




 **ENVIRONMENTAL STUDIES**
UNIVERSITY of WASHINGTON | PROGRAM ON THE ENVIRONMENT

**Case Study Pedagogy:
Practicing Analytical Skills
with Environmental Cases**

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Case Study Pedagogy

- ▶ Students learn principles of the field and gain relevant skills by analyzing real-world examples and problems
- ▶ Commonly practiced in medicine, law, business, and increasingly in science
- ▶ Can we teach socio-environmental synthesis through cases?

Case Study Pedagogy

▶ What is a case in teaching socio-environmental issues?

- Compelling stories, real-world issues, events, controversies, problems ...
- Scenarios, storylines, characters/stakeholders, multiple sources of information, competing knowledge claims ...

▶ Why using a case in teaching socio-environmental issues?

- Engage students, motivate learning, draw interest
- Provide context for how to practice analytical skills in a real-world situation
- Student-centered learning
- Explore complexity in social-environmental issues

Case Study Pedagogy

Gains

- ▶ Context: Why what students are learning matters?
- ▶ Real-world application
- ▶ Practice problem-solving and analytical skills
- ▶ Student-centered learning
- ▶ Explore socio-environmental complexity

Challenges

- ▶ How to find a relevant case?
- ▶ How to guide students to apply the same analytical skills to other cases?
- ▶ Too complex and overwhelming?
- ▶ Align with learning objectives
- ▶ Classroom management, student assessment, fairness in group work

Investigating socio-environmental issues with data

A QUBES/SESYNC Faculty Mentoring Network opportunity!

Are you interested in adopting interdisciplinary modules that address quantitative reasoning skills and socio-environmental issues? Apply now to join us for the Spring 2018 SESYNC/QUBES Faculty Mentoring Network (FMN).

Participants in this FMN will focus on how to use data-driven modules in undergraduate life science courses. Accepted applicants will customize and implement educational modules, including SESYNC case studies and other published materials. While doing this, they will participate in biweekly virtual sessions (including a mid-January kick-off event at SESYNC in Annapolis, MD) to collaborate with and support others in the network and to receive mentoring.

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CASE STUDY #1

Globally endangered sea turtles of the Palmyra Atoll National Wildlife Refuge: A Focus on Scientific Analysis



Authors: E. Naro-Maciel, K. Holmes, P.J. Ersts, K. McFadden, N. Bynum, E. Sterling

▶ <https://ncep.amnh.org/index.php/Detail/objects/62>

Course Context

- ▶ **ENVIR 250: Research Methods in Environmental Studies**
- ▶ **End-of-Quarter Group Project**
 - A. Project Introduction & Background: In-class Discussion & Worksheet
 - B. Oral Presentation: Literature Review of Two Scientific Articles
 - C. Research Project Proposal

The Case Module

Globally endangered sea turtles of the Palmyra Atoll National Wildlife Refuge: A Focus on Scientific Analysis

Eugenia Naro-Maciel, Katherine Heines, Peter J. Erst, Katherine McFadden, Nora Synn and Eleanor Sterling

OVERVIEW

Little is known about sea turtles and their habitats at the remote Palmyra Atoll National Wildlife Refuge (PANWR) in the Central Pacific. This lack of knowledge may hinder management and conservation efforts. To help provide insights into protection strategies, in this exercise you will make suggestions for designing a comprehensive research program on globally endangered sea turtles of the Palmyra Atoll National Wildlife Refuge. You will then use existing survey data to answer questions about the relative abundance of endangered sea turtles along the atoll, and critically analyze your results. Finally, you will carry out research to devise your own methods for studying sea turtles at the PANWR.

INTRODUCTION

The world's oceans and seas, which span about three quarters of the earth's surface and contain a substantial part of the planet's biodiversity, are under threat. Systems are strained by unsustainable fishing practices, habitat degradation, coastal development, climate change, and other factors. Over the course of their lives, sea turtles play important ecological roles in many marine systems. These charismatic animals have long been important elements of diverse cultures, and their conservation can benefit humans as well, through for example ecotourism or environmental employment. Even so, many of these ancient reptiles are now endangered worldwide due to harvest, fisheries interaction, habitat loss, pollution and disease, climate change, and other threats. Sea turtles are flagship species, whose conservation can also protect the vast, diverse, and often threatened habitats they utilize. Sea turtles, also known as marine turtles, have inhabited the earth for over 100 million years, since the Cretaceous Period (Priyayama, 1996). The fossil record reveals that turtles were established during this period, two of which have survived into the present (Pritchard, 1996). The family Dermochelyidae contains only the hawksbill turtle, *Caretta caretta*, while the second family, the Cheloniidae, is commonly thought to include six species classified into five genera. These include the critically endangered hawksbill turtle, *Caretta caretta*.

EXERCISE

A) Asking questions about sea turtle research at Palmyra Atoll

Why study sea turtles of Palmyra? Based on the information above, can you formulate three scientific or management/conservation questions that can be addressed through research at the PANWR? In a group or as part of a classroom discussion, organize the various questions raised by your class into overarching research themes.

B) Identifying objectives for sea turtle research at the PANWR

Next, please identify three to five priority objectives for sea turtle research at the PANWR. Include a justification of why meeting each objective is important to science or conservation.

C) Methods and Results: A focus on sea turtle surveys at Palmyra Atoll

To advance the research and conservation of sea turtles at Palmyra Atoll, studies began there in 2005. One major objective of the early research at Palmyra was to gain some understanding of sea turtle distribution and abundance there. To that end, surveys were carried out to document the occurrence of sea turtles along the atoll about every three months from August 2005 to September 2006, and approximately annually thereafter. Survey counts were conducted by 5 to 10 researchers who simultaneously traveled by kayak and boat along non-linear transects, each counting the number of turtles that they encountered on the transect. The total number of turtles counted was influenced by weather and visibility conditions, and as many as 120 turtles were seen during the roughly 2-hour survey period.

To help provide insights into conservation and management, you will use data from the first survey to investigate the abundance of endangered sea turtles along the atoll. The coordinates of sea turtle sightings were recorded in this survey using Global Positioning System (GPS) technology and overlaid with satellite images to investigate ecological interactions. Below are the results of this survey, which took place in August 2005 (Figures 4-6). Use these data to reply to the following questions. For each question, also consider what some limitations might be in only using these survey data to formulate your answers.

- 1) Which species appears to be most common along the atoll?
- 2) Are sea turtles found randomly throughout the atoll? If not, identify areas where sea turtles are most commonly seen.

- 3) Assuming the data are correct, what might be some explanations to account for their distribution?

- 4) Identify strengths and weaknesses of using this survey to assess turtle distribution at the PANWR. Should additional background information be needed, please see the NCEP module "Census and Survey Techniques: An Overview of Theoretical and Technical Issues".

- 5) How would you carry out future surveys to improve the quality of conclusions drawn from these data?

- 6) Now look at the results of additional surveys, which followed a more defined survey design (Figures 8-11). Do they confirm the conclusions based on the first survey? Are these data sufficient to estimate distribution and relative abundance of sea turtles along the atoll? Based on these data, design three testable hypotheses for future studies investigating distribution and abundance.

D) Developing methods for sea turtle research

Now, consider the following research questions currently being investigated at Palmyra: a) diet; b) health; c) local movements at the edge; d) migratory connections to other sites outside the Refuge. Choose one of these areas, and carry out library research to identify methods you would use if you were carrying out the research. Report your findings by writing two to three paragraphs in a format suitable for publication in the Introduction or Methods section of a scientific journal article.

A. Background & Worksheet

- 1) Ask questions about sea turtle research at Palmyra Atoll
- 2) Identify objectives for sea turtle research at the PANWR
- 3) Methods and Results: A focus on sea turtle survey at Palmyra Atoll (data interpretation)

Figure 4. GPS locations of sea turtle sightings (+) from the August 2005 survey (number of turtle sightings (n) = 224). **Note:** For many of these turtles, it was not possible to assign a size or species classification, although all individuals captured in subsequent studies were green sea turtles.

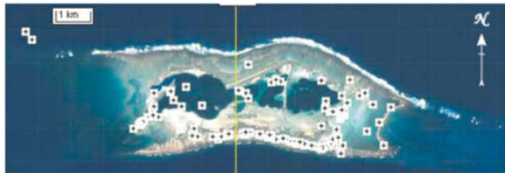
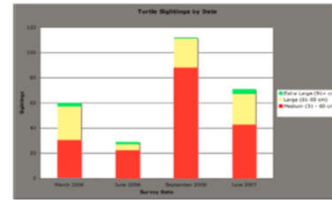


Figure 10. Summary of survey results – turtle sightings by date. **Note:** For many of these turtles, it was not possible to assign a species classification, and all size categories are estimates since the turtles were not measured.



B. Literature Review (Oral Presentation)

- ▶ Introduction: a brief overview of your chosen aspect of the sea turtle conservation project
- ▶ Strategies for identifying relevant and high quality articles
- ▶ Summary of the two articles
- ▶ Comparison and evaluation: in terms of methods, results, and data presentation
- ▶ Brief overview of proposal ideas

Example Student Work: Habitat Preferences

This presentation consists of 15 slides. Slide 1 is the title slide. Slide 2 is the 'Outline' slide. Slide 3 is the 'Introduction' slide. Slide 4 is the 'Background and Rationale' slide. Slide 5 is the 'Research Objectives' slide. Slide 6 is 'Article 1 Summary'. Slide 7 is 'Article 2 Summary'. Slide 8 is 'Comparison and Evaluation - Method'. Slide 9 is 'Comparison and Evaluation - Method'. Slide 10 is 'Article 1 Result and Data Presenting'. Slide 11 is 'Article 1 Result and Data Presenting'. Slide 12 is 'Article 1 Result and Data Presenting'. Slide 13 is 'Article 2 Data Presenting'. Slide 14 is 'Article 2 Results'. Slide 15 is the 'Proposal Overview' slide.

Example Student Work: Health & Debris Ingestion

This presentation consists of 11 slides. Slide 1 is the title slide. Slide 2 is the 'Introduction' slide. Slide 3 is the 'Strategies for Identifying Articles' slide. Slide 4 is 'Article 1: Debris Ingestion by Juvenile Marine Turtles: an Underestimated Problem'. Slide 5 is 'Article 2: Risk Analysis Reveals Global Hotspots for Marine Debris Ingestion by Sea Turtles'. Slide 6 is the 'Methods' slide. Slide 7 is the 'Results' slide. Slide 8 is the 'Data Presentation' slide. Slide 9 is the 'Weaknesses' slide. Slide 10 is the 'Significance' slide. Slide 11 is the 'Our Proposal' slide.

C. Research Project Proposal

- ▶ Introduction & background
- ▶ Research questions
- ▶ Study design and data collection plan:
 - ▶ Sampling plan & justification
 - ▶ Data collection plan
- ▶ Time line and overall feasibility of the project
- ▶ Expected results and significance

Example Student Work: Sea Turtle Health

Palmyra Atoll Sea Turtle Health Proposal

Introduction

Green sea turtles (*Chelonia mydas*) and hawksbill sea turtles (*Eretmochelys imbricata*) are globally endangered species on the IUCN Red List of Threatened Species. Sea turtles are highly migratory and serve as prey for some species of sharks and play other important ecological roles as marine systems such as lobster populations and nutrient transporters (Bjornstad and Jackson 2003).

It is key to study sea turtles because these animals have had history of overexploitation, which is the attraction of certain metals and chemicals to certain organs and tissues. This makes sea turtles a great bio-indicator of heavy metals in our oceans (Cowan 2009). We are focusing on heavy metal accumulation in sea turtles because some studies indicate an increasing prevalence of elevated metal levels in marine life. The metals that we are studying are Cadmium (Cd), Zinc (Zn) and Copper (Cu) because these metals have been shown to be ecologically toxic. Bio-accumulation (the increase in abundance of pollutants with each step up the food chain) of these metals through various food chains puts great a health threat to humans as well. Studying these may provide some insight on the implications of heavy metal bioaccumulation.

The Palmyra Atoll National Wildlife Refuge in the central Pacific has been indicated as a foraging ground for turtles of wide geographic origin and has to gross turtles genetically differentiated from others in the Indo-Pacific (Naro-Maciel, et al. 2014). Palmyra Atoll is one of the only tropical atoll systems in the Central Pacific not impacted by growing human populations. Palmyra also has an abundance of native and migrant species available to bioaccumulate.

A study in the French Atlantic Coast (Cowan 2009), indicated that sea turtles accumulate large concentrations of heavy metals in their proteins, which is critical for the digestive system, amongst several other organs. This led to the idea of organotopes, which has led us to want to study this turtles. Another heavy metal study in Chile discovered that there was high levels of numerous metals such as cadmium, plumbum, and thallium in blood, which was hazardous to turtle health (Munoz, Vives et al. 2010). This resulted in environmental protection policies and evaluation of pollution sources.

By understanding the role of sea turtles in terms of their health and ecology we have decided to apply some heavy metal analytical techniques to the Palmyra Atoll's Sea Turtles by conducting the following research question: *How does bioaccumulation of heavy metals affect the health of sea turtles in the Palmyra Atoll?*

Palmyra Atoll Sea Turtle Health Proposal

Methods and Data Collection

Heavy Metal Analysis

Heavy metal analysis would take place by collecting data on common heavy metal isotopes to accumulate in the Palmyra Atoll such as Cadmium (Cd), Copper (Cu) and Zinc (Zn). This data would be collected by monitoring organotopes from already dead and living sea turtles in Palmyra. In terms of the living sea turtles, blood, skin and composite samples would be taken to not harm or degrade the health of the individual. For already dead turtles that would be spotted, organotopes such as the kidney, liver and pancreas would be extracted for analysis.

We would also be taking bioenergetic measurements, such as Body Condition Index (BMI) and Standard Curvature Length (indicator of age), which would result in a deeper understanding on what factors could be enhancing or preventing bioaccumulation and assessing the current state of health for specific individuals. Temperature measurements would also be taken to see if water temperatures in different locations would have an effect on heavy metal bioaccumulation. This will also allow the long term research on the effect of rising sea levels and temperatures to be applied to Palmyra, which could be future research.



Figure 1: Satellite image showing the Palmyra Atoll (red dot) in the central Pacific (courtesy of NOAA).

Collection of this data would take in the sampling of sea turtles, using stratified sampling. The purpose of using the stratified sampling method would be to maintain the ratio of turtle samples seen in each of these grid locations (Figure 1). Initially, a Global Positioning System (GPS) to record the sea turtle sightings, which was then correlated with the different grid cells. According to the August 2007 GPS readings, there were 234 sightings of sea turtles were recorded (Naro-Maciel et al. 2009). To ensure a high enough sample size 20% of the sea turtles in each grid should be sampled, which would

Palmyra Atoll Sea Turtle Health Proposal

Island	Population	Sampling Size
Tenara	1,133	78
Takaroa	2,339	127
Karua	5,115	258

Table 1: showing the 1% sampling size for each of the 3 islands that are the focus of the survey. Population was taken using the last census for these areas in 2003.

Our goal is to extend our survey audience beyond our island to question data from various viewpoints on sea turtle health. We want to identify potential solutions for conservation strategies and how to maintain sea turtle populations. Our target audiences include marine conservation, population, from each island, and people who could be affected by the loss of the sea turtles in the food web. We will analyze the data by grouping together common responses that occur. From each question into themes to identify any solutions that benefit sea turtle health. The way we will collect data from each island is to survey individuals through in person interviews (Table 2). We will accept data from the first 5% we survey to eliminate bias from the survey. The survey data will then be analyzed by using common themes and content mapping.

Questions
What ways do you think there are to ensure sea turtle health?
What do you do to contribute to sea turtle conservation?
What are your potential strategies for protecting sea turtles?
Do you think sea turtles a priority compared to other marine organisms?
Are there any environmental laws regarding sea life?

Table 2: showing potential survey questions

Expected Results and Significance

Timeline & Feasibility

We expect this research to last multiple years, and will have ongoing efforts to it. The survey is expected to take two months to conduct. This is because we have to send a boat to all the correct orders and stakeholders that may have involvement in this Research. For instance, this survey needs to be taken by anyone that is on the island as well as anyone on surrounding or nearby islands. It will also be important to gather results from nearby communities that might be research on Palmyra Atoll as well. Environmental organizations that are nearby would be important too. After that we expect one month for corroborating the results. We plan to have bi- yearly work and capture observations to find our success

Example Student Work: Threats of Fisheries

The Threat of Fisheries on Palmyra Atoll Sea Turtles

Keywords: Palmyra Atoll, Pacific Ocean, Fisheries, Fishing Gear, Sea Turtles

Research Question: Which type of fishing gear is the greatest threat to sea turtles on Palmyra Atoll?

Introduction

Research shows that fisheries are a great threat to sea turtle populations due to constant bycatch. There is currently no regulatory authority that keeps track of bycatch. Bycatch is a major threat because it can cause health problems such as decompression sickness, gas embolism, and elevated stress levels in sea turtles. The two articles we used to further look into the relationship between fisheries and sea turtles were Lewison et al.'s article *Quantifying the effects of fisheries on strandings of juvenile longfin mackerel and southern leather sea turtles* and Fabbiano et al.'s *Bycatch risk*.

Figure 1. Shows the hot spots of commercial fishing effort; the bars and oval(s) mark the world in the year 2005. The dark spots on the map are where areas have the most bycatch.

Data Collection Plan

Our data will come from fisheries that operate within a 500-kilometer radius of Palmyra (See Figure 2). First, we will set up meetings with the different fishing companies in the area to lay out a framework for our specific guidelines. We will establish a relationship with the people who work for the fisheries by going out onto the boats (one from each company) every 6 months.

Information on the types of fishing gear used by fishing companies within 500 kilometers of Palmyra will be compiled from the Secretariat for the Pacific Community Ocean Fisheries Programme database.

We will collect data from variables including depth of gear deployment which is crucial in order to determine the risk and severity of gas embolism and decompression sickness in sea turtles. Figure 4 is a graph from Fabbiano's study which demonstrates what our data would look like. Additionally, we will collect data on type of fishing gear used by each fishery to determine which one is the most commonly used. This data will be presented in the form of a bar graph with the number of boats on the Y axis and the different types of fishing gears they use on the X axis.

Figure 3. Probability of 10% bycatch of gear deployment for turtles based on gear depth and gear type. Number values symbol is 1 of animals to each bin.

Overall Feasibility and Limitations

Our major limitation is that there might not be enough sea turtles on Palmyra to collect data for our ideal sample size. Our goal is to tag the first 500 turtles that we find. We are assuming that we will be able to find that many turtles, and that we will have to search a variety of places on the island to find them. However, we might find that 200 is too big or too small of a number. Another limitation of our data collection method is that we did not use a specific sampling square. We did not identify the island area specific zones to collect the turtles which may cause our final results could be biased.

In addition, fisheries may not be consistent in reporting accurate data. Since we will only be visiting the boats every six months, we will be heavily reliant on the data that the fishermen give us. They might not report accurate numbers of bycatch turtles out of fear that they will be given fines or other repercussions. We will need to ensure the fishermen that the numbers are purely for scientific research and that they will suffer no negative repercussions.

Potential confounding factors of our study include age, size, or any pre-existing health conditions that the turtles may have. These are important to keep in mind as they may have an impact on our results.

Expected Results

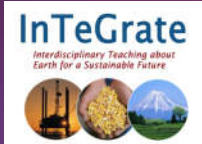
We hypothesize that the most commonly used fishing method within the 500-kilometer radius will be the greatest threat to sea turtles on Palmyra simply because there is a greater chance that the sea turtles will come into contact with that type of fishing gear. The significance of this study is to further conservation efforts on Palmyra by collaborating with fisheries and creating stronger regulations to combat sea turtle bycatch. This may cause implementing larger restricted areas that fisheries cannot be in. Or most likely, our study will bring awareness to fisheries and the public about the health effects of bycatch on sea turtles. This will allow us to train fisheries on what steps to take when they encounter bycatch turtles. This is essential because it will ensure that the turtles receive the proper care and treatment to prevent death from diseases such as gas embolism and decompression sickness.

Student Feedback

1. Better grasp of how to **conduct literature review** of scientific articles, including database search
2. **Practice critical review of research** design, methods, data collection, and interpretation of results
3. **Learning research methods** through a specific case provides contexts and practical considerations
4. Skills learned are **transferable** to other cases
5. **Challenges:** unfamiliar case, remote location, lack of content knowledge about sea turtle biology

CASE STUDY #2

Regulating Carbon Emissions



Authors: Robyn Smyth, Sandra Penny, Curt Gervich, Gautam Sethi, Eric Leibensperger, and Pinar Batur

► https://serc.carleton.edu/integrate/teaching_materials/carbon_emissions/index.html

InTeGrate: Regulating Carbon Emissions

Table of Contents

- Instructor Materials: Regulating Carbon Emissions Module
- Unit 1 Evidence and Impacts of Climate Change
- Unit 2 Climate Forcings
- Unit 3 Dynamic Integrated Climate Economy (DICE) Modeling
- Unit 4 Towards Climate Change Policy in the U.S.
- Unit 5 Abating Carbon Emissions
- Unit 6 Carbon Emissions Game
- Unit 7 Climate Change from the Socio-Environmental Systems Perspective
- Student Materials
- Assessment
- Instructor Stories

Course Context

- ▶ **ENVIR 495C: Socio-Environmental Data Analysis**
- ▶ **Data Visualization with Tableau**
 - A. Visualizing CO2 emissions data with Tableau
 - Bar chart, time-series line chart, proportional symbols map, choropleth map, Tableau dashboard
 - B. Practice the same skills with another data set

Tableau: Business Intelligence & Analytics

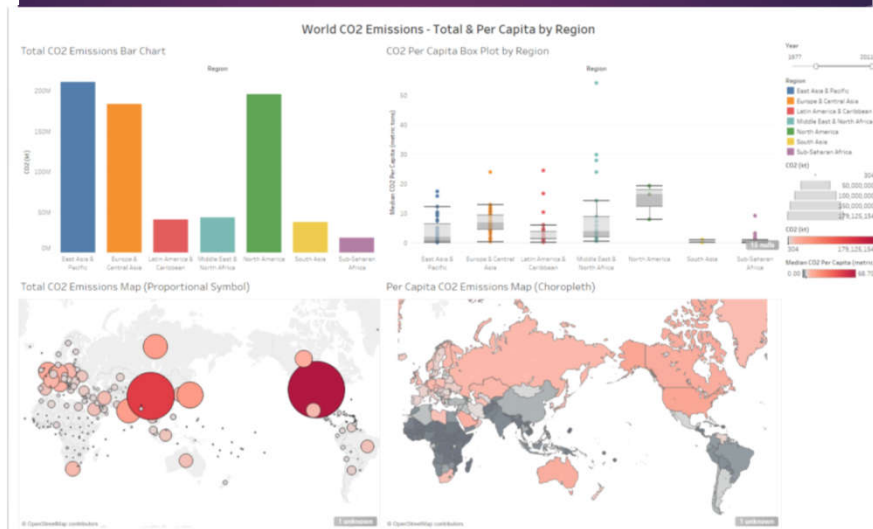
- ▶ Tableau Public: <https://public.tableau.com/>



Tableau Public - Resources

- ▶ <https://public.tableau.com/en-us/s/resources>
- ▶ World Bank CO2 Emissions Data Set (& many other data sets)
- ▶ Step-by-step video tutorials
- ▶ Free, users can publish their visualization work on the Tableau Profile webpage
- ▶ Inspirations: Tableau Public Gallery – Viz of the Day
<https://public.tableau.com/en-us/s/gallery>

Tableau Public Dashboard



Student Feedback

1. Context/Case → data sources → **visualization and data analysis** ideas
2. **Advance data analysis skills** to the next level
3. Let **data visualization** tell the story
4. **Free, intuitive, easy to use, sharable**
5. Lots of **self-learning resources**
6. Another **marketable skill** to add to the resume in addition to Excel

CASE STUDY #1

Globally endangered sea turtles of the Palmyra Atoll National Wildlife Refuge: A Focus on Scientific Analysis

▶ <https://ncep.amnh.org/index.php/Detail/objects/62>

Applicable Courses: Research methods, quantitative ecology, measurements and field methods, conservation biology

CASE STUDY #2

Regulating Carbon Emissions

- ▶ https://serc.carleton.edu/integrate/teaching_materials/carbon_emissions/index.html

Tableau Public

- ▶ <https://public.tableau.com/en-us/s/resources>

Applicable Courses: Climate change, carbon regulation, climate policy, data analysis & visualization

 **ENVIRONMENTAL STUDIES**
UNIVERSITY of WASHINGTON | PROGRAM ON THE ENVIRONMENT

W

Roundtable Discussion:

Saturday, 10:30-11:10,

Room 206CD

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- ▶ Forestry and Natural Resources
<https://environment.yale.edu/academics/case-studies/>

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- ▶ STEM & Some Social Sciences
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- ▶ Sustainability
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