# Teacher Guide: Coral Reef Ecology: Coral Bleaching

Standalone Gizmos Investigation

## Overview

**Grade Level:** 6–8
**Subjects:** Life Science, Earth Science
**Time: 30 min**
**Topic: Ecosystem Interactions and Dynamics**

Why did brightly colored corals turn white? To answer this question, students manipulate an ecosystem model and analyze data to determine how changes in storm severity, ocean temperature, and pH affect coral reef populations over time. They use evidence from their investigations to construct scientific arguments about the effects of these abiotic factors.

### Student Learning Objectives

By the end of this lesson, students will be able to:

- Manipulate abiotic factors in an ecosystem model to test predictions.
- Analyze data in graphs and tables to describe changes in populations over time.
- Define coral bleaching and algae blooms, and describe how changes in biotic and abiotic factors affect coral reef ecosystems.
- Construct scientific arguments about whether changes in specific abiotic factors could be responsible for a decrease in fish populations in a coral reef ecosystem.

## Summary

| Driving Question | Practices | Learning Outcomes |
|---|---|---|
| Why did brightly colored corals turn white? | Analyzing and interpreting data, developing and using models, constructing explanations, and engaging in argument from evidence | Determine which abiotic factor caused the observed changes in the coral reef ecosystem. |

# Standards Alignment

Gizmos Investigations are designed to align with the Next Generation Science Standards. This is achieved through addressing the three dimensions of disciplinary core ideas (DCIs), science and engineering practices (SEPs), and crosscutting concepts (CCCs). These correlations should also apply to other states' standards that similarly reference DCIs, SEPs, and CCCs or their equivalents (although individual states' numbering schemes will likely differ).

Please note that our alignment is specifically to the **middle grades (grades 6–8)** level learning goals for the below-listed DCIs, SEPs, and CCCs.

| Disciplinary Core Ideas (DCI) | Science and Engineering Practices (SEP) | Crosscutting Concepts (CCC) |
|---|---|---|
| **LS2.A: Interdependent Relationships in Ecosystems**<br><br>**LS2.C: Ecosystem Dynamics, Functioning, and Resilience** | **Analyzing and Interpreting Data**<br><br>**Developing and Using Models**<br><br>**Constructing Explanations**<br><br>**Engaging in Argument from Evidence** | **Patterns**<br><br>**Cause and Effect**<br><br>**Systems and System Models**<br><br>**Stability and Change** |

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The *Coral Reef Ecology: Coral Bleaching* lesson builds toward the following NGSS Performance Expectations (PEs):

- ***MS-LS2-1:*** *Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. [Clarification statement: Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources.]*
- ***MS-LS2-4:*** *Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. [Clarification statement: Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.]*

## Prior Knowledge

Prior to completing this Gizmos Investigation, students should know the following:

- An ecosystem includes all the living and nonliving things that interact in a particular area.
- An organism is a living thing. A population is a group of organisms of the same species living together in a particular area.
- Producers make their own food from inorganic sources of energy, such as sunlight; consumers must get energy by eating other organisms; decomposers get energy from breaking down other organisms.
- Predators are consumers that hunt, kill, and eat other consumers, called their prey.

# Coral Reef Ecology: Coral Bleaching—Scientific Background

Coral reef ecosystems are known for their biodiversity, or variety of living things. Scientists consider biodiversity an important measure of ecosystem health and stability. Corals are tiny invertebrates that live in large groups; a single coral organism is called a polyp. Over time, the hard exoskeletons of some types of corals accumulate to form large reefs. The bright colors of a coral reef come from the photosynthetic algae living inside the corals in a type of symbiosis called mutualism, in which both species benefit from living together in a close relationship. Corals provide algae with a place to live, and algae provide energy for corals.

Other coral reef organisms featured in this Investigation include staghorn and boulder star corals, algae, sponges, hawksbill sea turtles, queen angelfish, stoplight parrotfish, yellowtail snapper, and Nassau grouper. Sponges are filter feeders that consume plankton suspended in the water. Hawksbill sea turtles are large turtles that feed primarily on sponges. Groupers are large predatory fish that feed on many reef fish, including snappers, angelfish, and parrotfish. Snappers eat smaller fish, shrimp, crabs, and worms. Queen angelfish mainly eat sponges, while stoplight parrotfish and long-spine sea urchins feed on algae.

Biotic factors are the living things in an ecosystem—like fish, coral, algae, plants, and sponges. Predators and prey are biotic factors. Abiotic factors are the nonliving parts of an ecosystem—like sunlight, water, air, nutrients, sand, temperature, storms, and other environmental conditions. Corals are affected by many environmental factors, including ocean temperature, pH, and storm damage. The pH scale ranges from 0 to 14 and measures how acidic or alkaline (basic) a substance is. Lower numbers indicate a strong acid, while higher numbers indicate a strong base. A pH of 7 indicates a substance that is neutral (neither an acid nor a base). Pure water has a pH of 7. Historically, ocean water has had a slightly basic pH, around 8.2 on the pH scale. It has become more acidic as the ocean absorbs carbon dioxide from the atmosphere. Global warming has increased ocean temperatures and storm severity. Warmer water and other environmental stresses can cause corals to bleach, or expel their symbiotic algae. Bleached corals appear white and cannot survive long without their main food source.

Warmer waters and nutrient pollution from runoff and sewage overflows lead to algae blooms, when algae populations suddenly overgrow. The algae cover corals and block sunlight from reaching their symbiotic algae. Later, bacteria break down dead algae, using up dissolved oxygen in the process. Populations of corals, fish, and other organisms decrease because they cannot breathe.

# Coral Reef Ecology: Coral Bleaching—Key Vocabulary

Students: Draw pictures to support your learning of key vocabulary words from the Gizmos Investigation.

| Glossary Term | Definition | Picture |
|---|---|---|
| Corals<br><br>(“***kor***-*uhls*”) | **Corals** are tiny animals with hard exoskeletons (outsides) that live in the ocean and form large structures called *reefs*. | |
| Algae<br><br>(“***al***-*jee*”) | **Algae** are tiny plant-like organisms that get energy from sunlight through photosynthesis. | |
| Symbiotic relationship<br><br>(“***sim***-*bee*-***ah***-*tik ree*-***lay***-*shuhn*-*ship*”) | A **symbiotic relationship** is when organisms of two different species live together in a close relationship, and at least one organism benefits (is helped). | |
| Biotic factors<br><br>(“*bahy*-***ah***-*tik* ***fact***-*ors*”) | **Biotic factors** are the living parts of an ecosystem. | |
| Abiotic factors<br><br>(“*ey*-*bahy*-***ah***-*tik* ***fact***-*ors*”) | **Abiotic factors** are the nonliving parts of an ecosystem. | |

| | | |
|---|---|---|
| pH scale | The **pH scale** ranges from 1 to 14 and measures how acidic or alkaline (basic) a substance is. Lower numbers indicate a strong acid; higher numbers indicate a strong base; a pH of 7 indicates a neutral substance. | |
| Coral bleaching<br><br>(“***kor****-uhl* ***blee****-ching*”) | **Coral bleaching** happens when corals become stressed by environmental changes, and they expel (get rid of) their symbiotic algae. | |
| Algae bloom<br><br>(“***al****-jee* ***bloom***”) | An **algae bloom** happens when a population of algae suddenly overgrows, leading to low oxygen levels in the water. | |

# Coral Reef Ecology: Coral Bleaching—Usage Guide

This guide provides recommendations for using the *Coral Reef Ecology: Coral Bleaching* Investigation in your classroom and offers general information about Gizmos Investigations for new users.

In this Investigation, students manipulate an ecosystem model and analyze data to determine how changes in storm severity, ocean temperature, and pH affect coral reef populations over time. They use evidence from their investigations to construct scientific arguments about the effects of these abiotic factors on coral populations.

This standalone lesson is designed to be completed in one class period.

## Series vs. Standalone Lessons

Our lesson platform offers both **series** and **standalone** lessons to support flexible use in a variety of classroom contexts. Teachers can choose to implement an entire sequence of lessons or use a single lesson independently, depending on instructional goals, student readiness, and available time.

### Series Lessons

- Designed to be taught in a specific order, with each lesson building on the ideas, models, and evidence from previous lessons.
- Students revisit and revise models, refine explanations, and apply their learning to new scenarios over time.
- Encourage deeper understanding of disciplinary core ideas, crosscutting concepts, and science and engineering practices through a coherent storyline.
- Ideal for comprehensive instruction, sustained engagement, and performance-based assessments.

### Standalone Lessons

- Fully self-contained and can be used independently from other lessons in the series.
- Include necessary background or recap content to ensure all students can engage meaningfully, even without completing prior lessons.
- Useful for targeted instruction, intervention, enrichment, or aligning to specific standards or pacing needs.
- Designed to deliver meaningful learning outcomes in a single class or unit without requiring prior knowledge from other lessons.

### Recommendation

Use **series lessons** when you want students to explore a phenomenon over time, develop and revise models, and connect concepts across multiple lessons. Use a **standalone lesson** when you're focusing on a specific concept, skill, or standard—or when time constraints require a more flexible instructional approach.

## Teacher Preview Version

We highly recommend that teachers complete a preview version of an Investigation before assigning it to their class. In the teacher version, each page functions as it would for your students, so you can preview feedback, scaffolding, and other support tools. You can use this version to familiarize yourself with the activities that students will complete. You can also use it to review concepts with your class by presenting them via a projector or smartboard.

## Heatmap

The heatmap is a tool available for all Investigations that allows teachers to observe their students' current thinking and monitor student progress in real time. It can also be used to determine what additional support students might need in the content and practices involved, individually or as a class.

Some questions are automatically graded and instantly populate the heatmap with a score and color, while others are categorized as "teacher graded." These questions require a teacher to grade a student's response for points to be awarded. All teacher-graded questions are provided with rubrics to support grading.

### Prior Knowledge

Throughout the Investigation, students are encouraged to share their current thinking and preconceptions to help relate new information they explore to their prior knowledge and experiences. These questions are shown on the heatmap with a purple lightbulb and labeled as "Conversational Questions."

### Formative Assessment

Students are assessed on their learning by answering questions and receiving feedback as they progress through the Investigation. Students can check their understanding and receive targeted feedback when answering questions to discover if they have a misunderstanding. Students receive three tries on a formative question, listed to the left of the submit button.

Formative questions are color-coded within the heatmap to help teachers best support students. Detailed "scoring criteria" within the question view explains how colors were assigned for the heatmap question. The heatmap color codes are based on colors distributed across three percentage categories:

| Mastered | Developing | Below Expectations |
|---|---|---|
| 75–100% | 50–75% | 0–50% |

### Summative Assessment

Additionally, some questions within the Investigation are labeled as summative. These questions reflect moments where students have had ample opportunity to practice their understanding of a concept or skill and are thus assigned points after a single attempt to judge their current knowledge. These questions are color-coded in the heatmap using the same percentages described above. The only difference here is that students are only given one attempt to answer a summative question. Summative question point values are the only points included in the total on the heatmap. Teachers can use these question types to assess students' knowledge or skills to better support learning in their classroom.

While rubrics are provided for teachers to score free-response summative questions, we recommend considering your own understanding of student abilities when assigning points.

## Student Support and Accessibility

Investigations include the following supports to help students further their learning.

### Vocabulary Support

- The Key Vocabulary handout provides definitions and phonetic pronunciation for all key vocabulary terms used in the Investigation. The handout also includes space for students to draw pictures to help them learn these terms.
- Teachers can preview vocabulary using the handout to help support students before starting the Investigation.

### Writing Support

- Where applicable, sentence stems are provided for open-response questions to help students structure their writing.
- For some open-response questions, key vocabulary terms are automatically highlighted in green when included in student responses. This helps reinforce student vocabulary usage.
- Validation feedback is triggered for open-response questions when students submit vague answers or skip important vocabulary. This feedback guides students toward complete and meaningful responses. There is a checkbox at the bottom of this type of feedback so that students can move forward if they choose without getting stuck.