



Abstract

Marine pollution is an escalating global concern, threatening both ecological and economic stability. Our oceans, vital sources of water and aquatic life, are flooded with two major pollutants: chemicals and trash ([Stanley, 2024](#)). This commentary delves into the economic costs of marine pollution, with a focus on its sector-specific impacts on fisheries, tourism, and shipping industries. It also explores key themes such as market stability, socio-economic well-being, and sustainable solutions to address this pressing issue.

Introduction

Marine pollution, encompassing plastic waste, chemical spills, and other contaminants, has become a critical challenge for global economies. Plastics constitute the largest, most harmful, and most persistent fraction of marine litter, accounting for at least 85% of total marine waste ([UNEP, 2021](#)). In 2024, an estimated 75 to 199 million tons of plastic waste will currently pollute our oceans, with an additional 33 billion pounds entering the marine environment annually ([Fisher, 2024](#)). According to the United Nations Environment Assembly (UNEA) and the United Nations Environmental Program (UNEP), plastics in the environment annually burden the global economy by \$19 billion ([Xia et al., 2023](#)). This figure includes the overall economic costs of plastics in the world such as environmental damage, clean-up efforts, and impact on industries. These alarming statistics highlight the urgency for economic and policy interventions to protect marine ecosystems and ensure sustainable economic growth.

Fun Fact: An interesting yet troubling fact about plastics is that they do not biodegrade; instead, they break down into smaller fragments known as microplastics and nanoplastics. These particles persist in the environment, causing significant and long-lasting damage to marine life and human health. ([UNEP, 2021](#))

Economic Impacts by Sector

1. Fisheries and Aquaculture

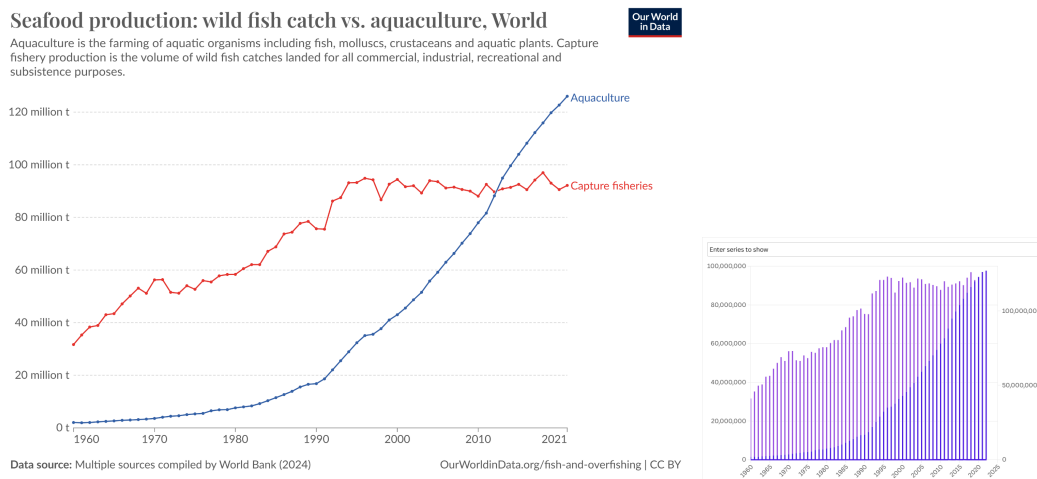


Figure 1: Seafood Production, wild fish catch vs aquaculture (Ritchie, 2019)

According to Figure 1, the rapid expansion of aquaculture has outpaced wild fish capture since the early 2000s, positioning it as a key solution to overfishing and declining fish stocks. However, aquaculture also contributes significantly to marine pollution. Sherrington et al. (2016) estimate that fisheries generate 1,700 - 12,000 tonnes of ocean debris annually in the European Economic Area, while aquaculture adds 3,000 – 41,000 tonnes. Plastics such as nylon nets, fish cages, buoys, and processing materials are major contributors.

Despite its environmental impact, fishing and aquaculture are vital to the global economy. According to the Organisation for Economic Co-Operation and Development (OECD), the oceans add \$1.5 trillion to the economy annually, supporting 40 million jobs worldwide (Amirul, 2021). Fish export values have also surged from \$8 billion in 1976 to \$152 billion in 2017 (FAO, 2024b). However, marine pollution affects profits both directly and indirectly.

The costs associated with repairing damaged fishing vessels and aquaculture facilities are significant. For instance, the European Union spends approximately \$65.7 million annually on these repairs, representing 0.9% of the yearly fishing income (Mouat et al., 2010; Arcadis, 2014). Besides, ghost fishing where abandoned or derelict fishing gear continues to trap marine life also reduces fisheries resources, which leads to lost catch opportunities and financial losses for fishers (Iñiguez et al., 2016).

2. Tourism

Perceived annoying of beach litter

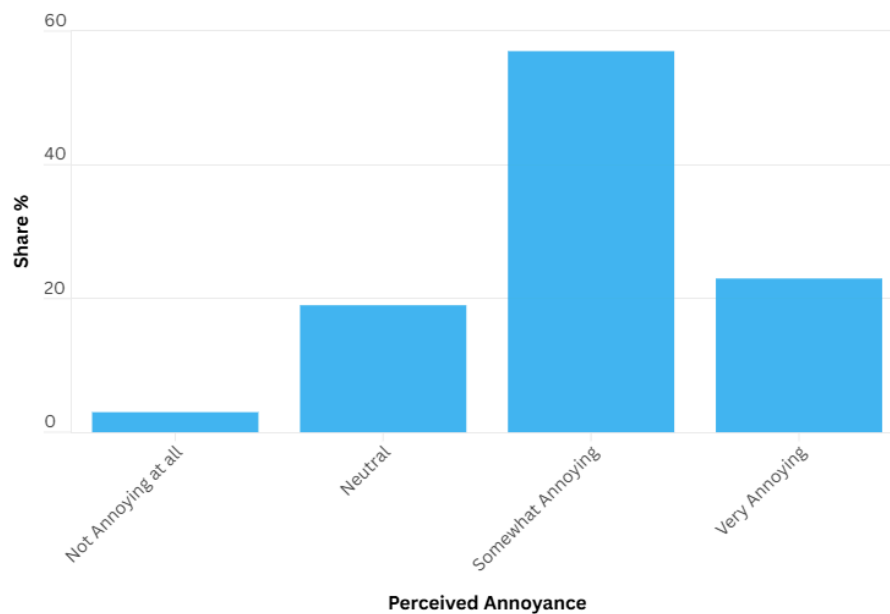


Figure 2. Perceived annoying of beach litter. (<https://doi.org/10.1080/09669582.2019.1684931>)

Furthermore, a survey on the perception of beach litter found that the majority of respondents (over 50%) consider it "Somewhat annoying," while smaller proportions find it "Very annoying" or "Not annoying at all" (Figure 2). This suggests that beach litter significantly impacts visitor experience, which may have broader implications for tourism.

Ocean-based tourism and recreation contribute approximately \$143 billion to the gross domestic product of the United States, providing employment for 2.5 million people. This highlights the industry's vital role in job creation ([NOAA, 2016](#)). However, tourism heavily relies on the natural environment, and the quality of these surroundings directly affects the competitiveness of destinations ([Smith, 1994](#); [Hsu et al., 2009](#)). Given the negative perception of beach litter, maintaining clean coastal areas is essential for sustaining tourism revenue and ensuring visitor satisfaction.

Marine litter not only degrades beach aesthetics but also diminishes tourists' enjoyment, ultimately shortening their visits ([Krelling et al., 2017](#)). This decline in visitor satisfaction has direct financial consequences— [McIlgorm et al. \(2011\)](#) estimate that marine debris results in an annual economic loss of \$622 million in the marine tourism sector across the Asia-Pacific region, representing a 0.3% decline in revenue.

3. Shipping and Maritime Trade

According to the United Nations Conference on Trade and Development (UNCTAD), global shipping handles over 80% of trade and contributes 1–3% of the world's GDP. However, industrial pollution poses serious risks, disrupting ecosystems, increasing costs, and threatening port infrastructure ([Ullah et al., 2023](#)).

One major issue is chemical discharges, including heavy metals and toxic effluents, which pollute port waters, creating navigation hazards and requiring costly repairs ([Garg et al., 2021](#)). Oil and chemical spills further disrupt shipping by causing temporary port closures and logistical delays, impacting global supply chains ([Kaiser, 2023](#); [Kennish, 1991](#)). For example, the 2011 Rena oil spill in New Zealand cost over \$130 million in clean up efforts and \$50 million in lost revenue due to port closures and delays.

Another concern is eutrophication, where excess nutrients from industrial waste trigger algal blooms, lowering water quality and driving up dredging costs. Meanwhile, the destruction of coral reefs and mangroves weakens coastal defenses, making ports more vulnerable to erosion and extreme weather, leading to expensive reinforcements ([Fanning et al., 2021](#); [Nagelkerken et al., 2002](#)).

Socioeconomic Inequalities

As we explore the economical impact on various sectors, marine pollution causes socioeconomic inequalities by disproportionately impacting **coastal communities**, particularly in low-income regions that depend on fishing, aquaculture, and tourism for their livelihoods. The depletion of fish stocks, contamination of seafood, and damage to tourist attractions **reduce incomes and job opportunities**, leaving poorer communities with limited options to adapt compared to wealthier regions or individuals who can shift to alternative

livelihoods. Additionally, polluted waters and contaminated seafood pose serious **health risks**, including gastrointestinal diseases, respiratory problems, and toxic chemical exposure, which are further compounded by limited access to healthcare and clean alternatives in economically disadvantaged populations. Marine pollution also undermines **access to clean water and seafood**—essential resources for subsistence in many coastal and island communities—forcing poorer populations to bear the brunt of declining resource quality, while wealthier groups can afford alternative food sources or advanced water treatment systems.

Technological Solutions

While many global technological innovations continue to explore and utilize the vast ocean that covers over 70% of Earth's surface, a growing number of research efforts focus on marine technology for conservation and reducing pollutants. In this commentary, I will highlight three of the most innovative and effective technologies currently tackling marine pollution.



First is *The Ocean Cleanup Project*, which aims to intercept plastic and solid waste before it reaches open water ([The Ocean Cleanup, 2022](#)). This ambitious project seeks to reduce global ocean plastic by 90% by 2040. With its ability to remove up to 100,000 kilograms of garbage daily from rivers, the Interceptor system uses floating barriers to guide plastic into a central collection point. The debris is then shuttled into dumpsters for recycling, creating a sustainable approach to waste management.

Fun fact: Malaysia is home to two Ocean Cleanup Interceptors—Interceptor 002 and Interceptor 005—both actively operating in the Klang River. ([Selangor Maritime Gateway, n.d.](#))



Secondly, its the *Autonomous Underwater Vehicles (AUVs)*. These robots, such as SeaSwarm Robots and RanMarine’s WasteShark, are pushing the boundaries of marine technology. Seaswarm Robots work as a fleet, or “swarm” of vehicles, which communicate their location through GPS and WiFi to autonomously collect oil spills without human intervention ([Senseable City Lab, 2023](#)). Meanwhile, RanMarine’s WasteShark, often described as an "aquatic Roomba," is designed to navigate water bodies and capture waste, including plastics, oils, and organic debris ([RanMarine, n.d.](#)). These innovative robots offer a scalable and cost-effective solution for monitoring and cleaning waterways, and are expected to reduce marine clean-up costs by 20% ([Andriolo et al., 2023](#))



Third is the *Seabin Project* ([Seabin, 2024](#)), a simple yet effective technology to clean surface-level pollutants in marinas, ports, and other water bodies. Acting like a trash can for the ocean, Seabins collect floating debris, microplastics, and even oil. One Seabin can capture an estimated 1.4 tons of debris a year at a cost of only \$1,095 dollars! ([Oceans Plastic](#)

[Cleanup, n.d.](#)) They provide a localized solution that is affordable and easy to deploy, making it a popular choice for combating pollution in urban coastal areas.

Investment Opportunities in Sustainability

As we discussed the major issues of marine pollution, addressing these concerns has also unlocked significant investment opportunities in sustainability, offering both environmental and financial returns. Blue bonds, such as Seychelles' \$15 million Blue Bond and Barbados' \$73 million Blue Bond, have successfully funded sustainable marine projects and the protection of marine ecosystems while providing steady returns to investors up to 6.5% interest rate annually ([Hale, 2023](#)). Similarly, ESG-focused investments are gaining traction, with notable examples like the Galapagos Marine Bond, which redirected \$550 million from Ecuador's restructured debt toward conserving the Galapagos Islands ([Oceans Finance Company, 2024](#)). Circular economy and marine innovation startups are also creating value by transforming recovered ocean plastics into consumer goods like clothing and packaging, highlighting the profitability of sustainable innovations. These initiatives align with global trends toward a greener economy, demonstrating the potential to drive progress while achieving strong financial outcomes.

Conclusion

Marine pollution is not only an environmental crisis but also an economic burden with far-reaching consequences. The fisheries, tourism, and shipping industries bear significant financial losses due to declining marine health, impacting jobs, trade, and livelihoods. While technologies like The Ocean Cleanup Project and the Seabin Project offer promising tools to curb pollution and restore marine ecosystems, their scope remains limited, and emerging challenges may further complicate their effectiveness. Nevertheless, the emergence of sustainable investment options, such as blue bonds and ESG-focused funds, underscores the dual potential for environmental recovery and financial gain. By committing to sustainable practices and coordinated global efforts, humanity can reframe this urgent crisis as a catalyst for innovation and inclusive prosperity, safeguarding our oceans for generations to come.

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