

ENVIRONMENTAL SCIENCE CASE STUDIES: DATA ANALYSIS AND GRAPHING INVESTIGATIONS



NO PREP

Turn students into environmental scientists analyzing real-world data to solve ecosystem case files.



GRAPHING AND ANALYZING ECOSYSTEM IMPACTS USING REAL DATA

SCROLL

to take a look inside!

★ Complete student case files with guided investigation worksheets.

★ Multiple real-data datasets per case (tables & graphs).

★ Structured analysis tasks and CER writing prompts.

★ Full teacher answer keys with sample responses.

★ A clear grading rubric and Extension activity focused on solutions and monitoring plans.

What You Get

NO-PREP. JUST PRINT TO GO!

Full Case File breakdown

The Coral Reef Bleaching CASE FILE

Date: _____ Class: _____
Group Members: _____

Driving Question
Why are corals turning white in this reef ecosystem, and which evidence best explains what happened?
Students act as marine environmental scientists. They analyze multiple datasets collected by different research teams, evaluate reliability, identify outliers, and construct a Claim-Evidence-Reasoning explanation for the most likely cause of coral bleaching in the reef ecosystem.

Learning Targets

- Interpret tables and graphs to identify trends and compare sites
- Identify data quality issues (outliers, inconsistent methods)
- Use evidence to support a scientific explanation (CER)
- Connect human activities and environmental changes to ecosystem impacts

Group Roles
Each group member should take on one of the following roles to help your team work efficiently in the investigation.

Data Manager
Reads datasets aloud and helps organize the information being analyzed. Ensures all group members understand the data before moving on.

Trend Spotter
Identifies patterns in water temperature, pH, CO₂ levels, sunlight exposure, or pollution data.

Quality Checker
Looks for unusual or inconsistent data points (outliers). Evaluates which datasets are most reliable.

Reporter
Leads the discussion when writing the final Claim-Evidence-Reasoning (CER) explanation and conclusions.

Note: You can also have your students complete the CER individually as an assessment of understanding of the activity and content.

Part 2 – Evidence Packet
Create a graph for each dataset.

Team Notes
Team A: Measured average summer water temperatures at all four sites over the past 10 years.
Team B: Measured Ocean pH levels at each site.
Team C: Recorded atmospheric CO₂ levels over the past decade.
Team D: Measured pollution runoff levels near the reef after rainfall events.

Dataset 1 – Team A Water Temperature Trends

Year	Avg. Summer Temperature (°C)
2014	26.1
2016	26.4
2018	26.9
2020	27.3
2022	27.8
2024	28.4

Dataset 2 – Team B Ocean pH Levels

Site	pH
Nearshore Reef	7.95
Mid-Reef Zone	8.02
Outer Reef	8.05
Open Ocean	8.08

Dataset 3 – Team C Atmospheric CO₂ Levels

Year	CO ₂ (ppm)
2014	397
2016	404
2018	410
2020	416
2022	421
2024	427

Dataset 4 – Team D Pollution Runoff Levels

Site	Nitrate Levels (mg/L)
Nearshore Reef	2.8
Mid-Reef Zone	1.4
Outer Reef	0.6
Open Ocean	0.2

Rubric:

Criteria	1 – Beginning	2 – Approaching	3 – Meets Expectations	4 – Exceeds Expectations
Graphing & Data Representation	Graphs are incomplete, missing labels, incorrect graph type, or data is largely inaccurate	Graphs include some correct elements but have missing labels or plotting mistakes	Graphs are mostly accurate with correct labels and appropriate graph type	All graphs are accurate, clearly titled, correctly labeled (axes & units), appropriate graph type is chosen, and patterns are clearly visible
Trend Analysis	Struggles to identify patterns or provides incorrect conclusions	Identifies some trends but explanations are unclear	Correctly identifies major patterns with some supporting data	Accurately identifies and explains other patterns across multiple datasets with supporting data
Data Quality Evaluation	Does not correctly evaluate data reliability	Identifies reliability issues but explanations are unclear	Correctly evaluates most datasets with reasonable explanations	Correctly evaluates all datasets with clear, logical, and detailed explanations
Checklist / Evidence Interpretation	Shows limited understanding of the evidence	Shows some understanding of the evidence	Correctly interprets most evidence with clear, concise explanations	Correctly interprets all evidence with clear, concise explanations and strong justification
Claim (CER)	Claim is missing or incorrect	Claim is incomplete	Clear claim that answers the driving question	Clear claim that directly answers the driving question
Evidence (CER)	Evidence is missing or incorrect	Evidence is limited or not clearly accurate	Uses at least three relevant data points	Uses three or more specific, accurate data points from multiple datasets
Reasoning (CER)	Reasoning is unclear or missing	Shows basic understanding of cause and effect	Shows clear cause-and-effect reasoning with relevant data	Shows clear cause-and-effect reasoning with relevant data and logical connections
Collaboration & Role Participation	Limited participation in group work	Participates in group work	Participates in group work and encourages others	Completes assigned role independently and encourages others to participate
Environmental Drawing	Minimal drawing	Simple drawing	Clear drawing showing cause and effect	Clear drawing showing cause and effect with labels

Teacher Answer Key Part 2 Graphs

Dataset 1 – Team A Water Temperature Trends

Dataset 2 – Team B Ocean pH Levels

Dataset 3 – Team C Atmospheric CO₂ Levels

Dataset 4 – Team D Pollution Runoff Levels

Glossary of Terms

Acidification – The process of something becoming more acidic.
Algae – Tiny plant-like organisms that live in water. Some algae live inside corals and help them get energy.
Analyze – To look closely at information to figure something out.
Atmospheric CO₂ – Carbon dioxide gas in Earth's atmosphere.
Bleaching – When corals turn white because they lose the algae that live inside them.
Carbon dioxide (CO₂) – A gas in the atmosphere produced by burning fossil fuels and by living organisms breathing.
Claim – Your main answer to the investigation question.
Climate change – Long-term changes in Earth's temperature and weather patterns.
Coastal – Located near the ocean.
Conduct a measurement – To collect data using tools or instruments.
Data reliability – How accurate and trustworthy the data is.
Dataset – A group of information shown in a table or graph.
Dissolve – To mix completely into a liquid.
Ecosystem – Living and nonliving things interacting in one area.
Evidence – Facts or data that support your claim.
Fossil fuels – Energy sources like coal, oil, and natural gas formed from ancient plants and animals.
Greenhouse gases – Gases like carbon dioxide that trap heat in Earth's atmosphere.
Investigation – A careful study to find out what happened.
Marine – Related to the ocean.
Marine protected area – A section of the ocean where human activities are limited to protect ecosystems.
Monitoring – Checking something regularly over time.
Ocean acidification – When the ocean becomes more acidic because of carbon dioxide from the atmosphere.
Ocean warming – The increase in ocean temperature over time.
Outlier – A data value that is very different from others.
pH – A measure of how acidic or basic water is. Lower pH means more acidic.
Photosynthesis – The process plants and algae use to make energy from sunlight.
Pollution runoff – Runwater that carries pollutants from land into oceans or rivers.
Pollution – (per million) – A unit used to measure very small amounts of a substance, like in the air or water.

HOW THIS ACTIVITY HELPS YOU

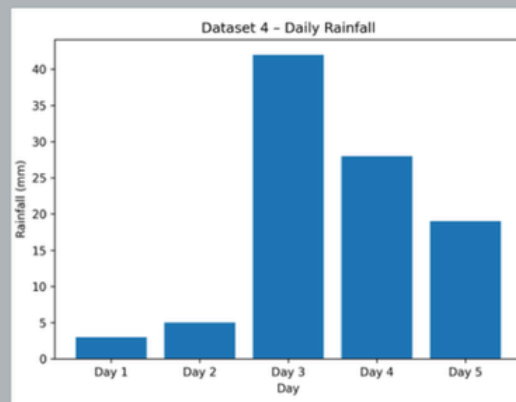
- Saves prep time with a fully structured, print-and-go investigations.
- Drives high engagement while still meeting academic goals as students are interested in what they're doing.
- Builds deep understanding with **real-world relevance** as the students analyze real evidence, make connections, and using CER to explain the impact on the environment.

SKILLS YOUR STUDENTS WILL DEVELOP

- Data Analysis & Graphing
- Evidence Evaluation
- Scientific Reasoning
- Claim–Evidence–Reasoning Writing
- Collaborative Problem Solving

Dataset 1 – Team A Water Temperature Trends

Year	Avg. Summer Temperature (°C)
2014	26.1
2016	26.4
2018	26.9
2020	27.3
2022	27.8
2024	28.4



HOW THIS MYSTERY WILL HELP YOU



- Prep-FREE and fully editable **Environmental Science Investigations** - just print/upload and assign with no materials.
- Engages every learner through hands-on, high-interest, real-life **Environmental Case Studies** that boost motivation and participation.
- Provides a consistent assessment tool with answer keys and rubrics.
- **Builds essential skills** such as data literacy, graphing, problem-solving, teamwork, and evidence-based writing skills.

What Will Your Students Learn?

- ✓ How human activities impact ecosystems (pollution, land use, climate change, etc).
- ✓ How environmental factors affect water quality, soil health, and marine systems.
- ✓ The causes and effects of ecosystem disruptions (fish kills, algal blooms, bleaching, erosion, salinity).
- ✓ How temperature, pH, CO₂, and nutrients influence ecosystem stability.
- ✓ How interconnected Earth systems respond to environmental change.



Part 1 - Mission Briefing

Part 1 – Mission Briefing

A coral reef located near a coastal community has recently experienced widespread coral bleaching. Large sections of coral appear white instead of their usual vibrant colors. Marine biologists are concerned about long-term reef health.

The reef is located near a growing coastal city. Scientists are investigating whether environmental changes may be responsible.

Sites (in order moving away from shore)

Site 1: Nearshore Coastal Reef → Site 2: Mid-Reef Zone → Site 3: Outer Reef → Site 4: Open Ocean Reference Site

Your Job

- Study the evidence (datasets and notes)
- Create graphs for each data set
- Decide which data is most reliable
- Determine what likely caused the coral bleaching
- Support your conclusion using evidence

Background

Corals live in partnership with tiny algae called zooxanthellae. These algae provide corals with color and energy through photosynthesis. When ocean temperatures rise too high, corals become stressed and may expel the algae, causing bleaching (turning white).

Ocean acidification occurs when excess carbon dioxide (CO₂) dissolves in seawater, lowering pH levels. Lower pH can weaken coral skeletons. Pollution runoff and increased sunlight exposure can also stress coral ecosystems.

First Task

Create a drawing of the reef and surrounding coastal areas using the information provided. Use the information provided but also be creative.

- Learn about an environmental issue affecting an ecosystem
- Review background science concepts
- Examine site locations within the ecosystem
- Create a labeled environmental drawing
- Prepare to analyze multiple datasets
- Investigate possible causes of ecosystem change
- Use evidence to determine the most likely explanation

Part 2 - Evidence Packet

Part 2 – Evidence Packet

Create a graph for each dataset.

Team Notes

Team A: Measured average summer water temperatures at all four sites over the past 10 years.

Team B: Measured Ocean pH levels at each site.

Team C: Recorded atmospheric CO₂ levels over the past decade.

Team D: Measured pollution runoff levels near the reef after rainfall events.

Dataset 1 – Team A Water Temperature Trends

Year	Avg. Summer Temperature (°C)
2014	26.1
2016	26.4
2018	26.9
2020	27.3
2022	27.8
2024	28.4

Dataset 2 – Team B Ocean pH Levels

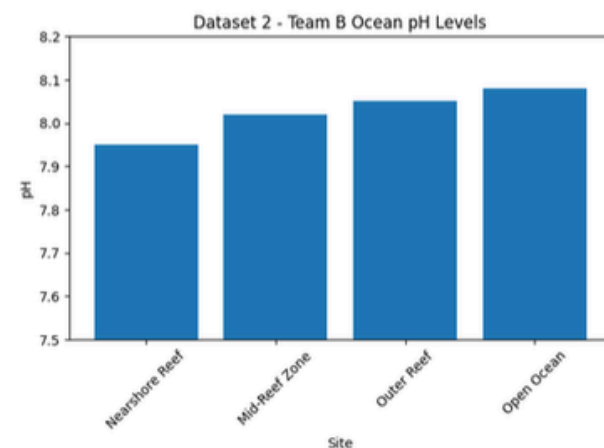
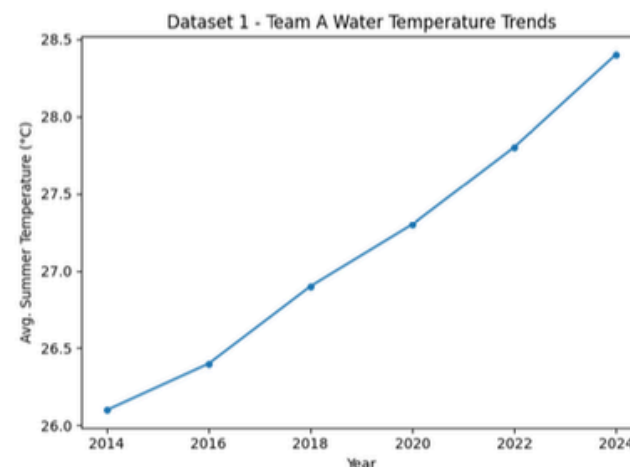
Site	pH
Nearshore Reef	7.95
Mid-Reef Zone	8.02
Outer Reef	8.05
Open Ocean	8.08

Dataset 3 – Team C Atmospheric CO₂ Levels

Year	CO ₂ (ppm)
2014	397
2016	404
2018	410
2020	416
2022	421
2024	427

Dataset 4 – Team D Pollution Runoff Levels

Site	Nitrate Levels (mg/L)
Nearshore Reef	2.8
Mid-Reef Zone	1.4
Outer Reef	0.6
Open Ocean	0.2



- Review team notes and data collection methods
- Examine multiple environmental datasets
- Create graphs for each dataset
- Compare data across sites or over time
- Look for patterns, trends, and relationships
- Prepare to evaluate evidence and determine the cause of change

Part 3 - Analysis Tasks

Part 3 – Analysis Tasks

A. Trend Hunt

- 1. How have water temperatures changed over time?
- 2. Which site has the lowest pH level?
- 3. What trend is seen in atmospheric CO₂ levels?
- 4. Where are pollution runoff levels highest?

B. Data Quality Check

Dataset	Rating (Strong/Caution/Unreliable)	Why?	What would you do to double-check?
Dataset 1			
Dataset 2			
Dataset 3			
Dataset 4			

C. What Really Happened?

- | | |
|---|----------|
| Evidence shows ocean temperatures increased | YES / NO |
| Evidence shows pH levels decreased nearshore | YES / NO |
| Evidence shows CO ₂ levels increased | YES / NO |
| There is at least one dataset that suggests an additional stress factor | YES / NO |

- Answer trend-based questions using data
- Identify patterns and relationships across datasets
- Evaluate data reliability and possible errors
- Decide which evidence is strongest
- Determine what most likely caused the environmental change
- Use evidence to support conclusions

Part 4 - Claim, Evidence, Reasoning

Part 4 – CER

Claim

What is the most likely cause of coral bleaching in this reef ecosystem?

Evidence

Evidence 1:

Evidence 2:

Evidence 3:

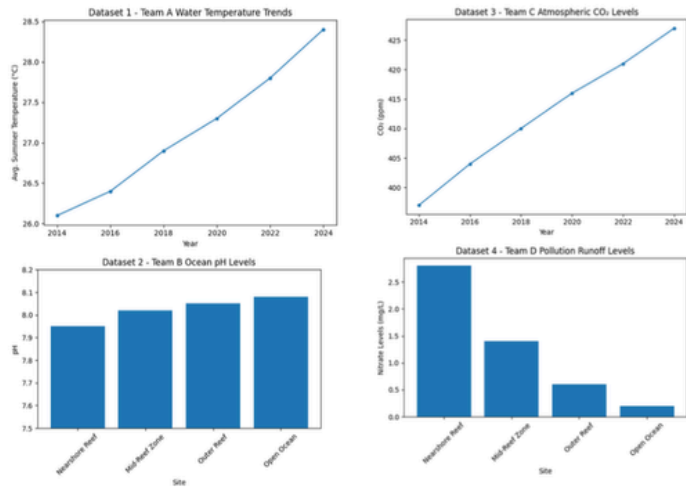
Reasoning

Explain why your evidence supports your claim using terms like ocean warming, acidification, CO₂, pH, and coral health.

- Write a clear **claim** answering the driving question
- Select specific **evidence** from the datasets
- Students use data to support their **explanation**
- Explain the cause-and-effect relationships
- Connect scientific concepts to your conclusion

Full Teacher Answer Key

Teacher Answer Key
Part 2 Graphs



Part 3:
A. Trend Hunt
1. How have water temperatures changed over time?
Water temperatures have steadily increased over the past 10 years.
• 2014 = 26.1°C
• 2016 = 26.4°C
• 2018 = 26.9°C
• 2020 = 27.3°C
• 2022 = 27.8°C
• 2024 = 28.4°C
This shows a clear upward trend in summer ocean temperatures, which can stress coral ecosystems.
2. Which site has the lowest pH level?
Nearshore Coastal Reef (Site 1)
• Nearshore Reef = 7.95
• Mid-Reef Zone = 8.02
• Outer Reef = 8.05
• Open Ocean = 8.08
Lower pH indicates more acidic conditions. The nearshore site has the lowest pH, suggesting stronger acidification closer to land.
3. What trend is seen in atmospheric CO2 levels?
Atmospheric CO2 levels have steadily increased over time.
• 2014 = 397 ppm
• 2016 = 404 ppm
• 2018 = 410 ppm
• 2020 = 416 ppm
• 2022 = 421 ppm
• 2024 = 427 ppm
This increase in CO2 contributes to ocean warming and ocean acidification.
4. Where are pollution runoff levels highest?
Pollution runoff is highest at the Nearshore Coastal Reef (Site 1).
• Nearshore Reef = 2.8 mg/L
• Mid-Reef Zone = 1.4 mg/L
• Outer Reef = 0.6 mg/L
• Open Ocean = 0.2 mg/L
This suggests coastal runoff may be adding additional stress to nearshore coral.

Extension Activity: Protecting the Coral Reef Ecosystem
Now that your team has identified the most likely cause of coral bleaching in the reef ecosystem, your group has been asked to help reduce future bleaching events.
Your task is to:
1. Recommend One Environmental Solution
Propose one action that could reduce coral stress in this reef ecosystem.
Explain how your solution would help protect coral health.
Environmental Solution:

2. Plan a Follow-Up Investigation
Choose one factor that affects coral health (water temperature, pH, CO2 levels, or pollution runoff).
Design a simple investigation that marine scientists could carry out next year to monitor whether reef conditions are improving.
Your investigation should include:
• what you would measure
• where you would measure it
• why this would help track coral health

Table with 4 columns: Dataset, Rating, Why?, and What would you do to double-check? It contains data for four datasets related to coral reef health and a section for follow-up investigation.

Part 4 Sample CER
Claim
Ocean warming and acidification caused by increasing atmospheric CO2 levels are the most likely causes of coral bleaching in this reef ecosystem.
Evidence 1:
Average summer water temperatures increased from 26.1°C in 2014 to 28.4°C in 2024, showing a steady warming trend.
Evidence 2:
Atmospheric CO2 levels increased from 397 ppm to 427 ppm over the same time period.
Evidence 3:
The lowest pH level was recorded at the Nearshore Reef (7.95), which is lower than offshore sites (8.02–8.08), indicating increased acidification.
Reasoning
Corals depend on tiny algae for energy and color. When ocean temperatures rise too high, corals become stressed and expel these algae, causing bleaching. The steady increase in ocean temperatures suggests warming is stressing the reef. Increasing atmospheric CO2 contributes to both ocean warming and ocean acidification. When CO2 dissolves in seawater, it lowers pH levels, making the water more acidic. Lower pH can weaken coral skeletons and make corals more vulnerable to stress. The combination of ocean warming and acidification reduces coral health and increases the likelihood of bleaching events.

Glossary of Terms

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Algae — Tiny plant-like organisms that live in water. Some algae live inside corals and help them get energy.
Analyze — To look closely at information to figure something out.
Atmospheric CO2 — Carbon dioxide gas in Earth’s atmosphere.
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Evidence — Facts or data that support your claim.
Fossil fuels — Energy sources like coal, oil, and natural gas.
Greenhouse gases — Gases in the atmosphere that trap heat.
Investigation — A careful study to learn more about something.
Marine — Related to the ocean.
Marine protected area — A designated area of the ocean where human activities are restricted to protect marine resources.
Monitor — To check or observe something regularly.
Ocean acidification — The process of ocean water becoming more acidic due to increased atmospheric CO2.
Outlier — A data value that is significantly different from the others.
pH — A measure of how acidic or basic a liquid is.
Photosynthesis — The process by which plants and some organisms use sunlight to make food.
Pollution runoff — Rainwater that flows over land and carries pollutants into the ocean.
ppm (parts per million) — A unit of measurement for concentration.
Reef — A large underwater structure made of coral.
Resilience — The ability to recover from or adapt to change.
Site — A location where data is collected.
Stressor — Something that causes stress.
Trend — A pattern shown in data over time.
Zooxanthellae — Tiny algae that live inside coral and provide them with energy.

Rubric table with 5 columns: Criteria, 1 – Beginning, 2 – Approaching Expectations, 3 – Meets Expectations, 4 – Exceeds Expectations. It evaluates student work across categories like Graphing & Data Representation, Trend Analysis, Data Quality Evaluation, Checklist / Evidence Interpretation, Claim (CER), Evidence (CER), Reasoning (CER), Collaboration & Role Participation, and Environmental Drawing.

Glossary & Rubric

Thanks
**for your interest
in this resource!**

I am a real person and if
you have any questions,
suggestions, or concerns,
please reach out.



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*Let's
Connect!*

