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Popular Article

Marine Ecosystem and Life-Threatening Pollutants

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Introduction

The marine ecosystem, the largest on Earth, covers 70% of the planet's surface and houses the majority of its living species. It contributes 50% of Earth's oxygen. According to the World Register of Marine Species (WoRMS), approximately 242,000 marine species have been identified as of 2022, with an average of 2,332 new species discovered annually. However, human activities pose significant threats to marine life, primarily through noise pollution, various forms of contamination and climate change. Overfishing, oil spills, plastic pollution, agricultural runoff, personal care products, prescription drugs, military sonar, deep-sea mining and industrial waste are major contributors to these threats.

Major Threatening Pollutions and pollutants

Plastic Pollution

Plastic pollution is a growing concern, predicted to outweigh all fish in the oceans by 2050. Annually, 19–23 million tonnes of plastic waste enter aquatic ecosystems, equivalent to 2,000 full garbage trucks daily. Marine species suffer from entanglement, ingestion, and toxic contamination, with over 100,000 marine mammals and over a million seabirds dying annually. Microplastics are found in all sea turtle species and in two-thirds out of 100 research papers on fish and plastic ingestion across 500 fish species.

Plastic Type	Description	Risks
Macroplastics	Plastics > 20 mm, such as fishing equipment, six-pack rings, and plastic bottles	Entangle and trap fish and marine mammals, causing malnutrition, injuries, and increased susceptibility to predators. Broken coral reefs hinder growth.
Mesoplastics	Plastics 5 to 10 mm, including pellets and pieces of larger polymers that have broken apart	Accumulate on the water's surface, mistaken for food by seabirds and marine life, leading to poisoning, asphyxia, and hunger.
Microplastics & Nanoplastics	Plastics < 5 mm, including microscopic	Easily ingested by wildlife, toxins

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	particles (e.g., granules in toothpaste and face washes), textile microfibers, and disintegrating larger plastics	absorbed by them can be transferred to fatty tissues of organisms. Long-term effects unknown due to recent discovery.

Agricultural Runoff

Agriculture, which uses 70% of global water, releases large amounts of organic waste, salty drainage, agrochemicals, and drug residues into water bodies. These pollutants pose risks to human health, aquatic ecosystems, and productive activities. Non-point source pollution from agricultural runoff is particularly challenging to control.

Personal Care Products

Cosmetics contain bioactive ingredients like polymers and preservatives that persist in the environment. Pharmaceuticals and Personal Care Products (PPCPs) include non-biodegradable chemicals, contributing significantly to pollution. These chemicals enter treatment facilities, landfills, and the environment, causing long-term ecological harm.

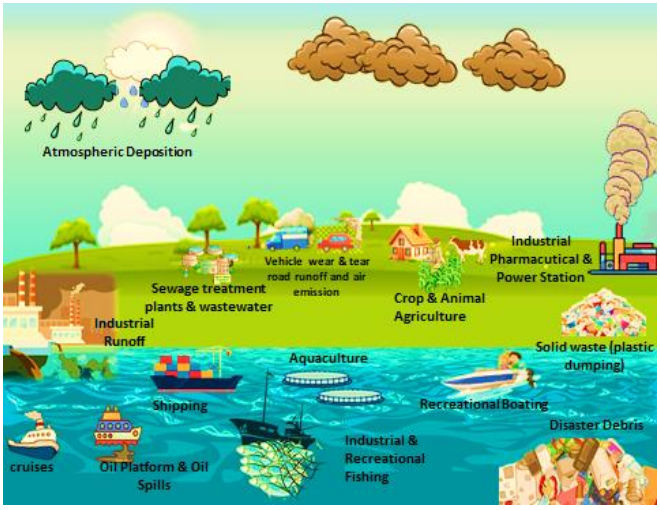
Prescription Drugs

Pharmaceuticals, essential for human health, pose rising threats to marine habitats. Contaminants from unused medications flushed or washed down drains and from pharmaceutical manufacturing plants enter waterways. These pollutants pass through water treatment facilities, affecting marine life. A recent comprehensive three-year investigation underscored the severity of pharmaceutical contamination in marine environments, revealing the presence of up to 17 different prescription medications in a single bonefish and detecting 58 distinct pharmaceuticals across a sample of 93 bonefish.

Major threats in marine system

Overfishing

Overfishing depletes breeding populations, threatening species like sharks and rays. Despite the significant employment in the fishing industry, overfishing persists due to inadequate regulation and



control. Overfishing disrupts ecosystems, such as coral reefs, and leads to issues like eutrophication. The Mediterranean Sea is a major hub for industrial fishing operations, with approximately 100,000 fishing vessels operating annually. Overfishing is a significant concern, with at least 75% of fish populations in this region being overexploited—a figure that escalates to 93% within European Union waters. Consequently, fish populations in the Mediterranean have plummeted by one-third.

Bluefin tuna, a highly prized species, has been particularly affected by overfishing, nearing extinction in the Mediterranean. Similar trends have been observed in the Pacific Ocean, where the bluefin tuna population has also been severely depleted.

Overfishing not only threatens individual species but also poses a grave risk to coral reef ecosystems. It disrupts the ecological balance, leading to the decline of various marine animals. For instance, overfished species like Baltic cod, which prey on sprat, create an imbalance. Sprat, a small fish that feeds on zooplankton, proliferates when cod populations dwindle. This imbalance reduces zooplankton numbers, which in turn allows algae to flourish unchecked. The resulting algae blooms lead to eutrophication, causing oxygen depletion in the water and the formation of "dead zones," areas where marine life cannot survive.

Military Sonar

Military sonar, used for testing, training, and navigation, disrupts marine life behavior, potentially causing harm or death. It can prevent whales from

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vocalizing and foraging, leading to starvation. Sonar has also been linked to widespread whale and dolphin strandings.

Deep-Sea Mining

Deep-sea mining involves dredging the ocean floor to collect minerals, destroying habitats of coral, sponge, and other marine life. It also affects unique species around hydrothermal vents and generates sediment clouds that can spread and harm marine ecosystems.

Oil Spills

Oil spills harm marine life, contaminate seafood, and spoil recreational areas. They cause physical damage and oil toxicity, leading to serious health issues for marine organisms. The 2010 Deepwater Horizon spill, the largest in US history, highlighted the long-term impacts of oil spills on marine environments.

Climate Change

Climate change significantly impacts marine life and ecosystems, causing warming oceans, rising sea levels, increased floods and droughts, and ocean acidification. The ocean absorbs 30% of carbon emissions and 91% of the heat from greenhouse gas emissions, leading to detrimental effects like the "deadly trio" of ocean acidification, sea warming, and deoxygenation.

Ocean Noise

Noise pollution from shipping, military activities, oil rigs, and seismic surveys threatens marine biodiversity. Noise interferes with marine species' communication, leading to behavioral changes and reduced commercial catches. It affects human food chains and increases bycatch. A 2018 study demonstrated that noise pollution can reduce commercial fish catches by up to 80%, as larger fish tend to avoid areas with elevated noise levels. Additionally, acoustic disturbances increase bycatch and reduce fish abundance. This noise pollution not only disrupts marine behavior but also affects human food chains.

Industrial Waste

Industrial waste, including chemicals, heavy metals, and sewage, alters ocean ecosystems, promoting algal blooms and causing health and reproductive issues in marine species. Radioactive waste from nuclear power plants and hazardous chemicals like DDT contribute to long-term ecological damage.

Mitigation Approaches for Pollutants

1. **Reduce Plastic Production and Waste**

   Implementing policies to limit plastic production and promoting alternatives can reduce the influx of plastic into marine ecosystems. Encouraging recycling and supporting innovations in biodegradable materials are crucial steps.

1. **Improve Wastewater Systems**

   Upgrading wastewater treatment facilities to filter out pharmaceuticals and other harmful chemicals can prevent contaminants from reaching marine environments. Implementing stricter regulations on industrial discharge is also essential.

2. **Utilize Environmentally Friendly Products**

   Promoting the use of eco-friendly personal care products and cosmetics that do not contain harmful chemicals can reduce pollution. Labels should provide information on environmentally persistent compounds, allowing consumers to make informed choices.

3. **Reduce Chemical Pollutants**

   Enforcing regulations on agricultural runoff and industrial waste can mitigate the entry of harmful chemicals into water bodies. Encouraging sustainable farming practices and proper disposal of pharmaceuticals can

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also help.

4. **Control Oil Spills**
   Developing better technologies and protocols for preventing and responding to oil spills can minimize their impact. Regular inspections and maintenance of oil drilling platforms and transportation systems are critical.
5. **Cleanups of Rivers and Beaches**
   Organizing and supporting community clean-up efforts for rivers, beaches, and other coastal areas can help remove accumulated waste. These initiatives raise public awareness and encourage responsible behavior.
6. **Tracking and Evaluating Performance**
   Implementing systems to monitor pollution levels and the effectiveness of mitigation measures can guide policy adjustments. Regular assessments ensure that strategies remain effective and adapt to emerging challenges.
7. **Promoting Sustainable Fishing Practices**
   Establishing and enforcing sustainable fishing regulations can prevent overfishing. Supporting aquaculture and alternative livelihoods for fishing communities can reduce pressure on marine resources.

Conservation Acts for Marine Systems

Numerous international and national regulations aim to protect marine ecosystems. These include the Clean Water Act, Endangered Species Act, Marine Mammal Protection Act, and various international conventions like UNCLOS and CITES. Effective implementation and enforcement of these laws are critical to safeguarding marine biodiversity. The list of major Acts:

- The Wild Life (Protection) Act, 1972, establishes a framework of laws to safeguard different kinds of wild animals and plants, manage their natural habitats, and regulate and control the trade in wild animals, plants, and products derived from them.
- The Merchant Shipping Act, 1958 is a comprehensive legislation dealing with merchant shipping in India
- Magnuson-Stevens Fishery Conservation and Management Act (1976) - Governs marine fisheries management in U.S. federal waters.
- Coral Reef Conservation Act (2000) - Provides for the conservation and protection of coral reefs.
- Antarctic Marine Living Resources Convention Act (1984)- Implements international conservation measures for marine living resources in Antarctica.
- Shark Finning Prohibition Act (2000) - Prohibits the practice of shark finning in U.S. waters.
- United Nations Convention on the Law of the Sea (UNCLOS) (1982) - Establishes legal framework for marine and maritime activities.
- Convention on Biological Diversity (CBD) (1992) - Aims to conserve biological diversity, including marine biodiversity.
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (1973) - Regulates international trade in specimens of wild animals and plants.
- International Convention for the Regulation of Whaling (1946)- Establishes the International Whaling Commission to regulate whaling and conserve whale populations.

Conclusion

Mitigating the threats to marine ecosystems is an imperative that demands a comprehensive and multifaceted approach. The complexity of marine pollution and its wide-ranging impacts on

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biodiversity necessitate coordinated efforts across policy-making, technological advancement, and public engagement.

1. **Policy Changes:** Enforcing stringent regulations on pollution, overfishing, and habitat destruction is essential. International cooperation through treaties and conventions, such as UNCLOS and CITES, provides a framework for protecting marine biodiversity. National laws, including the Clean Water Act and the Endangered Species Act, must be rigorously implemented and periodically updated to address emerging threats.
2. **Technological Innovations:** Investing in advanced wastewater treatment facilities can significantly reduce the flow of harmful chemicals and pharmaceuticals into marine environments. The development of eco-friendly materials, such as biodegradable plastics, can mitigate the impact of plastic pollution. Technologies for early detection and rapid response to oil spills and other marine disasters can minimize long-term ecological damage.
3. **Public Engagement:** Raising awareness about the consequences of marine pollution and overfishing is crucial. Educational programs and public campaigns can foster a culture of environmental stewardship. Community involvement in clean-up efforts and sustainable practices can lead to significant positive changes.
4. **Sustainable Practices:** Promoting sustainable fishing methods and alternative livelihoods for fishing communities can alleviate the pressure on marine resources. Encouraging the use of environmentally friendly personal care products and responsible disposal of pharmaceuticals can reduce the introduction of harmful substances into the ocean.
5. **Conservation Efforts:** Protected marine areas and sanctuaries play a vital role in conserving biodiversity. Effective management of these areas, along with restoration projects for damaged ecosystems, can help maintain the ecological balance. International efforts, such as the Convention on Biological Diversity, underscore the global commitment to preserving marine life.
6. **Research and Monitoring:** Continuous research is necessary to understand the long-term effects of pollutants, such as microplastics and pharmaceuticals, on marine life. Monitoring pollution levels and assessing the effectiveness of mitigation strategies can guide policy adjustments and ensure that efforts remain impactful.

By addressing the root causes of pollution, implementing sustainable practices, and fostering global cooperation, we can protect the marine ecosystem and its diverse species. This collective action is not only vital for the health of our oceans but also for the well-being of future generations who depend on the myriad benefits provided by a thriving marine environment.

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