fishing and aquaculture** lead with 82% (9 of 11). For these companies, the health of fish stocks and coastal waters is the business itself; as one fishing company writes in its report, its "business relies on a healthy ocean". **Ports and warehousing** follow with 71% (10 of 14), and often link the goal to the coastal habitats around their terminals, such as mangroves, artificial reefs and the water quality of the bay. **Maritime transportation** reaches 55% (16 of 29) and **shipbuilding** 44% (7 of 16). These are the two sectors whose impacts on the ocean happen mostly far from the company's own site: at sea, or after the vessel has been delivered.

THE MENTION OF SDG 14 FOLLOWS HOW DIRECTLY A SECTOR DEPENDS ON LIVING MARINE RESOURCES

FIGURE 9.1 · Depth of commitment to SDG 14, by sector



9.2 Named, linked or measured: how deep the commitment goes

A positive verdict covers very different levels of commitment. To show this, the 42 positive cases were grouped into three levels (Figure 9.1).

- **Listed only (11 companies of the 42).** SDG 14 appears as an icon, in a list of goals or in a mapping table, with no ocean action attached. In some cases, the goal is shown only as an icon or is claimed for the whole industry rather than for the company. This is the weakest level of commitment: it shows that the goal is recognised, but not what the company does to contribute to it.
- **Linked to a strategy pillar, a policy or concrete actions (26 companies of the 42).** This is the most common level. One company makes "Healthy Oceans" one of the four pillars of its strategy and tags SDG 14 on its noise-reduction and artificial-reef projects. One names "Climate Action and Life Below Water" as the two goals "where we can have the greatest impact", and lists mangrove restoration, ballast water treatment, hull cleaning that protects biodiversity and quieter propellers.
- **Linked to a specific SDG 14 target or a measured company target (5 companies of the 42).** One salmon farmer links three quantified targets (the number of wild fish used in feed, feed efficiency, and impact on the seabed under its farms) to SDG targets 14.1 and 14.4. One port operator links the management of its sea outfalls to target 14.1 and reports full compliance for all direct discharges to the sea. Two shipyards map their work on pollution prevention, habitat restoration and underwater noise to targets 14.1 to 14.4.

One container line has set a target of more than 100 marine-life protection activities by 2030 and tracks it year by year. It is the only SDG 14 commitment in the sample supported by a number, an outcome, external recognition and multi-year data.

9.3 Why companies do not name SDG 14

LACK OF MENTION OF SDG 14 RARELY MEANS SILENCE ON THE OCEAN

Lack of mention of SDG 14 rarely means silence on the ocean. Eleven of the 26 companies do not use the SDG framework at all: they report against other standards, such as GRI, SASB, TCFD, a stock exchange ESG guide or the European Sustainability Reporting Standards (ESRS). Several companies in this group publish some of the most detailed nature reporting in the sample (biodiversity assessments using the TNFD approach, marine-mammal protection, ballast water management, marine surveys, artificial reefs) without ever linking it to SDG 14.

This gap is likely to grow. As European companies move to the ESRS and to nature frameworks such as the TNFD, ocean impacts are reported under water and marine resources (ESRS E3) and biodiversity (ESRS E4) rather than mapped to the SDGs, which in any case remain a valid reference for all companies, regardless of geographic location.

Engagement with NGOs and conservation partnerships

Roughly three-quarters of the ocean economy companies in our sample (78%) report funding or taking part in at least one ocean conservation initiative led by a non-governmental organisation (NGO) or another kind of environmental organisation.

This makes partnership with NGOs one of the most widely disclosed good practices in this report. Partnerships of this kind play a key role in ocean protection because they combine complementary strengths. NGOs and research bodies contribute scientific knowledge, local presence and long-term monitoring, while companies mainly offer funding and, in some cases, also staff and logistics. Together, they can reach places and scales of action that neither could achieve alone.

PARTNERSHIP WITH NGOs IS ONE OF THE MOST WIDELY DISCLOSED GOOD PRACTICES ANALYSED IN THIS REPORT

Unlike the other practices in this report, it does not act on the pressures that a company exerts through its own operations, but represents a contribution to ocean health beyond the company's own footprint. For this reason, it was kept out of the sector adoption figures and is analysed separately in this chapter.

10.1 Why ocean conservation partnerships matter

Ocean conservation initiatives led by NGOs, research institutes and community bodies cover a recognisable range of activity. Examples of projects comprise habitat restoration, which includes replanting mangroves and seagrass, restoration activities for corals, re-establishing kelp, seaweed and shellfish beds, building artificial reefs and restocking depleted river and estuary systems.

But also the removal of material already present in the environment, such as the clean-up of beaches, harbour edges and the seabed, and the recovery of derelict fishing gear and plastic debris. Additional activities include marine research, monitoring and protected-area work, from population surveys of cetaceans, seabirds and fish stocks to water-quality and benthic monitoring and the management of marine reserves.

Few companies are equipped to carry out such work alone. It depends on ecological expertise, long observation series, permits and regulatory relationships and, above all, on continuity, since a restoration site is worth little if it is abandoned after eighteen months. Conservation NGOs, marine research institutes, universities and coastal community associations hold this expertise and continuity, as well as the local standing needed to work in a particular bay, estuary or reef system.

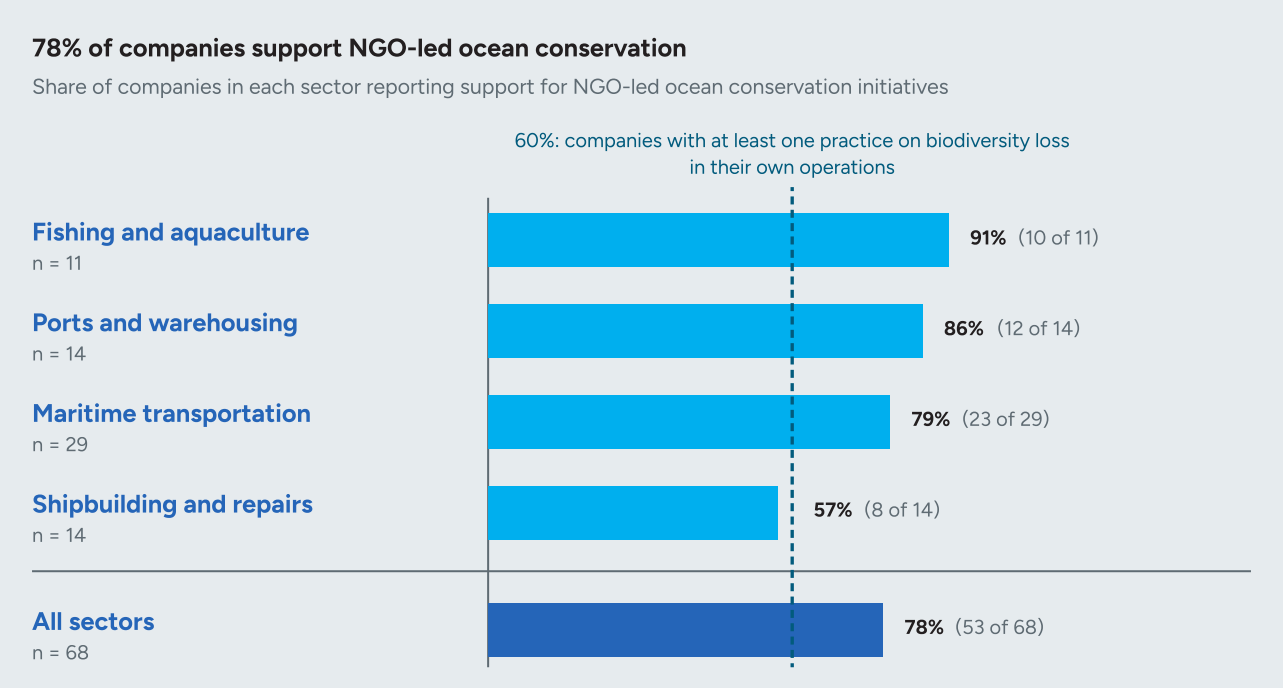
What corporate involvement adds is complementary. The most evident contribution is finance, in the form of grants, foundation allocations and multi-year commitments. Less obvious, but more distinctive, are the logistical assets that ocean economy companies uniquely control: vessels able to carry researchers and instruments along commercial routes, terminal land adjacent to degraded habitat, marine crews equipped to dive safely, and the reach to replicate an intervention across dozens of facilities. Several companies in the sample contribute precisely in this way, supplying access and hardware rather than funding alone.

10.2 What companies do: from beach clean-ups to habitat restoration

Figure 10.1 presents the share of companies in each sector that report supporting ocean conservation initiatives led by NGOs or other environmental organisations.

Fishing and aquaculture shows the highest rate (91%), followed by ports and warehousing (86%) and maritime transportation (79%). Shipbuilding and repairs lags far behind, with just over half of the companies (57%). The high rate in fishing and aquaculture comes as no surprise, since these companies depend directly on healthy ecosystems and wild fish stocks for their own business. Many of their initiatives therefore focus on the species and habitats closest to their operations. In shipbuilding, on the contrary, several companies describe active community programmes, but these are directed towards social causes, rather than towards the ocean. This can probably be attributed to the fact that shipyards have less daily contact with marine ecosystems than ship operators or fish farmers.

FIGURE 10.1 · Adoption of NGO-led ocean conservation support, by sector



It is interesting to note that this single practice is reported by more companies than the full set of practices addressing biodiversity loss within companies' own operations (60%, dashed line).[1] This suggests that supporting external projects is easier to adopt than changing the way a company operates, as it requires lower investment, offers greater flexibility and is highly visible to stakeholders.

SUPPORTING EXTERNAL PROJECTS IS EASIER TO ADOPT THAN CHANGING THE WAY A COMPANY OPERATES

In particular, the activities that companies report include:

Clean-ups. This is the most popular type of activity because it is simple to organise, involves employees directly and delivers immediate, visible results. Removing litter from beaches and the seabed also prevents it from breaking down into microplastics and from entangling or being ingested by marine wildlife.

Species protection. Initiatives of this type focus mostly on marine mammals, seabirds and fish. A cruise operator reports working with a whale and dolphin conservation NGO since 2015, placing conservation staff on board 15 of its itineraries. Similarly, a fishing company describes a plan developed with a bird conservation NGO and local purse-seine fishers to protect seabirds.

Habitat restoration. Activities in this area target blue carbon ecosystems and reefs, which store carbon, protect coasts from erosion and act as nurseries for fish. One cruise company declares that its coral programme with a university has outplanted more than 2,500 corals, and a port operator reports having donated 12 decommissioned tugboats to form artificial reefs.

[1] Share of companies with at least one practice addressing biodiversity loss in their own operations, as presented in the cross-sector chapter of this report (n = 70).

Research and funding. These activities complete the picture. Some ship operators turn their vessels into platforms for science, for example by sharing ocean temperature and pH data with an oceanographic institute, or by sampling environmental DNA (eDNA) to detect more than 600 species.

10.3 Final considerations

Overall, the analysis paints an encouraging picture. Engagement with NGOs is one of the most common good practices in the ocean economy, and it stands as a testament to a growing sense of shared responsibility for ocean health. Nevertheless, there is room for improvement:

- **A complement, not a substitute.** Conservation partnerships cannot replace action on the pressures arising within companies' own operations, where adoption remains lower.
- **From activities to outcomes.** Companies could agree with their partners on a small set of ecological indicators, such as hectares of habitat restored and their survival rate or species population trends and report them every year. In this way, a list of initiatives would become evidence of impact.
- **Closer links to the company's own pressures.** Support has the greatest value when it addresses the pressures that a company exerts on the ocean, as when ship operators protect whales along their own routes or fish farmers restore wild salmon rivers. By contrast, several initiatives are general clean-ups or even land-based tree planting, with no clear link to the company's activity.

This reflects the path from awareness to activation that One Ocean Foundation promotes in three steps: **understand**, by building scientific knowledge of how one's activities affect the ocean; **engage**, by involving employees, partners and local communities; and **act**, by carrying out concrete, measurable projects that protect and restore marine ecosystems. Partnerships built on the first two steps are more likely to target the pressures that matter most.

In conclusion, the partnerships described in this chapter show what becomes possible when businesses, NGOs, the scientific community and public authorities work together. If these collaborations become longer-lasting, better measured and more closely linked to each company's footprint, they can help restore the ecosystems on which the ocean economy, and all of us, depend, for current and future generations.



Comparing the 2024 and 2025 reports

As explained in the methodology section, the analysis uses the 2024 sustainability reports as its baseline, since not all companies in the sample had published their 2025 reports at the time of the assessment. To check whether the results are still up to date, the assessment was repeated on the 2025 reports of a subset of companies. The aim was to verify whether the more recent reports would change the picture presented in this report, which is based on the 2024 reports.

For this check, the comparison looked at the verdict (Yes or No) given to each good practice for the same company in its 2024 and 2025 reports. The comparison covers 20 companies, five in each of four sectors, and 384 verdicts. **Around one verdict in ten changed (36 of 384, 9%)**: 22 practices went from Yes to No and 14 from No to Yes. Because the changes go in both directions, the total number of Yes answers decreased only slightly, from 180 to 172 (−4%).

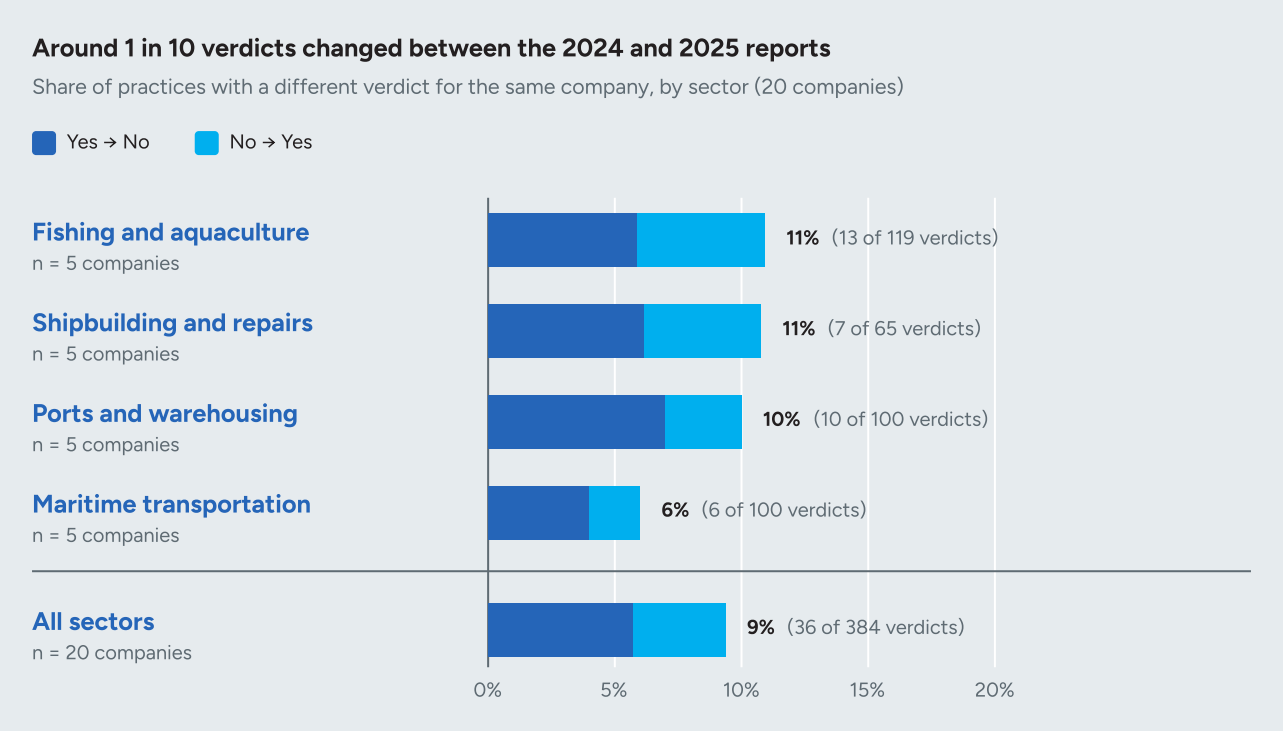
The share of changed verdicts is similar in three sectors (10% to 11%) and lower in maritime transportation (6%), as shown in Figure 11.1.

11.1 Why did the verdicts change?

Almost all changes (33 of 36) come from differences in what the reports say, not from how they were read. Two main causes were identified.

- **Practices no longer reported (21 Yes → No).** The practice described in 2024 does not appear in the 2025 report. Typical cases are pilot projects that were not repeated (a recycled mooring rope trial, a hybrid feed barge, a whale-detection system tested on one cruise ship), one-off events (an oil-spill response after a ship collision in 2024) and initiatives that a company stopped or found unsuitable (electric propulsion for fishing vessels). In four cases, the reference to SDG 14 (Life Below Water) disappeared. This is likely linked to the European Sustainability Reporting Standards (ESRS): one company now lists oceans and seas as “not material”.

FIGURE 11.1 · Share of verdicts that changed between the 2024 and 2025 reports, by sector



– **New practices reported (12 No → Yes).** Twelve practices appear for the first time, across all four sectors. Examples include a rainwater treatment plant and limits on single-use plastics at port terminals, a more efficient hull design and a robot that replaces dangerous work in shipyards, seaweed lines that absorb nutrients and route optimisation in fish farming, and electric equipment at container terminals.

11.2 How critical are these differences?

At sector level, the differences are **not critical**. Nine verdicts out of ten are stable; the changes go in both directions and the net effect on Yes answers is small (−4%). Sector results and the main trends from the 2024 baseline can therefore be presented with confidence.

At company and practice level, some changes are **more visible**. However, they do not affect the validity of the findings, for two reasons:

1. **A missing practice is not a stopped practice.** Most changes from positive to negative mean that a practice was not reported, not that it ended. A practice that disappears from a report, whether in 2025 or in an earlier year, has not necessarily been discontinued. The method measures disclosure, so year-on-year changes should be described as changes in reporting, not in action.

2. **Some verdicts are borderline.** A few verdicts depend on a single sentence, so a small change in wording can change the answer. In these cases, the change reflects how the report is written rather than a real difference in practice.

Overall, the comparison shows that **the 2025 reports do not change the picture presented in this report**. Nine verdicts out of ten are unchanged; the changes that do occur go in both directions, and most of them reflect what companies choose to report in a given year rather than a change in what they do. The findings based on the 2024 reports therefore remain valid and current and offer an up-to-date picture of the good practices disclosed by companies in the four sectors.

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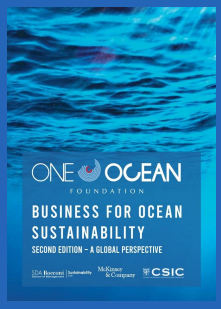

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