Seven Reefs and a Heat Wave Lab: Teacher Guide

mrsajdak.com/reefs · Environmental Science, Chapter 6, Explorers at Work: Saving the Last Wild Places in the Ocean (pp. 158–159) · one period, about 40 minutes · © Ryan Sajdak, CC BY-NC-SA 4.0

What students do

The virtual version of the reef survey card lab. Students count living coral on seven real reef surveys from Enric Sala's 2005 Northern Line Islands expedition, plot heat stress against coral cover, and find that the hottest reefs are not the ones with the least coral. They box the fished reefs, test pairs until they find a fair comparison, and open each reef's strip to see what happened from 1997 to 2005. Then they read 56 years of heat waves out of a coral core from Jarvis Island (reef A) and use the record to answer "does one hot year prove the climate changed?"

Tab	Students	Learn It teaches	Sheet
Do Now	A first idea (warmer water, fishing, not sure) and one thing a scientist could measure.		A, B
1. Survey the reefs	Click the survey rings on living coral in seven photo quadrats (25 points each). The lab checks each count (two tries, then it shows the fix) and plots the reef by heat weeks and coral cover.	transect, photo quadrat, coral cover, heat weeks; reading the plot	1–5
2. A fair comparison	Box the fished reefs (B, E), compare pairs (the lab names what differs and says whether it is a fair test of heat), then open the strips: names and 1997 to 2005 change.	Enric Sala and Pristine Seas, fair comparison, coral bleaching, cause and effect, resilience, Kingman's sharks, Palmyra as the odd one out	6–11
3. Sixty years in a coral	Scan a CT image of a Jarvis core, mark the 10 stress bands, and build a bar chart of bleaching since 1960.	stress bands, El Niño, 2015-16 (95% died), weather vs climate, many places and many years	12–16

Every Learn It box opens only after the student has the data for that part, so no worksheet question asks about an idea before it is taught. Questions before each READ FIRST line are data only.

Standards

NYSSLS	**HS-ESS2-7** Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth: a change in ocean temperature changes which community a reef can hold. Touches **HS-ESS2-5** through ocean heat. DCI ESS2.D Weather and Climate; LS2.C Ecosystem Dynamics, Functioning, and Resilience.
SEP 3 Planning and Carrying Out Investigations	Choosing the fair pair of reefs (Q7, Q11); planning a Buffalo measurement with two places, a schedule and many years (Q16).
SEP 4 Analyzing and Interpreting Data	Turning photo quadrats into coral cover and reading the heat vs coral plot (Q1–2); reading the 56-year bleaching record (Q12–13).
SEP 7 Engaging in Argument from Evidence	Judging "one record-hot summer proves the climate changed" (Q14) and "C and E prove heat kills coral" (Q11).
CCC Patterns	No downhill line on the plot: the fished reefs are low, not the hot ones.

CCC Cause and Effect	Hot water drives out the coral's algae; heat waves killed the most coral where people fish (Q9–10).
CCC Stability and Change	What fell and what stayed the same, 1997 to 2005 (Q8); a reef that bounced back nine times, then lost 95% (Q12–15).

Misconceptions to plan for

- **"One hot year (or one dead reef) proves the climate changed."** One hot summer is weather; climate is the pattern over about 30 years. The Jarvis record is the answer: the 2015-16 die-off was only known to be unusual because of 56 years of cores. Q14–15.
- **"The hottest reefs have the most coral, so heat doesn't hurt coral."** Heat waves do bleach and kill coral (Jarvis lost 95% in one). The hot reefs on the cards are unfished, and they bounced back: resilience. Q10, Q13.
- **Boxing F because people live there.** Box only "Fishing: Yes". The lab's check says so.

Running it

- Pairs work well: one clicks, one checks and writes. Seven cards take about 6 to 8 minutes. If time is short, cards A, B, C and E are enough to see the pattern and make the fair-test choice.
- Tab 2's strip button stays locked until students have boxed B and E, compared one unfair pair and found one fair test of heat.
- Tab 3: the arrow keys step the core one year at a time. A band counts if the reader sits on either year of the event (for example 1997 or 1998).
- Pairs with the hands-on reef card lab in the lesson plan: same seven reefs, same numbers, so either can stand in for the other. The answer key is kept off the site.

Sources

Sandin SA, Smith JE, ... Knowlton N, Sala E (2008) Baselines and degradation of coral reefs in the Northern Line Islands. PLoS ONE 3(2): e1548. Table 1: population, fishing, mean maximum annual degree heating weeks, alert years and coral cover (Jarvis, Howland and Baker are NOAA data in that table); 85% vs 19% top predators and 527 vs 132 g of fish per square metre at Kingman and Kiritimati. Barkley HC, Cohen AL and others (2018) Repeat bleaching of a central Pacific coral reef over the past six decades (1960–2016). Communications Biology 1: 177. Ten events, eight severe (over 30%) and two moderate, each during El Niño: 1965-66 74%, 1972-73 38%, 1977-78 17%, 1982-83 66%, 1987-88, 1992-93 and 2001-02 40 to 50% (drawn at 45%), 1997-98 82%, 2009-10 12%, 2015-16 91%; about 95% of corals dead by May 2016. Photo quadrats and the CT scan are drawings that match these numbers. Heat-week thresholds (about 4 for significant bleaching, about 8 for widespread death) follow NOAA Coral Reef Watch.