# DATA IN THE CLASSROOM: LEVEL 1
What Factors Affect Coral Reef Distribution?

Where in the World? Examine the distribution of coral reefs around the world using the interactive map in Level 1, and complete the following:

Latitude	Corals reefs are generally located between **30** °South and **30** °North
Depth	Are most corals reefs located in **shallow** or **deep** water? **shallow** Make a prediction to explain why corals are found at certain depths: **Answers may include: sunlight penetrates shallow waters more effectively, providing the necessary light for photosynthetic algae that live within coals; corals thrive in warm water typically found in shallow tropical areas.**

Reading Ocean Surface Temperature Maps: Beyond depth and latitude, another factor that plays a key role in determining the distribution of coral reefs is temperature. Use the interactive ocean surface temperature map (or the map below) to complete the following questions:

What is the average ocean surface temperature at 140 °East and 10°South.	**Approximately 82°F / 28°C**
Between which latitudes do most of the world's warmest ocean temperatures (orange-red) occur?	between **30** °South and **30** °North
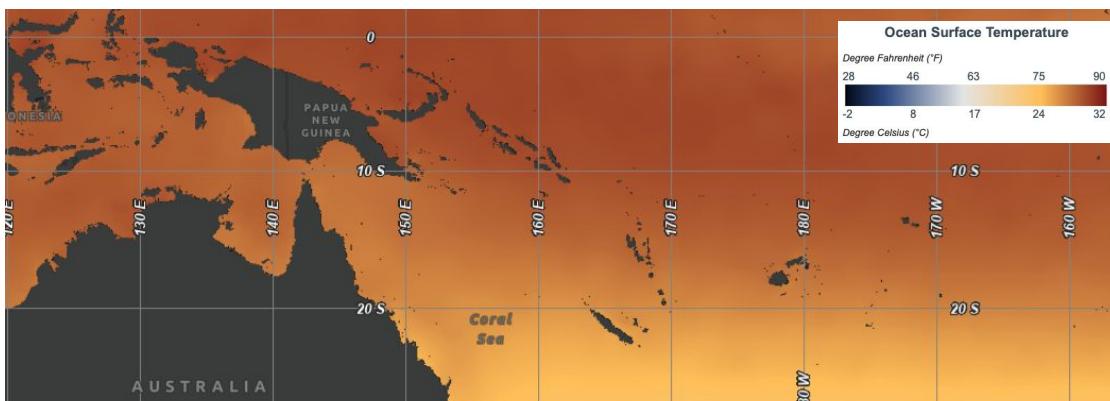
What Factors Affect Coral Reef Distribution? Use the interactive maps to summarize your ideas.

| *What factors limit the distribution of coral reefs around the world?* | **Temperature:** Corals live in a narrow range of warm ocean temperatures, generally between 23°C and 29°C (73°F and 84°F).
Latitude: Corals are found between 30°S and 30°N
Depth: Corals are found in relatively shallow waters, typically within a depth range of 0 to 30 meters (0 to 98 feet). |

DATA IN THE CLASSROOM: LEVEL 2
Measuring Coral Heat Stress

Measuring Heat Stress: In 2024, satellite data recorded one of the most severe global oceanic heat waves in modern history. Here, we'll examine data to find out how this heat wave impacted corals on the the Great Barrier Reef, the largest coral reef system in the world. Answer the questions using the graph.

During what months are ocean temperatures highest in Australia?	**The ocean is generally warmest from January to March. These months correspond with summer and early fall in Australia.**
How would you define the term 'bleaching threshold'?	**The temperature at which corals experience heat stress and begin to bleach. This value is one degree Celsius (1 °C) above the monthly average maximum surface temperature for a particular region.**
Use the data to describe the 2024 heat wave on the Great Barrier Reef in terms of its duration. In other words, how long did the heat wave last?	**Ocean surface temperatures remained at or above the bleaching threshold for 11 consecutive weeks between January and March. Then, it rose again for one additional week before temperatures declined in April.**

Calculating Accumulated Heat Stress: Prolonged and severe heat stress makes coral bleaching more likely and recovery more difficult. Use the graph to answer the questions below.

Calculate the total value of accumulated heat stress on the Great Barrier Reef during the first 12 weeks of 2024.	**Accumulated heat stress$_{12 \text{ weeks}}$ = 5.7**
Explain why calculations of accumulated heat stress are useful and important.	**These calculations help predict coral bleaching events. By monitoring ocean surface temperatures and calculating the heat stress over time, scientists can forecast when and where bleaching is likely to occur. This information is critical for coral reef conservation efforts, allowing for timely interventions to protect vulnerable reefs.**

Understanding Maps of Accumulated Heat Stress: Do you agree or disagree with the claim below? Support your answer with specific evidence from the map.

Claim – During the time period indicated on the map, most corals around the starred area were at a very low risk of bleaching.	**Disagree: Corals at the location on the map (around the area denoted by the star) were at risk of bleaching. The data map is colored orange around this region, indicating an accumulated heat stress value of approximately 7. When values are between 4 and 7, the region is at risk of reef-wide bleaching. When heat stress exceeds a value of 8, reef-wide coral bleaching with mortality of heat-sensitive corals can be expected. Therefore, many corals across this area were at high risk of bleaching due to heat stress.**

Monitoring Coral Reefs

Identifying Differences Between Healthy, Bleached & Dead Corals: Summarize your observations below.

What are the key differences between healthy, bleached and dead corals?	Healthy: **Vibrant shades of green, brown, yellow, and other colors due to the presence of symbiotic algae called zooxanthellae.**
	Bleached: **White or very pale. This is because they have expelled or lost their zooxanthellae, which are responsible for their color.**
	Dead: **Gray or brown as they are overgrown by algae and other organisms. They often appear fuzzy as a result of the algae growth.**

Observing the Effect of Bleaching on Coral Reefs: Visit each of the four coral reefs. Examine the photos and complete the table below. *Note: Reef #1 is partly completed for you.*

Coral Reef Name and Location	Time period	**Observations:** Do corals appear mostly healthy, bleached or dead? What else do you notice?
Reef #1: Phoenix islands, Republic of Kiribati	2004 *(image at left)*	*Example: Most coral appears <u>healthy</u>.* *Coral is bright green and yellow. Lots of colorful fish are present.*
	2016 *(image at right)*	***Most coral appears <u>dead</u>.***** **Other observations will vary.**
Reef #2: Pago Pago, American Samoa	2015 *(image at left)*	***Most coral appears <u>healthy</u>.***** **Other observations will vary.**
	2016 *(image at right)*	***Most coral appears <u>bleached</u>.***** **Other observations will vary.**
Reef #3: Lizard Island, Great Barrier Reef, Australia	March *(image at left)*	***Most coral appears <u>bleached</u>.***** **Other observations will vary.**
	May 2016 *(image at right)*	***Most coral appears <u>dead</u>.***** **Other observations will vary.**
Reef #4: Kahului Point, Maui, Hawaii	August 2015 *(image at left)*	***Most coral appears <u>healthy</u>.***** **Other observations will vary.**
	Nov 2015 *(image at right)*	***Some coral appears <u>bleached</u>.***** **Other observations will vary.**
Summarize your observations: What are 2-3 of the most visible signs that a coral reef has undergone a bleaching event?		***Loss of color;*** ***increased algae growth;*** ***changes in abundance or diversity of fish and other species that rely on the reef for food and/or protection.***

Monitoring Coral Health Using Quadrat Sampling:

2. Estimated values for coral health within each reef image:

REEF #1

Square #	Dead	Bleached
4	1	n/a
16	0	3
20	1	2
22	0	1
32	0	2
44	0	3
45	0	3
74	0	1
93	0	1
94	0	3
	Total Sum = 2	**Average = 2.1**
	% dead = 20%	**% bleached = 21%**

REEF #2

Square #	Dead	Bleached
1	1	n/a
3	1	n/a
20	1	n/a
27	1	n/a
44	0	4
48	0	0
49	0	2
61	0	5
62	0	4
89	0	3
	Total Sum = 4	**Average = 3**
	% dead = 40%	**% bleached = 30%**

REEF #3

Square #	Dead	Bleached
4	1	n/a
5	1	n/a
8	n/a	n/a
12	1	n/a
37	0	1
42	1	n/a
49	1	n/a
55	0	3
78	1	n/a
95	0	8
	Total Sum = 6	**Average = 4**
	% dead = 60%	**% bleached = 40%**

REEF #4

Square #	Dead	Bleached
4	0	1
16	0	1
20	0	1
22	0	1
32	0	4
44	0	1
45	0	2
74	0	0
93	0	2
94	0	0
	Total Sum = 0	**Average = 1.3**
	% dead = 0%	**% bleached = 13%**

1. <u>Analyzing Data From the Florida Keys:</u> To what extent is heat stress affecting the health of Florida's coral reefs? Collect & analyze evidence from interactive map & links provided within Level 4. Record your observations in the table below.

Graph: Were the corals in the Florida Keys at high risk, moderate risk or low risk of bleaching due to heat stress during the last 4 years? *Describe data and trends shown on the graph.*	**Answers will vary.** **Example: Corals in the Florida Keys have been at moderate or high risk of bleaching during summer months over the past 4 years. An accumulated heat stress value of 4 was exceeded during mid summer to fall in 2018 and 2021. A value of 8 was briefly exceeded during 2019 and 2020. Coral's likely experienced significant bleaching each summer and fall during this 4 year time period, though more so in 2019 and 2020.**
Observations from Condition Report: Where did bleaching occur in the Florida Keys during the past year(s). How severe was it? *Describe specific data & observations from the report.*	**Answers will vary.** **Example: According to the reports, in 2020 and 2021 only minor signs of coral bleaching were observed in the Florida Keys. Most observations noted partial bleaching with only 1-10% of corals affected at most of those sites during summer and fall.**

2. <u>Construct an Explanation:</u> Is heat stress affecting the health of Florida's coral reefs? Use the claim, evidence, reasoning format to construction an explanation below.

Claim: To what extent is heat stress affecting the health of Florida's coral reefs?	**Answers will vary.** **Example: Moderate to severe heat stress regularly caused some coral bleaching in the Florida Keys between 2018-2021.**
Evidence: Include specific data from your table above to support your claim.	**Answers will vary.** **Example: Accumulated heat stress values have exceeded a value of 4 each summer and fall between 2018-2021. Values briefly exceeded a value of 8 in 2019 and 2020. In-the-field observations from Mote Marine Lab noted that partial bleaching occurred in 1-10% of corals at each location that was surveyed in 2020 & 2021.**
Reasoning: Connect what you observed (evidence) and what you believe (claim). This part also often includes scientific principles or concepts.	**Answers will vary.** **Example: When accumulated heat stress values exceeded 4 each summer & fall between 2018-2021, I expected moderate to severe coral bleaching in the Florida Keys. In-the-field observations reported that partial bleaching occurred in a small percentage of corals throughout the Florida Keys during these same time periods. In conclusion, though heat stress caused partial bleaching, it was not as severe as the accumulated heat stress values predicted.**

DATA IN THE CLASSROOM: LEVEL 5
Design an Investigation

1. <u>Develop Your Question:</u> Ask a question that can be answered using the available data. Some 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?

Identify a question of interest.	

2. <u>Collect Data:</u> Collect the data that you need to answer your question using the data tools from Level 5. If possible, paste or attach any relevant graphs or data tables to this document.

3. <u>Construct an Explanation:</u> Use the claim, evidence, reasoning format to construction an explanation below.

Claim: Record a simple statement that answers your question and is based upon evidence.	
Evidence: Include specific data from the the data maps or graphs you have analyzed.	
Reasoning: Connect the evidence to your claim.	