



Advanced Manufacturing & Prototyping Integrated to Unlock Potential

## Life Science Data-Driven Decision Making (7DMS)

*“Don’t Wreck the Reef”*

Coral Reef Challenge

<p><b>Module Description</b></p>	<p>Students engage as biologists advising the government and citizens of Fiji on recent acceleration in the death of coral reefs around Fiji. Students investigate a model of the food web at the coral reef to generate and then project species population data. Students combine their knowledge of ecology with the economic needs of different regions in Fiji to make recommendations about fishing permits. The module covers some basic concepts of ecosystems, food web/chains, and predator prey relationships, seeding further exploration of GSE standards later in the semester or year.</p> <p><i>Module features Dr. Mark Hay’s work in the School of Biology on coral reef degradation.</i></p>	
<p><b>Related Georgia Standards of Excellence</b></p>	<p><b><i>S7L4. Obtain, evaluate, and communicate information to examine the interdependence of organisms with one another and their environments.</i></b></p> <ul style="list-style-type: none"> <li><i>a. Construct an explanation for the patterns of interactions observed in different ecosystems in terms of the relationships among and between organisms and abiotic components of the ecosystem.</i></li> <li><i>c. Analyze and interpret data to provide evidence for how resource availability, disease, climate and human activity affect individual organisms, populations, communities and ecosystems.</i></li> </ul>	
<p><b>Module Timeline</b></p>	<p><b>50-minute class periods:</b> 5 days</p> <p>Day 1: Section 1, 2 Day 2: Section 3 Day 3: Section 3 Day 4: Section 4 Day 5: Section 4</p>	<p><b>90 minute blocks:</b> 3 days</p> <p>Day 1: Sections 1, 2, 3 Day 2: Section 3, 4 Day 3: Section 4</p>
<p><b>Documents Included in the Download</b></p>	<p><b><u>Student Materials Folder</u></b></p> <ul style="list-style-type: none"> <li>• Student Edition (<i>recommended to be printed double sided</i>)</li> <li>• Student Worksheet Packet (<i>recommended to be printed double sided</i>)</li> <li>• Procedure Sheets (<i>recommended to be printed single sided on cardstock</i>)</li> <li>• Sorting Sheet (<i>recommended to be printed single sided on cardstock</i>)</li> <li>• Coral Reef Matrix</li> </ul> <p><b><u>Teacher Materials Folder</u></b></p> <ul style="list-style-type: none"> <li>• Materials List</li> <li>• Material Preparation Instruction Guide</li> <li>• Labels for Canisters</li> <li>• Annotated Teacher’s Edition</li> <li>• Teacher Preparation Guide</li> <li>• Answer Keys</li> <li>• Videos</li> </ul>	

5E Stage	Student Activities	Teacher Activities
<p><b>Engage</b> How does the lesson capture student interest, activate prior knowledge, and connect to a complex question, global issue, or real world problem?</p>	<ul style="list-style-type: none"> <li>Students are introduced to the challenge of degrading coral reefs in Fiji and that they will assist Georgia Tech researchers with analyzing data &amp; making recommendations for managing the reef (1.1, 1.2)</li> </ul>	<ul style="list-style-type: none"> <li>Guide students through reading and challenge understanding</li> <li>Play videos of Dr. Mark Hay's research and team</li> </ul>
<p><b>Explore</b> How does the lesson allow students to develop a common base of experiences by actively investigating the phenomenon or problem?</p>	<ul style="list-style-type: none"> <li>Students conduct a simulation to survey the population of organisms present in the zone they are investigating. (3.1,3.2)</li> <li>Using the simulation and relationships in the food web, they predict how the populations will change over several years (3.3 3.4)</li> <li>Based on the projected changes students determine the health of the populations and the overall zone (3.5,3.6)</li> </ul>	<ul style="list-style-type: none"> <li>Review/model the relationships with sorting counters. Students need to be careful to get accurate projections.</li> <li>Facilitate a class discussion about factors supporting the health of the zones (i.e. why is the MPA the healthiest?)</li> <li>Review how the research survey methods by the GT team compare to what they are doing</li> </ul>
<p><b>Explain</b> How does the lesson allow students to develop, share, critique, and revise their own explanations before connecting those to accepted scientific explanations and terminology?</p>	<ul style="list-style-type: none"> <li>Students learn ecology basics and terminology and apply the content to the coral reef ecosystem they are investigating. (2.1)</li> </ul>	<ul style="list-style-type: none"> <li>Facilitate reading of text on ecosystem vocabulary</li> <li>Review additional food web/food chain examples (ex: carrots, rabbits, owls, hawks)</li> <li>Apply vocabulary to the challenge and review the predatory relationships in the coral reef ecosystem.</li> <li>Have students brainstorm possible reasons why the corals may be degrading</li> </ul>
<p><b>Elaborate</b> How does the lesson allow students to extend their conceptual understanding of the three dimensions through opportunities to apply knowledge, skills, and abilities in new experiences?</p>	<ul style="list-style-type: none"> <li>Students use their knowledge of the relationships among populations in the coral reef ecosystem and apply it to recommend water use permits for new regions with unique economic interests. (4.1,4.2,4.4)</li> <li>Students use a simulation to predict the impact of how many/type of fishing permits will affect the ecosystem of the coral reef in each new region and make recommendations based on their findings (4.3-4.6)</li> </ul>	<ul style="list-style-type: none"> <li>Facilitate a discussion about the 3 new regions and their unique economic needs. Students should realize that the reef serves many needs (providing fish, beauty for tourism, etc.). This information plus a simulation of how populations would change over time will help students make decisions about how many and what type of permits to recommend for each region.</li> </ul>
<p><b>Evaluate</b> How does the lesson—through both formative assessments embedded throughout the lesson and a summative assessment that might coincide with the elaborate phase—make visible students' thinking and their ability to use practices with core ideas and crosscutting concepts to make sense of phenomena and/or to design solutions?</p>	<p><b>Formative:</b> Ongoing questioning and discussion (<i>all sections</i>) Reef Survey Data Sheet (3.2-3.5) Coral Reef Permit Impact Decision Matrix (4.5)</p> <p><b>Summative:</b> Permit Recommendation Sheet (4.6)</p>	

	1.1	1.2	2.1	3.1	3.2	3.3	3.4	3.5	3.6	4.1	4.2	4.3	4.4	4.5	4.6
Engage	_____	_____													
Explore				_____	_____	_____	_____	_____	_____						
Explain			_____												
Elaborate										_____	_____	_____	_____	_____	_____
Evaluate					_____	_____	_____	_____						_____	_____

## Section 1 – The Coral Reef Challenge (20 minutes)

The focus of Section 1 is to provide students with a background of the Coral Reef Challenge. Students are introduced to the Republic of Fiji and environmental factors that affect the economic growth of the island. Specifically, students will learn about changes in the coral reef along the coastline of Fiji. They will look at pictures of these degraded reefs and understand how this degradation can affect the quality of life in Fiji. Students will be informed that they will be assisting Georgia Tech Biology Professor, Dr. Mark Hay and his research team diagnose problems in the Coral Reef and examine how organisms on this reef are interacting. Their challenge will be to assist the George Tech team to analyze reef data and provide the Fiji citizens with a better sense of what might be wrong with their reef.

### Preparation

Materials	Student Pages
<ul style="list-style-type: none"> <li>• <a href="#">Video #1</a>: Degraded Coral</li> <li>• <a href="#">Video #2</a>: Dr. Mark Hay</li> </ul>	<ul style="list-style-type: none"> <li>• N/A</li> </ul>
<b>Prep the Day Before:</b> Review the section and challenge.	

### Planning

GSE	<i>S7L4. Obtain, evaluate, and communicate information to examine the interdependence of organisms with one another and their environments.</i> <ul style="list-style-type: none"> <li>c. Analyze and interpret data to provide evidence for how resource availability, disease, climate and human activity affect individual organisms, populations, communities and ecosystems.</li> </ul>	
NGSS	<b>Performance Expectation:</b> <b>MS-LS2-1:</b> Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. <b>Disciplinary Core Ideas: LS2.A: Interdependent Relationships in Ecosystems</b> <b>Practice: Analyzing and Interpreting Data</b> <b>Crosscutting Concepts: Cause and Effect</b>	
Key Terms and Concepts	Essential Questions	Assessment and Grading Opportunities
<ul style="list-style-type: none"> <li>• Environment</li> <li>• Degraded Reef (Degradation)</li> <li>• Interaction of Organisms</li> </ul>	<ul style="list-style-type: none"> <li>• What affect do changes in the environment have on organisms?</li> </ul>	<ul style="list-style-type: none"> <li>• Discussion Questions: <b>Participation</b></li> </ul>

## Section 2 – Add To Your Understanding (30 minutes)

In order for students to understand the context of their challenge and how to assist Dr. Hay’s team to analyze reef data, they need to understand background information on the ecology of the reef. This section introduces students to key vocabulary words and concepts that they will use as they begin to solve the coral reef challenge. Students first will receive a general overview of ecology and will review common predator/prey relationships. They will then be introduced to the specific food web that exists within the Fiji Coral Reef.

### Preparation

Materials	Student Pages
<ul style="list-style-type: none"> <li>N/A</li> </ul>	<ul style="list-style-type: none"> <li>N/A</li> </ul>
<p><b>Prep the Day Before:</b> Review section and appropriate vocabulary on ecosystems. Brainstorm a list of food webs/food chains – here is a good website for examples: <a href="http://examples.yourdictionary.com/examples-of-food-chains.html">http://examples.yourdictionary.com/examples-of-food-chains.html</a></p>	

### Planning

GSE	<p><b>S7L4. Obtain, evaluate, and communicate information to examine the interdependence of organisms with one another and their environments.</b></p> <p>a. Construct an explanation for the patterns of interactions observed in different ecosystems in terms of the relationships among and between organisms and abiotic components of the ecosystem.</p> <p>c. Analyze and interpret data to provide evidence for how resource availability, disease, climate and human activity affect individual organisms, populations, communities and ecosystems.</p>	
NGSS	<p><b>Performance Expectation:</b>  <b>MS-LS2-1:</b> Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors.</p> <p><b>Disciplinary Core Idea:</b>  <b>LS2.A Interdependent Relationships in Ecosystems</b>  <b>LS2.B Cycle of Matter and Energy Transfer in Ecosystems</b></p> <p><b>Practice: Analyzing and Interpreting Data</b>  <b>Crosscutting Concepts: Cause and Effect</b></p>	
Key Terms and Concepts	Essential Questions	Assessment and Grading Opportunities
<ul style="list-style-type: none"> <li>Ecosystem</li> <li>Abiotic, Biotic</li> <li>Habitat</li> <li>Herbivores, Carnivores</li> <li>Food Web</li> <li>Predator-Prey Relationship</li> </ul>	<ul style="list-style-type: none"> <li>What affect do changes in the environment have on organisms?</li> <li>How is matter transferred within the environment?</li> <li>How do organisms depend on each other and on their environment for survival?</li> </ul>	<ul style="list-style-type: none"> <li>Discussion Questions: <b>Participation</b></li> </ul>

## Section 3 – Investigate the Food Web (90 minutes)

During this section students use a simulation to model the food web in the coral reef. They use canisters containing different colored counters to represent the starting population of organisms (Fishing crews, Goby fish, coral and seaweed) in different sections of coral reef that were surveyed. Based on the predatory-prey relationship of the organisms, students determine how the population will change over time and will the overall health of the area. Determining the health of the locations helps students advise the Fiji government on how to protect the reefs.

### Preparation

Materials	Student Pages
<ul style="list-style-type: none"> <li>Cardboard Collection Tray (1 per group)</li> <li>Plastic Canisters, 2 of each (A, B, C, D)</li> <li>Counters for canisters (Pink, orange, green, purple)</li> <li>Colored pencils (red, green)</li> <li><b>Coral Reef material preparation instruction guide- this sheet will be your guide to arranging the canisters.</b></li> </ul>	<ul style="list-style-type: none"> <li>Procedure #1 Current Populations Sheet</li> <li>Procedure #2 Year 1 Simulation Sheet</li> <li>Procedure #3 Years 2-5 Simulation Sheet</li> <li>Reef Survey Data Sheet</li> <li>Reef Survey Sorting Sheet</li> </ul>
<p><b>Prep the Day Before:</b> Prepare canisters with the correct number of counters for each section. Review the student text and make sure to have student sheets and collection trays ready for use.</p>	

### Planning

GSE	<i>S7L4. Obtain, evaluate, and communicate information to examine the interdependence of organisms with one another and their environments.</i>
NGSS	<p><b>Performance Expectation:</b></p> <p><b>MS-LS2-1:</b> <i>Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors.</i></p> <p><b>MS-LS2-3:</b> <i>Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.</i></p> <p><b>MS-LS2-4:</b> <i>Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.</i></p> <p><b>Disciplinary Core Idea:</b></p> <p><b>LS2.A Interdependent Relationships in Ecosystems</b></p> <p><b>LS2.B Cycle of Matter and Energy Transfer in Ecosystems</b></p> <p><b>LS2.C Ecosystem Dynamics, Functioning and Resilience</b></p> <p><b>Practice:</b> <i>Analyzing and Interpreting Data, Developing and Using Models</i></p> <p><b>Crosscutting Concepts:</b> <i>Cause and Effect, Energy and Matter, Stability and Change</i></p>

Key Terms and Concepts	Essential Questions	Assessment and Grading Opportunities
<ul style="list-style-type: none"> <li>Food Web/Food Chain</li> <li>Marine Protected Area</li> <li>Model</li> </ul>	<ul style="list-style-type: none"> <li>What affect do changes in the environment have on organisms?</li> <li>How is matter transferred within the environment?</li> <li>How do organisms depend on each other and on their environment for survival?</li> </ul>	<ul style="list-style-type: none"> <li>Discussion Questions: <b>Participation</b></li> <li>Reef Survey Data Sheet: <b>Formative</b></li> </ul>

## Section 4 – Making Decisions Based on Data (80 minutes)

Students apply their knowledge of the food web relationships along the coral reef to 3 new regions. Each region has unique economic needs and students use that information to make decisions about how many and the type of fishing permits to allow. They conduct another simulation using canisters and a digital Coral Reef Impact Decision Matrix, to investigate how the populations change over 10 years based on the type and number of permits. They then write recommendations for the number of permits that to allow for each region and provide evidence.

### Preparation

Materials	Student Pages
<ul style="list-style-type: none"> <li>Digital Coral Reef Impact Decision Matrix</li> <li>Cardboard Collection Tray (1 per group)</li> <li>Plastic Canisters (8), 2 of each set (E, F, G)</li> <li>Counters for sorting into canisters (Pink, orange, green, purple)</li> <li><b>Coral Reef material preparation instruction guide (Your guide to arranging the canisters).</b></li> </ul>	<ul style="list-style-type: none"> <li>Procedure #4 Fishing Permits Simulation Sheet</li> <li>Coral Reef Permit Impact Decision Matrix (3 per student)</li> <li>Permit Recommendation Sheet</li> </ul>
<p><b>Prep the Day Before:</b> Prepare canisters with the correct number of counters for each section. Review the student text and make sure to have student sheets and collection trays ready for use.</p>	

### Planning

GSE	<i>S7L4. Obtain, evaluate, and communicate information to examine the interdependence of organisms with one another and their environments.</i>	
NGSS	<p><b>Performance Expectation:</b></p> <p><b>MS-LS2-1:</b> <i>Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors.</i></p> <p><b>MS-LS2-3:</b> <i>Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.</i></p> <p><b>MS-LS2-4:</b> <i>Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.</i></p> <p><b>Disciplinary Core Idea:</b></p> <p><b>LS2.A Interdependent Relationships in Ecosystems</b></p> <p><b>LS2.B Cycle of Matter and Energy Transfer in Ecosystems</b></p> <p><b>LS2.C Ecosystem Dynamics, Functioning and Resilience</b></p> <p><b>Practice:</b> <i>Analyzing and Interpreting Data, Developing and Using Models</i></p> <p><b>Crosscutting Concepts:</b> <i>Cause and Effect, Energy and Matter, Stability and Change</i></p>	
Key Terms and Concepts	Essential Questions	Assessment and Grading Opportunities
<ul style="list-style-type: none"> <li>Simulation</li> <li>Recommendation</li> <li>Permits</li> <li>Economy</li> </ul>	<ul style="list-style-type: none"> <li>What affect do changes in the environment have on organisms?</li> <li>How is matter transferred within the environment?</li> <li>How do organisms depend on each other and on their environment for survival?</li> </ul>	<ul style="list-style-type: none"> <li>Discussion Questions: <b>Participation</b></li> <li>Reef Survey Data Sheet: <b>Formative</b></li> <li>Permit Recommendation Sheet: <b>Summative</b></li> </ul>