NATIONAL GEOGRAPHIC

**RESOURCE LIBRARY**
ACTIVITY : 1 HR

# Coral Reef Succession

Students use coral reef ecosystem case studies to explore the ecological principles of shifting baselines, natural and anthropogenic disturbance, succession, and sustainability.

**GRADES**

9 - 12+

**SUBJECTS**

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

**CONTENTS**

2 Links, 2 PDFs, 1 Video

## OVERVIEW

Students use coral reef ecosystem case studies to explore the ecological principles of shifting baselines, natural and anthropogenic disturbance, succession, and sustainability.

For the complete activity with media resources, visit:
http://www.nationalgeographic.org/activity/coral-reef-succession/

## DIRECTIONS

**1. Activate students' prior knowledge of ecological succession and types of disturbances.**
Lead a class discussion or have students use think-pair-share, followed by a class discussion. Ask: *Do ecosystems change over time? What could cause those changes?* Record students' responses on the board. Students may give examples such as volcanic eruptions (Mount St. Helens or Krakatau), wildfires (Yellowstone, western U.S.), nuclear contamination (Chernobyl,

Three Mile Island), deforestation (Amazon rainforest), and hurricanes (Katrina, Mitch). They may also mention that ecosystems change gradually as different species flourish and others decline due to a variety of factors.

**2.Explore anthropogenic and natural causes of change and ecological succession.**
Next, have students draw a two-column chart in their notebooks. Do the same on the board, labeling one column "Anthropogenic Cause for Change" and the other column "Natural Cause for Change." Based on the types of changes they brainstormed, have students classify them as anthropogenic or natural. Explain that one reason for ecosystem change is succession, the progressive change in the species composition of an ecosystem. Ecological succession in terrestrial and marine ecosystems results from both human-caused, or anthropogenic disturbances, and natural disturbances. Often, after a major disturbance, you can observe an ecosystem move through several stages of succession. Discuss the successional stages that occur after one or two of the examples students listed.

**3. Build background on shifting baselines and succession in marine ecosystems.**
Tell students they will watch a video of the TED talk, "Glimpses of a Pristine Ocean," by Enric Sala. Ask them to pay attention to how Dr. Sala's talk relates to the concept of ecological succession. Show students the first 3 minutes, 30 seconds of the video. After viewing, ask students to summarize what they saw. Elicit from students that the video uses coral reefs with varying degrees of human habitation and impacts to show how the composition of reef species changes over time. Ask students to provide examples of disturbances that occur in marine ecosystems. Add their ideas on the table from Step 2. Elicit examples such as hurricanes, ocean warming, dead zones (anoxia), overfishing, habitat destruction (trawling, coastal development), and pollution (toxic waste, oil spill). Using the example of coral reefs from the video to provide context, ask: *What is a baseline?* Elicit from students that a baseline is a point of reference against which significant change can be measured. Explain that a "shifting baseline" is when our point of reference about what is natural in an ecosystem shifts until we accept its current state as normal, and therefore, lower our standards about its health and sustainability. Ask: *Why is it important to have an accurate baseline for marine ecosystems like coral reefs?* Elicit from students that if we know the baseline for an ecosystem in decline, we can work to restore it to that level. If the baseline has shifted, we may be accepting a degraded system as normal.

**4. Divide students into small groups and have them start the worksheet.**
Distribute a copy of the Shifting Baselines and Succession worksheet to each student. Divide students into small groups and read aloud the directions. Ask each group to provide at least

one example of each item in column 1. Have a whole-class discussion about students' examples. Use the examples generated from Steps 1-3, including the video, to correct any misconceptions students have about each of the items in the list. For example, students may think that a pristine ecosystem is an ecosystem to which humans have no access. Clarify that the ocean and atmosphere connect humans to all marine ecosystems. Also clarify that sustainability can be defined in different ways, but for this activity they need to think about it in terms of ocean resources and ecology.

**5. Have students watch the National Geographic video "Belize Coral Reef."**
As students watch the National Geographic video (4 minutes) have them work individually on their worksheets to fill in examples and explanations for as many of the terms as possible. After the video, have groups work together to discuss and refine their examples and explanations. Use the provided answer key to facilitate the discussion. Ask: *Do you think coral reefs can recover from natural disturbances at the same time that anthropogenic disturbances are increasing? Why or why not?*

**6. Have students watch Part 2 of the video podcast "Paradise Redefined: Line Islands."**
As students watch the Scripps Institution of Oceanography video (7 minutes, 30 seconds), have them work individually on their worksheets to fill in examples and explanations for as many of the terms as possible. After the video, have groups work together to discuss and refine their examples and explanations. Use the provided answer key to facilitate discussion and check for completeness. Ask: *How did the scientists describe the initial stages of coral reef succession? What stages do you think might follow?* Elicit from students that the scientists stated that a hard or rocky substrate free of algae was needed so that the small coral recruits, or polyps, could attach and begin to multiply into a coral colony. The coral colonies would then provide food, space, and shelter for other reef creatures, including herbivores. Then, carnivorous fish and invertebrates would multiply and feed on the herbivores. As biodiversity increased, additional niches would develop. And in the case of the more pristine Line Islands, the reef supported more predators than herbivores and showed signs of stability and resilience.

**6. Have students reflect on what they have learned.**
Lead a class discussion about how the terms *shifting baseline, disturbance, succession,* and *sustainability* are all interconnected. Have students use their worksheets to share examples of these ecological principles in coral reef ecosystems. Ask students to brainstorm about how these principles are applicable in other marine or terrestrial ecosystems.

# Modification

In Step 1, use a video, animation, or ecosystem diagram to help students visualize the successional stages an ecosystem undergoes after a disturbance.

# Modification

In Step 1, you may choose to incorporate the concepts of pioneer species, primary succession, secondary succession, and climax community throughout the discussion.

# Informal Assessment

Assess students' worksheets for completeness and accuracy. Check students' understanding by asking them to restate their examples and explanations of the key terms.

# Extending the Learning

Have students use Google Earth: Oceans to explore the Ocean Now 2009 Line Islands Expedition Log and reflect upon the current state of the research and how it could impact the establishment and design of coral reef marine protected areas.

## OBJECTIVES

# Subjects & Disciplines

**Biology**

- Ecology

**Earth Science**

- Oceanography

**Geography**

- Human Geography
- Physical Geography

# Learning Objectives

Students will:

- provide marine examples of shifting baselines, ecological succession, sustainability, pristine and disturbed ecosystems, and anthropogenic and natural disturbances

- discuss the relationship among coral reef communities and how anthropogenic disturbances affect reef baselines, ecological succession, sustainability, and pristine versus disturbed conditions

# Teaching Approach

- Learning-for-use

# Teaching Methods

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

# 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'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:**

Natural and human-induced hazards

- **(9-12) Standard G-3:**

Historical perspectives

## OCEAN LITERACY ESSENTIAL PRINCIPLES AND FUNDAMENTAL CONCEPTS

- **Principle 5d:**

Ocean biology provides many unique examples of life cycles, adaptations and important relationships among organisms (such as symbiosis, predator-prey dynamics and energy transfer) that do not occur on land.

- **Principle 5e:**

The ocean is three-dimensional, offering vast living space and diverse habitats from the surface through the water column to the seafloor. Most of the living space on Earth is in the ocean.

- **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 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 6d:**

Much of the world's population lives in coastal areas.

**Preparation**

**What You'll Need**

### MATERIALS YOU PROVIDE

- Pencils

### REQUIRED TECHNOLOGY

- Internet Access: Required
- Tech Setup: 1 computer per classroom, Projector, Speakers
- Plug-Ins: Flash, Quicktime

### PHYSICAL SPACE

- Classroom

### GROUPING

- Large-group instruction

### OTHER NOTES

Before starting the activity, download and queue up the videos.

## BACKGROUND & VOCABULARY

# Background Information

A baseline is a reference point upon which ecological change can be measured or compared. Coral reef ecosystems are especially sensitive to the compounded effects of anthropogenic and natural disturbances that can shift their baselines and limit their ability to recover to a more balanced, pristine state. Marine ecologists recognize the importance of studying pristine reef systems and using that data as a baseline for monitoring and managing the succession and sustainability of disturbed coral reef communities and ecosystems.

# Prior Knowledge

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# Recommended Prior Activities

- None

# Vocabulary

| Term | Part of Speech | Definition |
|---|---|---|
| **anthropogenic disturbance** | *noun* | changes to the natural environment caused by human activity. |
| **ecological succession** | *noun* | gradual, predictable changes to an ecosystem or habitat. |
| **marine ecosystem** | *noun* | community of living and nonliving things in the ocean. |
| **shifting baseline** | *noun* | slow changes in the standard characteristics of an ecosystem, which cause the standards to be adjusted, such as overfishing leading to a lower "baseline" estimate of the fish population. Also called a sliding baseline. |
| **sustainability** | *noun* | use of resources in such a manner that they will never be exhausted. |

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**For Further Exploration**

**Audio & Video**

- Coral Reef Systems Multimedia: Mini-Documentaries—Shifting Baselines

## Websites

- SCRIPPS Explorations Magazine: Paradise Redefined—Part 1
- SCRIPPS Explorations Magazine: Paradise Redefined—Part 2
- NOAA Coral Reef Conservation Program
- National Geographic Education: National Teacher Leadership Academy (NTLA)

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