EarthLabs: A National Model for Earth Science Lab Courses

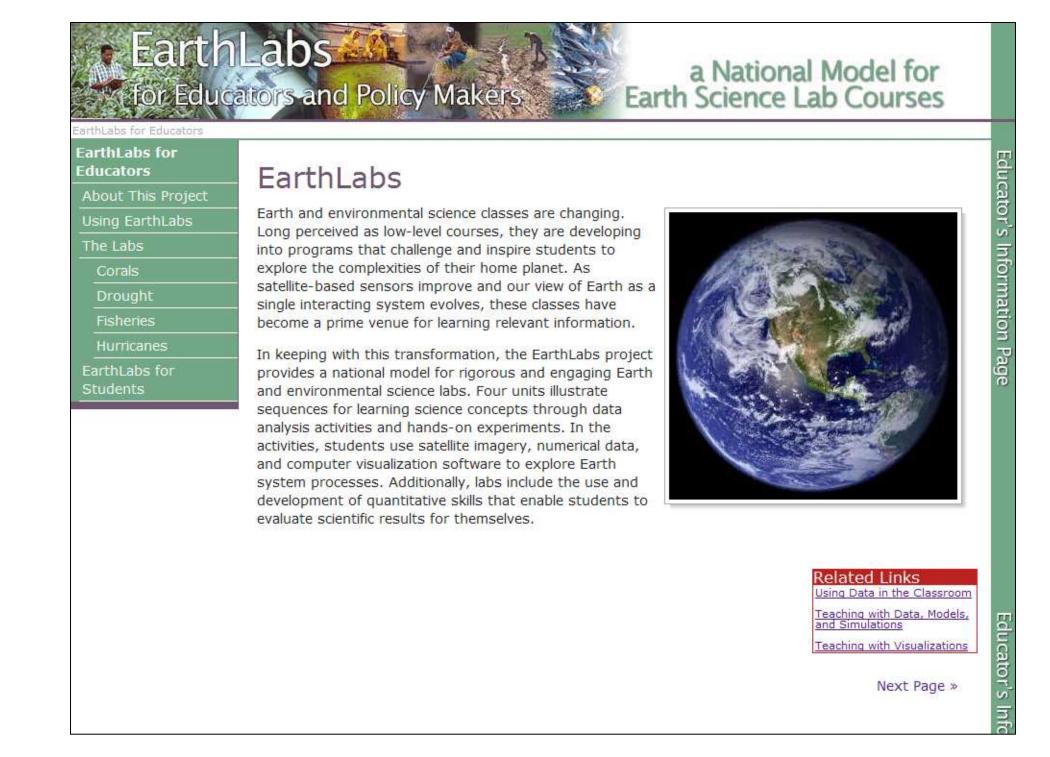
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http://serc.carleton.edu/earthlabs/index.html

EarthLabs is a model Earth science lab course for high school students. The lab experiences feature a combination of classroom experiments and computer access to data and visualizations, and demonstrate the rigor and depth of a true lab course. This effort aims to create a set of exemplary lab modules that span several days or more, engage students in deep and long-lasting investigations, enable them to explore the rich interconnections in the Earth system, and involve a variety of inquiry-based experiences.

NOAA initiated work on the EarthLabs course by funding four prototype units, focusing on the domains of oceans and the atmosphere and their connections with other components of the Earth system. These topics were selected because they represent rich domains of current research of interest to NOAA and the other partners.

On the web, EarthLabs is composed of two sites, one for educators or policy makers and the other for students. This strategy provides teachers with the support they need without overwhelming the students with all this additional information. The students get pages that lead them through the activities which they need to complete. To avoid potential confusion for instructors, we've given the different pages distinct characteristics and labeling. There are also links from the Educator's Page to the Student's Page but not in the other direction.



EarthLabs Topics

Four Prototype Chapters Focused on Ocean and Atmosphere issues and the connections between EarthLabs initial release includes four modules. The sequence of labs in each them and the rest of the Earth System. meant to be a part of integrated instructional units.

Corals: Rainforests of the sea

40% of Earth's coral reefs are in critical condition or already degraded beyond recovery. Find out why these amazing marine animals are so important to our planet.

Drought: Dealing with a dry spell

What happens when a region gets less than its "normal" amount of rain and snow in a year? What if the new, drier conditions last for a

Fisheries: A Case Study: Ecosystem-based management in the Gulf of California

Can marine fisheries continue to serve humanity in the future as they have in the past? What can humans do to keep this resource

<u>Hurricanes: Earth's Meteorological Monsters</u>

Investigate how, where, and when hurricanes occur. Explore the dangers to humans and property caused by hurricanes and how we can be prepared to deal with those risks.

Lab 5: Exploring Factors that Impact Coral Health

The lab activity described here was created by Erin Bardar of TERC for the EarthLabs project.

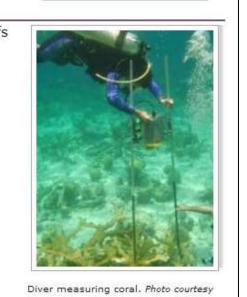
In the previous lab, students explored the characteristics of the ocean environment in which coral reefs thrive. Unfortunately, there are a number of factors, both natural and anthropogenic (resulting from human activities), that can alter the ocean environment and threaten the health of coral reef ecosystems. In this activity, students will examine the three main factors that disrupt corals.

After completing this investigation, students will be able to:

Activity Overview and Teaching Materials

Activity Summary and Learning Objectives

- use a Geographic Information System (GIS) tool to evaluate threats on coral reefs; explain how certain fishing practices, pollution, and climate change can damage coral ecosystems; and
- describe the predicted consequences for coral reefs.

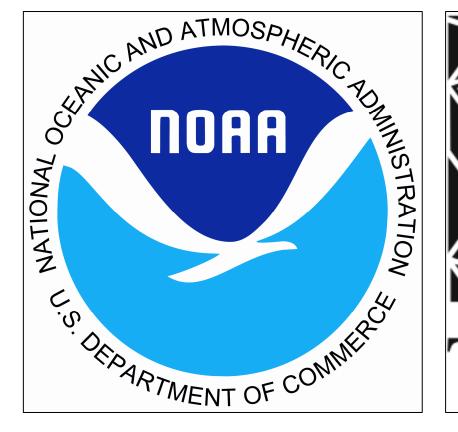


On the Educator's Page, headings break out Context for use This activity follows Lab 4: Finding Coral's Ideal Environment, in important information for teachers: coral reefs. Now that students are familiar with the environment

- Learning Objectives explore the factors most likely to disrupt these conditions and
 - Teaching Notes and Tips
- students work in pairs or small groups for all three parts of this periods. Part A and the first step of Part B will take approxima • Teaching Materials - Activity Sheets, assigned for homework. Part C will take approximately 1 class
 - Grading Sheets, Supporting References • Context for Use
 - Background Information
- In Part A, students learn to use the ReefGIS geographic inform reefs in and around the Caribbean Sea. To access the ReefBasi Applicable State and National 6.0 or Mozilla Firefox 1.5. Javascript will also need to be enable
- information about ReefGIS, visit ReefBase's ReefGIS FAQ page In Part B, students examine different layers of the "Reefs at Risk" map of the Caribbean to separate the effects different human

activities have on coral reefs. They also read a series of short articles about the impacts watersheds, exploitive fishing, and coastal development have on coral reefs.

In Part C, students perform simple hands-on experiments designed to help them better understand the effects of ocean acidification on coral reefs and read the NOAA article What is Ocean Acidification? The following materials are needed for each group of 3-5







Teacher's Website

Lab Overviews

Students are introduced to the dire predictions about the future of the global fishing industry. Students re an NSF press release about the projected collapse of currently fished seafood. Students also use ImageJ analyze oceanic biodiversity maps spanning 40 years. Tools Needed: ImageJ



Students learn about destructive and wasteful fishing practices contributing to the decimation of the world's fisheries. Students explore various resources for identifying sustainable seafood and visit local markets and restaurants to investigate the availability of seafood on regional and national watch-lists in their community. Tools Needed: Adobe Flash Player, Adobe Reader



Students learn about ecosystem-based approaches to

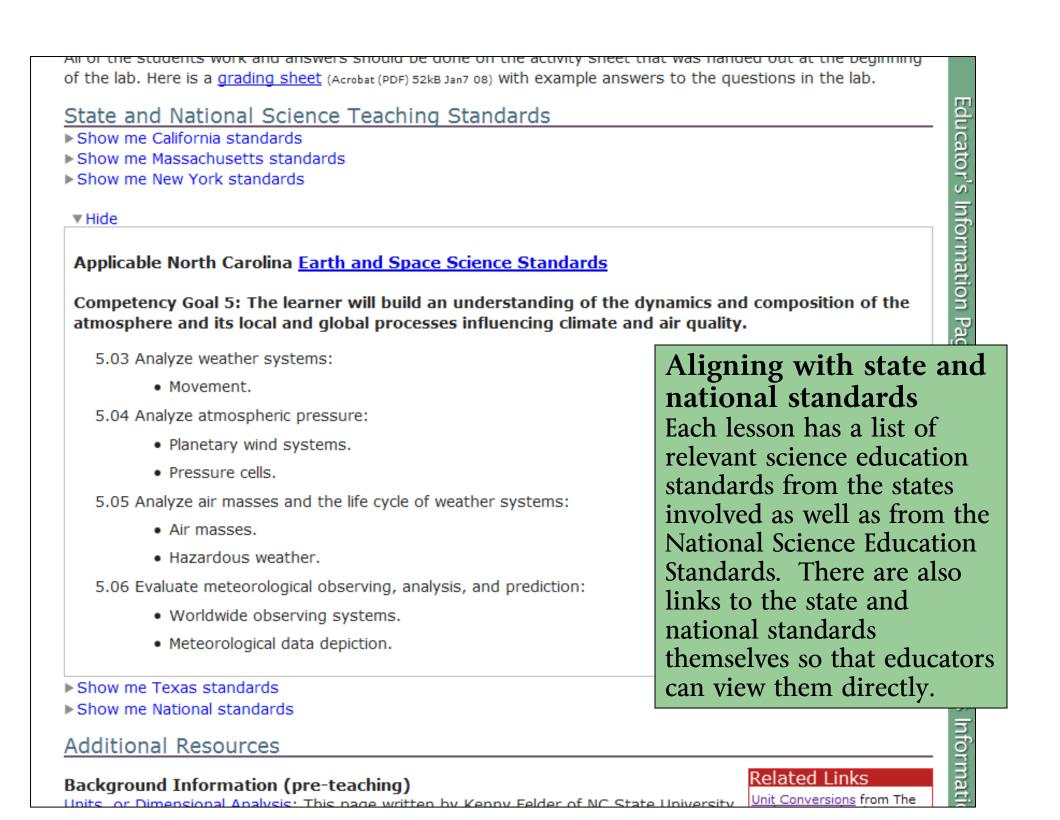
- and manage marine ecosystems, including The labs in each chapter are Integrated of Marine Life (CoML) Project-that will tag
 Students also play the Great Australian Fis

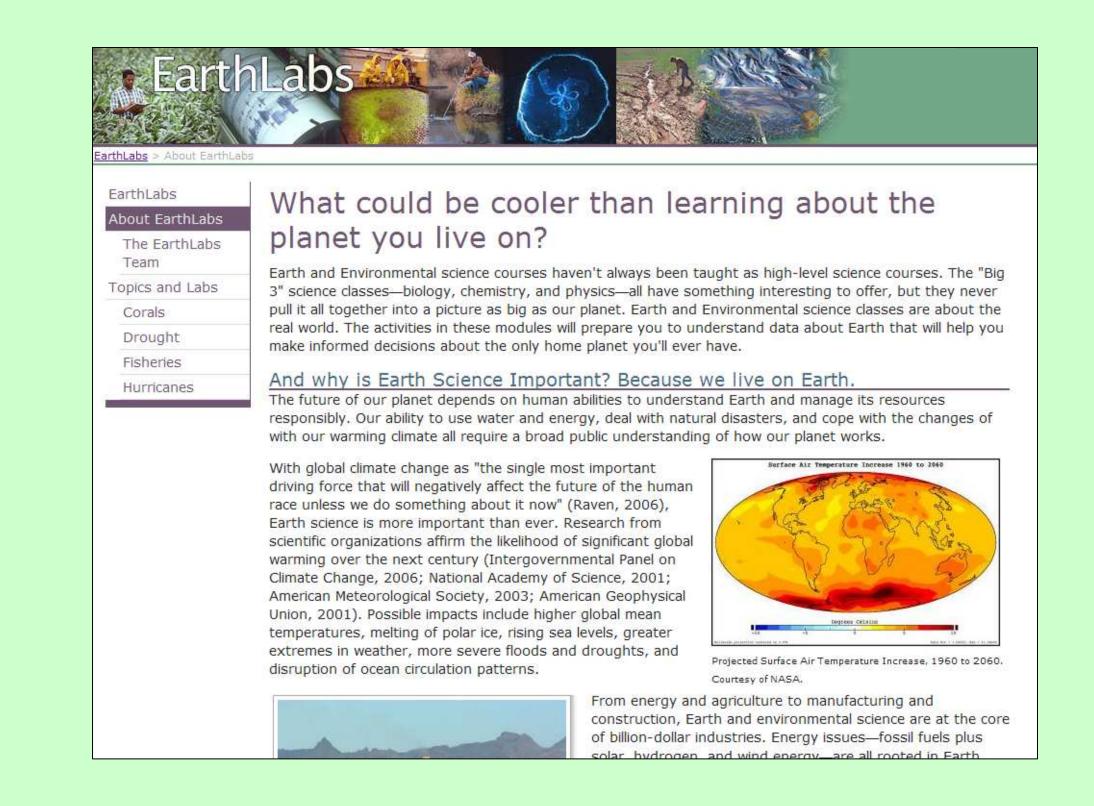
 Instructional Units, as described in America's
- in the management of three fisheries. Lab Report (NRC, 2006) Tools Needed: QuickTime Player, Adobe
 - Learner Centered Knowledge Centered
- 4. To Fish or Not to Fish? Assessment Supports Learning Students are introduced to Marine Protecte
- Community Centered foremost locations for marine conservat Tools Needed: TV/DVD Player, Adobe Read

5. Gone Fishing

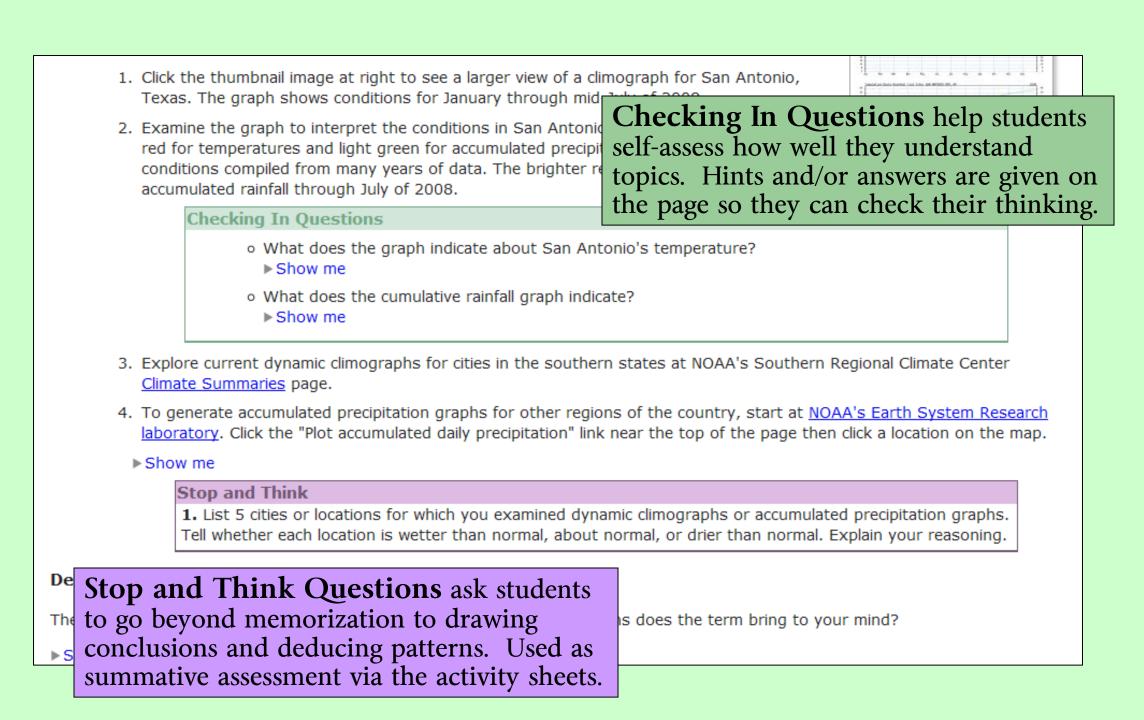
Students learn about the consequences of overfishing by examining the sharp declines in groundfish landings in New England over the last several decades. They also investigate whether or not the effects of overfishing

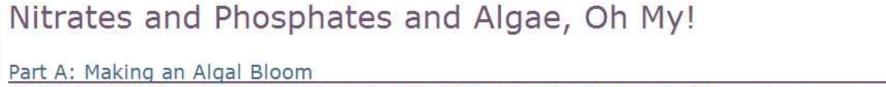






Student's Website





Because algae and other planktonic species are the primary producers upon which the rest of the

differences or inconsistencies.

marine food chain depends, it is important to understand why algal blooms occur and what effects they have on the surrounding water and marine life. In this part of the investigation, you will make your own algal bloom and test what factors influence the occurrence and duration of the bloom.

> Prepare a "Control" container and a "+ Nutrients" container for your algae samples. ▶ Show me materials needed for this experiment

- a. Label one container with your group number and the word "Control". Label the other container "+ Nutrients".
- Add an equal amount of water to each container.
- c. Add 3 of drops of algal culture to each container.
- d. Add 1 teaspoon of liquid fertilizer to the 250 mL of distilled or bottled water Organization of the United Nations (FAO) and mix well. The use of distilled or bottled water will ensure that you do not contaminate your experiment with trace metals, nutrients, or chlorine found in tap water. e. Using a pipette or eyedropper, decide on a small unit (such as one half or one third of the pipette), that

Microscopic view of tetraselmis algae.

Image source: Food and Agricultural

- to your "+ Nutrients" container. Write the number of fertilizer units you ad Hands-On Labs All the units have labs 2. Take a drop of water from each sample and look at it under a microscope. 10x magni and record the number of phytoplankton visible in both sample. Have each member o where students do
- the average number of phytoplankton per drop in both the "Control" and "+ Nutrient something to learn about 3. Place both containers near a window, out of direct sunlight, but where they will receiv the topic. light and are kept at the same temperature (don't place some containers on a heater
- 4. Every day or two over the course of 1-2 weeks, make observations (e.g., color, opacity, smell) on the algal cultures in each of the containers. You should also observe one drop of water from each sample and count the number of phytoplankton per drop as you did in Step 3. Carefully record your findings.
- Analyze your findings. a. For each treatment ("Control" and "+ Nutrients"), create a graph to illustrate algal growth (determined by number of phytoplankton cells per water drop) on the y-axis versus number of days on the x-axis.

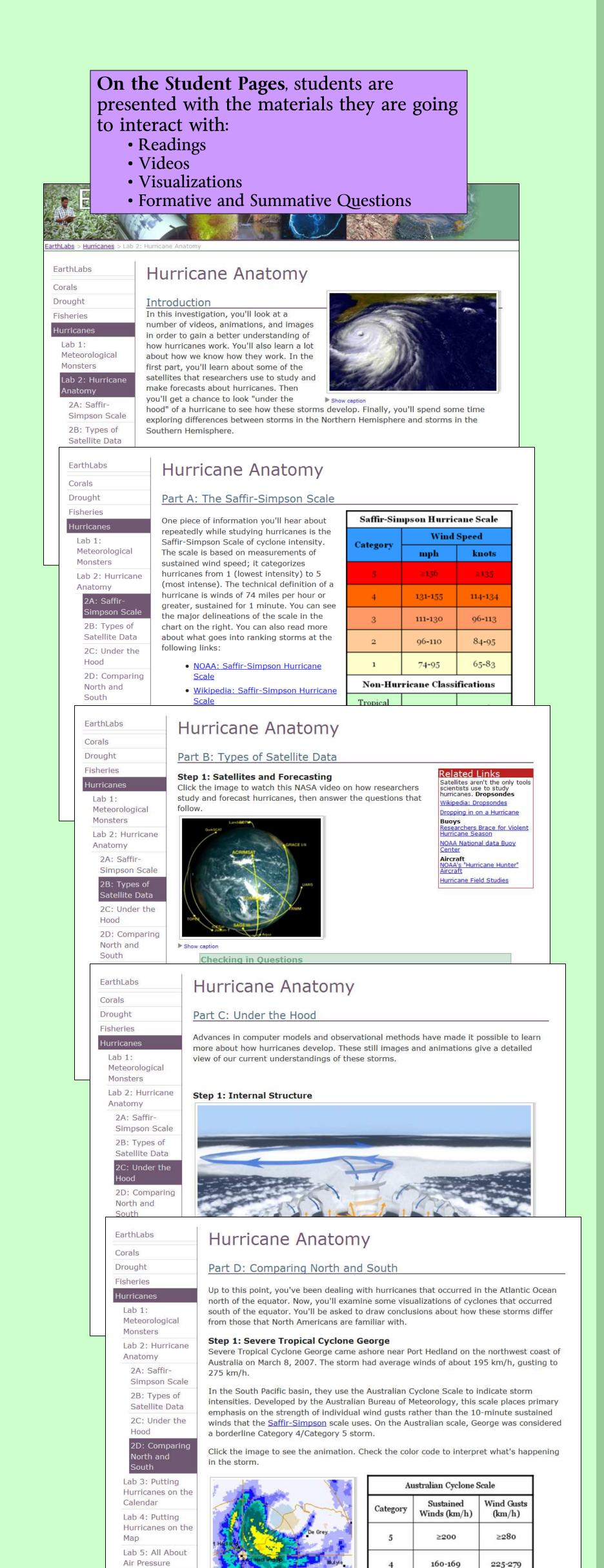
will be your standard base unit of fertilizer. As a class, decide how many units of fertilizer mixture each

group with add to their "+ Nutrients" containter. Add the proper number of units of liquid fertilizer mixture

c. As a class, create a graph of final cell density versus fertilizer concentration for each nutrient treatment.

b. Compare your findings to those of other groups using different amounts of fertilizer. Discuss any

RELATED RESOURCES Hurricane Visualizations serc.carleton.edu/NAGTWorkshops/visualization/collections/hurricane.html Teaching Biocomplexity in the Geosciences serc.carleton.edu/NAGTWorkshops/biocomplexity/index/html Teaching the Ocean System serc.carleton.edu/NAGTWorkshops/ocean/index.html Using an Earth Systems Approach serc.carleton.edu/introgeo/earthsystem/index.html Using Data in the Classroom serc.carleton.edu/usingdata/index.html



Lab 6: Why Kee