Ocean Cleanup

Plastic from the Great Pacific Garbage Patch washes ashore in Hawaii. Scenes like this show why efforts to track, collect, and prevent ocean debris are underway around the world.

Credit: By Justin Dolske from Cupertino, USA - Beach trash, CC BY-SA 2.0, https://commons.wikimedia.org/w/index.php?curid=60788415

Plastic has remarkable value to humans. But it's also a major source of ocean plastic pollution.

Most of it is nets and rope from fishing boats, or municipal garbage that's carried down rivers into the ocean. There it accumulates in spinning gyres of plastic, twice the size of Texas. Large pieces eventually break down into fragments and microplastics. But because plastic is made to be durable, it won't degrade any farther than that.

Wouldn't it be great if we could clean it up?

That's what a Dutch teenager thought when he was diving in Greece and saw more plastic bags than fish. He created a high school science project -- that has since grown into an international nonprofit, called The Ocean Cleanup, employing engineers, marine biologists and collection teams.

They set up huge U-shaped nets that float with the current in the spinning gyres, in the top few feet of water where most plastics (but few fish) are. These gradually capture the debris, which their boats collect and haul to shore.

They've also installed collection systems at the mouths of rivers to intercept plastic before it enters the ocean. Together, their systems have captured millions of pounds of plastic waste, which they sort, recycle or properly landfill. There's much more to do, but they've inspired governments and other nonprofits to work on plastic waste management on land and at sea.

Hopefully, with growing awareness, we can all make a meaningful difference in ocean plastic pollution.

I'm Scott Tinker.

SWITCH ENERGY ALLIANCE

Background: Ocean Cleanup

Synopsis: Plastic has remarkable value to humans across all sectors of industrial, commercial, residential, and transportation uses. But plastic also creates a major pollution challenge. Plastic carried by rivers and currents gathers in swirling ocean gyres, forming enormous accumulation zones. Guided by ocean mapping and real-time data, large-scale cleanup systems are targeting offshore debris while strategic river programs work to cut off new plastic at its source.

The Start of the Journey

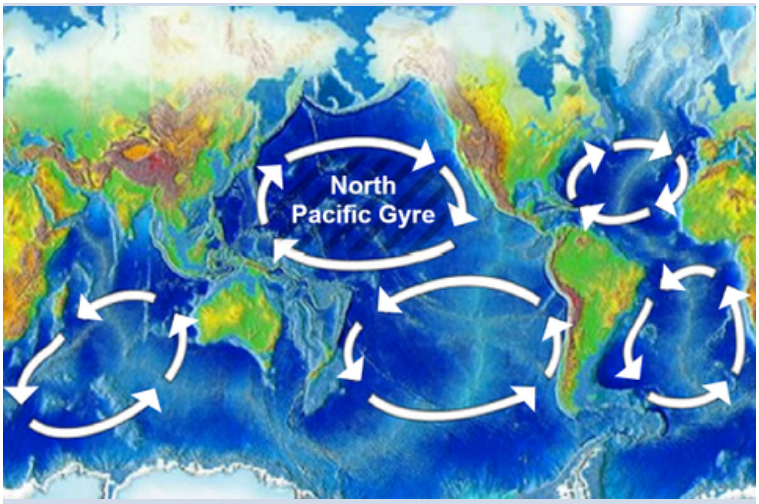
- It's a sunny day at the beach with family and the tide is coming in. Suddenly, a big wave comes washing up the shoreline, drenching your beach towels, and sending your beach chairs and sand toys into the surf. You manage to grab the chairs and get them to safety, but the plastic buckets, shovels and rakes are nowhere to be seen. Where will they end up?
- In a previous EarthDate, Ocean Plastic Pollution, we looked at how ocean plastic accumulates and the detrimental effects on fish, birds, and mammals in marine ecosystems.
- Personal actions can certainly help but larger, global efforts are underway to address the enormous problem of ocean plastic.

Ocean Garbage Cans

- Ocean currents spiral into massive circular systems called gyres (rhymes with "fires"). Plastic carried to sea becomes caught in these rotating currents, where it slowly accumulates.
- Over time, the trapped debris forms enormous "patches," vast areas of concentrated plastic often described as floating "garbage patches." In effect, the gyres become ocean garbage cans, collecting what the world has thrown away.
- Gyres do not create plastic pollution, but their circular motion concentrates debris that is already in the ocean. The centers of these systems are relatively calm, allowing floating material to remain trapped for long periods of time.
- Most plastics in oceans do not biodegrade. Instead, they persist for decades or centuries in the marine environment.
- Sunlight and wave action may weaken larger pieces, but the plastic itself remains in circulation.
- Because new plastic continues to enter the ocean each year, these accumulation zones continue to grow.

Designed to Last

- Plastics fall into several categories, including biodegradable, bio-based, and those made from petroleum and natural gas.
- Biodegradable plastics are designed to break down through the action of microorganisms and are often made from plant material such as corn starch or sugar cane.



Five major ocean gyres rotate across the globe, each capable of concentrating floating debris. While plastic is present in every ocean basin, the accumulation within the North Pacific Gyre, known as the Great Pacific Garbage Patch, is the largest.

Credit: By Fangz (talk) - Fangz created this work entirely by himself in Photoshop, using materials in the public domain., Public Domain, https://commons.wikimedia.org/w/index.php?curid=5077997

Background: Ocean Cleanup

- Bio-based plastics are derived partly or entirely from plant sources, but many are still chemically similar to conventional plastics and may not readily decompose.
- The most common plastics in global production are made from petroleum and natural gas, including polyethylene (PE), polyethylene terephthalate (PET), and polyvinyl chloride (PVC).
- These petroleum and gas-based plastics are generally not biodegradable and can persist in the environment for decades or even centuries.
- Much of the plastic found in ocean garbage patches consists of these durable, non-biodegradable materials.

What the Garbage Patch Really Looks Like

- Given their durability, you might imagine ocean garbage patches as floating islands piled high with bottles, food containers, toys, foam, and construction debris.
- But that is not what researchers see. These patches are often not even visible from satellites.
- Instead, much of the plastic has broken into smaller and smaller fragments, forming vast fields of microplastics that are barely visible to the naked eye. Rather than solid islands, the water can appear hazy or speckled, with only occasional larger items such as shoes or fishing nets, ropes, or buoys drifting on the surface.
- Most plastic that reaches the ocean begins on land, carried by rivers and coastal runoff.
- However, the material that accumulates far offshore can tell a different story. Surveys of the Great Pacific Garbage Patch show that the larger floating debris, especially by mass, is dominated by abandoned or lost fishing nets, ropes, and other equipment.
- Because the debris ranges from nearly invisible fragments to heavy, tangled fishing nets, cleaning these offshore patches requires more than simply collecting what can be seen.

From Science Fair to Global Engineering Project

- Boyan Slat was 16 years old when he first began thinking seriously about cleaning up ocean plastic. While scuba diving in Greece, he noticed more plastic bags than fish.
  - Instead of accepting the problem as too large to solve, he began researching how ocean currents move debris.
- For a high school science project, Slat proposed a different approach. Instead of sending ships to chase plastic across the ocean, he suggested using the ocean's natural circulation to concentrate debris and designing systems that passively collect it where it gathers.
- In 2013, at age 18, he founded The Ocean Cleanup in the Netherlands. What began as a student project grew into a nonprofit engineering organization with specialists in fluid dynamics, marine biology, and offshore operations.
- Early crowdfunding campaigns and foundation support allowed the group to test prototypes in the North Sea before deploying larger systems into the Pacific.

Boyan Slat, founder and CEO of The Ocean Cleanup, stands amid plastic waste that has accumulated along a shoreline in Honduras. Scenes like this illustrate the scale of debris carried from rivers to sea and reflect the organization's broader effort to combine engineering and data-driven research to understand and reduce ocean plastic pollution.

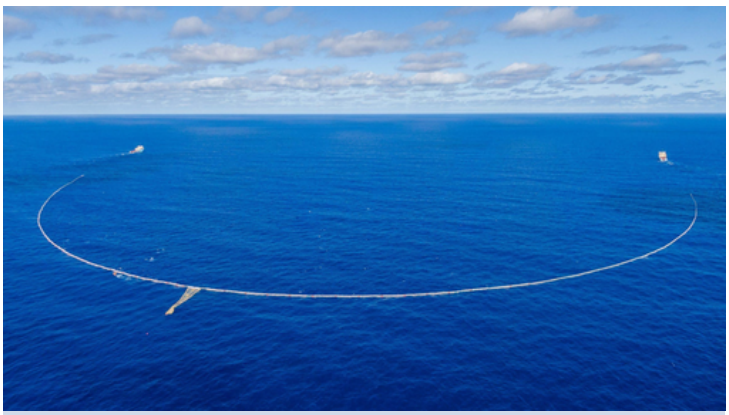
Credit: The Ocean Cleanup
https://theoceancleanup.com/media-gallery/#&gid=1&pid=2

Background: Ocean Cleanup

- Slat's journey illustrates how scientific curiosity, paired with engineering design, can evolve into large-scale environmental action.

Engineering a Floating Cleanup System

- The Ocean Cleanup's offshore system is designed specifically for gyres like the Great Pacific Garbage Patch.
- Rather than anchoring to the seafloor, the system consists of long floating barriers that form a wide U-shape at the surface. A submerged screen hangs several meters below, preventing plastic from escaping underneath while allowing marine life to pass below more easily.
- The system does not move under its own power. Instead, it drifts with the current.
  - Because plastic floats and is pushed slightly faster by wind and surface motion than the system itself, debris naturally accumulates inside the curved barrier.
  - Support vessels periodically collect the concentrated material and transport it to shore.



Ocean Cleanup System 03 in operation in the Great Pacific Garbage Patch. By scaling to multiple systems working simultaneously, the organization aims to substantially reduce floating plastic in the region.

Credit: The Ocean Cleanup https://theoceancleanup.com/media-gallery/#&gid=1&pid=1

- Early deployments revealed engineering challenges, including structural stresses from waves and the need to optimize retention.
- Over time, designs were refined to improve durability and capture efficiency. Newer systems have successfully removed substantial amounts of plastic, especially large, entangled fishing gear that is among the most persistent debris in offshore gyres.
- Since operations began, the organization reports removing millions of kilograms of plastic from the Great Pacific Garbage Patch, with scaling efforts aimed at increasing annual removal rates.
- Once recovered, the plastic is sorted by type and condition. Much of the material collected from the ocean is too degraded or contaminated to be recycled. The portion that can be recycled is processed into certified plastic pellets, which have been used to make products such as sunglasses and durable car components like trunk liners, helping offset cleanup costs.
  - Materials that cannot be recycled are directed to appropriate waste treatment, such as controlled disposal or waste-to-energy processes, to prevent them from reentering the environment.

Stopping Plastic Before It Reaches the Ocean

- Cleaning up offshore gyres addresses what has already accumulated. But most plastic entering the ocean begins on land. To reduce that influx, The Ocean Cleanup also developed river-based Interceptor Systems.
- Before an Interceptor is installed, each river project begins with a detailed analysis of how plastic moves through a city's waterways. Engineers use aerial drones, satellite imagery, and AI-powered image analysis to map debris pathways.
  - In some cases, GPS-tagged "dummy" plastics are released to track how waste travels from streets to rivers and toward the sea.

Background: Ocean Cleanup

- BThese data guide placement of Interceptors at strategic points where debris naturally concentrates. The information also provides a measurable baseline, allowing cities to track reductions over time.
- Through its 30 Cities Program, The Ocean Cleanup aims to reduce plastic flowing from targeted rivers by roughly one-third by 2030. In addition to intercepting new waste, efforts extend to removing debris from nearby coastlines and sensitive ecosystems such as mangroves and coral reefs.
- Interception works best alongside improvements in local waste management and community awareness, helping reduce the amount of plastic entering waterways in the first place.

Where We Go From Here

- Cleaning up ocean plastic is a long-term challenge. Engineering solutions like offshore collections systems and river interceptors can remove existing debris and slow the flow of new pollution, but they cannot solve the problem alone.
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- Ocean plastic did not accumulate overnight, and it will not disappear overnight. But with sustained effort, better data, and coordinated action, the tide can begin to turn.

The Ocean Cleanup's largest Interceptor deployed on the Rio Motagua removes plastic before it can enter the Gulf of Honduras, reducing the flow of river-borne debris to the ocean.

Credit: The Ocean Cleanup https://theoceancleanup.com/media-gallery/#&gid=1&pid=4

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