



Coral Check-up Field Journal



Photo by Greg McFall/NOAA, 2011

Welcome to your Field Journal for the [Office of National Marine Sanctuaries](#) (ONMS) **Coral Check-up Lesson Series**. ONMS protects over 620,000 square miles of marine and Great Lakes waters, including vast areas of beautiful coral reefs. Here is a chance for you to put on your mask and fins to virtually explore and study one of these important coral ecosystems. In this multi-part lesson series, you will explore reefs, understand their challenges, and join in the efforts to protect them. Use this Field Journal to find instructions, hyperlinks, and guiding questions, as well as room to record your observations and notes for each section of this lesson series.





Coral check-up: Unit 1

Searching for coral bleaching across the Hawaiian Archipelago

Lesson 1: Pre-trip training

How do we know if coral reefs are healthy?

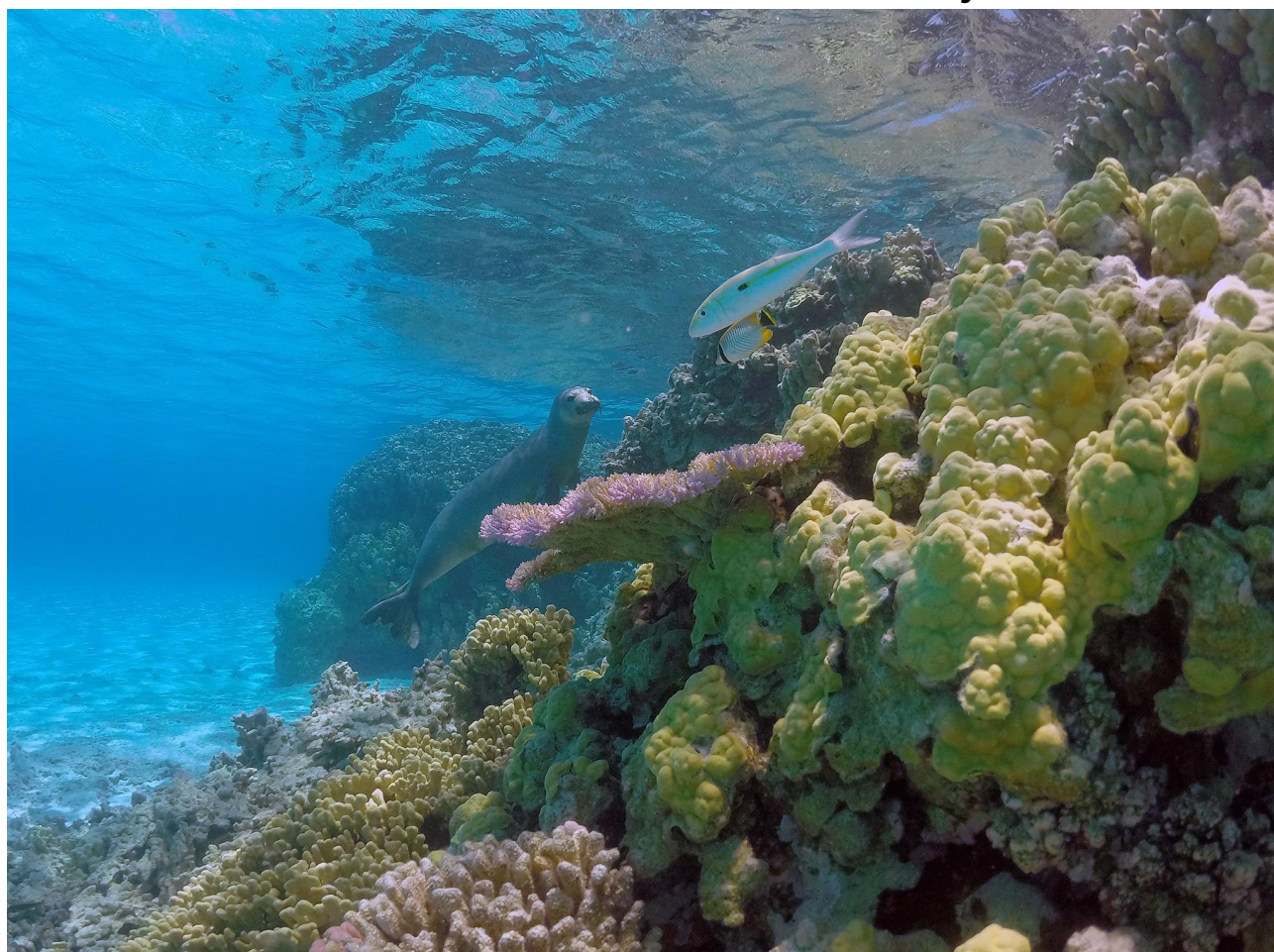


Photo by Mark Sullivan/NOAA Fisheries Hawaiian Monk Seal Research Program, 2012

Before we can begin, we need to build our knowledge of coral reefs. Watch the three videos listed below. Write your observations and answer the questions in the spaces provided.



[Explore a Coral Reef with Michael Caban \(15 min\)](#)

Michael will swim you through a popular reef located near Hilo, Hawai'i. Learn the basics of Hawai'i coral reefs and how you can be a good coral steward.

Please write at least three (3) observations using a vocabulary term from the ID sheet in each.

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[Hawaiian Islands Humpback Whale National Marine Sanctuary 360° video](#) (3min 40sec)

A beautifully filmed 360° video that looks more broadly at coral reefs in Hawai'i and some of the species that depend on this habitat. Don't forget to use your mouse to look around!

Please write at least three (3) observations.

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[Earth is Blue: Coral Reef Bleaching](#) (1min 11sec)

A brief look at one way scientists study coral bleaching. You'll be doing a virtual version of this type of coral research at the end of the lesson!

Please write at least three (3) observations.

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4. How do scientists monitor coral reef health?

5. Why is it important to monitor coral reef health?

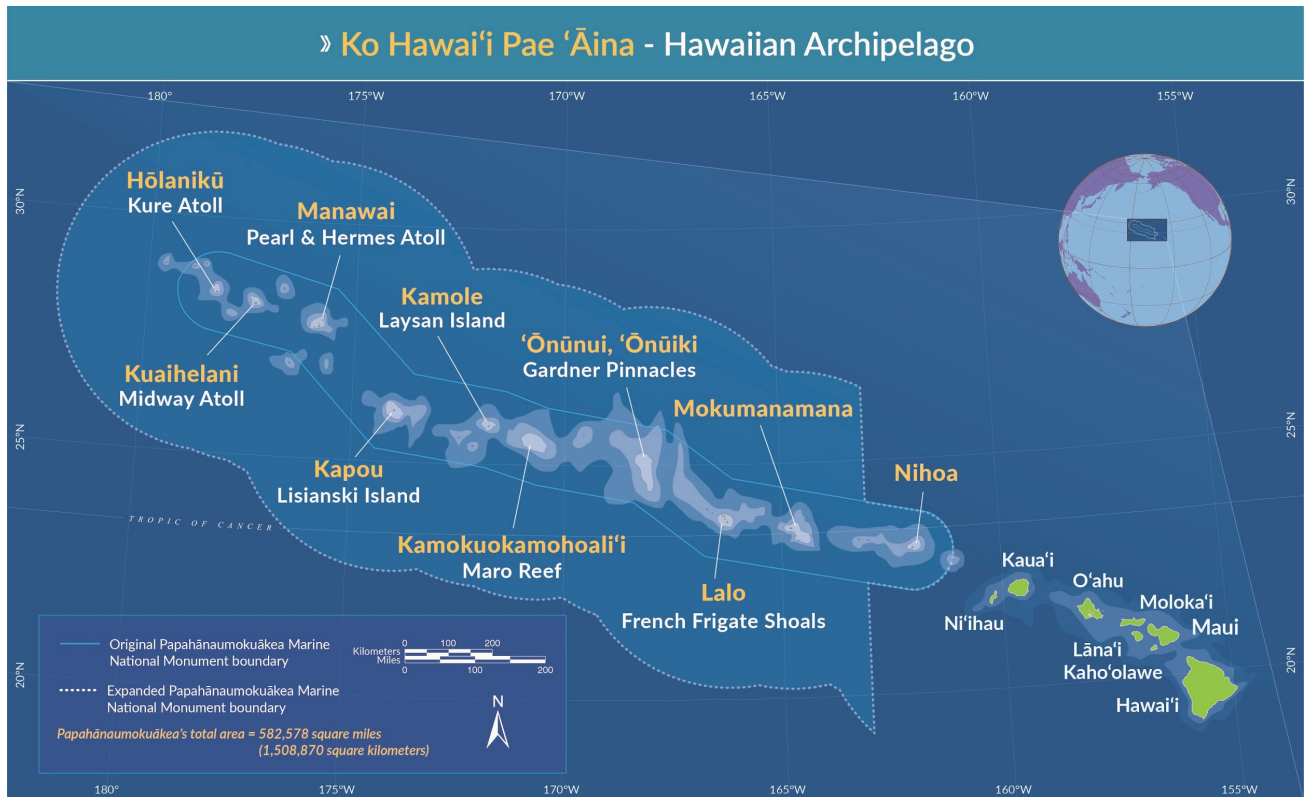


Lesson 2: Entering Papahānaumokuākea Marine National Monument



Photo by Brad Ka'aleleo Wong/Office of Hawaiian Affairs

Part of your research later on in this series will be in the eight Main Hawaiian Islands (MHI) — the islands we are more familiar with — like Hawai'i Island, Maui, O'ahu, and Kaua'i for example. The rest of your research will take place in the much older Northwestern Hawaiian Islands (NWHI). These islands and surrounding waters are protected as [Papahānaumokuākea Marine National Monument](#) (PMNM). PMNM is one of the largest permanently protected areas in the world, and is recognized as a United Nations [UNESCO World Heritage Site](#) for its cultural and ecological significance, an honor only given to the most significant area in the world.



A map of the Hawaiian archipelago. Papahānaumokuākea Marine National Monument boundaries include everything within the white dotted line.

Before anyone enters Papahānaumokuākea, they participate in a workshop to help them better understand and honor the place they are going to study and learn. Just like anyone visiting PMNM, you will begin your journey by learning more about this special place.



[Safe Haven Video \(7 min\)](#)

Working with partners, NOAA produced an introduction video to the Northwestern Hawaiian Islands Marine National Monument in 2006. Although much has changed since then (including the gifting of the name Papahānaumokuākea in 2007 and the expansion of the boundaries in 2016), *Safe Haven* provides an excellent summary of what makes Papahānaumokuākea Marine National Monument special.

Please write at least three (3) observations

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[*PMNM Cultural Briefing Video*](#) (13 min)
(scroll down page to find the video)

The Office of Hawaiian Affairs (OHA) is one of four co-trustees who cooperatively manage Papahānaumokuākea. The Cultural Briefing Video highlights perspectives from some of the prominent Native Hawaiian Cultural Practitioners and Researchers working within the monument.

Please note: The video references PMNM boundaries before they were expanded in 2016.

Please write at least three (3) observations.

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4. What is significant about the reefs in the Northwestern Hawaiian Islands?

5. What are the key protections created by the Northwestern Hawaiian Islands becoming a marine national monument?



Lesson 3: Virtual Coral Scientist

Now that you have learned about corals and why Papahānaumokuākea is so significant, it is time to dive in and look at a reef up close. Look at the list of coral areas listed below, and choose one located in the Main Hawaiian Islands (MHI) and at least one of the reef areas located in the Northwestern Hawaiian Islands. Your first job will be to virtually visit your sites and collect data on the area. You will use four different sources to learn more about your sites, recording your observations and questions here in your Field Journal. There are instructions below explaining how to use each source. ***At the end of this lesson, you will be presenting your findings to your classmates.***



Photo by Scott Godwin/NOAA, 2012



Student Study Sites

Northwestern Hawaiian Islands (NWHI)	Main Hawaiian Islands (MHI)
Lalo/French Frigate Shoals (now altered due to Hurricane Walaka in 2018)	Waiopae, Hawai'i Island (now covered in lava from the 2018 eruption)
Kamole/Laysan Island	Puako/Kīholo, Hawai'i Island
Kapou/Lisianski Island	Waiuli, Hawai'i Island
Manawai/Pearl & Hermes Atoll	Kāne'ōhe, O'ahu
Hōlanikū/Kure Atoll	Lehua, Ni'ihau

You will visit each site using the following virtual resources:

Please read the instructions for each resource before beginning. Detailed instructions are included for each of the four websites in the following pages. Be sure to take screenshots, download images, and collect other information for your upcoming presentation.

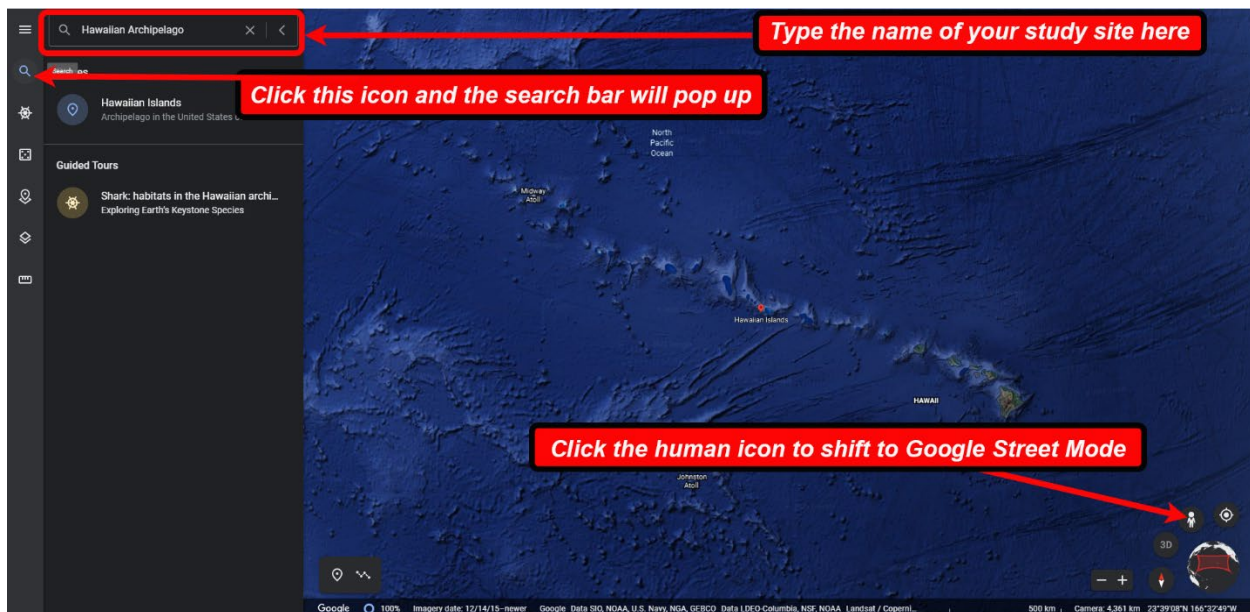
1. [Google Earth Web](#)
Learn the geography of your site and make street view virtual visits.
2. [Papahānaumokuākea Marine National Monument Website](#)
A summary of your study site in the NWHI including cultural, biological, historical, and geographic information.
3. [University of Hawai'i Coral Health Atlas](#) and [MEGA Lab at UH Hilo](#)
360° underwater videos, cultural information, reef data, and 3D reef models for your site.
4. [Papahānaumokuākea Flickr Site](#)
Pictures, videos, and short descriptions of your site, and the terrestrial and marine life located there.

Google Earth Web: Geography and Terrestrial Exploration

Before we submerge ourselves, let's get a better sense of the area where your reef is located. When studying the health of a coral reef, it is important to consider how the surrounding area might be affecting it. For example, a nearby stream could be washing soil into the ocean where it covers the coral, limiting the ability of the coral polyp to feed. Look at the geography of your site. Where is it located in relation to the rest of the Hawaiian Islands? Where is it in relation to your other study sites? What does the area look like through Google Street View? How would you describe the shoreline? Is it rocky or sandy? Is it covered in vegetation or is it barren? Is there evidence of human presence? How are the two sites similar or different? Take a screenshot of each location for your presentation.

Instructions

Using the magnifying glass search icon located in the upper left corner, type in "Hawaiian Archipelago." Do you recognize some of the islands? Now search for the location of your selected sites. Google Earth does not always recognize the correct Hawaiian name so try the English version first. An example would be, "Kure Atoll, Hawaii" instead of "Hōlanikū, Hawai'i."



Click on the human icon located in the lower right corner to switch to Google Street View mode. The human icon will turn yellow when on. Look for light blue dots on the map and click them to see pictures. If there is a light blue line, click on it to virtually walk around the area. Click on the human icon again to leave street view mode.

Please write at least three (3) observations about your study sites. Use the guiding questions in the text above for ideas on some observations you may make.

Main Hawaiian Islands (MHI): My site location is _____.

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Northwestern Hawaiian Islands (NWHI): My site location is _____.

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Dig deeper into the Northwestern Hawaiian Islands with Papahānaumokuākea.gov

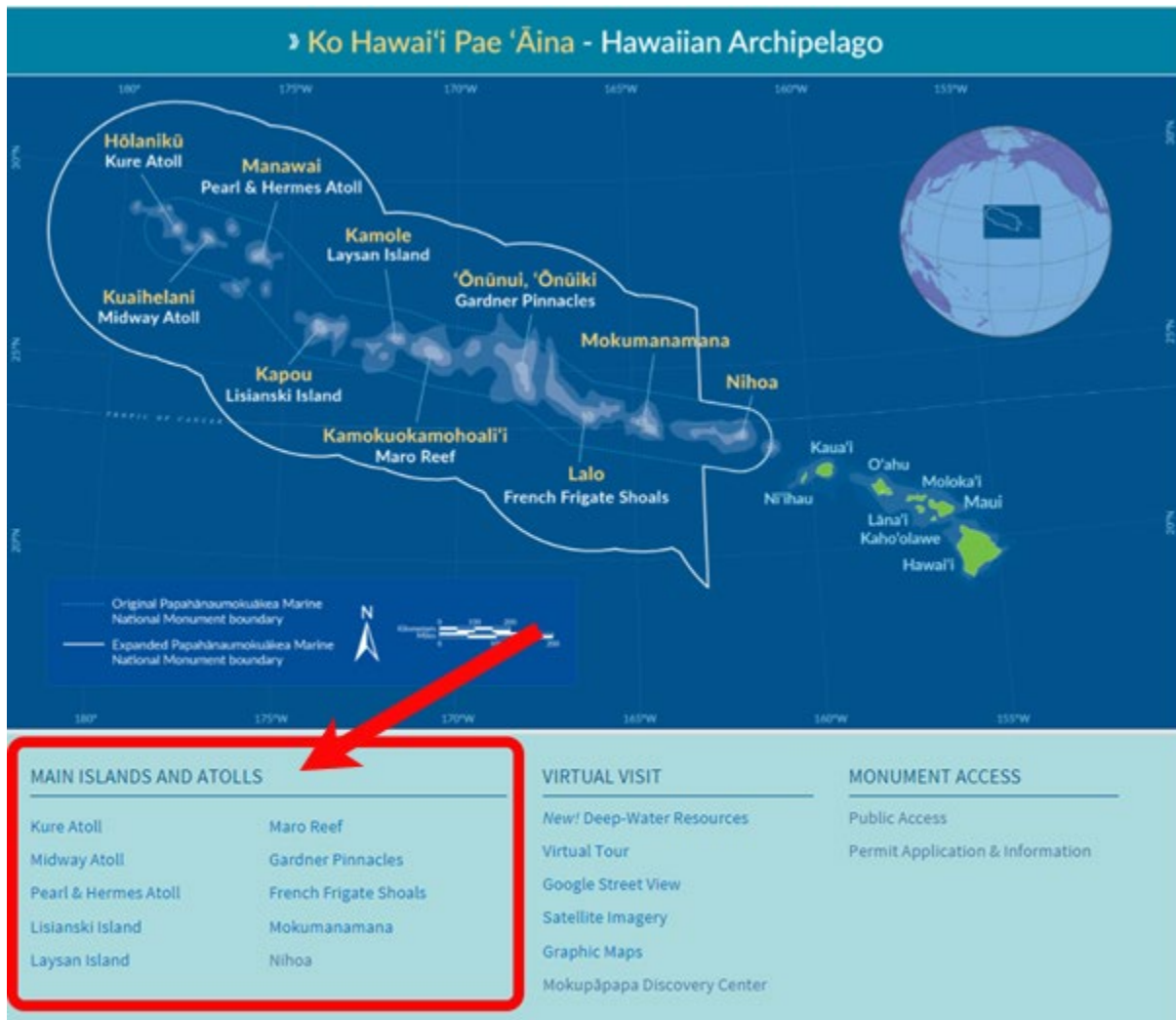


*Photo by Mark Sullivan/NOAA, 2007
Photo collected under NMFS Research Permit #848-1695*

The Papahānaumokuākea Marine National Monument website is an important place to learn more about your Northwestern Hawaiian Islands (NWHI) study site. Take time to explore the website links to see what you can find.

Instructions

Click on your Northwestern Hawaiian Islands (NWHI) study site from the Papahānaumokuākea [Virtual Visit map](#).



Please write at least three (3) notes or observations about your NWHI study site based on the resources you reviewed.

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Questions:

1. What are the Hawaiian and English names for your NWHI site? What is the significance of the place names and how can they help inform your understanding of the study site? (*Hint: Use the Ancient Names Remembered Map.*)

Marine Exploration with University of Hawai'i [Coral Health Atlas Interactive Map](#)

Immerse yourself in your site by submerging for a closer look at the reef and marine life through 360° virtual dive videos and 3D models. These two websites are created by Dr. John Burns and his team through the University of Hawai'i at Hilo. Answer the questions below and record observations or questions in your Field Journal.

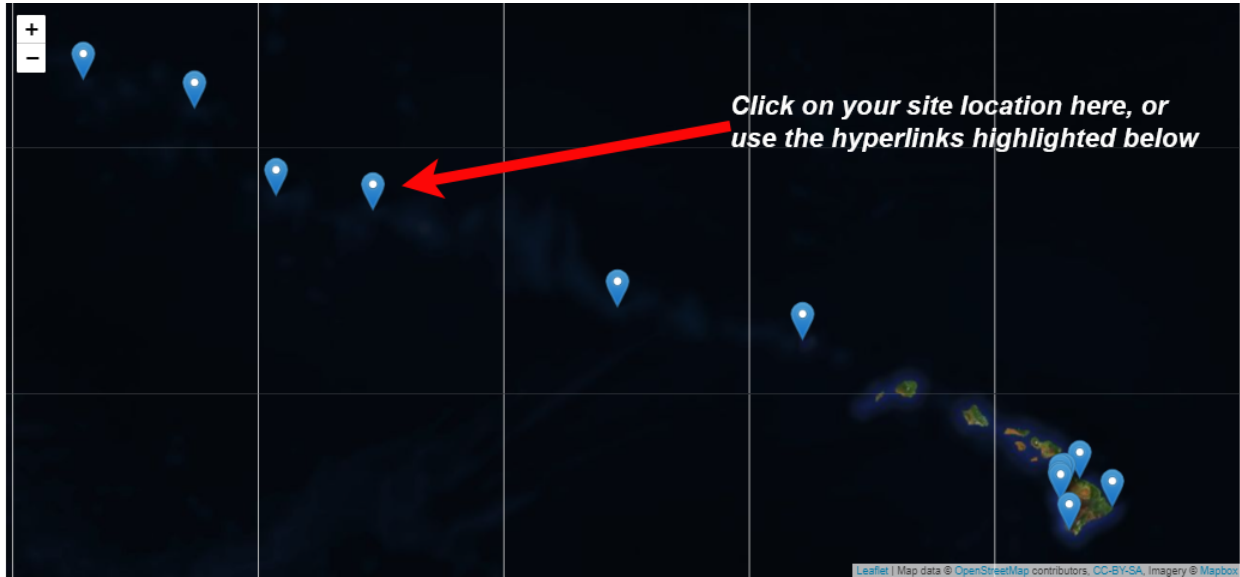


Screenshot from Coral Health Atlas, John Burns/University of Hawai'i

Instructions

Go to the [Coral Health Atlas website](#).

Using the map or the site names links located just below the map, select the hyperlink name for each of your sites. (Note: Kāneʻohe Bay and Lehua are not on this website. Links for those sites are provided farther below.)

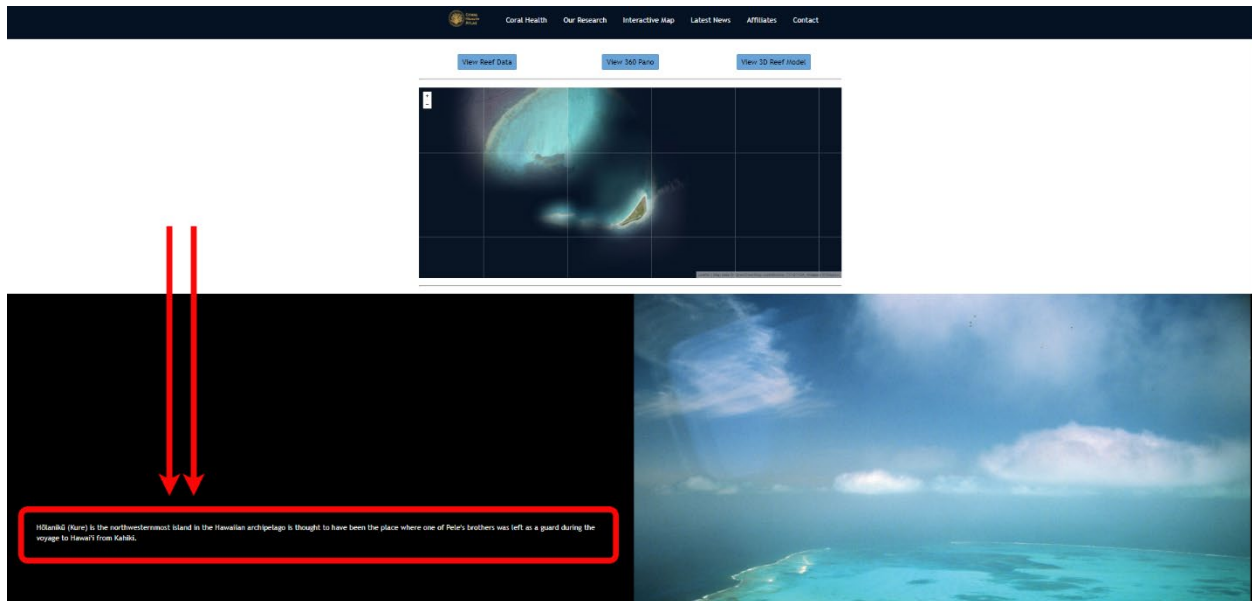


Keep checking back as we update data and provide more 360-degree panoramic videos and 3D models for our study sites.

- [Hōlanikū, Mokupāpapa](#)
- [Kahuwai](#)
- [Kailua](#)
- [Kaloko](#)
- [Kamole, Kauō](#)
- [Kapou, Papaʻāpoho](#)
- [Kīholo](#)
- [Lalo, Kānemiloʻaʻi, Mokupāpapa](#)
- [Manawai, Holoikauaau](#)
- [Nihoa](#)
- [Pohue](#)
- [Waiuli](#)
- [Waiʻōpae](#)

- If you chose **Kāneʻohe Bay** as a study site, [follow this link](#).
- If you chose **Lehua** as a study site, [follow this link](#).

Once you click on your study site, scroll down the page to read the descriptions for each site (Note: there are multiple facts so keep scrolling to the bottom).



Write down at least two facts about the cultural or biological significance of your study sites. If you have been to this location in person (MHI), include a short description of how you and your 'ohana (family) view this place.

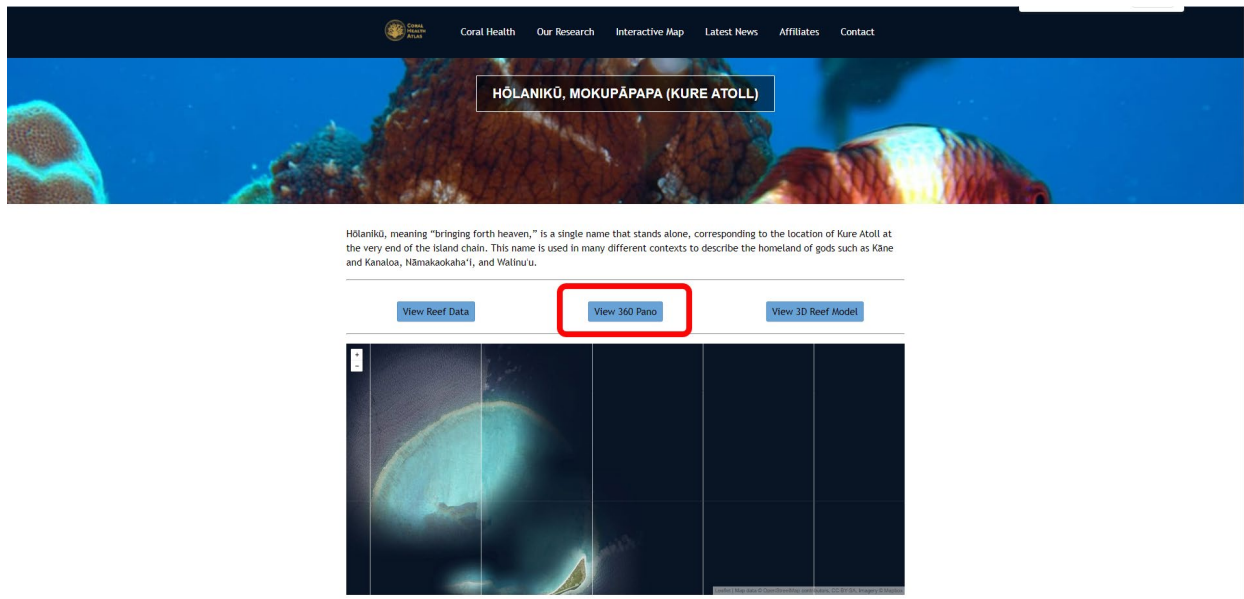
Write your facts here for your MHI and NWHI sites.

My MHI site location is _____.

My NWHI site location is _____.

Click on the “**View 360 Pano**” button and click play to watch the video. Use your mouse to drag the camera in all directions or connect through VR goggles. If you have any trouble viewing the video through the site, go directly to [Dr. Burn’s YouTube channel](#).

When finished, click the “Back” button on your browser to return to the Interactive Map.



- If you chose **Kāne’ohe Bay** as a study site, [follow this link](#).
- If you chose **Lehua** as a study site, [follow this link](#).

Take notes on what you observe. Be sure to keep your MHI and NWHI site notes separate.

Questions:

1. What marine life do you observe? Note the type of habitat the reef provides. How would you describe the reef? What is the shape like? What are the corals like?

Main Hawaiian Islands Site:

Northwestern Hawaiian Islands Site:

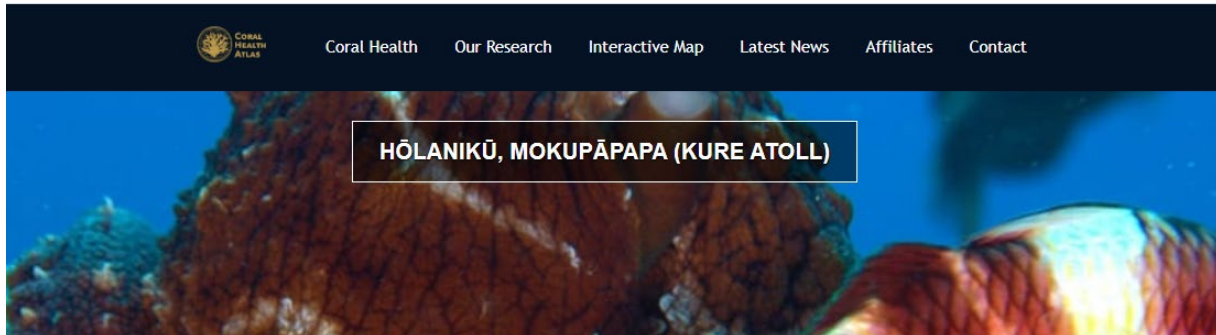
2. How are the reefs at your two study sites similar? How are they different?

Now click on the “**View 3D Reef Model**” button and click play (wait for model to load).

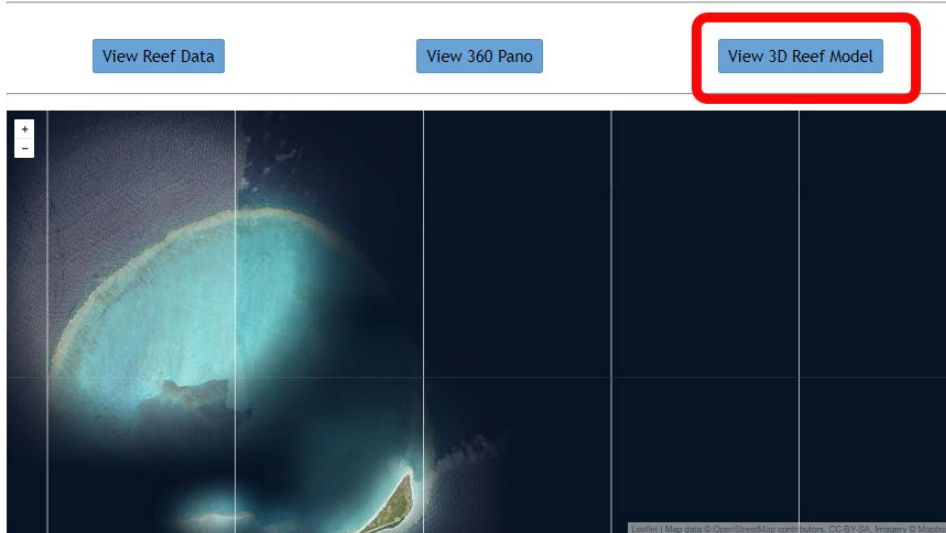
Although scientists continue to snorkel or scuba to study reefs, some people are also using a new technique called [Structure-from-Motion Photogrammetry](#), where computer software converts hundreds of photos into a 3 dimensional model of the reef so scientists can use it to see changes to the reef over time, as well as look for bleaching and diseases. This is an emerging technology still being developed (as of 2021).

When finished, click the “Back” button on your browser to return to the Interactive Map.

Use your mouse to move and zoom as you explore the 3D reef.



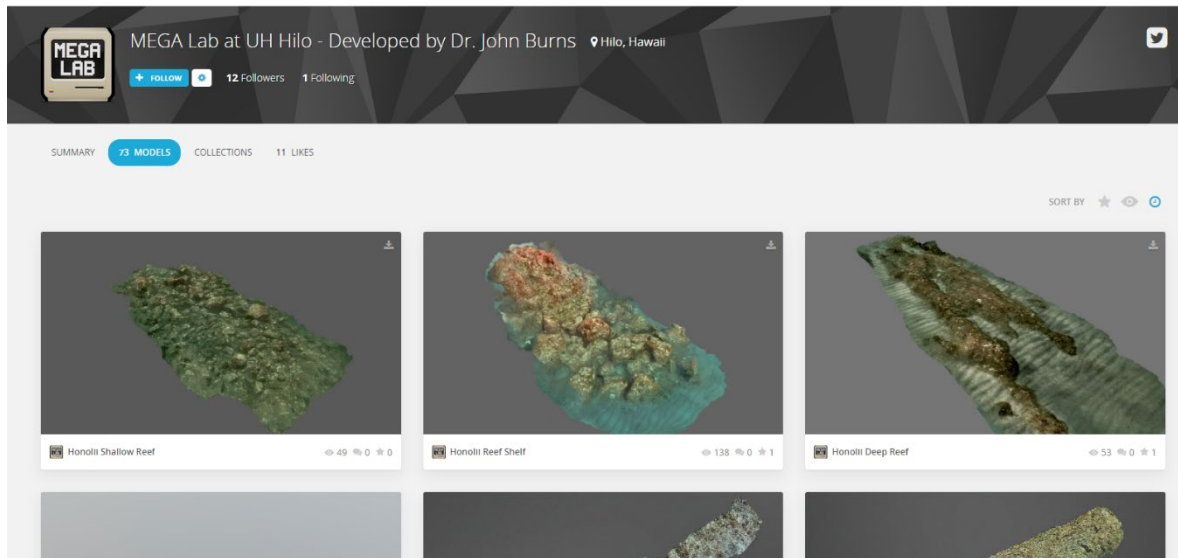
Hölanikū, meaning “bringing forth heaven,” is a single name that stands alone, corresponding to the location of Kure Atoll at the very end of the island chain. This name is used in many different contexts to describe the homeland of gods such as Kāne and Kanaloa, Nāmakaokaha’i, and Walinu’u.



[MEGA Lab at UH Hilo](#) (Hosted on SketchFab)

Some of the study sites are not available on Coral Health Atlas. In that case, you will find 3D models of the coral at your chosen study site on the newer MEGA Lab site. Click on the image and it will load the 3D model. Be sure to scroll to the bottom of the page to read the description of the site. You can use the mouse to zoom and move the model. You will find models for:

- [Kāneʻohe, Oʻahu \(Kbay\)](#)
- [Lehua, Niʻihau](#)
- Lalo/French Frigate Shoals (bonus)
- Kuahelani/Midway Atoll (bonus)



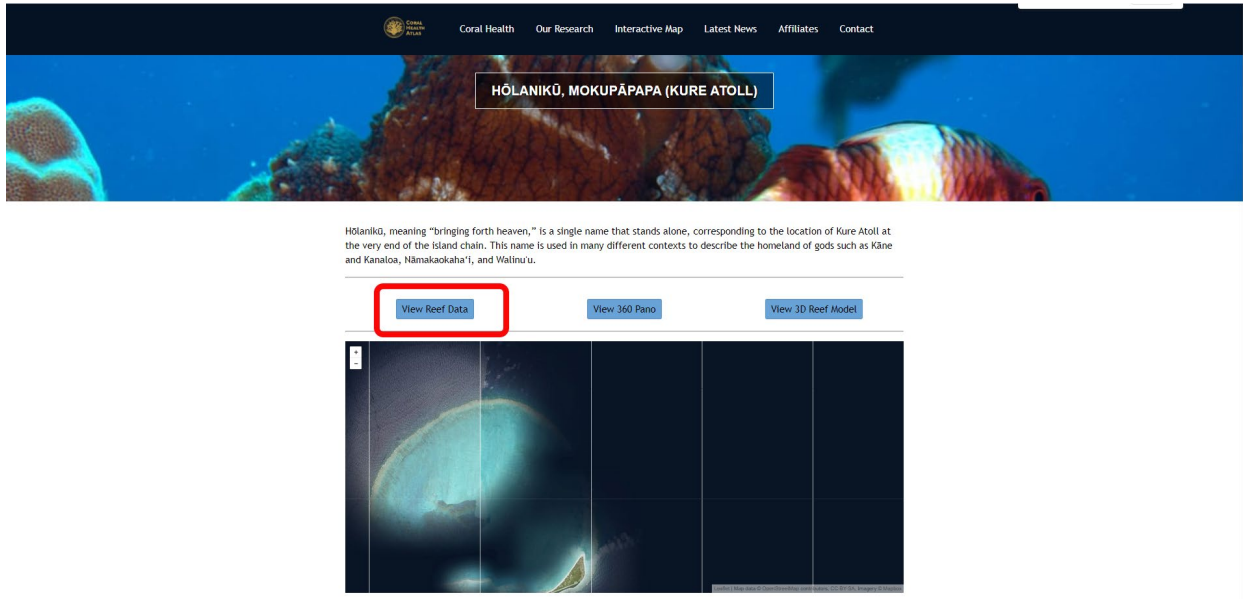
Questions:

1. What else do you observe? Now that you've seen the reef model, is there anything else you would add to describe the habitat this reef provides?

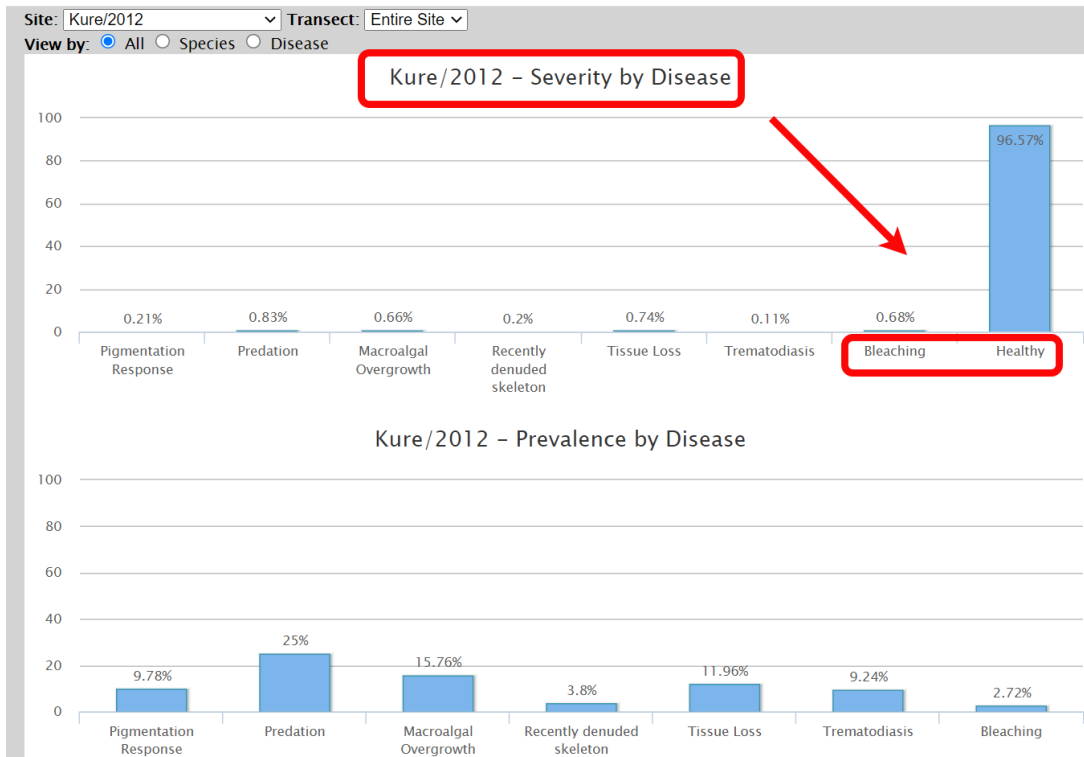
Main Hawaiian Islands site:

Northwestern Hawaiian Islands site:

Click on the “View Reef Data” button (in Coral Health Atlas)



You will see a bar graph showing two sets of information. For this task, focus on the top graph, *Severity by Disease*. The primary information you’ll need is highlighted in the image below — the percentage of coral bleaching and the percentage of healthy coral.



Questions:

1. What percent of the reef is healthy?

Main Hawaiian Islands site:

Northwestern Hawaiian Islands site:

2. What percent is showing bleaching?

Main Hawaiian Islands site:

Northwestern Hawaiian Islands site:

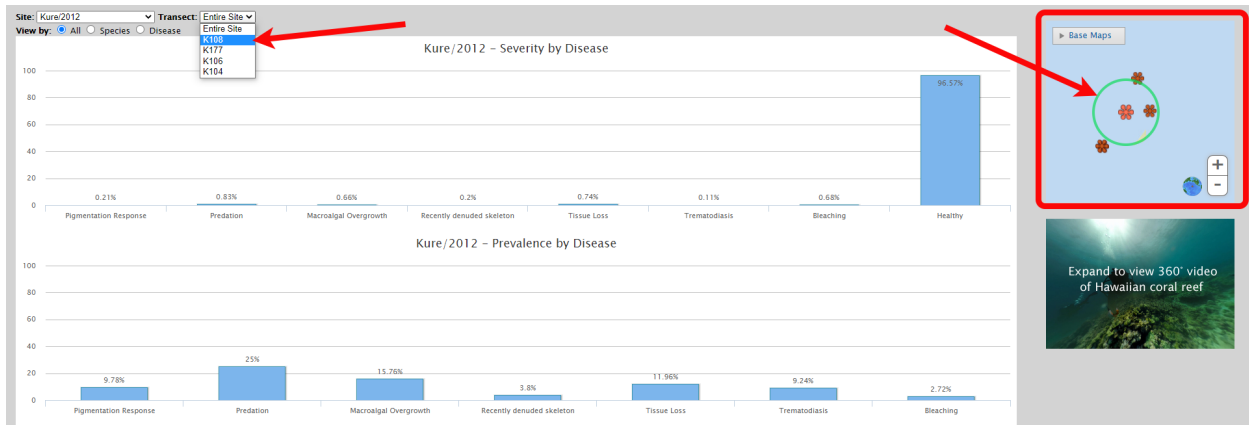
3. Are there any other diseases/problems showing up in the graph (more than 1%)?

Main Hawaiian Islands site:

Northwestern Hawaiian Islands site:

Note the map in the upper right corner of the screen. Hover your mouse over the map and scroll to zoom in. You should see multiple flower icons. Each icon represents one of the sections of reef the researchers studied to make this graph. The line of reef they studied is called a **transect**.

Click on one of the flower icons. Notice how the bar graph changes. Instead of an average of all of the sites, the graph now shows you data for that specific transect location. Click through the different transects and note if any of them had especially high coral bleaching or other problems. You can also use the Transect drop down menu located in the upper left.



Please write at least three (3) notes on any part of the University of Hawai'i websites you just explored.

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Papahānaumokuākea Marine National Monument [Flickr Site](#)



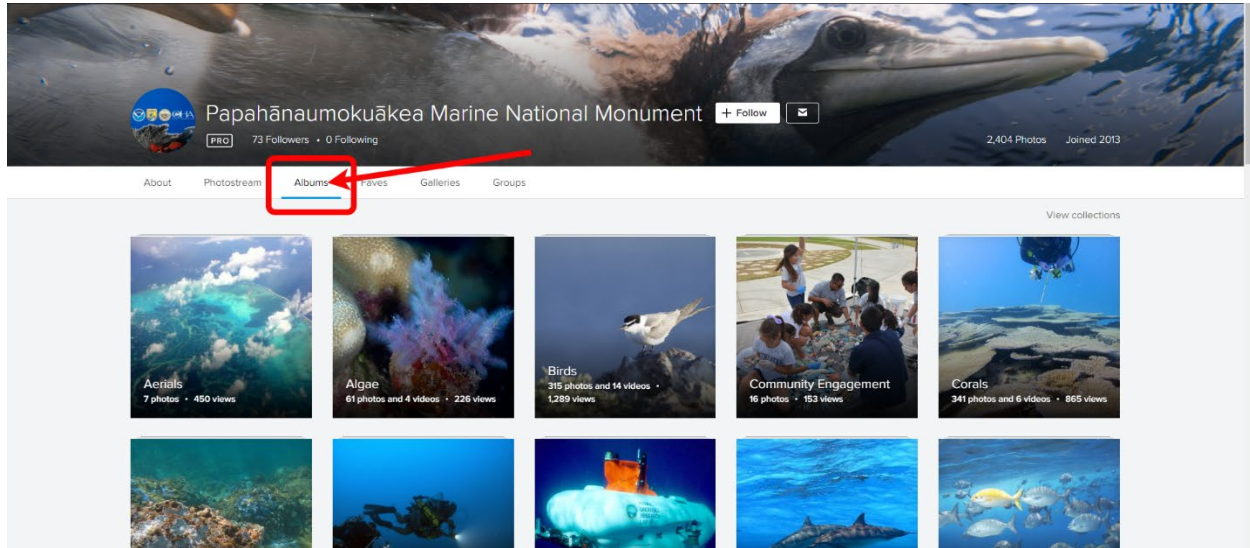
Photo by John Burns/NOAA, 2017

While 360° video and 3D models are fast becoming the norm, the highest resolution products we have are still photos and 2D videos. View the pictures and videos on Flickr and take notes of your observations in this Field Journal. What wildlife and plants are found at each of your sites?

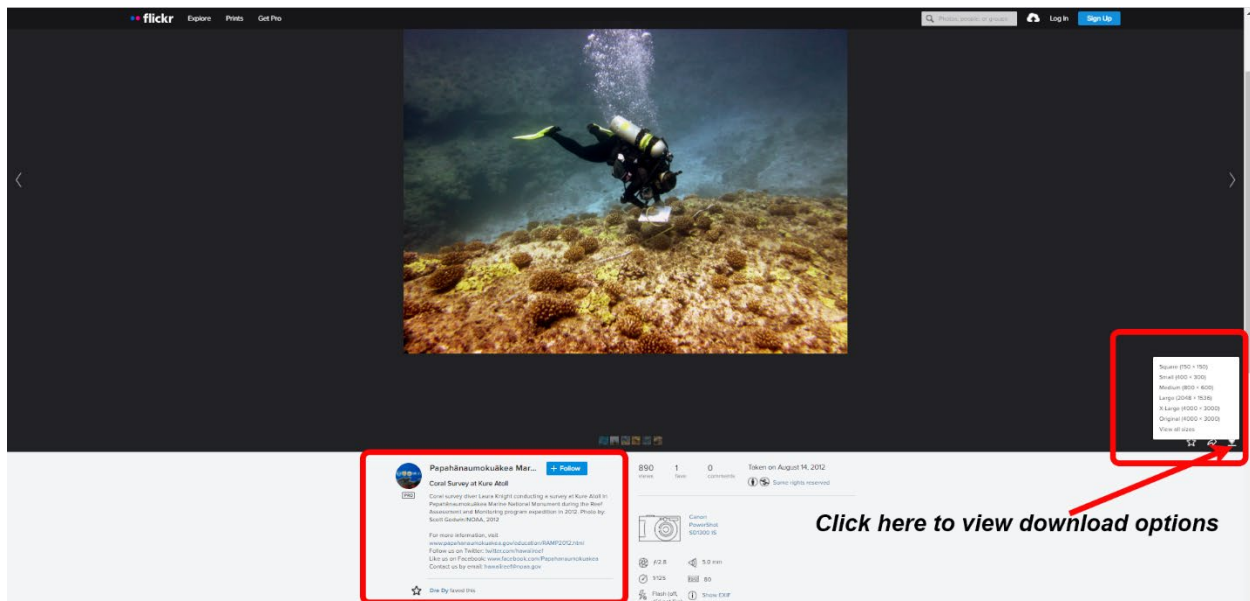
NOTE: This activity should be done with an adult.

Instructions:

When you open the link, “Photostream” Mode will be selected automatically. Click on “Albums” Mode. Scroll down and select the album for each of your Northwestern Hawaiian Islands sites.



Scroll through the different photos and videos. If there is one you like, you can download it by clicking on the download arrow icon in the bottom right of your screen and selecting the file size you want. If you look below the photo, you can learn more about the image, the photographer, and, sometimes, links to further information. Note: While most images are in the public domain, some are copyrighted by the photographer and will not allow you to download them.



Please write at least three (3) notes about your MHI or NWHI study sites based on your review of the Papahānaumokuākea Marine National Monument Flickr site. Be sure to indicate what site you are writing about.

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Lesson 4: Coral Bleaching Virtual Survey



Photo by Jeff Kuwabara/University of Hawai'i Marine Option Program, 2017

Why do we conduct coral surveys? What is the purpose of them and how do they work? There are various types of surveys that help us answer different questions about a reef environment. Together, the results of those surveys help us build a more complete understanding of overall reef ecosystem health over time. Your job today is to conduct a coral bleaching survey, assessing the amount of bleaching in each of your study sites.

Reviewing the Stages of Coral Bleaching

As a coral scientist-in-training, it is important for you to be able to identify the differences between healthy, bleached, and dead coral. You learned some of this in the video [Explore a Coral Reef with Michael Caban](#) when you first began this journey.

For the next section you will need to understand the symbiotic role of zooxanthellae with the coral polyp. Please view the NOAA Ocean Today video [The Coral and the Algae](#) (3min 15sec).

The screenshot shows a video player interface for a NOAA Ocean Today video. The video title is "The Coral and the Algae" and the subtitle is "In one way of thinking, corals are part animal, vegetable, and mineral. How is that possible?". The video player shows a coral polyp with three checkboxes: "ANIMAL" (checked), "VEGETABLE" (unchecked), and "MINERAL" (checked). The video player controls show a progress bar at 0:00 / 3:15.

NOAA OCEAN TODAY EVERY FULL MOON
A supplemental resource for educators

Home Videos Deeper Dive Collections Search

HOME / COLLECTIONS / CORAL COMEBACK / THE CORAL AND THE ALGAE

The Coral and the Algae

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

- ANIMAL
- VEGETABLE
- MINERAL

0:00 / 3:15

View the following three Office of National Marine Sanctuaries 360° images from [National Marine Sanctuary of American Samoa's](#) Airport Pool Coral Reef on Tutuila. Note the changes that occurred to the reef during and after the 2015 bleaching event. You should see a progression from healthy color, to bleached, to algae-covered dead coral.

- Pre-2015 [Healthy Coral](#)
- During the early [2015 Bleaching Event](#)
- After the 2015 Bleaching, [Coral Die-Off](#)



Image courtesy of XL Catlin Seaview Survey/The Ocean Agency.

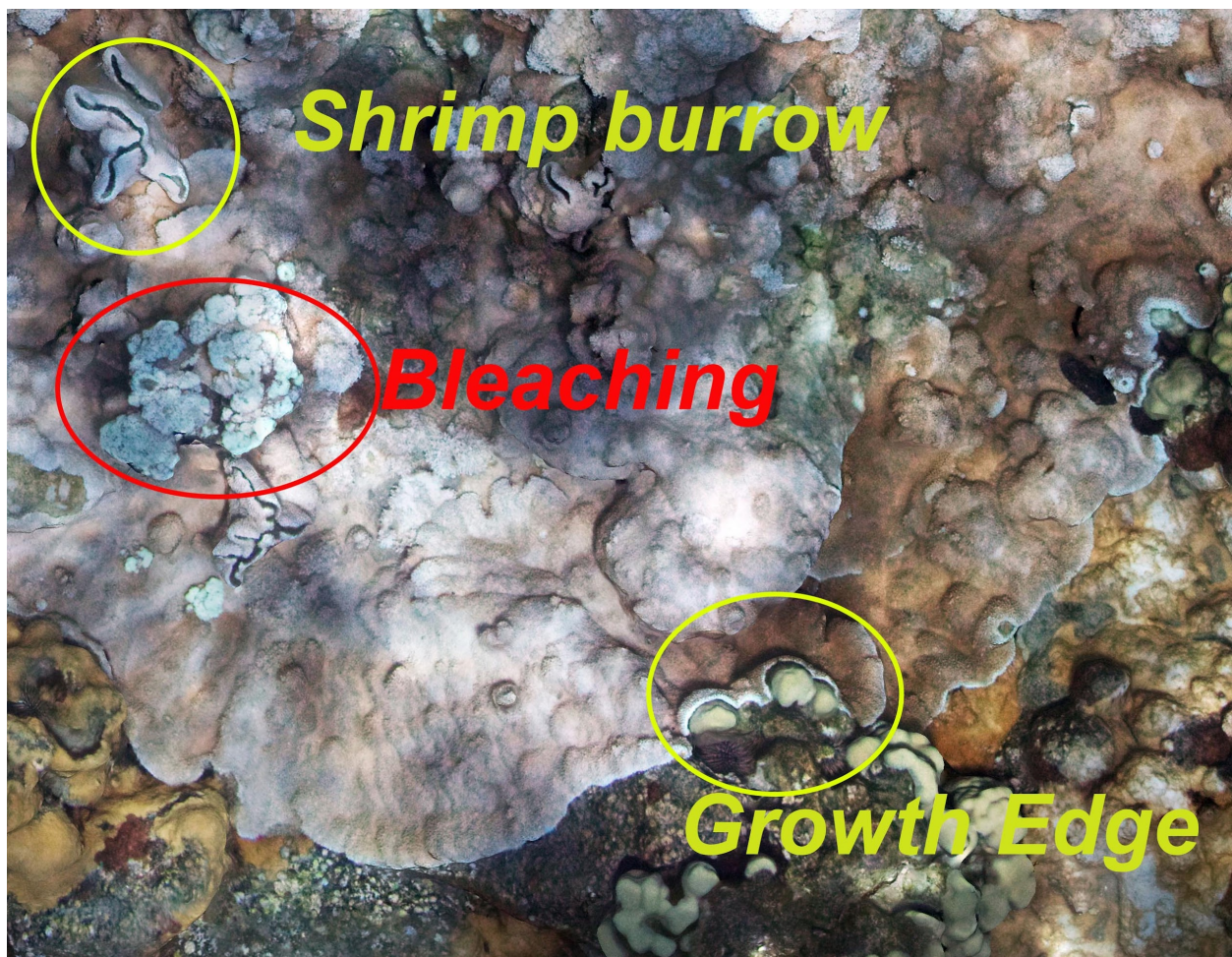
As we've learned, coral bleaching is an indicator of coral polyp stress, but does not mean the coral polyps are dead. If conditions improve, corals can re-establish their symbiotic relationship with zooxanthellae and rebuild their health. Monitoring coral bleaching helps us identify areas that may require special attention and support.

Important Details

Now that you have an idea of how to identify bleached coral, we want to introduce a few more things that will help you in your survey — by showing you something we will NOT be counting.

Coral Growth Edges

You will see what looks like coral bleaching along the edges of individual coral colonies. This is NOT bleaching. As coral colonies expand, the polyps build new white calcium carbonate skeletons, but have not yet ingested zooxanthellae to gain their color. That is different from coral bleaching due to stress. You also shouldn't count the white edges around petroglyph shrimp burrows.



Crustose Coralline Algae (CCA) and Halimeda

You will likely see two other confusing things that are NOT coral, but are integral parts of a coral reef. There are some algae that are **calcareous**, meaning they contain calcium carbonate, the same material used to make shells and coral skeletons. The pinkish purple crusts on the rocks are species of red algae called crustose coralline algae (CCA). CCA helps cement rock and rubble to form the foundation on which corals can grow. The small, green bushy shapes are *Halimeda*, a genus of green algae also made of calcium carbonate material. *Halimeda* is a major source of sand in some areas as parts of it die and the calcium carbonate erodes into small sand particles.

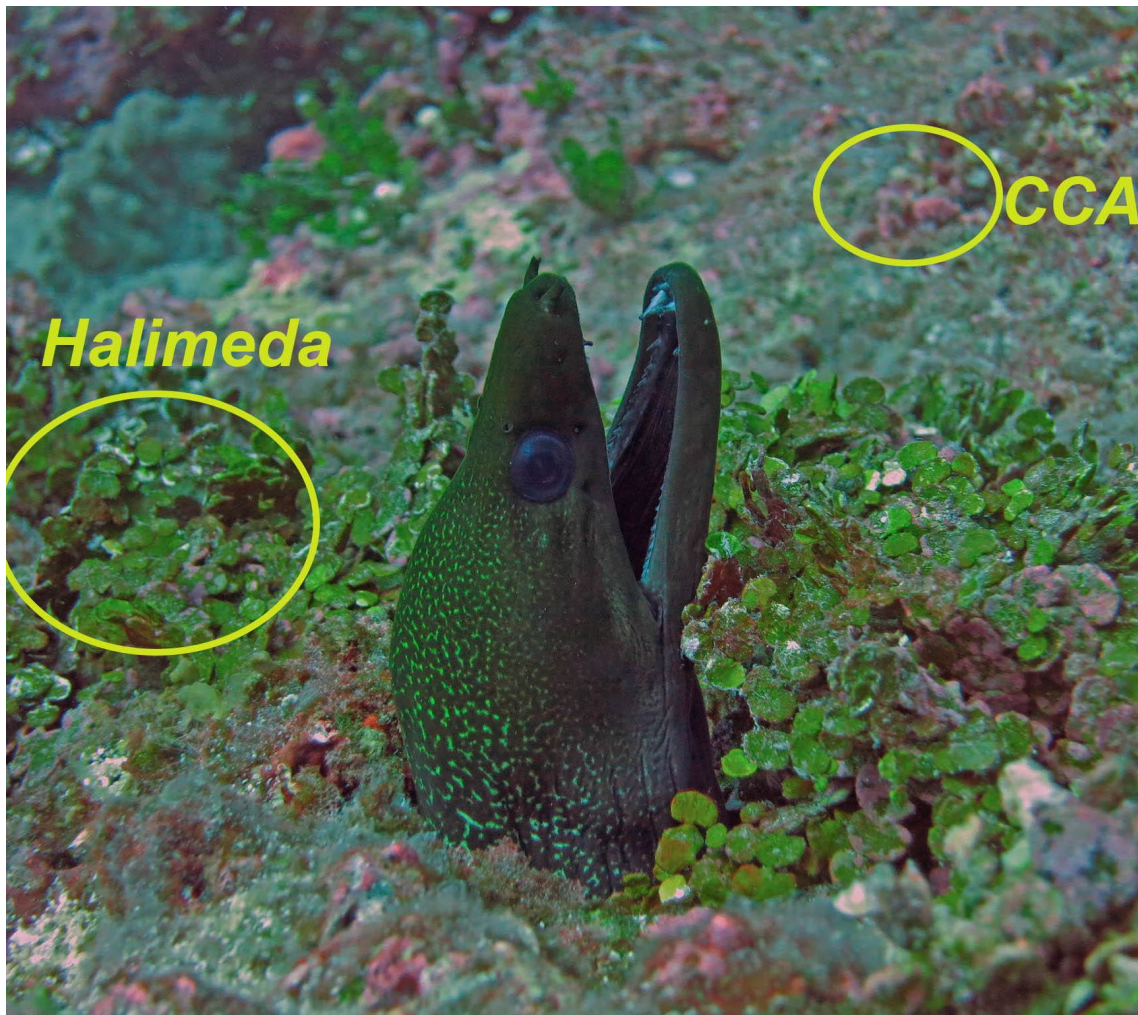


Photo by Karen Bryan/HIMB, 2017

Visual Survey

You are going to “swim” across your study sites and conduct a visual bleaching survey. The data you gather will offer a snapshot of coral bleaching impacts, telling us about the bleaching conditions right now. Find your Main Hawaiian Island and Northwestern Hawaiian Island study site(s) on the [Coral Check-up Student Page](#) on the Papahānaumokuākea.gov website. Download the files or view online. Open each coral image and use your photo viewer tools to examine the entire reef. Be sure to zoom in and look closely at the reef image. We have provided you with examples of how to conduct a visual survey on the next few pages. Once you have viewed the images for your two study sites, answer the questions below.



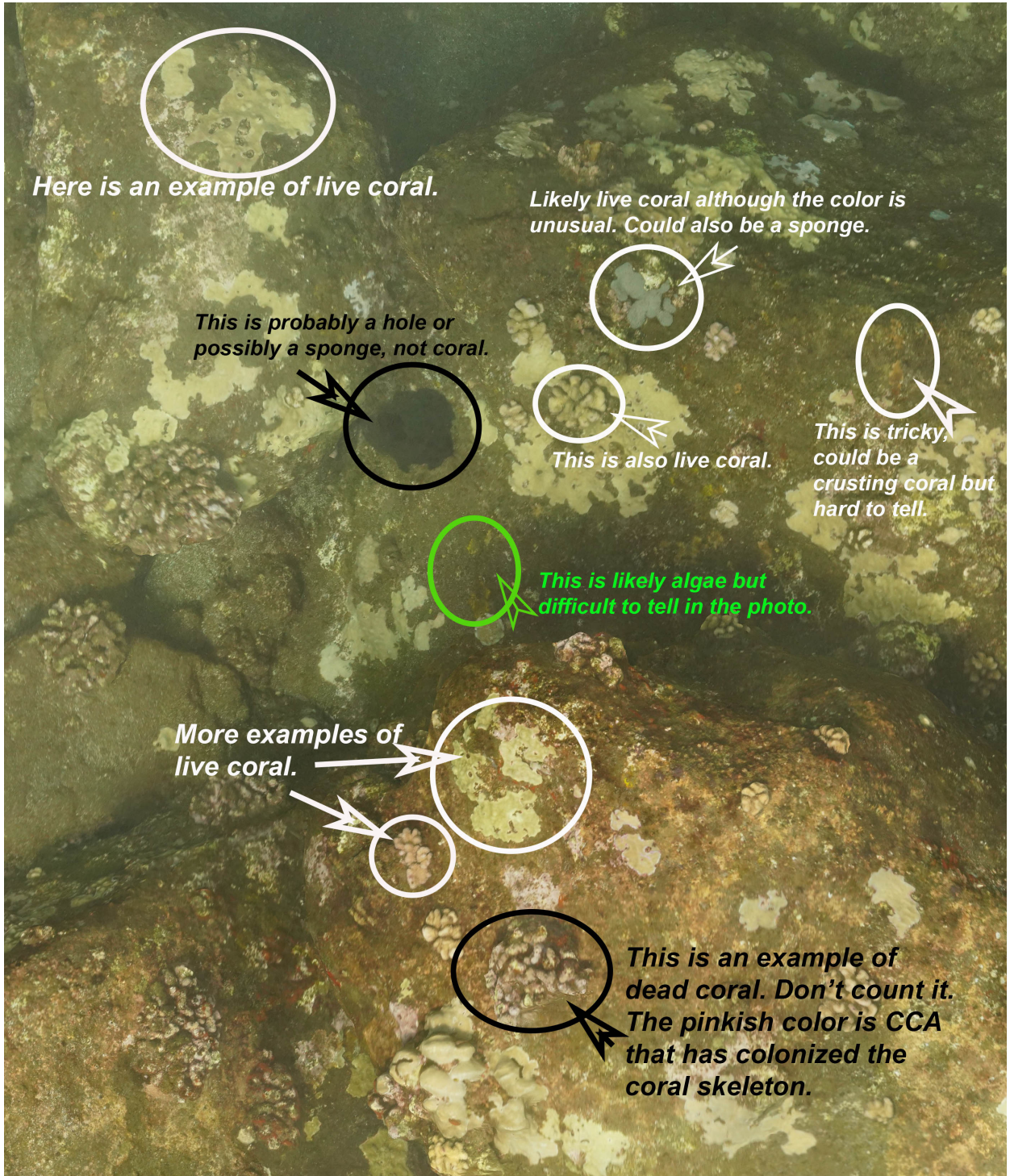
Photo by James Watt, 2002

Visual Survey Example

Here you see an overhead image of the rocky reef of Honoli'i, located on Hawai'i Island. Look at the entire image. Take note of the coral you can see, as well as any marine life. When viewing your own study sites you will estimate the bleaching impact using a scale of 1-10, where 0 is no bleaching and 10 is completely bleached. First identify all of the living coral, then note any coral that shows at least some bleaching. The coral doesn't have to be completely white, but should look paler than similar coral nearby or show splotches of bleaching. Do not include dead coral or algae in your estimate. See below for some hints to help you along.



Look at the image below. We've marked up examples of live coral, dead coral, and some tricky items that are likely algae or sponges. Note that most of the dead coral is overgrown with algae and also has a pinkish color — remember, that is the crustose coralline algae (CCA) and not live coral.



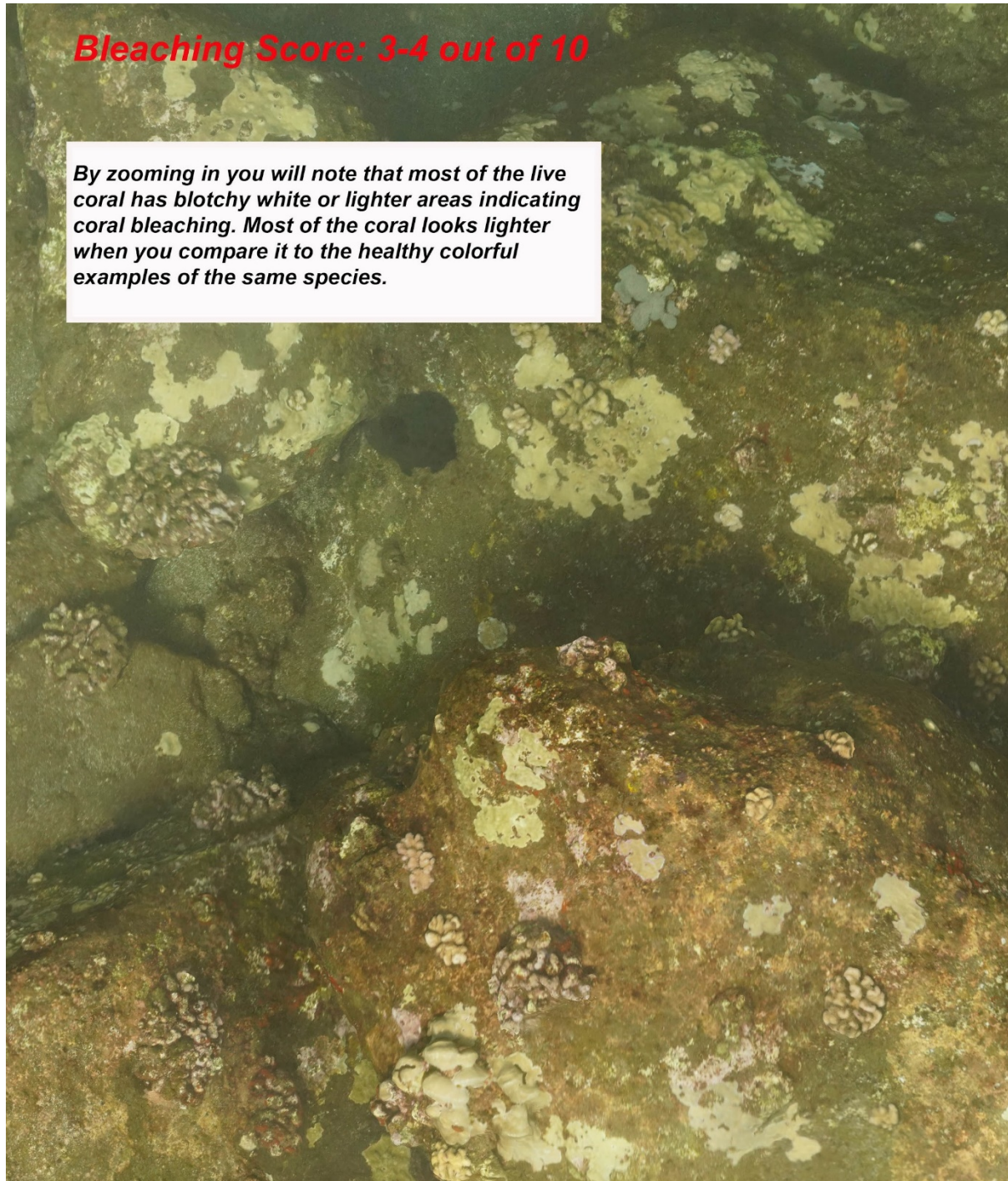
The activity will be easier using the zoom feature of the picture viewer to look at the individual corals up close. Comparing the colors of similar nearby species helps identify coral colonies that are partially bleached. Partially bleached coral colonies will have a paler color due to the partial loss of their zooxanthellae, or else the colony will show patches of white (bleached) coral within an overall health colony. You may also see both paler color and bleached patches within a colony, again indicating partial bleaching (and showing increasing stress). You should count these partially bleached corals in your bleaching estimate.



As you attempt to calculate your bleaching number, if it helps, think about your answer as a percentage. If you think 30% of the live coral in the image shows bleaching, put a 3 as your answer, if 50%, put 5 as your answer, etc. If you are viewing the image in a program with drawing options, you can mark areas to help you visualize.

Visual Survey Example Answer: Score-3-4

Being a coral scientist isn't easy, is it? View the questions below and get started on your own study sites! This is a challenging exercise. Do your best.



Questions

1. What marine life can you find hidden within this habitat? Note any other observations as well.

Main Hawaiian Islands (MHI) Site: My site location is _____.

Northwestern Hawaiian Islands (NWHI) Site: My site location is _____.

2. What signs of bleaching coral do you observe?

Using a scale of 1-10, where 0 is no bleaching and 10 is completely bleached, estimate the bleaching impact on your reef sites. Please write a short explanation for your answer.

Estimated bleaching for the MHI _____. *My site location is _____.*

Estimated bleaching for the NWHI site _____. *My site location is _____.*

3. Be prepared to share your results with your class. Your teacher will give you more information on how they would like you to proceed.

Quadrat Transect Survey

As we've learned, relying on a quick visual survey leads to many different answers for the same location. While a visual survey can help us gather a general impression of coral reef health for an area, we need methods that will produce more reliable results. If every scientist gets a different answer, what use is the data when comparing it or making important decisions? A well-trained team of science divers can improve the data consistency, but we need approaches that keep us all following the same ground rules.

There are many methods and protocols to survey a coral reef, each built to address specific questions and use available resources. Using a quadrat along a transect survey is one way to get more reliable and consistent results (see the image below). You will now conduct a coral survey of your sites by "swimming" a transect line and analyzing three quadrats (squares). Science divers gather data along the same transect over many years to be able to monitor changes to the coral over time. New approaches include using specialized software and artificial intelligence to capture and analyze reef data based on photos and video footage, even rendering it into three dimensions as you've already seen.

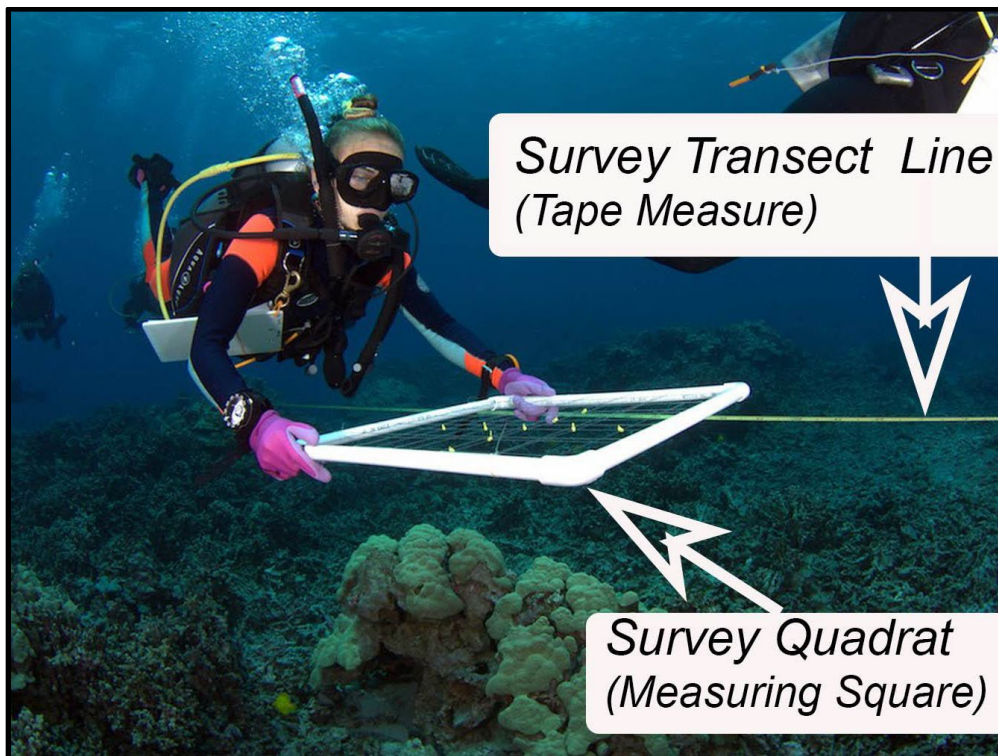
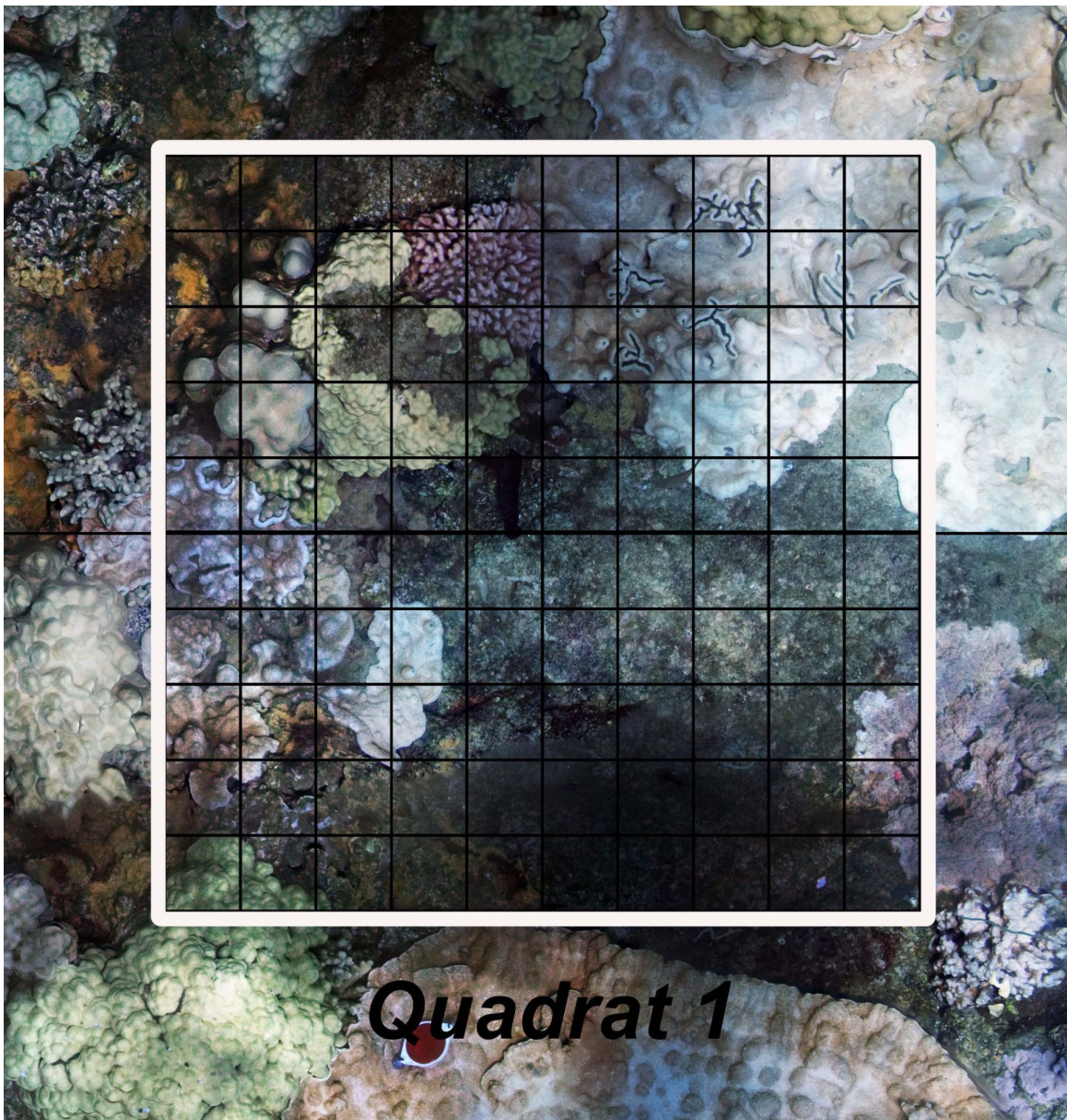


Photo by Jeff Kuwabara/University of Hawai'i Marine Options Program, 2017

Find your Main Hawaiian Island and Northwestern Hawaiian Island study sites on the [Coral Check-up Student Page](#). Download the files or view online. Open the coral image and use your photo viewer tools to examine the three quadrats. See below for instructions and questions.

Transect Survey Instructions

For this exercise, each photo will have three quadrats for you to analyze. Each quadrat is divided into 100 small squares (see picture below). Your job is to identify how much coral is bleached within each quadrat for both your Main Hawaiian Islands and your Northwestern Hawaiian Islands study sites.



EXAMPLE QUADRAT (This image only shows 1 of 3 quadrats)

Transect Survey Methodology:

There are different ways scientists set up their **methodology** — the agreed-upon plan of action. Our methodology will keep your bleaching identification fairly simple since this is your first time conducting this type of survey. More complex versions of this visual quadrat method have been widely used in Hawai'i for the past 30 years.

Step 1: Identify coral in your quadrat

Look at each individual square within your quadrat. Highlight all of the squares that are at least ½ full of coral. We will count each of these as 1. We have provided an example here.

Example: How to identify coral

White square = coral

It's hard to tell, but this is likely rock covered with some algae.

Doesn't count since it doesn't fill 1/2 of the square.

This area is rock with some CCA (crustose coralline algae)

This was a tough call, but the coral does NOT quite take up 1/2 of the square

This is a crusting coral. The color is a helpful clue.

QUADRAT #1

$8+10+8+9+4+3+4+4+5+5=60$ squares with coral

Step 2: Identify coral bleaching

Now that you have identified the coral in your quadrat, we need to mark where there is coral bleaching — this time using red to highlight the square. Again, we will follow the $\frac{1}{2}$ rule. If the bleaching takes up at least $\frac{1}{2}$ of the square, then it counts as 1. If the small square is less than $\frac{1}{2}$ full, then count the entire small square as no bleaching. For this activity, you can count coral that is partially bleached — meaning it will have spots of bleaching or will show a visibly lighter color than the healthy coral around it. For fun, also note any organisms within your quadrat. We highly recommend zooming in to the image to help with your bleaching identification. Again, refer to the example below.

Example: How to identify bleached coral

Red square=bleaching

Petroglyph shrimp burrows, NOT bleaching

This was a tough call, but while these surrounding squares show some partial bleaching, they do not quite make up $\frac{1}{2}$ the square.

Growth edges NOT bleaching

Reef fish

Loli / Sea Cucumber

Another tough call, but these squares show more than $\frac{1}{2}$ healthy color

Ina'ala / Rock boring urchin

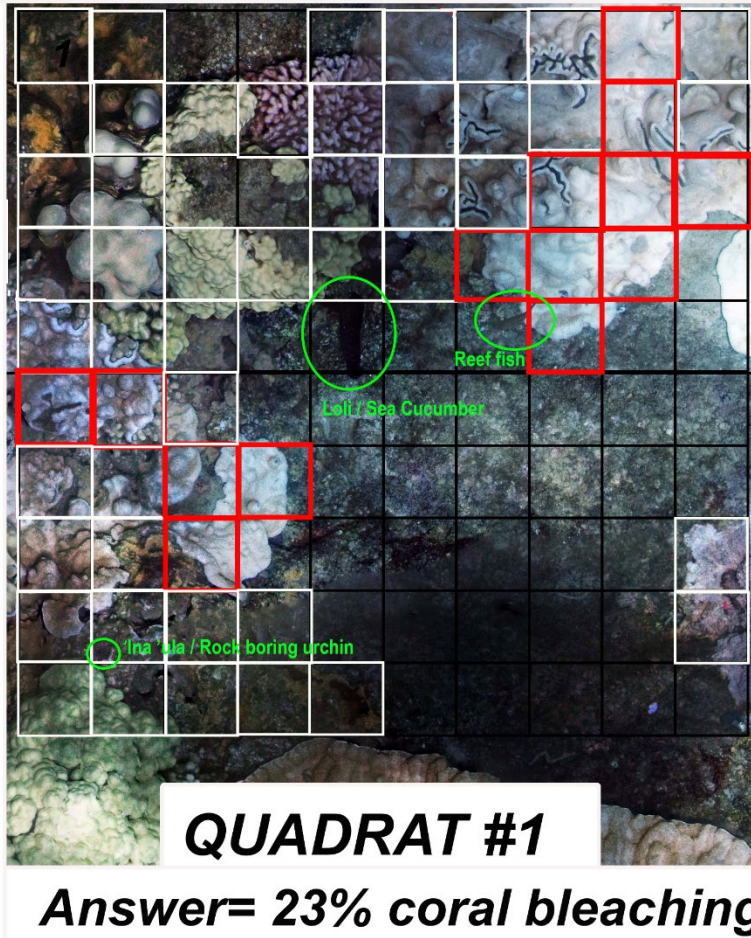
QUADRAT #1

Number of **RED** squares = **14**

Step 3: Calculate percent coral bleaching

You now are ready to analyze your data to calculate your results. To figure out the percent of coral bleaching, we need to look at the ratio of bleached coral to total coral within your quadrat.

$$14 \text{ red} \div 60 \text{ white} = .23 \text{ or...}$$



1. Count the number of **WHITE** squares in your quadrat (the total amount of coral). In the example, 60 of the squares meet our criteria.
2. Count the number of **RED** squares in your quadrat (the total amount of bleached). In the example, 14 squares meet our criteria.
3. Calculate the percent bleaching for your quadrat.

$$14 \text{ bleached coral squares} \div 60 \text{ coral squares} (14/60) = .23$$

$$\text{Let's shift this to a percentage: } .23 \times 100 = \underline{23\% \text{ coral bleaching}}$$

Follow these same steps for your study sites to answer the questions below.

Discussion

Even our simplified methodology can be tricky. Some coral is mostly bleached but not yet completely white. Other squares have some bleached coral, but it is difficult to tell if $\frac{1}{2}$ the square is filled. Do your best. This is why coral scientists go to school to study and practice these skills. They also work in teams and conduct multiple surveys to make sure their results are reliable. As a class, you can look at everyone's results and figure out an average for similar sites. Your teacher will have an answer key and can help you with any questions.

We recommend you write any confusing parts, challenges, or other thoughts in your notes. It is important to bring these issues up with your team to ensure the best accuracy in your results.

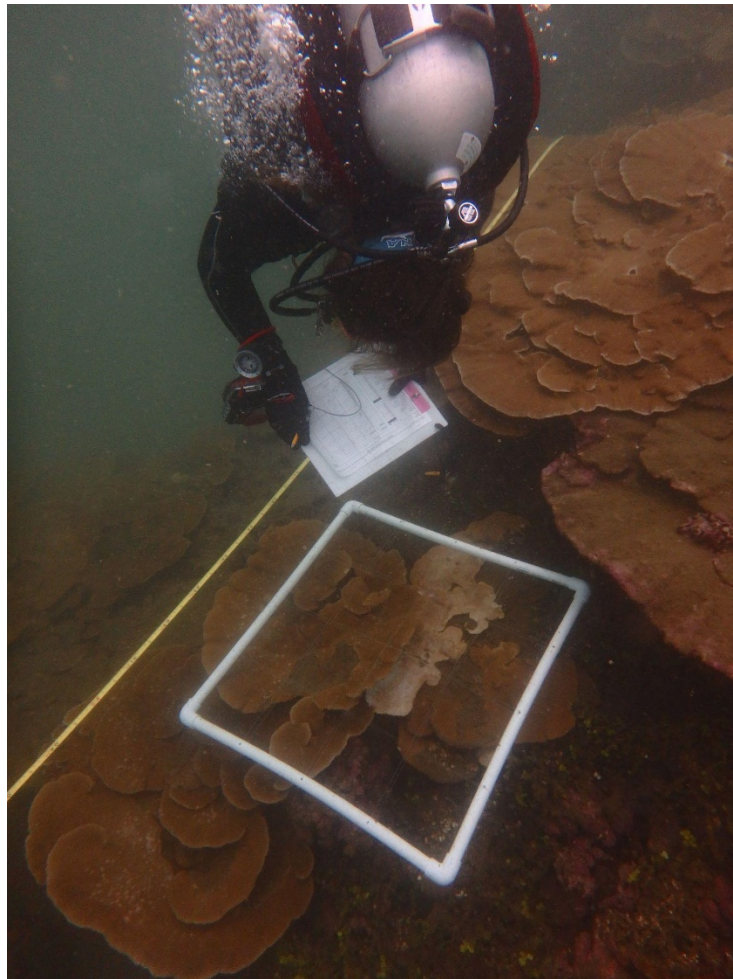


Photo by Stewart/UH Hilo MOP program, 2016

Coral Survey Questions:

1. What is the **percentage of bleached coral** for each quadrat?
(*hint: 1 small square = 1%*)

Main Hawaiian Island Site: *My site location is* _____.

Quadrat #1

Number of white squares (squares with coral): _____

Number of red squares (squares with bleached coral): _____

_____ Red Squares ÷ _____ White Squares x100 = _____ % bleached.

Quadrat #2

Number of white squares (squares with coral): _____

Number of red squares (squares with bleached coral): _____

_____ Red Squares ÷ _____ White Squares x100 = _____ % bleached.

Quadrat #3

Number of white squares (squares with coral): _____

Number of red squares (squares with bleached coral): _____

_____ Red Squares ÷ _____ White Squares x100 = _____ % bleached.

Notes:

Northwestern Hawaiian Island Site: *My site location is* _____.

Quadrat #1

Number of white squares (squares with coral): _____

Number of red squares (squares with bleached coral): _____

_____ Red Squares ÷ _____ White Squares x100 = _____ % bleached.

Quadrat #2

Number of white squares (squares with coral): _____

Number of red squares (squares with bleached coral): _____

_____ Red Squares ÷ _____ White Squares x100 = _____ % bleached.

Quadrat #3

Number of white squares (squares with coral): _____

Number of red squares (squares with bleached coral): _____

_____ Red Squares ÷ _____ White Squares x100 = _____ % bleached.

Notes:

2. What is the **mean average of bleaching** for the entire transect?
(*hint: average all three quadrats together — add all three values and divide by three*)

Mean Average Coral Bleaching for **MHI Site**.

Quadrat 1 ____ + Quadrat 2 ____ + Quadrat 3 ____ ÷ 3 = ____ %

Mean Average Coral Bleaching for **NWHI Site**.

Quadrat 1 ____ + Quadrat 2 ____ + Quadrat 3 ____ ÷ 3 = ____ %

3. What marine life can you find hidden within this habitat? Note any other observations as well. (*Don't forget you can use the marine life ID resources shared earlier.*)

Main Hawaiian Islands (MHI) Site:

Northwestern Hawaiian Islands (NWHI) Site:

Class Presentation

Prepare a 10 minute presentation for the class that includes:

- A short introduction to your study sites including images, location, and both ecological and cultural importance.
- A summary of your findings. Draw from your Field Journal notes to highlight important data, observations, and questions. Share visuals (pictures, screenshots, etc.).
- Report back on the bleaching condition of your study sites. What is your assessment of the health of your sites based on your research?
- Share your hypothesis that may explain differences in coral bleaching between your MHI and NWHI sites.



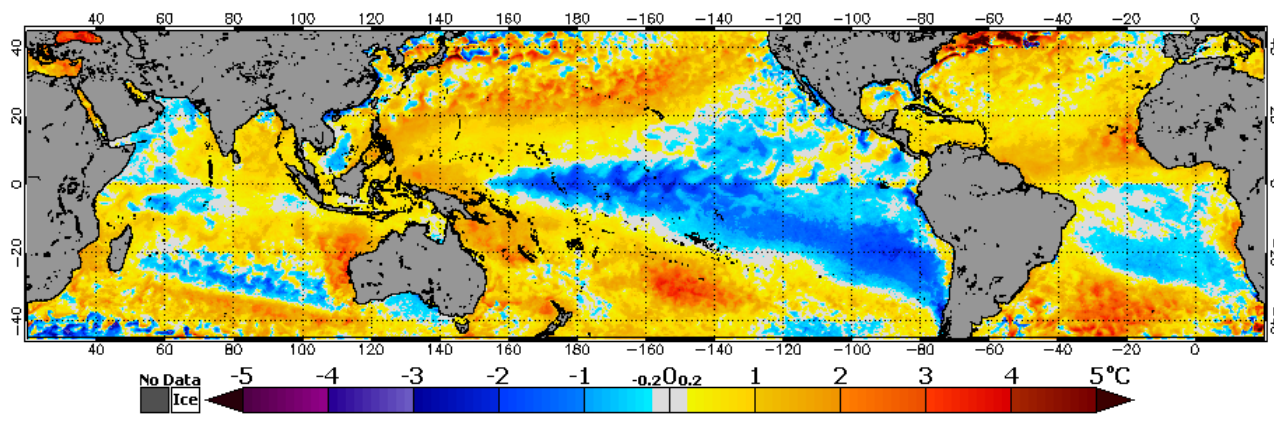
Photo by Andrew Gray/NOAA, 2017



Coral check-up: Unit 2

Reading Satellite Data and Seeking Solutions

NOAA Coral Reef Watch Daily 5km SST Anomalies (Version 3.1) 6 Jan 2021



In Unit 1 you acted as a science diver, gathering data from in-person surveys and virtual site visits. During this unit, we will take a step back and use NOAA satellite data to look at bigger picture coral reef monitoring and learn how satellite data helps scientists keep up with large-scale changes. By the end of this lesson, you will be able to see where and when corals are at risk all across the world.

Once you build your data skills, it's time to take action! Research ways to protect coral reefs and share it back to the class.



Lesson 1: NOAA Data in the Classroom

NOAA Data in the Classroom takes complex information and turns it into an interactive series of story map lessons.

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

Introduction

Objectives
Students will learn how prolonged, warmer than usual ocean temperature can contribute to coral bleaching.

Activities:

- Learn how to calculate accumulated heat stress from sea surface temperature data
- Use Degree Heating Week data to understand patterns of coral bleaching

Caption: The image to the right shows the NOAA JPSS satellite that is used to measure ocean temperature and coral bleaching around the globe.

Here you will learn how to read real satellite data to identify areas where coral reef health is at risk. Follow the links below and complete the activities. Be sure to watch the videos within the lessons. After finishing each level, please answer the questions provided.

[NOAA Data in the Classroom: Coral Bleaching Level 1](#) *(select the "Level 1" tab)*
Coral reef locations and temperatures.

Where are coral reefs located in the world? How do we read sea surface temperature maps? Read and answer the questions located on the left of the image. Scroll down using your mouse. New images will load to the right as you scroll down.

Question

4. Why do satellites measure sea surface temperature (SST)?

[NOAA Data in the Classroom: Coral Bleaching Level 2](#) *(select the "Level 2" tab)*
Measuring coral heat stress.

How does prolonged, warmer-than-usual ocean temperature contribute to coral bleaching? Read and answer the questions located on the left of the image.

Question:

5. What are Degree Heating Weeks (DHW)?

We depend on a combination of satellite data and human on-site surveys to monitor the health of our coral reefs, especially in more remote areas like the Northwestern Hawaiian Islands.

Satellite-derived observations average sea surface temperature (SST) over large areas of the ocean. Do you think these averages apply equally to all areas within a reef? Satellite data guides our efforts, but it is vital to “ground truth” the big picture observations with surveys and other direct monitoring by people on-site. The rest of this unit will introduce you to tools for big picture analysis, but don’t forget the importance of the in-the-water survey skills you learned in Unit 1.

Read this article from October, 2019 to see an example of how this all works in real-life.

Article: [Coral Bleaching Observed in Papahānaumokuākea Marine National Monument](#)

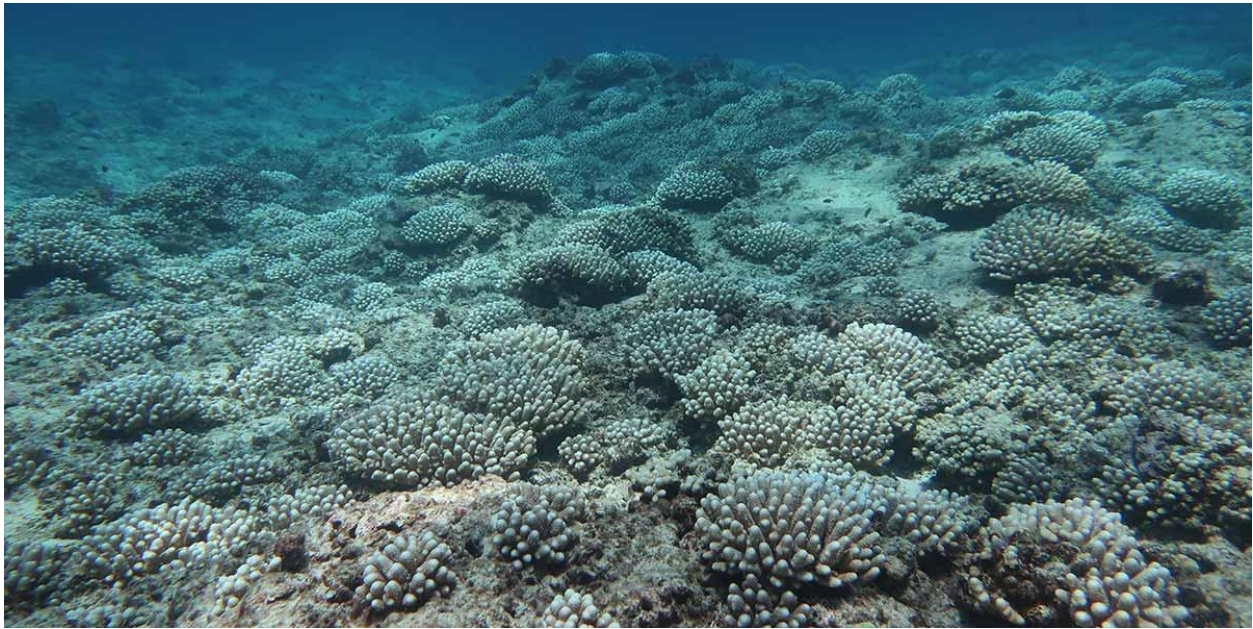


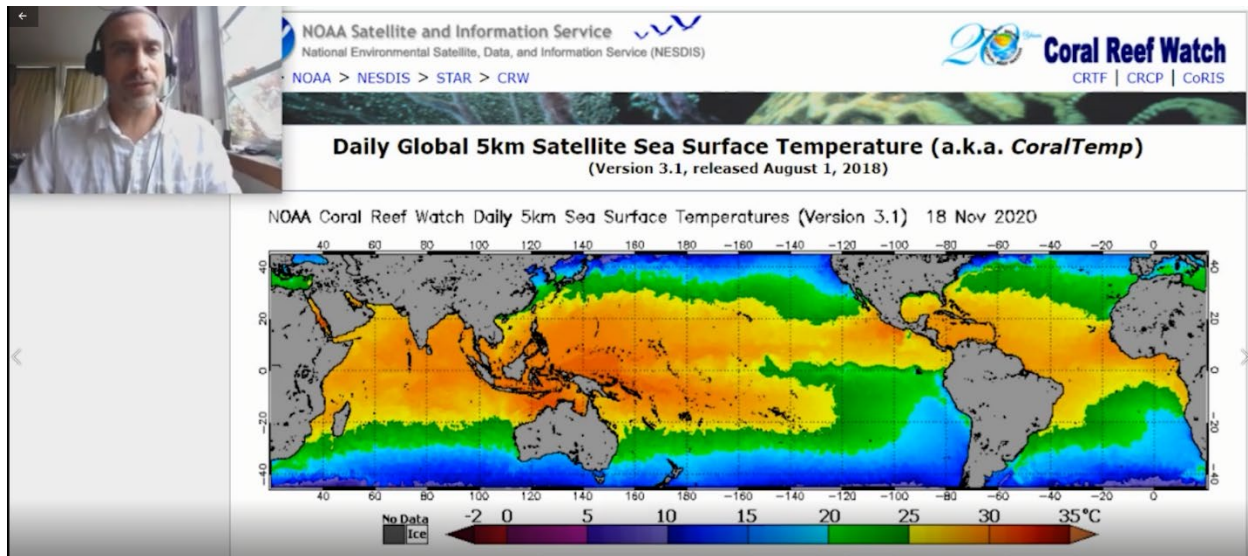
Photo by Morgan Winston/NOAA

Question:

6. What does the article *Coral Bleaching Observed in Papahānaumokuākea Marine National Monument* say about coral bleaching in Hawai‘i? Is it common?

Lesson 2: NOAA Coral Reef Watch

One of the most difficult parts of coral conservation is keeping track of what is going on! As we've seen in Lesson 1, coral reefs cover huge areas across the Hawaiian Archipelago. The Northwestern Hawaiian Islands are especially challenging to monitor due to the difficulty and expense to get research teams out to these remote locations. Satellite monitoring is one tool that helps scientists keep track of larger trends so they can focus on-the-ground efforts where they are most needed. NOAA's Satellite and Information Service and NOAA Coral Reef Watch provide near real-time data on sea surface temperatures and coral bleaching risks.



Reading satellite maps can be intimidating at first.

Our friend Dr. Paulo Maurin works for [NOAA's Coral Reef Conservation Program](#) and has created a series of videos to help you understand how to read satellite data visualizations.

Paulo's first video is a good review of what you've already learned about sea surface temperatures (SST) and Degree Heating Weeks (DHW). He'll walk you through how to use Coral Reef Watch. Open [Coral Reef Watch](#) and follow along.

[Watch Paulo's Video Part 1](#) (4min 51sec)

Coral Bleaching Heat Stress Maps and Coral Bleaching Alert Gauges

It's time to put what you've learned to the test and apply it to your study sites! Paulo will walk you through it. [Follow along!](#) You will also find written instructions below.

[Watch Paulo's Video Part 2](#) (5min 9sec)

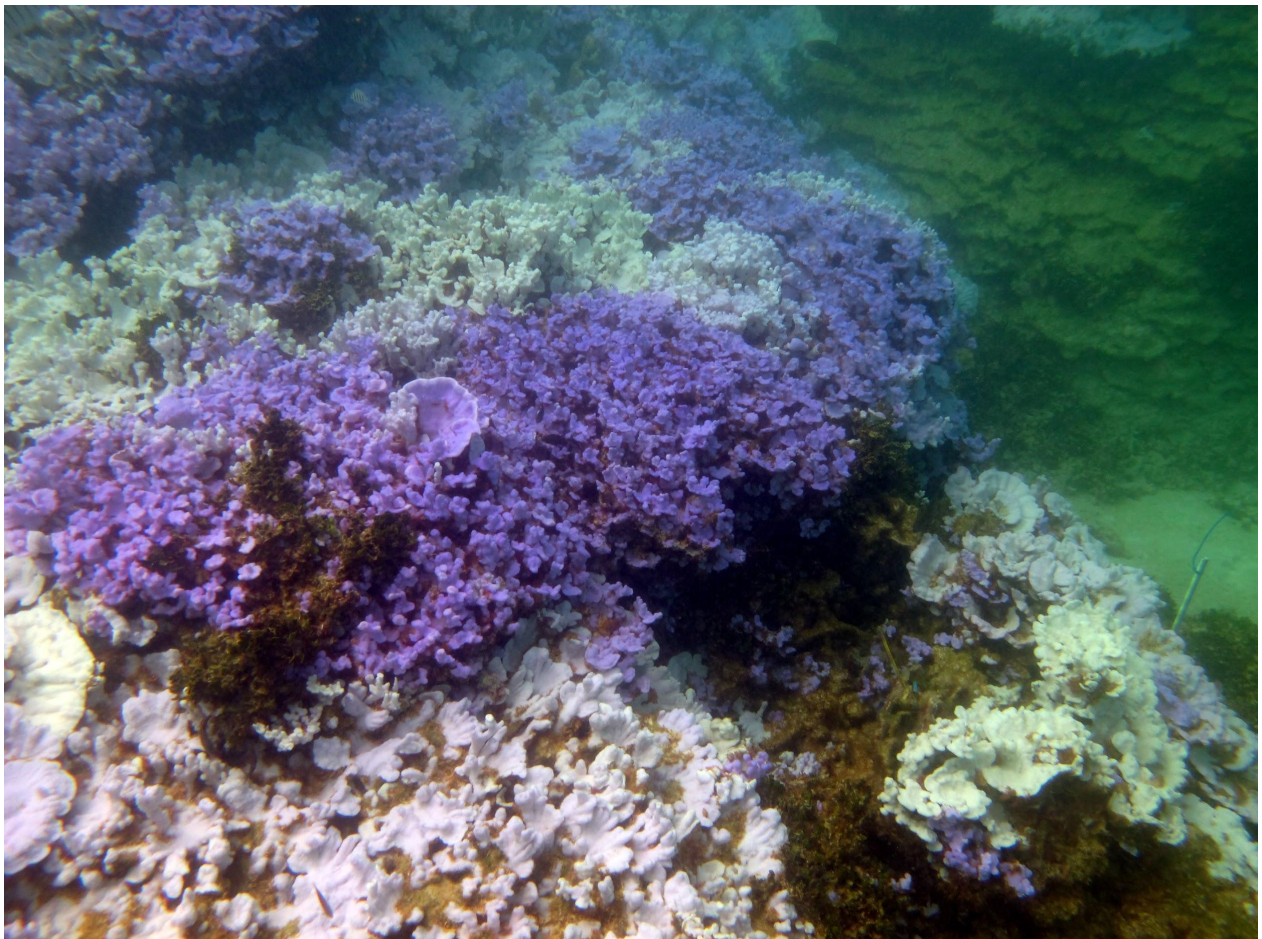


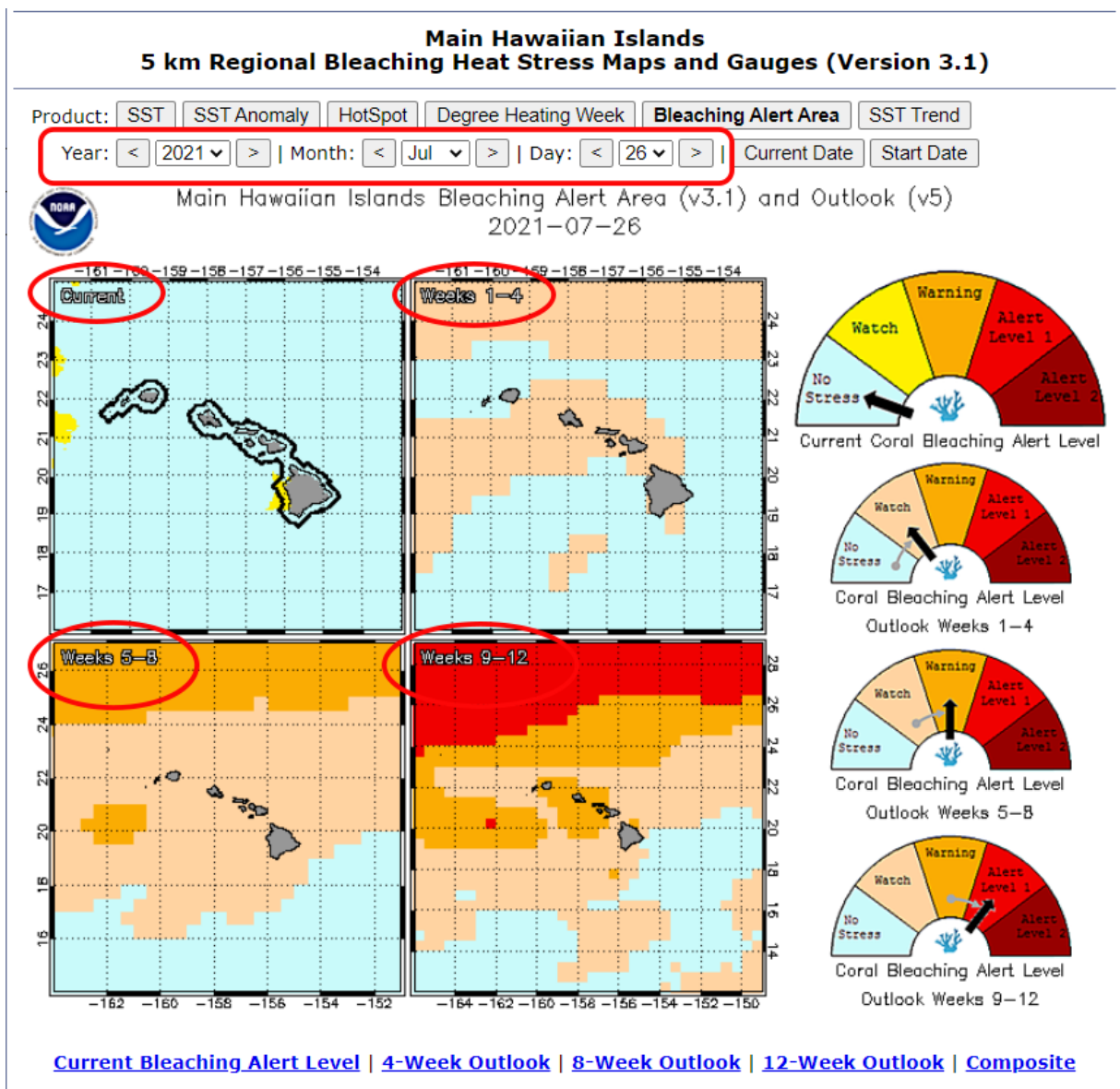
Photo by NOAA and Courtney Couch/Hawai'i Institute of Marine Biology, 2014

Instructions

Open Coral Reef Watch: [Main Hawaiian Islands \(MHI\)](#)

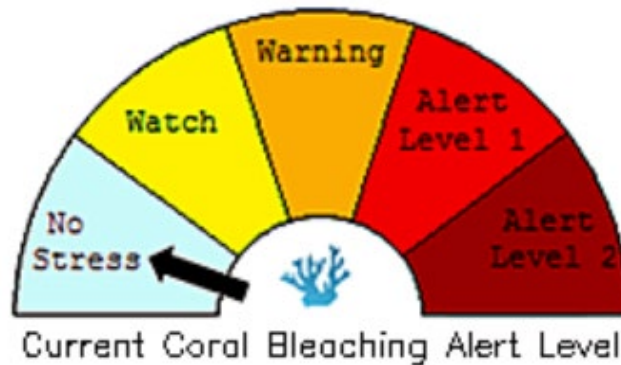
When you first arrive, you will see four maps with alert gauges on the right. The colors will be different from the example below since the maps will show you the most current information. Each map represents a different time period, much like a weather forecast. The upper left map is the heat stress now (current). The other three maps forecast future heat stress going out 1-4 weeks, 5-8 weeks, and 9-12 weeks. Notice the gauges on the right side of the image. The top gauge is for the “current” map, the next gauge down is for the forecast 1-4 weeks out, etc. (see example image below).

EXAMPLE



Understanding the Alert Gauge

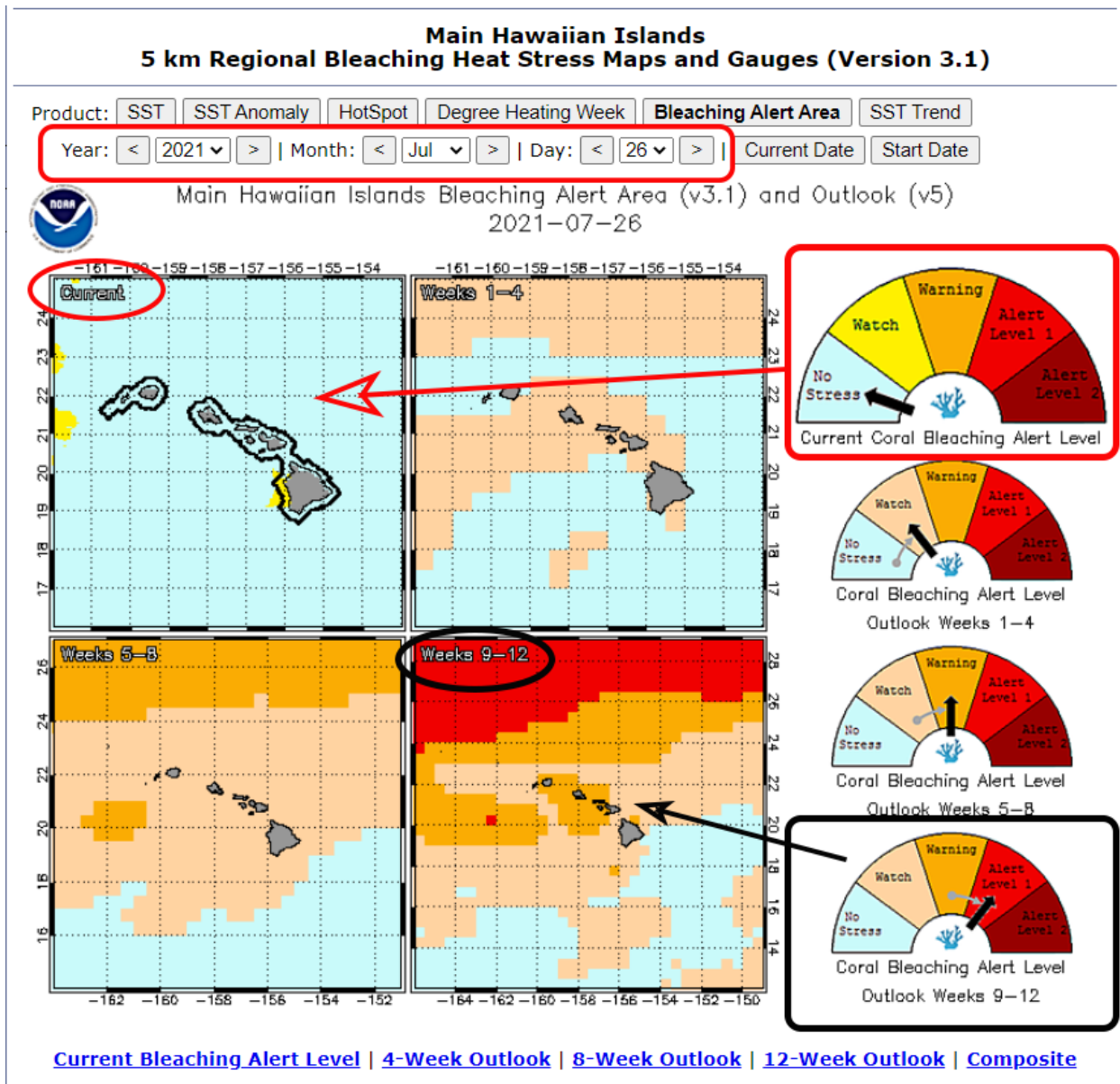
As Paulo explains in the tutorial video, the heat stress gauge gives you an idea of how stressful the buildup of sea surface temperature conditions are for the coral reef in a particular area.



How to Read the Coral Bleaching Alert Level Gauge		
	No Stress	There is no heat buildup at this point.
	Watch	Heat stress is just beginning to build. There may be 1-2 Degree Heating Weeks (DHW). Not much concern for corals, but time to pay attention.
	Warning	Heat has been building. The area is now at 3-4 DHW. The corals may start showing light signs of stress. Time to take this more seriously.
	Alert Level 1	We have passed the 4 DHW threshold. Expect to see coral bleaching.
	Alert Level 2	We are now past 8 DHW and the corals have been under enough heat stress that we are likely to see some mortality (death).

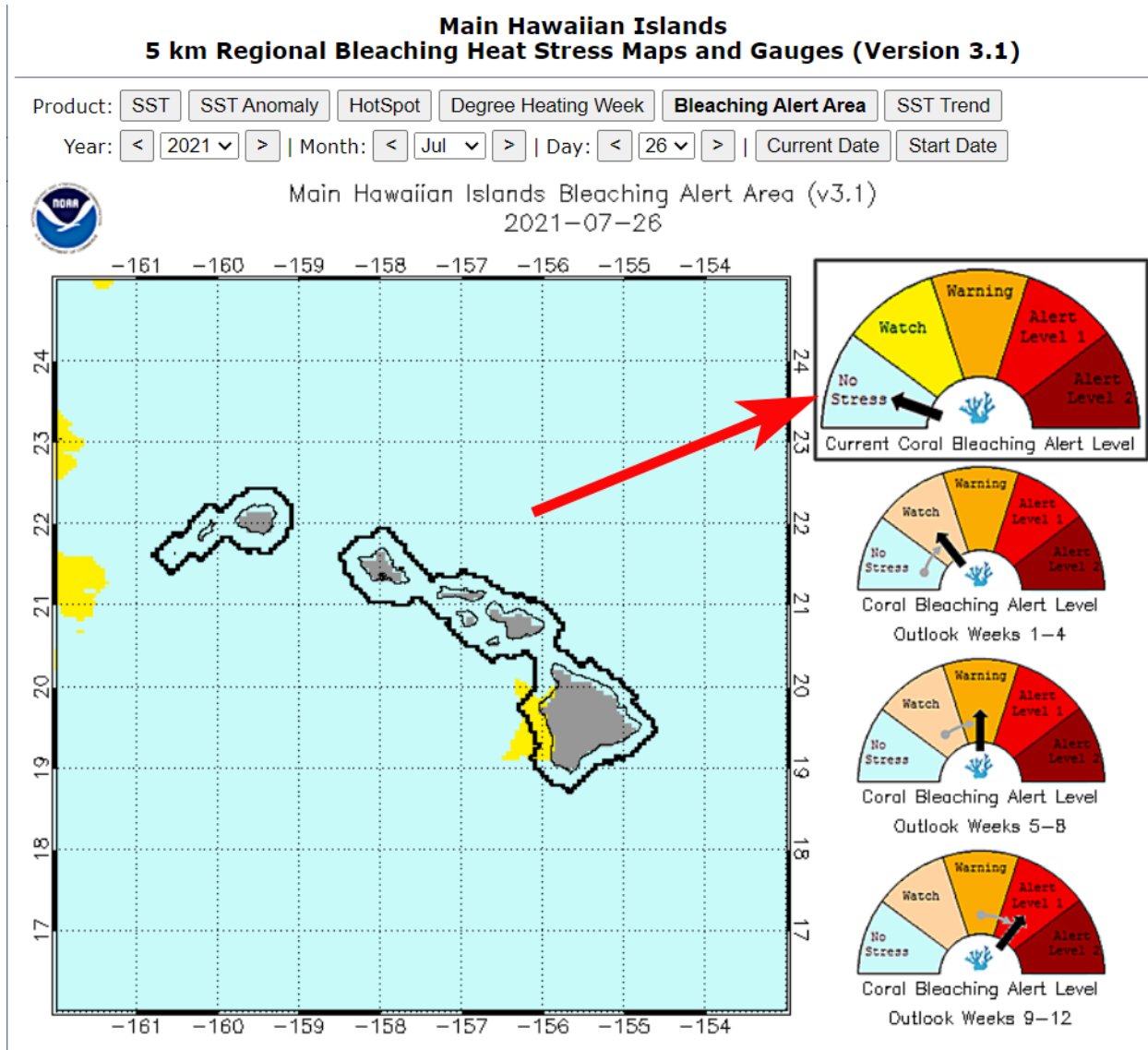
Practice Interpreting the Maps

In the example below, the current conditions map is light blue. The alert gauge indicates that light blue equals no heat stress. Did you notice the small amount of yellow on the west coast of Hawai'i Island? According to the gauge, yellow means that particular area is under a "Watch" status. Looking ahead to the forecast maps, you can see that heat stress is expected to build to Alert Level 1 in 9-12 weeks (light red)!

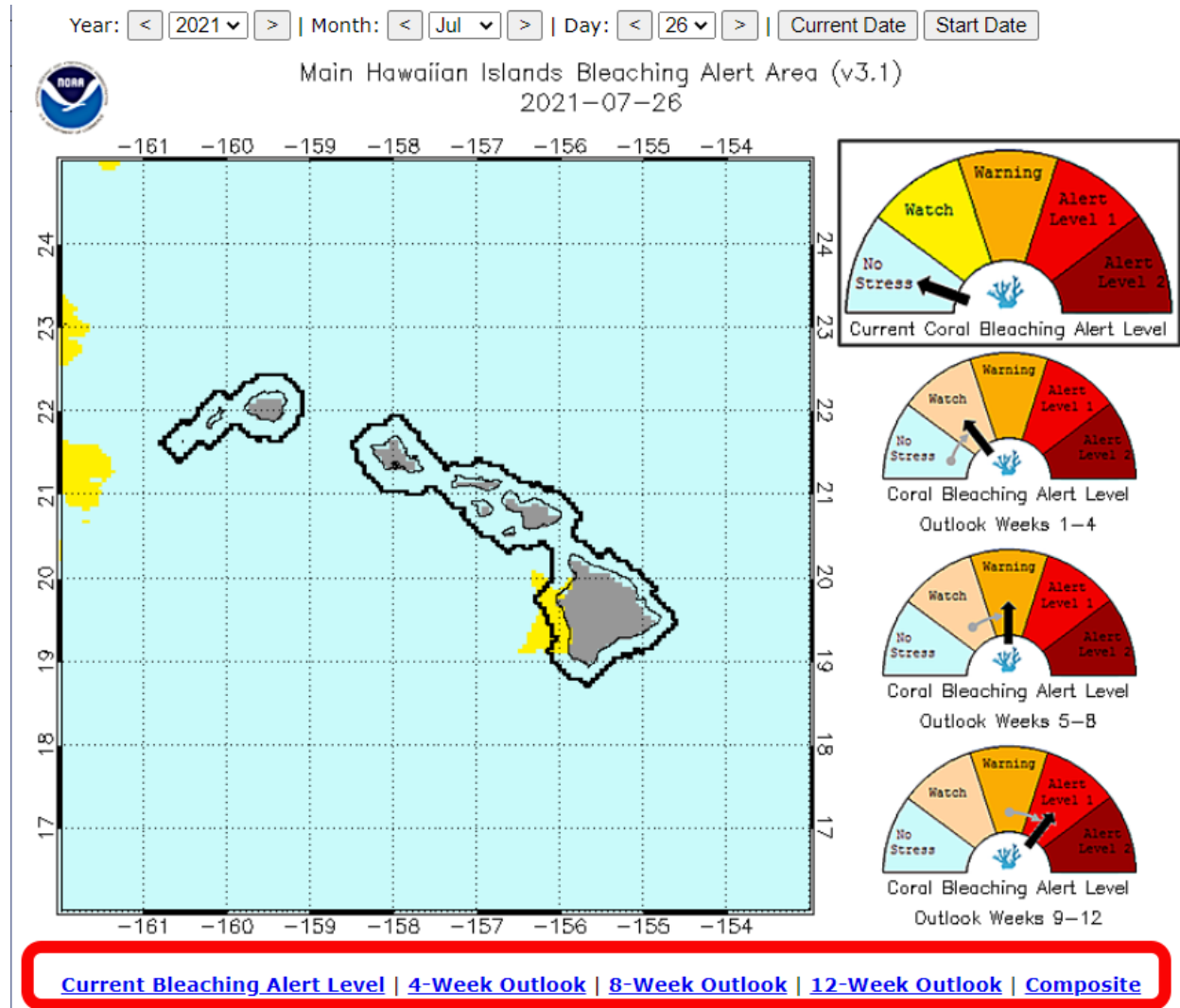


Taking a Closer Look

By clicking on an individual map, the image will enlarge and allow you to zoom in and better identify your study sites. We've provided labeled maps farther below in the instructions.



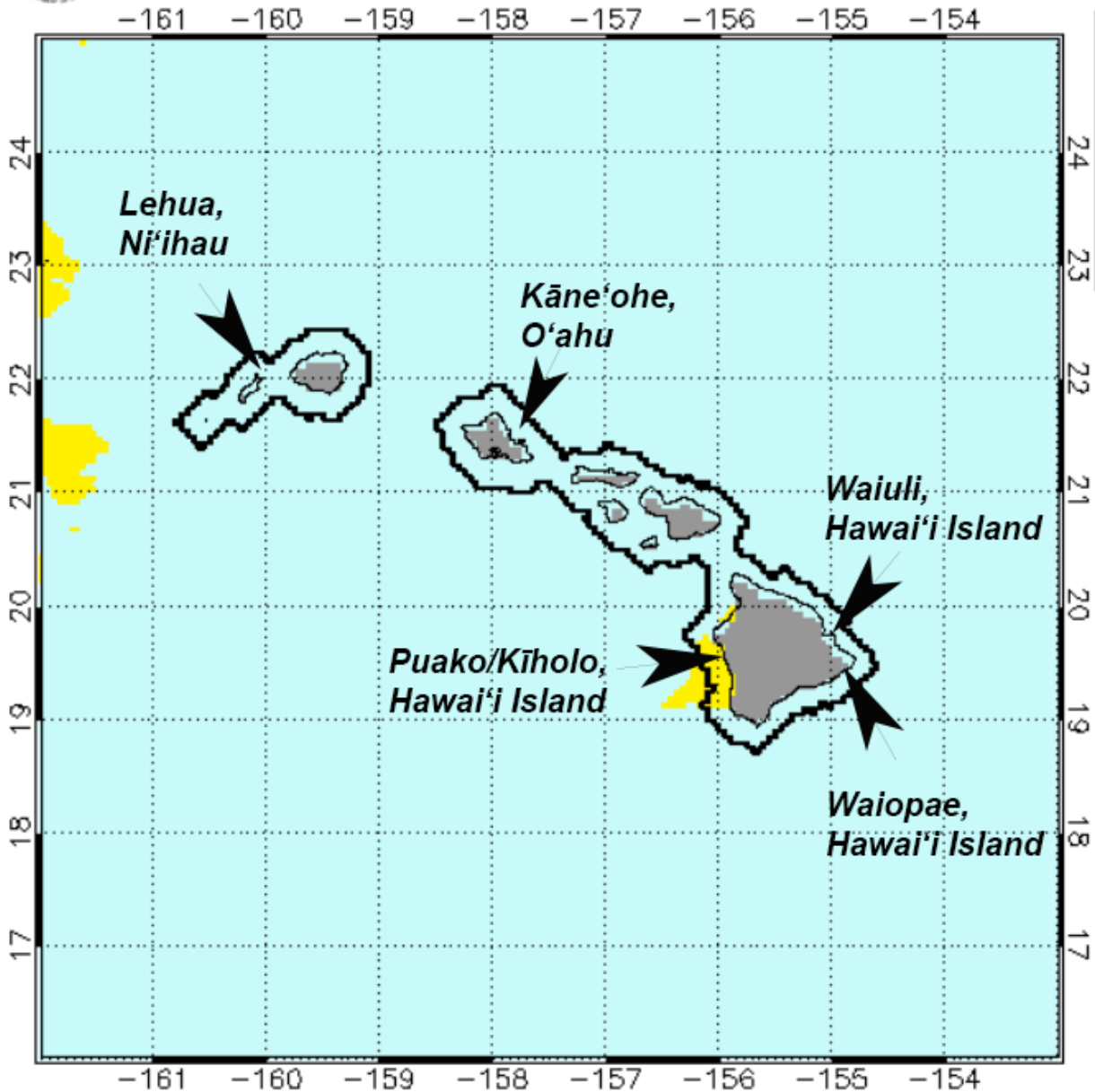
You can change maps by clicking on the different gauges or on the hyperlinks at the bottom of the map. Choosing the “Composite” hyperlink takes you back to the 4-map view.



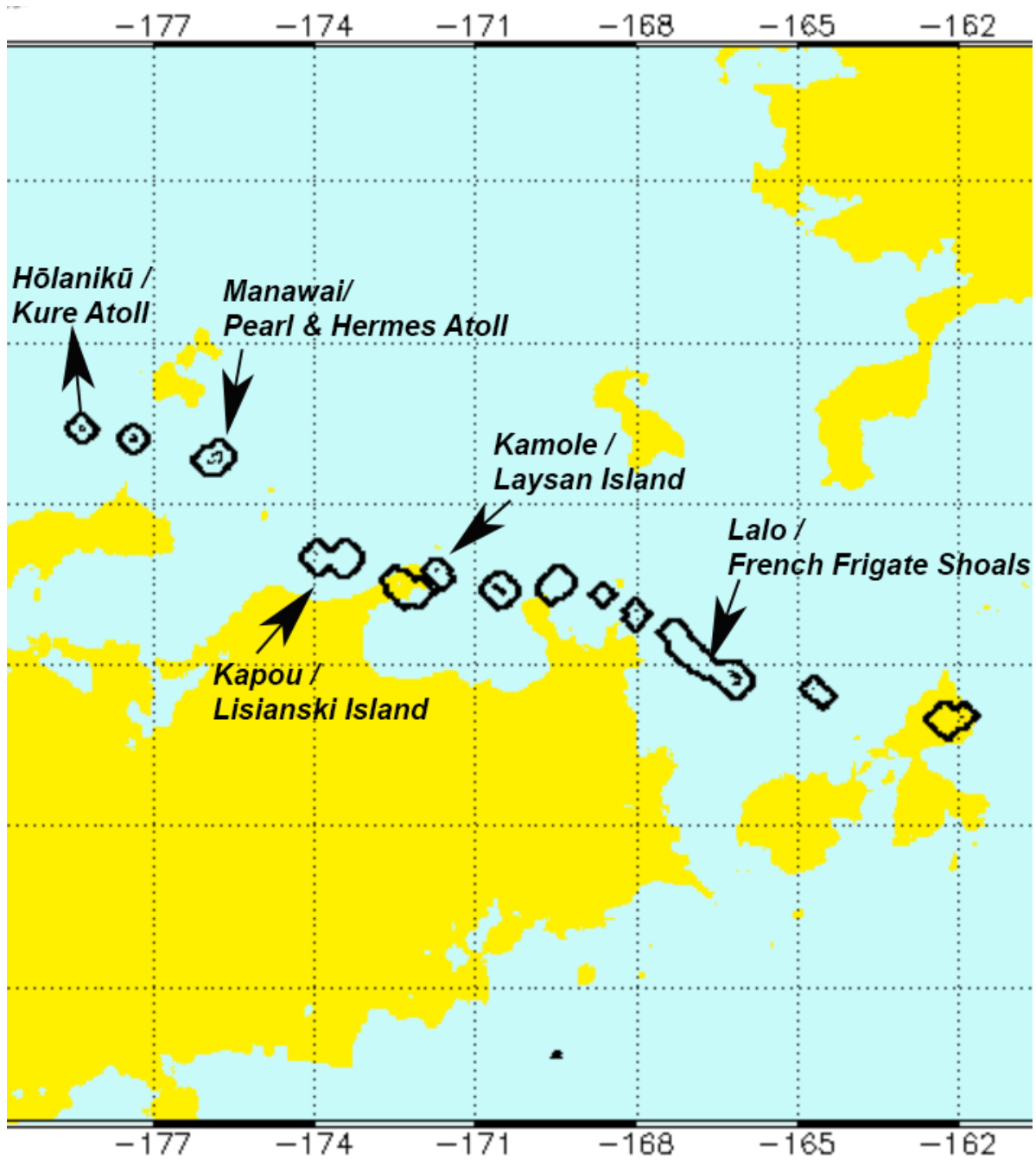
Find your study sites

Using your knowledge of your study sites, identify the site's approximate location on the Coral Watch Coral Bleaching Heat Stress Maps for the MHI and NWHI (see labeled maps below).

[Click Here to Find your Main Hawaiian Islands \(MHI\) Study Site](#)



[Click Here to Find your Northwestern Hawaiian Islands \(NWHI\) Study Site](#)



Answer the following questions for each of your sites

1. What are the alert levels for your study sites?
(*hint: look at each of the four gauges*)

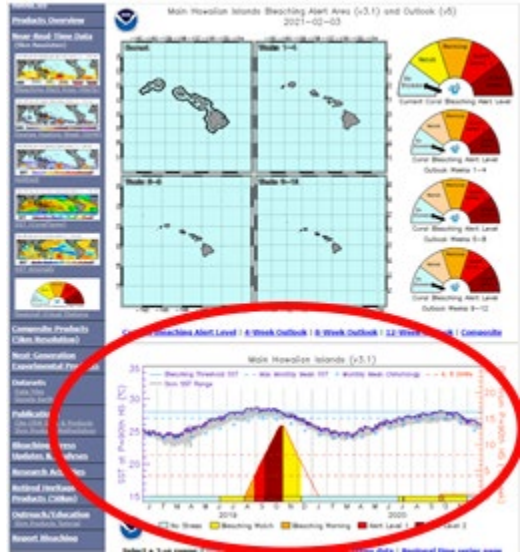
Main Hawaiian Islands My site location is _____.

- a. Currently:
- b. In 1-4 weeks:
- c. In 5-8 weeks:
- d. In 9-12 weeks:

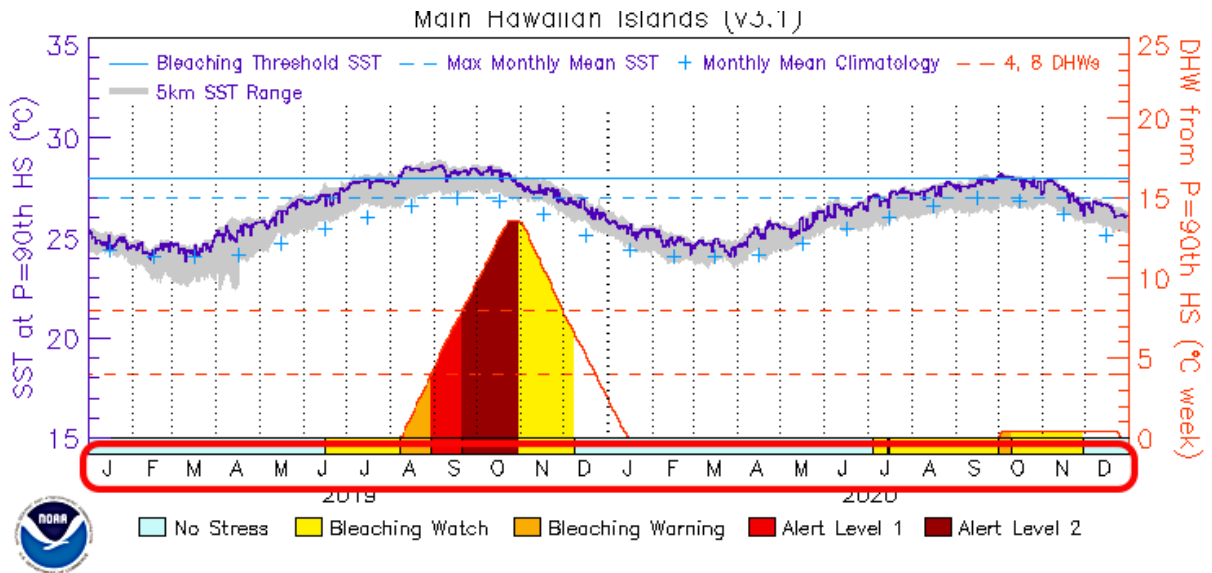
Northwestern Hawaiian Islands My site location is _____.

- a. Currently:
- b. In 1-4 weeks:
- c. In 5-8 weeks:
- d. In 9-12 weeks:

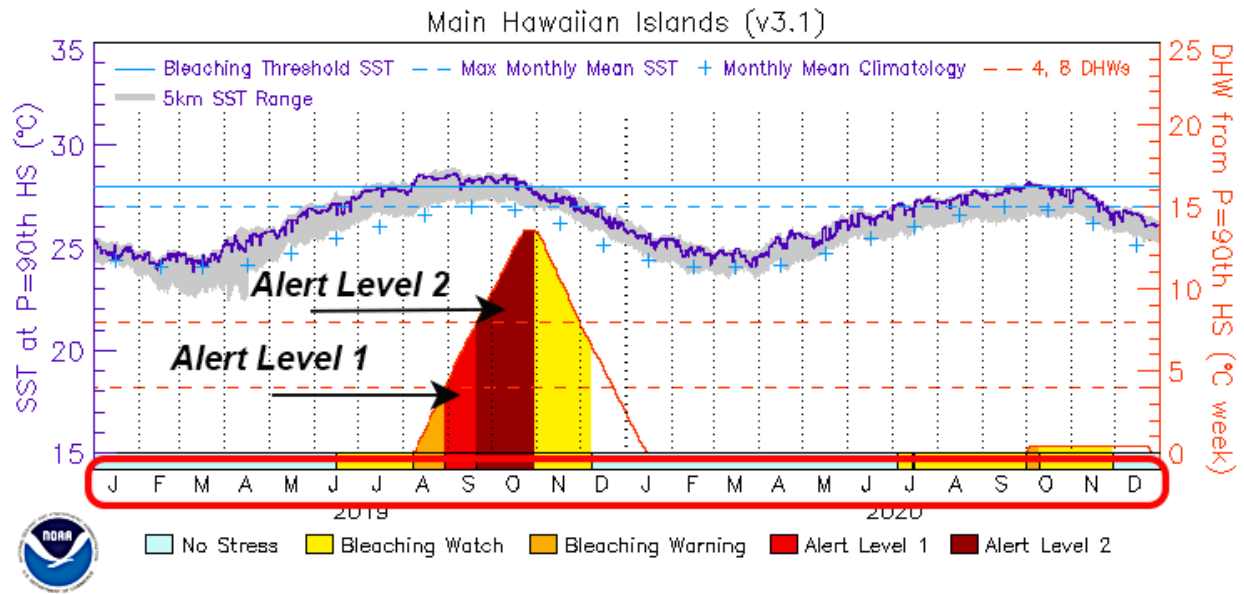
2. What months of the year was your study site in Alert 1 and/or Alert 2 levels?
 (hint: scroll down to the 2-year heat stress graph just below the Alert gauges)



Please note the letters along the X-axis (circled in red below) correspond to the months of the year. J=January, F=February, M=March, etc.



Select a 2-yr range: | [Multi-year graph](#) | [Time series data](#) | [Regional time series page](#)



Select a 2-yr range: | [Multi-year graph](#) | [Time series data](#) | [Regional time series page](#)

In the example above, September would be at Alert Level 1 and the last part of September and all of October would be Alert Level 2.

List the months of the year your study sites were in Alert Level 1 or 2.

Main Hawaiian Islands:

Months of the year:

Northwestern Hawaiian Islands:

Months of the year:

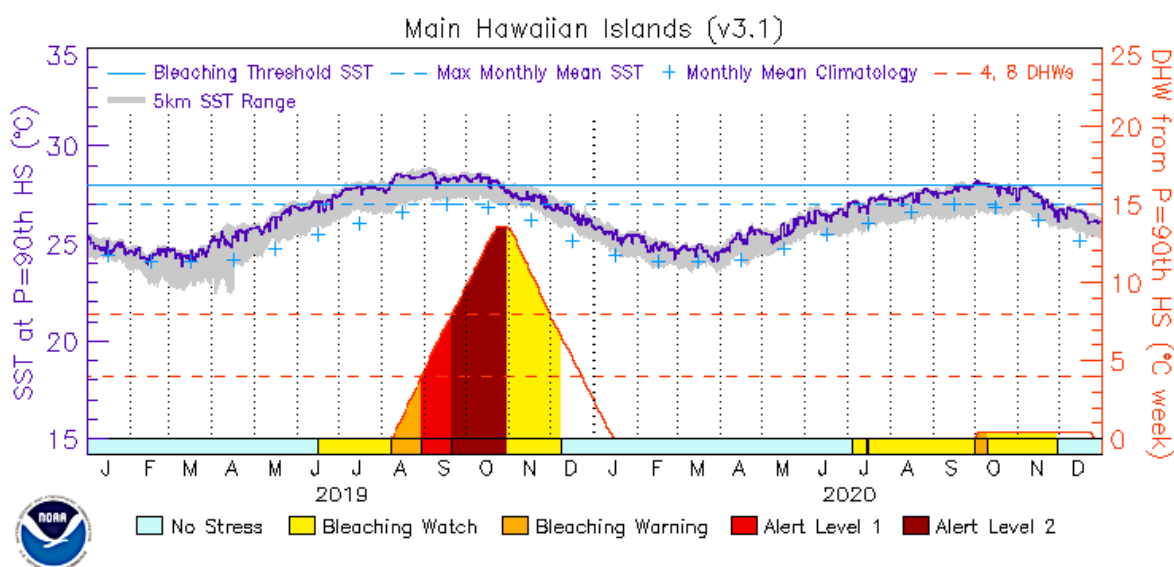


Lesson 3: Bleaching Alerts Across Time

The Bleaching Alert and Heat Stress Graphs can be changed to look at data from different dates. You can see how the reefs in your study sites were affected in the past. Knowing that will help you understand how well the corals can handle new heat stresses.

Let's ask Paulo to explain how to look into the past. There are written instructions below as well.

[Watch Paulo's Video Part 3](#) (3min 24sec)



See the next page for the questions you should answer about your study sites. You can use the same maps as before. Here are the links again:

Find your Main Hawaiian Island site here:

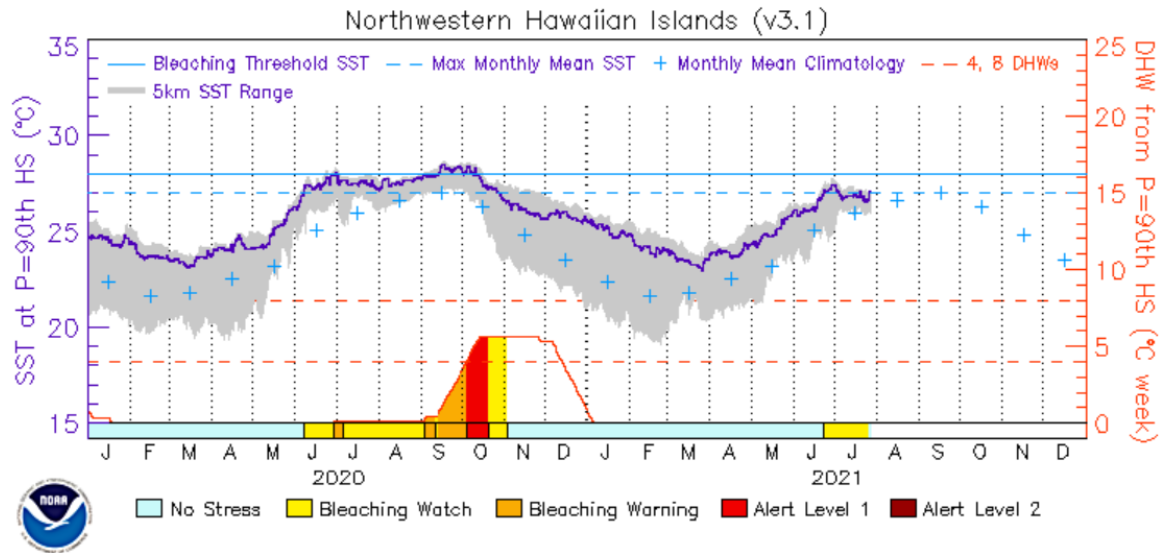
[MHI Coral Heat Stress Monitoring](#)

Find your Northwestern Hawaiian Island site here:

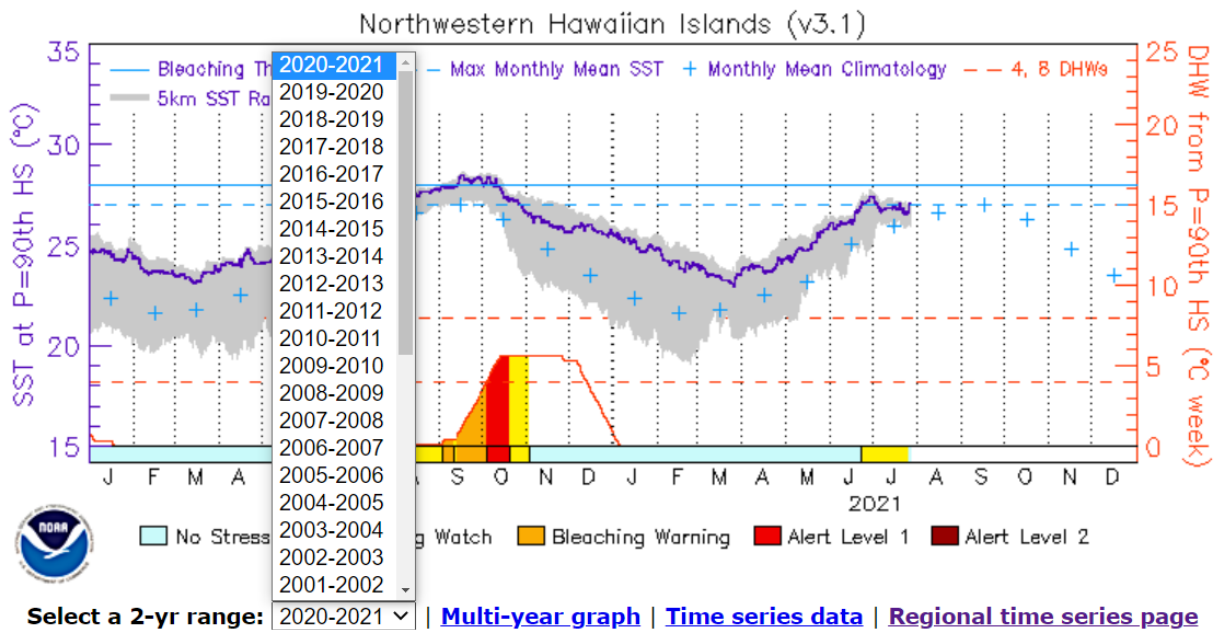
[NWHI Coral Heat Stress Monitoring](#)

Instructions:

Just like Paulo showed us, change the 2-year date range on the Heat Stress Graph and look for the years and months where there were significant heat stress events (Alert 1 and 2) for both the MHI and the NWHI.



Select a 2-yr range: 2020-2021 | [Multi-year graph](#) | [Time series data](#) | [Regional time series page](#)



List the months and years that have been under Alert Level 1 or 2.
Be sure to check the years going back to 1986.

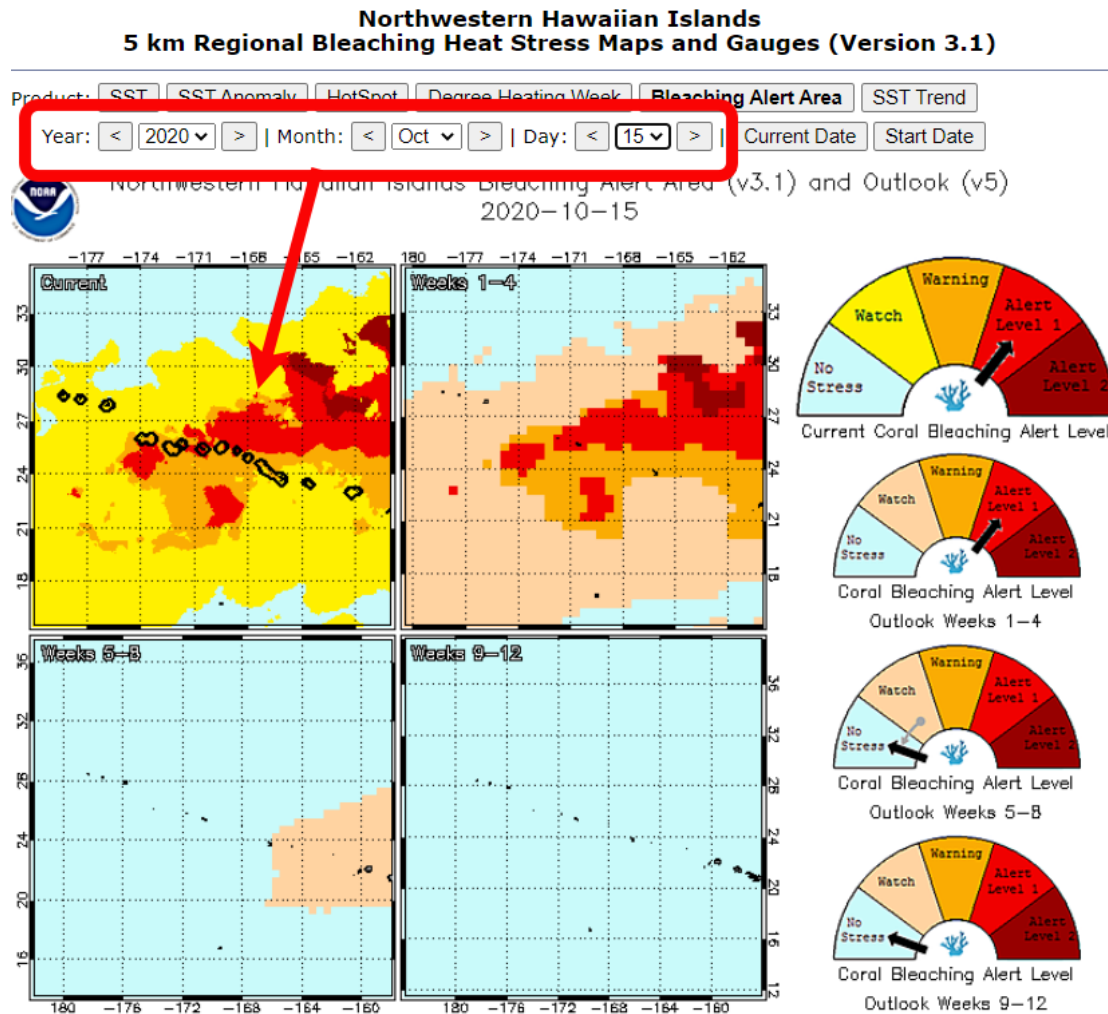
Main Hawaiian Islands:

Northwestern Hawaiian Islands:

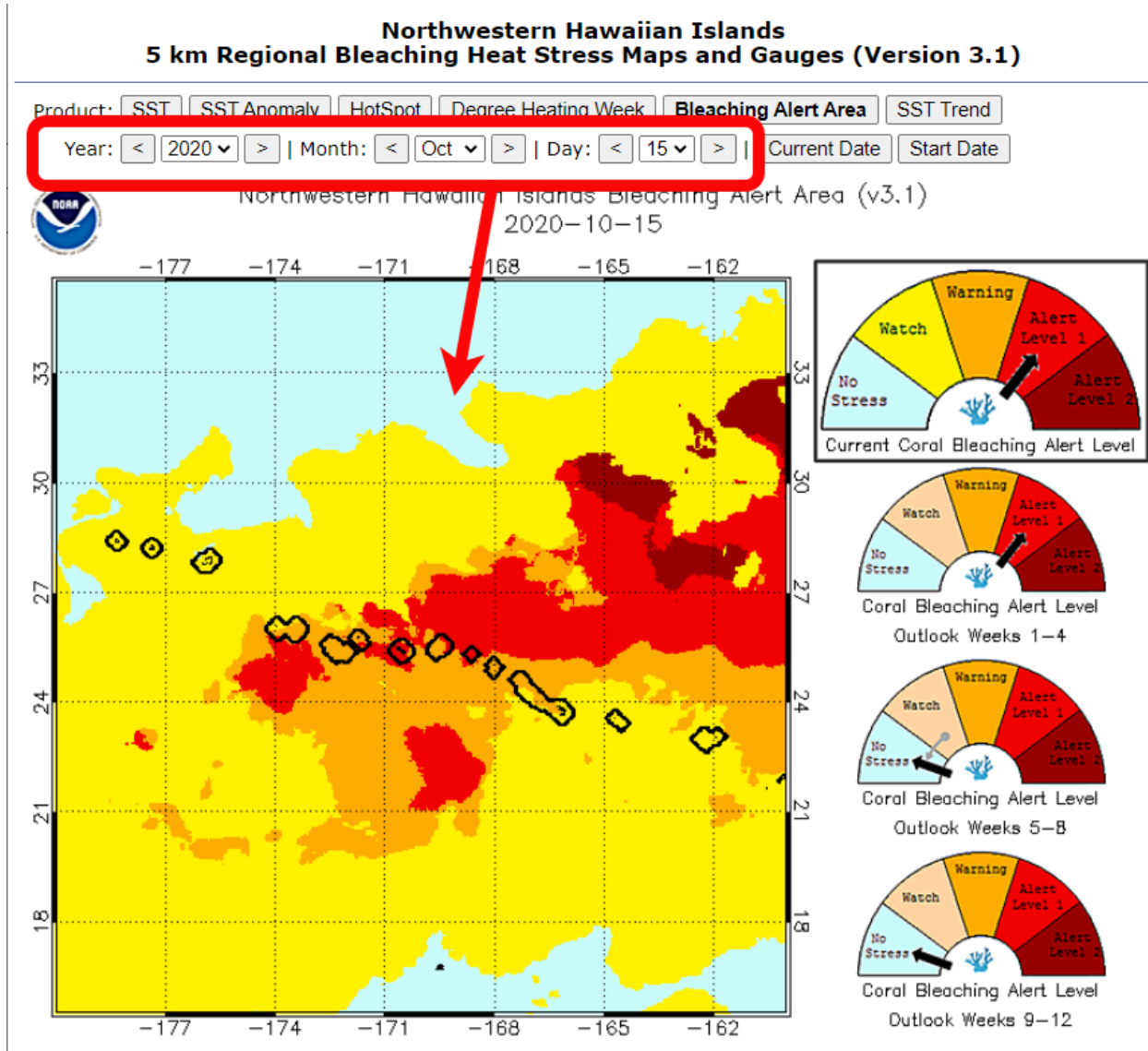
Apply what you've learned to your sites:

Using what you have learned, **change the dates for the Bleaching Heat Stress Maps** to look more closely at how those bleaching events affected your specific study sites. Click on the upper left map to enlarge the image. Then click the Day forward arrow or use the drop-down menu to change the date. You will often see major shifts in alert status within even a few days. Remember to refer to the labeled maps above to help you find your site. Go to the next page to see the questions to answer.

Example: In the previous activity, we saw that the NWHI had a bleaching Alert Level 1 in October, 2020. Now you can change the dates (circled below) to see what the heat stress maps show for different days in October, 2020 near your study sites.



Clicking on the “Current” map allows you to zoom in to find your site.



Questions:

Based on your research, how have your sites been affected by bleaching over time?

MHI: my site location _____

NWHI: my site location _____

1. Has your site been affected by Alert Level 1 or 2 for more than one year?

MHI:

NWHI:

2. Has your site been affected by Alert Level 1 or 2 for more than one year in a row?

MHI:

NWHI:

3. What other observations did you make as you looked through historic heat stress data for your sites?

Observations for the MHI:

Observations for the NWHI:





Class Presentation

Congratulations! You just learned how to use a powerful tool that can be applied all over the world. It's time to prepare another site report based on your new information and share back what you've learned.



Photo by Toni Parras/NOAA, 2014

Prepare a 5-10 minute presentation for the class that includes:

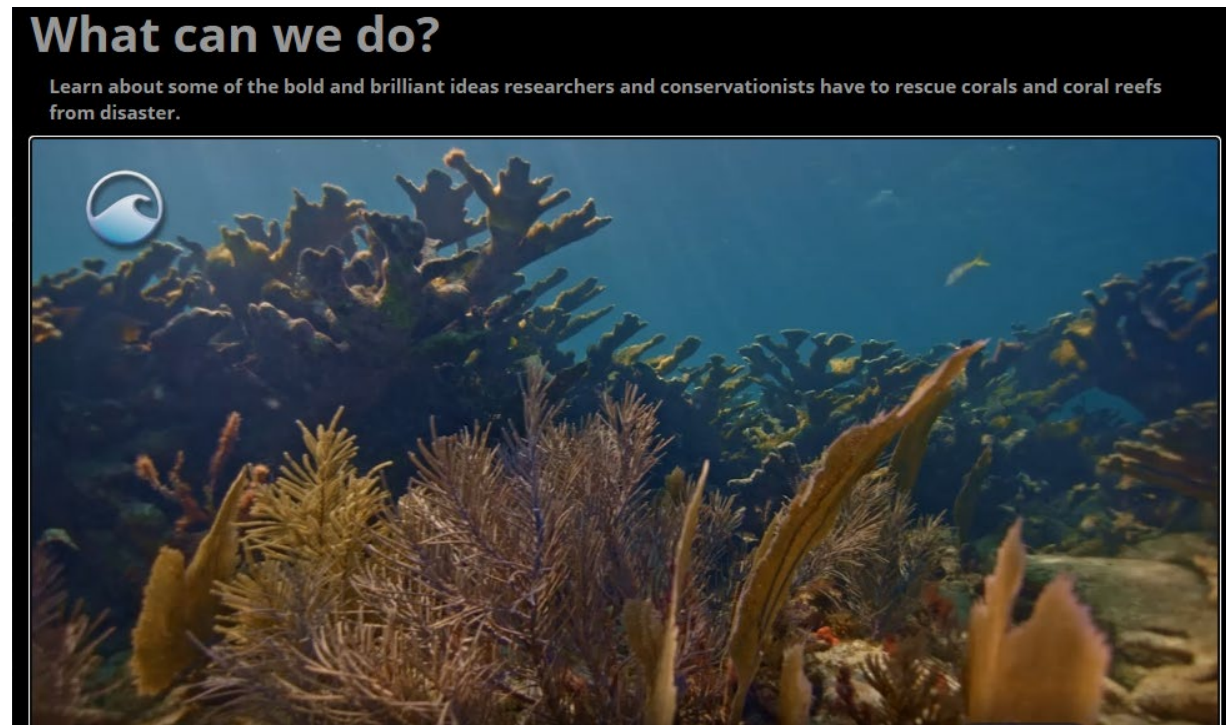
- A brief summary of each of your study sites. No need to repeat your earlier presentation, simply remind your classmates of your site names, locations, and your earlier coral bleaching assessment.
- A summary of your new findings related to the Heat Stress your sites have experienced over the last 10 years. Draw from your Field Journal notes to highlight important data, observations, and questions.
- Share your opinion on what your findings mean for the health of your study sites.

Lesson 4: What actions will you take?

You've built great skills as a coral scientist-in-training and learned a lot about the challenges impacting coral reefs. In this lesson, we're going to dive into what we can do about it!

Let's start with this NOAA Oceans Today video introducing the subject.

Watch: [What Can We Do?](#) (5min 30sec)



Action! Presentations

As you heard in the video, the survival of coral reefs is a challenge for THIS generation if we want corals to survive. In this section, you and your group will choose one of the research topics mentioned in the video to create a presentation for your class.

Look below to choose a topic or ask your teacher for permission if you have another idea.



Photo by Andrew Gray/NOAA, 2017

Presentations should include:

- A statement of the problem, including at least three different sources.
- A summary of current actions in Hawai'i and the Pacific Islands Region, including at least one county, state, or federal action and at least one community-based action.
- A summary of how traditional ecological knowledge is shaping approaches and solutions.
- Dive Deeper and interview one person working in this field (can be a community member, organization, or government agency).

Presentation Topics

Mauka to Makai/Ridge to Reef

Watersheds are a central part of Hawaiian resource management with the clear understanding that what people do on land affects what happens to shoreline ecosystems. Study one of the current land-based pollution issues that impacts coral reefs. Examples include contaminated water (fertilizers, oils, pesticides, etc.), plastic and other marine debris, and sedimentation (soil runoff).

Here are some resources to get you started...

- [Everything is Connected: Mauka Makai Connection](#) (3 min)
- NOAA infographic: [Threats to coral reefs, land-based sources of pollution](#)
- [USGS Article](#) on polluted groundwater
- [NOAA Marine Debris Program in the Pacific Island Region](#)
 - [United by the Ocean, Marine Debris in Papahānaumokuākea Marine National Monument](#) (7min 20sec)

Marine Protected Areas

Marine protected areas (MPAs) are considered one of the best options to maintain our ocean's health and to protect our most vulnerable and valuable ocean ecosystems. What are MPAs and why are they viewed that way? What benefits do they provide? How do areas become protected?

Here are some resources to get you started...

- NOAA National Marine Protected Areas:
 - [Main Website](#)
 - [Map of U.S. MPAs](#)
- [NOAA Office of National Marine Sanctuaries](#)
- Pew Charitable Trust: [The Push to Safeguard 30% of the Ocean](#)
- [The Marine Protection Atlas](#)
- [United Nations Environment Programme](#)

Sunscreen Chemical Impacts to Coral

Recent research has shown how some common sunscreen ingredients can negatively impact coral and other marine life. What is happening and what can we do to protect ourselves and the marine environment?

Here are some resources to get you started...

- NOAA Infographic and links to research: [How sunscreen chemicals can affect marine life](#)
- [News Release](#): Governor Ige Signs Bill Making Hawaii First in the World to Ban Certain Sunscreens
- Hawai'i Department of Land and Natural Resources (DLNR) [Video](#) (4min 35sec)
- 2016 [DLNR News Release](#)

Climate Change

Climate change is a big issue. For the purposes of this lesson, focus your research on how climate change affects ocean temperatures and other ways it can endanger coral reefs. What are solutions at a local, national, and global level?

Here are some resources to get you started...

- NASA Jet Propulsion Laboratory: [Oceans of Climate Change](#) (3 min 50sec)
- NOAA Infographic: [How does climate change affect coral reefs?](#)
- NOAA [Climate.gov](#)
- NOAA Earth is Blue Video: [Coral Bleaching and Climate Change](#) (2 min 7 sec)

Coral Restoration and Assisted Evolution

Scientists and communities around the world are striving to protect and restore coral reefs. What do they think might work? What are the main projects globally and in Hawai'i?

Here are some resources to get you started...

- NOAA Fisheries, [Restoring coral reefs](#)
- The [Science of Super Corals](#) (5min 25sec)
- [DNLR/DAR Coral Nursery](#) (5min)
- UH Hilo PACRC [Coral Nursery](#)
- University of Hawaii's Hawaii Institute of Marine Biology, Gates Lab: [Coral Assisted Evolution](#)
- [Coral Restoration 360° video](#) at Florida Keys National Marine Sanctuary

Sustainable Reef Fisheries

The health of coral reefs depends on a balanced ecosystem. Many of the fishes and other marine life that live in and around coral reefs also provide vital roles in keeping coral healthy. How do humans respect and support that balance as we nourish ourselves and our communities?

Here are some resources to get you started...

- NOAA Infographic: [Threats to coral reefs, overfishing](#)
- NOAA Coral Reef Conservation Program, [Improving Fisheries Sustainability](#)
- NOAA Fisheries, [How do coral reefs benefit the economy?](#) (1 min)



Ho'omaika'i! Congratulations!



Photo by John Burns/NOAA 2017

You've completed your virtual coral scientist training! It's been a long journey, let's review all of your accomplishments:

- Explored and researched coral reefs across the Hawaiian Archipelago.
- Conducted virtual coral bleaching assessments.
- Analyzed satellite data to identify coral heat stress bleaching events.
- Researched local and global actions to protect and conserve coral reefs.
- Prepared and presented your findings to your colleagues (classmates).

We need more people like you joining the NOAA team to help study and protect our communities and our ocean. Learn more about steps you can take NOW!

Make your school an [Ocean Guardian School!](#)

Does your school want to protect and conserve its local watersheds, the world's ocean, and special ocean areas like national marine sanctuaries? Become an Ocean Guardian School, get engaged, and make this commitment by proposing then implementing a school- or community-based conservation project.

[Student Corner NOAA](#) (Pacific Islands Region focus)

- Access more NOAA data tools for your school projects
- Learn about NOAA careers in the Pacific Islands Region
- View Community Science Projects you can get involved with

[Student Opportunities with NOAA](#)

Consider an internship and volunteer position with NOAA at locations all across the country! This website also provides links to scholarships and other programs built to help you start your NOAA career.

Once again, well done! We hope you enjoyed this experience and will continue to keep exploring and learning about the amazing reefs right in our backyard.