The Plastics Plague

MARINE MAMMALS AND OUR OCEANS IN PERIL

A Report by the International Marine Mammal Project of Earth Island Institute • 2022

INTERNATIONAL MARINE MAMMAL PROJECT
A PROJECT OF EARTH ISLAND INSTITUTE

Acknowledgments

Edited by Mark J. Palmer, Associate Director, and Mary Jo Rice, Associate Director, International Marine Mammal Project, Earth Island Institute. Additional editorial assistance from Hannah Hindley.

Hot Spot Research and Analysis by:

Natasha Batista (MS BS - Stanford University)
Sadie Cwikiel (MS BS - Stanford University)
Vicky Fong (BS - University of California, Berkeley)
Lilah Mccormick (Prospective BS 2024 - Stanford University)
Fiona Mulhern (BS - Santa Clara University)
Tara Van Hoorn (BS 2022 - University of California, Berkeley)

Special thanks to Dr. Ingrid Visser, Orca Research Trust, and Captain Charles Moore, Algalita Marine Research Foundation, who reviewed portions of this report. Illustrations on pages 34 and 39 by Sophia Zaleski. Proofreading by Elizabeth Farry.

A number of government agencies and nonprofit organizations contributed information, shared resources, and reviewed sections of our report. We would like to thank the many individuals working with those agencies and organizations for their help, including:

- National Marine Fisheries Service, USA
- National Oceanic and Atmospheric Administration, USA
- The Marine Mammal Center, USA
- Department of Environmental Science, Queensland Government, Australia
- Queensland Shark Control Program, Australia

Additionally, we are grateful to the scientists and journalists who contributed data and recommendations.

Our IMMP team expresses appreciation to the foundations whose funding made this report possible.

The International Marine Mammal Project works to protect whales, dolphins, and their ocean homes. This report is part of our nonprofit educational efforts.

All conclusions in this report are by the International Marine Mammal Project of Earth Island Institute, which takes full responsibility for its contents.

Cover photo: Hawai'ian Monk Seal caught in fishing tackle off KureAtoll, Pacific Ocean © Michael Pitts/NPL/Minden Pictures.
Design: Monica DuClaud

Printed on 100% post-consumer recycled paper, FSC certified, Green-e certified, processed chlorine-free.

Introduction

On February 14, 2020, a whale-watching boat out of San Diego, California, spotted an enormous whale leaping out of the water. The vessel drew closer to watch. The humpback breached again and again, breaking the surface with thunderous splashes. Soon, astonishment turned to horror as the spectators saw that the whale's body and mouth were tangled tightly with green netting. The frantic whale thrashed and dove, violently trying to rid itself of the deadly meshes. Rescuers arrived, hoping to cut the net away, but they were unable to safely approach the agitated, school bus-sized animal.

The following day, the humpback was sighted again, farther north—still moving too erratically for safe rescue efforts. All up the California coast, whale watchers and response teams stood by, hoping for another sighting and another chance to help the panicked animal.

Sadly, the fate of that whale, and many like it, is unknown. Perhaps it shook free of the netting; perhaps it died at sea and sank.[1]

Wildlife photographer and whale watch operator Dominic Biagini, the first to sight the breaching whale, shared his pictures on Instagram: thick green cords drawn tightly across skin; water agitated into a white froth. Biagini wrote, "I don't have the words to describe the heartbreak."

Commercial killing in the 19th and 20th centuries drove many marine mammals to the edge of extinction. Those vulnerable populations continue to rebound, but as the devastation of industrial whaling diminishes, new and more insidious threats are emerging. Of these dangers, the most ubiquitous is plastic—plastic nets and fishing lines, and plastic debris from our throw-away culture. The results are lethal:

- More than 300,000 dolphins, porpoises, and small whales are killed globally every year as a result of entanglement in fishing gear.[3]
- Plastic fishing gear now poses the most deadly environmental threat to whales, dolphins, seals, and sea lions worldwide.[4]
- Many species of endangered marine mammals, such as the North Atlantic right whale (*Eubalaena glacialis*), the vaquita (*Phocoena sinus*), and the Hawaiian monk seal (*Monachus schauinslandi*), are being driven toward extinction—not only through direct killing by humans, but more often from entanglement in plastic fishing nets and lines and ingestion of plastic waste. The last Irrawaddy dolphin in Cambodia was found dead in March 2022, drowned in a gillnet.[5]
- The ingestion of plastic pieces and microplastics by marine mammals is escalating the death toll by starvation, drowning, and suffocation.
- With an estimated life span of at least 450 years, plastic debris is a persistent threat to virtually all life in the oceans.[6] Plastic bits in the ocean contain toxic materials and act as magnets that concentrate toxic pollutants in the water, such as pesticides and hormone-disrupting toxicants.

"Kingtide": A Sea Lion Ziplocked to Death

On January 22, 2019, an adult female California sea lion was found stranded on Moss Beach (Fitzgerald Marine Reserve) in San Mateo. The rescue team found the weak and distressed sea lion, named Kingtide, suffering from a major shark bite and swelling of its back legs. Just one day after being admitted into the animal care hospital at The Marine Mammal Center based in Marin County, CA, Kingtide endured a seizure so intense that the veterinarians chose euthanasia to end her pain. Time of death: 2:09pm, January 25, 2019.

Although Kingtide's death was initially attributed to the shark bite, the true cause of death was unveiled in the necropsy (an autopsy on animals). The sea lion's nasal passage was infected with mites, leading down to a stomach filled with more than 50 nematodes (parasitic roundworms) floating in a mysterious green fluid with the culprit—a single plastic Ziploc bag.

The purpose of this report is threefold:

- To illustrate the dangers of fishing gear and plastic waste to marine mammals by highlighting specific hot spots around the world. Specificity like this provides sharp focus and tangible starting points for addressing an otherwise overwhelming problem.
- To identify major plastics producers; identify fisheries that imperil marine mammals; and name the manufacturers of plastic fishing gear that entangles marine mammals and is often discarded. Holding these companies at the root of the problem accountable will fuel powerful change.
- To establish a plan of action for decision-makers to address existing plastic dangers and propose long-term solutions to rid the oceans of the plastics plague. Facts without forward movement aren't enough.

This report is based on scientific research, consultations with marine mammal scientists and conservationists, and analysis of data sets provided by various researchers, organizations, and governments on stranding records and plastic ingestion by stranded marine mammals.

Plastics and Marine Mammals

As more and more fishing gear and marine debris choke our oceans, marine mammals face mounting risks of serious injury or death by entanglement. They are also increasingly harmed through direct consumption of plastics or through eating prey that have consumed plastics. High loads of toxins from plastics build up in the bodies of marine mammals, and plastics can cause blockages or pierce the linings of stomachs and intestines.

Entanglement Issues

Entanglement can wound and kill. If marine mammals are unable to free themselves from an entanglement, they drag the heavy plastic net or fishing lines with them. This is an enormous energy burden and puts them at greater risk of predation, and it is also physically traumatic. Cuts from nets and lines lead to infections and sometimes cause deep fatal wounds, even the severing of limbs, tails, and fins.

Sometimes death comes from the sheer pressure or weight of the entanglement: tangled gear can suffocate or drown a trapped mammal.[7]

Fishing Gear: A Plastics Problem

Virtually all modern fishing gear—fishing lines, fish trap lines, and nets—is made from plastic.

The most common fishing gear responsible for marine mammal entanglements are gillnets. These walls of plastic netting hang in the water column with specific mesh sizes that allow fish to only get their heads through and catch their gills as they try to back out of the net. While marine mammals are generally larger than the species of fish the nets are targeting, smaller body parts like fins, beaks, and tails often snag in the mesh.

In addition to gillnets, the plastic lines used to secure crab pots and lobster traps to surface buoys create serious risks for many cetacean species, such as the critically endangered North Atlantic right whale.[8] Depending on areas of use and fishing practices, other types of nets and lines can also entangle, injure, and drown marine mammals.

Ingestion Issues

Parts of the sea are more plastic than fish by volume. In these waters, marine mammals can suffer slow deaths from starvation as their stomachs fill with plastic instead of food. Plastic debris lodged in airways suffocates and kills.[9] Marine mammals are increasingly at risk; in the North Pacific Ocean alone, concentrations of microplastics have increased more than 100 times in the last four decades.[10]

“Water and air, the two essential fluids on which all life depends, have become global garbage cans.”

—Jacques Yves Cousteau, naval officer and marine conservationist[2]

Plastic in the Alps. Photo by panaramka.

Marine mammals are also subject to slow poisoning by toxins in plastics, and that adhere to plastics, that impair their mental awareness and increase their vulnerability to predation, entanglements, and other human-caused trauma such as boat strikes.[11]

Studies around the world have found microplastics in more than a third of the stomachs of fish species sampled, either from direct consumption or from eating smaller organisms like zooplankton and fish that had eaten plastics.[12,13,14] Marine mammals that eat fish or other smaller organisms that have already ingested plastic are exposed to the same physical and chemical risks, magnified by the number of animals they eat.

A New Species Discovered Due to Death by Plastic

*Imagine discovering a species entirely new to science. Imagine, too, that the only known specimen is a dead body. Biologists recently identified a new species of baleen whale, Rice's whale (*Balaenoptera ricei*), found in the Gulf of Mexico, and previously believed to be a form of Bryde's whale (*Balaenoptera edeni*). The species was discovered because a dead individual washed up after its stomach lining was pierced by a piece of plastic. Only 50 individuals of this species are believed to survive.*[15]

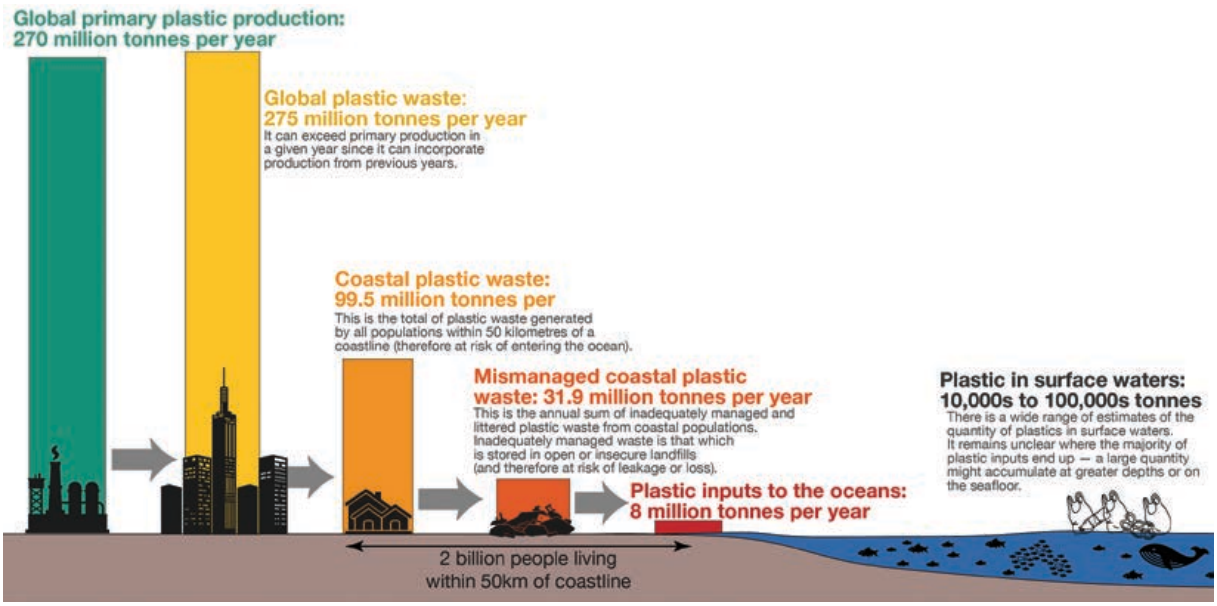
Plastic in the Ocean Is Everywhere

Everything flows toward the sea. Plastic makes its way into the ocean in a variety of ways, carried by rivers, storm-water runoff, and wastewater discharges, swept from beaches, and carried by wind. Land-based sources of plastic contribute approximately 80% of plastic debris in the oceans, while maritime sources are responsible for the other 20%.[16]

An estimated total of 5.3 million to 14 million tons (4.8 million to 12.7 million metric tons) of plastic waste enter the ocean each year.[17] This amount of plastic could fill nearly enough garbage trucks, parked end-to-end, to encircle the entire globe.

THE PATHWAY BY WHICH PLASTIC ENTERS THE WORLD'S OCEANS

Estimates of global plastics entering the oceans from land-based sources in 2010 based on the pathway from primary production through to marine plastic input.



Source: based on Jambeck et al. (2015) and Eriksen et al. (2014). Icon graphics from Noun Project. Data is based on global estimates from Jambeck et al (2015) based on plastic waste generation rates, coastal population sizes, and waste management practices by country. This is a visualization from OurWorldInData.org, where you will find data and research on how the world is changing. Licensed under CC-BY-SA by the authors.

Hannah Ritchie and Max Roser (2018) "Plastic Pollution," OurWorldInData.org. https://ourworldindata.org/plastic-pollution

A CALL TO ACTION

Ending the plastic plague in our oceans requires acts of reimagining our lifestyles and restructuring our industries. To save whales, dolphins, seals, and sea lions from suffocation, injury, starvation, and drowning, we must take immediate, intentional strides, changing how we live and consume, as well as pushing for essential changes in materials and practices used by the fishing, plastics, and petrochemical industries.

Technologies for alternative plastics exist; these must be far more widely developed and accompanied by legislation requiring their use. This calls for expanded action by local, state, federal, and international governments to ensure that plastic products are replaced by biodegradable and ecologically sustainable alternatives.

The plastic industry itself—the oil and petrochemical companies, makers of plastic products, net and fishing line producers, and other companies responsible for plastic products that are pouring into the ocean—must be made to pay for cleanup, recycling, and damages caused by their products.

The Committee on the United States Contributions to Global Ocean Plastic Waste has called for an extensive program in the US to research, reduce, and prevent plastic pollution in the ocean through reductions in plastic production and "leakage" from the waste management stream.[18] That such a huge government management process is not already in place is an indication of how serious the problem has become in a very short time and how important it is for the federal government to prioritize addressing the plastics peril.

Through our report, we aim to empower citizens and guide policy makers to take strong, solutions-based action against the growing threat that plastics pose to the fate of marine mammals and all of us who depend on ocean ecosystems. We also seek to outline steps that people can take to change consumer and company policies. We must act together and quickly to avert this worsening crisis.

1. Fox Five News, San Diego (2020) https://fox5sandiego.com/news/whale-seen-tangled-in-net-struggling-as-it-swims-up-coast-from-san-diego/

2. *Naturaler* (2019) https://naturaler.co.uk/quotes-on-plastic-pollution/

3. World Wildlife Fund (Accessed 9/18/21) https://www.worldwildlife.org/threats/bycatch

4. Reeves, Randall R., Kate McClellan, and Timothy B. Werner. "Marine mammal bycatch in gillnet and other entangling net fisheries, 1990 to 2011." *Endangered Species Research* 20, no. 1 (2013): 71-97.

5. Bennet, P., "Last Freshwater Irrawaddy Dolphin in Cambodia Died Tangled in a Fishing Net, Officials Say"; *EcoWatch* (2022) https://www.ecowatch.com/irrawaddy-dolphin-cambodia-death.html

6. Whiting, K., "This is how long everyday plastic items last in the ocean"; World Economic Forum (2018) https://www.weforum.org/agenda/2018/11/chart-of-the-day-this-is-how-long-everyday-plastic-items-last-in-the-ocean/

7. Moore, S. L., M. Sutula, T. V. Bitner, G. Lattin, K. C. Schiff. "Southern California Bight 2013 Regional Monitoring Program: Volume III. Trash and Marine Debris." Southern California Coastal Water Research Project Authority, Technical Report 928 (2016).

8. Stevens, Bradley G., "The ups and downs of traps: environmental impacts, entanglement, mitigation, and the future of trap fishing for crustaceans and fish." *ICES Journal of Marine Science* (2020).

9. Gregory, Murray R. "Environmental implications of plastic debris in marine settings—entanglement, ingestion, smothering, hangers-on, hitchhiking and alien invasions." *Philosophical Transactions of the Royal Society B: Biological Sciences* 364, no. 1526 (2009): 2013-2025.

10. Secretariat of the Convention on Biological Diversity. "Impacts of Marine Debris on Biodiversity: Current Status and Potential Solutions." *Technical Series* No. 67 (2012): 61.

11. International Whaling Commission. "Report on IWC Workshop on Mitigation and Management of Threats Posed by Marine Debris to Cetaceans." *IWC* 65 (2014): CC Rep 04.

12. Lusher, Amy L., Matthew Mchugh, and Richard C. Thompson. "Occurrence of microplastics in the gastrointestinal tract of pelagic and demersal fish from the English Channel." *Marine Pollution Bulletin* 67, no. 1-2 (2013): 94-99.

13. Boerger, Christiana M., Gwendolyn L. Lattin, Shelly L. Moore, and Charles J. Moore. "Plastic ingestion by planktivorous fishes in the North Pacific Central Gyre." *Marine Pollution Bulletin* 60, no. 12 (2010): 2275-2278.

14. Avio, Carlo Giacomo, Stefania Gorbi, and Francesco Regoli. "Experimental Development of a New Protocol for Extraction and Characterization of Microplastics in Fish Tissues: First Observations in Commercial Species from Adriatic Sea." *Marine Environmental Research* 111 (2015): 18-26.

15. Roman, Joe. "America's New Whale Is Now at Extinction's Doorstep." *New York Times*. March 6, 2021. https://www.nytimes.com/2021/03/06/opinion/discovery-whale-extinction.html

16. Andrady, Anthony L. "Microplastics in the marine environment." *Marine Pollution Bulletin* 62, no. 8 (2011): 1596-1605.

17. Jambeck, Jenna R., Roland Geyer, Chris Wilcox, Theodore R. Siegler, Miriam Perryman, Anthony Andrady, Ramani Narayan, and Kara Lavender Law. "Plastic waste inputs from land into the ocean." *Science* 347, no. 6223 (2015): 768.

18. The National Academies of Sciences, Engineering, and Medicine. *Reckoning with the U.S. Role in Global Ocean Plastic Waste.* Washington, DC: The National Academies Press, (2021). http://doi.org/10.17226/26132

Solutions

Science alone, without solutions, won't drive the scale of change that is necessary to tackle ocean plastics. The International Marine Mammal Project (IMMP) of Earth Island Institute offers recommendations for action.

Can We Stop Strangling Our Seas?

Tracked by a team of scientists, a single plastic bottle tossed in the Ganges River traveled nearly 2,000 miles in only three months. The reach of plastics is planetary in scale; no single nation can claim responsibility or own the solutions. The answer lies in collaborative ingenuity and international solidarity. The scale of the crisis calls for a global treaty among other worldwide actions. Nations' leaders must be lobbied to develop rules and secure commitments to force urgent change.

Global action is not beyond reach. The United Nations enacted a global ban on the use of high-seas fishery driftnets in 1992 because of the deaths and injuries of dolphins, whales, and other species. The effects of plastic entanglement and pollution are even direr now. The use of smaller gillnets inshore, along with plastic pollution pouring ever more heavily into the ocean, each year harms or kills tens of thousands of marine mammals.

International commitments do not come about without work. Pressure—intense and persistent—will be necessary to ensure that the United Nations Environmental Assembly, the world's highest-level decision-making body on the environment, effectively takes up the matter of global plastic pollution.

As an example, the International Marine Mammal Project of Earth Island Institute, alongside 140 countries and more than 700 groups, has called for establishment of a legally binding international treaty to address the plastics crisis. Earth Island Institute's Plastic Pollution Coalition Project attended the Nairobi UN Environment Assembly sessions February 28th to March 2, 2022, which successfully negotiated preliminary steps to establish a global plastics treaty, endorsed by 175 countries.

Unfortunately, it is not clear that this treaty proposal will address issues involving fishing gear, which comprise a major portion of ocean plastic and are responsible for the entanglement and drowning of thousands of marine mammals annually.

Specialized agencies and treaties under the United Nations, such as the International Maritime Organization (IMO), have made it illegal—at least on paper—for ships to dump plastic anywhere in the world. But imposing such restraints requires on-the-ground implementation by member nations. The IMO must ramp up its institutional pressure to improve enforcement efforts by member nations, which often fall short, rendering the laws and treaty ineffectual.

IMMP fully endorses an international treaty that will require mandatory reduction of plastics production and use, a ban on plastics disposal in the marine environment, and vigorous enforcement. This must occur at local, national, and international levels.

HOLDING PLASTIC MANUFACTURERS ACCOUNTABLE

Single-use plastics clog the oceans—millions of tons every year—and the life cycle of plastic begins with oil and gas. The climate consequences of oil extraction mean that from its origin at drill sites to its slow death at sea, plastic wreaks immeasurable havoc—not just for marine mammals but also for all life on earth. The world's major oil and gas corporations, including ExxonMobil (US), PetroChina and Sinopec (China), and

Saudi Aramco (Saudi Arabia) generate the most plastic pollution. Other companies, such as Dow Chemical and ExxonMobil Chemical (US), that produce polymers and products derived from petroleum also hold major responsibility for the plastics plague.

This entire supply chain must be required—by treaties, by laws, by media scrutiny, by consumer pressure, and by litigation—to help fund the development of alternatives that are truly recyclable yet benign to marine life when they decompose. This is critical in freeing the planet from the legacy of fossil fuels.

Plastic substitutes can be made from more sustainable sources such as corn starch that break down in the ocean into harmless components. Despite millions of dollars spent by the plastics industry to convince the public otherwise, it is well established that most plastics cannot be recycled. That same level of investment could be funneled toward the mass production of sustainable alternatives that could carry us into a new era. Marine life is magnitudes more valuable than industrial profit. While visionary internal leadership might transform the industry from within, it is the obligation of governments to establish enforceable mandates.

IMMP asserts that the plastics industry be required to subsidize costs associated with remediating the harm it has created. Precedent shows that this is possible. The cigarette industry has been forced to compensate society for the health problems caused by smoking. Oil, gas, and coal companies are being challenged to fund ways to address global warming caused by the burning of their products. The plastics industry, too, should be called upon to fund efforts to prevent and mitigate the devastation to marine mammals and the ocean caused by plastic pollution.

IMMP is a plaintiff in a landmark lawsuit filed by Earth Island Institute against ten major food, beverage, and consumer goods companies—giants such as Coca-Cola, Clorox, PepsiCo, and Nestle—to hold them accountable for their plastic pollution and false claims of recyclability. “Earth Island Institute v Crystal Geyser Water et al.” aims to compel them to take financial responsibility for preventing and mitigating the effects of plastic pollution on humans, wildlife, oceans, and waterways in California, where the impacts are particularly acute.

Well-informed legislation is tricky without clear reporting on the activities of plastics manufacturers. Historically, these polluters have concealed critical information about their operations and products, by way of private incorporation, or establishing operations in foreign nations with little to no public scrutiny or environmental laws. Policy makers, enforcement agencies, scientists, the media, and the general public all must know what practices these manufacturers follow, which chemicals they are making and using, and how and where they dispose of their waste. Strong environmental laws must require industries to disclose the specific products they make and where the products are used.

CONFRONTING PLASTIC POLLUTION AND ENTANGLEMENT BY THE FISHING INDUSTRY

From remote Pacific islands to isolated Arctic shores, from dolphins drowned by the weight of tangled nets to whales with tails severed from binding lines, discarded fishing gear accounts for the heaviest plastic pollution in the ocean. Just as with polymer producers, the makers of fishing gear must also be held accountable for the entanglement and ingestion deaths and injuries of marine mammals and other marine life. These makers should be funding measures to protect marine life and employing substitutes for materials that do not break down naturally in seawater. Transparency in their operations is also imperative.

The fishing industry must adhere to the following:

- Indelibly mark plastic fishing gear with the origin of the gear, to enable better monitoring.
- Plastic gillnets, the worst threat to marine mammals, should be banned by international agreement.
- Nations and international regional fisheries management organizations must establish—and enforce—mandatory retrieval of discarded fishing nets and recycling of plastic fishing gear.
- MARPOL convention regulations on dumping of plastics at sea must be strengthened, setting plastic reduction mandates and enforcement measures.
- Current plastic Fish Aggregating Devices (FADs) should be phased out. New FADs should be constructed of materials that do not entangle marine life and that are fully biodegradable.
- Marine protected areas, sanctuaries, and monuments should prohibit commercial fishing and the plastic pollution associated with these activities. Plastic fishing gear should be phased out and replaced by biodegradable gear that does not entangle or harm marine life.
- Fishing companies and governmental programs should establish plastic net buyback programs, net retrieval rules, and plastic fishing net recycling requirements.

Polymer producers, net and line makers, and the commercial fishing industries should be held accountable for the harm they cause marine species. They should be required to provide the funding necessary to:

- Pay fishers to remove and recycle their dangerous entangling fishing gear, such as plastic gillnets.
- Reimburse fishers for using alternative gear, such as ropeless traps for lobster and crab.
- Provide training to fishers around the world to fish in a sustainable manner without plastic gear.
- Provide skills training for alternative work for fishers if fishing is not viable.
- Pay for cleanups in areas where removal and recycling of discarded plastic fishing products are feasible.

US FISHERIES REGULATORY STEPS NEEDED

In order to save marine mammals and ocean ecosystems, fisheries must transition to alternative gear and methods of fishing.

Fisheries that use plastic nets and lines kill more than 300,000 small whales and dolphins every year.

In 2021, the US Congress introduced legislative packages to address the plastic crisis, including proposals named "Break Free from Plastics Act" and the "Ocean-Based Climate Solutions Act." These bills are garnering significant support and should be enacted by Congress.

There are also key regional proposals for new laws. In the case of right whales in the northwest Atlantic, the US National Marine Fisheries Service has proposed a new Atlantic Large Whale Take Reduction Plan, aimed at controlling ship strikes and fisheries that entangle critically endangered right whales in particular. However, the proposed rules do not cover all of the right whale's territory and contain other flaws. These regulatory proposals must be strengthened and implemented as soon as possible. In 2022, new legislation has been introduced in the US House and Senate to provide better protection to right whales, called the "Right Whale Coexistence Act."

Advances in technology, if accompanied by robust and enforced regional laws, could offer a survival path for right whales. Researchers are developing ropeless fishing gear for lobster and crab traps, potentially eliminating entanglement of right whales in lobster and crab trap gear. Instead of being tethered to plastic lines and surface buoys, ropeless gear allows the traps to be released from the bottom and rise to the surface where they can be retrieved by the fishers. Ropeless traps are currently more expensive than traditional traps with plastic lines. Government subsidies would help lower the price. Similar ropeless gear has been proposed in California to protect endangered whales.

Elsewhere, local laws are reducing dolphin entanglement. In the Eastern Tropical Pacific, the establishment of the Dolphin Safe tuna program by the International Marine Mammal Project, codified in US law, slashed the number of dolphin entanglement deaths in plastic purse seine nets to officially fewer than 1,000 dolphins per year since 2011, compared with 80,000 to 100,000 dolphin deaths annually in the late 1980s.

Regional programs like this must be modeled and scaled up by other nations. In particular, Mexico, Colombia, and Venezuela must be pressured to illegalize the fishing practice of chasing, netting, and drowning dolphins to catch tuna. The vast majority of global tuna fishing operations do not engage in the intentional encircling of dolphins with mile-long nets. The monitoring of fisheries by nations, regional organizations, and nonprofit entities—including IMMP—should be tasked with reporting on the effects of plastic net and line entanglement of marine species. IMMP and others are proposing that remote electronic monitoring with onboard closed-circuit cameras be put on all tuna vessels to help monitor and track fishing practices and their effects on dolphins and other marine species.

Positive Steps Forward

The changes that we call for are sweeping, but achievable. Here are examples of people taking action to combat the harm of plastic pollution to marine life:

CALIFORNIA TACKLES MICROPLASTICS WITH ACTION PLAN

The California Department of Natural Resources has proposed 22 actions to address microplastics and issues around plastic pollution. Plans include banning single-use plastic bags and other similar items in

© Rosanne Tackaberry/Alamy Stock Photo

Abandoned fishing nets, ropes, and other marine debris washed ashore by ocean currents, collected to be shipped off island for recycling or disposal. Midway Atoll National Wildlife Refuge, Hawai'ian Islands, USA

the state and preventing plastics from getting into the environment. California is the first state to take this important action, and other states are likely to adopt similar programs.

CALIFORNIA GILLNET FISHERY

California, the most populous state, has banned almost all use of plastic gillnets. This ban—reflecting the work of the California legislature, conservationists, and the fishing industry—has decreased use of plastics for fishing in California state waters. The ban has also reduced the entanglement of marine mammals such as harbor porpoises (*Phocoena phocoena*), sea otters (*Enhydra lutris*), and harbor seals (*Phoca vitulina*). A final gillnet fishery, known as the offshore shark and swordfish driftnet fishery, is being phased out, in part through government buybacks of the gillnets from the fishers.

FISHING NET RECYCLING

In the town of Unalaska, Alaska, local fishers and conservationists collaborate, collecting old plastic nets and sending them to Denmark for recycling. In 2020, the town gathered 240,000 pounds (109,000 kilograms) of plastic nets for recycling.

DISENTANGLING MARINE MAMMALS FROM PLASTIC NETS

All along the coastlines of the US, an extended network of responders stands at the ready for news of entangled marine mammals. These scientific institutions, government agencies, and nonprofit organizations are at the frontlines of disentanglement operations. They rescue mammals from nets and lines, share information, document deaths and strandings, and train personnel. Such efforts are important but incomplete, as many animals die at sea, never having been recorded or rescued. Some scientists put the number of unobserved marine mammal deaths at 10 to 20 times higher than those stranded, seen, or rescued.

BANNING SINGLE-USE PLASTIC ITEMS

Whole ecosystems and the marine mammals that call them home are devastated not just by plastic fishing gear, but by the deluge of single-use plastics that chokes our oceans. Around the world, there have been bans established on single-use plastics, such as plastic bottles and grocery bags. These successful efforts were made possible by pressuring local governments, retailers, drink makers, and other plastic polluters.

Steps You Can Take

From greenhouse gases to plastics and everything in between, industry accounts for an enormous share of global damage, and legislation will be essential for the scale of change necessary to shift the norm. However, this doesn't discount the critical importance of individual engagement. Plastics companies are able to fuel complacence by funding studies that make us feel that recycling is enough and that change is the responsibility of consumers. Governments easily make public gestures toward change without tangible follow-through. Collectively, our individual actions hold enormous power to steer industry and government alike.

INSPIRATION FOR CHANGE

Environmental action is fueled not just by fear of collapse, but most powerfully by our love of the natural world. We encourage those of you who have the capacity to share time in nature with children to do so for your own pleasure, as well as for the opportunity to nurture the next generation of environmental stewards. So, lace up your walking shoes, pack a lunch, strap on your daypack, and head out with a young person to enjoy something you love in the incomparable, beautiful outdoors. Such direct connection can ignite a lasting commitment to protect nature and will help in safeguarding ocean life from plastic pollution.

ELIMINATE SINGLE-USE PLASTIC

Decrease and eliminate personal use of plastics. Purchase products that are not packaged or shipped in plastic and avoid single-use plastics. The Plastic Pollution Coalition, a project at Earth Island Institute, shows how: https://www.plasticpollutioncoalition.org/get-started-living-plastic-free

HOLD PLASTIC POLLUTERS ACCOUNTABLE

Push back against the greenwashing of companies that are making false claims about the recyclability of their products. Write letters to companies (check their addresses on product labels or do a Google search) urging them to end their plastic packaging. Alternatively, make your letter public: companies can be tagged and held accountable on social media or on letters-to-the-editor pages. Next time you find plastic debris at sea or on the beach, do a "brand audit"—look for brand names on the plastic, take a picture, and tag the companies as well as your local politicians in a public post. Check out the litigation that Earth Island Advocates and IMMP are pursuing against the worst plastic polluters including Coca-Cola, PepsiCo, BlueTriton Brands (formerly Nestle Waters North America), and others: https://www.earthisland.org/journal/index.php/articles/entry/earth-island-coke-pepsi-nestle-plastic-pollution-lawsuit. Stay up to date on Earth Island Institute litigation and opportunities to participate by signing up for their monthly newsletter, IslandWire, or following their social media channels: https://www.earthisland.org/index.php/take-action

You can also sign up for IMMP's newsletter and other updates on marine mammal issues around the world: https://savedolphins.eii.org

SUPPORT GOVERNMENTAL ACTION AGAINST PLASTIC POLLUTION

In the US, implore your legislators to support the Break Free from Plastic Pollution Act. Find out more about this here: https://www.breakfreefromplastic.org/pollution-act/

Volunteer beach cleanup in San Diego, Calif © ZUMA Press, Inc./Alamy Stock Photo

At the state level, tell your elected officials to do as California has done, and work for candidates who commit to supporting efforts to limit production and sale of single-use plastics and force removal of the circular arrow label from types of plastics that cannot actually be recycled. Recent reporting has revealed that the claims that plastics can be recycled are mostly bogus—and industry officials have known this since the 1970s. Stay informed, and stay vocal in pushing for industry transparency and strong legislation. Write to your state legislators using addresses found here: https://www.usa.gov/elected-officials/

California activists have placed a measure on the November 2022 ballot, the California Recycling and Plastic Pollution Reduction Voter Act. If approved by voters, this measure would require that single-use plastic packaging, containers, and utensils be reusable, recyclable, or compostable.

See more details on California actions that your state legislators can emulate: https://www.plasticpollution-coalition.org/blog/california-leads-plastic-reduction

REPORT PLASTIC IMPACTS ON MARINE MAMMALS

Watch for and report instances of harm caused by plastic to marine mammals including entanglements, strandings, and deaths. Avoid approaching stranded or entangled marine mammals, as animals could be frightened back into the sea where rescuers can't reach them. Bear in mind that in the US, the Marine Mammal Protection Act prohibits the public from approaching marine mammals. Instead, report incidents and wait for specialists to take action. Find regional contact information at https://www.fisheries.noaa.gov/report or get the Dolphin and Whale 911 app for your smartphone: https://www.citizenscience.gov/catalog/56/#

JOIN COASTAL CLEANUPS

Urban and undeveloped beaches alike pile up with plastics carried in from all corners of the globe. Many organizations and governments around the world are promoting beach cleanups; the third Sunday of September has been designated International Coastal Cleanup Day. Check locally to find dates and times for beach cleanups sponsored by local organizations. And anytime you head to the beach, bring along a serviceable used bag and gloves for picking up plastics and properly disposing of them. All One Ocean, also an Earth Island Institute project, is a fine example of a group establishing beach cleanup stations and educating the public: https://www.earthisland.org/index.php/project/entry/all-one-ocean

SUPPORT ORGANIZATIONS

Support organizations like the International Marine Mammal Project (https://savedolphins.eii.org) and Plastic Pollution Coalition (https://www.plasticpollutioncoalition.org), which are on the front lines of protecting the environment and eliminating the plastics plague. The Moore Institute for Plastic Pollution Research (https://mooreplasticresearch.org) utilizes scientific research and innovation to address the growing marine microplastic and nanoplastic crisis. Many other organizations are working on this issue and are also worthy of your support. Donate, follow, and amplify their research and advocacy. Organizations like these rely on community backing to make powerful change.

Holding Plastic and Fishing Gear Manufacturers Accountable

Research and writing by Sadie Cwikiel

To solve the plastic plague in our oceans, the manufacturers of plastic materials and fishing gear must be held accountable for the mounting damage their products cause to marine mammals and other ocean life.

There are many companies that make knotted or braided netting used for purse seine or trawl nets, monofilament (made from one strand of plastic) netting used for gillnets, fishing line, single-use plastic products, and the plastic resin pellets from which all of these products are made. At every step of the supply chain, plastic producers and fishing gear manufacturers are responsible for the plastic debris that threatens whales, dolphins, seals, and sea lions.

We urge these companies to step up and be part of the solution. The health of marine ecosystems benefits us all, and powerful companies have the opportunity to adopt sustainable—and profitable—new technologies that could turn the tide. In light of what we now know about the far-reaching environmental impacts—from nervous system damage to strangulation—continuing to produce, sell, and discard plastic products is unacceptable. If these companies do not take action to resolve the plastics plague, action must be forced through public pressure, legislation, and lawsuits.

In this regard, our own action is necessary, too. We must mobilize together to hold these companies accountable, through lawsuits, lobbying, and strongly reported media coverage. These companies are responsible for this crisis; they are obligated to help solve it. Robust and rapid social and political measures are needed to redirect our plastic-dependent society.

Here, we focus on the companies that contribute the most to the plastics problem. The top companies by annual revenue in each category of plastic production are listed on the following pages.

It is important to note that many of these companies are private enterprises, so access to information about their activities is limited. The information included in annual or other reports varies from company to company; for example, some revenue reports are not separated by production segments, or some companies report annual sales and not volume produced and vice versa.

Additionally, the information for major companies includes domestic and/or international subsidiaries, joint ventures, or nonconsolidated affiliates that produce polyethylene or other raw materials used to produce plastic goods. In these cases, the production and sales reported for each company include their majority-owned subsidiaries. In all cases, we have listed the parent company.

Ocean pollution begins with the production and sale of plastic products; more transparency is necessary on the front end of this process.

A minimum of 5.25 trillion particles weighing nearly 270,000 tons (245,000 metric tons) are floating on the surface of the world's oceans, an amount that is growing every day.[27]
—Marcus Eriksen et al.

Entangled Minke whale. By DejaVuDesigns.

Fishing net on a fishing vessel deck. By Valerii.

Plastics are manufactured in a wide array of different materials that have different properties (such as hard and soft plastic) and different toxicity levels.

Top Rope and Net Producers (purse seines, trawls, etc.)

- Nitto Seimo Co., Ltd. (Japan, $167.18 million in 2020[1])
- Garware Technical Fibres Ltd. (India, $132.3 million in 2020[2])
- King Chou Marine Technology Co., Ltd. (China, $92.19 million in 2020[3])
- Lankhorst Euronete Portugal, S.A. (Portugal, $82.93 million in 2020[4])
- Fibras Industriales S.A. (Peru, subsidiary of Miramar Associates, $20.27 million[5])

Top Gillnet Producers

- Anhui Golden Monkey Fishery Science and Technology Co., Ltd. (China, Estimated annual sales of $5.5 million, total assets of $24.8 million[6])
- Cadilhe & Santos Lda (Portugal, $3.45 million sales in 2020[7])
- Chaohu City Qiangli Fishery Co., Ltd. (China, $2.5 million to $5.0 million annual sales[8])
- Aike Fishing Gear Co., Ltd. (China, $1.0 million to $2.5 million annual sales[9])
- ChaoHu Running Water Fishing Net Factory (China, $1 million annual sales[10])

Top Plastic Polymer, Resin, and Pellet Producers[11,12,13,14]

- Dow Chemical (United States)[15]
- ExxonMobil Chemical (United States)[16]
- Saudi Aramco (includes SABIC) (Saudi Arabia)[17,18]
- Sinopec (China)[19]
- PetroChina (China)[20]
- Indorama Ventures (Thailand)[21]
- BASF (Germany)[22]

- Lyondellbasell Industries (Netherlands)[23]
- Chevron Phillips Chemical (United States)[24]
- DuPont (United States)[25]

Top Banks that Fund Single-Use Plastic Production[26]

- Barclays (United Kingdom, $3.1 billion)
- HSBC (United Kingdom, $3.1 billion)
- Bank of America (United States, $2.9 billion)
- Citigroup (United States, $2.8 billion)
- JPMorgan Chase (United States, $2.7 billion)
- Mitsubishi UFJ Financial (Japan, $2.1 billion)
- Sumitomo Mitsui Banking Corporation (SMBC) Group (Japan, $1.5 billion)
- Mizuho Financial (Japan, $1.5 billion)
- UniCredit (Italy, $1.1 billion)
- Crédit Agricole (France, $1.0 billion)

1. Dun and Bradstreet. "Nitto Seimo Co., Ltd. Company Profile, 2020 Revenue." *D&B Business Directory*. Accessed September 10, 2021. https://www.dnb.com/business-directory/company-profiles.nitto_seimo_coltd.c544a8f8c164d0d5b796c7e68ee8738c.html

2. Dun and Bradstreet. "Garware Technical Fibres Ltd. Company Profile, 2020 Revenue." *D&B Business Directory*. Accessed September 10, 2021. https://www.dnb.com/business-directory/company-profiles.garware_technical_fibres_limited.20f350c22b64c7452a71f0ce2368ad04.html

3. Dun and Bradstreet. "King Chou Marine Technology Co., Ltd. Company Profile, 2020 Revenue." *D&B Business Directory*. Accessed September 10, 2021. https://www.dnb.com/business-directory/company-profiles.king_chou_marine_technology_co_ltd.6554cc9e4a2cbf1382d1f860d-6b83a38.html

4. Dun and Bradstreet. "Lankhorst Euronete Portugal, S.A. Company Profile, 2020 Revenue." *D&B Business Directory*. Accessed September 10, 2021. https://www.dnb.com/business-directory/company-profiles.lankhorst_euronete_portugal_sa.7e975f86564182ec7fc49fae192e35a7.html

5. Dun and Bradstreet. "Fibras Industriales S.A. Company Profile, 2020 Revenue." *D&B Business Directory*. Accessed September 10, 2021. https://www-stgaka.dnb.com/business-directory/company-profiles.fibras_industriales_sa.9bf8e912234f87ed28ea7e502bb2a38d.html

6. "About Us." Golden Monkey Fishery. 2021. http://www.fishingnets.cn/About_us/

7. Dun and Bradstreet. "Cadilhe & Santos, Lda Company Profile, 2020 Revenue." *D&B Business Directory*. Accessed September 10, 2021. https://www.dnb.com/business-directory/company-profiles.cadilhe__santos_lda.d77777839fd1fa1c658f83ab164045b2.html

8. "Chaohu City Qiangli Fishery Co., Ltd. Company Overview, Total Annual Revenue." *Alibaba*. Accessed September 10, 2021. https://qlfishingnet.en.alibaba.com/company_profile.html

9. "Aike Fishing Gear Co., Ltd. Company Profile, Annual Revenue." *China Suppliers*. Accessed September 10, 2021. https://gyfishing.en.china.cn/

10. "ChaoHu Running Water Fishing Net Factory Company Overview, Total Annual Revenue." *Alibaba*. Accessed September 10, 2021. https://running-water.en.alibaba.com/company_profile.html?spm=a2700.icbuShop.81.5.3afc20a1oSIYgD

11. Minderoo Foundation. "Flows." *Plastic Waster Makers Index*. Accessed September 10, 2021. www.minderoo.org/plastic-waste-makers-index/data/flows/#/sankey/global/10

12. "Plastic Pellet Pollution." As You Sow. Accessed September 10, 2021. https://www.asyousow.org/our-work/waste/plastic-pellets

13. "Crow's Top 10 Plastics and Resins Producers." Polymer Properties Database. 2019. Accessed September 10, 2021. https://polymerdatabase.com/Polymer%20Brands/Plastic%20Manufacturers.html

14. Premier Plastic Resins website. Accessed September 10, 2021. http://www.premierplasticresins.com/

15. "Dow Annual Report 2020." Accessed September 10, 2021. https://www.annualreports.com/HostedData/AnnualReports/PDF/NYSE_DOW_2020_3dc5d0e41b19481e8dc4e532e1ea0fb8.pdf

16. "ExxonMobil 2020 Annual Report." Accessed September 10, 2021. https://corporate.exxonmobil.com/-/media/Global/Files/investor-relations/annual-meeting-materials/annual-report-summaries/2020-Annual-Report.pdf

17. "Saudi Aramco Annual Report 2020: Resilience and agility." Accessed September 10, 2021. https://www.aramco.com/-/media/publications/corporate-reports/saudi-aramco-ara-2020-english.pdf

18. "Sabic Annual Report 2020: Thriving with Resilience." Accessed September 10, 2021. https://www.sabic.com/assets/en/Images/SABIC_Annual_Report_2020_ENG_tcm1010-26526.pdf

19. "Sinopec 2020 Annual Reports and Accounts." Accessed September 10, 2021. https://www1.hkexnews.hk/listedco/listconews/sehk/2021/0415/2021041500411.pdf

20. "PetroChina Company Limited 2020 Annual Report." Accessed September 10, 2021. http://www.petrochina.com.cn/ptr/ndbg/202104/eafc059543d2429ab3ad454d519cde56/files/a1e7963d63a9429d8226c56c19928dc8.pdf

21. Indorama Ventures website. Accessed September 10, 2021. https://www.indoramaventures.com/en/home

22. "Business Review by Segment." BASF Online Report 2020. Accessed September 10, 2021. https://report.basf.com/2020/en/managements-report/segments.html

23. "Revenue of key products produced by Lyondell Basell Industries from 2019 to 2020." Statista. Accessed September 10, 2021. https://www.statista.com/statistics/1246251/revenue-of-lyondellbasell-by-product/

24. "Financials." Chevron Phillips Chemical. Accessed September 10, 2021. https://www.cpchem.com/who-we-are/financials

25. "Dupont De Nemours Inc. Income Statement Annual." *CSI Market*. Accessed September 10, 2021. https://csimarket.com/stocks/income.php?code=DD&annual

26. Total loan value data from KPMG via *The Guardian* (original data from KPMG was unavailable): Laville, Sandra. "Twenty firms produce 55% of world's plastic waste, report reveals." *The Guardian*. May 17, 2021. https://www.theguardian.com/environment/2021/may/18/twenty-firms-produce-55-of-worlds-plastic-waste-report-reveals?utm_term=4e41c63f6d32d781cdc44349764963dd&utm_campaign=GreenLight&utm_source=esp&utm_medium=Email&CMP=greenlight_email

27. Eriksen, Marcus, Laurent CM Lebreton, Henry S. Carson, Martin Thiel, Charles J. Moore, Jose C. Borerro, Francois Galgani, Peter G. Ryan, and Julia Reisser. "Plastic pollution in the world's oceans: more than 5 trillion plastic pieces weighing over 250,000 tons afloat at sea." *PloS one* 9, no. 12 (2014): e111913.

Plastic pollution in ocean. By Magnus Larsson.

Hot Spots Around the World

THE PLASTICS PLAGUE SPANS THE GLOBE FROM THE OCEAN DEPTHS, TO REMOTE ISLANDS, AND EVEN TO THE POLAR REGIONS. THIS REPORT FOCUSES ON JUST EIGHT OF THE MAJOR HOT SPOTS THAT ARE ILLUSTRATIVE OF THE DEVASTATING IMPACTS OF PLASTICS ON MARINE MAMMALS.

HOT SPOT

South Africa

Research and writing by Lilah McCormick

SPECIES: SOUTHERN RIGHT AND HUMPBACK WHALES; LONG-BEAKED COMMON, INDO-PACIFIC BOTTLENOSE, AND INDIAN OCEAN HUMPBACK DOLPHINS; SOUTHERN ELEPHANT AND FUR SEALS

Shoe soles and yogurt containers in the bellies of beached orcas; dolphins drowned in shark nets; whales wrapped in lobster trap lines. South Africa's coastline is a kaleidoscope of ecosystems supporting over 40 species of marine mammals, from inquisitive seals to endangered southern right whales. While citizen action has created positive change—such as the illegalization of whale-killing octopus traps—annual whale entanglements continue to rise decade after decade; endangered Indian Ocean humpback dolphins lose 10% of their fragile population every year in fatal nets; and leached toxins from urban plastics continue to threaten mammals' brains, hormones, and immune systems. Collective, concerted action will be necessary to turn the tide.

The South African coastline pulses with life while suffocating in the filth of a country globally ranking high in plastic pollution. Home to a vast array of endangered, recovering, and endemic species, it supports both colder kelp forest communities and warmer-water coral reefs. Some animals use the coastline as a migratory route, and many more depend on it year-round.

Tourists come to witness the extraordinary biodiversity of South Africa, bringing in much-needed revenue for the developing country. Yet fishing nets, shark nets, traps, lines, and consumer plastics all lurk under the surface, unremittingly destroying the coastal life that makes South Africa so special.

Along this coast there are more than 40 species of marine mammals alone—whales, dolphins, seals, and sea lions—including the crowd favorites: the humpback (*Megaptera novaeangliae*) and Southern right (*Eubalaena australis*) whales, orcas (*Orcinus orca*), and several species of dolphins such as the long-beaked common dolphin (*Delphinus capensis*), Indo-Pacific bottlenose dolphin (*Tursiops aduncus*), and the endangered Indian Ocean humpback dolphin (*Sousa plumbea*).[1]

Entanglement Issues

SEALS

South African seals, fur seals in particular, are frequent victims of entanglement. Curious and playful, especially as juveniles, seals like to investigate floating objects, and they sometimes prove to be lethal toys.[2]

One study conducted research on entanglements from 1991 to 2001 on Marion Island, home to subantarctic fur seals (*Arctocephalus tropicalis*), Antarctic fur seals (*Arctocephalus gazella*), and Southern elephant seals (*Mirounga leonina*).[3] Some 67% of the recorded entanglements were caused by fishing-related gear, and entanglements increased by 50% after longline fishing methods were introduced to the area.[4] While only 0.24% of the estimated seal population was entangled, the combination of an increasing density of marine plastics

Octopus Traps Entangle Whales

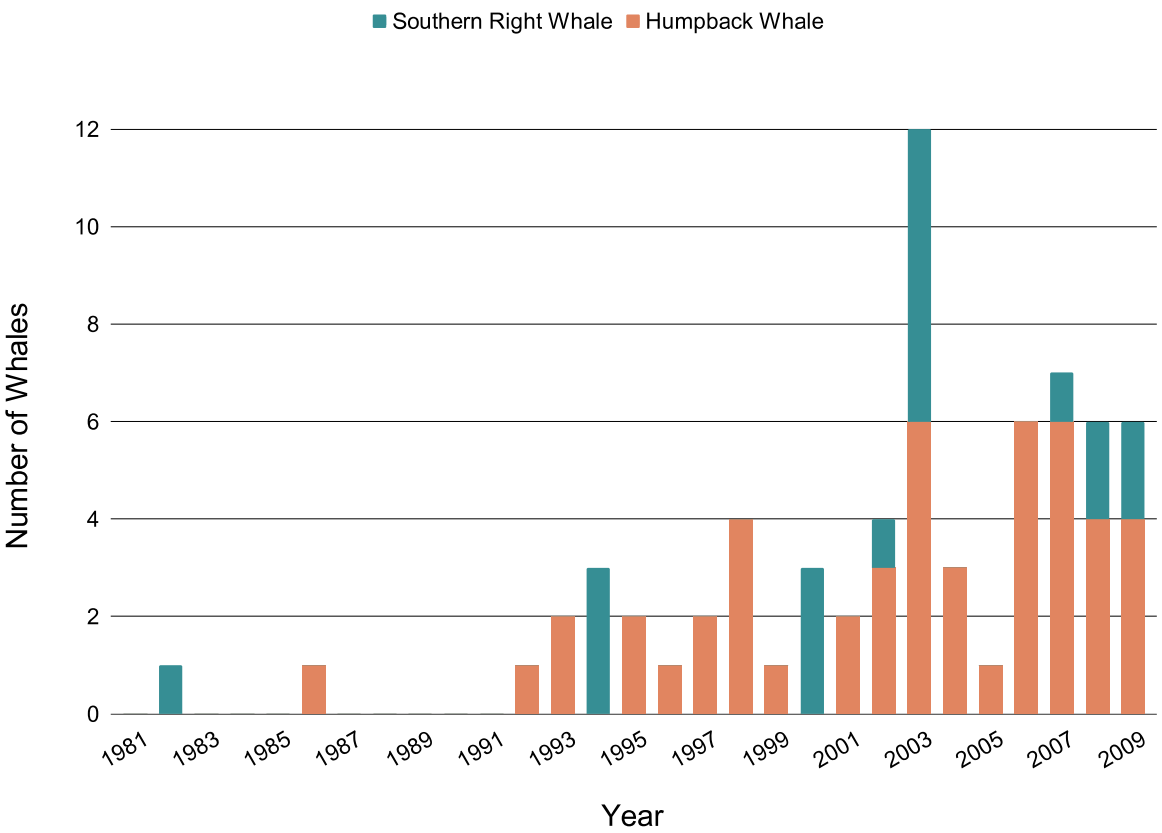
In June 2019, three whales were entangled in octopus traps near Cape Town.[14] For two of them, a young humpback and a Bryde's whale, the entanglements were fatal. At least six whales had died in the previous four years in octopus traps, and the addition of two deaths in one month was just too much for residents of the area to stomach. Following an online petition with 25,000 signatures, the Environment Ministry banned octopus fishing until scientists can develop improved gear.[15]

worldwide and the inquisitive nature of seals means they may be at ever-increasing risk of entanglement.[5]

WHALES

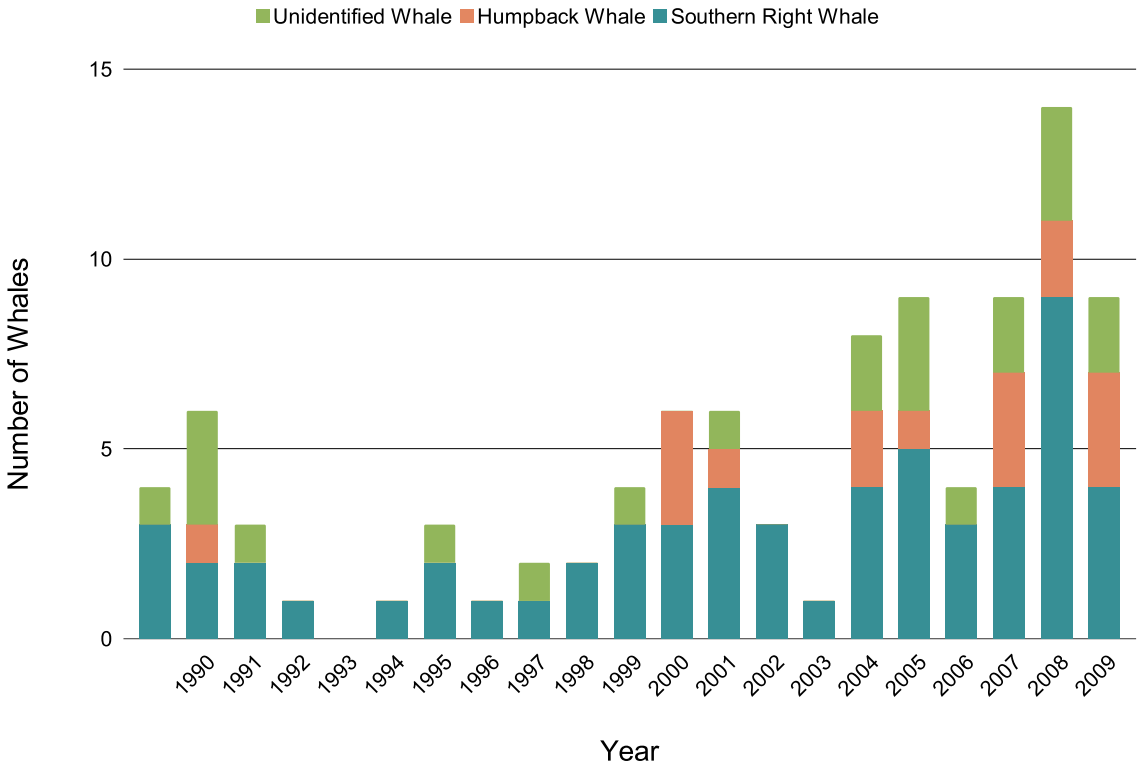
South African whale entanglement levels have steadily increased since the late 1990s.[6] Southern right and humpback whales are the most commonly entangled large whale species, and entanglement rates spike during breeding migrations.[7] These two species comprised 85% of the large whale entanglements in shark nets from 1981 to 2009.[8]

NUMBER OF SOUTHERN RIGHT WHALES AND HUMPBACK WHALES ENTANGLED IN SHARK NETS IN THE KWAZULU-NATAL DISTRICT, SOUTH AFRICA, FROM 1981 TO 2009[9]



Separate from entrapment in shark nets, there were 96 large whale entanglements in fishing gear recorded in a 35-year period, most of which were in West Coast lobster fishing gear.[10] Right whales typically stay close to shore, feed at the surface with mouths open, and investigate floating or anchored objects, making them especially vulnerable to entanglement.[11] Fifty-seven percent of adult right whale mortalities are due to human activities.[12] The species is considered endangered worldwide.

ENTANGLEMENT OF WHALES IN OTHER (NON-SHARK NET) GEAR FROM 1990 TO 2009 IN SOUTH AFRICA[13]



DOLPHINS

Much like their whale cousins, South Africa's resident dolphins spend much of their time in shallow waters, where they frequently come into contact with boats, fishing and shark nets, and pollution.[16] From 2012 to 2015, long-beaked common dolphins, Indian Ocean humpback dolphins, and Indo-Pacific bottlenose dolphins were all victims of the shark nets in KwaZulu-Natal (KZN).[17]

Between 1980 and 2009, more than 200 endangered Indian Ocean humpback dolphins died in the KZN shark nets, an average of 6.8 dolphins annually, or 5% to 10% of the estimated population per year, a rate which scientists have deemed "highly unsustainable."[18] Sixty percent of the annual KZN catch occurred in Richards Bay, which represents up to 10% of the population estimate in the area.[19]

Pingers and other acoustic devices attached to nets to deter the dolphins have been unsuccessful.[20] Some shark nets were replaced by baited lines, which do not catch dolphins, but do harm shark populations.[21]

Ingestion Issues

Aquatic animals fortunate enough to evade fishing nets, shark nets, and other entangling plastics are still at risk of ingesting plastic—and at a great cost. Pathogenic bacteria such as *Escherichia coli*, often occurring in waters near densely populated areas, can be transferred to marine mammals through ingestion of plastics.[22]

Death by Plastic/Shoe/Yogurt Container?

In 2015, an orca in Plettenberg Bay appeared to be sick and was separated from her pod, swimming in shallow waters and garnering public attention.[26] After a week in the bay, she washed ashore. A rescue team moved her into deeper waters. Three days later, she washed up dead. A necropsy (an autopsy of an animal) revealed a full stomach—packed with plastic wrappers, containers, and even a shoe—but almost no food. Scientists were unable to find the cause of her death, but believe she may have been eating anything she could find, and plastic was readily available. Or she may have swallowed something that blocked her digestive tract, making her feel full while she starved to death.[27]

Global plastic production reached a record high of 359 million tons in 2018 and is projected to reach 1,800 million tons a year by 2050.[29]

Plastic bottles in a landfill for recycling.By Aliaksei

Flame retardants in plastic products leach into the water and can interfere with marine mammals' hormonal, neuronal, thyroid, endocrine, and liver activity.[23] One study found flame retardants in long-beaked common, Indian Ocean humpback, and Indo-Pacific bottlenose dolphins comparable to those in more industrial regions.[24]

Humpback dolphins had the highest level of organochlorines (a type of pesticide) of South African marine mammals, most likely because of the steady flow of pesticides and plastic waste that is dumped from coastal cities such as Durban into their habitat.[25] Plastics that are ingested can also block the digestive tract or pierce the linings of the tract, causing death. Without further data and research, scientists cannot determine the full effect of plastic ingestion on marine mammal populations. But until humans end the flood of industrial waste into the oceans, the problem will only escalate.

Gwenith S. Penry

Gwenith S. Penry

Stranded female orca on South African shore and the contents of her stomach.

Conclusion

The South African marine mammal population was under siege by the lucrative whaling industry in the early- to mid-1900s with humpbacks and right whales hunted until they became endangered. After an international whaling moratorium went into effect in 1986, their populations began to rebound.[28] Sadly, they, along with other marine mammals, are again dying in dangerously large numbers, suffocating as collateral damage of a misguided tourism industry and suffering myriad deaths in an ocean of plastic. Saving them from these fates will again take strong, collective, concerted action driven by public awareness, concern, and pressure to help preserve the treasures off the South African coast.

1. "Whales and Dolphins." Marine Protected Areas South Africa. Accessed June 3, 2021. https://www.marineprotectedareas.org.za/whales-and-dolphins

2. Butterworth, Andrew. "A Review of the Welfare Impact on Pinnipeds of Plastic Marine Debris." *Frontiers in Marine Science* 3 (August 4, 2016). https://doi.org/10.3389/fmars.2016.00149

3. Hofmeyr, Greg, M. Maine, Marthán Bester, Stephen Kirkman, Pierre Pistorius, and A. Makhado. "Entanglement Of Pinnipeds At Marion Island, Southern Ocean: 1991-2001." *Australian Mammalogy* 24 (January 1, 2002): 141. https://doi.org/10.1071/AM02141

4. Ibid.

5. Ibid.

6. Meÿer, M. A., P. B. Best, M. D. Anderson-Reade, G. Cliff, S. F. J. Dudley, and S. P. Kirkman. "Trends and interventions in large whale entanglement along the South African coast." African Journal of Marine Science 33, no. 3 (2011): 429-439. https://doi.org/10.2989/1814232X.2011.619064

7. Ibid.

8. Ibid.

9. Ibid.

10. Ibid.

11. Best, Peter B., Victor M. Peddemors, Victor G. Cockcroft, and Nan Rice. "Mortalities of Right Whales and Related Anthropogenic Factors in South African Waters, 1963-1998." *J. Cetacean Res. Manage.* (October 30, 2020): 171–76. https://doi.org/10.47536/jcrm.vi.293

12. Ibid.

13. Meÿer, M. A., P. B. Best, M. D. Anderson-Reade, G. Cliff, S. F. J. Dudley, and S. P. Kirkman. "Trends and interventions in large whale entanglement along the South African coast." *African Journal of Marine Science* 33, no. 3 (2011): 429-439. https://doi.org/10.2989/1814232X.2011.619064

14. AFP. "S. Africa Halts Cape Town Octopus Fishing after 2 Whales Die." June 28, 2019. https://phys.org/news/2019-06-safrica-halts-cape-town-octopus.html

15. Ibid.

16. Braulik, Gill T., Ken Findlay, Salvatore Cerchio, and Robert Baldwin. "Chapter Five - Assessment of the Conservation Status of the Indian Ocean Humpback Dolphin (*Sousa plumbea*) Using the IUCN Red List Criteria." *Advances in Marine Biology*, 72:119–41. Humpback Dolphins (Spp.): Current Status and Conservation, Part 1. Academic Press, 2015. https://doi.org/10.1016/bs.amb.2015.08.004

17. Aznar-Alemany, Òscar, Berta Sala, Stephanie Plön, Hindrik Bouwman, Damià Barceló, and Ethel Eljarrat. "Halogenated and Organophosphorus Flame Retardants in Cetaceans from the Southwestern Indian Ocean." *Chemosphere* 226 (July 1, 2019): 791-799. https://doi.org/10.1016/j.chemosphere.2019.03.165

18. Braulik, Gill T., Ken Findlay, Salvatore Cerchio, and Robert Baldwin. "Chapter Five - Assessment of the Conservation Status of the Indian Ocean Humpback Dolphin (*Sousa plumbea*) Using the IUCN Red List Criteria." *Advances in Marine Biology*, 72:119–41. Humpback Dolphins (Spp.): Current Status and Conservation, Part 1. Academic Press, 2015. https://doi.org/10.1016/bs.amb.2015.08.004

19. Atkins, Shanan, Geremy Cliff, and Neville Pillay. "Humpback Dolphin Bycatch in the Shark Nets in KwaZulu-Natal, South Africa." *Biological Conservation* 159 (March 1, 2013): 442–49. https://doi.org/10.1016/j.biocon.2012.10.007

20. Ibid.

21. Ibid.

22. Naidoo, Trishan, Anusha Rajkaran, and Naidoo Sershen. "Impacts of Plastic Debris on Biota and Implications for Human Health: A South African Perspective." *South African Journal of Science* (June 28, 2020).

23. Aznar-Alemany et al. "Halogenated and Organophosphorus Flame Retardants in Cetaceans." 791-799.

24. Ibid.

25. Ibid.

26. "Orca Found Dead with a Stomach Full of Garbage | The Inertia." Accessed May 31, 2021. https://www.theinertia.com/environment/orca-found-dead-with-a-stomach-full-of-garbage/

27. Ibid.

28. NOAA Fisheries. "Humpback Whale Species Directory." NOAA. May 26, 2021. https://www.fisheries.noaa.gov/species/humpback-whale

29. Garside, M. (2019) "Global plastic production from 1950-2018." www.statista.com/statistics/282732/global-production-of-plastics-since-1950/

HOT SPOT

California, USA

Research and writing by Vicky Fong

SPECIES: CALIFORNIA SEA LION, HUMPBACK AND GRAY WHALE

The Golden State has made strides in addressing plastic pollution, but along the California coast, whales still wash up dead with bellies clogged with everything from fishing line to Cheetos bags, and seals and sea lions are found with hooks in their stomachs and monofilament lines encircling their necks. Plastics pose an even higher threat when animals are already weakened and disoriented by other environmental factors, such as the red tides that have been increasing in frequency as climate disruption accelerates. The State of California and US government must raise the bar for protecting California's diverse and fragile marine mammal populations.

The California coastline is rich in diversity of marine species and serves as important habitat for a wide range of marine mammals, with six species of pinnipeds (sea lions and seals), seventeen species of cetaceans (dolphins, whales, and porpoises), plus the Southern sea otter (*Enhydra lutris*).

While humans rarely have direct interactions with marine mammals, the indirect harm from humans from recreational activities and commercial fishing are threats to these species. Plastic debris, from single-use food and beverage containers to cigarette filters and fishing lines, pollutes the Golden State's beaches and waters. California also has a fishing industry, which harms marine mammals through entanglement by nets and woven and monofilament fishing lines.[3]

Effects on Marine Mammals

In the last two decades in California alone, there were a total of 1,114 incidents involving plastics and marine mammals, where the animal was either found entangled in plastic fishing gear or plastic was found in its stomach. The sperm whale that died at Point Reyes was just one of the victims. These deaths are only the tip of the plastic iceberg, as many animals will die at sea and sink or will be eaten by predators and scavengers, without the scourge of plastic being recorded. Most incidents occurred in San Diego (18%), Los Angeles (17%) and Monterey (14%) counties, although this distribution may reflect the large population of humans with easy access to the shores.

ENTANGLEMENT ISSUES

Of 949 marine mammals entangled in the past two decades, 22% were decomposing, and their deaths were likely caused by physical restrictions and injuries from plastic.

Nets Kill a Sperm Whale

*On March 15, 2008, an adult male sperm whale (*Physeter macrocephalus*) was found stranded at Driftwood Beach, Tomales Point (Point Reyes National Seashore) in Marin County, California. The body had decomposed and was too large to transport, thus a necropsy (an autopsy on animals) was performed at the stranding site. Biologists from the California Marine Mammal Center were horrified to discover the whale's "stomach crammed with nets of differing types and several plastic tarps; rope marks on pectoral fins"—a tragic loss.*[4]

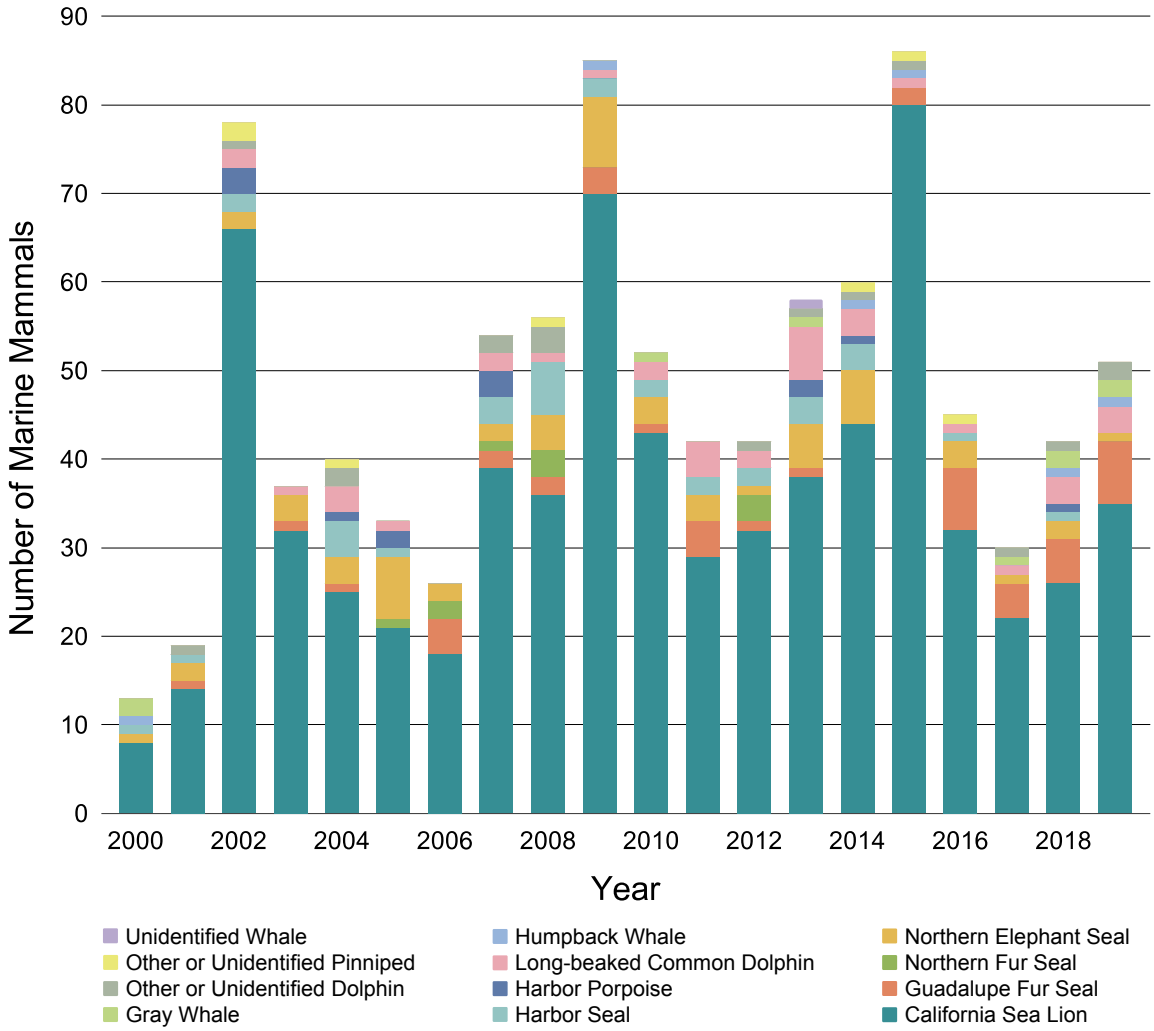
Ten of these California marine mammal species are listed under the US Endangered Species Act—with fragile populations, even the loss of a few animals can have severe population and social impacts on endangered marine mammals.[1,2]

Entangled humpback whale. By Domenic Biagini.

An analysis of California stranding data confirms that California sea lions (*Zalophus californianus*) were the marine mammal most often entangled in fishing nets or other plastic debris (75%), with 707 California sea lions and three Steller sea lions (*Eumetopias jubatus*) entangled, harmed, or killed.

On the chart, the sharp increases of cases in 2002, 2009, and 2015 are likely linked to harmful algae blooms called "red tides," a result in part of climate change, that produce domoic acid—a toxin that attacks brain function and to which sea lions are particularly susceptible. Fish eat the toxic algae and pass it up the food chain to sea lions, resulting in lethargy, disorientation, and seizures, all of which can cause the animals to be more susceptible to entanglement and stranding.

THE NUMBER OF MARINE MAMMAL STRANDINGS CAUSED BY ENTANGLEMENTS IN PLASTIC DEBRIS IN CALIFORNIA WATERS FROM 2000-2019[5]



Surveys have found that neck-encircling debris, particularly gillnets, were the most common trauma to sea lions,[6] and a similar trend appeared in our California review as gillnet and monofilament fishing lines were involved in 72% of sea lion entanglements.

Similar trends were observed with seals (family Phocidae) as fishing monofilament lines and nets cause nearly half of the seal entanglements. Seals, however, appear to be more susceptible to getting tangled in the packing straps commonly used in shipping to secure packages.

Dolphins, whales, and porpoises seem to fare somewhat better with their encounters with plastic debris, making up 10% of entanglement cases. Aside from fishing lines and nets, both dolphins and whales were also found entangled in plastic rope and lines from crab and lobster traps.

Five different species of dolphins were identified in entanglements (percentages given are of all reported entangled dolphins in California waters):

1. Long-beaked common dolphin (*Delphinus capensis*) (69%)
2. Bottlenose dolphin (*Tursiops truncatus*) (6%)
3. Pacific white-sided dolphin (*Lagenorhynchus obliquidens*) (6%)
4. Short-beaked common dolphin (*Delphinus delphis*) (2%)
5. Spinner dolphin (*Stenella longirostris*) (2%)
6. Unidentified as to species (15%)

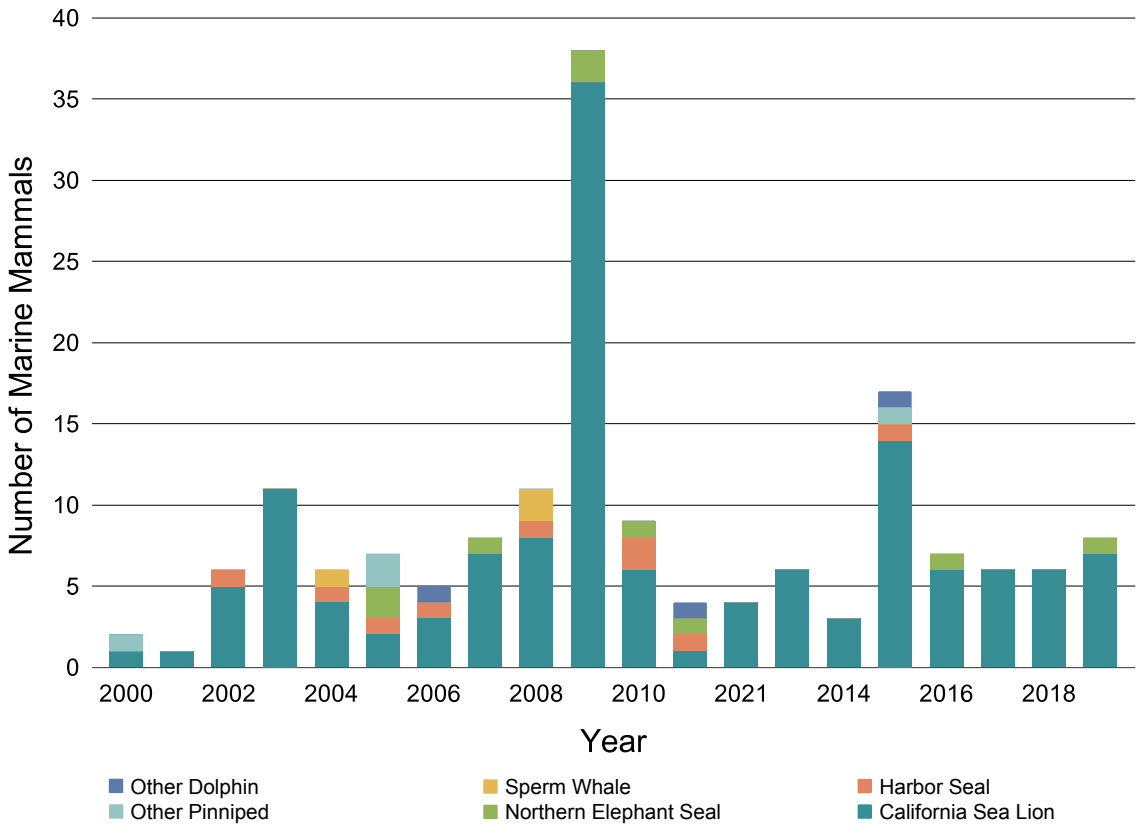
All 148 reported harbor porpoise (*Phocoena phocoena*) cases involved entanglement in fishing nets and monofilament lines.

Gray (*Eschrichtius robustus*) and humpback whales (*Megaptera novaeangliae*) were most frequently entangled of the three whale species identified. Whale entanglements appear to be on the increase.

INGESTION ISSUES

With respect to ingestion of plastic, California seals and sea lions again were the most impacted group of marine mammals. Ninety-eight percent of sea lions found with ingested plastics were California sea lions (*Zalophus californianus*), with monofilament fishing line being the most common offender (71% of ingested plastics), where the hook with attached monofilament line was caught inside the animals' mouths or stomachs. Fishing lures (12%) and plastic bags (4%) were other types of debris commonly found in sea lions' stomachs. Sea lions are known to grab fish caught on fishing lines.

THE NUMBER OF MARINE MAMMAL STRANDINGS CAUSED BY INGESTION OF PLASTIC DEBRIS IN CALIFORNIA WATERS FROM 2000-2019[7]



Six stranded marine mammals (three whales, two porpoises, one dolphin), upon necropsy, had ingested plastics consisting of monofilament line and Cheetos bags, deadly cast-offs of our consumer culture. While these are low numbers of whales, marine biologists believe that for every whale that washes ashore, as many as 10 to 20 may have died at sea and sunk.

Conclusion

In the state of California, some progress has been made to address entanglements, especially through the banning of gillnets that entangled and drowned many marine mammals during the 1980s. But much still needs to be done, especially to protect whale species that are still recovering from commercial whaling and endangered species of whales and seals. Discarded plastic fishing line is ubiquitous throughout the region, as are thousands of tons of plastic debris and microplastics.

1. Antonelis, G. A., and H. F. Clifford. "The pinnipeds of the California Current." *California Cooperative Oceanic Fisheries Investigations* 21 (1980): 68-78.

2. Hildebrand, J. A., A. J. Debich, and B. Thayre. "California cooperative fisheries investigation marine mammal surveys 2016-2017." *Marine Physical Laboratory Technical Memorandum* (2018): 621.

3. Stevenson, C. "Plastic Debris in the California Marine Ecosystem: A Summary of Current Research, Solution Strategies and Data Gaps." University of Southern California Sea Grant Synthetic Report (2011).

4. Information supplied by The Marine Mammal Center, Sausalito, CA.

5. US National Marine Fisheries Service.

6. M. J. Moore et al. "Criteria and case definitions for serious injury and death of pinnipeds and cetaceans caused by anthropogenic trauma." *Disease of Aquatic Organisms* 103 (2013): 229-264.

7. US National Marine Fisheries Service.

HOT SPOT

Mediterranean Sea

Research and writing by Sadie Cwikiel

SPECIES: FIN WHALE

Microplastics—tiny particles of plastic no larger than jewelry pearls—flood into the Mediterranean Sea by the thousands of tons every year. These toxic fragments, consumed directly or bioaccumulated in the bodies of larger animals, cripple mammals with immunosuppression, reproductive impairment, and cancer. Where plastics poison from within, gillnet fisheries throughout the Mediterranean entangle and strangle mammals in high enough numbers that some local populations may not be able to sustain the annual kill rate. Mediterranean plastics—especially the disproportionately heavy surge of microplastics—must be curbed.

The Mediterranean Sea is surrounded by three continents, fringed by densely populated coastal cities, and receives heavily polluted water from major river systems, making it a trap for plastic waste and one of the seas with the highest levels of plastic pollution in the world.[1]

Alarmingly, the Mediterranean holds only 1% of the world's seawater but 7% of all global microplastics.[2] Each year, an estimated 209,000 tons (230,000 metric tons) of plastic enters into the Mediterranean from land-based sources,[3] equivalent to 500 shipping containers dumped each day.[4] There is an estimated total of 1,069,000 tons (1,178,000 metric tons) of plastic that have accumulated in the sea today.[5]

Plastic waste flows into the Mediterranean from 33 countries in the region either directly or via major river systems.[6] Mismanaged waste accounts for 67% of that plastic.[7] The top three countries responsible are Egypt, Italy, and Turkey.[8] The Nile River catchment—a drainage basin for eight countries—is one of the top 10 highest contributing river systems to ocean plastic leakages globally.[9]

Microplastics

While 94% of the land-based waste that enters into the Mediterranean Sea consists of large pieces of plastics, the median estimate of microplastics, generally small pieces of plastic less than 1/20 of an inch (5 mm) in length, entering the sea is 11,800 tons (13,000 metric tons) a year.[10] Many of the larger plastics eventually break down into microplastic particles at sea. Aside from degraded plastics, the top sources of microplastics are tire dust, textiles, cosmetics, and pellet loss from plastic production.[11]

This plastic waste inevitably makes its way into animals and poses a significant threat to marine life. Because of their smallness and ubiquity, microplastics are ingested directly by zooplankton, small fish, or filter feeders like baleen whales, or they can be ingested indirectly when animals eat prey containing microplastics. Around half of a small fish species (*Boops boops*) sampled in multiple studies throughout the Mediterranean were found to have microplastics in their stomachs.[12] Nearly 20% of large predatory fish in the region also had eaten microplastics.[13]

Microplastics contain chemicals such as phthalates, toxic chemicals used in making plastics to increase flexibility, and they also attract and absorb persistent organic pollutants (POPs) and endocrine-disrupting

chemicals (EDCs) that exist in the surrounding seawater. Microplastics act as a vehicle that transports contaminants such as polychlorinated biphenyls (PCBs)—a compound used in manufacturing, in electrical equipment, or as lubricants or heat transfer fluids—or other POPs.[14] POPs can be found everywhere in seawater at low concentrations, but microplastics attract them into concentrations that are several orders of magnitude higher than the seawater.[15]

The tendency for POPs to stick to plastics varies by the type of plastic and the amount of surface area available on any given piece of plastic.[16] More surface area means more POPs can stick. Therefore microplastics, although their total surface is smaller than a large piece of plastic, can actually carry higher amounts of POPs per mass.[17]

Given how easy it is for microplastics to be ingested and make their way up the food chain, POP contamination is a serious problem for marine mammals. The contaminants bioaccumulate and biomagnify as they are consumed by the next predator and are especially dangerous to animals with longer life spans because the chemicals can build up to higher levels over time.[18] They are easily absorbed by fatty tissue, for example blubber in marine mammals.[19]

Negative health effects of PCBs include suppression of the immune system, harm to reproduction, and cancer.[20] In the northwestern Mediterranean Sea, 80% of blubber samples from individuals of the vulnerable Cuvier's beaked whale (*Ziphius cavirostris*) population had PCB levels above the safe toxicity threshold for negative physiological effects.[21] In the western Mediterranean, PCB concentrations in blubber samples of

© imageBROKER/Alamy Stock Photo

Plastics break down into smaller and smaller parts, resulting in microplastics, some small enough to enter the bloodstream. Above: Plastics tangled in seaweed on a beach in Lanzarote, Canary Islands, Spain.

bottlenose dolphins (*Tursiops truncatus*), striped dolphins (*Stenella coeruleoalba*), and orcas (*Orcinus orca*) all consistently exceeded toxicity thresholds throughout the 1990s and 2010s.[22]

In the northwestern Mediterranean Sea, the Pelagos Marine Reserve, a project of France, Italy, and Monaco, has some of the highest microplastic levels recorded anywhere. In one study that collected water samples at 40 stations in this region, 90% contained microplastic particles.[23] The Pelagos Reserve is an important marine protected area for marine mammals, including the endangered fin whale (*Balaenoptera physalus*).[24] While such protected areas are an essential tool in ocean conservation, they are ineffective at protecting marine life from the dangers of ocean plastics.

Phthalates reach concentrations that can be very high in microplastics and krill, even if those levels are undetectable in the water. Baleen whales such as fin whales filter large volumes of seawater to eat krill and other small organisms.[25] Unfortunately, microplastics also get trapped by their baleen (the filter system in their mouths), and the whales can ingest plastic particles both in their food and in the seawater.

In the Mediterranean, the blubber of stranded fin whales was tested for phthalates, and 80% of the whales had relevant concentrations of MEHP, a marker scientists use for exposure to DEHP, a type of phthalate.[26] Scientists also detected concentrations of other persistent and toxic chemicals in Mediterranean fin whales, which was not the case for fin whales found in the Sea of Cortez, also known as the Gulf of California, where there are far less abundant microplastics.[27]

Plastics do not biodegrade. Instead, they break down into smaller and smaller pieces that damage and/or disrupt physiological processes in marine life. Even humans carry significant levels of microplastics in our bodies.

Aside from degraded plastics, the top sources of microplastics are tire dust, textiles, cosmetics, and pellet loss from plastic production.

Entanglement Issues

In the Mediterranean Sea, marine mammals—primarily dolphins—are threatened by gillnets. Overfishing has depleted fish stocks,[28] so it is harder for the dolphins to find food, spurring an increase in dolphin-fisheries conflicts in the last decade.[29] Gillnets provide for alternative foraging methods for dolphins, and they can often take advantage, at their peril, of the concentrated food source by feeding at the gillnets.[30] Young dolphins are entangled in nets more often than adults, indicating that lack of foraging experience may increase young dolphins' vulnerability.[31]

Off the northeastern coast of Sardinia, on average one bottlenose dolphin a month was accidentally captured by the nets surrounding a fish farm.[32] From 1999 to 2004, fishers in Sardinia observed bottlenose dolphins around their fishing nets during almost 70% of days fished, and the annual entanglements estimated for that time period was 3.54% of the individual dolphins.[33] The resident bottlenose dolphins in the area may not be able to sustain an annual kill of this magnitude.[34]

In addition to getting entangled and caught in the nets, the dolphins can also choke on parts of the nets they accidentally eat when trying to eat fish. From 1990 to 2008, 120 dead stranded bottlenose dolphins were found along the Croatian coast of the Adriatic Sea where small-scale commercial and private fisheries use gillnets year-round. While the cause of death can be difficult to determine, at least 10% of the dead dolphins had suffered strangulation by parts of gillnets.[35]

Conclusion

Marine mammals will continue to be poisoned by this plastic waste. Action must be taken to slow the flood of plastic into the Mediterranean Sea. Better reporting of entanglements is also critical to reducing marine mammal deaths due to fisheries.

1. *Out of the Plastic Trap: Saving the Mediterranean From Plastic Pollution* (2018) http://awsassets.panda.org/downloads/a4_plastics_med_web_08june_new.pdf

2. Suaria, Giuseppe, Carlo G. Avio, Annabella Mineo, Gwendolyn L. Lattin, Marcello G. Magaldi, Genuario Belmonte, Charles J. Moore, Francesco Regoli, and Stefano Aliani. "The Mediterranean Plastic Soup: synthetic polymers in Mediterranean surface waters." *Scientific Reports* 6 (2016).

3. Boucher, J., and G. Bilard. *The Mediterranean: Mare plasticum*. Gland, Switzerland: IUCN (2020). https://portals.iucn.org/library/sites/library/files/documents/2020-030-En.pdf

4. IUCN. "Over 200,000 tonnes of plastic leaking into the Mediterranean each year—IUCN report." *IUCN News*. October 27, 2020. https://www.iucn.org/news/marine-and-polar/202010/over-200000-tonnes-plastic-leaking-mediterranean-each-year-iucn-report

5. Boucher, J. "*Mare plasticum*."

6. Ibid.

7. Ibid.

8. Ibid.

9. Schmidt, Christian, Tobias Krauth, and Stephan Wagner. "Export of plastic debris by rivers into the sea." *Environmental Science & Technology* 51, no. 21 (2017): 12246-12253.

10. Ibid.

11. Ibid.

12. Garcia-Garin, Odei, Morgana Vighi, Alex Aguilar, Catherine Tsangaris, Nikoletta Digka, Helen Kaberi, and Asuncion Borrell. "Boops boops as a bioindicator of microplastic pollution along the Spanish Catalan coast." *Marine Pollution Bulletin* 149 (2019): 110648.

13. Romeo, Teresa, Battaglia Pietro, Cristina Pedà, Pierpaolo Consoli, Franco Andaloro, and Maria Cristina Fossi. "First evidence of presence of plastic debris in stomach of large pelagic fish in the Mediterranean Sea." *Marine Pollution Bulletin* 95, no. 1 (2015): 358-361.

14. NOAA. "What are PCBs?" National Ocean Service. Last modified April 5, 2021. https://oceanservice.noaa.gov/facts/pcbs.html

15. Andrady, Anthony L. "Microplastics in the marine environment." *Marine Pollution Bulletin* 62, no. 8 (2011): 1596-1605.

16. Syberg, Kristian, Camilla M. H. Knudsen, Zhanna Tairova, Farhan R. Khan, Yvonne Shashoua, Torsten Geertz, Henrik B. Pedersen et al. "Sorption of PCBs to environmental plastic pollution in the North Atlantic Ocean: Importance of size and polymer type." *Case Studies in Chemical and Environmental Engineering* 2 (2020): 100062.

17. Ibid.

18. Fossi, Maria Cristina, Cristina Panti, Cristiana Guerranti, Daniele Coppola, Matteo Giannetti, Letizia Marsili, and Roberta Minutoli. "Are baleen whales exposed to the threat of microplastics? A case study of the Mediterranean fin whale (Balaenoptera physalus)." *Marine Pollution Bulletin* 64, no. 11 (2012): 2374-2379.

19. Murphy, Sinéad, Robin J. Law, Robert Deaville, James Barnett, Matthew W. Perkins, Andrew Brownlow, Rod Penrose, Nicholas J. Davison, Jonathan L. Barber, and Paul D. Jepson. "Organochlorine contaminants and reproductive implication in cetaceans: a case study of the common dolphin." *Marine Mammal Ecotoxicology* (2018): 3-38.

20. Ibid.

21. Baini, Matteo, Cristina Panti, Maria Cristina Fossi, Paola Tepsich, Begoña Jiménez, Frazer Coomber, Alice Bartalini, Juan Muñoz-Arnanz, Aurelie Moulins, and Massimiliano Rosso. "First assessment of POPs and cytochrome P450 expression in Cuvier's beaked whales (*Ziphius cavirostris*) skin biopsies from the Mediterranean Sea." *Scientific Reports* 10, no. 1 (2020): 1-13.

22. Jepson, Paul D., Rob Deaville, Jonathan L. Barber, Àlex Aguilar, Asunción Borrell, Sinéad Murphy, Jon Barry et al. "PCB pollution continues to impact populations of orcas and other dolphins in European waters." *Scientific Reports* 6, no. 1 (2016): 1-17.

23. Collignon, Amandine, Jean-Henri Hecq, François Glagani, Pierre Voisin, France Collard, and Anne Goffart. "Neustonic microplastic and zooplankton in the North Western Mediterranean Sea." *Marine Pollution Bulletin* 64, no. 4 (2012): 861-864.

24. Fossi et al. "Are baleen whales exposed," 2374-2379.

25. Ibid.

26. Ibid.

27. Ibid.

28. Lucchetti, A., M. Virgili, A. Petetta, and P. Sartor. "An overview of gill net and trammel net size selectivity in the Mediterranean Sea." *Fisheries Research* 230 (2020): 105677.

29. Pardalou, Androniki, and Athanassios C. Tsikliras. "Anecdotal information on dolphin-fisheries interactions based on empirical knowledge of fishers in the northeastern Mediterranean Sea." *Ethics in Science and Environmental Politics* 18 (2018): 1-8.

30. Díaz López, Bruno. "Interactions between Mediterranean bottlenose dolphins (*Tursiops truncatus*) and gillnets off Sardinia, Italy." *ICES Journal of Marine Science* 63, no. 5 (2006): 946-951.

31. Ibid.

32. Díaz López, Bruno, and Julia Andrea Bernal Shirai. "Bottlenose dolphin (*Tursiops truncatus*) presence and incidental capture in a marine fish farm on the north-eastern coast of Sardinia (Italy)." *Journal of the Marine Biological Association of the United Kingdom* 87, no. 1 (2007): 113-117.

33. Díaz López. "Interactions between Mediterranean bottlenose," 946-951.

34. Ibid.

35. Gomerčić, Martina, Ana Galov, Tomislav Gomerčić, Darinka Škrtić, Snježana Ćurković, Hrvoje Lucić, Snježana Vuković, Haidi Arbanasić, and Hrvoje Gomerčić. "Bottlenose dolphin (*Tursiops truncatus*) depredation resulting in larynx strangulation with gill-net parts." *Marine Mammal Science* 25, no. 2 (2009): 392-401.

HOT SPOT

Queensland, Australia

Research and writing by Vicky Fong

SPECIES: INDO-PACIFIC BOTTLENOSE DOLPHIN, HUMPBACK WHALE AND DUGONG

While plastic debris poses a threat to marine mammals in Australia, an even more serious challenge looms in the shallow waters surrounding Australia's famous surfing beaches: shark nets. While intended to minimize dangerous shark attacks, drumlines with baited hooks also attract hungry dolphins. Furthermore, the long walls of underwater nets trap and tangle dugongs, whales, and dolphins. Australia faces the unique challenge of finding alternatives to shark nets at a time when the coastal ecosystem increasingly suffers from the loss of shark and marine mammal species alike.

Queensland—Australia's second largest state by area—hosts a striking diversity of dolphins moving through its rich estuarine ecosystems, rugged surf zones, and sheltered waters protected by outlying barrier islands. Dolphins here range from commonly found nearshore residents (Indo-Pacific bottlenose dolphin *Tursiops aduncus*) to pelagic travelers (Short-beaked common dolphin *Delphinus delphis* and spinner dolphin *Stenella longirostris*), as well as small populations of rare, threatened species (Australian humpback dolphin *Sousa sahulensis* and snubfin dolphin *Orcaella heinsohni*).[1,2]

Other cetaceans, including humpback whales (*Megaptera novaeangliae*), arrive in winter to breed in warmer waters during their annual migration from Antarctica.[3] The eastern Australian population is the largest and most studied of the vulnerable Southern West Pacific humpback whale, which—after recovering from historic commercial whaling and poaching—is now increasingly threatened by entanglement.[4]

Tropical seagrass habitats in Queensland are home to dugongs (*Dugong dugon*), a type of sirenian also known as the sea cow and a close relative of manatees.[5] Compared with other marine mammals, dugongs have been underrepresented in research on the harm of plastics.[6]

Entanglement Issues

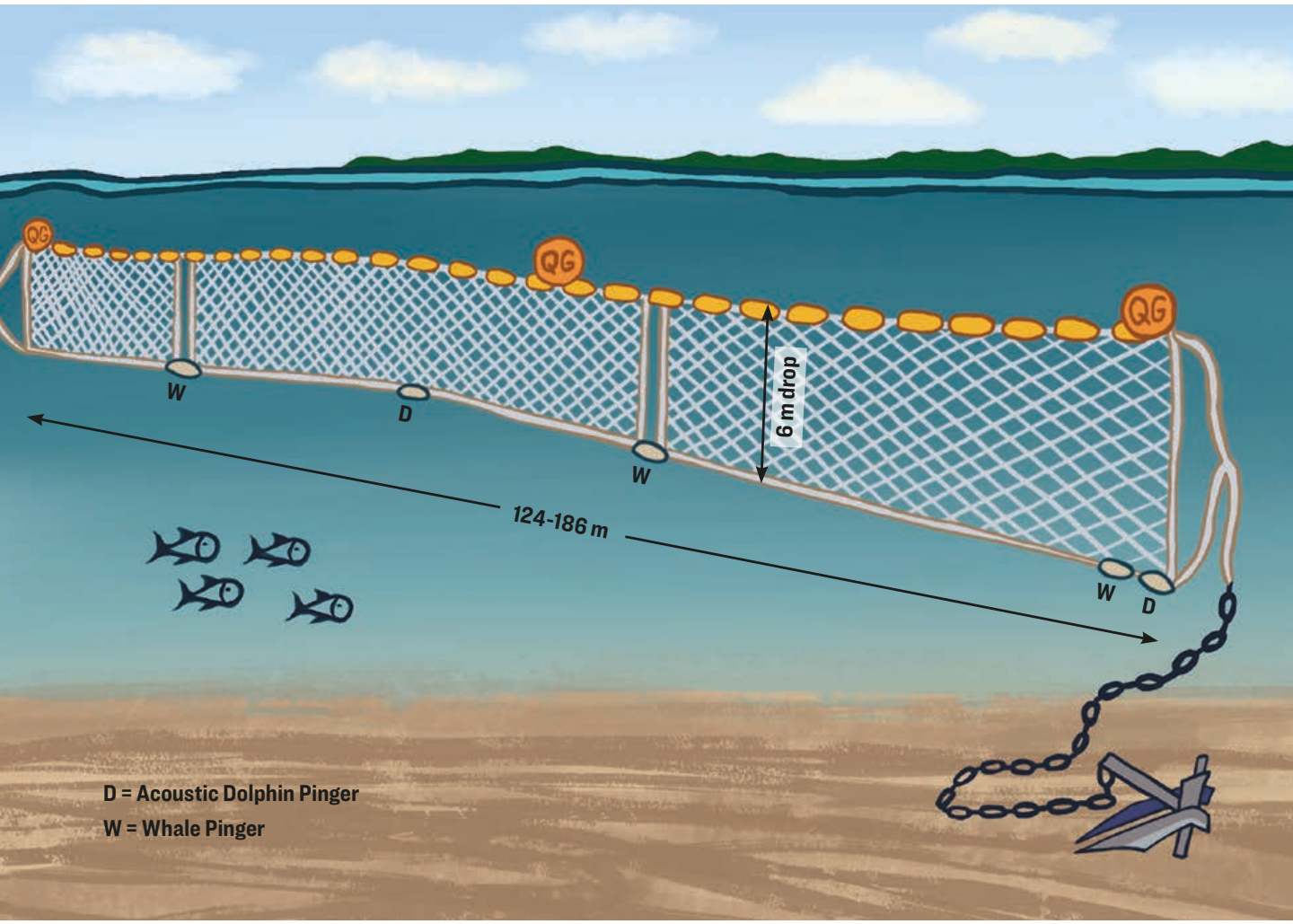
Shark nets are common, strung across large reaches of the ocean in order to protect swimmers. But the nets also catch and drown marine mammals.

The large coastal population of people crosses paths with sharks at a relatively higher rate than in other areas around the world, averaging one human fatality each year (still low compared to deaths from other causes).[7] After extensive (if misinformed) media coverage on shark attacks, the Queensland government established shark "control" programs.

Since 1962, the Queensland Shark Control Program (QSCP) has deployed 369 drumlines and 30 surface-set nets to remove "potentially dangerous sharks from the vicinity of popular bathing areas in the state."[8,9]

Drumlines use baited hooks suspended from a plastic buoy anchored to the sea floor. Shark nets are made of thin plastic strands that are .063 inches (1.6 mm) thick. The nets are 19.7 feet (6 m) deep and extend 610 feet (186 m) in length.[10]

SHARK NET ARRANGEMENT IN QUEENSLAND, AUSTRALIA[11]

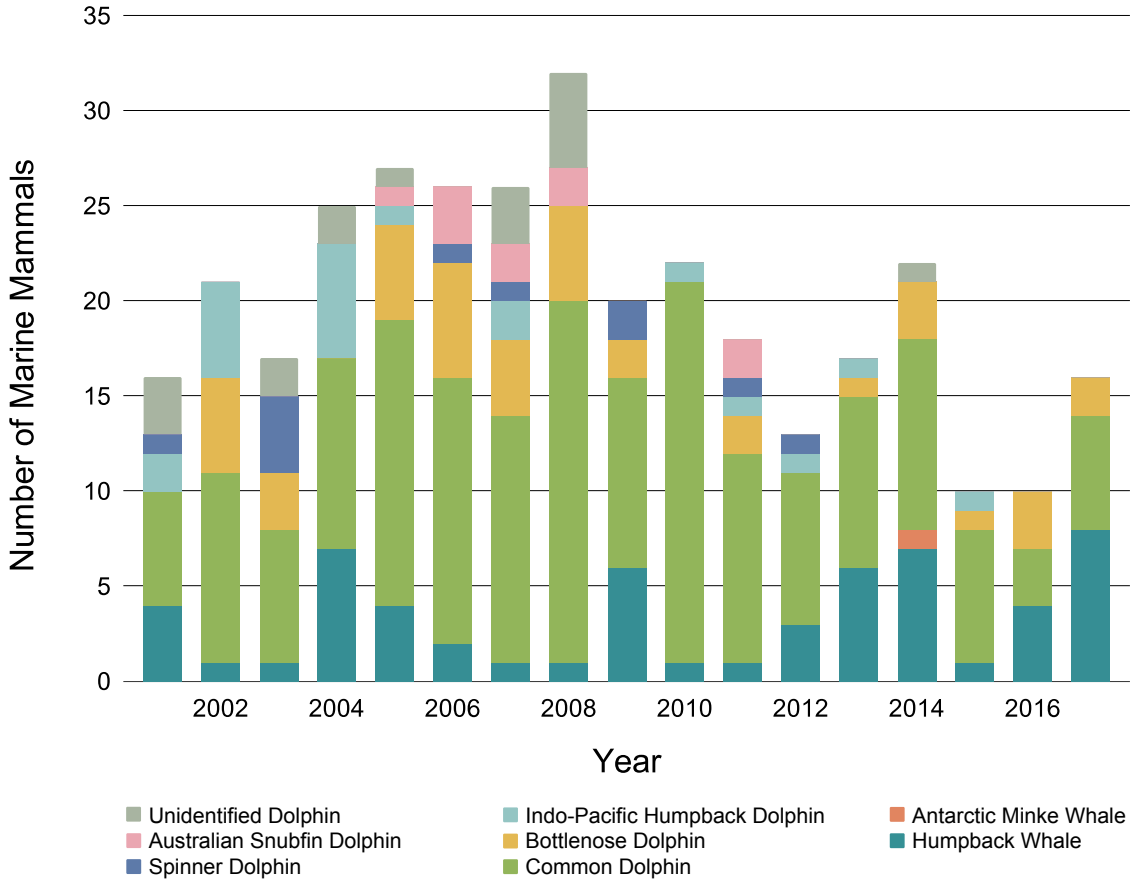


Not only has QSCP depleted many shark populations, but marine mammals often fall victim to the invisible wall of nets and hooks meant to catch sharks. From its inception through the 1990s, QSCP recorded an annual loss of 0.1 humpback whales (the equivalent of one humpback every ten years), two small whales, 18 dolphins and 20 dugongs.[12] Despite efforts to reduce marine mammal deaths in the mid-1990s, entanglements increased from 1996 to 2008.[13]

Short-beaked common and spinner dolphins are more commonly caught in the nets as they approach shore to feed.[14] Bottlenose dolphins are found on the shore side of the nets and appear to have learned the risk of swimming near shark nets, but sometimes get caught on drumlines trying to steal bait from hooks.[15] Attempts to improve shark nets have included changing net sizes to target specific species while avoiding entanglement of non-target species, but as a result smaller dolphin species, including the Australian humpback dolphins, have been caught more frequently.[16]

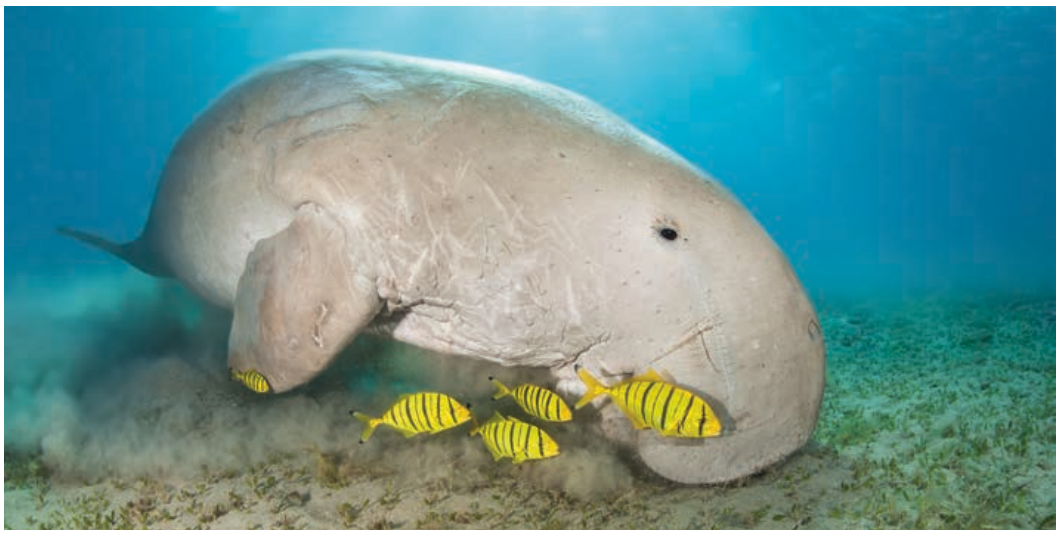
From the start of the century to 2017, there were 359 entanglements of non-target species in shark nets along Queensland's coastlines, consisting of 284 dolphins, 59 whales, and 16 dugongs. More than half of the entanglements were concentrated in the Gold Coast region—which attracts four million tourists each year—followed by Sunshine Coast North (17%), Rainbow Beach (14%), and Sunshine Coast South & Bribie Island (11%). The percentages are roughly proportional to the number of nets deployed in each area.[17]

NUMBER OF MARINE MAMMAL ENTANGLEMENTS IN QUEENSLAND'S SHARK NETS FROM 2000-2017[18]



There was a general increase in annual entanglements until 2008, but entanglements began declining after new alarms were installed to deter dolphins.[19] It is unclear what proportion of the trapped animals were released and whether or not they survived. The common dolphin was involved in 64% of dolphin entanglements.

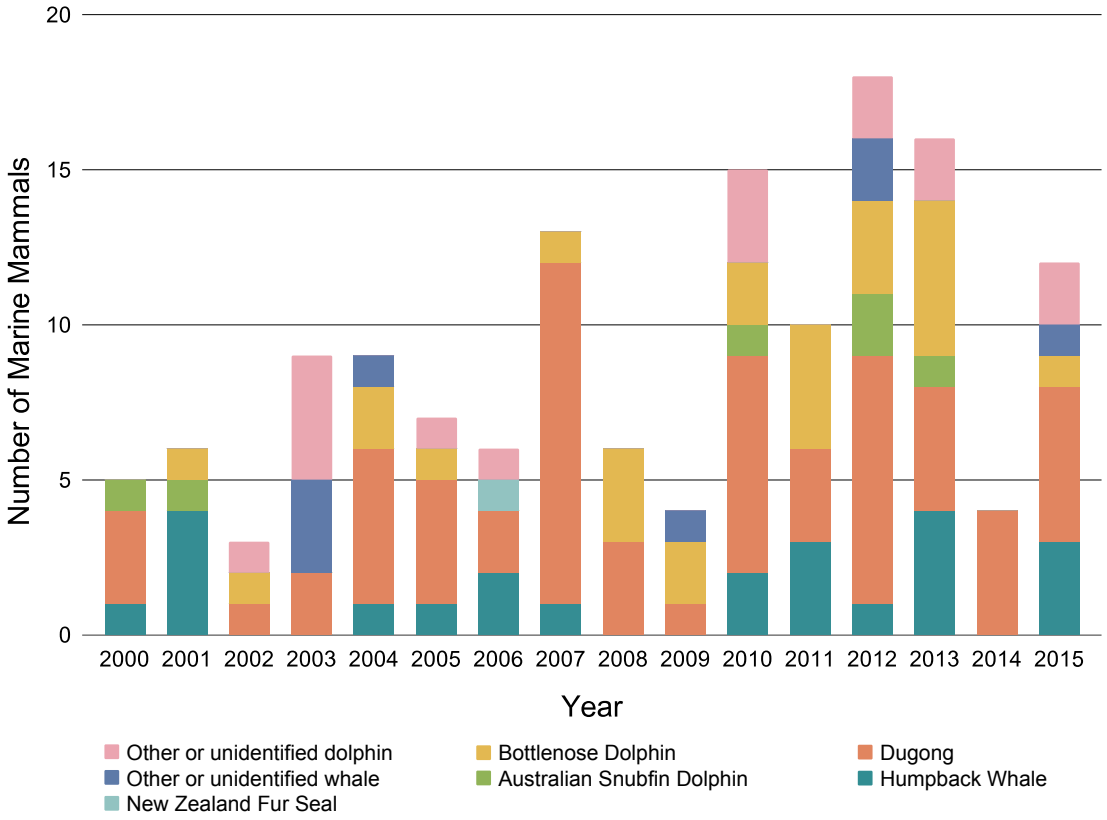
All but one of the whale entanglements involved humpback whales. The number of entanglements fluctuates annually, but peaks in September during annual migrations.[20]



By b. neeser

Dugongs, ocean-going cousins of manatees, are one of the world's most endangered marine mammals. They are easily entangled in nets used to protect swimmers from sharks near Australian beaches.

THE NUMBER OF MARINE MAMMAL STRANDINGS DUE TO ENTANGLEMENT IN PLASTIC, INCLUDING FISHING GEAR, IN QUEENSLAND FROM 2000-2015[21]



From 2000 to 2015 there were 143 cases of marine-mammal strandings in Queensland that involved plastic, of which 94% were entanglements. The highest concentration of strandings occurred in Moreton Bay near Brisbane (19%), Gold Coast (18%), and Sunshine Coast (13%).[22]

Dugongs were involved in almost half of the strandings and were the species most susceptible to death after being entangled, followed by dolphins (36% of cases) and whales (23%). Dugongs were most likely to be caught in nets of any kind, including gillnets, whereas dolphins were more likely to be caught in monofilament fishing lines and whales in anchor ropes. Other plastics identified in the strandings included crab pot lines, mooring lines, and float/buoy lines, as well as plastic bags and other garbage.[23]

Conclusion

Ways must be found to reduce the impact of shark nets on non-target species including whales, dolphins, and dugongs. While fears of sharks are understandable, these animals are an important part of the ocean ecosystem and are being hunted at levels that have seriously decreased their populations. Finding alternatives to the nets will benefit marine mammals and sharks alike.

1. Chilvers, B. L., I. R. Lawler, F. Macknight, H. Marsh, M. Noad, and R. Paterson. "Moreton Bay, Queensland, Australia: an example of the co-existence of significant marine mammal populations and large-scale coastal development." *Biological Conservation* 122, no. 4 (2005): 559-571.

2. Meager, J. J., and W. D. Sumpton. "Bycatch and strandings programs as ecological indicators for data-limited cetaceans." *Ecological Indicators* 60 (2016): 987-995.

3. Chilvers et al. "Moreton Bay, Queensland," 559-571.

4. Ibid.

5. Ibid.

6. Stelfox, Martin, Jillian Hudgins, and Michael Sweet. “A review of ghost gear entanglement amongst marine mammals, reptiles and elasmobranchs.” *Marine Pollution Bulletin* 111, no. 1-2 (2016): 6-17.

7. Pushaw, Carolyn. “The impact of the Queensland Shark Control Program on local populations of threatened shark species, 1962-2014.” Independent Study Project (ISP) Collection (2015): 2211.

8. Ibid.

9. Meager. “Bycatch and strandings programs as ecological indicators,” 987-995.

10. Sumpton, W. D., S. M. Taylor, N. A. Gribble, G. McPherson, and T. Ham. “Gear selectivity of large-mesh nets and drumlines used to catch sharks in the Queensland Shark Control Program.” *African Journal of Marine Science* 33, no. 1 (2011): 37-43.

11. Department of Agriculture and Fisheries, Queensland.

12. Gribble, N. A., G. McPherson, and B. Lane. “Effect of the Queensland Shark Control Program on non-target species: whale, dugong, turtle and dolphin: a review.” *Marine and Freshwater Research* 49, no. 7 (1998): 645-651.

13. Meager and Sumpton. “Bycatch and strandings programs as ecological indicators,” 987-995.

14. Ibid.

15. Ibid.

16. Ibid.

17. J. A. Bolin et al. “A current affair: entanglement of humpback whales in coastal shark-control nets.” *Remote Sensing in Ecology and Conservation* 6, no. 2 (2020): 119-128.

18. Queensland Shark Control Program. https://www.daf.qld.gov.au/business-priorities/fisheries/shark-control-program

19. McPherson, G. “Bycatch mitigation in the Queensland Shark Control Programme: Results not previously acknowledged.” Shark mitigation and deterrent measures Submission 67 to the Australian Senate Hearing, March 3, 2017.

20. E. Volep et al. “Effect of environmental conditions on cetacean entanglements: a case study from the Gold Coast, Australia.” *Marine and Freshwater Research* 68, no. 11 (2017): 1977-1987.

21. Queensland Government Department of Environment and Science. https://www.des.qld.gov.au/

22. Queensland Department of Environment and Science. “Shark control program non-target species statistics.” Queensland Government Open Data Portal. 2016. https://www.data.qld.gov.au/dataset/shark-control-program-non-target-statistics-by-year/resource/166510fb-2648-4bb7-b7a8-ed2b0815cd67?truncate=30&inner_span=True

23. Ibid.

HOT SPOT

New England and Western North Atlantic Ocean, US and Canada

Research and writing by Sadie Cwikiel

SPECIES: NORTH ATLANTIC RIGHT WHALE

It is nearly impossible for right whales to evade the obstacle course of plastic nets, ropes, and crab and lobster traps scattered throughout their habitat along the North Atlantic coast. Because these mammals swim across all levels of the sea, from surface to bottom, they are susceptible to entanglement in everything from gillnets to crab traps. Every year, about 50 of these critically endangered whales are entangled, and only about 100 reproductive females remain alive today. Is it too late for the North Atlantic right whale?

By Peter Duley/Northeast Fisheries Science Center/NOAA/collected under MMPA

North Atlantic right whale entangled in the Gulf of St. Lawrence.

The coastal North Atlantic Ocean, along the eastern United States and Canada, is home to iconic fisheries—including Maine lobster—and is also home to one of the world's most endangered marine mammals. The North Atlantic right whale (*Eubalaena glacialis*) is perched on the brink of extinction, and entanglement in vertical ropes hanging in the water that connect lobster traps, crab traps, other fish traps, and gillnets on the bottom of the ocean to buoys on the surface, is a primary factor keeping the whale population from recovering.[1]

North Atlantic right whales live in coastal waters from Florida to eastern Canada, some of the world's most heavily fished and trafficked waters. The shifting of shipping lanes in the US and Canada, along with the implementation of ship speed reduction rules around ports along the eastern United States, are believed to have contributed to a decline in ship strikes.[2] Unfortunately, despite some limited fishing restrictions, there has been no observation of a reduction in entanglements in fishing lines and nets.[3]

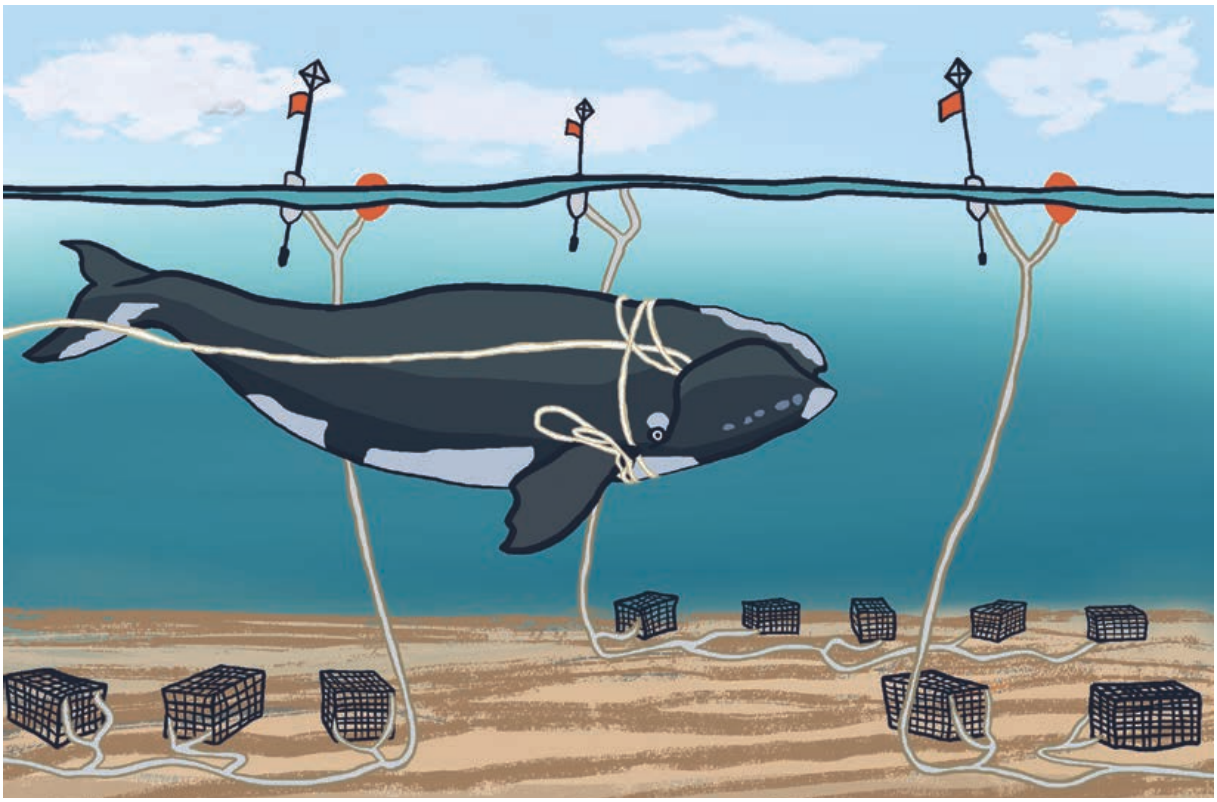


Diagram of the lines and traps that are most dangerous to the right whale.[4]

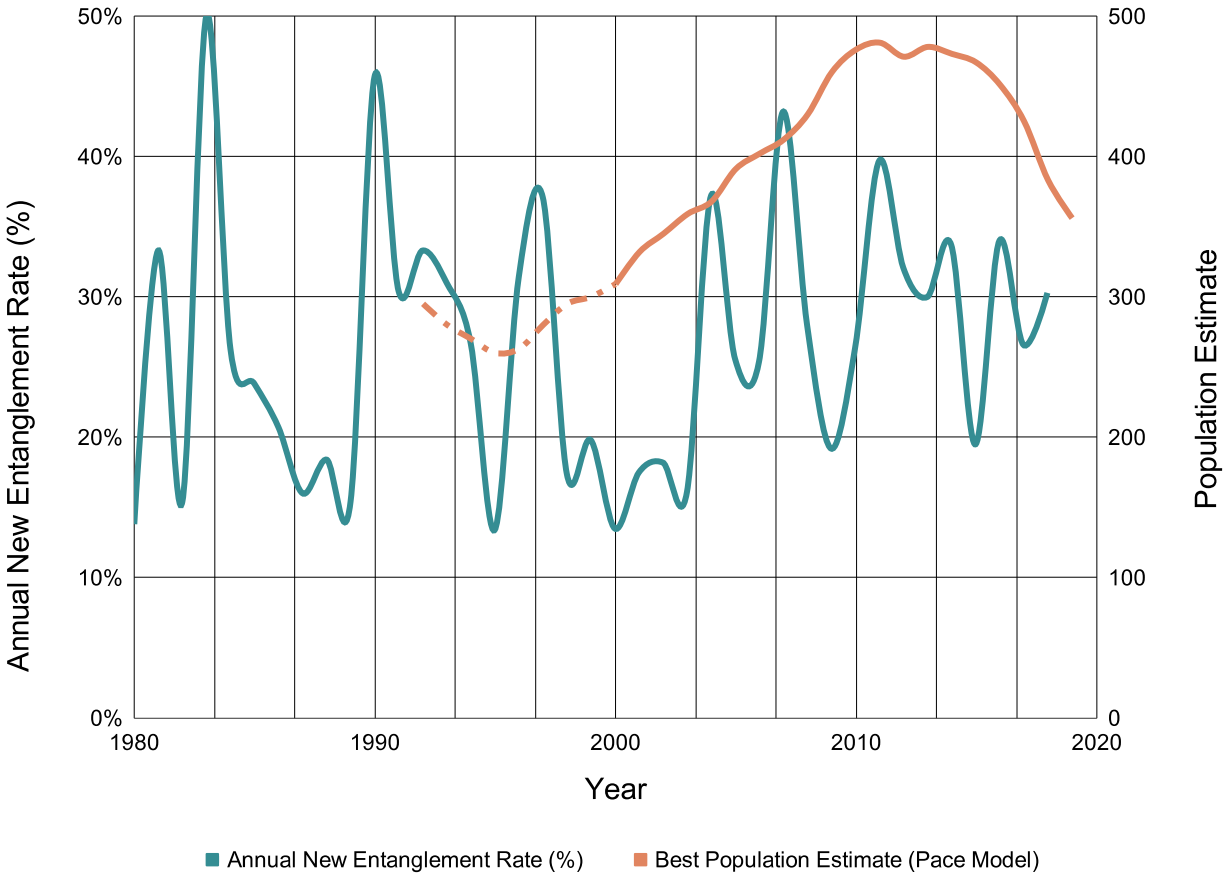
Today, commercial fisheries are still economically important in the region, and large-scale operations for harvesting lobster, crab, cod, and various species of small schooling fish such as menhaden still exist.[5] Due to the plastic gear used and lack of effective policy implementation, these commercial fisheries continue to decimate target species populations while also posing a massive threat to right whales.

Entanglement Issues

Right whale entanglements are primarily caused by fixed fishing gear—ropes and lines in active use—as opposed to so-called "ghost" gear or discarded fishing equipment.[6] These ropes are made from plastic and therefore do not degrade or break easily, so they cause lasting damage to entangled whales.

It's estimated that a mere 356 right whales were alive in the wild at the end of 2019, fewer than 100 of which were females able to reproduce.[7] For almost 1,000 years, the right whale was decimated by commercial whaling. In 1935, the species became internationally protected.[8] Despite conservation efforts, the mortality rate has increased since the 1980s, primarily because of ship strikes and entanglement in active fishing gear. Although the population grew from the years 2000 to 2010, recent deaths and a lack of reproduction have brought the count back down to the 2003 level.[9]

ESTIMATES OF NORTH ATLANTIC RIGHT WHALE POPULATIONS AND ANNUAL NEW ENTANGLEMENT RATES[11]



It's a nearly insurmountable challenge for a right whale to safely navigate through the nets, ropes, and traps scattered throughout their coastal habitat. Right whales do not just feed at the surface, but can also swim and feed at depths, so entangling fishing gear anywhere in the ocean poses a threat.[12] Fishing gear entanglements are increasing in number and severity, and entanglement is the number one cause of death for these whales.[13,14] Eighty-three percent of right whales have scars from entanglement, and half of the endangered animals show evidence of having been entangled more than once.[15]

Ruffian, an adult male North Atlantic right whale, became entangled in snow crab fishing gear off the east coast of Canada sometime between August 2016 and January 2017. He dragged 448 feet (138 meters) of rope and a 134-pound (61 kg) snow crab trap all the way to Florida before a team of experts luckily disentangled him. Ruffian suffered wounds from the line and trap, and he had to burn an additional 27,000 calories a day because of the increased load. To keep up with this energy loss, he would have had to spend an extra hour or two a day feeding. He was thinner when he was spotted in Florida and had lost blubber along his journey.[19]

For many right whales, entanglement in fishing gear is a death sentence. Ropes and lines cut into their skin, causing deep lacerations or even amputations. In addition to direct injuries, dragging the gear through the water causes substantial energy loss; whales may have to carry the gear for months or years.[17] Tangled gear wrapped around a whale can increase their drag on average by 160%—tugging a weighted lobster trap can increase drag by 300%—causing the animal to burn around an extra 25,000 calories each day.[18]

To prepare themselves for energy-intensive life stages, such as pregnancy and nursing, right whales are usually able to increase blubber stores. Should entanglement occur when a whale does not have adequate fat stores, the animal may be doomed.[20] Entanglement also can make it harder to feed, especially if there are lines wrapped around a whale's mouth. When forced to expend extra energy at the same time their feeding is inhibited, whales can rapidly lose body mass necessary for survival.

This unexpected energy loss is especially dangerous for females. Drag from fishing gear can use as much as 8% of the four-year-long female reproductive energy budget, in turn delaying potential reproduction by months or years.[21] Births have dropped by 40% since 2010.[22] For whales that already have low reproductive rates, delaying reproduction because of energy loss from entanglement has been an added detriment.

By Peter Duley/Northeast Fisheries Science Center/NOAA/collected under MMPA

Starboard, a North Atlantic right whale, died after being entangled in snow crab traps—twice—off the coast of Canada.[10, 23]

Conclusion

Is it too late for the North Atlantic right whale? Unfortunately, past efforts to conserve this species have failed. Neither selective area closures of certain fisheries nor gear modifications have decreased right whale deaths. Current closures do not sufficiently encompass the seasonal movements of right whales, and changes in gear have not reduced entanglement rates.[24] Some experts believe that the right whale will be so reduced within the next two decades that the species will never recover.[25] Extreme efforts to protect the remainng right whales are needed, including closing some areas to fishing and replacing entangling gear with ropeless crab and lobster traps.

1. Kraus, Scott D., Moira W. Brown, Hal Caswell, Christopher W. Clark, Masami Fujiwara, Philip K. Hamilton, Robert D. Kenney et al. "North Atlantic right whales in crisis." *Science* 309, no. 5734 (2005): 561-562.

2. Sharp, Sarah M., William A. McLellan, David S. Rotstein, Alexander M. Costidis, Susan G. Barco, Kimberly Durham, Thomas D. Pitchford et al. "Gross and histopathologic diagnoses from North Atlantic right whale *Eubalaena glacialis* mortalities between 2003 and 2018." *Diseases of Aquatic Organisms* 135, no. 1 (2019): 1-31.

3. Ibid.

4. Pew Charitable Trust 2019.

5. National Marine Fisheries Service. "Fisheries Economics of the United States, 2017." U.S. Dept. of Commerce, NOAA Technical Memorandum (2017). https://media.fisheries.noaa.gov/2021-12/FEUS2017-final-v2.pdf

6. Asmutis-Silvia, R., et al. "Rebuttal to Published Article 'A Review of Ghost Gear Entanglement amongst Marine Mammals, Reptiles and Elasmobranchs' by M. Stelfox, J. Hudgins, and M. Sweet." *Marine Pollution Bulletin* 117 no. 1-2 (2017): 554-555,. http://dx.doi.org/10.1016/j.marpolbul.2016.11.052

7. Pettis, H. M., R. M. Pace III, and P. K. Hamilton. "North Atlantic Right Whale Consortium 2020 Annual Report Card." North Atlantic Right Whale Consortium (2020).

8. Kraus, Scott D., Moira W. Brown, Hal Caswell, Christopher W. Clark, Masami Fujiwara, Philip K. Hamilton, Robert D. Kenney et al. "North Atlantic right whales in crisis." *Science* 309, no. 5734 (2005): 561-562.

9. Pettis et al. "North Atlantic Right Whale Consortium." https://www.narwc.org

10. New England Aquarium and Canadian Whale Institute.

11. Knowlton, Amy R., Marilyn K. Marx, Philip K. Hamilton, and Heather M. Pettis. "Task 2: Final Report on 2018 Right Whale Entanglement Scar Coding Efforts." In Maintenance of the North Atlantic Right Whale Catalog, Whale Scarring and Visual Health Databases, Anthropogenic Injury Case Studies, and Near Real-Time Matching for Biopsy Efforts, Entangled, Injured, Sick, or Dead Right Whales (2020), prepared by Philip K. Hamilton, Amy R. Knowlton, Marianna N. Hagbloom, Kelsey R. Howe, Marilyn K. Marx, Heather M. Pettis, Amy M. Warren, and Monica A. Zani, 43-68; Pettis et al. "North Atlantic Right Whale Consortium." https://www.narwc.org

12. Hamilton, Philip K., and Scott D. Kraus. "Frequent encounters with the seafloor increase right whales' risk of entanglement in fishing groundlines." *Endangered Species Research* 39 (2019): 235-246.

13. Kraus, Scott D., Robert D. Kenney, Charles A. Mayo, William A. McLellan, Michael J. Moore, and Douglas P. Nowacek. "Recent scientific publications cast doubt on North Atlantic right whale future." *Frontiers in Marine Science* 3 (2016): 137.

14. Pennisi, Elizabeth. "The North Atlantic right whale faces extinction." *Science Magazine* (November 7, 2017).

15. Knowlton et al. "Task 2: Final Report."

16. Knowlton et al. "Task 2: Final Report."

17. Moore, Michael J., and Julie M. Van der Hoop. "The painful side of trap and fixed net fisheries: chronic entanglement of large whales." *Journal of Marine Biology* (2012).

18. van der Hoop, Julie M., Peter Corkeron, John Kenney, Scott Landry, David Morin, Jamison Smith, and Michael J. Moore. "Drag from fishing gear entangling North Atlantic right whales." *Marine Mammal Science* 32, no. 2 (2016): 619-642.

19. Pennisi, Elizabeth. "The North Atlantic right whale faces extinction." *Science Magazine*. November 7, 2017. https://www.sciencemag.org/news/2017/11/north-atlantic-right-whale-faces-extinction

20. van der Hoop, Julie, Peter Corkeron, and Michael Moore. "Entanglement is a costly life-history stage in large whales." *Ecology and Evolution* 7, no. 1 (2017): 92-106.

21. Ibid.

22. Kraus et al. "Recent scientific publications cast doubt," 137.

23. Peter Duley/Northeast Fisheries Science Center/NOAA, collected under MMPA #17355.

24. Kraus et al. "North Atlantic right whales in crisis," 561-562.

25. Pennisi, Elizabeth. "The North Atlantic right whale faces extinction."

As we begin to understand how entanglement and other stressors can lead to large energy depletion that can delay reproduction, we have a better understanding of why the North Atlantic right whale population has decreased a lot in recent years: it's not only the mortality rates, it is the major decline in reproduction and the increase in time between mothers having calves.
—Julie van der Hoop, Marie Sklodowska-Curie Research Fellow at Aarhus University; PhD from MIT and WHOI (direct communication, January 2021)

HOT SPOT

Indian Ocean

Research and writing by Natasha Batista

SPECIES: HUMPBACK AND BLUE WHALE; ASIATIC RIVER, IRRAWADDY, AND SPINNER DOLPHINS

The immense Indian Ocean—home to the tiny, endangered Irrawaddy dolphin and the colossal blue whale—is densely littered with plastics and is heavily fished using destructive plastic gillnets. The Indian Ocean fisheries are dominated by artisanal fishing utilizing vessels less than 50 feet (15 meters) long with catches for local food consumption and income. This makes regulation and data monitoring extremely difficult. This fishing industry also includes larger industrial gillnet vessels and distant-water fleets from Europe and Asia. Collectively, these fishing activities are responsible for large-scale entanglements of whales and dolphins. Neither the rate of entanglement nor the number of marine mammal deaths by plastic ingestion are well documented in the area, and bycatch is underreported, as it is often hidden or disposed of at sea. Alternative methods to gillnet fishing must be formulated to create more sustainable local fisheries and to reduce harm to marine mammals.

Some of the most damaging fisheries in the world to whales and dolphins are found in the Indian Ocean. Among these local fisheries, the use of gillnets is distressingly common, causing large-scale entanglements of a variety of whales and dolphins. There are similar fisheries practices and entanglement issues across Southeast Asia.

The vast Indian Ocean is home to more than 50 species of whales and dolphins.[1] These live in a range of habitats, from shallow river basins to the continental shelf, and migratory species such as humpback whales (*Megaptera novaeangliae*) travel from as far as Antarctica to enjoy the tropical coastal waters and raise their calves.[2]

The Indian Ocean covers more than 27 million square miles. The warmer waters surrounding India alone are inhabited by 26 species of whales and dolphins, including the Irrawaddy dolphin (*Orcaella brevirostris*), spinner dolphin (*Stenella longirostris*), and blue whale (*Balaenoptera musculus*).[3]

Gillnet entanglement poses the largest threat to marine mammals in the Indian Ocean. Bycatch remains poorly reported.[4] Plastic debris also presents a threat: while a unique blend of monsoons and oceanic currents prevent a garbage patch from forming, copious levels of plastic can still be found in marine mammal habitats.[5,6]

A recent study estimates that 4.1 million dolphins were killed in gillnets between 1950 and 2018. This number does not include dolphin killing, such as harpooning, delayed mortality not recorded, and other causes.[7]

The Bay of Bengal (covering one million square miles) is heavily littered with plastic waste, found on shorelines, seafloors, and suspended in seawater.[8] This bay is surrounded by some of the largest river networks in the world, and the Ganges River between India and Bangladesh discharges an estimated 0.11 to 0.19 million tons (0.099 to 0.17 metric tons) of plastic annually into the ocean.[9] A 2019 study on the Cocos Keeling Islands, a remote archipelago in the eastern Indian Ocean, found 414 million pieces (238 million tons or 216 million metric tons) of plastic on its beaches. The most common forms of plastic waste were single-use items, such as bottle caps and straws, as well as shoes, sandals, and toothbrushes.[10]

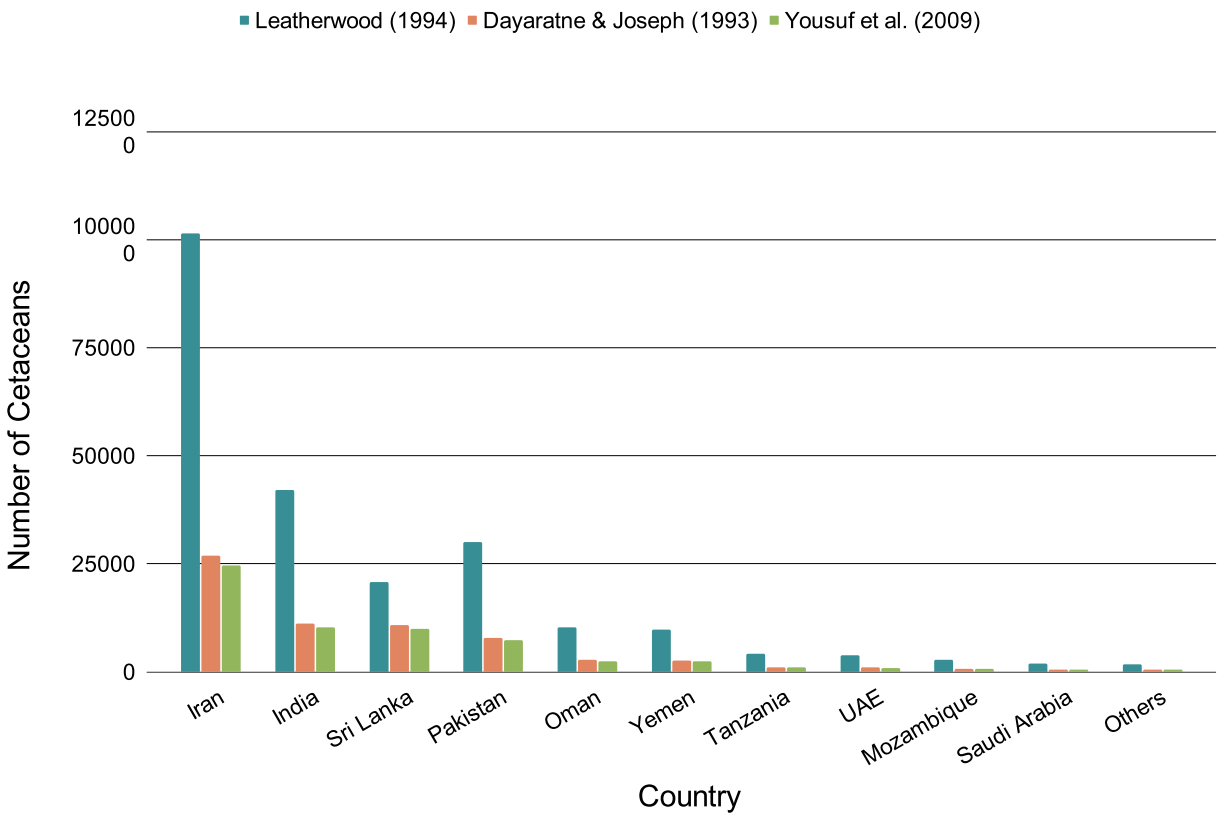
The ingestion of plastic by marine mammals, directly or through bioaccumulation, is not documented in the Indian Ocean and should be investigated as a high priority, along with better reporting of entanglements and captures of whales and dolphins.

Entanglement Issues

Indian Ocean fisheries, especially due to widespread use of gillnets, cause bycatch problems, particularly involving smaller species of dolphins.[11] The main fishing methods among tuna fisheries are gillnetting, purse seining, and longlining, and the industry comprises both nearby vessels (in Sri Lanka and India, for example) and distant-water fleets from Europe and Asia.

Gillnetting is the most common practice and has the highest proportion of whale and dolphin entanglement. Estimated dolphin and whale bycatch is in excess of 60,000 per year for all Indian Ocean tuna gillnet fisheries according to a 2020 study published in *Endangered Species Research*.[12] Scientists who wrote the paper also emphasized that cetacean bycatch estimates are not definitive and are based on limited data and high uncertainty. Clearly, there must be improved monitoring, sustainable fishing method development, and better management. Purse seine fishing comprises approximately one-quarter of the total fish catch according to the Indian Ocean Tuna Commission (IOTC). There is no known association between tuna and dolphins in this area, and purse seine vessels do not chase and encircle dolphins as a method of catching tuna and have observers on board. The IOTC notes that the Indian Ocean tuna purse seine fleet is dominated by French and Spanish vessels. Longlining, using multiple baited hooks, is known to occasionally hook dolphins, but is more problematic for marine birds and sea turtles.

THREE ESTIMATES OF CETACEAN BYCATCH BASED ON REPORTED CATCHES OF TUNA AND TUNA-LIKE SPECIES IN 2012 AND ESTIMATED BYCATCH RATES[13]



© Volvox Inc/Alamy Stock Photo

The tiny Irrawaddy dolphin is widespread in the Indian Ocean and Southeast Asia, but nowhere is it abundant. Recently, the last Irrawaddy dolphin known in the Mekong River of northeast Cambodia was drowned in a gillnet. There are only three remaining populations of these dolphins in the Philippines, where conservationists are petitioning the government to designate them as critically endangered.

Spinner and spotted dolphin (*Stenella attenuata*) populations in particular have been harmed and killed by drift gillnet tuna fisheries. These species are the most common dolphins in the tropical Indian Ocean.[14] Risso's dolphins (*Grampus griseus*) have similarly been hurt in parts of the Indian Ocean and are now rare around Sri Lanka.[15]

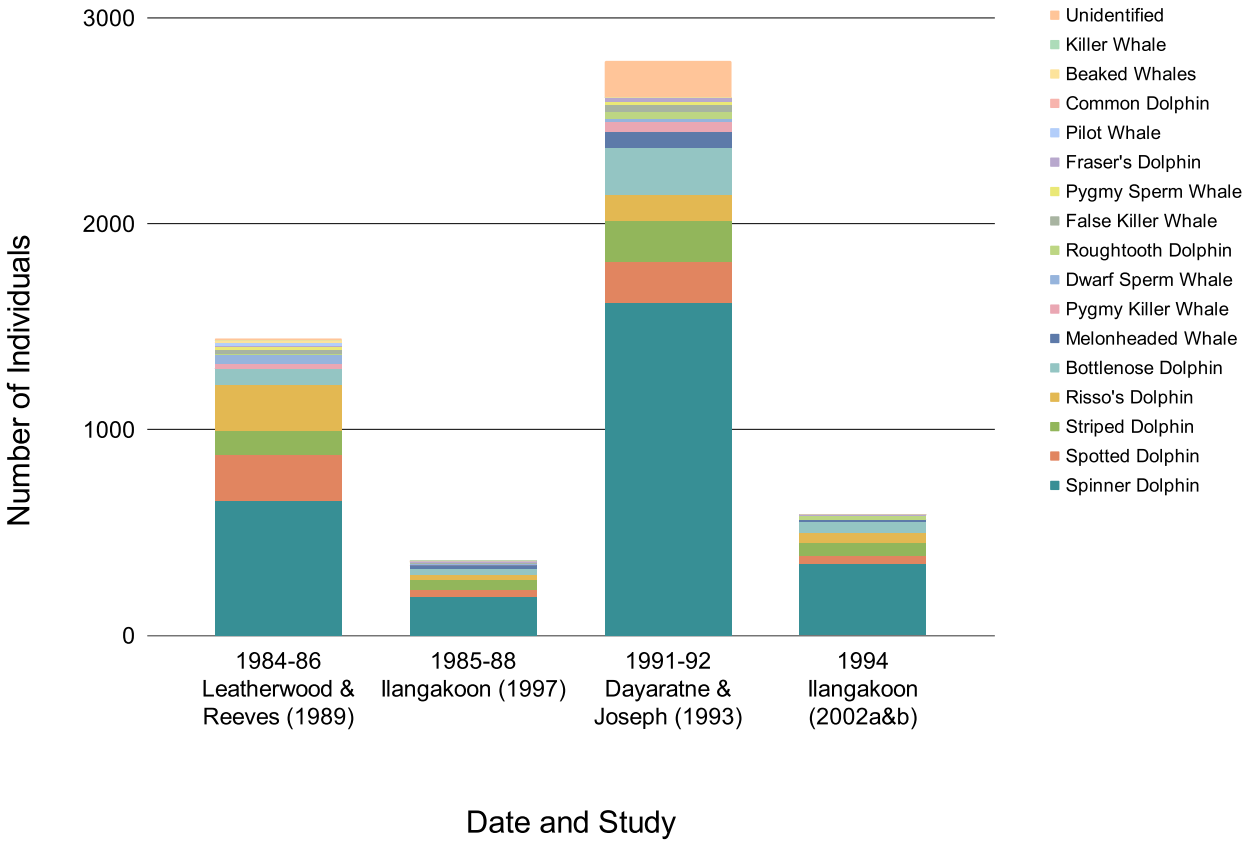
In Bangladesh, gillnet fisheries target sharks, rays, and skates, and are potentially capturing unsustainable levels of Irrawaddy dolphins as bycatch.[16] Larger marine mammals, such as Bryde's and Eden's whales (*Balaenoptera edeni*), are also known to associate with large yellowfin tuna. Mortality from entanglement in pelagic gillnets may be more than 10 annually, which can cause significant harm to smaller populations.[17,18]

SRI LANKA

The primary threat to spinner dolphins is entanglement in fishing gear. Research suggests that more than half of dolphins and whales caught as bycatch in Sri Lanka's coastal fisheries are spinner dolphins.[19] While cetaceans have national protection under Sri Lankan law, notably from bycatch, enforcement is rare. Fishers are aware of the law, but bycatch is usually hidden, disposed of at sea, or used as bait.[20]

Estimates of the annual marine mammal bycatch range from an upper bound of 49,863 dolphins caught from 1984 through 1986 to a lower bound of 5,181 dolphins caught in 1991 and 1992. It is not clear whether the estimates differ because of changes in the fishery or because of methods used in the calculations.[21] More systematic research and reporting on cetaceans and bycatch in the area are needed.

CETACEAN LANDINGS BY SPECIES RECORDED BY FOUR DIFFERENT STUDIES AROUND THE COAST OF SRI LANKA[22]



Direct hunting of cetaceans is an emerging problem as demand for their meat increases in Sri Lanka. By the 1980s, gillnetters were landing thousands of dolphins at fishing ports, and fishers began to harpoon dolphins. Most estimates suggest that 8,000 to 13,000 small cetaceans were caught per year in the 1980s, even before harpooning became popular.[23] Thus the figures in our charts most likely represent only the tip of the iceberg of dolphin catches and entanglement deaths in Sri Lanka.

INDIA

After Sri Lanka, Indian fishers catch the second-highest quantity of tuna and tuna-like species by gillnet in the Indian Ocean. Large-mesh gillnets have long been recognized as a threat to dolphins and whales in Indian waters. Gillnets do not qualify under international standards as Dolphin Safe. The most common species entangled are spinner, common (*Delphinus spp.*), bottlenose (*Tursiops spp.*), and Indo-Pacific humpback dolphins (*Sousa chinensis*). A total of 937 dolphins have been recorded brought ashore, presumably to supply the meat market for human consumption and bait market for sharks and other fish,[24] among five published studies of cetacean bycatch during the past 40 years; however, there are large gaps in the reporting. The most recent estimate of dolphin entanglement in Indian gillnet fisheries is that 9,000 to 10,000 dolphins are caught as bycatch each year.[25]

Conclusion

The wide-ranging use of gillnets is a global problem for whales and dolphins. The plastic nets are strong and do not degrade in the ocean when lost by fishers. Artisanal small-scale gillnet fishing, especially in places such as Sri Lanka and India, provides protein for local people and is extremely difficult to monitor and manage. The Indian Ocean Tuna Commission (IOTC), the regional fisheries management organization, must step

up its monitoring and management of larger and industrialized vessels to confront bycatch, entanglement, and unsustainable fishing methods and address the dangers of plastic fishing netting on marine mammals and ocean ecosystems.

1. Anderson, R. C. "Cetaceans and Tuna Fisheries in the Western and Central Indian Ocean." *International Pole and Line Foundation Technical Report* 2 (2014) International Pole and Line Foundation, London.

2. Ibid.

3. Ibid.

4. Ibid.

5. Riskas, Kimberly. "The Indian Ocean's Great Disappearing Garbage Patch." *Hakai Magazine* (June 19, 2019). https://www.hakaimagazine.com/news/the-indian-oceans-great-disappearing-garbage-patch/

6. Van der Mheen, Mirjam, Charitha Pattiaratchi, and Erik van Sebille. "There's no 'garbage patch' in the Southern Indian Ocean, so where does all the rubbish go?" *The Conversation* (April 15, 2019) https://theconversation.com/theres-no-garbage-patch-in-the-southern-indian-ocean-so-where-does-all-the-rubbish-go-114439

7. Anderson, R. Charles, Miguel Herrera, Anoukchika D. Ilangakoon, K. M. Koya, M. Moazzam, Putu L. Mustika, and Dipani N. Sutaria. "Cetacean Bycatch in Indian Ocean Tuna Gillnet Fisheries." *Endangered Species Research* 41 (2020): 39-53. https://www.int-res.com/abstracts/esr/v41/p39-53/

8. Ibid.

9. Lebreton, Laurent C., Joost van der Zwet, Jan-Willem Damsteeg, Boyan Slat, Anthony Andrady, and Julia Reisser. "River plastic emissions to the world's oceans." *Nature Communications* 8, no. 1 (2017). https://www.nature.com/articles/ncomms15611

10. Lavers, J. L., L. Dicks, M. R. Dicks, and A. Finger. "Significant Plastic Accumulation on the Cocos (Keeling) Islands, Australia." *Scientific Reports* 9, no. 1 (2019). https://www.nature.com/articles/s41598-019-43375-4

11. Calderan, Susannah, and Russell Leaper. "Investigations of countries exporting seafood to the US which may be subject to regulation under the MMPA bycatch rule with respect to cetaceans." World Wildlife Fund. Revised (April 10, 2017). https://wwfint.awsassets.panda.org/downloads/investigations_of_countries_exporting_seafood_to_the_us_which_may_be_subject_to_regulati_1.pdf

12. Anderson et al. "Cetacean bycatch," 39-53.

13. Anderson. "Cetaceans and Tuna Fisheries."

14. Calderan and Leaper. "Investigations of countries."

15. Ibid.

16. Ibid.

17. Ibid.

18. Anderson. "Cetaceans and Tuna Fisheries.

19. Calderan and Leaper. "Investigations of countries."

20. Ibid.

21. Anderson. "Cetaceans and Tuna Fisheries."

22. Ibid.

23. Ibid.

24. Ibid.

25. Yousuf, K. S. S. M., A. K. Anoop, B. Anoop, V. V. Afsal, E. Vivekanandan, R. P. Kumarran, M. Rajagopalan, P. K. Krishnakumar, and P. Jayasankar. "Observations on incidental catch of cetaceans in three landing centres along the Indian coast." *Marine Biodiversity Records* 2 (2009). http://eprints.cmfri.org.in/5708/1/yousuf.pdf

HOT SPOT

Hawai'i

Research and writing by Sadie Cwikiel

SPECIES: HUMPBACK WHALE; HAWAI'IAN MONK SEAL

From rare monk seals with circular hooks skewered through their cheeks to humpbacks snarled and drowned by heavy nets, Hawai'i's marine mammals are vulnerable to ocean plastics and fishing gear. The scattered islands and blue depths draw a dazzling variety of mammals to Hawai'i, but these waters are also at the edge of the North Pacific Gyre, and they are home to extensive longline fishing. While disentanglement efforts are an important stop-gap measure, these animals will be susceptible to entanglement disasters until plastics can be stemmed closer to the source.

At least 25 species of marine mammals inhabit Hawai'ian waters,[1] including the Hawai'ian monk seal (*Neomonachus schauinslandi*), one of the world's most endangered seal species.[2] Only about 1,300 seals were alive in the wild in 2015, the majority living in the remote Northwestern Hawai'ian Islands.[3]

The warm, shallow waters surrounding the archipelago are also important habitat for northern humpback whales (*Megaptera novaeangliae*). Each winter, 8,000-12,000 humpbacks migrate to the islands from British Columbia and Alaska to breed and to give birth to their calves.[4]

Numerous other species of dolphins and whales also call the islands home, including the spinner dolphin (*Stenella longirostris*), bottlenose dolphin (*Tursiops truncatus*), melon-headed whale (*Peponocephala electra*), and short-finned pilot whale (*Globicephala macrorhynchus*).[5]

Hawai'i—a US state consisting of eight major islands and numerous islets—is positioned near the North Pacific Gyre, a system of converging ocean currents that collect and concentrate plastics from around the world. This "trash vortex" threatens marine life in the region.[6,7] Despite the remoteness of the islands—especially the Northwestern Hawai'ian Islands—their beaches bear some of the world's heaviest plastic pollution.[8]

Derelict and active fishing gear injures and kills marine life throughout the region as well. In addition to entangling marine mammals, abandoned fishing gear catches on reefs and damages coral.[9]

Entanglement Issues

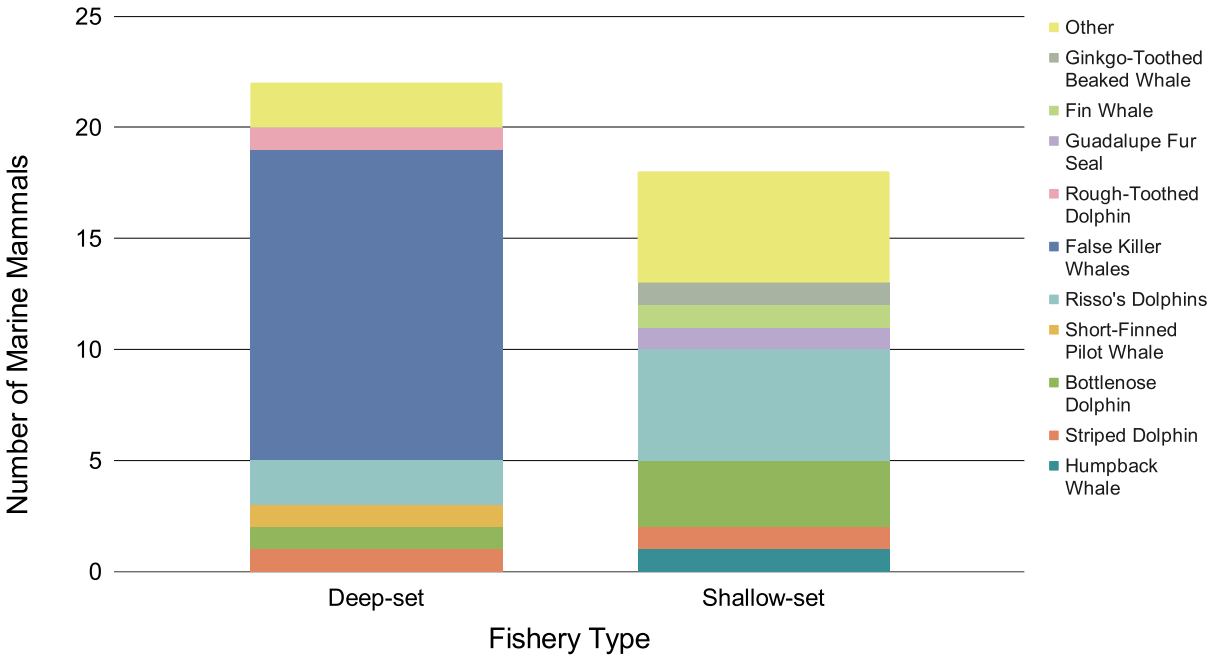
While all forms of plastic pollution pose threats for Hawai'ian monk seals, humpback whales, and other marine mammals in the region, interactions with longline fisheries and gillnets cause the most injuries and mortalities each year. According to onboard fishery observers, dozens of marine mammals are injured or killed from hookings or entanglements from the deep-set and shallow-set longline fisheries that target tuna and swordfish, respectively, for the restaurant trade.[10]

The endangered Hawai'ian monk seal is particularly susceptible to entanglement in plastic fishing gear, including nets and fishing line.

© NOAA/Alamy Stock Photo.

DEEP-SET AND SHALLOW-SET LONGLINE FISHERIES INTERACTIONS WITH MARINE MAMMALS IN THE HAWAIIAN ISLANDS

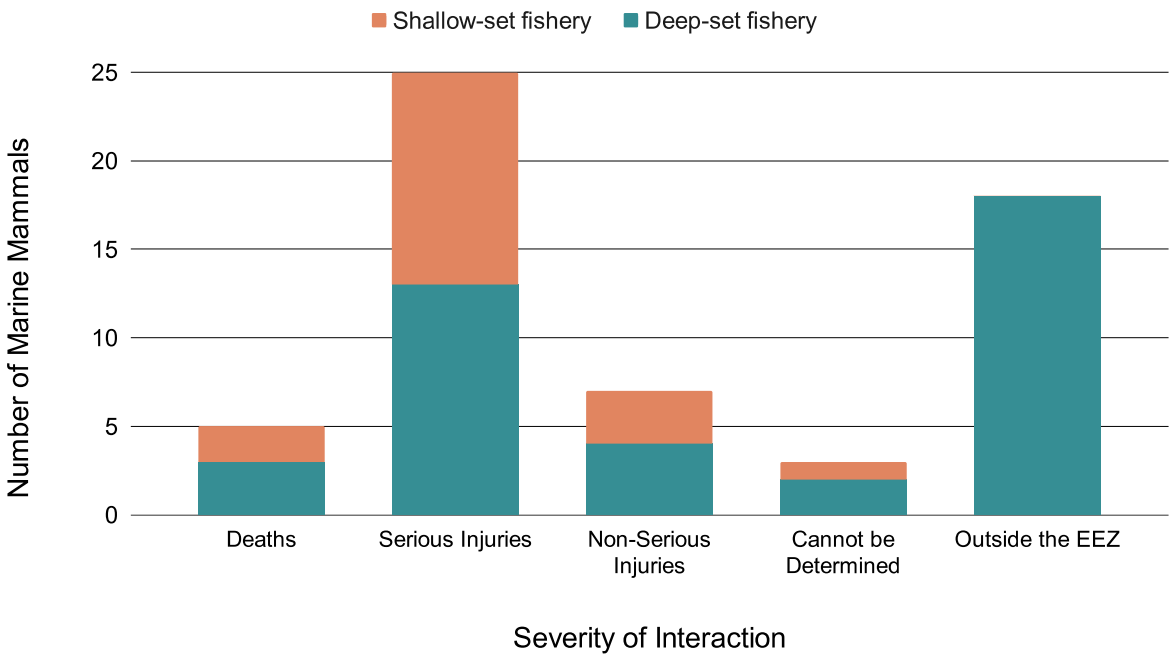
The interactions are recorded by onboard fisheries observers, and the majority of interactions result in serious injuries to the animals.[11]



The interactions that occur in the deep-set longline fisheries are sometimes outside the US Exclusive Economic Zone, and slightly more marine mammals are harmed by the deep-set longline fisheries compared with the shallow-set fisheries.[12] The longlines affect many species of marine mammals, including false killer whales (*Pseudorca crassidens*), Risso's dolphins (*Grampus griseus*), short-finned pilot whales, rough-toothed dolphins (*Steno bredanensis*), striped dolphins (*Stenella coeruleoalba*), and bottlenose dolphins.[13]

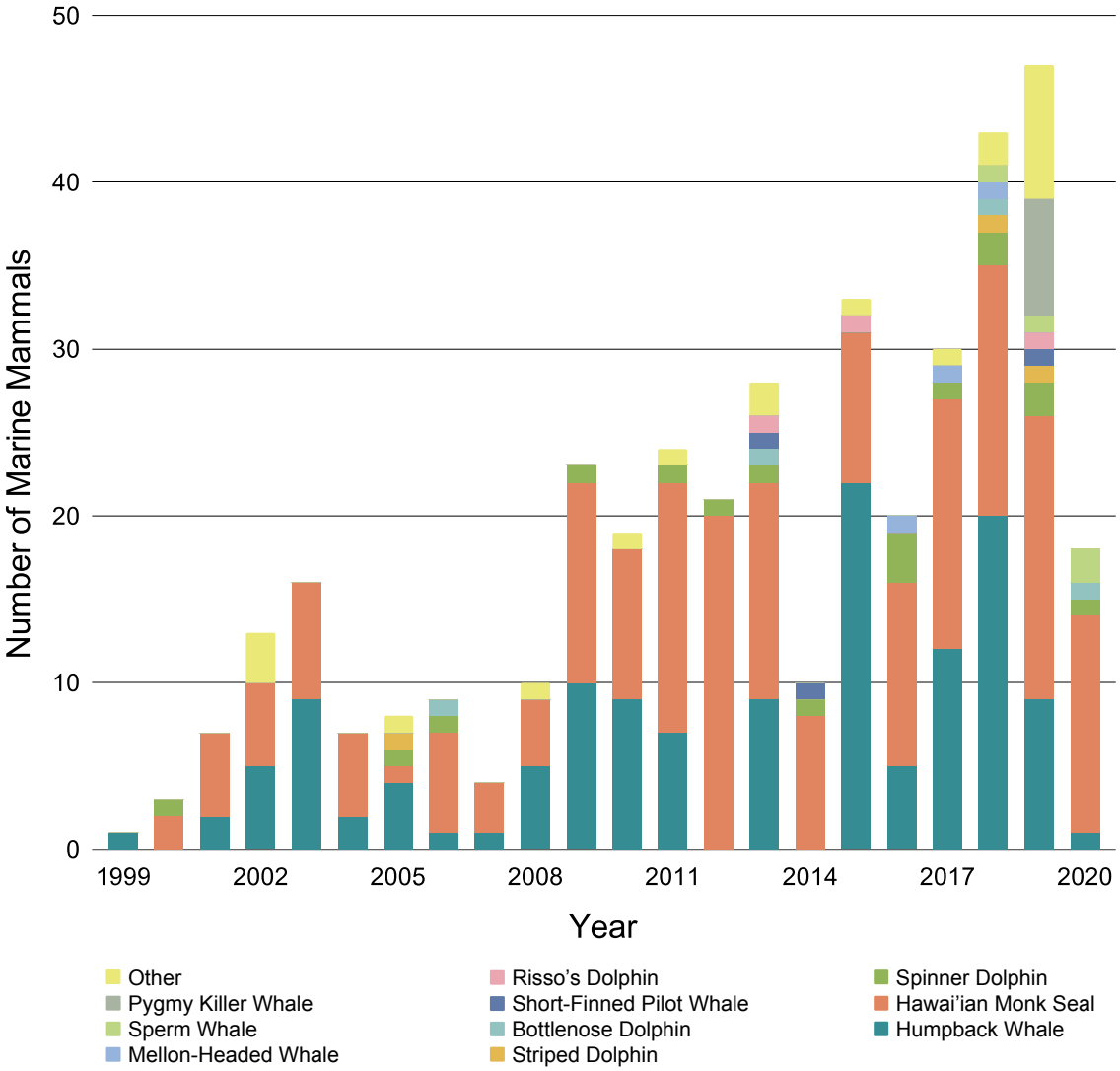
THE SEVERITY OF INJURY TO MARINE MAMMALS FROM INTERACTION WITH DEEP-SET AND SHALLOW-SET LONGLINE FISHERIES IN THE HAWAI'IAN ISLANDS

The interactions are recorded by onboard fisheries observers, and the majority of interactions result in serious injuries to the animals.[14]



In addition, each year, dozens of marine mammals are found entangled in fishing gear and other marine debris. The majority of recorded entanglements hurt Hawai'ian monk seals and humpback whales.[15]

MARINE MAMMAL ENTANGLEMENTS BY SPECIES IN HAWAI'IAN WATERS FROM 1999-2020[16]



HAWAI'IAN MONK SEALS

Hawai'ian monk seals are often found with circular hooks in their mouths or cheeks from longline fisheries or entangled in gillnets. While the vast majority of the seals live in the Northwestern Hawai'ian Islands, fisheries interactions are most frequent near Kaua'i and O'ahu.[17]

According to the US National Marine Fisheries Service (NMFS), Hawai'ian monk seals have one of the highest documented entanglement rates among seal and sea lion species. Juvenile seals, known as pups, are most often entangled.[18] From 1998 to 2014, 28% of individually identified monk seals had at least one documented hooking or entanglement.[19] Since 1982, NMFS teams have observed more than 300 seals entangled in derelict fishing gear and other marine debris.[20]

HUMPBACK WHALES

Humpback whales also suffer from entanglement in the ocean surrounding the Hawai'ian Islands. Whales are entangled by local fishing gear including traps; longline and monofilament line; mooring gear; marine debris;

fish aggregating devices (FADs); and actively fished gear.[21] In many cases, the netting and lines come from fisheries beyond Hawai'i, such as netting picked up by humpback whales in the Gulf of Alaska and British Columbia during their feeding season in those waters. One whale was found to have dragged fixed-gear fishing equipment over 2,450 nautical miles from Wrangell (in Alaska) to Mau'i (in Hawai'i).[22]

Since 2002, the community-based Hawai'ian Islands Large Whale Entanglement Response Network and Hawai'ian Islands Humpback Whale National Marine Sanctuary have received more than 400 reports of large-whale entanglements, all but a few of which involved humpbacks. While disentanglement efforts increase an animal's chance of survival, each effort is a difficult and dangerous task. The network has been able to disentangle about 30 whales, a fraction of the 200 confirmed entanglements since 2002.[23]

While disentanglement is an essential tool to help marine mammals, it is a band-aid solution on the bullet-hole wound that is plastic pollution in the oceans.

Conclusions

The US Environmental Protection Agency (EPA) took an unprecedented step in Hawai'i in July 2020 to address ocean plastic pollution, which is hopefully a harbinger of more focused federal actions to come. EPA declared the waters around two beaches—Tern Island and Kamilo Beach—were severely impaired by plastic pollution under the Clean Water Act. It ordered the reluctant State of Hawai'i to take action to remedy the situation. This is a tremendous precedent that should be expanded to other beaches and impaired coastal habitats.

Hawai'i is home to diverse and unique marine ecosystems. If plastic pollution and irresponsible fishing practices continue unabated, the reefs, beaches, and open waters will continue to be hazardous for the marine mammals that call them home. No part of the ocean, no matter how remote, is safe from the plastics plague.

1. National Marine Sanctuaries. "Marine Mammals of Hawai'i." National Marine Sanctuary System. https://nmssanctuaries.blob.core.windows.net/sanctuaries-prod/media/archive/dolphinsmart/pdfs/marine_hawaii.pdf

2. NOAA. "Species Directory: Hawaiian Monk Seal." NOAA Fisheries. https://www.fisheries.noaa.gov/species/hawaiian-monk-seal

3. Baker, Jason D., Albert L. Harting, Thea C. Johanos, and Charles L. Littnan. "Estimating Hawaiian monk seal range-wide abundance and associated uncertainty." *Endangered Species Research* 31 (2016): 317-324. https://www.int-res.com/articles/esr2016/31/n031p317.pdf

4. "What's in a Song? Hawaii's Humpback Whale Population." *University of Hawai'i System News*. December 18, 2020. https://www.hawaii.edu/news/2020/12/18/hawaii-humpback-whale-population/

5. National Marine Sanctuaries. "Marine Mammals of Hawai'i."

6. NOAA. How Currents Carry Marine Debris to the Hawaiian Islands." *NOAA Marine Debris Program* (blog). July 6, 2020. https://blog.marinedebris.noaa.gov/how-currents-carry-marine-debris-hawaiian-islands

7. Barney, Liz, and Michelle Broder Van Dyke. "Welcome to Hawaii's 'Plastic Beach', One of the World's Dirtiest Places." *The Guardian* (2020). https://www.theguardian.com/us-news/2020/jan/10/kamilo-beach-plastic-hawaii-pollution

8. Ibid.

9. Suka, Rhonda, et al. "Successful application of a novel technique to quantify negative impacts of derelict fishing nets on Northwestern Hawaiian Island reefs." *Marine Pollution Bulletin* 157 (2020): 111312. https://www.sciencedirect.com/science/article/pii/S0025326X20304306?casa_token=URcO2IKluZ4AAAAA:mJ9SWDA_yTOOvuFy07Zo5C0HgfB01ZK3h-cTiPDQ9ocdUxYlmuTbr7HhGCsSjJQpNOAnzdlaBg

10. Bradford, Amanda L. "Injury Determinations for Marine Mammals Observed Interacting with Hawaii and American Samoa Longline Fisheries During 2015–2016." NOAA technical memorandum NMFS-PIFSC (2018): 70. https://repository.library.noaa.gov/view/noaa/17874

11. Ibid.

12. Ibid.

13. Ibid.

14. Ibid.

15. Data Source: NOAA Fisheries, Pacific Islands Region.

16. US National Marine Fisheries Service, Pacific Islands Region.

17. NOAA. "Species Directory: Hawaiian Monk Seal."

18. Ibid.

19. Gobush, K. S., et al. "Prevalence of interactions between Hawaiian monk seals (*Nemonachus schauinslandi*) and nearshore fisheries in the main Hawaiian Islands." *Pacific Conservation Biology* 23, no. 1 (2017): 25-31. https://www.publish.csiro.au/PC/pdf/PC15029

20. Marine Mammal Commission. "Threats to Hawaiian Monk Seals." MMC Priority Topics. https://www.mmc.gov/priority-topics/species-of-concern/hawaiian-monk-seal/threats-to-hawaiian-monk-seals/

21. NOAA. "Large Whale Entanglement Response." Hawaiian Islands Humpback Whale National Marine Sanctuary. https://hawaiihumpbackwhale.noaa.gov/protect/entanglement.html

22. Ibid.

23. Ibid.

HOT SPOT

The English Channel

Research and writing by Lilah McCormick and Fiona Mulhern

SPECIES: HARBOR PORPOISE; SHORT-BEAKED COMMON, BOTTLENOSE, AND STRIPED DOLPHIN; LONG-FINNED PILOT WHALE

High above the English Channel, British Coast Guard satellites pick up what appears to be "potential pollution"—but on closer inspection, these are the discarded carcasses of dolphins and porpoises left in the wake of trawl vessels, seen from space.[1] Here, rich currents draw diverse cetaceans to waters that are heavily trawled. Their bodies—thousands every year—are hacked free from fishing gear and left to drift ashore. As these populations approach collapse, existing rules and agreements must be enforced along with appropriate new laws.

The English Channel, the busiest shipping lane in the world, is home to seven species of dolphins and whales, now threatened by fishing trawlers.[2,3]

In the channel, which separates Northern France from Southern England, freshwater tributaries mix with saltwater to create turbid waters and strong tides. A diverse group of inhabitants includes harbor porpoises (*Phocoena phocoena*), short-beaked common dolphins (*Delphinus delphis*), bottlenose dolphins (*Tursiops truncatus*), Risso's dolphins (*Grampus griseus*), striped dolphins (*Stenella coeruleoalba*), long-finned pilot whales (*Globicephala melas*), and minke whales (*Balaenoptera acutorostrata*). They are attracted by and feed upon the summer blooms of krill and fish, migrating to warmer climes during the colder seasons.[4]

The English Channel and northeast Atlantic Ocean are some of the "most productive and heavily fished waters on the planet."[5] Trawl fishing boats pull large nets through the channel to gather pilchards (*Sardina pilchardus*), mackerel (*Scomber scombrus*), and sea bass (*Centropristis striata*).[6,7] Dolphins and other mammals follow fishery vessels, most likely hoping to feed on the target catch (or associated non-target catch), and get swept up in nets.[8]

The Western English Channel in particular is trawled from October to May, which coincides with significant cetacean strandings. Hundreds of short-beaked common dolphins wash up on shore with scars and other signs of netting.[9] A study of the effects of the winter pelagic trawling on the year-round resident common dolphins concluded that "incidental catch in fishing gear (bycatch) forms a major threat to the conservation of cetaceans in European waters," and along with range-shifts due to global warming, may have contributed to declines in population of common dolphins.[10]

Existing regulations and agreements have failed to solve the problem. More than a dozen countries, including the UK and France, are parties to a pact known as ASCOBANS (the Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas), which took effect in 1994.[11] The measure requires that member states work to eliminate entanglement of whales and dolphins. But signatories don't appear to be committed to doing much to combat the entanglements, and the pact has no means of enforcement.[12]

In 2004, European Council Regulation 812/2004 required vessels 39 feet (12 meters) or longer in certain fisheries to appoint onboard observers to report entanglements.[13] But these observers are sometimes intimidated, bribed, and threatened in an attempt by fisheries to conceal illegal fishing practices, potentially skewing entanglement data.[14] The regulation also introduced the trial use of acoustic pingers (sirens giving warning to dolphins and whales close to nets).[15]

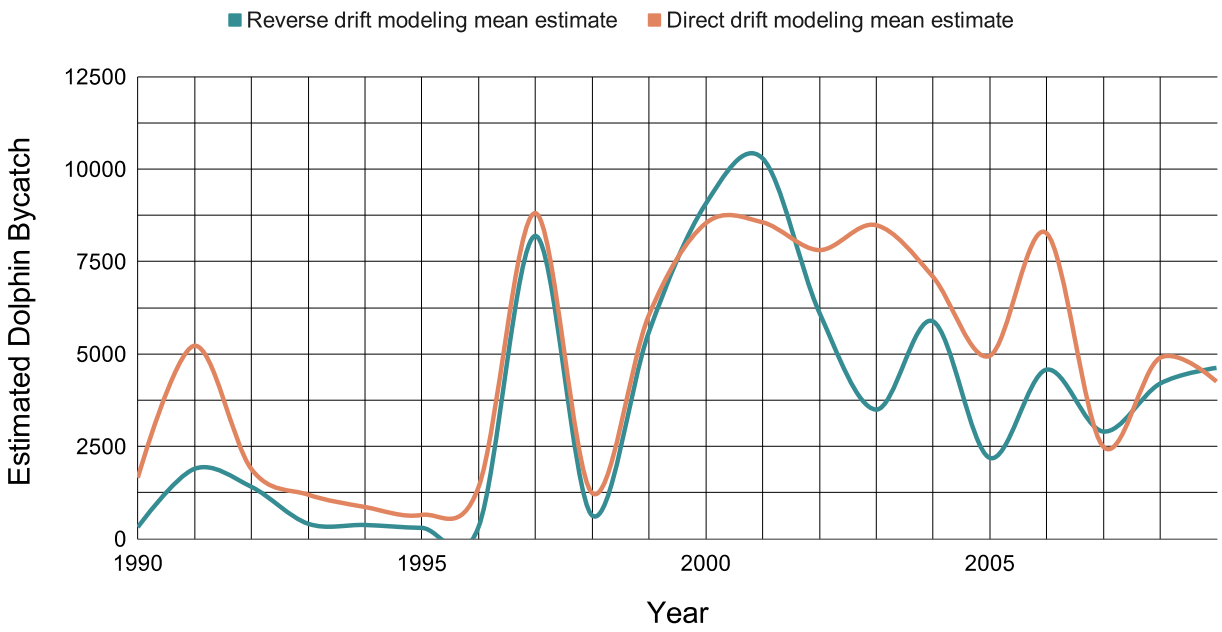
While these regulations and platforms for cooperation are steps toward cetacean conservation, they are not enough.

Entanglement Issues

Experts now estimate that in 2001, the deadliest year, more than 10,000 common dolphins died after entanglements in the English Channel and Bay of Biscay, primarily in sea bass (*Dicentrarchus labrax*) and albacore tuna (*Thunnus alalunga*) net fisheries.[16] For the years 1990 through 2009, dolphin entanglements were estimated to be between 3,650 and 4,700 annually, using different methods to estimate the kill rate.[17]

ESTIMATED ANNUAL COMMON DOLPHIN BYCATCH IN THE ENGLISH CHANNEL FROM REVERSE DRIFT MODELING AND DIRECT DRIFT MODELING

Reverse drift modeling reconstructs the estimated trajectory and geographic origin of each stranding using drift data. The estimated bycatch is then inferred from the probability of being stranded per dead individual. Direct drift modeling is not geographically specific, and infers estimated bycatch by relating probability of stranding to number of strandings.[18]



In contrast, using reports by onboard monitors, just 546 annual common dolphin fishery-related deaths were estimated for the same period, an indication that counts from observers on vessels reveal only 10% of the entanglements.[19] The 90% of unreported deaths may be from boats under 39 feet, which are not required, under the EU Agreement, to have observers despite the fact that they make up 80% of the French fishery alone. Observer bias may account for additional unreported deaths.[20] While the national reports estimated death rates of less than 0.6%, estimates inferred from dolphin strandings ranged from 0.9% to 5.7%, pointing to potentially unsustainable levels of deaths.[21]

Jorg Gill wald/iStock

Head of a stranded common dolphin on a French beach, likely drowned in a trawl net.

In December 2020, a family enjoying a day on the beach in Sussex, England, stumbled upon the decaying and gashed body of a young harbor porpoise. That winter, unusually high numbers of dead dolphins and porpoises washed up across England's south coast.[22] Many of the marine mammals' injuries were caused by fishing nets. Some of the animals were rotting, and others were missing body parts, both harms consistent with the practice of fishermen cutting trapped mammals out of the nets and then tossing the mutilated bodies into the sea, often hoping they would sink rather than strand ashore. A fleet of trawling vessels, dragging mile-long nets offshore, was most likely responsible.

In December 2020, according to Thea Taylor, co-leader of the Brighton Dolphin Project: "Since we started our records in autumn 2019 in Brighton, we've had 17 strandings, 13 related to super-trawlers." Taylor notes that studies indicate her group only finds 10% of bodies that have stranded, as opposed to bodies that sink at sea or are devoured by predators. "So this means," Taylor continued, "potentially, 130 dolphins have been killed in this area alone since then."[23] This increase in marine mammal mortalities has led to calls to the United Kingdom government to step up action against trawling.

Conclusion

The deaths of whales and dolphins caused by English Channel fisheries result in excruciating pain and suffering for individuals and jeopardize the future of these marine mammal populations. Once trapped in nets, these dolphins do anything to get out—including breaking their own backs or beaks out of desperation.[24] The rules in place to regulate fishing have failed to reduce—drastically, as needed—the entanglements of marine mammals. Vigorous enforcement and additional regulation are required to prevent the collapse of these populations.

1. Birrell, Ian. "Dolphins Are Being Killed By Mile-Long Trawler Nets in the English Channel." *Daily Mail Online*. December 12, 2020. https://www.dailymail.co.uk/news/article-9047475/Dolphins-killed-mile-long-trawler-nets-English-Channel.html

2. Whale and Dolphin Conservation Society and Greenpeace. "Cetaceans and Pelagic Trawl Fisheries in the Western Approaches of the English Channel." WDCS. 2005. https://www.wdcs.org/submissions_bin/fisheriespelagicpairtrawls.pdf?_ga=2.84427033.1829162954.1627146744-909553580.1627146744

3. Shubert, Atika, and Eoghan Macguire. "Channel Hopping: Keeping the World's Busiest Maritime Motorway Moving." *CNN*. Accessed August 8, 2021. http://edition.cnn.com/2013/09/04/business/channel-hopping-busiest-maritime-motorway/index.html

4. Laran, Sophie, et al. "Seasonal Distribution and Abundance of Cetaceans within French Waters—Part II: The Bay of Biscay and the English Channel." *Deep Sea Research Part II: Topical Studies in Oceanography* 141 (July 1, 2017): 31–40. https://doi.org/10.1016/j.dsr2.2016.12.012

5. Morizur, Y., et al. "Incidental Mammal Catches in Pelagic Trawl Fisheries of the North East Atlantic." ICES C.M. Q: 05, Theme Session: By-Catch of Marine Mammals: Gear Technology, Behaviour, and Ill Rates (January 1997).

6. Ibid.

7. de Boer, Marijke N., et al. "Interactions between Short-Beaked Common Dolphin (*Delphinus delphis*) and the Winter Pelagic Pair-Trawl Fishery off Southwest England (UK)." *International Journal of Biodiversity and Conservation* 4, no. 13 (October 2012): 481–499. https://doi.org/10.5897/ijbc12.016

8. Morizur et al. "Incidental Mammal Catches."

9. Whale and Dolphin Conservation Society.

10. de Boer et al. "Interactions between Short-Beaked Common Dolphin," 481-499.

11. Laran et al. "Seasonal Distribution and Abundance of Cetaceans," 31-40.

12. Ibid.

13. Whale & Dolphin Conservation UK. "Tackling Whale and Dolphin Bycatch in European Waters—Whale and Dolphin Conservation." *WDC UK* (blog). Accessed July 24, 2021. https://uk.whales.org/our-4-goals/prevent-deaths-in-nets/tackling-whale-and-dolphin-bycatch-in-european-waters/

14. Watling, Jack. "Fishing Observers 'Intimidated and Bribed by EU Crews.'" *The Guardian*. May 18, 2012. http://www.theguardian.com/environment/2012/may/18/fishing-inspectors-intimidated-bribed-crews

15. Whale & Dolphin Conservation UK. "Tackling Whale and Dolphin Bycatch."

16. Peltier, Hélène, et al. "Small Cetacean Bycatch as Estimated from Stranding Schemes: The Common Dolphin Case in the Northeast Atlantic." *Environmental Science & Policy* 63 (September 1, 2016): 7–18. https://doi.org/10.1016/j.envsci.2016.05.004

17. Ibid.

18. Ibid.

19. Ibid.

20. Ibid.

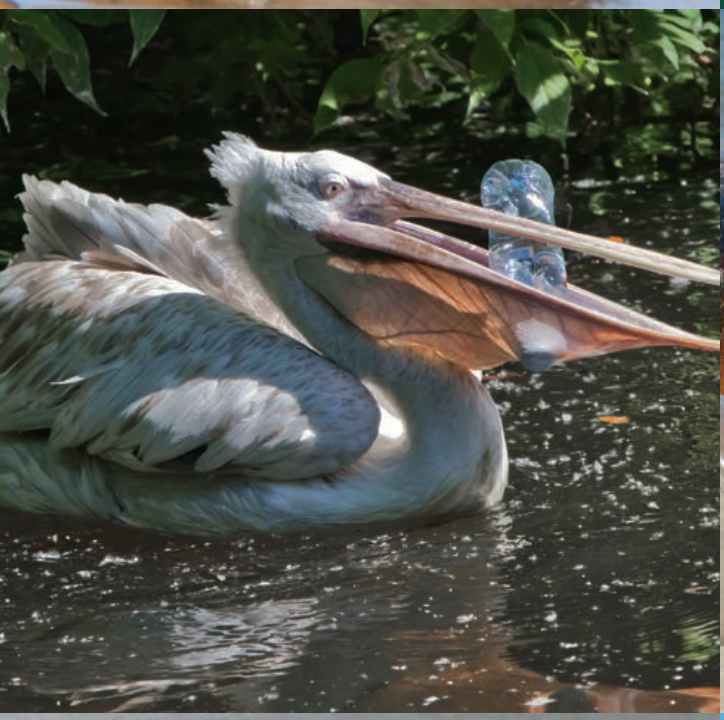
21. Ibid.

22. Birrell. "Dolphins Are Being Killed."

23. Ibid.

24. Martin, Nik. "Mass Dolphin Deaths off France, UK Likely Due to Trawling." *Deutsche Welle*. July 18, 2017. https://www.dw.com/en/mass-dolphin-deaths-off-france-uk-likely-due-to-trawling/a-39683636

Opposite page, clockwise from top left:
Harbor seal caught in fishing net. By Ian Dyball.
Fish swims surrounded by plastic. By Rich Carey/Shutterstock.
Dead dolphin with plastic bottles. By aerophoto/Shutterstock.
Sea turtle ingesting plastic. By Willyam Bradberry/Shutterstock.
Boy observing dead porpoise among plastic debris. By aerophoto/Shutterstock.
Pelican ingesting plastic bottle. By Mikhail Semenov.



INTERNATIONAL
MARINE MAMMAL PROJECT
A PROJECT OF EARTH ISLAND INSTITUTE

www.savedolphins.eii.org

2150 Allston Way, Suite 460 • Berkeley, CA 94704, USA

@internationalmarinemammalproject

@MarineMammalOrg

intlmarinemammalproject