Watersheds to Whales

Grade Level

4–8

Timeframe

45 minutes or more

Materials

- Materials to create watershed models (see Preparation section for options)
- Computer, projector and screen
- Presentation (available to download)

Key Words

Marine debris, ocean currents, precipitation, water cycle, watershed

Standards

NGSS: MS-LS2-4.
CCSS: W.6.10. SL.6.4.
Ocean Literacy Principles: 1, 6.
Climate Literacy Principles: 7, 3.
Details at end of lesson

A student with an Ocean Guardian School cleans up trash in their local watershed. Photo: Nick Zachar/NOAA

Activity Summary

Students will learn about watershed stewardship and make observations about how water and pollution run off and infiltrate landscapes and flow to the ocean. They create either a clay or paper model of a watershed and observe how water flows through the model. They consider sources of pollution and how that pollution could travel through a watershed and affect national marine sanctuaries or monuments and the organisms that live there.

Learning Objectives

Students will:

- Analyze a map of local streams to see how water returns back to the ocean and/or nearest national marine sanctuary or monument.
- Argue from evidence how water from their local watershed could get to the nearest national marine sanctuary through ocean currents and wind.
- Consider how pollution in their area might travel to sanctuaries and impact life found there.
- If the Enrich/Extend activity is completed, students will participate in a litter clean up event and suggest other ways to prevent marine pollution.

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National Geographic Society

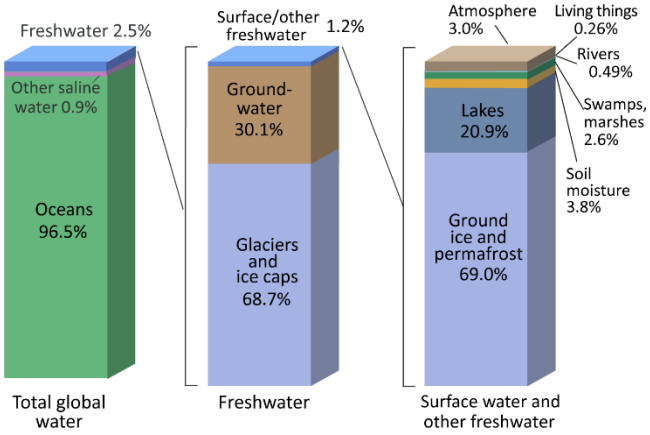
&

National Marine Sanctuary Foundation

Background Information

Water is finite, constantly being recycled and reused via the water cycle. It is also constantly in motion, either through ocean currents, precipitation or slowly moving through underground aquifers. Of the global water supply, greater than 97% is saltwater.

The vast majority of freshwater is locked up in glaciers or ice caps, trapped deep underground or circulating in the atmosphere. That leaves us only 0.5% available freshwater to use at any time. In addition, most precipitation lands in the ocean. Precipitation that falls onto land is part of a watershed, the primary source of water used by humans.



Freshwater is the most important, and limited, resource on Earth. Source: U.S. Geological Survey, Water Science School

Watersheds of All Shapes and Sizes

A watershed, also called a drainage basin or catchment, is an area of land that channels rainfall and snowmelt to creeks, streams and rivers, and eventually to reservoirs, bays and the ocean. Differing in size and shape, watersheds can encompass a small stream or span thousands of miles. The largest in the United States is the Mississippi River watershed. It drains 1.2 million square miles (3.2 million square kilometers) from all or parts of 31 U.S. states and two Canadian provinces, stretching from the Rockies to the Appalachians! Any given watershed is part of the larger whole of our global water supply.

The Mississippi River watershed encompasses a drainage area of over 1.2 million square miles (3.2 million square km)! Map: Shannon1 CC BY-SA 4.0

Critical Groundwater

Not all water flows directly to the sea, however. When precipitation falls on or across dry ground, a permeable surface, it can infiltrate the soil. This groundwater remains in the soil, where it will eventually seep into the nearest stream. Some water infiltrates much deeper, into underground reservoirs called aquifers. In other areas, where the soil contains a lot of hard clay, very little water may infiltrate. Instead, it quickly runs off to lower ground.

Percolation, the movement of water through soil, is a critical part of the water cycle for its ability to act as filtration. Permeable surfaces (those through which water can move) are necessary for percolation.

Impermeable Surfaces & Pollution

As we build communities and increase our infrastructure, we are adding significant amounts of impermeable surfaces (such as asphalt, concrete and steel) that do not allow water to penetrate. During periods of heavy rain

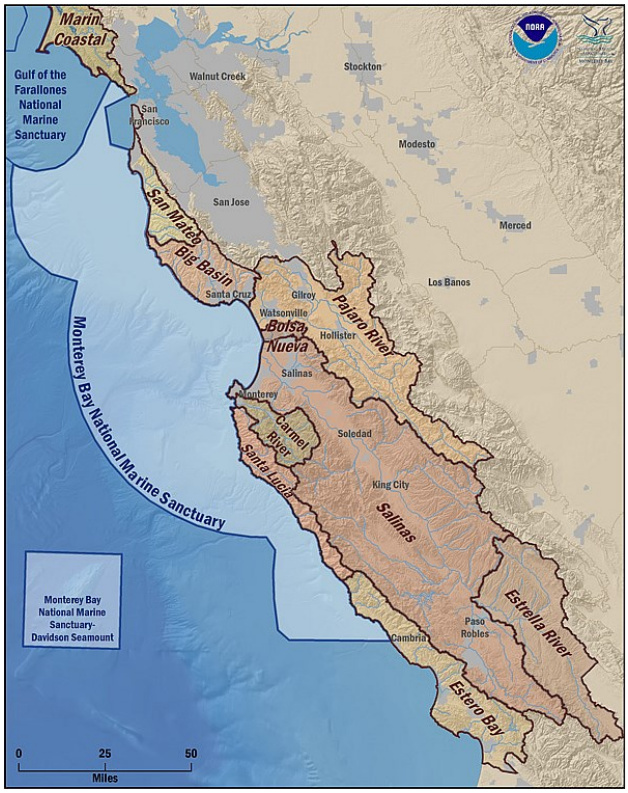
and snowfall, water may run onto and off of impermeable surfaces such as parking lots, roads, buildings and other structures because it has nowhere else to go. These surfaces act as "fast lanes" that transport the water directly into storm drains.

As water flows over and through the landscape, it transports materials like plastics, and oftentimes pollutants, moving them downstream and ultimately to the ocean. These pollutants may affect the ecology of the watershed and, ultimately, of the reservoir, bay or ocean where they end up.

National Marine Sanctuaries

National marine sanctuaries and monuments are a network of underwater areas in the ocean and Great Lakes that protect America's most iconic natural and cultural marine resources. Sanctuaries harbor a variety of habitats, such as coral reefs and kelp forests, and an abundance of life, including endangered species. Many sanctuaries are near large population centers and are sites where several waterways converge. For example, ten major watersheds flow into the Monterey Bay National Marine Sanctuary!

Unfortunately, sanctuary habitats and organisms are affected by pollution and marine debris that originate inland and also at coastlines. Animals like sea turtles, marine mammals, birds, fish and other creatures can die when they accidentally swallow or get tangled up in marine debris. Debris can also crush sensitive habitats like seagrass beds or coral reefs. All national marine sanctuaries face the challenges of marine debris and the harmful impacts that come along with managing this problem. Scientists and sanctuaries staff monitor water quality and marine debris and implement various cleanup efforts to mitigate the problem. Regardless of where we live, we can all help prevent marine pollution by getting involved locally to stop harmful materials from entering our watersheds.



Ten major watersheds flow directly into Monterey Bay National Marine Sanctuary alone. All precipitation that falls on land eventually flows to our global ocean (and all of our national marine sanctuaries). Map: NOAA

Learn more about watersheds and marine debris:

"Marine Debris." National Geographic Society: https://education.nationalgeographic.org/resource/marine-debris

"Marine Debris Solutions at National Marine Sanctuaries": https://sanctuaries.noaa.gov/education/teachers/marine-debris/background.html

"Watersheds, Flooding, and Pollution." NOAA: https://www.noaa.gov/education/resource-collections/freshwater/watersheds-flooding-and-pollution

"What is a Watershed?" NOAA Fisheries: https://www.fisheries.noaa.gov/new-england-mid-atlantic/habitat-conservation/what-watershed

Vocabulary	
Groundwater	Water contained below ground in soil and rock
Impermeable	When a surface does not have space for water to pass through (e.g., concrete, asphalt)
Marine debris	Any human-made material that enters the ocean or Great Lakes by dumping or as runoff from land via rivers, streams and storm drains. Marine debris can include everything from plastics and metals to toxic contaminants—anything human-made and solid that is intentionally or unintentionally disposed of or abandoned into the marine environment or the Great Lakes.
Ocean currents	Continuous and directed movements of ocean water driven by winds, water density and tides. Currents are on the ocean's surface and in its depths, flowing both locally and globally.
Permeable	When a surface has air space for water to pass through (e.g., pebbles, wood chips, soil)
Precipitation	Precipitation is any liquid or frozen water that forms in the atmosphere and falls to Earth. It is one of the three main parts of the global water cycle.
Runoff	Water that runs off the surface of land and flows downhill into streams, rivers, ponds, lakes and the ocean
Watershed	An area of land where water drains and collects in one place by way of rivers, lakes, wetlands and groundwater

Preparation

- Download (or prepare to show) all associated videos, the slideshow and text materials for this lesson.
- Identify which watershed is in your local area and in which the school sits and the source of your municipal water
- Materials:
    - 1 or more spray bottles containing tap water
    - 2 lbs. modeling clay (a softball sized amount for each group of students) OR one sheet of letter-size paper per student; large sheets of butcher paper for groups of students also work well
        - Note: Modeling clay can be made with cornstarch, water and salt. See https://raleighnc.gov/stormwater/create-clay-watershed-model.
        - Damp sand is another option for creating watershed models.
    - Toothpicks, chopsticks, utensils or other tools students can use to create clay models
    - One sturdy tray per group of students (if creating clay models)
    - Markers in a variety of colors (if creating paper models)
    - Something to wipe down wet tables

- Optional materials if crumpled paper models will be created*:*
    - Pieces of cardboard or wood on which to tape the crumpled paper models
    - Rolls of tape for students to share
    - Colored drink crystals (Kool-Aid, etc.): Before class, fill shaker containers with various colors that can represent different pollution sources. (Reused spice and salt shakers work well.)
    - Baking pans or other containers to contain water added to models
    - Vegetable oil to represent oil in the watershed; powered black tempera paint can be added to make it black
    - Dry oats to represent plastic pollution and other garbage
    - Sponges cut up into smaller pieces to represent wetlands

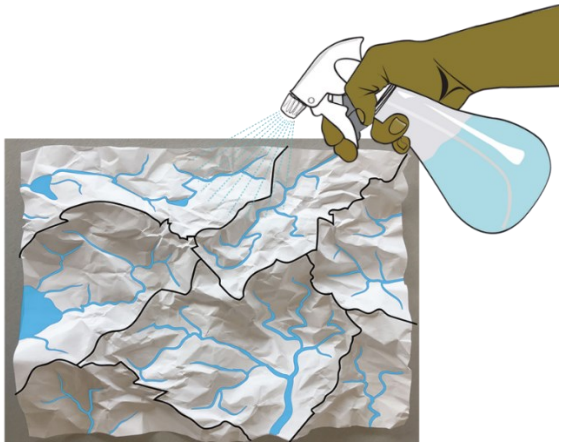
Procedure

Engage

- Ask students to form groups of 3–4.
    - Hold up a glass of water and take a sip. Ask students to think about where water from the tap comes from. They can discuss their ideas with their group, recording them in science notebooks.
    - After a minute, ask the groups to share their ideas.
    - Display slide 2 of the "Watersheds to Whales" presentation to the class. It shows an oil slick on a road, cigarette butts and a water bottle about to go down a storm drain. Present the following scenario:
        - While walking to school, a group of students notices that dripped oil has accumulated on the roads and in parking lots. They also notice lots of trash, including plastic and cigarette butts.
    - Ask groups to discuss the following questions, recording their ideas in science notebooks:
        - What will happen to the oil and trash when it rains?
        - What are some places where the oil and trash could go?
        - What are watersheds, and where can you find them?
- Ask the groups to briefly share their ideas with the class and discuss. Share information about your local water supply and that they will be learning about how water flows through watersheds and how water bodies are connected.

Explore

- Students work in groups to build 3D models and/or maps of a watershed.
    - For the clay model:
        - Distribute a softball-sized chunk of modeling clay to each group of students. Ask them to construct a mountainous landscape. The land should have peaks and valleys. They should leave space at the bottom of the pan for a river or the ocean. (You may create an example for them.)
    - A crumpled paper model can be substituted for clay:
        - Demonstrate each step with your own piece of paper so that the class can follow along. Begin by taking your piece of paper and crumple it into a tight ball. Then gently open up the paper, being careful to not flatten it out completely.
        - The highest points on the paper now represent mountaintops and the low places represent valleys.
        - Ask them use one color marker (such as green) to draw a line along the "mountain" ridges (and connect the highest points on the paper). These represent the mountain ridgelines.
        - Ask them to choose a second color (such as blue) and mark the low places where different bodies of water might be found (creeks, rivers, lakes, a bay, etc.).
        - Color or discuss human activity. With a third color, mark four or five places to represent places of human activity: housing, factories, shopping centers, schools, etc.
    - For both model types, ask students to predict the flow of water.
    - Ask students to observe the flow of water: Using a spray bottle, spray the clay or paper watersheds and observe where the water flows (or you may only spray your own model as a demonstration).



A crumpled paper watershed model
Graphic: Adapted from SERP (CC BY-NC-SA)

    - Ask students to record observations about where the water flows and their ideas about how any trash, oil or other chemicals in the watershed might impact the ocean. Ask:
        - What happens to chemicals or plastics if they enter rivers or the ocean?
        - Would all the plastic stay at the surface, or where would it go?
    - Ask students what they think a national marine sanctuary is. If they are unsure, describe them: National marine sanctuaries are a network of underwater areas in the ocean and Great Lakes that protect America's natural and cultural marine resources, such as shipwrecks. For example, Flower Garden Banks National Marine Sanctuary in the Gulf of Mexico protects fragile coral reef habitats and Thunder Bay National Marine Sanctuary in Lake Huron protects nearly 100 historic shipwrecks.
        - Show students a map of national marine sanctuary locations (e.g., at https://sanctuaries.noaa.gov/) and ask students: Is our watershed directly connected to any national marine sanctuaries?
- Students can look at the Ocean Currents layer in ArcGIS Online and/or paper maps showing the currents and predict where trash/oil/other chemicals flowing out of their watershed might travel to. See the "Mapping Friendly Floatees: Ship to Sanctuaries" lesson in this series for details.
    - Ask students to identify sanctuaries closest to your location. They can use the map at https://sanctuaries.noaa.gov and/or in the PowerPoint presentation.
        - Ask students: Could pollution in our watershed affect any of our national marine sanctuaries? Could microplastics eventually make it to all of the sanctuaries? If so, which sanctuaries?
        - How could it affect marine life, such as whales, albatross and sea turtles, found in sanctuaries? Could they enter the food chain and humans?
        - Ask them to record ideas in science notebooks.

Explain

- Ask students to do more questioning and investigation to develop their own explanations for what they are seeing with their models.
    - Ask them to record questions they have about water and/or pollution movement in watersheds or sanctuaries and list ideas how they might answer those questions, e.g., experiments they might conduct.
    - Ask students to conduct those experiments or test their ideas.
- Ask groups to share their ideas and discuss as a class.
- Facilitate discussion, answering questions and filling in details about watersheds, the water cycle, important ocean currents and the Global Conveyor Belt, supported by visual aids in the presentation.
    - As part of the global water cycle, water evaporates from the ocean, lakes or rivers (or from plants or soil) and falls across continents.

- Because water is a fluid, it flows along a downhill path that eventually leads back to the ocean.
- A watershed is an area of land where all the water that is shed off of the surface funnels to the same place. The water might flow into a stream, creek, lake or bay.
- Right now, we are standing in a particular watershed. If we climbed over a big mountain we might be in another watershed where the water would flow into different creeks and streams.

Enrich/Extend

- With your students' help, organize a service-learning event to clean up litter in your area.

  Use National Geographic Society's Marine Debris Tracker app (https://debristracker.org) to record the type of debris students collect.

  - Debris Tracker is designed to help citizen scientists make a difference by contributing data on plastic pollution in your community.
  - Students can compare the number of different types of items they collect with other organizations and/or areas using the filter on Marine Debris Tracker's website (https://debristracker.org).
  - Using information and data from Debris Tracker, ask students to argue from evidence how local efforts can have a big impact on marine pollution.
  - Free "Learning Through Citizen Science" online training modules that feature the Marine Debris Tracker app and iNaturalist can be accessed at https://account.nationalgeographic.org/courses/cit-sci-home.

- Ask students to think about how your local watershed and the ocean, including wildlife such as whales and sea turtles, might be impacted by various effects of plastic trash, other pollution and climate change. They can discuss these with a partner or small group and record their ideas in science notebooks in words and illustrations. Ask the students to share their best ideas with the class, which may include more intense rainstorms and storm surges, which can move more trash and oil into waterways.
- Instill hope by encouraging students to brainstorm ways to prevent pollution and mitigate the effects of climate change and extreme weather. Students could create posters to educate others about the problems and possible solutions.
  - Students can find information about cleanup efforts at national marine sanctuaries to inspire them: https://sanctuaries.noaa.gov/education/teachers/marine-debris/background.html.
  - Students could use the Ocean Surface Current Simulator (OSCURS) to show where plastic they prevented from entering the ocean might have traveled to: https://oceanview.pfeg.noaa.gov/oscurs.
  - You could also show the short "Ocean Plastics: Explorers in the Field" video from National Geographic for inspiration: https://education.nationalgeographic.org/resource/ocean-plastics.

    - Encourage students to present their ideas to the class and discuss which of them might be most feasible and impactful.

- Invite students to play the "Walter's Travels–Weathering and Erosion" game from National Geographic. Tie in those concepts and their impacts on our watersheds and the ocean: https://www.nationalgeographic.org/interactive/walters-travels-weathering-and-erosion.
- Students can create new games that help other students understand the concepts of watersheds, pollution, erosion and/or how they impact the ocean.
    - Encourage students to create engaging game boards, cards and/or other resources to make the games more fun and educational. They can also create computer games and/or digital stories using a tool like Scratch from MIT: scratch.mit.edu. It is an easy-to-learn, visual code builder for stories and animations, as well as games.
    - This can be an especially good activity to enrich students who complete their other projects quickly, as well as benefit the rest of the class that can play the completed games.
    - Invite younger students, families and/or school administrators into your class to play the games and to hear presentations from your class.

Evaluate

- Ask students to answer the following questions in science notebooks or as an exit ticket:
    - What did you observe about how water travels in the model watershed?
    - What path did the water follow? Were your initial predictions correct?
    - How does pollution and marine debris end up in a watershed and our global ocean?
    - How can we reduce human impacts on our watersheds and global ocean?
- Evaluate students' contributions to group and class discussions.
- Evaluate student projects if Enrich/Extend activities completed.

Education Standards	
Next Generation Science Standards	Ecosystems: Interactions, Energy, and Dynamics • 5-ESS2-1: Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. • MS-LS2-4: Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. Science and Engineering Practices: • Engaging in Argument from Evidence Crosscutting Concepts: • Cause and Effect • Systems and System Models

Education Standards	
Common Core State Standards	Writing: W.6.10 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences. Speaking and Listening: SL.6.4 Present claims and findings, sequencing ideas logically and using pertinent descriptions, facts, and details to accentuate main ideas or themes.
Ocean Literacy Principles	1. Earth has one big ocean with many features. (g) 6. The ocean and humans are inextricably interconnected. (d, g)
Climate Literacy Principles	7. Climate change will have consequences for the Earth system and human lives. (a, b, c) 3. Life on Earth depends on, is shaped by, and affects climate. (a, c) (If the related Enrich/Extend activities are completed.)

Additional Resources

"In Your Watershed" lesson plan. National Geographic Society: https://www.nationalgeographic.org/activity/in-your-watershed

"The Global Conveyor Belt." National Geographic: https://education.nationalgeographic.org/resource/global-conveyor-belt

"Mapping U.S. Watersheds" lesson plan. National Geographic Society: https://www.nationalgeographic.org/activity/mapping-us-watersheds

"Ocean Guardian School." NOAA Office of National Marine Sanctuaries: https://sanctuaries.noaa.gov/education/ocean_guardian

"Youth Ocean Action Toolkit." The Ocean Foundation: https://oceanfdn.org/youth-ocean-action-toolkit

For More Information

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