Ocean Today

Education/Climate Deep Dive

With

Kurt Mann - Executive Producer Ocean Today

Bekkah Lampe - Education Outreach Specialist

Bruce Moravchik - Ocean Service Education Coordinator

Frank Niepold - Climate Education Coordinator

What is Ocean Today?

Kurt Mann - Executive Producer Ocean Today


THE GLOBAL OCEAN
IS CONSTANTLY
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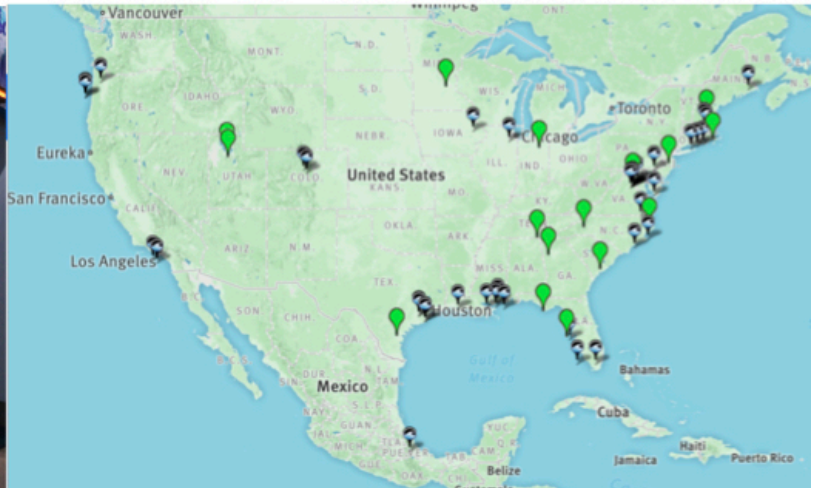
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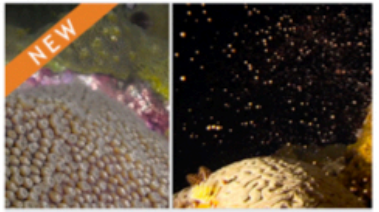
Marine Life

Life in the ocean is amazing! Cute and cuddly, creepy crawly, gigantic and microscopic - marine life comes in millions of shapes and size.

Danger Zone | Exploration | Fix the Ocean | Go Fish | Marine Life | Research | Collections



Coral Spawning

Horseshoe Crab Spawning - A Field Report

Bioluminescent Ocean

Bioluminescence

Endangered Ocean: Smalltooth Sawfish

Endangered Ocean: Manatees

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Fix the Ocean

The health of the ocean is in danger. Conservation planning and restoration projects are making a difference.

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Maritime Forests

TRASH TALK: Special Feature

TRASH TALK: What is Marine Debris?

TRASH TALK: Where Does Marine Debris Come From?

TRASH TALK: Impacts of Marine Debris

TRASH TALK: Why Is Plastic Marine Debris So Common?

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Research

Questions and answers about how we study the ocean and what we've learned.

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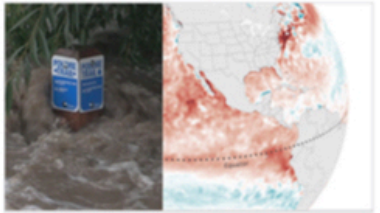
Climate Alive
2019: Second Warmest on Record

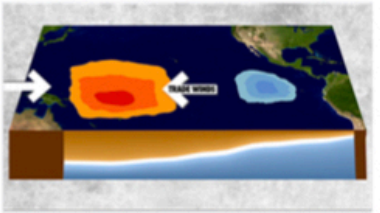
Old Weather

Mapping Goes Micro

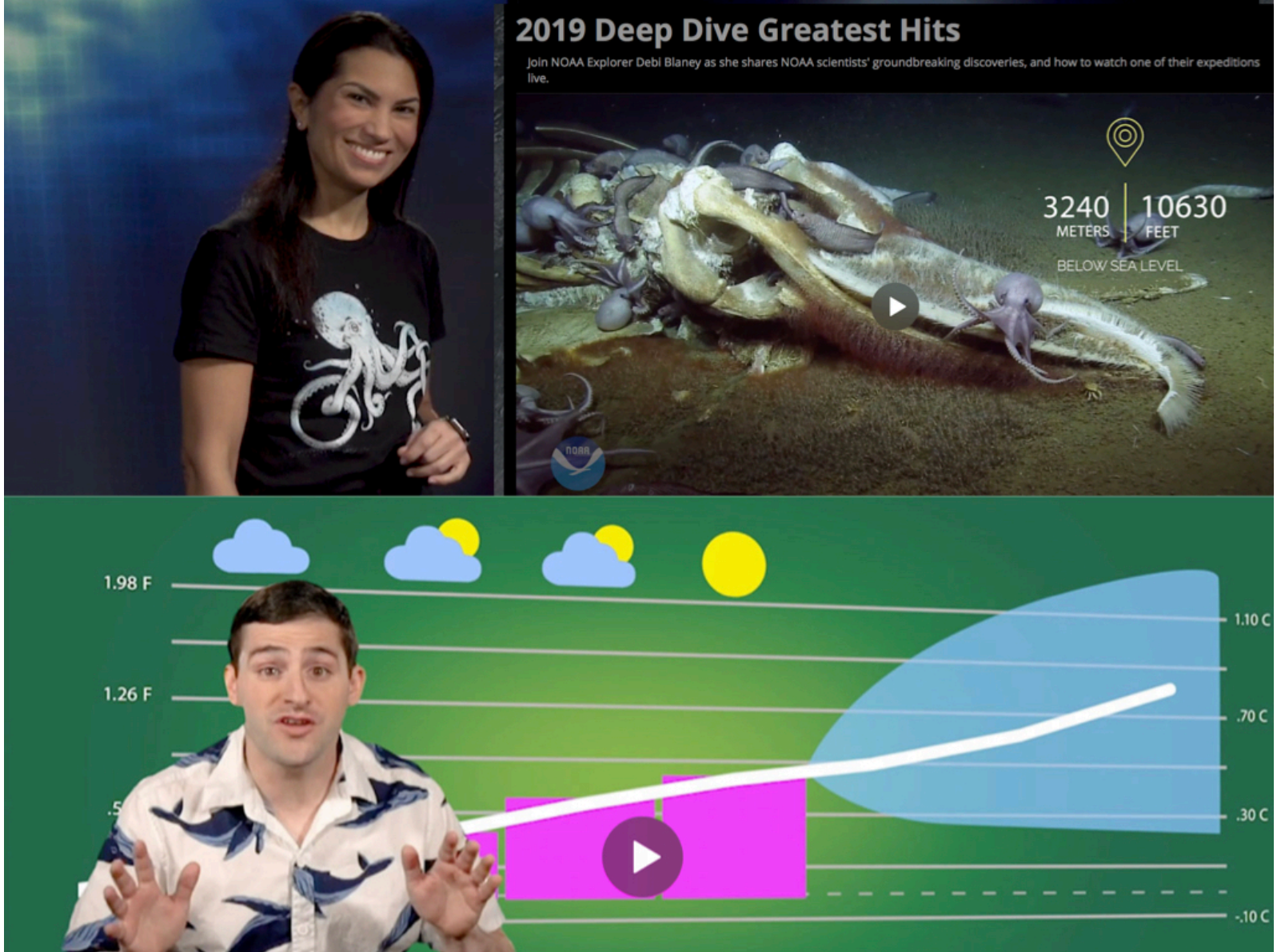
Life at Sea



Observing El Niño



El Niño and La Niña Explained


2019 Deep Dive Greatest Hits
Join NOAA Explorer Debi Blaney as she shares NOAA scientists' groundbreaking discoveries, and how to watch one of their expeditions live.
3240
METERS
10630
FEET
BELOW SEA LEVEL
1.98 F
1.26 F
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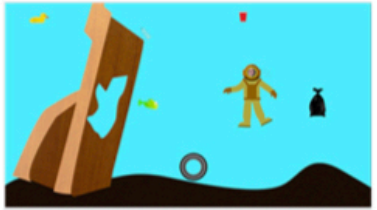
The health of the ocean is in danger. Conservation planning and restoration projects are making a difference.

Maritime Forests

TRASH TALK: Special Feature

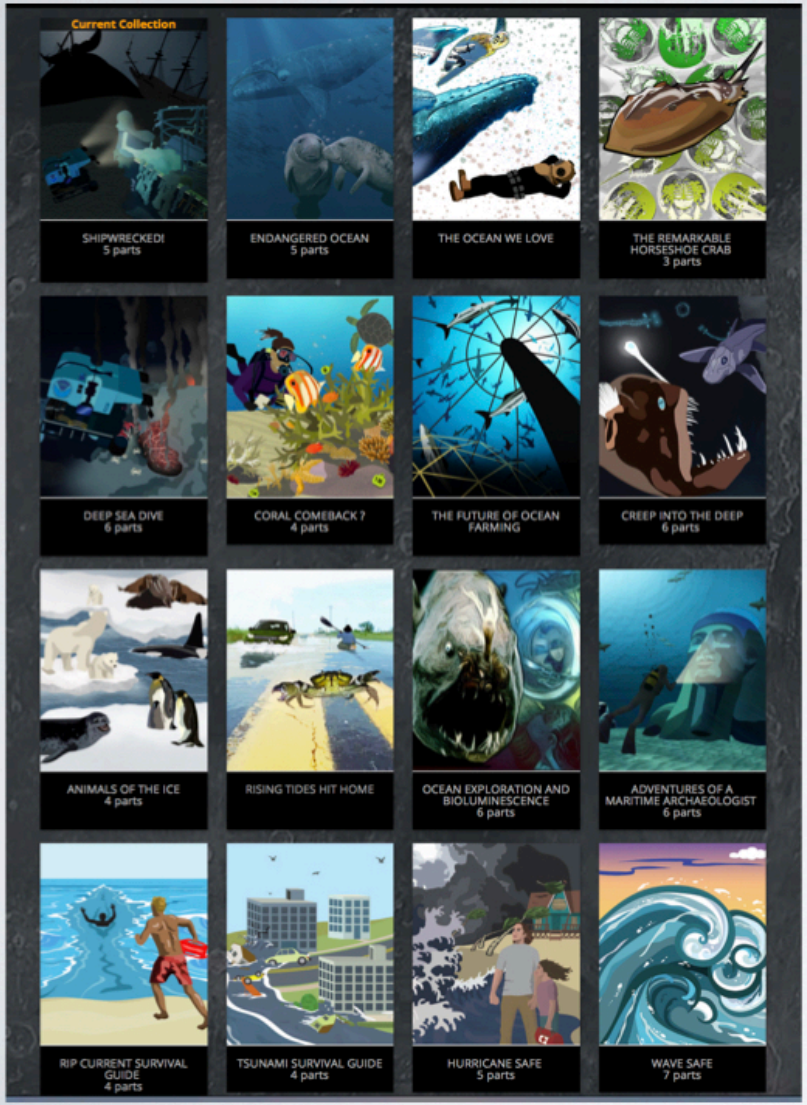


TRASH TALK: What is Marine Debris?

TRASH TALK: Where Does Marine Debris Come From?

TRASH TALK: Impacts of Marine Debris

TRASH TALK: Why Is Plastic Marine Debris So Common?



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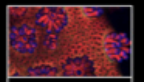
LET'S GET STARTED WITH SYMONE


CELEBRATE THE OCEAN


KNOW YOUR OCEAN


SCHOOL OF FISH


TRASH TALK - EMMY AWARD WINNING SPECIAL FEATURE


CORAL COMEBACK? - SUPER CORALS

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Links

NOAA Marine Debris Program

Types and Sources of Marine Debris

Fast Facts

Marine debris is defined as any persistent solid material that is

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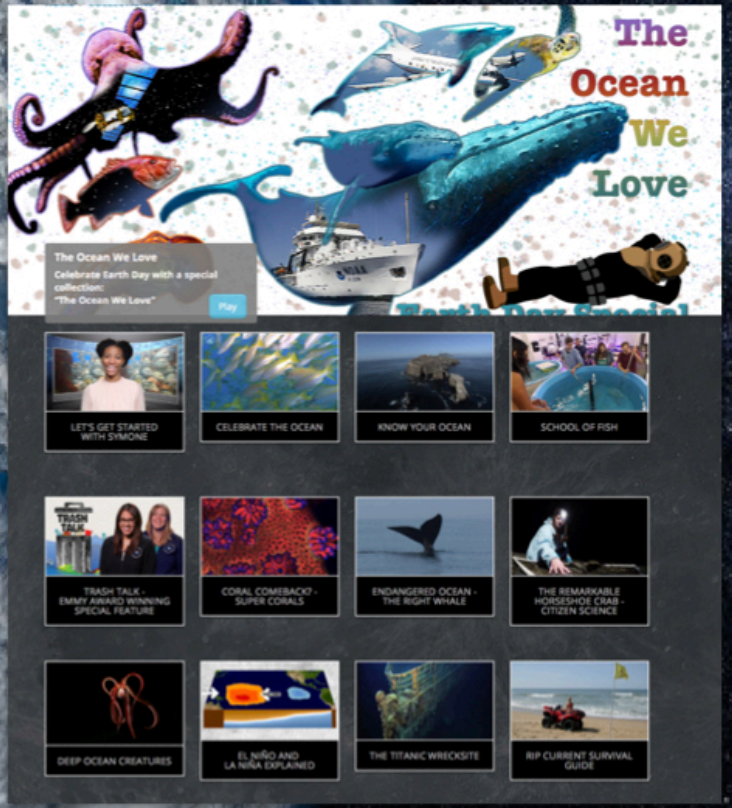
EVERY FULL MOON



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A supplemental resource for educators

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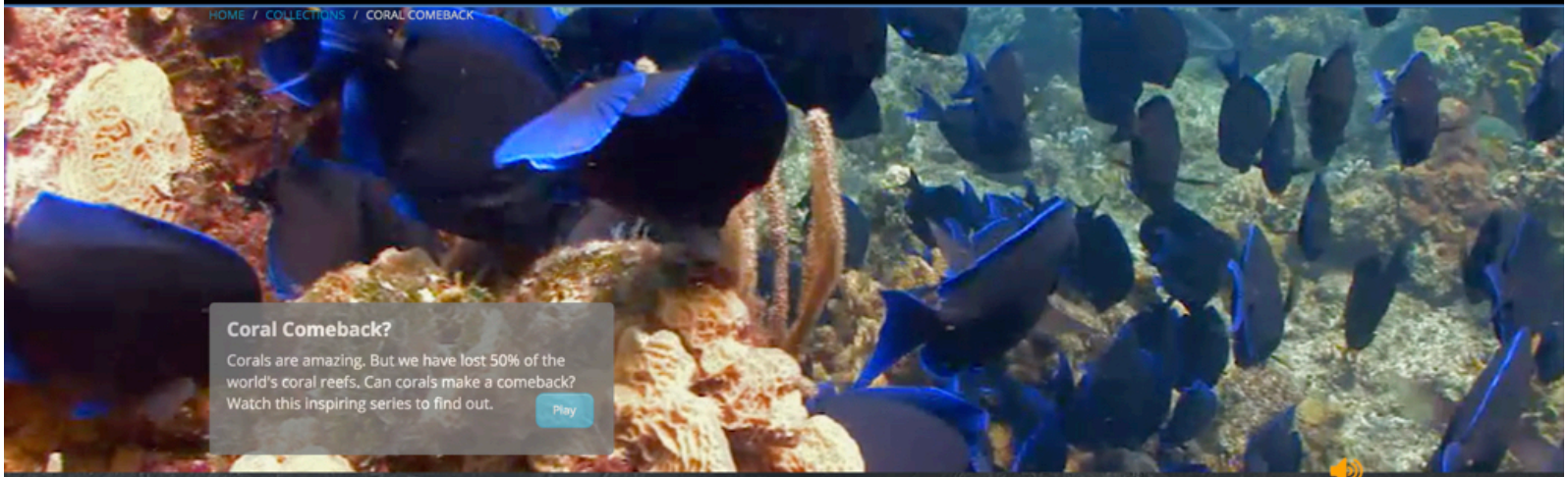


Coral Comeback?

Corals are amazing. But we have lost 50% of the world's coral reefs. Can corals make a comeback? Watch this inspiring series to find out.

Play

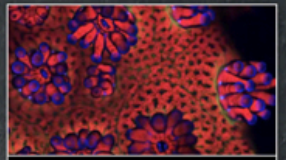
CORAL COMEBACK?
(INTRODUCTION)

RAINFORESTS OF THE SEA
(PART 1)

THE CORAL AND THE ALGAE
(PART 2)

CORALS UNDER THREAT
(PART 3)

WHAT CAN WE DO?
(PART 4)



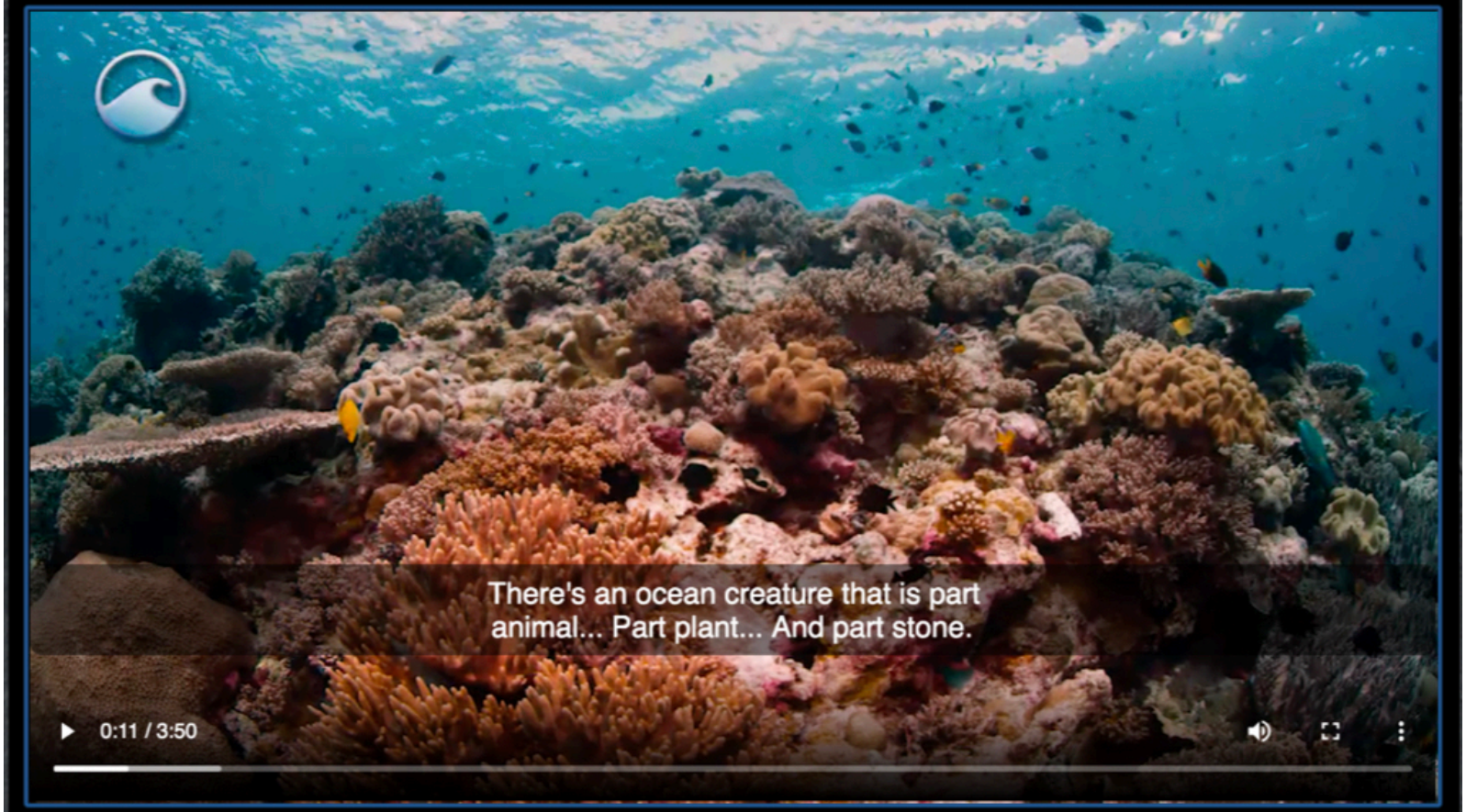
The Science of Super Corals
(PART 5)

THE ACID TEST
(BONUS 1)

RESTORING CORAL REEFS
(BONUS 2)

Rainforests of the Sea

Coral reefs are some of the most precious habitat in the ocean - which has earned them the nickname "rainforests of the sea." They're a complicated ecosystem where thousands of species are supported by some of the smallest of all - corals.



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The Coral and the Algae

In one way of thinking, corals are part animal, vegetable, and mineral. How is that possible?

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Corals Under Threat

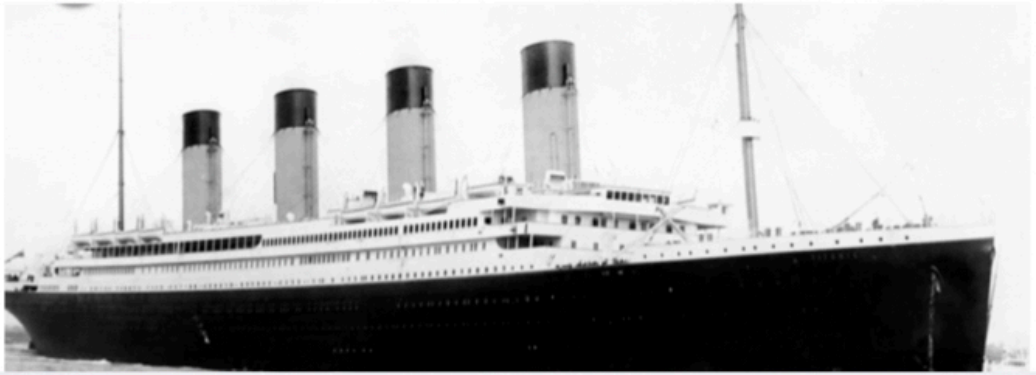
The growth of our civilization is changing the ocean in ways that are deadly for corals. If we don't act soon, it may be too late.

What can we do?

Learn about some of the bold and brilliant ideas researchers and conservationists have to rescue corals and coral reefs from disaster.

OCEAN TODAY

SHIPWRECKED! - Full Moon Video Collection



MONTHLY NEWSLETTER

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Bekkah Lampe - Education Outreach Specialist

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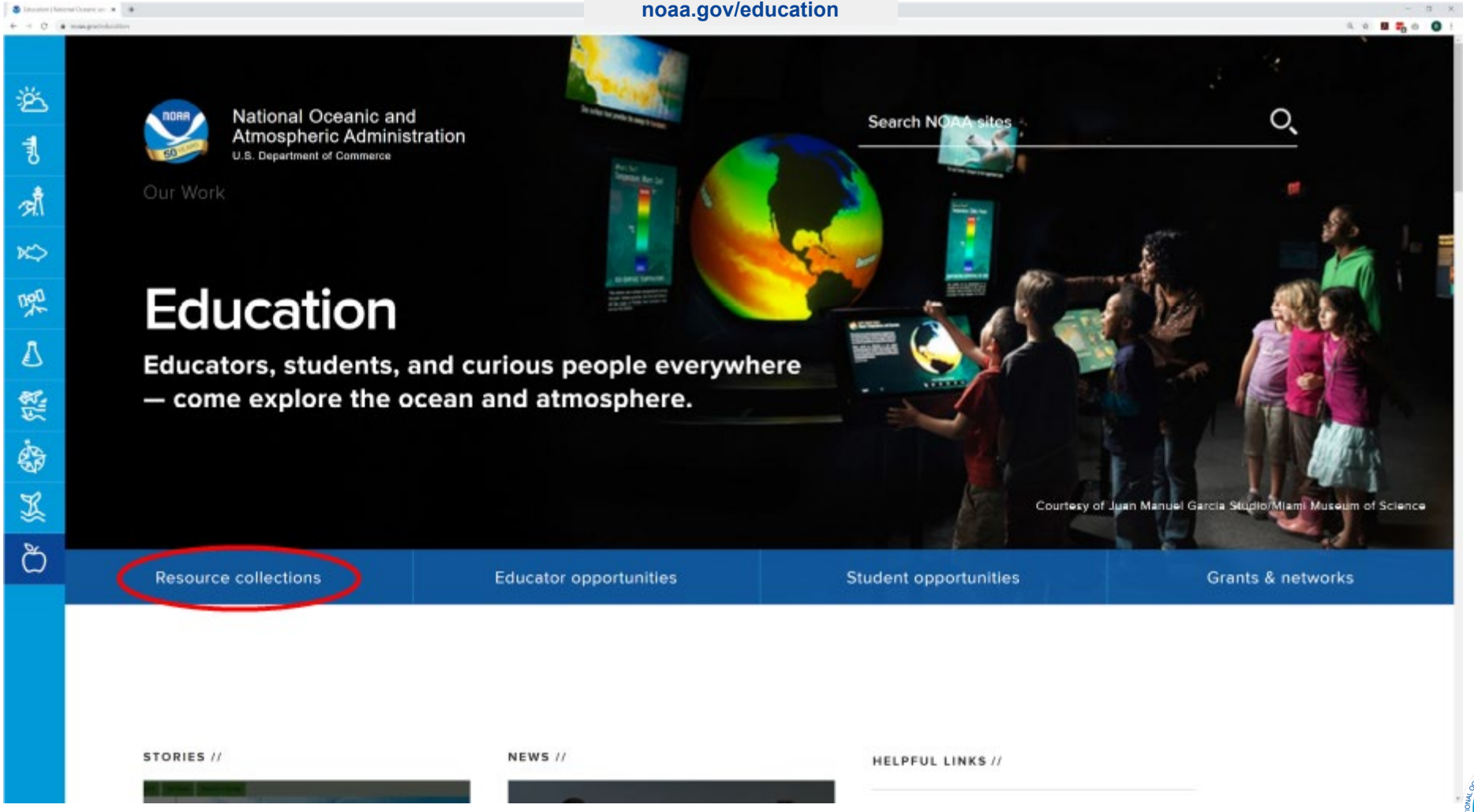

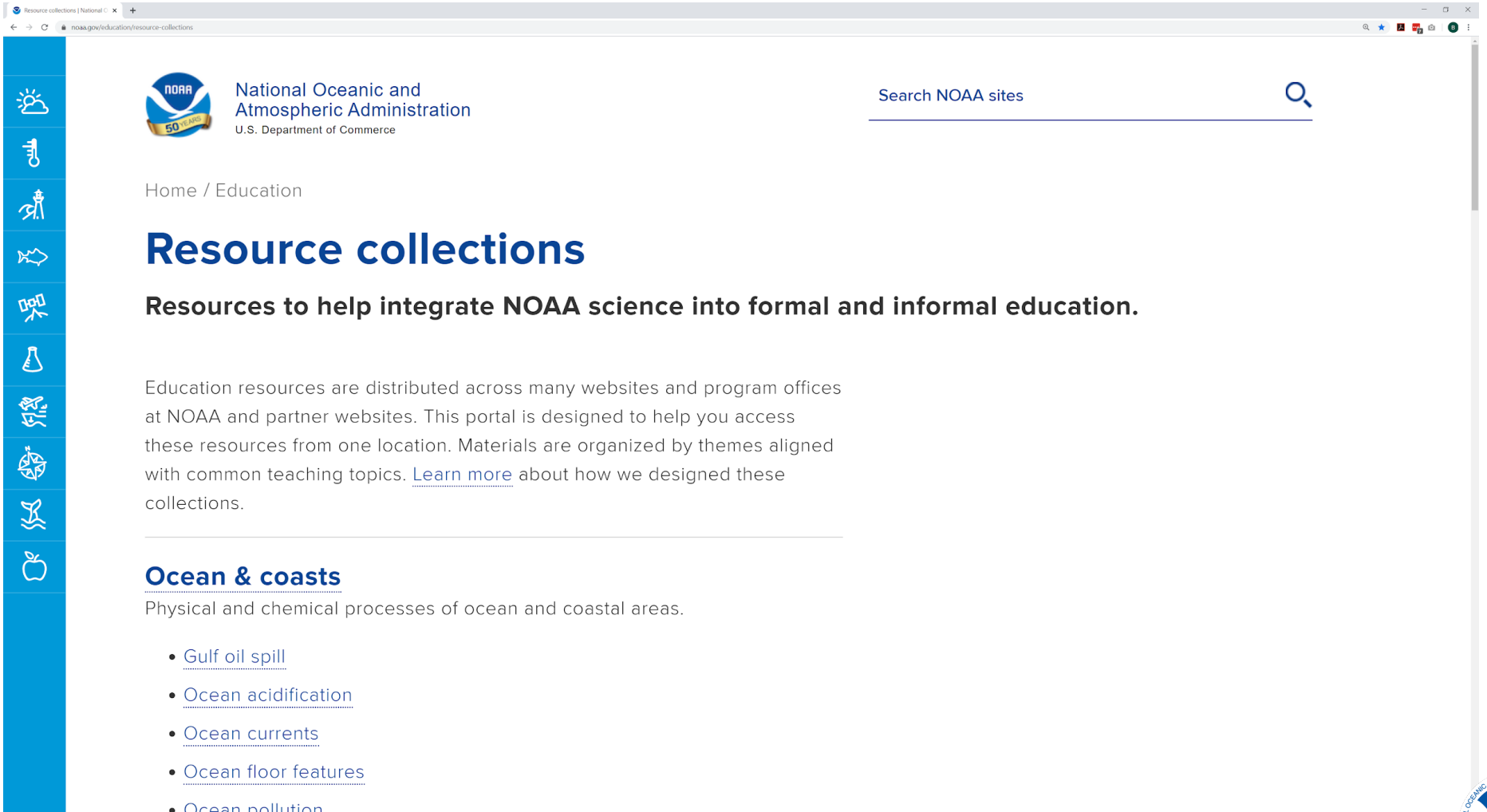
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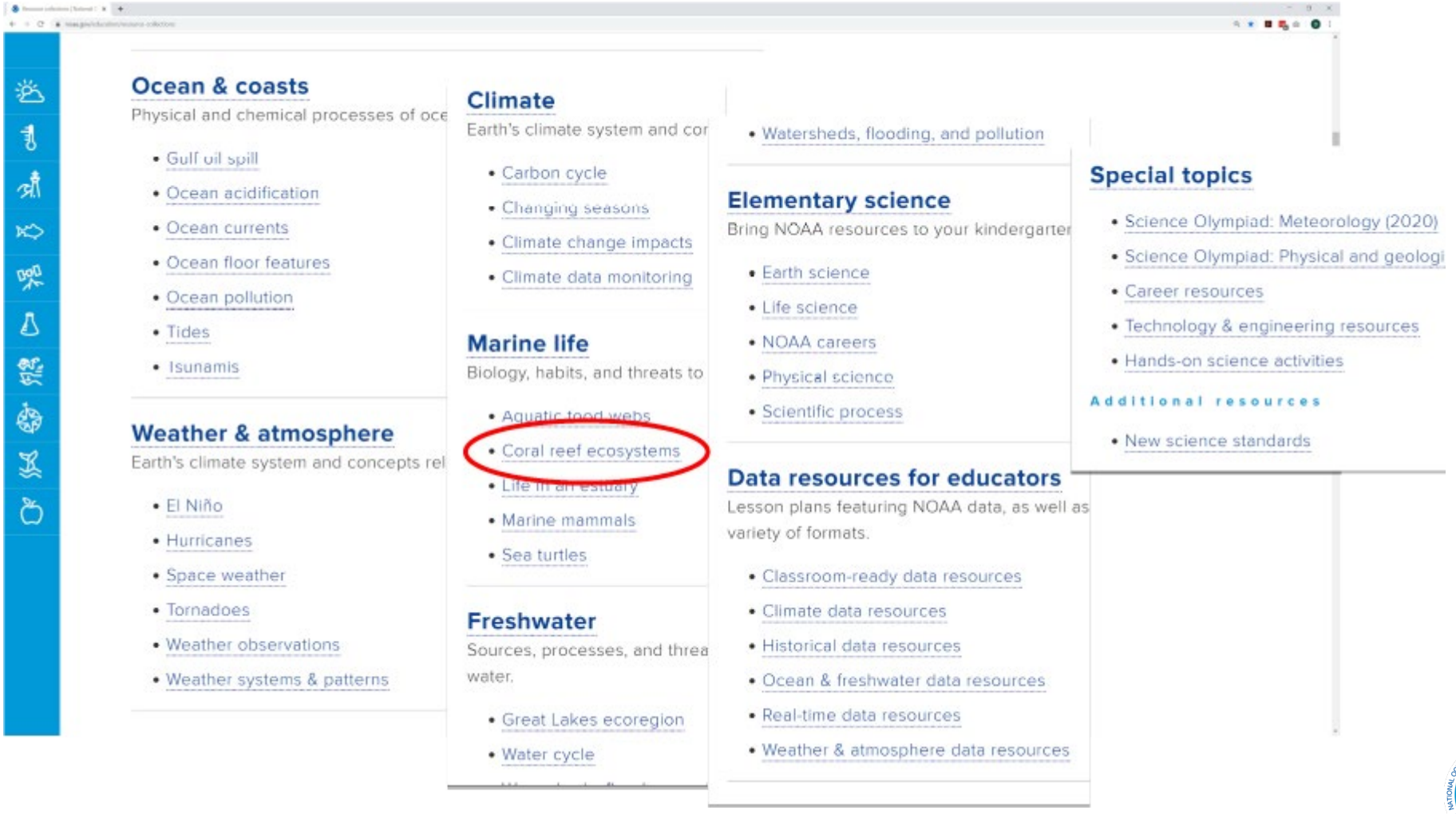
Resource collections
Resources to help integrate NOAA science into formal and informal education.
Education resources are distributed across many websites and program offices at NOAA and partner websites. This portal is designed to help you access these resources from one location. Materials are organized by themes aligned with common teaching topics. Learn more about how we designed these collections.
Ocean & coasts
Physical and chemical processes of ocean and coastal areas.
Gulf oil spill
Ocean acidification
Ocean currents
Ocean floor features
Ocean pollution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• Ocean acidification
• Ocean currents
• Ocean floor features
• Ocean pollution
• Tides
• Tsunamis
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• El Niño
• Hurricanes
• Space weather
• Tornadoes
• Weather observations
• Weather systems & patterns
Climate
Earth's climate system and cor
• Carbon cycle
• Changing seasons
• Climate change impacts
• Climate data monitoring
Marine life
Biology, habits, and threats to
• Aquatic food webs
• Coral reef ecosystems
• Life in an estuary
• Marine mammals
• Sea turtles
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• Hands-on science activities
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Coral reef ecosystems

Education | coral coral reefs education marine life

SHARE

Coral reefs are some of the most diverse ecosystems in the world. Coral polyps, the animals primarily responsible for building reefs, can take many forms: large reef building colonies, graceful flowing fans, and even small, solitary organisms. Thousands of species of corals have been discovered; some live in warm, shallow, tropical seas and others in the cold, dark depths of the ocean.

Coral reef diversity

Because of the diversity of life found in the habitats created by corals, reefs are often called the "rainforests of the sea." About 25% of the ocean's fish depend on healthy coral reefs. Fishes and other organisms shelter, find food, reproduce, and rear their young in the many nooks and crannies formed by corals. The Northwest Hawaiian Island coral reefs, which are part of the Papahānaumokuākea National Marine Monument, provide an example of the diversity of life associated with shallow-water reef ecosystems. This area supports more than 7,000 species of fishes, invertebrates, plants, sea turtles, birds, and marine mammals. Deep water reefs or mounds are less well known, but also support a wide array of sea life in a comparatively barren world.

NOAA launches 'Mission: Iconic Reefs' to save Florida Keys coral reefs

By restoring corals at seven iconic reef sites in Florida Keys National Marine Sanctuary, we can change the trajectory of an entire ecosystem and help save one of the world's most unique areas for future generations.

Read more ›

LESSON PLANS & ACTIVITIES

- Data in the Classroom: Coral bleaching ›
- EarthLab: Corals unit
- A reef of your own (HS) ›
- Coral cores: Ocean timelines (ES, MS, HS) ›
- Coral reef coloring book
- Deep coral communities curriculum ›
- Broadcast spawning activity ›
- Flower Garden Banks National Marine Sanctuary curriculum (ES, MS, HS) ›
- Remote sensing and coral reefs curriculum (ES, MS) ›

Coral characteristics

Shallow water, reef-building corals have a symbiotic relationship with photosynthetic algae called zooxanthellae, which live in their tissues. The coral provides a protected environment and the compounds zooxanthellae need for photosynthesis. In return, the algae produce carbohydrates that the coral uses for food, as well as oxygen. The algae also help the coral remove waste. Since both partners benefit from association, this type of symbiosis is called mutualism.

Deep-sea corals live in much deeper or colder oceanic waters and lack zooxanthellae. Unlike their shallow water relatives, which rely heavily on photosynthesis to produce food, deep sea corals take in plankton and organic matter for much of their energy needs.

Benefits of coral reef ecosystems

Coral reefs protect coastlines from storms and erosion, provide jobs for local communities, and offer opportunities for recreation. They are also are a source of food and new medicines. Over half a billion people depend on reefs for food, income, and protection. Fishing, diving, and snorkeling on and near reefs add hundreds of millions of dollars to local businesses. The net economic value of the world's coral reefs is estimated to be nearly tens of billions of U.S. dollars per year. These ecosystems are culturally important to indigenous people around the world.

MULTIMEDIA

- Ocean Today: Coral comeback (video collection) ›
- 3D-printed model brings coral education to life ›
- Coral spawning at Flower Garden Banks (videos) ›
- Marine life media library (photos) ›
- Deep sea corals (data, photos, technical reports) ›
- Restoring coral reefs (video) ›
- Coral reefs in hot water (SOS dataset) ›
- Coral forests of the deep (video) ›
- Coral reef economy (video) ›

DATA RESOURCES

- Coral reef satellite monitoring ›

Threats to coral reef ecosystems

Unfortunately, coral reef ecosystems are severely threatened. Some threats are natural, such as diseases, predators, and storms. Other threats are caused by people, including pollution, sedimentation, unsustainable fishing practices, and climate change, which is raising ocean temperatures and causing ocean acidification. Many of these threats can stress corals, leading to coral bleaching and possible death, while others cause physical damage to these delicate ecosystems. During the 2014-2017 coral bleaching event, unusually warm waters (partially associated with a strong El Niño) affected 70% of coral reef ecosystems worldwide. Some areas were hit particularly hard, like the Great Barrier Reef in Australia, where hundreds of miles of coral were bleached.

Corals are able to recover from bleaching events if conditions improve before they die, though it can take many years for the ecosystems to fully heal. Scientists are also testing new ways to help coral reef ecosystems, such as growing coral in a nursery and then transplanting it to damaged areas.

NOAA develops a new type of coral nursery

The nursery could help restore damaged reefs using fully formed coral colonies rather than small fragments.

Read more ›

About corals ›

Coral Reef Conservation Program ›

Coral bleaching basics ›

Smithsonian Ocean Portal-Corals

CAREER RESOURCES

Marine biologist career information ›

Amy Baco-Taylor: Deep Sea Biologist ›

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New study suggests coral reefs may be able to adapt to moderate climate change (2013) ›

Picture climate: How can we learn from corals? ›

MORE COLLECTIONS //

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- Coral reefs in hot water (SOS dataset) >
- Coral forests of the deep (video) >
- Coral reef economy (video) >

DATA RESOURCES

- Coral reef satellite monitoring >
- Coral bleaching data >
- Coral Reef Watch virtual station >
- Data in the Classroom: Coral bleaching >

BACKGROUND INFORMATION

- About corals >
- Coral Reef Conservation Program >
- Coral bleaching basics >
- Smithsonian Ocean Portal-Corals

CAREER RESOURCES

- Marine biologist career information >
- Amy Baco-Taylor: Deep Sea Biologist >

RELATED STORIES

- New study suggests coral reefs may be able to adapt to moderate climate change (2013) >
- Picture climate: How can we learn from corals? >

3D Printed Model Brings Coral Education to Life

This 3D coral polyp model shows a cross section of a single polyp, including its tentacles, gastrodermis, stomach cavity, and the complex skeletal structure underneath. It is a generic representation and not a replica of any particular species. Each half has interlocking pegs that allow a full polyp to be assembled.

Use a dual-spool 3D printer, if available, with white filament for the base (skeletal structure) and thermo-sensitive filament for the top polyp portion. For the best effect, use a filament that turns from color to white. When exposed to warm water, the polyp will then mimic the loss of its symbiotic zooxanthellae algae within and turn white. When the material cools down a few seconds later, the original color returns, signaling the restart of its symbiont algae and the return of the coral to a healthy state.

In addition, small pieces of material can be "fed" to the coral polyp through its "mouth" to symbolize the coral feeding in plankton.

3D Coral Polyp Model:

Coral Polyp Top (3 MB)

Coral Polyp Base (13 MB)

3D Print Specifications: The model file has two separate components—the polyp body and the skeletal base structure, which can be printed using two different filament materials (if available). The suggested 3D printer settings are

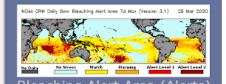
- Model printed at 50% scale (ideal)
- Layer height: 0.1 mm
- Infill: 20%
- Perimeter:
  - Base: 1.2 mm
  - Polyp tentacle tips: 2 mm
- Supports: off
- Print speed: 60mm/s

Watch the coral model change color from heat stress. When exposed to warm water, the polyp will mimic the loss of its symbiotic zooxanthellae algae within and turn white. This animated GIF is available in large or small files.

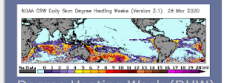
Education Video

Watch this video for a short demonstration of how the finished 3D coral polyp works, including brief introductions to basic coral biology and bleaching and how the model can be used to teach about coral bleaching and for general outreach purposes.

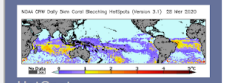
Coral Reef Watch Home
About Us
Products Overview
Near-Real-Time Data
(5km Resolution)



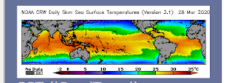
Bleaching Alert Area (Alerts)



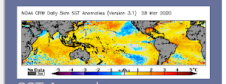
Degree Heating Week (DHW)



HotSpot



SST ('CoralTemp')



SST Anomaly

Coral Reef Watch Satellite Monitoring and Modeled Outlooks

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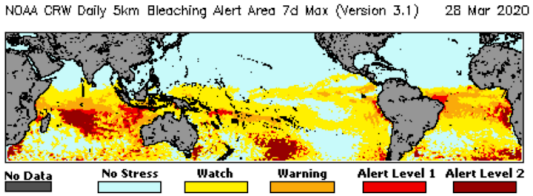
5km data
5km composite products
Outlook



CO2 ↑409.95

Alerts | DHW | HotSpot | SST ('CoralTemp') | Anomaly | SST Trend | Virtual Stations

2020 Update: Coral Bleaching Heat Stress on the Great Barrier Reef

Current ENSO Conditions and Forecasts

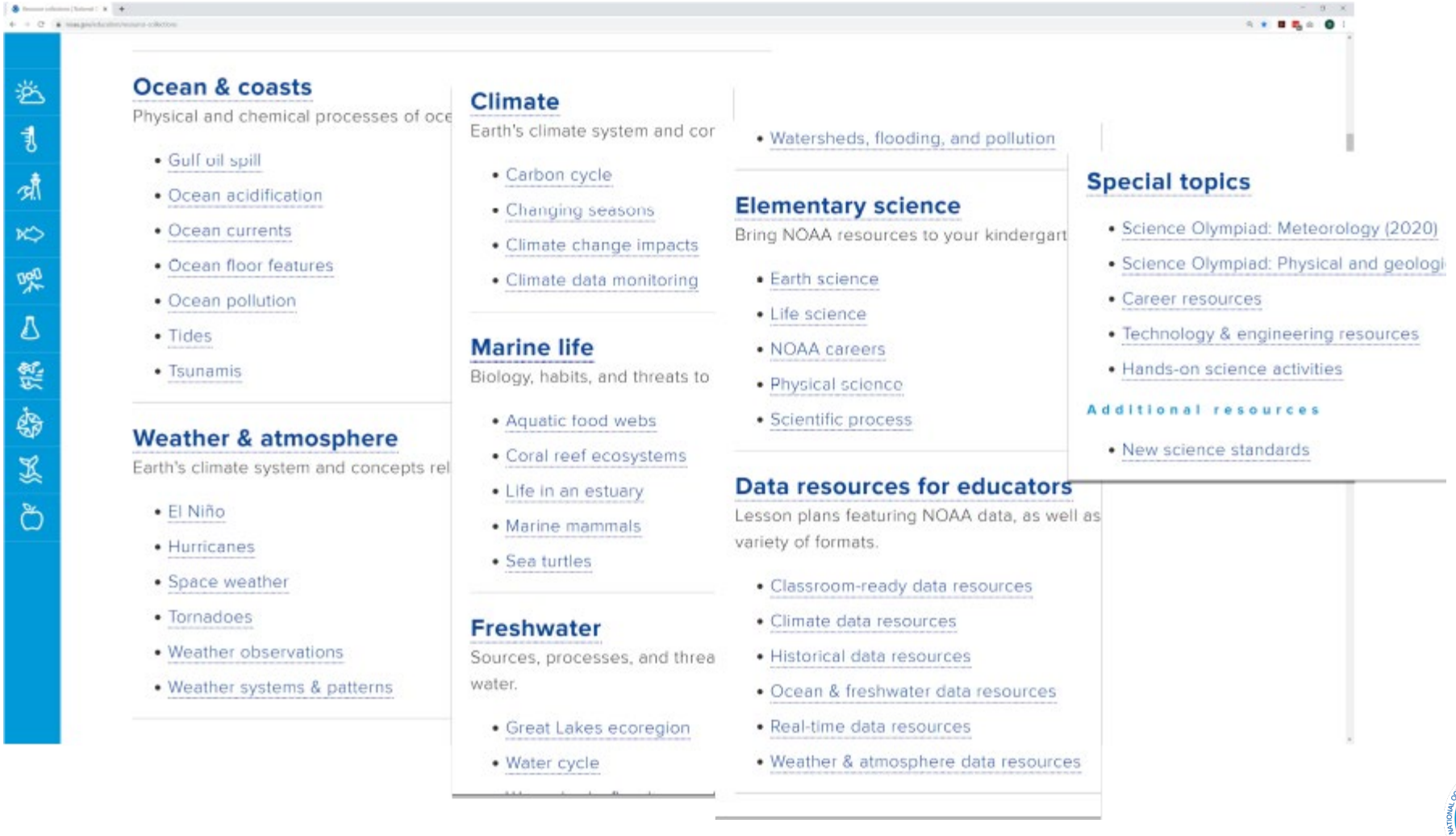
NOAA Coral Reef Watch is celebrating its 20th Anniversary (2000-2020)!

Coral reefs are one of Earth's most diverse ecosystems. They provide significant ecological, economic, and societal benefits valued, globally, at about USD$9.8 trillion each year (de Groot *et al.* 2012, Costanza *et al.* 2014). Unfortunately, reefs worldwide are threatened by an increasing array of impacts, primarily from global climate change, unsustainable fishing practices, and land-based pollution. First documented in the early 1980s, mass coral bleaching has become one of the most visible marine ecological

Announcements

from, but can cause and/or be more detrimental than coral bleaching events. For more information, click here, or visit the NOAA Coral Reef Information System's publication feature page.

July 1, 2019:
NOAA Coral Reef Watch releases its Version 3.1



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- Ocean currents
- Ocean floor features
- Ocean pollution
- Tides
- Tsunamis

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Earth's climate system and concepts rel

- El Niño
- Hurricanes
- Space weather
- Tornadoes
- Weather observations
- Weather systems & patterns

Climate

Earth's climate system and cor

- Carbon cycle
- Changing seasons
- Climate change impacts
- Climate data monitoring

Marine life

Biology, habits, and threats to

- Aquatic food webs
- Coral reef ecosystems
- Life in an estuary
- Marine mammals
- Sea turtles

Freshwater

Sources, processes, and threa water.

- Great Lakes ecoregion
- Water cycle

- Watersheds, flooding, and pollution

Elementary science

Bring NOAA resources to your kindergart

- Earth science
- Life science
- NOAA careers
- Physical science
- Scientific process

Data resources for educators

Lesson plans featuring NOAA data, as well as variety of formats.

- Classroom-ready data resources
- Climate data resources
- Historical data resources
- Ocean & freshwater data resources
- Real-time data resources
- Weather & atmosphere data resources

Special topics

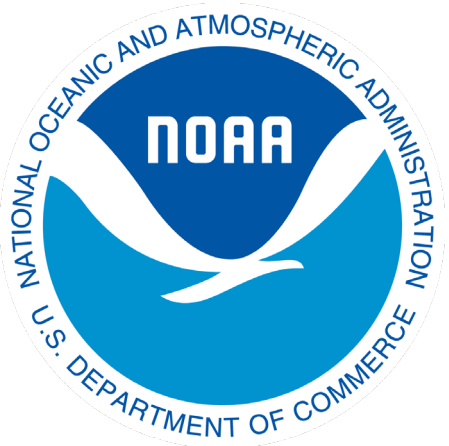
- Science Olympiad: Meteorology (2020)
- Science Olympiad: Physical and geologi
- Career resources
- Technology & engineering resources
- Hands-on science activities

Additional resources

- New science standards

NOAA's Data in the Classroom

Bruce Moravchik - Ocean Service Education Coordinator



National Ocean Service

National Environmental Satellite Service

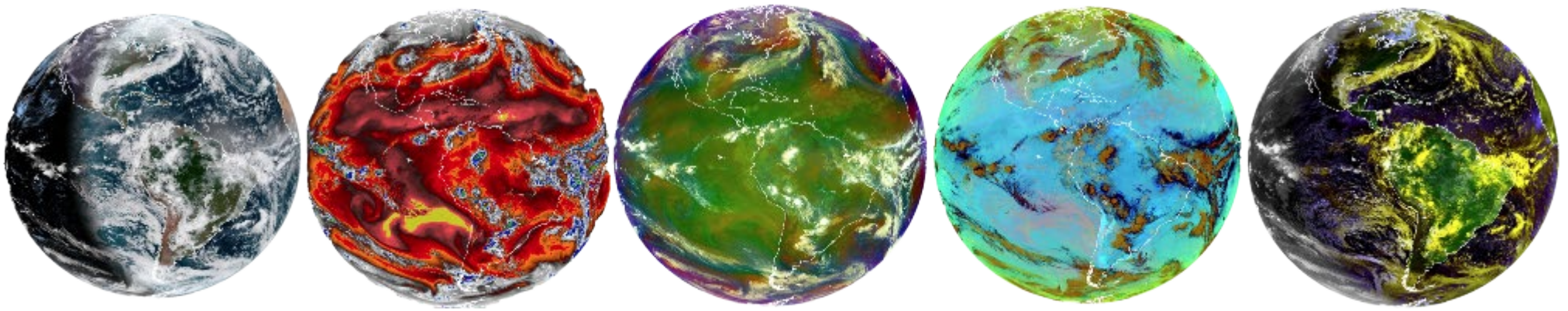
NOAA is Huge!

National Marine Fisheries Service

National Weather Service

Oceanic and Atmospheric Research

NOAA Takes the Pulse of the Planet



- Collects data to solve real-world problems
- Monitors earth, ocean, and coastal ecosystems.
- Does systems modeling for health and safety predictions
- Monitors and models human impacts
- Focuses on future solutions

National Oceanic and Atmospheric Administration

Satellite and Information Service

Data in the Classroom

Home El Nino Sea Level

Put Big Ocean Data to Work in Your Classroom!

With NOAA's Data in the Classroom, students use real-time ocean data to explore today's most pressing environmental issues, and develop problem-solving skills employed by scientists. Access online and classroom-ready curriculum activities with a scaled approach to learning and easy-to-use data exploration tools.

El Niño

People blame El Niño for all kinds of abnormal weather. But how does El Niño really work?

Sea Level

Scientists know that global sea level is rising. But how are water levels monitored and measured to understand impacts?

Coral Bleaching

Coming Soon - new, updated module resources, curriculum and data tools.

Water Quality

Coming Soon - new, updated module resources, curriculum and data tools.

Ocean Acidification

Coming Soon - new, updated module resources, curriculum and data tools.

Teaching Resources

- Teacher's Guide — In Each Module
- Supplemental PowerPoint — Using the Technology
- Student Activity Sheets — Pedagogical Approach
- Science Standards — Community and News

Investigating Coral Bleaching Using Real Data

Performance Expectations

NGSS MS-LS2 Ecosystems: Interactions, Energy, and Dynamics

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.

MS-LS2-4: Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

Common Core ELA-Literacy: Science and Technical Subjects

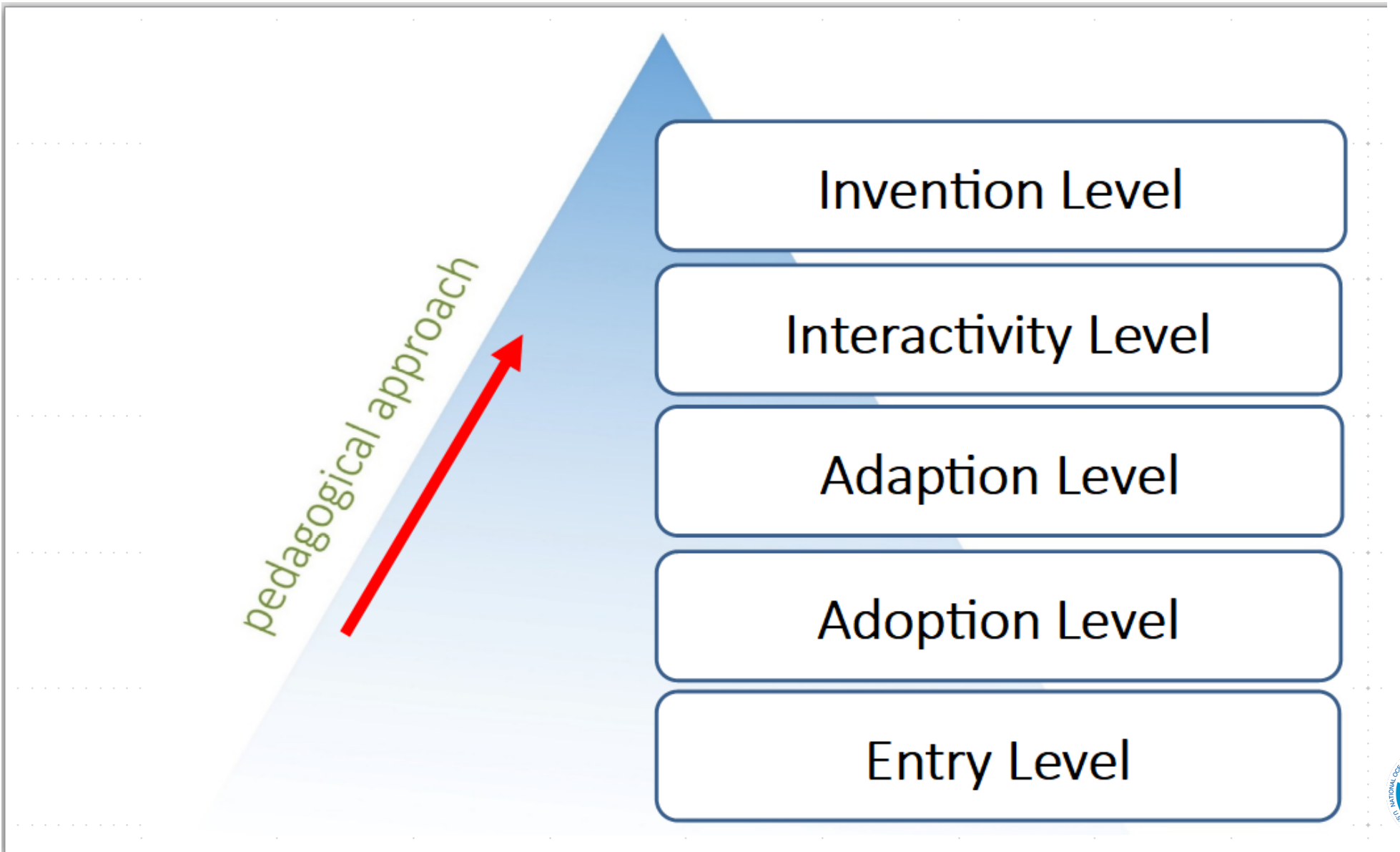
RST.6-8.7: Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). Suggestion: Encourage students to synthesize information from data products generated online into their own representations (e.g. time series, charts comparing two locations, etc.).

Common Core ELA-Literacy: Writing

WHST.6-8.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. Suggestion: Encourage students to document the research process in their own words.

WHST.6-8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. Suggestion: If students are having trouble formulating their own research questions, refer them to model questions used in earlier activities.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and interpreting data: students read and interpret remote sensing data products (Levels 1 & 3); students interpret data from in-situ monitoring simulation (Level 2); students interpret data products generated to investigate a research question (Levels 4 & 5). **Developing and using models:** students engage in role play to model data gathering techniques for in-situ monitoring of corals (Level 2). **Using mathematics and computational thinking:** students develop a working definition of temperature "anomalies, and use a Degree Heating Week calculator to examine the relationship of derived DHW to satellite-collected sea surface temperature data (Level 3). **Constructing explanations and designing solutions:** students develop presentations to communicate findings from their data gathering (Levels 4 & 5). **Engaging in argument from evidence:** students present data in support of a research question (Levels 4 & 5). **Obtaining, evaluating, and communicating information:** students construct query to select and generate remote sensing data products (Levels 1 & 3); students record, evaluate, and report on findings from in-situ monitoring simulation (Level 2); students develop presentations to communicate findings from their data gathering (Levels 4 & 5). **Planning and carrying out investigations:** students design their own investigation using real data to try to answer a research question of their choosing (Level 5).	**LS2.A: Interdependent Relationships in Ecosystems:** students construct models to understand the symbiotic relationship of corals and zooxanthellae (Level 2) . **LS2.C: Ecosystem Dynamics, Functioning, and Resilience:** students examine evidence from in-situ coral monitoring to assess changes in the population over time (Level 2); students examine how temperature anomalies contribute to accumulated thermal stress in corals (Level 3); students generate data products to investigate whether ecosystem changes produce conditions for thermal stress at coral locations (Level 4); students design their own investigation using real data to to examine factors related to thermal stress in coral ecosystems (Level 5).	**Patterns:** Observed patterns of forms and events guide organization and classification, and prompt questions about relationships and the factors that influence them (Levels 1 & 2). **Systems and System Models:** Defining the system under study - specifying its boundaries and making explicit a model of that system - provides tools for understanding and testing ideas that are applicable throughout science and engineering (Level 3). **Scale, Proportion, and Quantity:** In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance (Level 4). **Stability and Change:** For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study (Level 5).


pedagogical approach
Invention Level
Interactivity Level
Adaption Level
Adoption Level
Entry Level

Investigating Coral Bleaching Using Data in the Classroom

NOAA Data in the Classroom

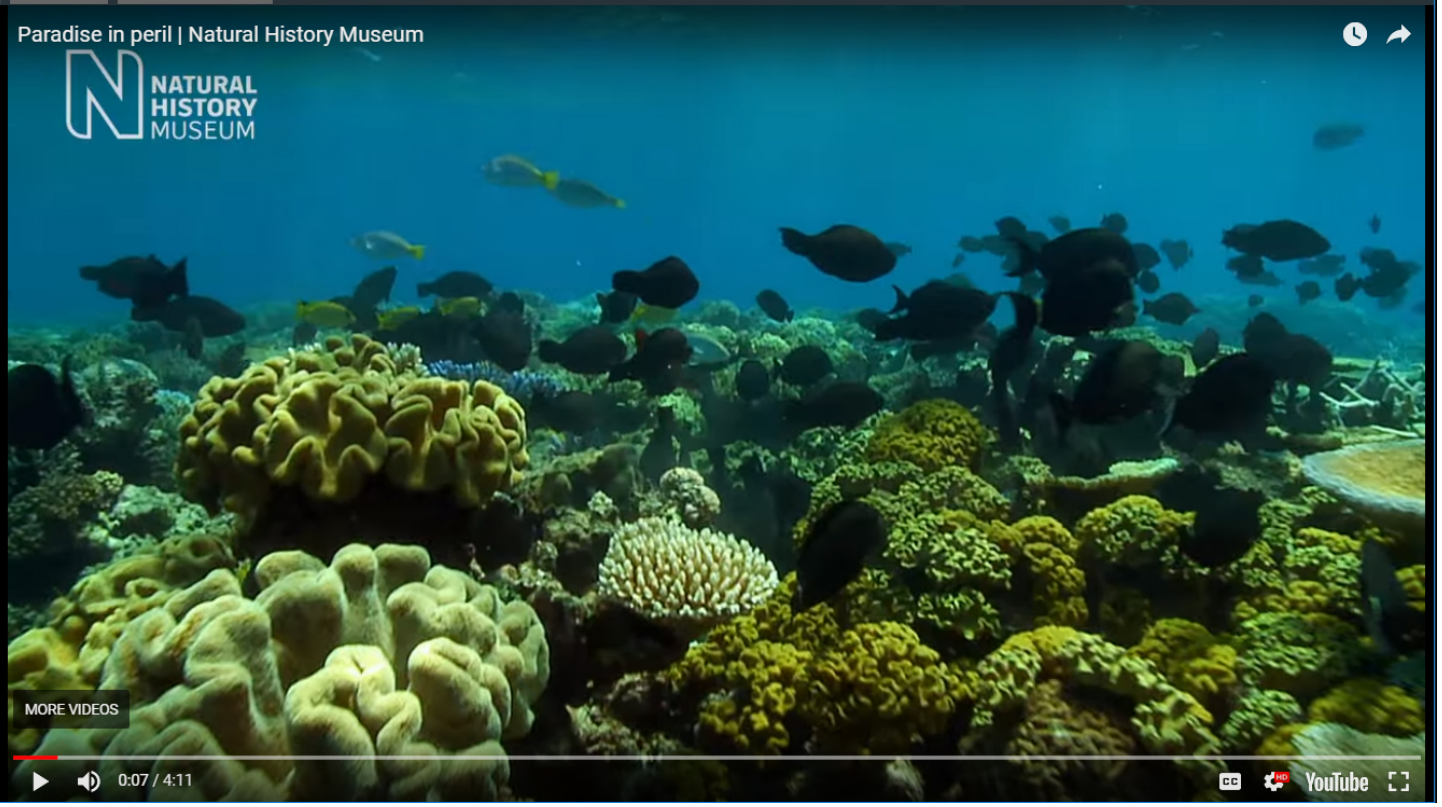
Introduction

The Threat to Coral Reefs

Coral reefs are one of the most important yet fragile ecosystems on the planet. To begin, watch the video to the right and learn how coral reef communities around the world are changing.

If you cannot view YouTube, you may download the video here.

Video courtesy the British Natural History Museum



Investigating Coral Bleaching Using Data in the Classroom

NOAA Data in the Classroom

Introduction | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Get Data | Teacher's Guide

Coral Reef Locations and Temperature

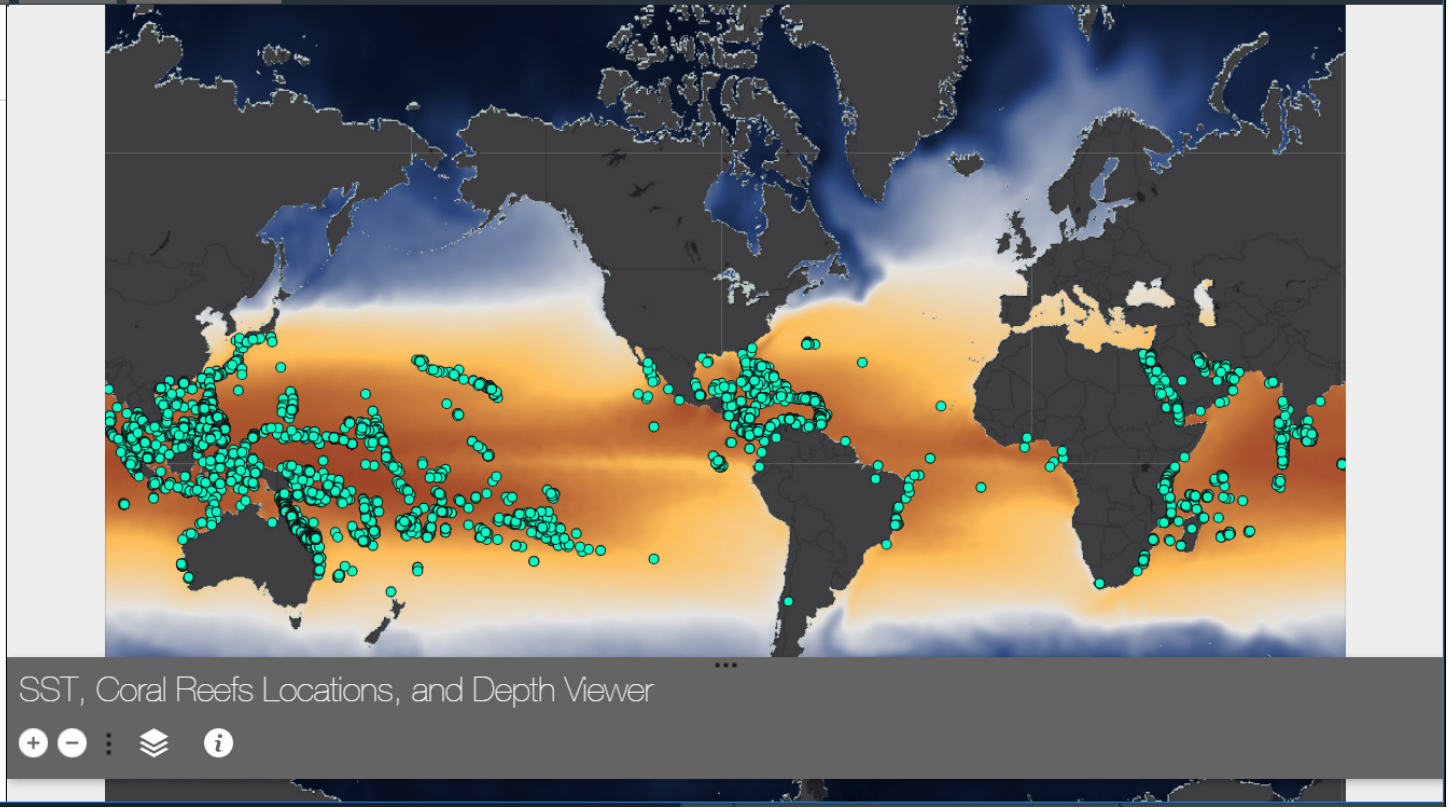
Coral Reef Habitat and Range

Building upon the earlier maps, analyze this map that combines coral reef locations, average SST, and ocean depth, along with a grid of latitudes and longitudes.

In the Layers box at the upper right, you can turn on/off each layer, or click the > next to the layer name and a slider will appear that allows you to change the transparency of a layer.

Question 4: Which best describes the range of coral reef habitats?

- Coral reefs occur anywhere that the SST is above 20°C
- Coral reefs occur at any temperature that is close to land
- Coral reefs occur in warm, deep waters between 30°N latitude and 30°S latitude
- Coral reefs occur in warm, shallow waters between 30°N latitude and 30°S latitude



Investigating Coral Bleaching Using Data in the Classroom

NOAA Data in the Classroom

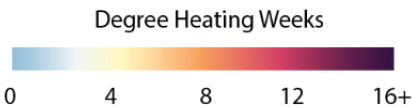
Introduction | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Get Data | Teacher's Guide

Measuring Coral Heat Stress

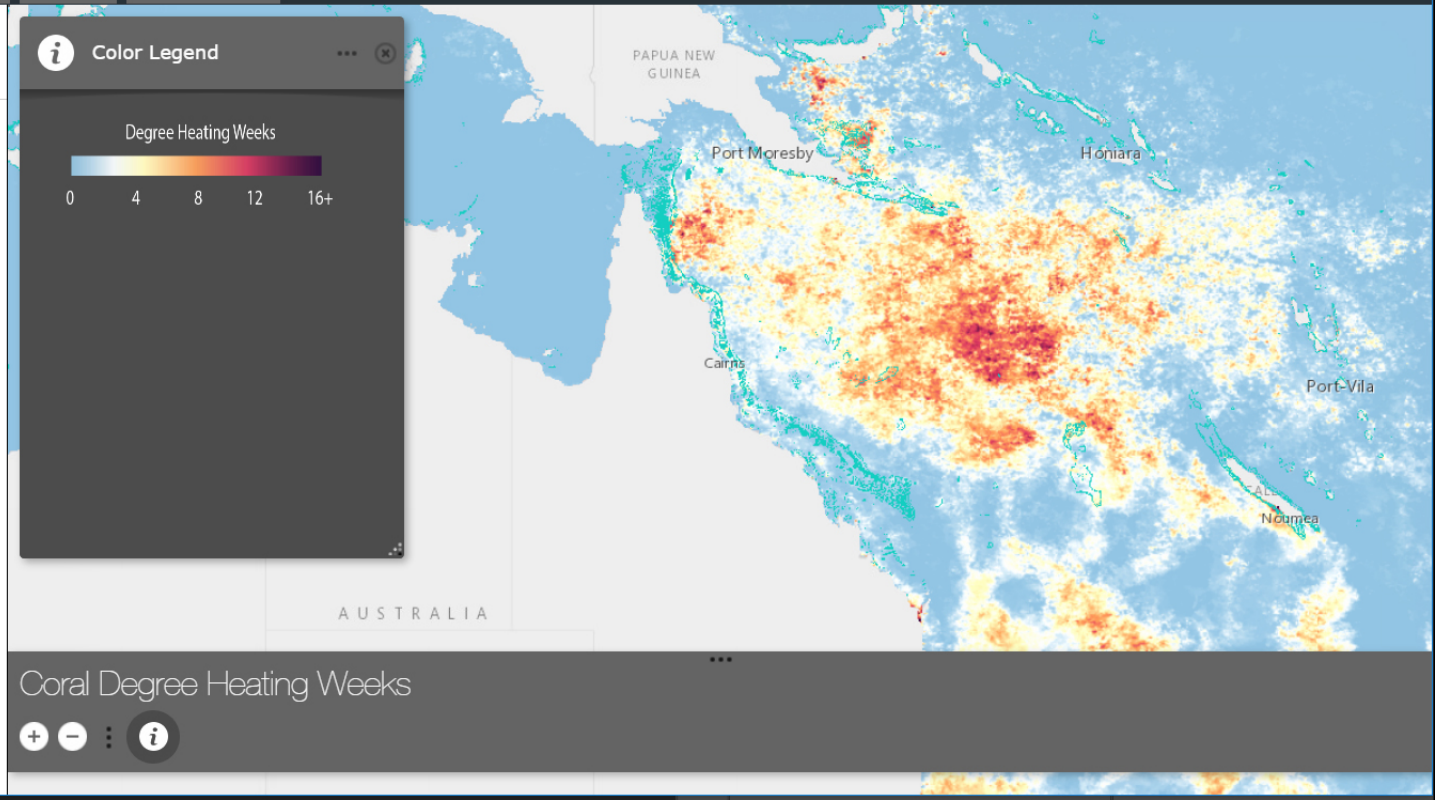
The same skills used to analyze maps of SST can be used to analyze maps of DHW. Examine the colorbar contained in the map or embedded below. The maps plot DHW from 0-16 values. There are some important values that correlated to coral bleaching intensity:

- DHW 0 = no stress
- DHW 4 = significant bleaching expected
- DHW 8 = widespread bleaching and mortality

The map also uses bright blue-green dots to map the locations of reefs. Notice that the DHW values are global and occur in places where corals do not exist - that is because the satellite data is global and scientists also like to see how heat stress may be moving into a particular area of the ocean - almost like watching a heat wave move across the U.S. In general, you may disregard the extreme values seen in the open ocean and north and south poles, since, as you found in Level 1, corals have a very limited distribution (shallow areas in the tropics).



Question 4: Analyzing the map to the right, how many DHW values were experienced along the northern Great Barrier Reef



Investigating Coral Bleaching Using Data in the Classroom

NOAA Data in the Classroom

Introduction | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Get Data | Teacher's Guide

Monitoring Coral Reefs in the Field

Identifying the Effect of Bleaching on Coral Reefs

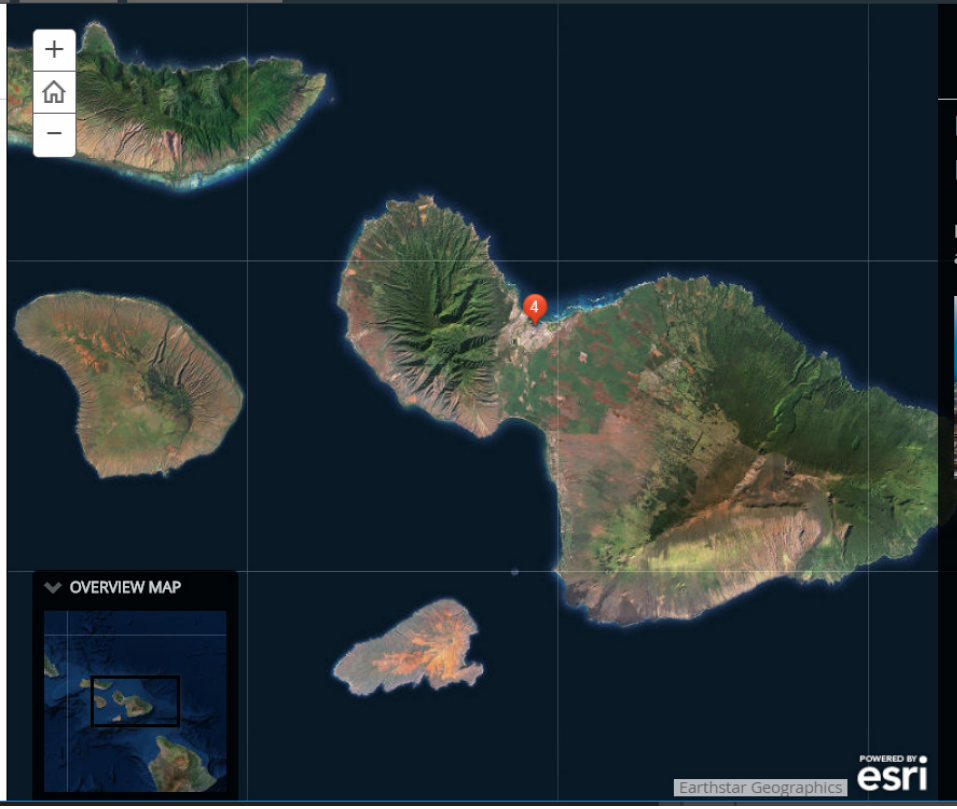
You've seen the difference between a bleached and healthy coral up close, now look at how reefs around the world look when they're healthy vs. bleached.

The map on the right has a series of locations with images of coral reefs that are either healthy, bleached, or dead. Use your student logs to make 3-5 observations about each reef.

Question 1: Besides the change in color, what are some other signs that a coral reef has undergone a bleaching event?

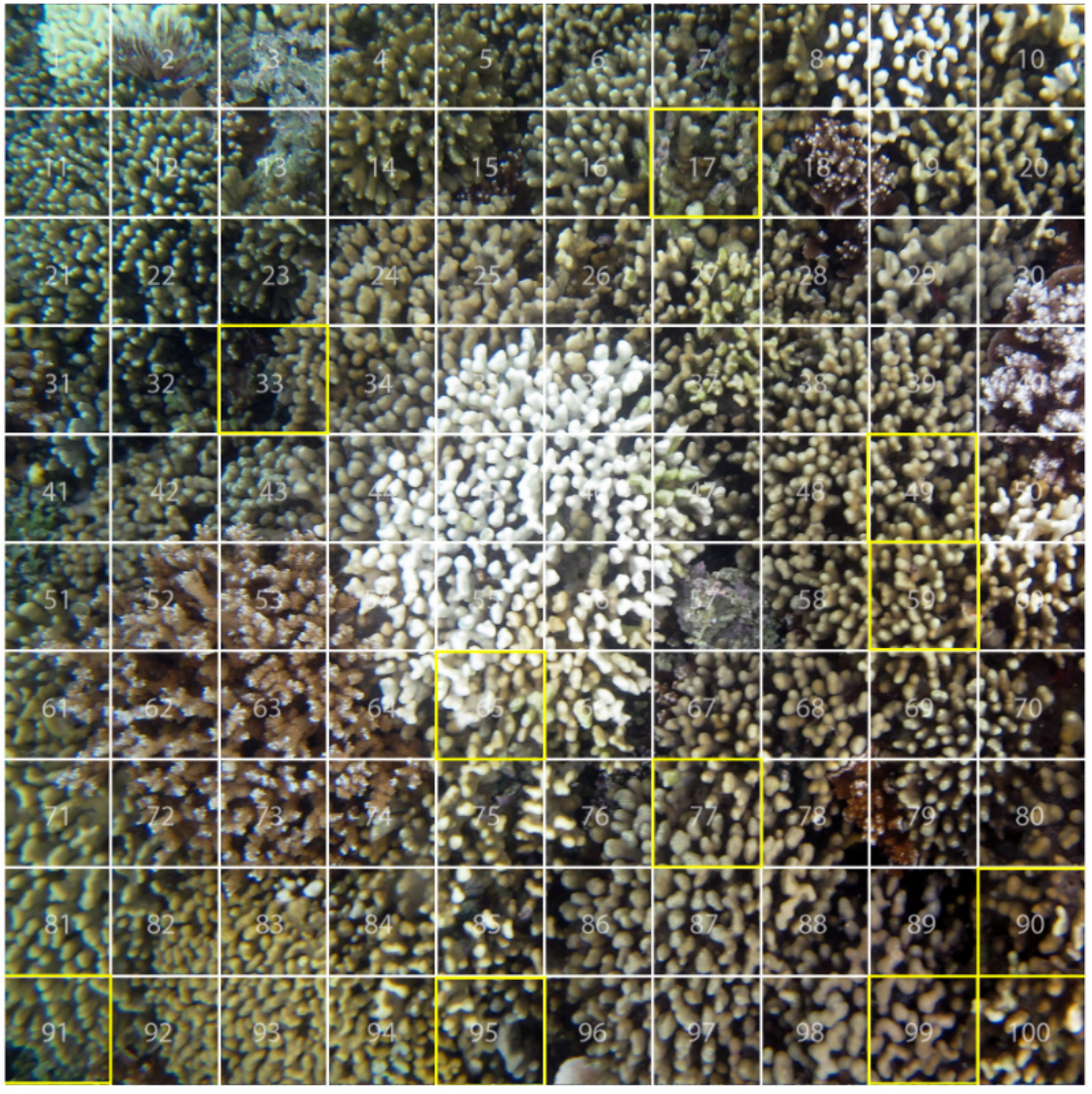
- A. Unhealthy reefs appear more dense than healthy reefs
- B. There are more algae on bleached reefs
- C. There are fewer fish swimming around bleached reefs
- D. Answer B and C

Check my answer



Reef #4: Kahului Point, Maui, Hawaii

Photos taken in August 2015 (left) and November 2015 (right)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Identifying a Bleaching Event

Analyzing Bleaching in the Florida Keys

Tourism is Florida's biggest industry - and the reefs of the Florida Keys are one of the largest attractions. As you might expect from their popularity, the health of the Florida Keys reefs in of huge importance to the state, and it is covered closely in the news.

Activity

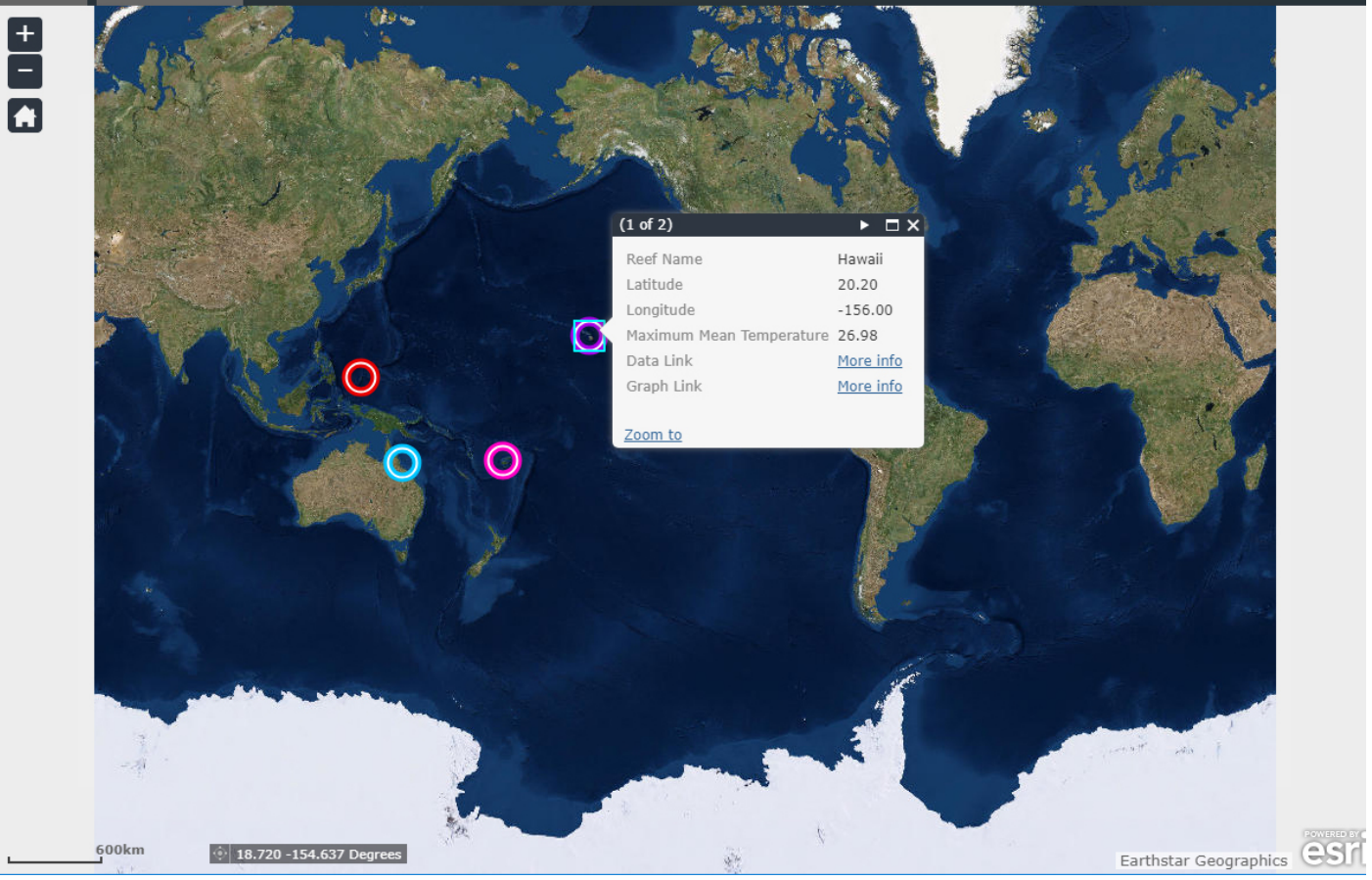
1. **Your Question:** How is sea surface temperature affecting the health of Florida's coral reefs?

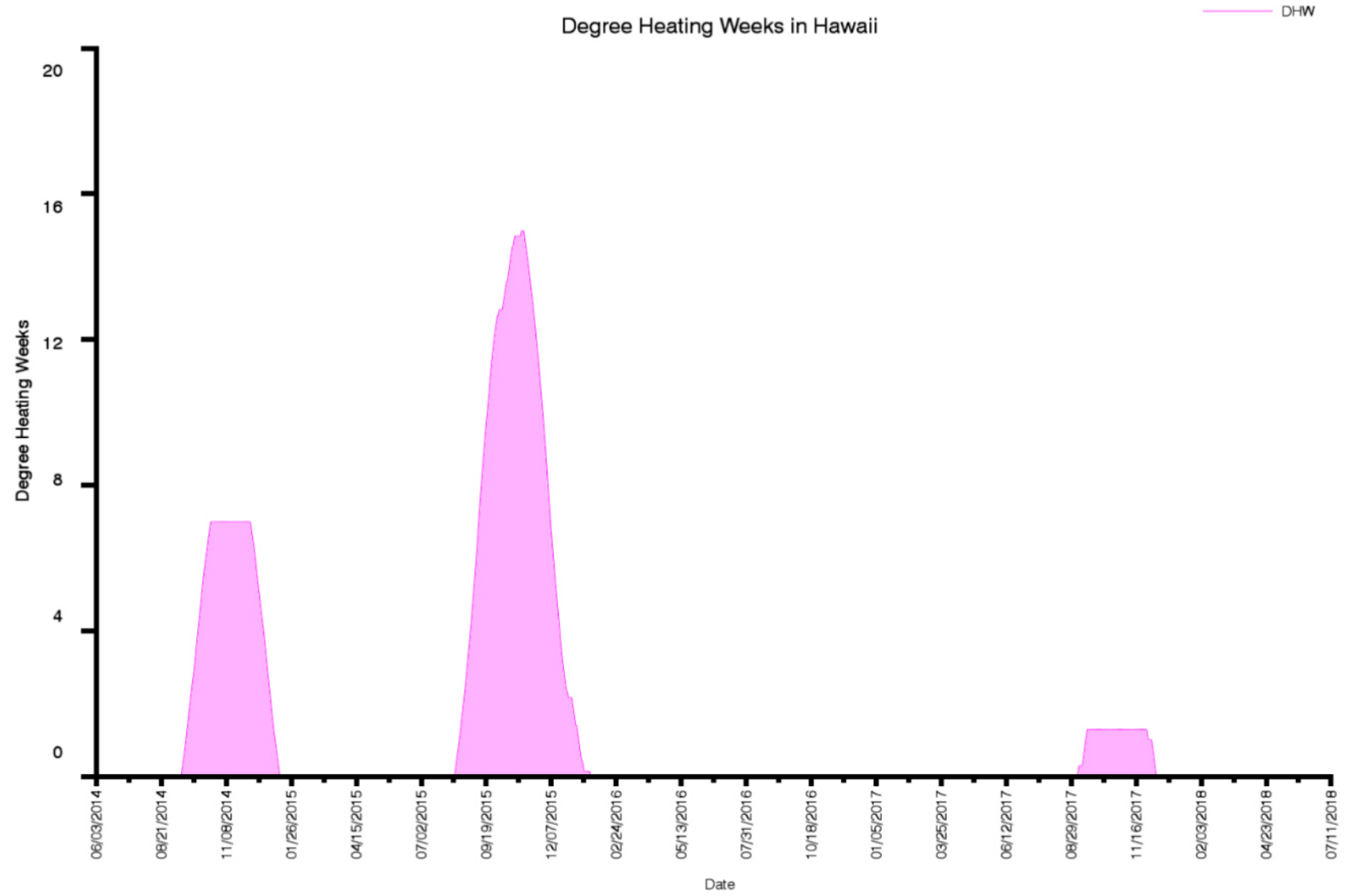
2. **Get Degree Heating Weeks Data:**
   Click on light yellow circle on the map to the right. In the popup box there are two options: download a graph, or download data.

   Click *Graph Link More Info* and the graph plots the Degree Heating Week data for the past few years.

   You can make your own graph, if desired. Click *Data Link More Info* and the downloadable data provide the time series of data you need to do your own analysis.

3. **Get Data from Monitoring Reports**: Florida's Mote Marine Lab publishes coral Conditions Report on their website. These reports will show you when and where bleaching occurred in the Florida Keys during a given time period. *See page 2 of the reports.




Degree Heating Weeks in Hawaii
DHW
Degree Heating Weeks
20
16
12
8
4
0
06/03/2014
08/21/2014
11/08/2014
01/26/2015
04/15/2015
07/02/2015
09/19/2015
12/07/2015
02/24/2016
05/13/2016
07/31/2016
10/18/2016
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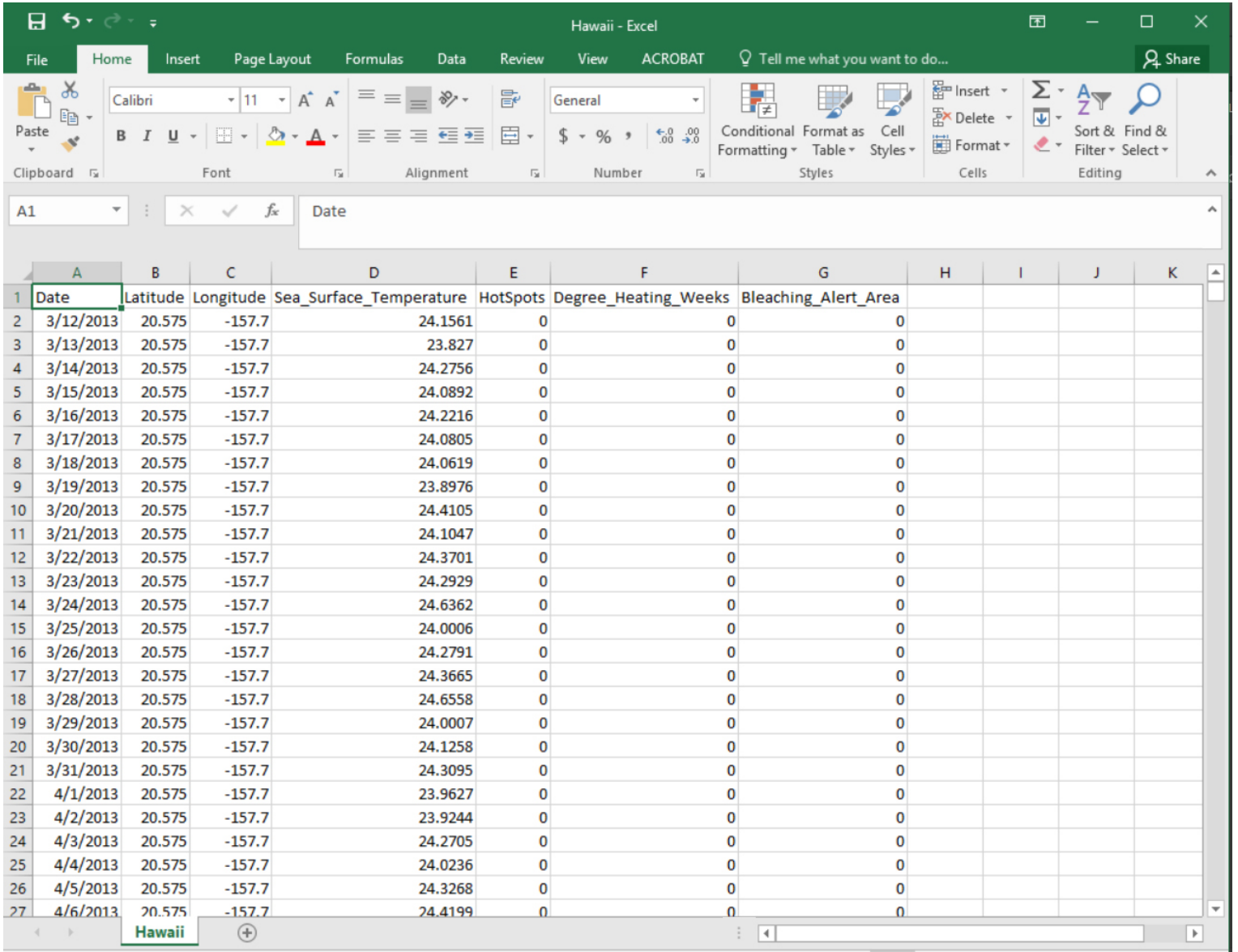
Date



	A	B	C	D	E	F	G	H	I	J	K
1	Date	Latitude	Longitude	Sea_Surface_Temperature	HotSpots	Degree_Heating_Weeks	Bleaching_Alert_Area				
2	3/12/2013	20.575	-157.7	24.1561	0	0	0				
3	3/13/2013	20.575	-157.7	23.827	0	0	0				
4	3/14/2013	20.575	-157.7	24.2756	0	0	0				
5	3/15/2013	20.575	-157.7	24.0892	0	0	0				
6	3/16/2013	20.575	-157.7	24.2216	0	0	0				
7	3/17/2013	20.575	-157.7	24.0805	0	0	0				
8	3/18/2013	20.575	-157.7	24.0619	0	0	0				
9	3/19/2013	20.575	-157.7	23.8976	0	0	0				
10	3/20/2013	20.575	-157.7	24.4105	0	0	0				
11	3/21/2013	20.575	-157.7	24.1047	0	0	0				
12	3/22/2013	20.575	-157.7	24.3701	0	0	0				
13	3/23/2013	20.575	-157.7	24.2929	0	0	0				
14	3/24/2013	20.575	-157.7	24.6362	0	0	0				
15	3/25/2013	20.575	-157.7	24.0006	0	0	0				
16	3/26/2013	20.575	-157.7	24.2791	0	0	0				
17	3/27/2013	20.575	-157.7	24.3665	0	0	0				
18	3/28/2013	20.575	-157.7	24.6558	0	0	0				
19	3/29/2013	20.575	-157.7	24.0007	0	0	0				
20	3/30/2013	20.575	-157.7	24.1258	0	0	0				
21	3/31/2013	20.575	-157.7	24.3095	0	0	0				
22	4/1/2013	20.575	-157.7	23.9627	0	0	0				
23	4/2/2013	20.575	-157.7	23.9244	0	0	0				
24	4/3/2013	20.575	-157.7	24.2705	0	0	0				
25	4/4/2013	20.575	-157.7	24.0236	0	0	0				
26	4/5/2013	20.575	-157.7	24.3268	0	0	0				
27	4/6/2013	20.575	-157.7	24.4199	0	0	0				

Designing Your Own Investigation

Activity

Design an investigation using real data to examine a research question of your choosing.

Plan Your Investigation

1. Develop Your Question

Ask a question that can be answered using the data available in this section. Sample questions are below:

- How has sea surface temperature affected the health of coral reefs near the Galapagos, Hawaii, Fiji, or the Great Barrier Reef in the past 12 months?
- How has changing sea surface temperature affected the frequency and intensity of coral bleaching at the Great Barrier Reef since 2000?
- Which coral reef is most at risk of bleaching due to rising sea surface temperatures: Florida Keys, Galapagos, Hawaii, or the Great barrier Reef?

2. Make a Plan

What data will you need to answer your question? Collect the data using the tools below:

Degree Heating Weeks Maps

Coral Reef Station Data

NOAA Climate Program Office

Frank Niepold - Climate Education Coordinator

CLEAN

CLIMATE LITERACY & ENERGY AWARENESS NETWORK

The CLEAN Collection of Climate and Energy Educational Resources A collection of 700+ free, ready-to-use learning resources rigorously reviewed by educators and scientists suitable for secondary through higher education classrooms.

Ways to Search »

Browse the Collection »

Browse by NGSS »

"I appreciate how you've linked climate and energy education to NGSS, and have provided good searching tools - a valuable resource for teachers!"

- NOAA Planet Stewards Educator

"I trusted b
approach
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CLEAN
Collection of Educational Resources
Guidance in Teaching Climate and Energy
CLEAN Network
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About the Project

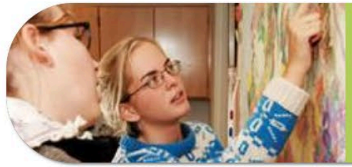
News

Register for the CLEAN Webinar Series

Register for the CLEAN AGU Workshop

Find Climate Literacy

Screenshot



Guidance in Teaching Climate and Energy Science Essential knowledge, instructional support, and links to relevant resources in the CLEAN collection.

CLEAN Network A community of professionals committed to improving climate and energy literacy.

About the CLEAN Project

CLEAN Review Process

Get Involved

NOAA Climate Program Office

"Once I learned of the CLEAN website, I have been consistently using the site as an instructional tool in all of my science teaching."

-Teacher in Metro Nashville Public Schools

CLEAN
- Climate and Energy Educational Resources
  - CLEAN Collection
  - CLEAN and NGSS
  - About the CLEAN Collection
- Teaching Climate and Energy
- CLEAN Network
- TrACE
- Get Involved
- About this Project

Climate and Energy Educational Resource Collection

The CLEAN Collection is a high-quality and rigorously reviewed collection of climate and energy educational resources aligned with the Climate Literacy and the Energy Literacy frameworks, and the Next Generation Science Standards .
Through the peer-review process scientists and educators ensure scientific accuracy, pedagogic effectiveness, and classroom readiness for each resource.

NGSS & CLEAN at a Glance »

Explore the Collection

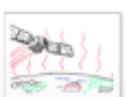
search

Help
Results 1 - 10 of 718 matches

Ocean Acidification in a Cup
https://www.exploratorium.edu/snacks/ocean-acidification...
This model of ocean-atmosphere interaction shows how carbon dioxide gas diffuses into water, causing the water to become more acidic. The video demonstration and instruction provide an explanation of ...
Reviewed Collection

Thermal Expansion Model
https://www.jpl.nasa.gov/edu/teach/activity/thermal-expa...
This activity allows students to demonstrate the thermal expansion of water for themselves using water bottles and straws. The discussion allows them to explore the connection between this concept ...
Reviewed Collection

Your Own El Nino
https://aamboceanservice.blob.core.windows.net/oceanservy...
This activity allows students to make El Nino in a container, but it might work better as a teacher demonstration. The introduction and information provided describe El Nino, its processes and its ...
Reviewed Collection



Sea Level Rise
https://www.youtube.com/watch?v=msnOHuPep9I&feature=youtu...
This very short video introduces the concept of sea level rise and ties it back to global warming. The video is brief, basic, and clear. It can be used for a quick introduction, but nothing deeper ...
Reviewed Collection

Refine the Results↓

Resource Type
- Activity 274 matches
- Curricula 4 matches
- Short Demonstration/Experiment 17 matches
- Teaching Guidance 34 matches
- Video 246 matches
- Visualization 149 matches
- Other 1 match

Grade Level
- Primary (K-2) 1 match
- Intermediate (3-5) 25 matches
- Middle (6-8) 502 matches
- High School (9-12) 621 matches
- College Lower (13-14) 403 matches
- College Upper (15-16) 154 matches
- Graduate/Professional 43 matches
- Informal 87 matches
- General Public 7 matches

NGSS Performance Expectations
- Middle School 91 matches
- High School 171 matches

NGSS Disciplinary Core Ideas
- K-2 1 match
- Middle School 472 matches
- High School 595 matches

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Through the peer-review process scientists and educators ensure scientific accuracy, pedagogic effectiveness, and classroom readiness for each resource.

NGSS & CLEAN at a Glance »

Explore the Collection

ocean search

Help

Current Search Limits: Text Search ocean

Results 1 - 10 of **509 matches**

Ocean Acidification
https://www.explainingclimatechange.ca/applets/OceanAcid...
This simulation allows students to explore the change in sea surface pH levels with increasing CO2 levels.
Reviewed Collection

Changing Planet: Ocean Temperatures
http://www.windows2universe.org/earth/changing_planet/oc...
This video follows Bermuda scientists into the field as they collect data that documents a warming trend in ocean temperatures. BIOS Director Tony Knapp discusses some of the impact of warming ...
Reviewed Collection

What Is Ocean Acidification?
http://www.pmel.noaa.gov/co2/story/What+is+Ocean+Acidifi...
This static image from NOAA's Pacific Marine Environmental Laboratory Carbon Program offers a visually compelling and scientifically sound image of the sea water carbonate chemistry process that ...
Reviewed Collection

Southern Ocean Sentinels
http://www.abc.net.au/catalyst/stories/2886137.htm
This video discusses two key signs of global change in the Southern Ocean: changes in Antarctic bottom water

Refine the Results↓

Resource Type
- Activity 160 matches
- Curricula 4 matches
- Short Demonstration/Experiment 8 matches
- Teaching Guidance 16 matches
- Video 220 matches
- Visualization 107 matches

Grade Level
- Primary (K-2) 1 match
- Intermediate (3-5) 21 matches
- Middle (6-8) 370 matches
- High School (9-12) 449 matches
- College Lower (13-14) 293 matches
- College Upper (15-16) 111 matches
- Graduate/Professional 34 matches
- Informal 73 matches
- General Public 6 matches

NGSS Performance Expectations
- Middle School 60 matches
- High School 108 matches

NGSS Disciplinary Core Ideas
- Middle School 371 matches
- High School 442 matches

NGSS Cross-Cutting Concepts

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CLEAN Collection
Collection of Climate and Energy Educational Resources
CLEAN and NGSS
CLEAN and NGSS
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Teaching Climate and Energy
CLEAN Network
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What Is Ocean Acidification?

http://www.pmel.noaa.gov/co2/story/What+is+Ocean+Acidification%3F

NOAA Pacific Marine Environmental Laboratory Carbon Group

Jump to this Static Visualization »

This static image from NOAA's Pacific Marine Environmental Laboratory Carbon Program offers a visually compelling and scientifically sound image of the sea water carbonate chemistry process that leads to ocean acidification and impedes calcification.

Learn more about Teaching Climate Literacy and Energy Awareness»

See how this Static Visualization supports the Next Generation Science Standards»

Middle School: 1 Disciplinary Core Idea

High School: 5 Disciplinary Core Ideas

Notes From Our Reviewers

The CLEAN collection is hand-picked and rigorously reviewed for scientific accuracy and classroom effectiveness. Read what our review team had to say about this resource below or learn more about how CLEAN reviews teaching materials

Teaching Tips | Science | Pedagogy | Technical Details

Teaching Tips

- Most relevant in a life science or chemistry class focusing on an often overlooked and enormously important impact of burning fossil fuels.
- Might best be used as context for a series of basic chemistry experiments understanding buffering, acidity, dissolution, and carbonate reactions.

About the Science

- In the text surrounding the image there is a good overview of the chemistry and consequences of ocean acidification.
- Image shows a simplified version of a portion of the sea water chemistry that leads to ocean acidification.
- Passed initial science review.

Topics

Carbon Cycle
See more on this topic.

Ecosystem Changes
See more on this topic.

Plants and Animals
See more on this topic.

Ocean Warming / Acidification
See more on this topic.

Grade Level

High School (9–12)
See more at this grade level.

College Lower (13–14)
See more at this grade level.

College Upper (15–16)
See more at this grade level.

- Background information the the science and how related research is conducted is included.

Related URLs These related sites were noted by our reviewers but have not been reviewed by CLEAN

This is the NOAA overview page on ocean acidification: http://www.pmel.noaa.gov/co2/story/Ocean+Acidification

▸ 3c (see details)
About Teaching Principle 3
Other materials addressing 3c

▸ 7d (see details)
About Teaching Principle 7
Other materials addressing 7d

Next Generation Science Standards See how this Static Visualization supports:

▾ hide

Middle School

Disciplinary Core Ideas: 1

MS-PS1.B1: Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants.

▾ hide

High School

Disciplinary Core Ideas: 5

HS-ESS2.D2: Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen.

HS-ESS2.D3: Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate.

HS-ESS2.E1: The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it.

HS-LS2.B3: Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes.

HS-PS1.B2: In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present.

Jump to this Static Visualization »

Teaching Tips

- Most relevant in a life science or chemistry class focusing on an often overlooked and enormously important impact of burning fossil fuels.
- Might best be used as context for a series of basic chemistry experiments understanding buffering, acidity, dissolution, and carbonate reactions.

About the Science

- In the text surrounding the image there is a good overview of the chemistry and consequences of ocean acidification.
- Image shows a simplified version of a portion of the sea water chemistry that leads to ocean acidification.
- Passed initial science review.
- Comments from expert scientist: Accurate, condensed information about ocean acidification and its impacts – both present (observed) and future (predicted).

About the Pedagogy

- This site has potentially helpful background on the complex chemical interactions and impacts of CO_2 from the atmosphere on the marine ecosystem.
- Additionally, this site provides links to papers, data, and graphs, which will aid further investigation.
- Other steps of the chemical process are shown in other graphics that are available on this website.

Technical Details/Ease of Use

- Good illustration with background information on ocean acidification.
- Background information the the science and how related research is conducted is included.

Related URLs

These related sites were noted by our reviewers but have not been reviewed by CLEAN

This is the NOAA overview page on ocean acidification: http://www.pmel.noaa.gov/co2/story/Ocean+Acidification

Ecosystem Changes
See more on this topic.

Plants and Animals
See more on this topic.

Ocean Warming / Acidification
See more on this topic.

Grade Level

High School (9–12)
See more at this grade level.

College Lower (13–14)
See more at this grade level.

College Upper (15–16)
See more at this grade level.

Informal
See more at this grade level.

Regional Focus

Islands, Oceans (Global)
See more for this region.

Climate Literacy

About Teaching Climate Literacy

▸ 2d (see details)
About Teaching Principle 2
Other materials addressing 2d

▸ 3c (see details)
About Teaching Principle 3
Other materials addressing 3c

▸ 7d (see details)
About Teaching Principle 7
Other materials addressing 7d

Next Generation Science Standards

See how this Static Visualization supports:

▸ Middle School (see details)

▸ High School (see details)

Learn more about CLEAN and NCSS

Jump to this Static Visualization »

Guidance in Teaching About Climate and Energy

Climate and energy are complex topics, with rapidly developing science and technology.

These pages offer easy-to-read explanations of science and policy, designed to step students through the key principles of climate and energy. Each page is illustrated with examples to bring these topics alive in your classroom.

- A summary of each of the climate and energy science principles
- Ideas to support learners
- Suggested teaching approaches, selected for various grade levels
- Relevant resources from the CLEAN collection

Teaching Climate

Walk students through key components of the climate system: the Sun, the atmosphere, life on Earth, human impacts, how scientists study climate, and actions humans can take.

Teaching Energy

Trace the story of energy in our lives, beginning with the physics of energy and how energy flows throughout the earth system. Explore energy's influence on human society, sources of energy, the ways we use energy, how we make decisions about energy, and the impacts of energy use.

Check out the Educator Toolbox to find more teaching resources

Explore tools for teaching about climate and energy science, including pedagogical approaches, activities, and instructional ideas:

- Creating Your Own Climate and Energy Units
- Earth Systems Investigations
- NCA Teaching Resources
- Newsletters
- Webinars
- Workshops

Climate change has consequences for the Earth system and human lives.

Climate Literacy Principle 7

Jump down to: Teaching these ideas | Find activities

Teaching the impacts of climate change is supported by six key concepts:

a. Melting of ice sheets and glaciers, combined with the thermal expansion of seawater as the oceans warm, is causing sea level to rise. Seawater is beginning to move onto low-lying land, contaminating coastal fresh water sources, and gradually submerging coastal facilities and barrier islands. Sea-level rise increases the risk of damage to homes and buildings from storm surges such as those that accompany hurricanes.

▶ There are 5 more fundamental concepts. See them all...

These ideas relate to the current and predicted consequences of climate change.

Most people are aware of the increasing frequency of extreme weather events, which is what climate scientists predicted for a warming world. The impacts of climate change on humans and environmental systems have become a focus for resource managers, medical professionals, emergency managers, insurance companies, and military planners. A great challenge of the 21st century will be to prepare communities to adapt to climate change while reducing human impacts on the climate system (known as mitigation). Additional factors such as poverty, a lack of resources, the absence of political will, and the necessity for nations to work together add further complexity to this challenge. Many jobs and industries will be affected by the changes that are happening or are anticipated for the future.

Climate change has profound impacts at home and afar, today and in the future

The importance of this principle is readily apparent: our climate is changing and so is our world. Symptoms of climate change are all around us: extreme weather, diminishing sea ice, year after year of record-breaking warmth, drought, fires, and stress to ecosystems. Many of these consequences will create hardship for humans. Some key points are:

- The impacts of human-caused climate change are already being seen, from polar regions, to our backyards, to communities around the world.

NOAA Climate Program Office

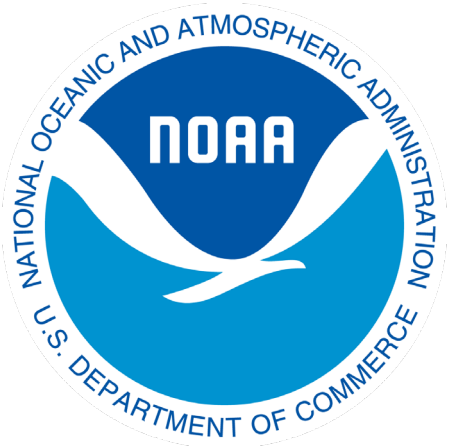
"It’s refreshing to have a clearinghouse of information that I can trust, especially in a pinch. I believe this material was a great success, as students responded positively to course content & level of teaching.”

Informal Educator, Philadelphia PA

Ocean Today

Any Questions?

Please use the chat window to post your question



Ocean Today

Education/Climate Deep Dive

With

Kurt Mann - Executive Producer Ocean Today

Bekkah Lampe - Education Outreach Specialist

Bruce Moravchik - Ocean Service Education Coordinator

Frank Niepold - Climate Education Coordinator

http://oceantoday.noaa.gov/