

## Coral Reef Lesson

This lesson makes use of Google Earth and ReefGIS in order to determine the health of the world's coral reefs. The students really like doing this activity because it allows the student to research something they are truly interested in; coral reefs. Coral reefs are in trouble due to human activities and this lesson brings that to light for the students. This lesson is assessable to all students regardless of academic acumen.

### Step 1: Key goals/standards to be addressed

As you develop your lesson topic, consider what goals and standards you would like the lesson to address. It may help to list the specific science standards you are addressing.

#### Maryland Core Learning Goals

- 1.2 The student will pose scientific questions and suggest investigative approaches to provide answers to questions.
- 1.7 The student will show that connections exist both within the various fields of science and among science and other disciplines including mathematics, social studies, language arts, fine arts, and technology.
- 3.5 The student will investigate the interdependence of diverse living organisms and their interactions with the components of the biosphere.
- 6.4 The student will develop and apply knowledge and skills gained from an environmental issue investigation to an action project which protects and sustains the environment.

#### Next Generation Science Standards

- HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
- HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
- HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

#### Common Core State Standards

English Language Arts Standards » Grade 11-12 » 7

Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, as well as in words) in order to address a question or solve a problem.

## Step 2: Describe your lesson

Write a description of the lesson you are planning. Your description should be detailed enough so that a colleague reading this plan could understand what you intend to teach, pedagogical strategies you will use, and what the students will do.

1. Describe the **logistics** of this lesson (How will the classroom and students be arranged? What materials will you need? How many class periods will the lesson take?)

The students will complete part of the lesson in the classroom using their textbooks and a video player. The student will complete the bulk of the lesson in the computer lab because this lesson will require them to access the REEF GIS. I anticipate that the coral reef unit will take 5-7 days.

2. How will you **introduce** this lesson?

I have a small coral reef aquarium in my classroom and I will have the student list the abiotic and biotic factors that are required to keep the tank operational. A picture of a coral reef could also be used if an actual aquarium is not available. We will start a discussion highlighting what may happen to a coral reef if one of these abiotic or biotic factors is not within the normal range.

3. What will students **do** during this lesson? Be sure to discuss the specific activities that students will do, as well as what type of products students will create by the end of the lesson.

I have included the entire lesson along with the questions the students will complete from their text books before starting the activity. The text book we use in class is *Marine Biology* by Castro and Huber, 7<sup>th</sup> Ed.

Name \_\_\_\_\_

### Chapter 14 Coral Reefs

1. Coral reefs are made of what compound? What organism (include the phylum) builds the reefs? What other organisms are included in this phylum (need to look back at earlier chapter)?
2. Identify the 9 types of corals. Which is the main reef builder? Give a description of each.
3. What are zooxanthellae? Why are they important?
4. Starting with the larval stage, explain how reefs are formed?
5. What are the methods of food consumption in corals?
6. Besides corals what other organisms (identify 4) help to build the reef? How do each of these organisms help?
7. Light and temperature affect reef growth. Explain how.
8. What other abiotic factors effect coral growth? Describe how each affects the organisms.
9. What are three main categories of coral reefs? Describe each in detail.
10. Describe how atolls form.
11. Coral reefs are the richest and most complex of marine ecosystems yet we know surprisingly little about them. Why is this?
12. The tropical waters where corals are found are usually poor in nutrients and therefore have very little phytoplankton. How can such a rich community grow when the surrounding sea is so unproductive?

13. Besides zooxanthellae, there are three other primary producers. What are they?
14. Draw a coral reef food web.
15. How do corals compete for space?
16. Explain the 2 hypothesis about competition amongst coral reef fish.
17. Why is grazing of algae important to coral communities?
18. Identify the types of symbiotic relationships found in a coral reef community. Give an example of each.

After the students complete the reading from the textbook and answer the questions that accompany the reading they will then be given the internet activity to complete which will require the class to go the computer lab. I have included the entire Coral Reef GIS Internet Lesson.

## **Coral Reef GIS Internet Activity**

### **What is GIS?**

GIS is the acronym for **Geographical Information System**. A GIS is a set of computer programs that can organize, display, and analyze spatially distributed data. At its simplest, GIS is "mapping," providing a way to view a map from all sorts of extremely diverse data. GIS has many applications in geology, biology, psychology, anthropology, sociology, linguistics, history, political science, economics, and many other fields. Within the sciences, it is a growing field with many opportunities for employment.

### **GIS and Coral Reefs**

In this lab activity, you will use a very simple, web-based GIS system called **ReefGIS** to explore the world's coral reefs. This application is provided by **ReefBase**, a nonprofit group that provides online information on coral reefs and provides information services to coral reef professionals involved in management, research, monitoring, conservation, and education.

You'll be using ReefGIS to explore the world's coral reefs and answer some questions about them: where are they? Where is coral bleaching a problem? Which coral reefs are protected and which aren't? Etc.

<http://reefgis.reefbase.org/default.aspx>

**STEP 1: GETTING STARTED** – Answer questions on a separate paper

Part A: The ReefGIS page that you have opened on the internet shows a map of the world with a bunch of grey dots on it. These grey dots mark the location of coral reefs in the world's oceans. Look to the left-hand side of the webpage: under the Maps tab, there is a list of features (location, diseases, etc.). You are looking at the Location of Coral Reefs map, if you click on the Layers tab, you will see that you can look at types of coral reefs, as well as looking at reefs based on depth and geomorphology.

### **Question 1. In which ocean are most of the world's coral reefs located?**

Part B: Click back on the Maps tab and select Reefs at Risk. The Layers tab also will change. The world map will refresh and you will see a new GIS map; this one will have blue, yellow and red dots marking the world's coral reefs. The blue dots represent reefs as low risk from human impacts; the yellow are those

with medium risk; and the red are reefs at high risk from human impacts. There are still some gray dots but they are not as obvious. The gray dots represent reefs for which ReefBase has no information about risks.

**Question 2. In what part of the world are reefs overall at the highest risk from human impacts? Where are they at the lowest risk overall?**

Part C: Time for a little break from the internet. On the last page of your worksheets is a map of the world. (Included at the end of activity for reference) Remember from reading Chapter 14 and answering your worksheet questions that there are 3 types of reefs: fringing reefs, barrier reefs, and atolls. We are going to take a closer look at the largest examples of these three types and focus on whether or not they are at risk from human impacts

**Question 3. On the map, circle and label**

- **Fringing Reefs: The Red Sea reef**
- **Barrier Reefs: The Great Barrier Reef, Australia and the Florida Reef Tract (south end of Florida and the Bahamas)**
- **Atolls: Suavadiya, Maldives Islands**

**Use GoogleMaps for help** (Type the name of each reef into the GoogleMaps search engine and it will take you to each one. Make sure you look at the satellite view of the reefs so you can see what coral reefs look like from outer space)

Part D: Well, if you are like me, you might be thinking: Coral reefs at risk from WHAT? We can answer that question by going back to the ReefGIS website and selecting the Reef at Risk map. In the Layers tab, you will see a list of choices for risks. Select “Coastal Development.”

The world map will refresh and you will see a new GIS map; this one will once again have blue, yellow, and red dots associated this time with low, medium, and high risk from coastal development. The orange dots represent reefs for which ReefBase has no information about risks—there are a lot more of them on this map. There are very few red dots, no obvious blue dots, and a bunch of yellow dots. Let’s take a closer look at the four reefs from Part C. At the top of the global map there is a tool bar with a bunch of buttons. The second one from the left is a magnifying glass with a “+” in the middle of it. This is the zoom-in tool. Click on it and then click on the Red Sea area of the global map. The map will refresh itself and the new map will have a closer up view of the Red Sea. Click on the Red Sea again. You’ll be able to see both the Red Sea reef and the Maldives Islands in the Indian Ocean in this view. [Suavadiya Atoll is at the far south end of the Maldives.]

Make a note about the threat of both these reefs from coastal development— overall is it high (red), medium (yellow), low (blue), or no data (orange)?

Now click on the top tool (the button with four arrows). This will bring you back to the global view. Use the zoom-in tool to look at both the Great Barrier Reef and Florida Reef Tract more closely and make a note about the threat of both these reefs from coastal development—overall is it high (red), medium (yellow), low (blue), or no data (orange)?

**Question 4. All four of these reef areas show medium risk from coastal development—even the Maldives which are out in the middle of nowhere in the Indian Ocean. Why do you think people are building in these areas?**

**[Give it your best guess! You don’t have to be correct.]**

Part E. Okay; let’s look at the threat from Marine Pollution for these four coral reef areas. Go back to a global view and in the Layers tab, select “Marine Pollution.”

The world map will refresh but stay at whatever zoomed-in view you were looking at. The new GIS map

will once again have blue, yellow, and red dots associated this time with low, medium, and high risk from marine pollution. The grey dots represent reefs for which ReefBase has no information about risk. Zoom in on the four reefs, read the information below, and answer Question 5.

The Red Sea reef has medium risk from marine pollution at both its north and south ends. Not many people live in this area, although parts of it are vacation destinations. Both of ends are major shipping routes (the north end is the Suez Canal and the south end is the Gulf of Aden). Think about the countries on the east side of the Red Sea—what do you think they are shipping? What kind of pollution do you think threatens these areas?

The Maldives Islands have no information about marine pollution, but the Great Barrier Reef is also a medium risk area. Most of Australia’s population lives on its northeast coast. What kinds of pollution do you think threaten the Great Barrier Reef? The Florida Reef Tract is at medium risk from pollution in the Florida Bay/Florida

Keys areas at the south end of the Florida Peninsula. What kinds of pollution do you think threaten the Florida Reef Tract?

**Question 5. What do you think is being shipped from the Red Sea? What kind of pollution do you think threatens the Red Sea’s shipping routes? What kinds of pollution do you think threaten the Great Barrier Reef? What kinds of pollution do you think threaten the Florida Reef Tract?**

Part F: Let’s look at the threat from pollution and sedimentation from inland sources for these four coral reef areas. In the Layers tab, select “Inland Pollution and Erosion.”

The world map will refresh but stay at whatever zoomed-in view you were looking at. The new GIS map will once again have blue, yellow, and red dots associated this time with low, medium, and high risk from inland pollution and erosion. The grey dots represent reefs for which ReefBase has no information about risk. Zoom in on the four reefs, read the information below, and answer Question 6.

Strangely enough, ReefBase has no information about inland pollution and erosion for the Florida Reef Tract; all the dots are grey. Hmmmm? Erosion is probably pretty low in this area, but the Florida Everglades and Florida Bay drain a huge part of southern Florida—and a lot of that area is agricultural. Also, Miami, one of the largest cities in the United States, is right at the north end of the Florida Keys. So, it’s pretty safe to say that at least the part of the Florida Reef Tract that is closest to the Florida Peninsula has a decent risk from inland pollution.

Parts of the Great Barrier Reef have medium risk of inland pollution and erosion; most likely as a result of their proximity to the populated coastal towns and cities of eastern Australia. Surprisingly, much of the Red Sea also has medium and even high risk of inland pollution and erosion. In this arid environment, any sort of development carries a risk of erosion (just think about the dust in the air in Tucson every time a new housing development is being built) plus most of the population centers in the Red Sea area discharge their wastes in to the seas.

There is no information about pollution and sedimentation from inland sources for the Maldives Islands. Think about it for a minute! These are a bunch of small islands—there is no “inland” source for pollution or sedimentation!

**Question 6. Besides agricultural and urban pollution, can you think of any other things that might contribute to coastal pollution and erosion in the Florida Reef Tract? [There’s no right or wrong answer here; just think about what you know about Florida, especially things that are newsworthy.]**

Part G: Let’s look at the threat from Overexploitation of Coral Resources for these four coral reef areas. This indicator assesses overfishing and destructive fishing on coral reefs.

In the Layers tab, select “Overexploitation.”

The world map will refresh but stay at whatever zoomed-in view you were looking at. The new GIS map will once again have blue, yellow, and red dots associated this time with low, medium, and high risk from inland pollution and erosion. The grey dots represent reefs for which ReefBase has no information about risk.

Zoom in on the four reefs and read the information below.

There is no information about overexploitation for the Maldives Islands or the Great Barrier Reef, which is too bad. The reef areas are essentially orange (no data). Much of the Red Sea is at medium-to-high risk from overexploitation, especially right along the coastline where access to the reef areas is easiest. The countries with the highest risks are Sudan, Eritrea, Saudi Arabia, and Yemen; with Sudan and Yemen having the highest risks. Yemen is one of the poorest countries in the Arab world, and Sudan has been ravished by wars and famine. Unfortunately, people in these countries probably need to think about short-term goals, like feeding themselves and their families, over bigger-picture concerns, like conservation. Much of the Bahamas portion of the Florida Reef Tract is at high-to-medium risk from overexploitation of coral resources. Besides its tourism and banking economy, the Bahamas relies on its coastal resources for food and income.

Part H: What about coral bleaching? Remember that from your reading and worksheets? Coral bleaching occurs when reef-building corals expel their mutualistic zooxanthellae partners as a result of heat stress. We can look at this phenomenon using ReefGIS.

Click on the Map layer tab and select “Coral Bleaching and SST.” In the Layers tab, select the years “Jan 1963” to “Dec 1984” and click on “Refresh Map.” Look in the Legend tab and you will see that the red dots are areas with more high severity bleaching events, the yellow dots are medium severity, the blue dots are low severity, and the green dots are no bleaching sites. Again, grey dots represent areas where the severity of bleaching is not known.

**Question 7. How many high severity bleaching events (red dots) are there from 1963 to 1984? How many total bleaching events are there? [I know it is difficult to count; just come up with a ballpark number: 10? 20? 50? 100? 200? More than 200?]**

Part I: Now, change the dates to “Jan 1985” to “Dec 2007” and click on the “Refresh Map” button.

**Question 8. How many high severity bleaching events (red dots) are there from 1985 to 2007? How many total bleaching events are there?**

**Question 9. Why do you think there is more than a 100X increase in coral bleaching from 1962–1984 to 1985–2007? There is no right or wrong answers here; just speculate and come up with a couple of possible answers to the question.**

After the students have completed the internet activity the students will then complete the following assignment as a culminating activity to wrap up the coral reefs unit.

You just moved to Puerto Rico and needed a job. You got hired by the Department of Conservation, based on your recommendation from me. They are establishing a coral reef marine reserve and were very impressed that you took marine biology in high school and know so much

about corals.

Coral Reefs can be legally protected by setting up a coral reef marine reserve. Specific rules and regulations will then govern the use of the reef and the waters surrounding it. You will complete one of the following as your first assignment for the Department of Conservation:

- **A brochure or pamphlet advertising the coral reef marine reserve for local use**
- **A notice board display that describes reef etiquette for visitors**
- **A brochure, describing the marine reserves, for oversea tourists**
- **A poster about the marine reserve for distribution in grade schools**

4. List at least one **internet resource** that you will use during this lesson.

<http://reefgis.reefbase.org/default.aspx>, <https://www.google.com/maps/@39.2847064,-76.6204859,12z>

5. How do you plan on using the **internet resource(s)** listed above?

The students will use this website to map current coral reefs and they will also use the mapping tool to help to determine which coral reefs are in danger and the causes of the problems.

6. What classroom **discussion topics** might enhance your teaching/learning goals?

### **Step 3: Incorporating inquiry**

Your lesson should be inquiry-based, and should incorporate some of the inquiry strategies that were explored in this course. In this section, explain how you will incorporate inquiry into your science lesson.

Reefbase GIS is an excellent tool for students to use to explore coral reef and the problems that coral reefs face from human activity.

### Step 4: Assessment

Discuss how you plan to assess your students' understanding of the specific learning goals that you are targeting in this lesson. If applicable, you may use the rubric that you created in Session 5.

## Baltimore Polytechnic Institute

### Coral Reef GIS Internet Activity

Name: \_\_\_\_\_

Teacher: Mr Reeser

Date Submitted: \_\_\_\_\_

Title of Work: \_\_\_\_\_

Criteria					Points
	4	3	2	1	
<b>Introduction</b>	All questions were answered completely and rationales for the answers <b>were</b> clearly stated.	All questions were answered completely, but rationales for the all the answers <b>were not</b> clearly stated.	Not all questions were answered completely, or greater than 2 rationales for the all answers <b>were not</b> clearly stated.	All questions <b>were not</b> answered completely.	_____
<b>Task</b>	All areas of the task were addressed and handled with a high degree of sophistication. The plan followed by the team demonstrated a great deal of thought.	At least one area of the task <b>was not</b> addressed. The plan followed by the team demonstrated a great deal of thought.	At least two areas of the task <b>were not</b> addressed. The plan followed by the team demonstrated a moderate level of thought.	The task is incomplete and/or it is apparent that little effort went into the development of the task.	_____
<b>Process: Originality</b>	The ideas expressed by the body of work demonstrate a high degree of originality.	The ideas expressed by the body of work are mostly original. The group may have improved upon a previous idea.	The ideas expressed by the body of work demonstrate a low degree of originality.	There were no original ideas expressed in this project.	
<b>Grammar, Format , and Spelling</b>	The final body of work was free of grammar, spelling, and formatting errors.	The final body of work had 1 error related to either grammar, spelling, and formatting errors.	The final body of work had 3-5 grammar, spelling, and formatting errors.	The final body of work had major grammar, spelling, and formatting errors.	

				<b>Total-----&gt;</b>	—
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**Teacher Comments:**

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## Website Research

Record the titles and URLs of sites you visit, and jot down a few notes about each site. Where could each site fit into a lesson? Which sites make most sense as background material? Material for research?

If you need to include more URLs, you can press the "Tab" key with the cursor in the lower-right cell of the table to add more cells

<p>Website: Reefbase GIS          URL: <a href="http://reefgis.reefbase.org/default.aspx">http://reefgis.reefbase.org/default.aspx</a>          Notes: This website is used to show a visual representation of the perils faces today's coral reef.</p>	<p>Website: Google Maps          URL: <a href="https://www.google.com/maps/@39.2847064,-76.6204859,12z">https://www.google.com/maps/@39.2847064,-76.6204859,12z</a>          Notes: Used to provide the location of particular coral reefs and also provide satellite imagery of coral reefs.</p>
<p>Website:          URL:          Notes:</p>	<p>Website:          URL:          Notes:</p>
<p>Website:          URL:          Notes:</p>	<p>Website:          URL:          Notes:</p>
<p>Website:          URL:          Notes:</p>	<p>Website:          URL:          Notes:</p>