

Environmental Studies

FACT SHEET



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Great Pacific Garbage Patch

The **Great Pacific Garbage Patch** is an area of marine debris, laying approximately 135° to 155° West and 35° to 42° north. It shifts its exact position every year; it remains within the North Pacific Gyre as it is confined by ocean currents.

The **Great Pacific Garbage Patch** is an area of marine garbage, located in the Pacific Ocean roughly between 135°-155° West and between 35°-42° North. The Garbage Patch has extremely high concentrations of plastics and other rubbish that have been trapped by the currents of the North Pacific Gyre. These currents create a circular effect that pulls in debris from North America, Asia and the Hawaiian Islands. Nevertheless, it consists mainly of small particles in the upper water layers.

Fig. 1 The Great Pacific Garbage Patch

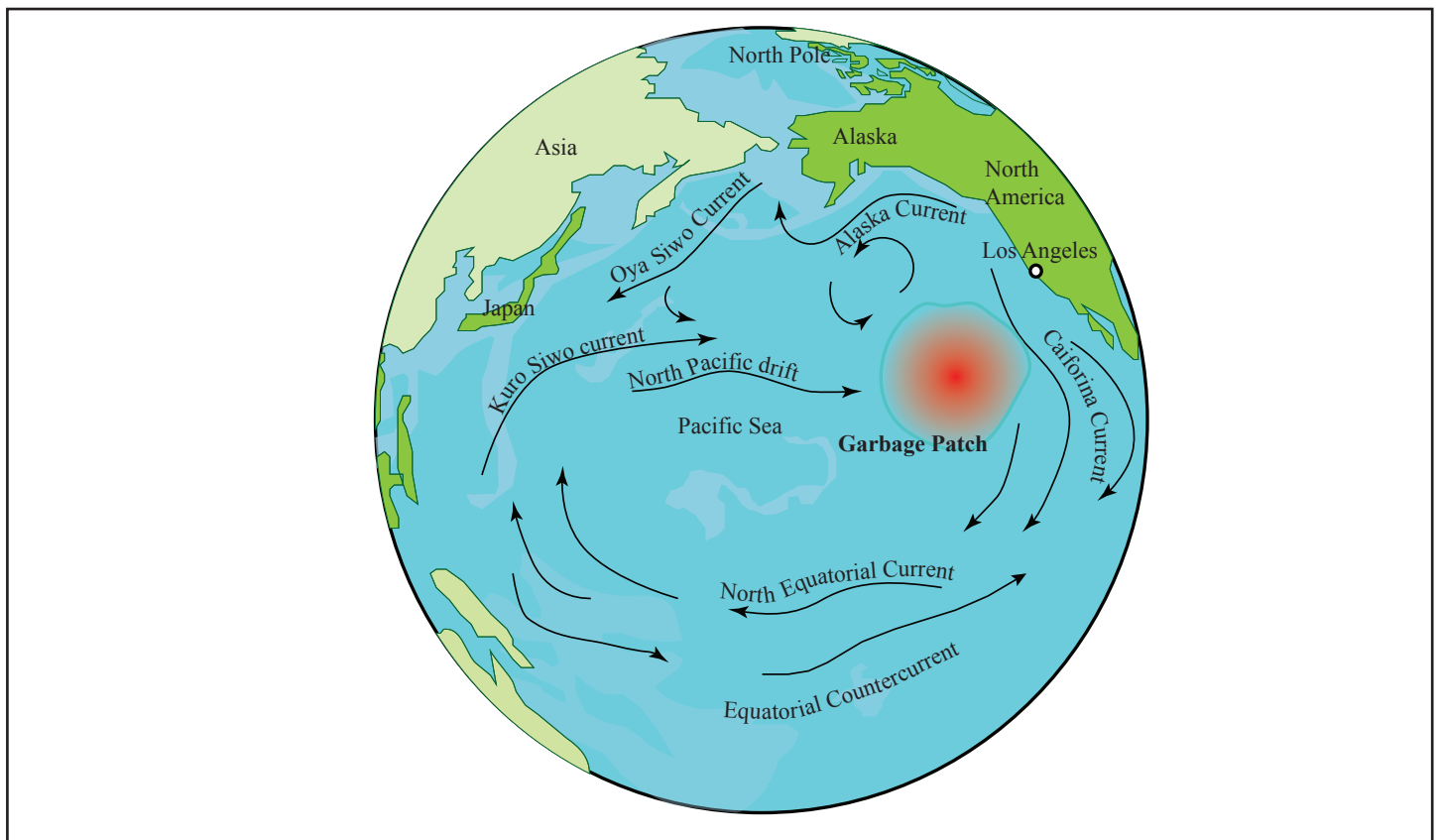


Table. 1 Problems caused by plastic

- Plastic fouls beaches throughout the world and reduces potential income from tourism and recreation
- Plastic entangles marine animals and drowns them, strangles them and makes them immobile
- Plastic garbage when washed ashore destroys habitats
- Plastic gets inside ships propellers and keels making ship maintenance more expensive
- Plastic does not degrade; it also makes an ideal medium for the transfer of invasive species

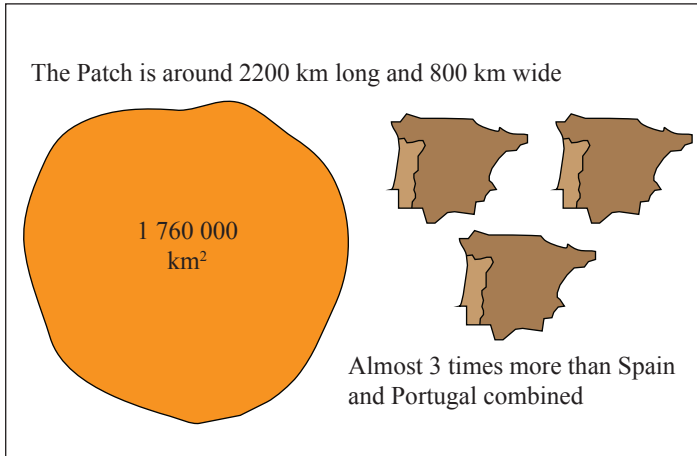
In 1988 a paper published NOAA (National Oceanic and Atmospheric Administration) reported high concentrations of marine debris accumulating in the Pacific. The garbage was essentially moved there by ocean currents. A similar, but much smaller patch can also be found in the Atlantic Ocean.

The origin of the Great Pacific Garbage Patch is due to the concentration of marine pollution by ocean currents. The GPP is a large, relatively slow moving mass, surrounded by the North Pacific Gyre. Circulation of the Gyre leads to the accumulation of pollutants from countries bordering the North Pacific Ocean. Currents carry debris from the west coast of North America to the gyre in about six years and debris from Asia in about five years.

Approximately 80% of the waste comes from land-based sources and the other 20% from shipping. According to a report from the United States Environmental Protection Agency in 2011 'The primary source of marine debris is the improper waste disposal or management of trash and manufacturing products, including plastics (e.g., littering, illegal dumping) ... Debris is generated on land at marinas, ports, rivers, harbors, docks, and storm drains. Debris is generated at sea from fishing vessels, stationary platforms and cargo ships'.

The size of the GPGP is unknown, although it is known to be very large (Fig. 2).

Fig. 2 The size of the Great Pacific Garbage Patch



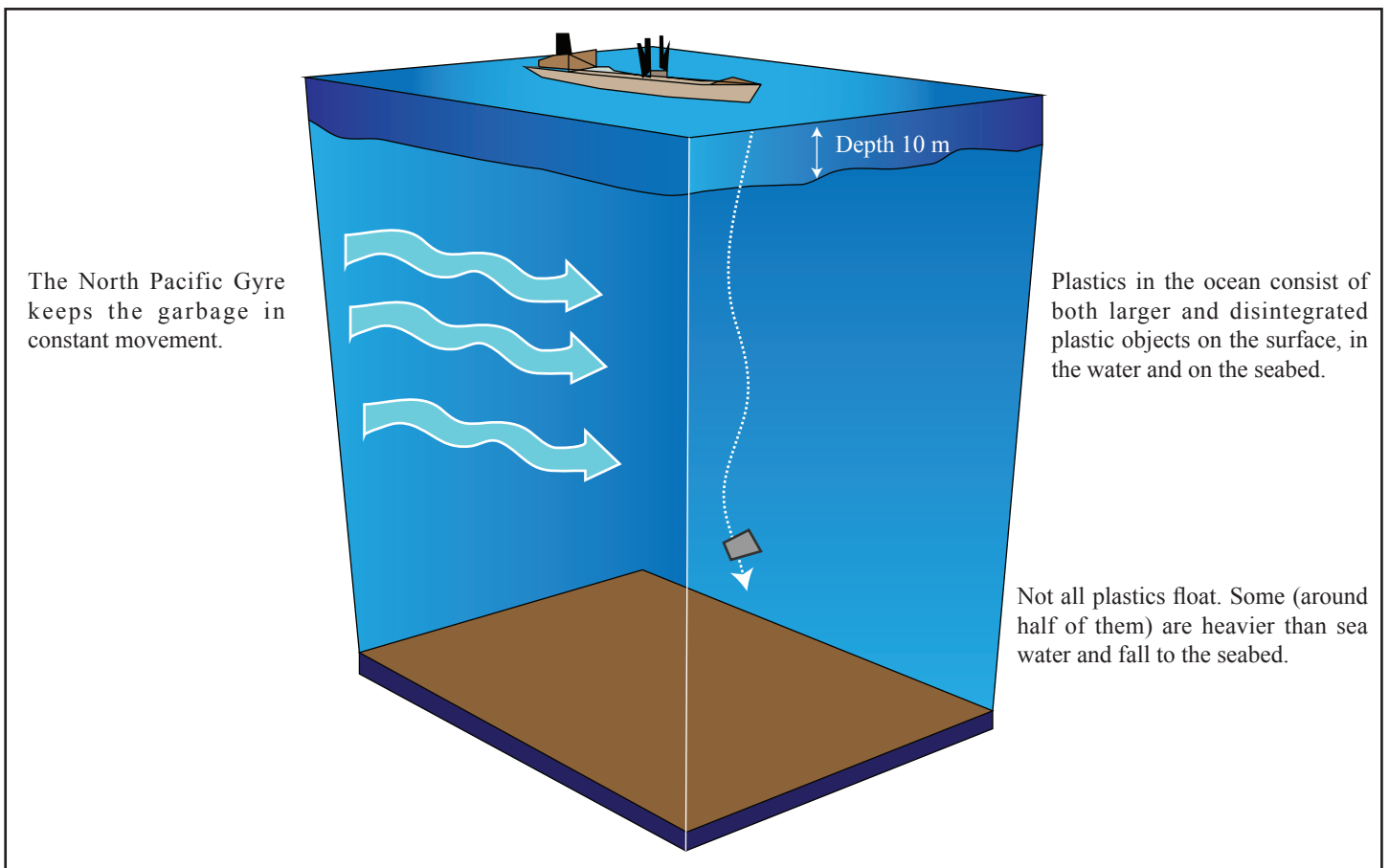
Estimates vary from 700,000 square kilometres to more than 15,000,000 square kilometres – between 0.41% and 8.1% of the size of the Pacific Ocean. Figure 2 suggests that it is at least three times the size of Spain and Portugal combined. The GPGP is also estimated to contain about 100 million tons of rubbish.

Photodegradation of plastics

Plastics never biodegrade. It does not break down into natural substances. Instead it goes through a photodegradation process, splitting into smaller and smaller particles that are still plastic.

The Great Pacific Garbage Patch has extremely high levels known of plastic particulate in the upper water column (Fig. 3). As the plastic photodegrades into smaller and smaller pieces, it concentrates in the upper water column. As it disintegrates, the plastic ultimately becomes small enough to be ingested by aquatic organisms that reside near the ocean's surface. In this way, plastic may enter the food chain.

Fig. 3 Concentration of plastics in the upper water column

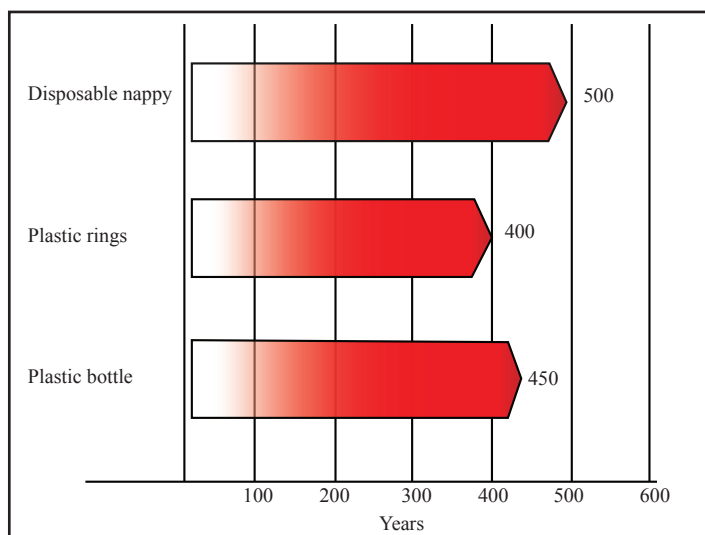


As a result of photodegradation, much of the plastic particulates in the Great Pacific Garbage Patch are too small to be seen. A 2001 study counted 334,721 pieces of plastic particles per km². The United Nations Environment Programme suggests that each square mile of ocean water contains 46,000 pieces of floating garbage. The overall concentration of plastics was seven times greater than the concentration of zooplankton. Samples collected from deeper points found much lower concentrations of plastic particles.

Effect on wildlife

Many of the plastics take a long time to photodegrade (Fig. 4). Consequently, some of these partly-degraded, small-plastics end up in the stomachs of marine birds and animals. Midway Atoll (also known as Midway Islands) is an atoll (coral reef) situated in the middle of the North Pacific Ocean. It has been severely affected by the GPGP. Most of the 1.5 million Laysan Albatrosses that nest on the island plastic in their digestive system, and about one-third of their chicks die. Many of the deaths are caused by parents feeding plastic to their young (it is believed the albatrosses confuse the brightly coloured plastic with their food sources). An estimated twenty tons of plastic debris is washed up on Midway Atoll every year and about one-quarter of this debris is fed to Albatross chicks. The physical size of the plastic can kill fish, birds and turtles as the animals' digestion cannot break down the plastic that is taking up space inside their stomachs. The animals may feel full (as their stomachs are not empty) but they have less room to take in food.

Fig. 4 Length of time for plastic to degrade



Moreover, the plastic can absorb organic pollutants from seawater, including PCBs and DDT. These toxin-containing plastic pieces can be eaten by jellyfish which are then eaten by larger fish. Some of these fish then enter the human food chain (i.e. the food that will be used to feed humans). This may lead to the bioaccumulation and biomagnification of toxic chemicals further up the food chain.

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Table. 2 Great Pacific Garbage Patch Fact file

<ul style="list-style-type: none"> Garbage in the GPGP consists of floating plastic of varying sizes which are suspended in the ocean at or just below the surface, as well as denser plastic pieces which sink to the ocean floor. Larger pieces of garbage are taken in by fish, sea birds and animals which may then die of starvation. Plastic is made from crude oil and is mostly not biodegradable by decomposers. So once plastic is made, it mostly remains on Earth in some form, often breaking into smaller and smaller pieces. Some smaller plastic pieces act as 'chemical sponges' and absorb POPs (persistent organic pollutants). Animals eating these also take in toxins. One study estimates that around 1 million sea birds (e.g. albatrosses) and 100,000 animals (e.g. turtles and whales) are killed by either ingestion of plastics or become entangled with plastic fishing nets. Recent research has found photosynthetic bacteria using the plastics as a food source. Because the plastics accumulate in the gyres, the rest of the oceans are relatively plastic free. About half of all albatross species are either endangered or critically endangered on the Red List <p>(Adapted from IB ESS, May 2013, Paper 2)</p>

Marine plastics can also enable the spread of invasive species. Some species may attach to floating plastic in one region and drift long distances to colonize other ecosystems.

Scientists have discovered some bacteria in the Sargasso Sea (in the North Atlantic Gyre that consume plastic. However, it is not known whether there are enough to consume all the plastic in the GPGP, or whether an equivalent species occupies a similar niche in the Pacific.

Conclusion

The Great Pacific Garbage Patch is a huge concentration of garbage in the ocean. It is likely that there are other patches, and that garbage patches will increase in size and extent in the forthcoming decades, as human development and standards of living increase. The potential impacts are great, and have a significant environmental and economic impact.

Activities

1. What is meant by the Great Pacific Garbage Patch? and where is it located.
2. Why does the Great Pacific Garbage Patch exist?
3. Explain the process of photodegradation.
4. Outline ways in which plastic in the upper water column and on islands may affect organisms.
5. Briefly outline the economic impact of the Great Pacific Garbage Patch.

1. The Great Pacific Garbage Patch is an area of marine debris, laying approximately 135 to 155 West and 35 to 42 North.
2. It is the result of the interaction of human activities and natural systems. Human activities produce the garbage from North America, Asia and the Hawaiian Islands. The currents of the North Pacific Gyre create a circular effect that pulls in debris, and prevents it from leaving the North Pacific.
3. Plastic is made from crude oil and is mostly not biodegradable by decomposers. In the presence of sunlight plastic is degraded (broken) into smaller and smaller pieces, eventually until it is too small to be seen by the human eye.
4. There are a number of potential impacts. Some plastic is ingested by organisms that confuse it for a food source. Some is fed by parents to their young. Plastics in the digestive system leave less room for food. Eventually the organism may die. Some plastics contain toxins and may kill an organism. There can be bioaccumulation and biomagnification of toxins higher up the food chain. Some plastics may give a 'lift' to invasive species.
5. There are many potential impacts. Economic losses may be large if species numbers are reduced (fishing revenues, sea birds/egg losses). It is expensive to clean-up polluted beaches. There may be reduced incomes due to reduced visitor numbers to beaches. Ship maintenance may be more expensive in order to clean up plastics from propellers/keels.

Suggested answers