**NATIONAL GEOGRAPHIC**

# Combined Impacts

Students make predictions about marine ecosystems based on combined impacts of anthropogenic and natural disturbances. They evaluate others' predictions and create concept maps to identify cause-and-effect relationships.

**GRADES**

9 - 12+

**SUBJECTS**

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

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# OVERVIEW

Students make predictions about marine ecosystems based on combined impacts of anthropogenic and natural disturbances. They evaluate others' predictions and create concept maps to identify cause-and-effect relationships.

For the complete activity with media resources, visit:

http://www.nationalgeographic.org/activity/combined-impacts/

# DIRECTIONS

**1. Elicit students' prior knowledge.**
Remind students of their previous learning about marine ecosystems, food webs, interdependent relationships, and impacts. Ask students to work in pairs to recall as many different types of marine ecosystems as they can. Have them record their answers. Next, ask the student pairs to try to recall examples of natural and/or anthropogenic disturbances that

may impact each of the ecosystems on their list. Have them record their answers. Discuss student responses as a class and any questions students may have. Remind them of the interdependent relationships (symbioses, food webs) that exist within and among marine ecosystems.

**2. Have students work in groups to predict combined impacts.**
Divide students into small groups. Distribute a copy of the blank Four-Column Chart to each group. Ask each group to write the following heads: Ecosystem Type, Impact 1, Impact 2, and Predicted Changes to the Ecosystem. Have each group select one of the ecosystems and its two associated impacts—either natural or anthropogenic—listed below. Encourage students to use what they have already learned to think about the effect of the two impacts separately. Then, have them consider the combined effect of the two impacts and predict what changes might occur within the ecosystem.

- **Antarctic**—introduction of invasive species; hunting of top predators such as whales/seals
- **Arctic**—ocean warming; oil and gas development/drilling
- **Coral Reef**—tourism; sediment runoff leading to decreased water clarity
- **Kelp Forest**—ocean warming; trophic imbalances leading to decreased carnivores and increased herbivores
- **Mangrove**—coastal development; hurricanes/tsunamis
- **Open Ocean**—commercial fisheries leading to diminished fish stocks; marine debris
- **Rocky Shore**—human access leading to trampling and collection of organisms; coastal development
- **Salt Marsh and Mudflat**—coastal development leading to water removal and habitat destruction; water pollution due to nutrients, sewage, and wastewater from human activities

**3. Have students share and discuss their predictions.**
Have each small group trade their written predictions with another group in the class. Ask each group to review and comment on the prediction they are given. Each group should respond to the following prompts on a piece of paper:

- Read the predicted changes of another group. Describe whether you agree or disagree with their prediction and why.
- Write two questions in response to the predicted changes of the other group.

As student groups work, facilitate their discussions and note important points or misconceptions that can later be discussed as a class.

**4. Have students create a concept map of ecosystem impacts and effects.**
Give each group butcher paper and markers. Using their predicted changes, have each group create a concept map to show the relationship between their ecosystem's combined impacts and the effects of those impacts. Model creating an example concept map using one of the ecosystems not used by the groups, such as sandy shore or deep sea. Write the ecosystem name in the middle and show the two impacts as the primary branches of the ecosystem. The effects of each of the impacts become secondary branches. Students can use arrows and action words to show the cause-and-effect relationships related to the individual impacts and then between the two impacts. Have groups present their concept maps to the whole class and facilitate discussion. Tell students to note similarities and differences in the cause-and-effect relationships of the different ecosystems and their impacts.

**5. Have students reflect on what they have learned.**
Lead a discussion to summarize student predictions and conclusions. Emphasize the fact that all of the ecosystems are affected by a combination of anthropogenic and natural impacts that interact in complex ways. Also note that many of the ecosystems are affected by similar impacts. Have students brainstorm actions that are being taken to address some of these impacts. Elicit from students that many citizen groups, research organizations, and governments are working to address these impacts by studying the ecosystems, establishing regulations, educating the public, and establishing marine protected areas. Explain that some conservation actions are comprehensive and occur on large scales, such as the creation of a MPA or network of MPAs. Other conservation actions occur at grassroots levels or by the work of individuals. Examples include fishermen using navigation tools and fixed buoys to avoid groundings and anchor damage; citizen action groups conducting volunteer monitoring projects; community groups participating in beach cleanups; and families selecting biodegradable or alternative products to decrease the addition of nutrients and harmful chemicals to their nearby waterways. Ask students to list ways that they can get involved and help address these impacts in order to restore balance and improve the health of the world ocean.

# Informal Assessment

Assess student predictions and concept maps for completeness and accuracy.

# Extending the Learning

For homework, have students watch the Northwestern Hawai'ian Islands "Navigating Change: Human Impacts" video. Then lead a discussion about ecosystem balance, combined impacts, management strategies, and efforts to address the negative impacts to Hawaii's marine environment.

OBJECTIVES

# Subjects & Disciplines

**Biology**
- Ecology

**Earth Science**
- Oceanography

**Geography**
- Human Geography
- Physical Geography

# Learning Objectives

Students will:

- discuss ecological changes to marine ecosystems within the context of combined natural and anthropogenic impacts
- list actions that can be taken to address impacts to marine ecosystems

# Teaching Approach

- Learning-for-use

# Teaching Methods

- Cooperative learning
- Discussions
- Information organization

# 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 Skills
  - Analyzing
  - Understanding
- Geographic Skills
  - [Acquiring Geographic Information](#)
  - [Answering Geographic Questions](#)

# 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&#39;s surface 

## NATIONAL SCIENCE EDUCATION STANDARDS

- **[(9-12) Standard C-4](#):**
Interdependence of organisms
- **[(9-12) Standard F-3](#):**
Natural resources
- **[(9-12) Standard F-4](#):**
Environmental quality
- **[(9-12) Standard F-5](#):**

## OCEAN LITERACY ESSENTIAL PRINCIPLES AND FUNDAMENTAL CONCEPTS

- **Principle 5f:**

Ocean habitats are defined by environmental factors. Due to interactions of abiotic factors such as salinity, temperature, oxygen, pH, light, nutrients, pressure, substrate and circulation, ocean life is not evenly distributed temporally or spatially, i.e., it is "patchy". Some regions of the ocean support more diverse and abundant life than anywhere on Earth, while much of the ocean is considered a desert.

- **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

### What You'll Need

## MATERIALS YOU PROVIDE

- Butcher paper
- Markers
- Pencils

## REQUIRED TECHNOLOGY

- Internet Access: Optional
- Tech Setup: 1 computer per classroom, Projector, Speakers

**PHYSICAL SPACE**

- Classroom

**GROUPING**

- Small-group instruction

# BACKGROUND & VOCABULARY

# Background Information

Ecosystems are rarely impacted by a single change. Living systems constantly undergo change due to natural and anthropogenic factors. These changes can combine in ways that lead to ecosystem degradation, ecosystem repair, or succession.

# Prior Knowledge

["marine ecosystems", "food webs", "interdependent relationships", "examples of natural and anthropogenic ocean impacts"]

# Recommended Prior Activities

- An Imbalance in our Ocean
- Create an Imaginary Marine Ecosystem
- Ecological Relationships
- Human Impacts on Marine Ecosystems
- Marine Ecology Video Scavenger Hunt

# Vocabulary

| Term | Part of Speech | Definition |
|---|---|---|
| **ecosystem** | noun | community and interactions of living and nonliving things in an area. |

**For Further Exploration**

**Websites**

- The EcoTipping Points Project: Feedback Analysis—The Apo Island Story
- National Geographic Education: National Teacher Leadership Academy (NTLA)

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