NATIONAL GEOGRAPHIC

RESOURCE LIBRARY
LESSON

Human Impacts on Marine Species

Students learn about three examples of human impacts on marine life: migration patterns and shipping, algal blooms and water chemistry, and marine debris. Some of these impacts are due to human activity in the ocean, and some impacts on the ocean are due to human activity on land.

GRADES

9 - 12+

SUBJECTS

Biology, Ecology, Earth Science, Oceanography, Geography, Human Geography, Physical Geography

CONTENTS

5 Activities

ACTIVITY 1: MARINE MIGRATION | 1 HR 40 MINS

DIRECTIONS

1. Have students watch and discuss the video "Census Ocean Observing."

Tell students that they will be using a series of videos and online resources to explore human impacts on specific marine species. Distribute the Marine Migration Video Notetaking worksheet and have students read the directions and questions for the video "Census Ocean Observing." Show students the Census of Marine Life video (4 minutes). Allow students time to answer the questions on the worksheet. Then check students' answers.

- *According to the video, what are three threats that affect all nations?* (overfishing, pollution, and the destruction of coastal habitats)

- *What effects can changing ocean temperatures have on marine organisms?* (changes in where species live and travel, distribution of essential nutrients, shifts in food webs)

- *What is the Census of Marine Life?* (a 10-year, 80-nation collaboration of marine scientists working on new technologies that monitor and measure life within an emerging global ocean observing system.)

- *What types of technologies are the scientists developing and using in their research?* (acoustic sensing to track marine animals at large scales; cataloguing of short DNA sequences for rapid and accurate species identification and biodiversity assessment; satellite tagging devices that can study animal life histories, collect physical and chemical data in previously inaccessible areas of the ocean, and track migratory routes to identify feeding and mating hotspots)

- *What are some of the outcomes scientists hope to achieve with this research?* (to measure the impact of climate change on marine life; to manage fisheries, coastal ecosystems, and water pollution; to detect harmful bacteria in seas; and discover new pharmaceuticals to help save lives)

2. Have students watch the Census of Marine Life video "About TOPP."

Have students read the "About TOPP" video questions that are included in the Marine Migration Video Notetaking worksheet. Tell students to think about the ecological questions and technologies the TOPP scientists are using in their research. Show students the video (3 minutes) for the Census of Marine Life's Tagging of Pacific Predators (TOPP) research program and discuss the questions. Check students' responses to the questions.

- *What ecological questions are the TOPP scientists hoping to answer through their research?* (How do pelagic animals live? Where do they forage and breed? Where do they go? Where are the hotspots and migratory corridors where species congregate to feed and breed?)

- *What oceanographic technologies are TOPP scientists using to answer these questions?* (microprocessors, satellites, electronic tags and tracking devices, oceanographic databases and data processing software)

- *How could TOPP project data be used to protect marine species from anthropogenic disturbances and threats?* (Data will help to identify important migratory corridors, feeding/mating/birthing grounds, and seasonal movement of these important predatory

species. With a better understanding of species biogeography, ocean resource managers and lawmakers can better protect these species by establishing marine protected areas, altering shipping lanes, and regulating fisheries and sources of sound pollution.)

3. Activate students' prior knowledge about migration and biogeography.

As a class have students brainstorm animals that migrate. Ask: *Why do animals migrate?* Elicit from students that different animals migrate for different reasons, but mostly it is to be in habitats and climates suitable for breeding, birthing, and feeding. Then ask students to break down the root words of *biogeography*. Explain that biogeography is the study of the distribution of biodiversity over space and time, and that the biogeography of ocean animals is an important part of marine biology.

4. Have students record and analyze data about marine migration.

Divide students into small groups and give each student a copy of the Marine Migration Research worksheet. Tell students that they will be using the TOPP oceanographic database and online resources to learn more about the biogeography and migratory habits of the seven Pacific Ocean predatory species listed on the worksheet. Assign each group one of the seven focus species. Review the directions with students and have them complete the worksheets. When students have completed their worksheets, have them go to the TOPP homepage, click on the Feature Story section of the page, and use the videos and slideshows provided to find out more about their species and its migratory habits.

5. Ask each group to present their findings.

Have each group present their findings to the class. As other groups listen, ask them to fill in the Marine Migration Chart worksheet with information about the other marine species presented by their classmates.

6. Have students map the data.

Using the Water Planet Mega Map or the World Physical Tabletop Maps, both included in the World Physical MapMaker Kit, have students draw the migration routes of the ocean predators they researched. Ask students to identify the ecosystems that their animal travels through. Compare the migration routes map to the National Geographic Global Shipping map. Ask: *Which migratory animals will be impacted by shipping?* Then compare the migration routes map to the MapMaker Interactive map with the population density layer turned on. Ask: *Which migratory animals will be impacted by coastal development, runoff, and other anthropogenic threats on land?*

7. Have students reflect on what they have learned.

Allow students time to discuss and record their answers to the following questions on their Marine Migration Chart worksheet. As a class, discuss their responses and emphasize main points by referring back to the videos and the ecological principles addressed. Ask:

- *Why do some marine animals migrate?* (feeding, mating, birthing, nesting, changing ocean or climate conditions, anthropogenic threats)
- *How could research on the biogeography and migratory habits of marine species help protect them from anthropogenic threats?* (information could improve management strategies and aid in the establishment of marine protected areas)
- *How do human activities both in and out of the ocean impact marine migrations?* (ship and boat traffic, boat strikes, sound pollution, fishing, coastal run-off, degradation of water quality)
- *Which stakeholders are most likely to be concerned about this problem?* (fishermen, commercial shipping companies, ecotourism ventures, coastal resorts)
- *What do you think their views would be?* (Possible response: loss of income if they change fishing practices or shipping routes; concern for migratory animals; loss of income from tourism)

Modification

Have students present information about their group's ocean predator using presentation or slideshow software.

Informal Assessment

Assess students' completed worksheets and ocean predator presentations for accuracy and comprehension.

Extending the Learning

Have students research and map the migratory habits and biogeography of other marine animals. Then ask them to present information about case studies of regulations or marine protected areas that were established to protect the migratory routes of those animals.

OBJECTIVES

Subjects & Disciplines

Biology

- Ecology

Earth Science

- Oceanography

Geography

- Human Geography
- Physical Geography

Learning Objectives

Students will:

- describe the migratory habits and biogeography of marine animals
- explain the ways in which anthropogenic threats impact the migratory habits and biogeography of marine animals

Teaching Approach

- Learning-for-use

Teaching Methods

- Cooperative learning
- Discussions
- Information organization
- Research
- Visual instruction

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Information, Media, and Technology Skills
    - Information, Communications, and Technology Literacy
    - Media Literacy
  - Learning and Innovation Skills
    - Communication and Collaboration
- Critical Thinking Skills
  - Analyzing
  - Understanding
- Geographic Skills
  - Acquiring Geographic Information
  - Analyzing Geographic Information
  - Answering Geographic Questions
  - Organizing Geographic Information

National Standards, Principles, and Practices

IRA/NCTE STANDARDS FOR THE ENGLISH LANGUAGE ARTS

• **Standard 8:**
Students use a variety of technological and informational resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.

NATIONAL GEOGRAPHY STANDARDS

- **Standard 1:**

How to use maps and other geographic representations, geospatial technologies, and spatial thinking to understand and communicate information

- **Standard 14:**

How human actions modify the physical environment

- **Standard 18:**

How to apply geography to interpret the present and plan for the future.

- **Standard 8:**

The characteristics and spatial distribution of ecosystems and biomes on Earth's surface

NATIONAL SCIENCE EDUCATION STANDARDS

- **(9-12) Standard C-4:**

Interdependence of organisms

- **(9-12) Standard C-6:**

Behavior of organisms

- **(9-12) Standard E-2:**

Understandings about science and technology

- **(9-12) Standard F-4:**

Environmental quality

- **(9-12) Standard F-5:**

Natural and human-induced hazards

OCEAN LITERACY ESSENTIAL PRINCIPLES AND FUNDAMENTAL CONCEPTS

- **Principle 5c:**

Some major groups are found exclusively in the ocean. The diversity of major groups of organisms is much greater in the ocean than on land.

- **Principle 6a:**

The ocean affects every human life. It supplies freshwater (most rain comes from the ocean) and nearly all Earth’s oxygen. It moderates the Earth’s climate, influences our weather, and affects human health.

- **Principle 6c:**

The ocean is a source of inspiration, recreation, rejuvenation and discovery. It is also an important element in the heritage of many cultures.

- **Principle 6g:**

Everyone is responsible for caring for the ocean. The ocean sustains life on Earth and humans must live in ways that sustain the ocean. Individual and collective actions are needed to effectively manage ocean resources for all.

- **Principle 7d:**

New technologies, sensors and tools are expanding our ability to explore the ocean. Ocean scientists are relying more and more on satellites, drifters, buoys, subsea observatories and unmanned submersibles.

- **Principle 7e:**

Use of mathematical models is now an essential part of ocean sciences. Models help us understand the complexity of the ocean and of its interaction with Earth's climate. They process observations and help describe the interactions among systems.

Preparation

BACKGROUND & VOCABULARY

Background Information

The biogeography of many marine animals involves wide-ranging migrations throughout a variety of habitats in order to access their necessary feeding, birthing, mating, and nesting grounds. Changing climatic and ocean conditions and a number of anthropogenic threats impact the success of migratory animals in accessing the ocean resources and conditions they need to survive. Research and technology that focus on the study of migratory patterns, biogeography, and preservation of marine animals will help identify and eliminate the anthropogenic impacts that threaten migratory marine species.

Prior Knowledge

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Recommended Prior Activities

- An Imbalance in our Ocean

Vocabulary

Term	Part of Speech	Definition
anthropogenic disturbance	*noun*	changes to the natural environment caused by human activity.
biogeography	*noun*	study of the distribution of species and ecosystems in space and time.
migration	*noun*	movement of a group of people or animals from one place to another.
overfish	*verb*	to harvest aquatic life to the point where species become rare in the area.
stakeholder	*noun*	person or organization that has an interest or investment in a place, situation, or company.

FUNDER

ORACLE

ACTIVITY 2: WATER QUALITY DEGRADATION IN THE OCEAN | 1 HR 30 MINS

DIRECTIONS

1. Activate students' prior knowledge and assign a pre-reading assignment for homework.

Ask students to brainstorm the contexts in which they have heard the term *water quality*. Write students' responses on the board. Explain that water quality degradation is a major issue for both freshwater and marine systems. Ask:

- *Have you ever heard of a harmful algal bloom? When? Where?*
- *What is the relationship between algae, oxygen, and nutrients?*

Explain to students that phytoplankton, or algae, are like plants. They use nutrients, sunlight, and carbon dioxide to produce oxygen and food that support aquatic food webs. Explain that these processes of cycling nutrients, oxygen, carbon dioxide, and water are natural and essential for life. Sometimes the cycling or balance of these resources is disrupted, resulting in negative consequences for humans and wildlife. Tell students they will complete a reading assignment to learn more about water quality degradation. Provide students with hard copies or the online link to the National Geographic encyclopedic entry, "Dead Zone." Have students

record the following vocabulary words: *harmful algal blooms (HABs), toxic phytoplankton, eutrophication, hypoxia, dead zone,* and *biomagnification*. Tell students to pay close attention to these terms as they read the entry. Point out that the term *biomagnification* is not used in the entry, but challenge students to research what it means and how it is related to water quality degradation.

2. Review the pre-reading homework assignment and vocabulary.

Ask student volunteers to summarize the main points of the National Geographic encyclopedic entry, "Dead Zone." Write the following definitions (without the matching terms) on the board, and number them so that students can match the definitions to the list of terms they wrote down and looked for throughout the entry. Have students first work individually and then pair up to check their answers. As a class, discuss which terms go with which definitions. Ask students if they are unclear about any of the terms and clarify as needed. Be sure to discuss *biomagnification* and which part of the entry it pertained to (the section about human and other marine animal illnesses).

- **Harmful Algal Blooms (HABs)**—accumulations of fast-growing, dense patches of harmful algae
- **Toxic phytoplankton**—a type of HAB that is poisonous to marine animals and to humans
- **Eutrophication**—a process in which bodies of water receive excess nutrients that stimulate excessive plant growth, such as algal blooms
- **Hypoxia**—a reduced level of oxygen in the water
- **Dead Zone**—an area of water with hypoxic conditions that kill most marine life
- **Biomagnification**—the increasing concentration of toxins as they move up the food chain

3. Have students work in small groups to complete the Water Quality Degradation worksheet.

Divide students into small groups and distribute the Water Quality Degradation worksheet. Explain to students that the water quality issues of toxic algae and dead zones have some similarities. Have groups use the National Geographic "Dead Zone" encyclopedic entry and "Harmful Algae" on the Woods Hole Oceanographic Institution site to answer the questions. Then use the provided answer key to review the correct answers with the whole class.

4. Ask small groups to research and generate hypotheses.

Distribute the Water Quality Degradation: Hypotheses worksheet and read aloud the two scenarios. Ask students to use what they have learned so far to generate hypotheses and support them with factual information.

5. Have students share and revise their hypotheses.

Ask each small group to share its hypothesis for toxic algae and the reasoning behind it. Click on the NOAA: Video Archive slide and show students the video "Sea Lion Sickness" (3 minutes). Discuss the most likely hypothesis for the toxic algae scenario. Have students confirm or revise their hypotheses. Ask each small group to share its hypothesis for dead zones and the reasoning behind it. Show students the NOAA video "The Dead Zone" (3 minutes, 50 seconds). Discuss the content of the video and have students confirm or revise their hypotheses.

6. Have students compare and contrast the two HAB-related water quality scenarios.

Distribute the Venn diagram worksheet, Compare and Contrast Toxic Algae and Dead Zones. Ask: *What are the similarities and differences between the two HAB-related water quality scenarios?* Have students work independently to complete the Venn diagram.

7. Have students use maps to trace the watersheds emptying into the Gulf of Mexico.

Ask students to look at the Water Planet Mega Map, included in the World Physical MapMaker Kit, paying special attention to the Gulf of Mexico. Remind them that they just learned about the annual "dead zone" in the Gulf and created a hypothesis for what could be causing it. Ask volunteers to come up to the map and trace with a marker the freshwater systems that connect to the Gulf of Mexico. Make sure students trace back to tributaries, or smaller waterways, which drain into the Mississippi River. Ask:

- *What waterways connect to the Gulf?*
- *What smaller waterways connect to those?*

- *What natural processes could be contributing to water quality degradation and the development of the Gulf dead zone?*

Elicit from students that the hydrologic cycle is a global/natural process that cycles and transfers water, nutrients, and other substances essential for life throughout terrestrial, atmospheric, and aquatic (freshwater and marine) systems. Then ask: *What anthropogenic activities or materials could be contributing to water quality degradation and the development of the Gulf dead zone*? Display the four National Atlas maps for reference. Elicit from students that areas of high agriculture, industry, development, and population density could all contribute. Remind them of the ways humans contribute to the eutrophication of freshwater systems, and eventually, marine systems like the Gulf. Examples include the use of fertilizers and detergents, deforestation and development that lead to soil erosion, inadequate wastewater treatment, sewage pollution, and contamination by livestock and poultry farms.

8. Have students read and discuss water quality success stories.

State that although water quality degradation is a serious threat to the health of humans and wildlife, efforts are being made to protect and improve the quality of our water. Project the National Water Program: Watershed Management Success Stories website. Ask students to read and discuss one success story as a class. Ask: *What actions are some people or groups taking to improve water quality?*

Modification

Pair this activity with a water sampling/water quality lab (marine or freshwater) or your biology curriculum's plankton and freshwater plant microscope lab.

Informal Assessment

Assess students' completed worksheets for completeness and accuracy.

Extending the Learning

Have students use the Watershed Management Success Stories website to research examples of how communities, governments, water quality managers, and task forces are working to reverse water quality degradation and improve water quality. Ask each student to summarize the organization or strategy and share examples of how water quality is improving and what individuals can do to address the problem.

OBJECTIVES

Subjects & Disciplines

Biology

- Ecology

Earth Science

- Oceanography

Geography

- Human Geography
- Physical Geography

Learning Objectives

Students will:

- use scientific terminology to describe the ecological principles related to water quality degradation
- describe the general process that leads to algal bloom formation
- list ways in which harmful algal blooms can cause water quality degradation
- explain the potential negative effects that harmful algal blooms can have on marine organisms
- give examples of how human behaviors and activities have contributed to water quality degradation
- discuss examples of how humans have worked to improve water quality

Teaching Approach

- Learning-for-use

Teaching Methods

- Cooperative learning
- Discussions
- Information organization
- Multimedia instruction
- Research

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Information, Media, and Technology Skills
    - Information Literacy
  - Learning and Innovation Skills
    - Communication and Collaboration
    - Critical Thinking and Problem Solving
- Critical Thinking Skills
  - Analyzing
  - Understanding
- Geographic Skills
  - Acquiring Geographic Information

National Standards, Principles, and Practices

NATIONAL GEOGRAPHY STANDARDS

• **Standard 14:**
How human actions modify the physical environment
• **Standard 8:**
The characteristics and spatial distribution of ecosystems and biomes on Earth's surface

NATIONAL SCIENCE EDUCATION STANDARDS

• **(9-12) Standard C-4:**
Interdependence of organisms

• **(9-12) Standard D-1:**
Energy in the earth system
• **(9-12) Standard F-4:**
Environmental quality
• **(9-12) Standard F-5:**
Natural and human-induced hazards

OCEAN LITERACY ESSENTIAL PRINCIPLES AND FUNDAMENTAL CONCEPTS

• **Principle 6e:**
Humans affect the ocean in a variety of ways. Laws, regulations and resource management affect what is taken out and put into the ocean. Human development and activity leads to pollution (such as point source, non-point source, and noise pollution) and physical modifications (such as changes to beaches, shores and rivers). In addition, humans have removed most of the large vertebrates from the ocean.
• **Principle 6f:**
Coastal regions are susceptible to natural hazards (such as tsunamis, hurricanes, cyclones, sea level change, and storm surges).
• **Principle 6g:**
Everyone is responsible for caring for the ocean. The ocean sustains life on Earth and humans must live in ways that sustain the ocean. Individual and collective actions are needed to effectively manage ocean resources for all.

Preparation

BACKGROUND & VOCABULARY

Background Information

Marine organisms have adapted to living in a variety of aquatic ecosystems that are impacted by natural and human-related changes. One of the most serious threats to marine organisms is water quality degradation due to nutrient pollution, harmful algal bloom formation, and hypoxia, or low oxygen levels. Monitoring and improving water quality can be challenging, because the harmful organisms and chemicals that threaten water quality are often microscopic, difficult to remove, and can accumulate within the food web and over time.

Prior Knowledge

["ecological principles related to food webs, adaptations, niche selection, and symbioses", "interactions between biotic and abiotic ecosystem components"]

Recommended Prior Activities

- Our Interconnected Ocean

Vocabulary

Term	Part of Speech	Definition
biomagnification	*noun*	process in which the concentration of a substance increases as it passes up the food chain.
dead zone	*noun*	area of low oxygen in a body of water.
eutrophication	*noun*	build-up of sediment and organic matter in bodies of water, which may cause a change in the productivity of the ecosystem.
harmful algal bloom (HAB)	*noun*	rapid growth of algae, bacteria, or other plankton that can threaten an aquatic environment by reducing the amount of oxygen in the water, blocking sunlight, or releasing toxic chemicals.
hypoxia	*noun*	condition of not having enough oxygen in a substance, such as water or blood.
toxic phytoplankton	*noun*	aquatic organism that produces chemicals that, in large amounts, can be deadly to plants and animals.

FUNDER

ORACLE

ACTIVITY 3: MARINE DEBRIS: A LEGACY OF LITTER | 2 HRS

DIRECTIONS

1. Activate students' prior knowledge.
Have students brainstorm different types of litter or debris. Make a list on the board. Ask:

- *What happens to litter? Where does it go?*
- *How could litter end up in the ocean?*

Elicit from students that garbage that does not make it to a landfill can become litter found along the sides of roads or in waterways, eventually ending up in the ocean. Emphasize that no matter where litter comes from, wind, streams, and ocean currents carry litter throughout the globe, including to the ocean and coasts where it becomes marine debris.

2. Have students watch the video "Marine Debris."
Give each student a Marine Debris Video worksheet. Show students the NOAA "Marine Debris" video (3 minutes, 30 seconds) and have them answer the questions as they watch. Then use the provided answer key to discuss the questions. Ask:

- *What is marine debris?* (any manufactured solid material that enters into the marine environment)
- *What are examples of marine debris?* (lost fishing nets and gear, plastic, paper, cigarette butts)
- *Why is marine debris so dangerous to marine animals?* (Animals can mistake it for food and it can fill them up so that they starve to death; toxins in the plastics and bacteria in the debris can accumulate in organisms and in the food chain; fishing line and rope can entangle organisms; lost fishing gear can trap animals until they die.)
- *How do people, even those who don't live by the ocean, contribute to the accumulation of marine debris?* (Marine debris comes from all over and is connected to the ocean by streams, rivers, and ocean currents.)

3. Have students list sources and impacts of land-based and ocean/waterway-based marine debris.
Divide students into small groups and provide each group with a NOAA Marine Debris Facts handout. Have half of the groups read about and summarize sources of land-based and ocean/waterway-based marine debris. Have the other half of the groups read about and summarize the effects of marine debris on ocean ecosystems, marine wildlife, and people. As a class, have the groups take turns presenting what they learned about the sources and impacts of marine debris. Emphasize the fact that the sources and impacts of marine debris are highly varied and involve all people, no matter where they live.

4. Have students watch the video "It's Time to Stop Trashing Our Beaches."
While watching the video (1 minute, 30 seconds), tell students to think about how their actions could contribute to or help solve the marine debris pollution problem. Explain to students that they will be conducting a school-site cleanup and collecting debris data. In their small groups, have students brainstorm types of debris/litter they expect to find around their

school grounds. Give each group a copy of the worksheet School Site Cleanup Data Table. Explain that the data sheet they will be using is designed to record the same information that is recorded during coastal clean-up events. Explain the proper data collection procedures to the groups. As needed, refer to the Ocean Conservancy's 2010 Report: Trash Travels (pages 26-32) to show students how to identify and classify different debris items.

5. Conduct the school site cleanup and compare data.
Using the School Site Cleanup Data Table, have students conduct their own cleanup on their school site. Remind students to use gloves and avoid any materials that could be considered hazardous waste. After groups have collected their data, they will count the total number of debris items found by category for the entire class and then calculate the percentage of the total comprised by each category. Have students compare their data and debris type percentages to the Top Ten Marine Debris Items Worldwide results from the Ocean Conservancy's 2010 Report: Trash Travels (page 11). Have students record their results in the School Site Cleanup Data Table.

6. Have students reflect on what they have learned.
Start a class discussion by asking students to summarize the effect marine debris accumulation is having on ocean ecosystems and wildlife. Then ask:

- *Are you surprised by the amount or type of debris you found? Explain.*
- *What are some similarities and differences in the two data sets (school site and world 2010 report)?*
- *What could be the reasons for these differences?*
- *What is the relationship between the debris data collected at the school site and the data collected at a coastal site?*
- *What did you learn about the role you play in marine debris accumulation?*
- *What are you willing to do to address the problem of marine debris?*

Modification

Create a blank class data table using a transparency or the whiteboard so it is easier for each group to share its data with the rest of the class.

Informal Assessment

Assess students' worksheets and data sheets for completeness and accuracy.

Extending the Learning

Have students complete the Marine Protected Areas activity Laysan Albatross Virtual Bolus Dissection and then compare their school site cleanup data to the debris found in the albatross bolus.

OBJECTIVES

Subjects & Disciplines

Biology

- Ecology

Earth Science

- Oceanography

Geography

- Human Geography
- Physical Geography

Learning Objectives

Students will:

- identify sources of marine debris
- describe ways that marine debris negatively impacts marine ecosystems and organisms
- collect and analyze debris data based on a school site cleanup
- explain how humans contribute to and help solve problems associated with marine debris

Teaching Approach

- Learning-for-use

Teaching Methods

- Discussions
- Experiential learning
- Information organization

- Multimedia instruction
- Reading

Skills Summary

This activity targets the following skills:

- 21st Century Themes
  - Global Awareness
- Critical Thinking Skills
  - Analyzing
  - Understanding
- Geographic Skills
  - Acquiring Geographic Information

National Standards, Principles, and Practices

NATIONAL GEOGRAPHY STANDARDS

• **Standard 1:**
How to use maps and other geographic representations, geospatial technologies, and spatial thinking to understand and communicate information
• **Standard 14:**
How human actions modify the physical environment
• **Standard 8:**
The characteristics and spatial distribution of ecosystems and biomes on Earth's surface

NATIONAL SCIENCE EDUCATION STANDARDS

• **(9-12) Standard C-4:**
Interdependence of organisms
• **(9-12) Standard F-4:**
Environmental quality
• **(9-12) Standard F-5:**
Natural and human-induced hazards

OCEAN LITERACY ESSENTIAL PRINCIPLES AND FUNDAMENTAL CONCEPTS

• **Principle 6d:**
Much of the world's population lives in coastal areas.
• **Principle 6e:**
Humans affect the ocean in a variety of ways. Laws, regulations and resource management affect what is taken out and put into the ocean. Human development and activity leads to pollution (such as point source, non-point source, and noise pollution) and physical modifications (such as changes to beaches, shores and rivers). In addition, humans have removed most of the large vertebrates from the ocean.
• **Principle 6f:**
Coastal regions are susceptible to natural hazards (such as tsunamis, hurricanes, cyclones, sea level change, and storm surges).
• **Principle 6g:**
Everyone is responsible for caring for the ocean. The ocean sustains life on Earth and humans must live in ways that sustain the ocean. Individual and collective actions are needed to effectively manage ocean resources for all.

Preparation

BACKGROUND & VOCABULARY

Background Information

Marine debris is any manufactured solid material that enters the marine environment, either intentionally or unintentionally. Marine debris has become one of the most pervasive pollution problems facing the world's oceans and waterways. A wide variety of marine debris can be found in large quantities throughout the ocean and can cause severe problems for marine organisms including birds, mammals, fish, and other creatures that get caught in it or consume it.

Prior Knowledge

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Recommended Prior Activities

- Laysan Albatross Virtual Bolus Dissection

Vocabulary

Term	Part of Speech	Definition
marine debris	*noun*	garbage, refuse, or other objects that enter the coastal or ocean environment.

FUNDER

ORACLE

ACTIVITY 4: LAYSAN ALBATROSS VIRTUAL BOLUS DISSECTION | 1 HR

DIRECTIONS

1. Activate students' prior knowledge.

Have students brainstorm different types of debris, or trash. List their ideas on the board. Ask:

- *How does trash get into the ocean? Where does it go? How does it travel?*
- *What impact does trash (marine debris) have on the ocean and organisms in the ocean?*

Elicit from students that trash that does not make it to a landfill can become litter found along the sides of roads or in waterways, eventually ending up in the ocean. Emphasize that no matter where litter comes from, wind, streams, and ocean currents carry litter throughout the globe, including the ocean and coasts where it becomes marine debris.

2. Build background about marine debris and the albatross.

Have students view SchoolTube's *Good Morning America* video, "The Great Pacific Garbage Patch" (4 minutes, 30 seconds total; stop after 3 minutes, 30 seconds). As they watch, have students note the types, shapes, and sizes of marine debris they see. Briefly discuss student observations. Next go to the NG Education encyclopedic entry for *marine debris*. Invite volunteers to read aloud a couple of the captions related to marine debris as you click through the photo gallery. Show the albatross carcass image and read the caption to the students. Tell students that they will observe the dissection of an albatross bolus. Explain that a *bolus* is formed from undigested materials that the bird then regurgitates as part of its normal feeding process. Distribute and allow students time to read the provided Laysan Albatross fact sheet. Ask students to share facts that they found interesting after reading about this species' life history, especially its diet. Explain that albatross are carnivores that feed mostly on squid and fish but also consume floating garbage, either intentionally or unintentionally.

3. Introduce and provide context for the virtual bolus dissection activity.

Distribute the Albatross Bolus-Dissection Activity Sheets. Explain that the albatross bolus is composed of animal parts albatross cannot digest, like squid beaks, and other materials they eat accidentally, like rocks and wood. As trash and plastics accumulate as marine debris, albatross accidentally eat these materials. Marine debris is found with more frequency in regurgitated bolus. Use the worksheet to focus student attention:

- Before viewing the dissection, tell students to record hypotheses about the types of items that they think they will find in the bolus and the reason for their predictions.
- While observing the virtual dissection, tell students to pay close attention to the number of plastic items versus natural items extracted from the bolus, and the size and color of these items.

4. Have students view the virtual bolus dissection flipbooks and photo gallery.

View the dissection media in the following order, allowing students time to complete their worksheets:

- Flipbook: Opening the Bolus

- Flipbook: Squid Beak Extraction
- Flipbook: Foreign Materials Extraction
- Bolus Dissection Photo gallery

5. Have students discuss and draw conclusions about the virtual bolus dissection.

After students have completed the Albatross Bolus worksheet, lead a discussion of their findings and conclusions. First ask students to summarize the ways in which marine debris affects the life and health of the laysan albatross. Then ask:

- *Why would plastics be a problem if ingested by the albatross?*
- *Do you think that the bird that regurgitated this bolus felt full?*
- *What are the health implications of a bird "feeling full" after eating the materials that were extracted from the bolus?*
- *What have you heard about BPAs or other plastic leaching agents?*
- *Could these toxic substances create health problems for the albatross? How? Why?*

6. Have students reflect on what they have learned.

Ask:

- *Could marine debris and the substances it contains create health problems for other ocean animals? Which ones? What about humans?*
- *What is being done to combat the global problem of marine debris?*
- *What can you do to combat the global problem of marine debris?*

Informal Assessment

Assess students' completed Albatross Bolus-Dissection Activity Sheets for completion and accuracy.

Extending the Learning

Have students go to the NOAA Marine Debris website to read more about other impacts of marine debris, including wildlife entanglement, alien species transport, and economic threats. Have students research programs and organizations working to combat the negative impacts of marine debris. Ask them to share what they learned with the class.

OBJECTIVES

Subjects & Disciplines

Biology

- Ecology

Earth Science

- Oceanography

Geography

- Human Geography
- Physical Geography

Learning Objectives

Students will:

- identify sources and examples of marine debris
- describe how marine debris affects the life and health of the laysan albatross
- predict negative impacts marine debris has on other ocean organisms
- discuss how humans contribute to and help solve problems associated with marine debris

Teaching Approach

- Learning-for-use

Teaching Methods

- Discussions
- Information organization
- Multimedia instruction
- Reading

Skills Summary

This activity targets the following skills:

- 21st Century Themes
  - Global Awareness
- Critical Thinking Skills
  - Analyzing
  - Understanding
- Geographic Skills
  - Acquiring Geographic Information

National Standards, Principles, and Practices

NATIONAL GEOGRAPHY STANDARDS

• **Standard 1:**
How to use maps and other geographic representations, geospatial technologies, and spatial thinking to understand and communicate information
• **Standard 14:**
How human actions modify the physical environment
• **Standard 8:**
The characteristics and spatial distribution of ecosystems and biomes on Earth's surface

NATIONAL SCIENCE EDUCATION STANDARDS

• **(9-12) Standard C-4:**
Interdependence of organisms
• **(9-12) Standard F-4:**
Environmental quality
• **(9-12) Standard F-5:**
Natural and human-induced hazards

OCEAN LITERACY ESSENTIAL PRINCIPLES AND FUNDAMENTAL CONCEPTS

• **Principle 6d:**
Much of the world's population lives in coastal areas.
• **Principle 6e:**
Humans affect the ocean in a variety of ways. Laws, regulations and resource management affect what is taken out and put into the ocean. Human development and activity leads to pollution (such as point source, non-point source, and noise pollution) and physical modifications (such as changes to beaches, shores and rivers). In addition, humans have removed most of the large vertebrates from the ocean.
• **Principle 6f:**
Coastal regions are susceptible to natural hazards (such as tsunamis, hurricanes, cyclones, sea level change, and storm surges).
• **Principle 6g:**
Everyone is responsible for caring for the ocean. The ocean sustains life on Earth and humans must live in ways that sustain the ocean. Individual and collective actions are needed to effectively manage ocean resources for all.

Preparation

BACKGROUND & VOCABULARY

Background Information

Marine debris is any manufactured solid material that enters the marine environment, either intentionally or unintentionally. It has become one of the most pervasive pollution problems facing the world's oceans and waterways. A variety of marine debris, especially plastics, can be found in large quantities throughout the ocean and can cause severe problems for marine organisms, including the laysan albatross, that ingest it. Scientists are learning more about these impacts by collecting and dissecting albatross boluses.

Prior Knowledge

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Recommended Prior Activities

- Marine Debris: A Legacy of Litter

Vocabulary

Term	Part of Speech	Definition
Great Pacific Garbage Patch	*noun*	area of the North Pacific Ocean where currents have trapped huge amounts of debris, mostly plastics.
marine debris	*noun*	garbage, refuse, or other objects that enter the coastal or ocean environment.

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ACTIVITY 5: MARINE CRITICAL ISSUES: CASE STUDIES | 1 HR

DIRECTIONS

1. Activate students' prior knowledge and build background.

Remind students that Marine Protected Areas (MPAs) are areas of the marine environment that are protected by laws in order to preserve their natural and cultural resources. In order to establish and manage MPAs, case studies are created. Ask: *What are case studies?* Elicit from students that case studies outline important information about an area's history, geography, habitats, species, human uses, and management goals. Case studies also describe threats to the area and explain why the area should be protected. The goals of such protection focus on restoring ecological balance to the area. Case studies help stakeholders understand how humans impact the area and what can be done to restore ecological balance and sustainably manage the area's cultural and natural resources. Ask: *Who are stakeholders?* Remind students that stakeholders are people, organizations, or political entities interested in and/or affected by the outcome of management decisions.

2. Use Apo Island as an example case study of human impacts on a marine ecosystem.

Distribute the Marine Ecosystem Critical Issues: Case Studies worksheet and read aloud the directions. Review the categories of information in the chart, making sure that students know what components of the case study they need to record. Explain that for Case Study #1: Apo Island, they will view a video and work together as a class to complete the chart. For Case Study #2: Galápagos Marine Reserve, they will review a written case study and work in small groups to complete the chart. Show students the video, "EcoTipping Point Success Stories: Apo Island" (6 minutes, 30 seconds) and have them take notes on their worksheets as they watch. After the video, discuss the information students recorded. Ask:

- *What happened as a result of Apo Islanders changing their fishing practices and establishing an MPA?*
- *What do you think would have happened if they did not establish the MPA or change the way they used their island's ocean resources?*

3. View the National Geographic video "Galápagos" to build background.

Tell students that they will watch a short video (4 minutes, 30 seconds) to learn about the Galápagos Islands and the establishment of the Galápagos Marine Reserve. As they watch, focus their attention by telling them to look for examples of the case study information they will record in their charts. Tell them to think about the human impacts that threatened the habitat and organisms of the Galápagos and eventually led to the establishment of the MPA.

4. Review the Galápagos Marine Reserve Case Study.

After viewing the video, divide students into small groups and distribute copies of the handout Galápagos Marine Reserve Case Study. Have students read through the case study and complete the charts on their worksheets. Have groups share the information they recorded for each of the case study components in their charts. Next, ask students to brainstorm the human impacts (threats) that led to the creation of the Galápagos Marine Reserve as a MPA. Ask: *Why did the Galápagos MPA need to be protected?* List student responses on the board. Then ask students to recall the human impacts that led to the creation of Apo Island's MPA. Draw a circle around the impacts that are the same as those threatening the Galápagos. Underline impacts that are different from those threatening the

Galápagos. Lead a discussion about the similarities and differences between the two case studies, including the human impacts that threaten the balance and sustainability of their marine ecosystems.

5. Have students reflect on what they have learned.

Ask:

- *Based on the two case studies, what was done to address human-induced threats and restore balance in the marine ecosystems?*
- *Do you think more could or should be done to protect the habitat and organisms of the Galápagos and Apo Island? Why or why not?*
- *If the establishment of a MPA results in so many positive changes that benefit the people and the ocean, why are there not more MPAs throughout the world?*

Informal Assessment

Assess students based on their responses to the discussion questions and the completeness and accuracy of their worksheets.

Extending the Learning

Using their worksheet Marine Ecosystem Critical Issues: Case Studies as a guide, have students research, create, and present a case study for a local aquatic or terrestrial protected area.

OBJECTIVES

Subjects & Disciplines

Biology

- Ecology

Earth Science

- Oceanography

Geography

- Human Geography
- Physical Geography

Learning Objectives

Students will:

- identify and describe human impacts to marine ecosystems
- summarize case study information, including the history, geography, habitats, species, human uses, stakeholders, and management goals for different MPAs
- discuss human actions that can be taken to restore balance to threatened marine ecosystems and species

Teaching Approach

- Learning-for-use

Teaching Methods

- Discussions
- Research

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Information, Media, and Technology Skills
    - Information, Communications, and Technology Literacy
  - Learning and Innovation Skills
    - Communication and Collaboration
- Critical Thinking Skills
  - Analyzing
  - Applying
  - Understanding

- Geographic Skills
  - Acquiring Geographic Information
  - Organizing Geographic Information

National Standards, Principles, and Practices

NATIONAL GEOGRAPHY STANDARDS

• **Standard 14:**
How human actions modify the physical environment
• **Standard 8:**
The characteristics and spatial distribution of ecosystems and biomes on Earth's surface

NATIONAL SCIENCE EDUCATION STANDARDS

• **(9-12) Standard F-3:**
Natural resources
• **(9-12) Standard F-4:**
Environmental quality
• **(9-12) Standard F-5:**
Natural and human-induced hazards

OCEAN LITERACY ESSENTIAL PRINCIPLES AND FUNDAMENTAL CONCEPTS

• **Principle 6e:**
Humans affect the ocean in a variety of ways. Laws, regulations and resource management affect what is taken out and put into the ocean. Human development and activity leads to pollution (such as point source, non-point source, and noise pollution) and physical modifications (such as changes to beaches, shores and rivers). In addition, humans have removed most of the large vertebrates from the ocean.
• **Principle 6g:**
Everyone is responsible for caring for the ocean. The ocean sustains life on Earth and humans must live in ways that sustain the ocean. Individual and collective actions are needed to effectively manage ocean resources for all.

Preparation

Background Information

Humans are having a negative impact on marine ecosystems due to pollution, overfishing, habitat destruction, and other unsustainable practices. Analyzing case studies of human impacts on marine ecosystems helps students to understand the critical issues facing the world's oceans today, as well as the positive effects that the establishment of marine protected areas can have on the health of the ocean.

Prior Knowledge

["Marine ecosystems, interrelationships, and human impacts"]

Recommended Prior Activities

- Marine Protected Areas: Case Studies
- MPA Designation and Management
- Protecting the Ocean

Vocabulary

Term	Part of Speech	Definition
case study	*noun*	form of problem-based learning, where the teacher presents a situation that needs a resolution. The learner is given details about the situation, often in a historical context. The stakeholders are introduced. Objectives and challenges are outlined. This is followed by specific examples and data, which the learner then uses to analyze the situation, determine what happened, and make recommendations.
marine ecosystem	*noun*	community of living and nonliving things in the ocean.
stakeholder	*noun*	person or organization that has an interest or investment in a place, situation, or company.

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