The 'Great Pacific Garbage Patch'
How ocean currents trap our plastic waste

Plastic pollution enters the ocean from rivers, coastlines and ships across the globe. Many plastic items float because they are less dense than seawater. Instead of spreading evenly across the oceans, floating plastics are gradually drawn into large rotating current systems called gyres. The Great Pacific Garbage Patches (GPGP) lie within the North Pacific Gyre and are two of the largest accumulations of floating plastic debris on Earth. They are not solid islands of rubbish, but regions with extremely high concentrations of floating plastic fragments and microplastics circulating near the ocean surface. These plastics can persist for decades, gradually breaking down into smaller pieces and entering marine food webs.

This activity allows pupils to investigate how ocean circulation concentrates floating plastics and to link a simple classroom model with a major global environmental issue.

Fig 1. One of the two Great Pacific Garbage Patches. (*Forbes (2019). Great Pacific Garbage Patch. See Links)*

Ask pupils to study the photo of the Eastern Great Pacific Garbage Patch in Figure 1 and discuss:

- Why do most plastics float in water? (*most plastics are of lower density than that of water).*
- What forces might be acting on plastics floating on the ocean surface? (*gravity; buoyancy; wind; waves; water currents. Also the mass tends to be held together by van der Waal's forces (see Underlying Principles)*
- What do you think happens to plastic once it enters the ocean from rivers, beaches or ships? (*Much of it is carried further from the coast by the prevailing winds and water currents, until it becomes trapped by water currents with a circular motion).*

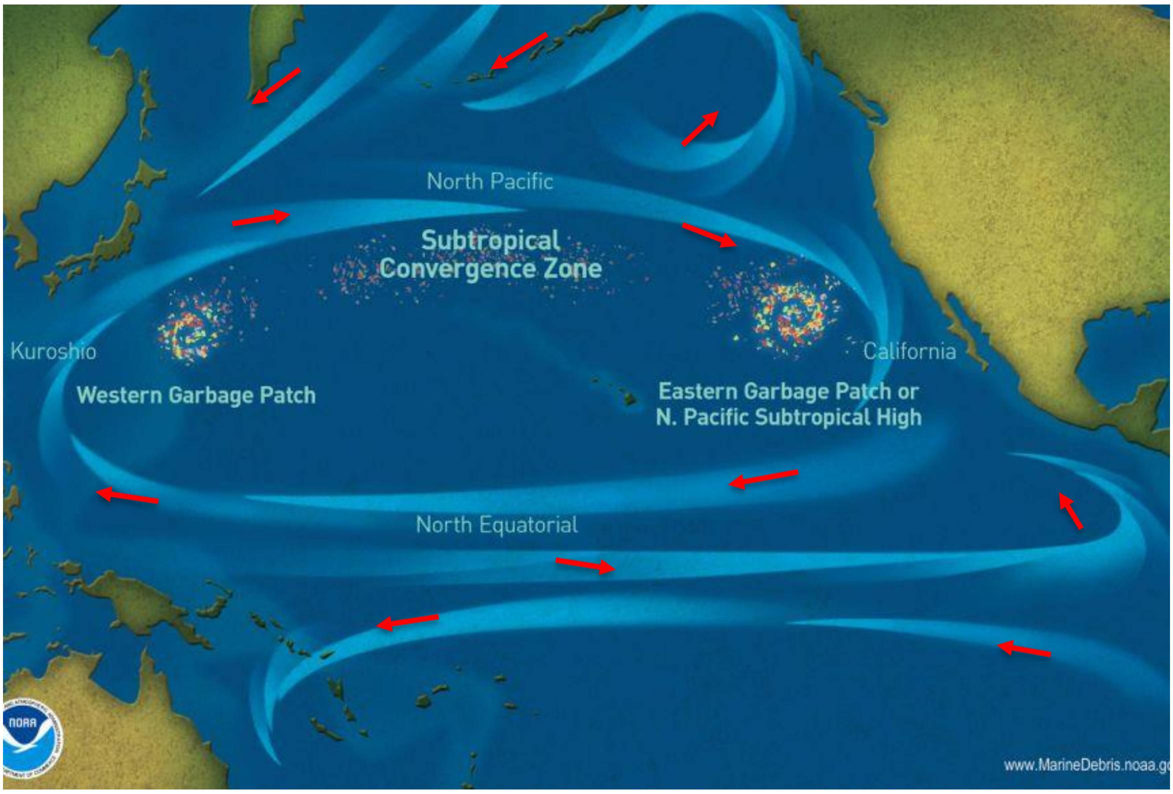

Fig 2. Map showing the location and extent of the Great Pacific Garbage Patches within the North Pacific Subtropical Gyre. (*National Geographic Society (n.d.). Great Pacific Garbage Patch. Map by NOAA (National Oceanic and Atmospheric Administration). See Links)*

Then ask pupils to study the map of the North Pacific Ocean in Figure 2 and discuss:

- What evidence does the map show which might explain why floating plastics collect in certain areas of the ocean rather than spreading evenly everywhere? (*Plastic collects where circular currents occur, allowing no escape for the debris*).
- Can you suggest a simple way of modelling the collection of plastics using a washing up bowl? (*Try making circular currents by stirring the water around some floating plastic*)

Fig 3. A simple classroom model showing floating plastic debris circulating and gradually concentrating in a rotating water current, representing the behaviour of plastics within an ocean gyre. (*Photo Lema Ashrafe*)

Ask pupils to model the movement of floating plastics using water and a simple current simulation:

1. Fill a large bowl or tray with water to represent the surface of the Pacific Ocean.
2. Add small pieces of paper, cork, or biodegradable packing material to represent floating plastic debris.
3. Use a spoon or stick to stir the water gently in a circular motion, creating a rotating current.
4. Continue stirring for 10–20 seconds, then stop and observe how the floating material continues to move.
5. Watch as the floating debris gradually migrates towards the centre of the bowl.

Pupils should describe the movement of the debris and record where it becomes concentrated.

Ask:

- Why did the floating debris continue moving even after stirring stopped? (*The water continues moving for a while under its own momentum*).
- Why did the debris tend to collect towards the centre of the bowl? (*the velocity of the water varies from maximum at the outer edge of the bowl to zero at the centre. Centrifugal force tending to separate the particles, is also nil at the centre of the bowl*).
- How does this model help explain the formation of the Great Pacific Garbage Patches? (Figure 2) (*It models the circular motion of water currents around floating plastic debris*).
- In what ways is the model unrealistic or oversimplified compared with the real ocean? (*The speed and depth of current are more regular than in the real ocean. In reality the circulation is*

more elliptical and minor currents split the debris into two separate patches).
Encourage pupils to consider the long-term consequences of plastic accumulation in ocean gyres, including impacts on marine organisms, food webs and human activity. Discuss how reducing plastic use and preventing waste from entering rivers and seas could help limit the growth of garbage patches in the future.

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The back up

Title: The 'Great Pacific Garbage Patch'

Subtitle: How ocean currents trap our plastic waste

Topic: This activity simulates how the ocean circulation of the North Pacific Gyre collects floating plastic pollutants, to form vast floating zones of rubbish.

Age range of pupils: 12 and above

Time needed to complete activity: 30 minutes

Pupil learning outcomes: Pupils can:
- describe how large-scale rotating ocean currents (gyres) move floating materials;
- explain why plastics become concentrated in the centre of gyres;
- model the process using a simplified classroom demonstration;
- interpret maps showing the location and extent of the Great Pacific Garbage Patches;
- discuss the environmental consequences of persistent floating plastics and microplastics.

Context: The world's oceans contain several major gyres- huge circular current systems driven by wind patterns and the rotation of the Earth. The North Pacific Gyre is the largest of these and is home to the Great Pacific Garbage Patches, accumulations of floating plastics ranging from large fragments to microscopic particles. This region holds extremely high concentrations of buoyant plastics that circulate for decades.

Following up the activity:
Research and compare the five major ocean gyres and investigate why some contain more plastic pollution than others.
- Explore how floating plastics break down into microplastics and how these particles enter marine food webs.
- Link this global investigation to local fieldwork on plastic pollution in rivers, beaches or ponds (see *The invisible plastic problem* below).
- Design posters, presentations or campaigns encouraging plastic reduction and improved waste management.
- Investigate technological and policy-based solutions aimed at reducing plastic inputs to the ocean.

Underlying principles:
- Ocean gyres form from interactions between global wind patterns, the Coriolis effect, and Earth's rotation.
- Floating plastics are carried by surface currents and tend to drift toward the centre of gyres, where water movement converges.
- Because many plastics are less dense than seawater, they remain at the surface and accumulate over time.
- Plastics are mostly polymers or giant molecules. They are typically formed from compounds such as ethylene (C_2H_4) with a double bond between the carbon atoms. The double bond is broken releasing single bonds which can link with others to form long chains. When a polymer material is broken, unsatisfied bonds, or dipoles, are exposed. Weak electrostatic fields draw dipoles together. The forces between the dipoles are called Van der Waal's forces. These forces may be significant in the aggregation of floating plastic particles.
- Microplastics form when larger plastics fragment; these tiny particles can persist for decades and travel long distances.
- The main currents affecting the North Pacific are shown in Figure 1, but minor currents separate the main garbage patches into two.

Thinking skill development:
- Construction - Pupils classify different types of plastic movement (floating, sinking and circulating) and construct an understanding of how rotating ocean currents influence the transport and accumulation of floating debris.
- Metacognition: Pupils reflect on how their simple model represents real ocean systems, considering what it shows well and recognising the limitations of using a small-scale classroom demonstration to explain large-scale ocean circulation.
- Cognitive conflict: Pupils may initially expect plastics to spread evenly across the ocean or to form a solid island. Observing plastics circulating and concentrating challenges these ideas and helps pupils revise their understanding of how the Great Pacific Garbage Patches form.
- Bridging: Pupils link their model to real-world environmental issues by reasoning about cause and effect in human–environment interactions and evaluating possible solutions to reduce plastic pollution entering the oceans.

Resource list:
- A large bowl or tray filled with water
- Small pieces of paper, cork, or biodegradable packing to act as "plastic debris"

- A spoon or stick to create a circular motion in the water
- The map image of the Great Pacific Garbage Patches (see caption and reference below)

Useful links:
https://www.forbes.com/sites/scottsnowden/2019/05/30/300-mile-swim-through-the-great-pacific-garbage-patch-will-collect-data-on-plastic-pollution/

https://education.nationalgeographic.org/resource/great-pacific-garbage-patch/

https://www.bbc.co.uk/newsround/39921749

https://www.bbc.co.uk/news/science-environment-59521211

ELI - The invisible plastic problem – can you find what the eye can't see?
https://www.earthlearningidea.com/PDF/467_Microplastics.pdf

Video – The cycle of a plastic bottle
https://www.youtube.com/watch?v=_6xlNyWPpB8

ELI -The ocean starts here
https://www.earthlearningidea.com/PDF/469_Ocean_current_litter.pdf

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