Exploration Guide

College Bio – 2023-2024

Name:

Player Code:

https://fielddaylab.wisc.edu/play/wake/ci/production/

How to Use This Booklet:

In the first section, each job is listed, along with what you need to do **before** starting the job, **during** the job, and **after completing** the job. After the job pages, there are sections for population ecology, community ecology, ecosystem ecology, and ecology in general, with each job listed where you record your notes and complete the other tasks or discussions that each job asks you to do. Finally, there are appendices at the end where you will write down questions that you have as you play through the game, take notes, and a record the conversations you have with your classmates as you play. When you finish each task, make a check next to it and move on. **You can play through the game in any order you wish**, just make sure to complete all of the listed jobs in order to work your way through this unit. There are quite a few assignments that will be handed in – please make sure to take note of the directions for these and hand in all required assignments as requested.

You will find that you need to work with groups from time to time and have conversations with many of your classmates – that's encouraged (in fact, most activities can/should be done with one or more partners!). Make sure to focus on working with different classmates throughout the entire class – that is, don't stay with the same group for the entire game, as different people will be at different spots in the game, and there isn't a lot of time to wait up for other people to get to the same spot so that you can work together. Additionally, if you want to take additional notes for something not listed in the book, please feel free to use the appendix for notes, your own notebook, or anything else you can think of. Finally, as you work through, you may see, based on the job order you've picked, that you have a question about something you haven't read about or learned much about yet. In these situations, use your resources and your classmates to get caught up on the topic and then work through the tasks.

Finally, a quick note about quizzes, Moodle homework, our outdoor labs, and the test. Regarding Moodle homework, see me for the corresponding Moodle homework password immediately after you finish the following jobs:

Population Ecology Moodle Homework: Urchin Farm, Start a Refuge, Salmon Monitoring, Missing Whale, Picky Eaters, Displaced Reef, Turtle Danger, Turtle Danger Part 2, Turtle Population, Turtle Stability, Fake Reef Fix, Fishy Business

Community Ecology Moodle Homework: Energy in the Kelp Forest Ecosystem, Arch Oasis Visualization, Mussel Fest, Mussel Fest Solution, Urchin Farm, Start a Refuge, Refuge Failure, Refuge Failure Simulation, Time of Death, Displaced Reef, Hide and Seek, Fake Reef Fix, the Lionfish Conspiracy, Tang Check-Up, Casting Shade

Ecosystem Ecology Moodle Homework: Welcome to the Forested Lagoon, Exploring a New Kelp Forest at Site A, Energy in the Kelp Forest Ecosystem, Predicting the Future of Arch Oasis, Saving Arch Oasis, Salmon Monitoring, Missing Whale, Time of Death, Cause of Death, Turtle Danger, Turtle Danger Part 2, Alternative Energy, So Much Algae, Stressed Coral, Casting Shade, Eat the Seaweed

And once you finish the Moodle Homework, you will take the quiz for that level of ecology. See me to get the quiz.

We will break about halfway through this unit to do our outdoor quadrat sampling lab, and at the end of this unit, we will break to do our outdoor pond sampling lab, as well as at a couple of other points (for other activities, such as games or full-class discussion).

The test will be given after the game and the outdoor labs are all complete.

Good luck, and have fun!

Total Points/Assignment Log:

Please note that these assignments are subject to change depending on pacing and other course requirements.

Assignment	Job	Points	Date Completed
Notes on “How to Read a Scientific Article”	Exploring a New Kelp Forest at Site A: Rodeo Cove	5 HW	
Experiment 1 – The Scientific Method	Exploring a New Kelp Forest at Site A: Rodeo Cove	80 Lab	
Species richness, relative abundance, and Shannon-Weiner calculation	A Cliffside Oasis Visualization	10 HW	
Notes on “Ecological Niche”	Mussel Fest	10 HW	
Niche Partitioning and Metabarcoding - Module 1/Hide and Seek	Start a Refuge	10 Lab	
Notes on “Giant kelp, *Macrocystis pyrifera*, increases faunal diversity through physical engineering”	Refuge Failure	15 HW	
Notes on “Successional patterns of hard-bottom microbenthic communities at kelp bed (*Lessonia trabeculata)* and barren ground sublittoral systems”	Refuge Failure Simulation	5 HW	
Pyramid drawing	Predicting the Future of Cliffside Oasis/Saving Cliffside Oasis	5 HW	
Pyramid drawing	Seal Habitats	5 HW	
Writing on abiotic/biotic factors impacting ecosystems	Stationary Survival	15 HW	
Demographics virtual lab	In the Ice	30 Lab	
Scenarios writing	Picky Eaters	10 HW	
Dead Zone writing	Dirty Detritus	5 HW	
Dead zone drawing	Shrimp-Tastrophe	5 HW	
Ecosystem simulation	Turtle Danger Part 2	20 Lab	

Notes on “Microbially Mediated Hydrogen Cycling in Deep-Sea Hydrothermal Vents”	Boom Cause	15 HW	
“Troph” writing	Alternative Energy	5 HW	
Serpentinization writing	Methanogen	5 HW	
Niche Partitioning and Metabarcoding - Module 1/Hide and Seek – Module 2	Hide and Seek	10 Lab	
Niche partitioning writing	Hide and Seek	5 HW	
Raptor population lab	Turtle Stability	15 Lab	
Notes on “Emerald Ash Borer (*Coleoptera: Buprestidae*) Densities Over a 6-yr Period on Untreated Trees and Trees Treated with Systemic Insecticides at 1-, 2-, and 3-yr Intervals in a Central Michigan Forest”	The Lionfish Conspiracy	15 HW	
Duck, Duck, Growth lab	Fishy Business	30 Lab	
Notes on “Seabird Colonies as Important Global Drivers in the Nitrogen and Phosphorus Cycles”	So Much Algae	10 HW	
Climate Change POGIL	Stressed Coral	15 HW	
Zebra mussel writing	Eat the Seaweed	5 HW	
Various community ecology tasks	Eat the Seaweed	15 HW	
Population Ecology Quiz	N/A	20 Quiz	
Community Ecology Quiz	N/A	20 Quiz	
Ecosystem Ecology Quiz	N/A	20 Quiz	
Population Ecology Moodle HW	N/A	30 HW	
Community Ecology Moodle HW	N/A	30 HW	
Ecosystem Ecology Moodle HW	N/A	30 HW	
Prairie Sampling Lab	N/A	25 Lab	
Pond Sampling Lab	N/A	50 Lab	

Conversation Logs (60 for full points)	N/A	30 HW	
Completion of booklet	N/A	15 HW	
Test	N/A	100 Exam	

Job Pages

Kelp Forest Jobs:

- **Welcome to the Forested Lagoon**
  - Before:
    - Read pp. 7-24 in the textbook.
    - Read pp. 1261-1265 and take notes in the "Ecology in General" section.
    - Under the "Community Ecology" section, write what you think a food chain is, what you think a food web is, then draw a simple example of a food chain, including labels.
  - After:
    - Go to the sample food chain that you drew before you started this job. Under your food chain, draw the food chain that was in this job, and explain what the arrows in the food chain represent. Label this food chain "Forested Lagoon".
    - Read p. 1343 and take notes in your "Community Ecology" section.
    - Begin (or continue) working on answering the posted practice questions and comparing your answers to the answer key given.

- **Exploring a New Kelp Forest at Site A: Rodeo Cove**
  - Before:
    - Under the "Ecosystem Ecology" section, write what you think an ecosystem is, and explain how you think it's different from a food chain or a food web.
  - After:
    - Under the "Ecosystem Ecology" section, draw the food chain that was in this job. Label this food chain "Rodeo Cove".
    - Under the "Ecosystem Ecology" section, and noting the fact that Rodeo Cove and the Forested Lagoon are different ecosystems, write down what makes an ecosystem an ecosystem. Compare this with your definition of an ecosystem you wrote before you started this job.
      - **When you have finished this task, talk to 1 classmate about your definition, log your conversation in the conversation log, and talk to me about your definitions.**
    - Read "How to Read a Scientific Article" and take notes (in your class notebook, not in this workbook, as we'll be using this article moving forward past this unit).
      - **When you have finished this task, show me your notes – this is worth 5 homework points.**
    - With a group of 1-2 others (for a total of 2-3 people per group), complete Experiment 1 – The Scientific Method
      - **When you have finished this task, hand it in – this is worth 80 lab points.**

- **Energy in the Forested Lagoon System**
  - Before:
    - Under the "Ecosystem Ecology" section, define the term "trophic level".

- During:
  - Without looking in your book, label the food chain you have drawn for the job "Exploring a New Kelp Forest at Site A: Rode Cove" with "primary producer", "primary consumer", and "secondary consumer".
  - In your "Ecosystem Ecology" section, differentiate between primary producers, primary consumers, and secondary consumers. Additionally, add the definition of tertiary consumers.
  - In your "Ecosystem Ecology" section, write down if you have any tertiary consumers in your food chain in "Exploring a New Kelp Forest at Site A". If you do, what are they? If you don't, what would be a tertiary consumer?
  - In your "Ecosystem Ecology" section, write down how energy is linked to food webs – make sure to talk about what the ultimate source of energy in most ecosystems is, as well as what happens to the energy between one trophic level and the next.
    - **When you have finished this task, talk to 1 classmate about your energy/food chain linkage, log your conversation in the conversation log, and talk to me about what you've written.**
- After:
  - Read pp. 1341-1346 and take notes in the "Ecosystem Ecology" section
  - Go back to your food chain for "Exploring a New Kelp Forest at Site A" and make any corrections necessary for "primary producer", "primary consumer", and "secondary consumer". Add the sun to your food chain and explain where the energy from the food chain comes from.
    - **When you have finished this task, talk to 1 classmate about your energy/food chain linkage, log your conversation in the conversation log, and talk to me about what you've written.**

- **A Cliffside Oasis Visualization**
  - Before:
    - In the "Community Ecology" section, use your understanding of these words and their everyday usage to predict what you think a "keystone species", an "ecosystem engineer", and a "foundation species" are. **Share your definitions with 2 other classmates and log your conversations in your conversation log.**
    - Read pp. 1322 and take notes in the "Community Ecology" section.
  - After:
    - Read the article, "What Is a Keystone Species", and take notes in the "Community Ecology" section
    - In the "Community Ecology" section, write down what you think the foundation species are for the Forested Lagoon and the Cliffside Oasis. Why are these species the foundation species?
    - Read pp. 1321-1324 and take notes in the "Community Ecology" section.
    - In the "Community Ecology" section, write down what the keystone species are for the Forested Lagoon, Rodeo Cove, and Cliffside Oasis. Write down how you know these are the keystone species, and what the predicted results are of removing the keystone species. Use examples from the jobs you have already done.
      - **When you have finished this task, talk to 2 classmates about your thoughts on the keystone species at each site, log your conversation in the conversation log, and talk to me about your what you've written.**
    - In the "Community Ecology" section, calculate species richness and relative species abundance in the urchin barren in Cliffside Oasis. Also, go to this website, look at the

definition of the Shannon-Weiner diversity index, and calculate the Shannon-Weiner index for the Cliffside Oasis (https://www.statology.org/shannon-diversity-index/).
    - **When you have finished this task, show me your answers – this is worth 10 homework points.**

- **Mussel Fest**
  - Before:
    - Read the article, "Ecological Niche", and take notes using any format you would like to use.
      - **When you have finished this task, hand it in – this is worth 10 homework points.**
    - Read pp. 1318-1319 and take notes in the "Community Ecology" section.
  - After:
    - Based on the stress tank values that you calculated in the stress tank, write down the mussels' niche values based in the "Community Ecology" section.
    - In the "Community Ecology" section, write down if the mussels in this job are in their niche, not in their niche, or something else. Use evidence from the job. Write down what can happen to the mussels if they're not in their niche.
      - **When you have finished this task, talk to me about what you've written.**
    - Answer if the mussels are in their niche or not. What can happen if they are not in their niche?
      - **When you have finished this task, talk to 2 classmates about what you have written, log your conversation in the conversation log, and talk to me about what you've written.**

- **Mussel Fest Solution**
  - Before:
    - Watch the Niche Loom video, review the PowerPoint, and take notes in the "Community Ecology" section.
    - In your "Community Ecology" section, compare and contrast "fundamental niche" and "realized niche".
    - Look at your notes for the Mussel Fest job and review the niche values for mussel that you wrote down from the stress tank values.
  - After:
    - In your "Community Ecology" section, write down how you stressed the mussels in this job? How did you give them unstressed conditions?
      - **When you have finished this task, talk to 1 classmate about what you have written and log your conversation in the conversation log.**

- **Urchin Farm**
  - Before:
    - Read pp. 1314-1318 and take notes in the "Community Ecology" section.
    - Look at the PowerPoint on population cycles and take notes in the "Population Ecology" section
  - During:
    - If you run any experiments in this job where you discover something you have already known, why is that? What happened that made this the case? Write your answer in the "Community Ecology" section.
      - **When you have finished this task, talk to 1 classmate about what you have written and log your conversation in the conversation log.**
  - After:

        - According to the pages you read before starting this job, what kind of species interaction/symbiosis is going on in this job? In the "Community Ecology" section, write this interaction down and label which species are doing which interactions.
        - In the "Community Ecology" section, draw an idealized population cycle for the species interacting in this job (as an example, look at the moose-wolf population cycle on Isle Royale in the PowerPoint). Underneath the cycle, describe why the population cycle looks like it does – also, describe why real population cycles (non-idealized) might not look like the idealized cycles.
            - **When you completed this task, talk to me about what you have drawn.**

- **Start a Refuge**
    - Before:
        - If you haven't yet completed the job "Hide and Seek" in the Bayou, get the "Niche Partitioning and Metabarcoding" worksheet and go to https://www.biointeractive.org/classroom-resources/niche-partitioning-and-dna-metabarcoding. Click "Start Interactive" and complete Module 1, both on the website as well as the worksheet. If you have completed "Hide and Seek" in the Bayou, skip this task.
            - Find 1 or 2 partners to go through this module with, including the quizzes. When you and your partner get a question wrong, talk to me about that question (right away – don't advance the question until you discuss it with me).
            - **When you have finished the Module 1 worksheet, hand it in – this is worth 10 lab points.**
    - During:
        - In the "Population Ecology" section, write down the populations and their numbers that are at the site in this job.
        - In the "Population Ecology" section, write down which population growth model will best model each populations' growth at this site in the short term, and explain why.
            - **When you have completed this task, talk to me about what you have written.**
    - After:
        - In the "Community Ecology" section, compare and contrast fundamental niche and realized niche, and explain how species who use similar resources are able to coexist in an area – use the concept of niches in your explanation. Additionally, write about how what you have written applies to this job.
            - **When you have completed this task, talk to me about what you have written.**
        - Read "For Many Species, Climate Change Brings Switches in Their Niches", located at https://wildlife.org/for-many-species-climate-change-brings-switches-in-their-niches/. Take notes in the "Community Ecology" section.
        - Based on what you have read and what you have seen, in the "Community Ecology" section, explain how climate change affects available niches in the ocean. How has this, or how might this impact the kelp populations involved in this job?
            - **When you have completed this task, talk to me about what you have written.**

- **Refuge Failure**
    - Before:
        - **Find a partner and review** by comparing notes on foundation species, ecosystem engineer, and keystone species.
            - Note any differences and identify what they are/figure out how to reconcile your notes
    - During:

        - In the “Community Ecology” section, write down how you are testing for reproduction rate of giant kelp when stressed and unstressed? Why did your method work to test for these things?
    - After:
        - In the “Community Ecology” section, explain what caused the bull kelp population to decline.
            - **Talk to 1 classmate about what you have written and log your conversation in the conversation log.**
        - Using the concept of ecological niche, explain how you can stress an organism.
        - Could you have used water conditions from the White Point site from the Arctic region (in this game) as a way to stress these organisms (if you haven’t been to the Arctic yet, find a classmate who has and look at their water conditions in AQOS)? Based on the concept of ecological niche and data from AQOS about the giant kelp, why or why not? Write down your answer in the “Community Ecology” section.
        - When you are testing reproduction rate, why do you turn on the auto feeder and the tank stabilizer? Think of basic principles of science and experimentation.
        - What caused the bull kelp population to decline?
            - **When you finish all of these tasks, talk to me about what you have written for all of these questions. This is worth 10 homework points.**
        - Read the article “Giant kelp, *Macrocystis pyrifera,* increases faunal diversity through physical engineering.” and take notes using the provided template for taking notes.
            - **When you have finished this task, hand it in – this is worth 15 homework points.**
        - In the “Community Ecology” section, answer if giant kelp are ecosystem engineers or keystone species. Additionally, explain how this applied in the game with bull kelp and giant kelp. Give evidence for your conclusion.
            - **Talk to 2 classmates about what you have written, log your conversation in the conversation log, and talk to me about what you have written.**

- **Refuge Failure Simulation:**
    - Before:
        - Read the article on ecological succession and take notes in the “Community Ecology” section
        - Read pp. 1324-1325 and take notes in the “Community Ecology” section
        - In the “Community Ecology” section, write down the answer to the following question: while the readings were about terrestrial succession, do you think succession happens in aquatic biomes? Why or why not, and how? Can you find any evidence of that, either in the game or online?
            - **Talk to 2 classmates about what you have written, log your conversation in the conversation log, and talk to me about what you have written.**
    - After:
        - Skim the article “Successional patterns of hard-bottom microbenthic communities at kelp bed (*Lessonia trabeculata*) and barren ground sublittoral systems” and in your “Community Ecology” section, answer if you think succession happens in aquatic ecosystems, and how you predict succession will be different in aquatic systems versus terrestrial systems. Also, answer if you think succession happens in aquatic ecosystems.
            - **When you have finished these 2 tasks, talk to me about what you have written – this is worth 5 homework points.**
        - Play the simulation “Succession Interactive” from Bioman Biology (located at the following website:

(https://www.biomanbio.com/HTML5GamesandLabs/EcoGames/succession_interactive/index.html), and complete the quiz in the game. When you have finished the quiz, in the "Community Ecology" section, write down how succession and niches are related.
    - **Do not close the window with the quiz in it. Talk to 2 classmates about what you have written regarding succession and niches, log your conversation in the conversation log, and talk to me about what your quiz and what you have written.**

- **Predicting the Future of Cliffside Oasis and Saving Cliffside Oasis**
    - Before:
        - Read pp. 1352-1354, and 1396-1397, and take notes in the "Ecosystem Ecology" section
        - Look at the PowerPoint "Ecosystem Ecology – Limitations and Changes in Ecosystems" and take notes in the "Ecosystem Ecology" section
    - During
        - In the "Ecology in General" section, write down what data you put into your model for Predicting the Future of Cliffside Oasis.
        - In the "Ecosystem Ecology" section, draw an energy pyramid, a biomass pyramid, and a pyramid of numbers for the species of Cliffside Oasis. Label each pyramid with the appropriate trophic level label.
            - **When you have finished this task, talk to me about what you have written – this is worth 5 homework points.**
        - In the "Ecosystem Ecology" section, explain how you plan(ned) to save the ecosystem. Additionally, explain what will happen if your numbers are incorrect.
            - **Talk to 2 classmates about what you have written, log your conversation in the conversation log, and talk to me about what you have written.**
    - After:
        - In your "Ecology in General" section, explain how models are used to explain a system and make predictions. Discuss the importance of good data, and what happens to a model if the data is incorrect or incomplete.
            - **Talk to 2 classmates about what you have written, log your conversation in the conversation log, and talk to me about what you have written.**
        - In the "Ecosystem Ecology" section, explain how you saved the ecosystem?
            - **Talk to me about what you have written.**

Arctic Jobs

- **Endangered Seals, Above and Below, and Seal Habitats**
    - No Tasks

- **Above and Below**
    - No Tasks

- **Seal Habitats**
    - After:
        - In the "Ecosystem Ecology" section, draw an energy pyramid, a biomass pyramid, and a pyramid of numbers for the species of Ephemeral Impasse. Label each pyramid with the appropriate trophic level label.

- When you have finished this task, talk to me about what you have written – this is worth 5 homework points.

- **Salmon Competition**
  - After:
    - If you have completed jobs going through the concept of the ecological niche, in the "Community Ecology" section, explain how the concept of the niche is involved in this job. If you have not yet gone through niches, read pp. 1318-1319 and quickly search online for the concept of ecological niches, then write the definition.
      - When you have finished this task, talk to me about what you have written.

- **Salmon Monitoring**
  - Before:
    - Under the "Population Ecology" section, write a **definition** of population in your own words.
    - Read p. 1264 and take notes in the "Population Ecology" section.
  - After:
    - In the "Population Ecology" section, write down the various populations, and their numbers, that live in the Frosted Sea site.
    - In the "Ecosystem Ecology" section, predict what a food web will look like between the species that live in the Frosted Sea.
      - Talk to 1 classmate about what you have written, and log your conversation in the conversation log.
    - Begin (or continue) working on answering the posted ecology practice questions and comparing your answers to the answer key given.

- **Under The Ice?**
  - No Tasks

- **Stationary Survival**
  - After:
    - In the "Ecosystem Ecology" section, draw a picture explaining how abiotic factors and biotic factors overlapped in this job. What would happen if those abiotic factors changed?
    - Read the article at the following website, and write how abiotic factors could affect current and how this could impact communities and ecosystems.
      - When you have finished both of these tasks, talk to 2 classmates about what you have written, log your conversation in the conversation log, and talk to me about what you have written – this is worth 15 homework points.

- **In The Ice:**
  - Before:
    - Read pp. 1265-1266 and p. 1298 and take notes in the "Population Ecology" section.
    - Look at the Demography PowerPoint and take notes in the "Population Ecology" section.
  - After:
    - In the "Population Ecology" section, explain how the cod were distributed in this job (think of the different types of distribution possible) and explain why this is the case. Is this due to biotic factors, abiotic factors, or both?
      - Talk to 1 classmate about what you have written, log your conversation in the conversation log, and talk to me about what you have written.

        - With 1 or 2 partners (for groups of 2 or 3), get a demographics data table and work through the lessons at the following website: https://www.learner.org/series/the-habitable-planet-a-systems-approach-to-environmental-science/demographics-lab/ (make sure to open the simulator). Answer the questions on a separate sheet of paper. Please note that this involves answering the step 1 and step 2 questions for "The Demographic Transition", "Population Momentum", and "Social Impacts", and then a **short** paragraph for each of the "For Your Consideration" sections.
            - **When you have finished this task, hand it in – it is worth 30 lab points.**

- **Missing Whale:**
    - Before:
        - Look at your food chain from the job "Exploring a New Kelp Forest at Site A" in the "Ecosystem Ecology" section. In your "Ecosystem Ecology" section, explain what is missing in this food web.
            - **When you have finished, talk to me about what you have written.**
        - Read p. 1264 and take notes in the "Population Ecology" section.
    - During:
        - In the "Population Ecology" section, write down the populations of decomposers in this job, as well as how many of each there are. Additionally, in the "Ecosystem Ecology" section, write down what decomposers in general do in an ecosystem.
            - **When you have finished this task, talk to me about what you have written.**
    - After:
        - Look at the diagram on p. 156 and write how the book describes decomposers and what their role in an ecosystem is under the "Ecosystem Ecology" section.
        - Based on what you read on p. 156, in the "Ecosystem Ecology" section, explain how decomposers fit in with the second law of thermodynamics – think of how energy flows through the trophic levels. As a hint, where does all of the energy that comes into an ecosystem ultimately go?
        - Read p. 625 and take notes in the "Ecosystem Ecology" section.
        - With 1-2 other partners, write an ode to decomposers in the "Ecosystem Ecology" section.
        - In the "Ecology in General" section, explain how the whale skeleton provides microenvironments and creates niches for other organisms.
            - **When you have finished all of these tasks, talk to 2 classmates about what you have written, log your conversation in the conversation log, and talk to me about what you have written.**

- **Disappearing Act**
    - Before:
        - Read the Article "What Happens After a Whale Dies", watch the videos located in the article, and take notes in the "Ecosystem Ecology" section. https://www.npr.org/2019/09/13/760664122/what-happens-after-a-whale-dies
        - In the "Ecosystem Ecology" section, explain how whalefalls transport nutrients throughout the ocean – include a discussion of if nutrients from the land can ever get into the ocean via whalefall.
            - **When you have finished these tasks, talk to 2 classmates about what you have written, log your conversation in the conversation log, and talk to me about what you have written.**
    - During:
        - Write down the species that are at the whalefall at the job site.

        - Look up the definition of a detrital food web and write it down in the “Ecosystem Ecology” section.
    - After:
        - In the “Ecosystem Ecology” section, write down the detrital food web from this job.

- **Time of Death**
    - Before:
        - Read the article, “The Fish and the Forest”. Take notes in the “Ecosystem Ecology” section.
        - Explain how this article is similar and how it is different from what is occurring at a whalefall.
            - **When you have finished this, talk to me about what you have written.**
        - If you haven’t already read pp. 1350-1353, read these pages and take notes in the “Ecosystem Ecology” section.
    - During:
        - Look at the energy flow diagram on p. 1349. Look up what bowhead whales eat and, in the “Ecosystem Ecology” section, draw one of these diagrams for a bowhead whale food chain - make sure to include decomposers. Use your diagram to explain where all of the energy **ultimately** goes. As a hint, think about thermodynamics.
            - **When you have finished this task, talk to 3 classmates about what you have written, log your conversation in the conversation log, and talk to me about your diagram and answer.**
    - After:
        - If you haven’t already, read pp. 1324-1325. In the “Community Ecology” section, explain how the whalefall and associated populations moving into the site have characteristics of succession.
            - **When you have finished this, talk to 1 classmate about what you have written, log your conversation in the conversation log, and talk to me about what you have written.**
        - Read p. 1353 and take notes in the “Ecosystem Ecology” section.
        - Look at the energy flow diagram you made before you started this job. In the “Ecosystem Ecology” section, explain why, due to a whale’s diet, toxic substances are biomagnified in higher levels of the food chain.
            - **When you have finished this, talk to 2 classmates about what you have written, log your conversation in the conversation log, and talk to me about what you have written.**

- **Cause of Death**
    - Before:
        - Read pp. 1354-1365 and take notes in the “Ecosystem Ecology” section.
    - After:
        - Remembering that a whale is a source of carbon, nitrogen, and phosphorus, explain how Linda transported these nutrients throughout the ecosystem, where specifically on each of these cycles her nutrients are at, and where they are going in the “Ecosystem Ecology” section.
            - **When you have finished this, talk to 2 classmates about what you have written, log your conversation in the conversation log, and talk to me about what you have written.**
        - In the “Ecosystem Ecology” section, explain what would happen in ecosystems if it were not for decomposers.

- When you have finished this, talk to 1 classmate about what you have written, log your conversation in the conversation log, and talk to me about what you have written.

- **Isolated Instance**
  - Before:
    - Think about ways that periodic migration of a population might impact a community. In the "Community Ecology" section, write down what might happen to the migrating population as well as the other populations in the community.
      - When you have finished this, talk to 1 classmate about what you have written, log your conversation in the conversation log, and talk to me about what you have written.
  - After:
    - How did the movement of the glass sponges impact the community? In the "Community Ecology" section, write down how this impacted the community.
    - Which experiments did you have to run to complete this job?
      - When you have finished this, talk to me about what you have written.

- **Picky Eaters**
  - Before:
    - Read pp. 1301-1303 and take notes in the "Population Ecology" section.
    - Look at the Population Dynamics, Regulation, and Age Structure PowerPoint and take notes in the "Population Ecology" section
  - During:
    - In the "Population Ecology" section, use the concepts of fecundity and energy balance to explain which food the cod would likely prefer to eat as well as why.
      - When you have finished this task, talk to 2 classmates about what you have written, log your conversation in the conversation log, and talk to me about what you have written.
  - After:
    - Look at the PowerPoint about Population Dynamics, Regulation, and Age Structure and take notes in the "Population Ecology" section.
    - In the "Population Ecology" section, give a couple of different scenarios that may happen to the population of arctic cod at the Frosted Sea if another species comes in to join the cod that also eats ice algae and diatoms. Use the terms "r-selected", "carrying capacity", "metapopulations", "immigration", and "emigration".
      - When you have completed this task, talk to me about what you have written. This is worth 10 homework points.

Bayou Jobs

- **Blue Water**
  - No Tasks
- **Dirty Detritus**
  - After:
    - Read the article on this website and take notes (use any format you would like). Under the notes, write how this job fits in with the concept of a dead zone, and how dead zones fit in with biogeochemical cycling (especially phosphorus and nitrogen) - https://www.noaa.gov/news-release/below-average-gulf-of-mexico-dead-zone-measured

- **When you have finished this task, talk to me about what you have written – your notes are worth 5 homework points.**

- **Oxygen Tracking**
  - No tasks

- **Displaced Reef**
  - Before:
    - Read pp. 1279-1284 and take notes in the "Ecology in General" section.
    - If you haven't read pp. 1319-1321, read these pages and take notes in the "Community Ecology" section.
  - During:
    - In the "Community Ecology" section, predict and build a model for what you think the community interactions will be between these populations – what are these types of interactions? Can you think of any specific type?
    - If you haven't already in a different job, look up the term "invasive species". Write down the definition in your "Community Ecology" section, as well as a brief hypothesis for why they might be damaging to a community.
  - After:
    - Begin (or continue) working on answering the posted practice questions and comparing your answers to the answer key given.

- **Shrimp Yields**
  - No Tasks

- **Shrimp-Tastrophe**
  - During
    - In the "Ecology in General" section, write down if there was anything wrong with your original model, and if there was, what was it? How did you fix the model?
      - **When you have finished this task, talk to me about what you have written.**
  - After
    - In the "Ecosystem Ecology" section, make a quick drawing (nothing complicated or fancy – this is sometimes called a "back of the napkin" drawing) explaining how dead zones form, using species from this job.
      - **When you have finished this task, talk to me about what you have written – your notes are worth 5 homework points.**

- **Turtle Danger**
  - Before
    - If you haven't looked at the PowerPoint about Population Dynamics, Regulation, and Age Structure, look at this PowerPoint and take notes in the "Population Ecology" section.
    - There is a population of loggerhead turtles at the Coral Reef site, as well. Research the definition of metapopulation, define it, and, in the "Population Ecology" section, explain what would make the turtles in the Bayou and at the Coral Reef metapopulations, as well as how and why individuals would join or leave these metapopulations.
      - **When you have finished this task, talk to 2 classmates about what you have written, log your conversation in the conversation log, and talk to me about what you have written.**
  - After

        - In the “Ecosystem Ecology” section, write down the food web you came up with in this activity. Compare it to the predicted model you came up with in the job “Displaced Reef”. Underneath the food web for this job, write down how close your predictions were to correct.
        - In the “Population Ecology” section, compare r and K selected species, and answer if loggerhead turtles are r or K selected and why.
            - **When you have finished this task, talk to 1 classmate about what you have written, and log your conversation in the conversation log.**
        - In the “Population Ecology” section, define carrying capacity, draw a logistic growth model, point out where you think the loggerhead turtles are on the curve, and explain why.
            - **When you have finished all of these tasks, talk to me about what you have written.**

- **Turtle Danger Part 2**
    - Before:
        - Read pp. 1341-1348 and take notes in the “Ecosystem Ecology” section
    - During:
        - In the “Ecology in General” section, write down what you needed to do to make your model as accurate as possible, what might happen if your model is incorrect, and the importance of continuing to study a system to improve models.
            - **When you have finished this task, talk to me about what you have written.**
    - After:
        - In the “Population Ecology” section, answer the question of are the turtles in danger, as well as how close they are to their carrying capacity and what happens if the turtle population would go over the carrying capacity. How might the turtles go above their carrying capacity in this job? Additionally, label the factors affecting their population change, as well as if those are density dependent or density independent factors.
            - **When you have finished this task, talk to 1 classmate about what you have written, log your conversation in the conversation log, and talk to me about what you have written.**
        - With 1 or 2 partners (for groups of 2 or 3), get an ecosystem simulation data table from me and work through the lessons at the following website: https://www.learner.org/series/the-habitable-planet-a-systems-approach-to-environmental-science/ecology-lab/
          (make sure to open the simulator and work through the section). Answer the questions for Steps 1 and Steps 2 on a separate sheet of paper, and make sure to read the “For Your Consideration” section, although you don’t need to answer those questions.
            - **When you have finished this task, hand it in – it is worth 20 lab points.**

- **Boom Cause**
    - Before:
        - If you haven’t already, read pp. 1271-1284 and takes notes in the “Ecology in General” section.
            - If you have already read pp. 1271-1284 and taken notes, please read pp. 1266-1271 and take notes in the “Ecology in General” section.
                - Please note that if you haven’t read p. 1271-1284, you need to read that as well as pp. 1266-1271.
    - During:

        - In the “Ecology in General” section, write down what biome this job is in as well as which zone of the ocean this job occurs in.
            - **When you have finished this task, talk to me about what you have written.**
    - After:
        - Read the article “Microbially Mediated Hydrogen Cycling in Deep-Sea Hydrothermal Vents” and take notes using the provided template for taking notes. Also, answer the question “what is methane and how does it fit in here” and “how does any ecosystem without the sun get its energy?”
            - **When you have finished this task, talk to me about the questions and hand in your notes – this is worth 15 homework points.**

- **Alternative Energy**
    - Before:
        - Read pp. 206-207 and take notes in the “Ecosystem Ecology” section.
        - Read pp. 551-553 and take notes in the “Ecosystem Ecology” section.
        - Look at the PowerPoint “Ecosystem Ecology – Energy and Matter Flow in Ecosystems, Food Chains, and Food Webs”, and take notes in the “Ecosystem Ecology” section.
    - During:
        - After scanning all species in the Ignis Collins Deeps, briefly research methane fire archaea (methanogenic archaea). In the “Ecosystem Ecology” section, write what it means that they consume hydrogen, as well as how they are connected to methane. Additionally, write out the table that shows photo/chemotrophs compared with auto/heterotrophs and quickly predict where methanogens are on this table (you’ll give a more official answer on this later).
            - **When you have finished this task, talk to me about what you have written – this is worth 5 homework points.**
    - After:
        - In the “Ecosystem Ecology” section, write about where these organisms get their energy from. Where does these organisms get their energy?
            - When you have finished this task, talk to me about what you have written.
        - Look at the PowerPoint “Ecosystem Ecology – Biogeochemical Cycles” and take notes in the “Ecosystem Ecology” section.
        - Read pp. 1284-1290 and take notes in the “Ecology in General” section.
        - Read the article at the following website and summarize how methanogenic archaea, like the ones found in this job, contribute to climate change. Additionally, explain what kind of “trophs” the methanogenic archaea area, based on the readings from earlier in this job and the table you wrote during the job.
            - https://asm.org/Articles/2022/May/How-Methanogenic-Archaea-Contribute-to-Climate-Cha
            - **When you have finished this task, talk to 2 classmates about what you have written, log your conversation in the conversation log, and talk to me about what you have written.**

- **Methanogen**
    - During:
        - Using your model, in the “Ecosystem Ecology” section, write down how the methane fire archaea are part of the ecosystem. Additionally, write down what they eat.
            - **When you have finished this task, talk to me about what you have written.**
    - After:

        - Look up the term “serpentinization”, and briefly take a few notes about this process in your “Ecosystem Ecology” section. In the “Ecosystem Ecology” section, answer the following questions:
            - How does serpentinization add energy to the ecosystem? What can use this energy?
            - How might serpentinization impact the ecosystem of the Ignis Collins Deeps?
            - Does serpentinization provide this impact for all deep sea ecosystems? Why or why not?
            - Is serpentinization a biotic or an abiotic process?
                - **When you have finished answering these questions, talk to me about what you have written – these questions are worth 5 homework points.**

- **Hide and Seek**
    - Before:
        - If you haven’t already read pp. 1318-1319, read these pages and take notes in the “Community Ecology” section.
        - If you haven’t yet completed the job “Start A Refuge” in the Kelp Forest, get the “Niche Partitioning and Metabarcoding” worksheet and go to https://www.biointeractive.org/classroom-resources/niche-partitioning-and-dna-metabarcoding. Click “Start Interactive” and complete Module 1, both on the website as well as the worksheet. If you have completed “Start A Refuge” in the Kelp Forest, skip this task.
            - Go to https://www.biointeractive.org/classroom-resources/niche-partitioning-and-dna-metabarcoding and go to Module 2. Use the “Niche Partitioning and Metabarcoding” worksheet and find 1 or 2 partners to go through this module with, including the quizzes. When you and your partner(s) get a question wrong, talk to me about that question (right away – don’t advance the question until you discuss it with me).
            - **When you have finished the Module 2 worksheet, hand it in – this is worth 10 lab points.**
    - During:
        - In the “Community Ecology” section, write how this job involve niche partitioning? Explain if the loggerhead turtles partition their niche, and if they do, why they have to. Explain what would happen if the loggerhead turtles couldn’t partition their niche, and explain what would happen to their population if they were unable to partition their niche. Finally, explain what you needed to do in this experiment to make an accurate model, and what might have happened (in terms of people making decisions about the system, such as politicians) had you not done this.
            - **When you have finished this task, talk to 2 classmates about what you have written, log your conversation in the conversation log, and talk to me about what you have written – this is worth 5 homework points.**

- **Reef Decision**
    - Before:
        - If you haven’t already, read pp. 1266-1272 and take notes in the “Ecology in General” section.
    - During:
        - In the “Ecology in General” section, write what your plan is as to how you will make an intervention model to see what will affect the turtles if the rig is removed, and explain why you came up with this idea. Explain why the historical species and water chemistry

data is so important in this decision, as well as what you did to solve the intervention model question and why your model led you to know that removing the rig would allow the turtle populations to be maintained.
        - **When you have finished this task, talk to 2 classmates about what you have written, log your conversation in the conversation log, and talk to me about what you have written.**
- After:
    - In the "Ecology in General" section, describe why the rig is so important to the turtles – utilize the concepts of food webs, biotic and abiotic factors, population distribution, carrying capacity, habitat, ecosystem engineers, keystone species, and energy flow in ecosystems, as necessary. Also discuss what you decided to do with the rig and why.
        - **When you have finished this task, talk to 2 classmates about what you have written, log your conversation in the conversation log, and talk to me about what you have written.**

Coral Reef Jobs

- **Turtle Population**
    - Before:
        - Read pp. 1295-1298 and take notes in the "Population Ecology" section
    - During:
        - In the "Population Ecology" section, calculate the species density of loggerhead turtles at the edge of the coral reef if it's assumed that the turtle population count is in a volume of 975000 m^3 of water.
            - **When you have finished this task, talk to me about your species density calculation.**
    - After
        - Begin (or continue) working on answering the posted practice questions and comparing your answers to the answer key given

- **Turtle Stability**
    - Before:
        - Read pp. 1298-1310 and take notes in the "Population Ecology" section.
        - Look at the PowerPoint "Demography" and take notes in the "Population Ecology" section.
    - During:
        - Using the equations from the "Demography" PowerPoint, write in the "Population Ecology" section about what is happening to the turtle population in this job, what would happen to the population if the food for the turtles suddenly increased, and what would happen if the food for the turtles suddenly decreased. Additionally, explain what would need to happen for the turtles to begin to experience exponential growth.
            - **When you have finished this task, talk to 2 classmates about what you have written, log your conversation in the conversation log, and talk to me about what you have written.**
    - After:
        - Use the survivorship data given below to graph the population of loggerhead turtles in the "Population Ecology" section, calculate survivorship using the example, and determine what type of survivorship curve loggerhead turtles have.

- **When you have finished this task, talk to me about what you have calculated and written.**

	Individuals Present (or hatched)	Survived	Survivorship
Time 0 (eggs laid)	1100	1100	1.0
Day 1	1100	1000	1000/1100 = .91
Day 2	1000	600	
Day 3	600	230	
Day 4	230	80	
Day 5	80	18	
Year 15	18	16	

- With 1-2 partners, complete the raptor population activity.
  - **When you have finished the raptor population activity, hand it in – this is worth 15 lab points.**

- **Fake Reef Fix**
  - Before:
    - Read pp. 1322 and take notes in the "Community Ecology" section if you haven't already.
  - During:
    - In the "Community Ecology" section, calculate species richness in the restoration site
    - In the "Community Ecology" section, calculate species relative abundance in the restoration site
  - After:
    - Read "Human Population Grows Up" and take notes in the "Population Ecology" section.
    - What would an age structure diagram for staghorn coral at this site look like based on the data you saw? Draw it in the "Population Ecology" section.
    - Read pp. 1310-1314 and take notes in the "Population Ecology" section.

- **The Lionfish Conspiracy**
  - Before:
    - Read p. 1323 and take notes in the "Community Ecology" section.
    - In the "Community Ecology" section, make a list of why an invasive species is considered "invasive".
      - **When you have finished this task, talk to 2 classmates about what you have written, log your conversation in the conversation log, and talk to me about what you have written.**
  - During:
    - In the "Community Ecology" section, write about how an invasive species might affect other populations if they interact with them directly or if they interact with them indirectly. Explain how invasive species may be damaging to a community. How

might the invasive species affect other populations if they do NOT interact with them directly? Why might this be damaging to a community?
    - **When you have finished this task, talk to 2 classmates about what you have written, log your conversation in the conversation log, and talk to me about what you have written.**
- After:
  - Read the Emerald Ash Borer Article and take notes using the provided template for taking notes.
    - **When you have finished this task, hand it in – this is worth 15 homework points.**
      - In the "Community Ecology" section, write about if the emerald ash borer is invasive, how the emerald ash borer interacts with the community, what impact the emerald ash borer has on local populations, the community, and the ecosystem in general, how population density of the emerald ash borer is part of this article, and how the emerald ash borer can best be stopped, based on the article.
        - **When you have finished this task, talk to 2 classmates about what you have written, log your conversation in the conversation log, and talk to me about what you have written.**

- **Fishy Business**
  - Before:
    - Read pp. 1303-1311, if you haven't already, and take notes in the "Population Ecology" section.
    - With 2-3 other classmates, play "Duck, Duck, Growth" and fill out the worksheet.
      - **When you have finished this task, hand it in – this is worth 30 lab points.**
  - During:
    - In the "Population Ecology" section, write down the sources of food for the red grouper, as well as what the red grouper population needs in the model in order to sustain its growth. Additionally, explain what may happen to the red grouper population growth rate, population, and carrying capacity if the fishermen fished for other species in the red grouper's food web.
      - **When you have finished this task, talk to 2 classmates about what you have written, log your conversation in the conversation log, and talk to me about what you have written.**
  - After:
    - In the "Population Ecology" section, explain from a carrying capacity perspective why it can be helpful for a population for fishermen to come and fish the waters. Use the concepts of density dependent/density independent population control and intraspecific competition. Finally, explain what you expect will happen if too many fish are removed.
      - **When you have finished this task, talk to 2 classmates about what you have written, log your conversation in the conversation log, and talk to me about what you have written.**

- **So Much Algae**
  - Before:
    - After reading the job description, write down a model in the "Ecosystem Ecology" section, based on what you've seen in the Coral Reef jobs and organisms so far, to describe the ecosystem that has enabled the turf algae to cover everything at the site.

- During:
    - In the “Ecology in General” section, write down how you went about stressing the organisms in this job as well as if your model had high accuracy right away or not, and if not, what you needed to do to fix your model. Include why it is important to understand stressed behavior, and what would happen if you didn’t include these behaviors in the model.
        - **When you have finished this task, talk to me about what you have written.**
- After:
    - In the “Ecology in General” section, explain how scientists can know if their models are correct, what correct models enable scientists to do, what scientists do when their models lack accuracy, and make a short list of models that scientists use.
        - When you have finished this task, talk to me about what you have written.
    - Read the article “Seabird Colonies as Important Global Drivers in the Nitrogen and Phosphorus Cycles” and take notes using the provided template for taking notes.
        - **When you have finished this task, hand it in – this is worth 10 homework points.**
    - With 1-2 partners, complete the Eutrophication POGIL, and when you have finished the POGIL, write at the top of the POGIL how this activity relates to this job.
        - **When you have finished this task, talk to me about your work – this is worth 10 homework points.**

- **Tang Check-Up**
    - Before:
        - Read pp. 1319-1321 and take notes in the “Community Ecology” section.
    - During:
        - In the “Community Ecology” section, write down what is stressing the blue tang, as well as how they stress the tang.
            - **Once you finish this task, talk to me about what you have written.**
        - Look up what’s stressing the tang (once you figure it out) – how do they stress the blue tang?
    - After:
        - With a group of 2-3 others, come up with a very brief play or skit showing you understand one type of symbiosis.
            - **Talk to me about this task once you have finished it.**

- **Stressed Coral**
    - Before:
        - In the “Ecology in General” section, compare and contrast “biotic” and “abiotic” factors.
    - During:
        - In the “Ecology in General” section, explain the biotic and abiotic factors involved in stressing the coral in this job. How did this stress the coral?
        - In the “Ecology in General” section, explain how, if, the coral die, this is a density dependent control, a density independent control, or both.
            - **Talk to me about both of these tasks once you have finished them.**
    - After:
        - With 1-2 partners, complete the Climate Change POGIL. In the “Ecosystem Ecology” section, explain how climate change could lead to the conditions that caused the coral to get stressed. Briefly look online to find how climate change can

stress coral, as well as how it has been stressed in the Florida Keys in the summer of 2023.
        - **Talk to me about what you have written once you have finished it. This is worth 15 homework points.**

- **Casting Shade**
    - Before:
        - Look at the "Ecosystem Ecology – Limitations and Changes in Ecosystems" PowerPoint and take notes in the "Ecosystem Ecology" section if you haven't already.
        - In the "Ecology in General" section, explain how producers are the base of the food web, and talk about the different types of productivity and their calculations.
            - **Talk to me about what you have written once you have finished it.**
    - During:
        - In the "Ecology in General" section, explain why you turn on the autofeeder and the tank stabilizer when measuring the reproductive rate of the sargassum (keep good experimental practices in mind). Additionally, explain how you stressed the staghorn coral in this experiment, why you selected this method to stress them, and how else you could stress them.
            - **Talk to me about what you have written once you have finished it.**
    - After:
        - In the "Ecosystem Ecology" section, predict how we can deal with the sargassum.
        - In the "Community Ecology" section, determine if this is considered niche partitioning, and, if it is, what may happen if it continues (based on what you know about niche partitioning).
            - **When you have finished this task, talk to 2 classmates about what you have written, log your conversation in the conversation log, and talk to me about what you have written.**

- **Ocean Plastics**
    - No Tasks

- **Eat the Seaweed**
    - Before:
        - Look at the "Community Ecology – Foundation Species and Keystone Species" PowerPoint and take notes in the "Community Ecology" section if you haven't already.
        - In the "Community Ecology" section, explain top down and bottom up control.
    - During:
        - In the "Community Ecology" section, explain what an invasive species is.
    - After:
        - Briefly research the zebra mussel and its role in Lake Michigan. In the "Community Ecology" section, explain what zebra mussels have done in Lake Michigan, if they are considered invasive, and if so, why. How could you consider zebra mussels as ecosystem engineers?
            - **When you have finished this task, talk to 1 classmate about what you have written, log your conversation in the conversation log, and talk to me about what you have written – it is worth 5 homework points.**
        - In the "Community Ecology" section, explain if there are already invasive species at the Coral Reef sites. Explain what makes a species invasive.

    - **When you have finished this task, talk to 1 classmate about what you have written, log your conversation in the conversation log, and talk to me about what you have written.**
- In the “Community Ecology” section, explain what may be a problem in introducing the species you found in this job into the system – what might happen?
- Search online for an example of where a non-native species was introduced in an attempt to control another species, and describe what happened. What needs to be carefully done in order to ensure there are no issues with introducing a non-native species into the community? Write your answers in the “Community Ecology” section.
- In this job, is bringing in the species you are planning on bringing in a top-down or bottom-up control? Explain in the “Community Ecology” section.
- Look at the “Community Ecology – Island Equilibrium and Succession” PowerPoint. Takes notes in the “Community Ecology” section.
- In the “Community Ecology” section, explain how island equilibrium relates to new species coming to an area, and additionally, explain what happens when an invasive species newly arrives – where is it typically on the carrying capacity graph? What are the resource considerations and interspecific competition issues?
- Is bringing in the species you’re going to bring in top-down or bottom up? Write you answer in the “Community Ecology” section.
    - **When you have finished all of these tasks, talk to me about what you have written. These tasks are worth 15 homework points.**

Notes and Tasks

Population Ecology

Urchin Farm:

Start A Refuge:

In The Ice:

Salmon Monitoring:

Missing Whale:

Picky Eaters:

Turtle Danger:

Turtle Danger Part 2:

Turtle Population:

Turtle Stability:

Fake Reef Fix:

Fishy Business:

Eat the Seaweed:

Community Ecology

Welcome to the Forested Lagoon:

A Cliffside Oasis Visualization:

Mussel Fest:

Mussel Fest Solution:

Urchin Farm:

Start a Refuge:

Refuge Failure:

Refuge Failure Simulation:

Salmon Competition:

Time of Death:

Isolated Instance:

Displaced Reef:

Hide and Seek:

Fake Reef Fix:

The Lionfish Conspiracy:

Tang Check Up:

Casting Shade:

Eat the Seaweed:

Ecosystem Ecology

Exploring a New Kelp Forest at Site A: Rodeo Cove:

Energy in the Forested Lagoon Ecosystem:

Predicting the Future of Cliffside Oasis/Saving Cliffside Oasis:

Seal Habitats:

Salmon Monitoring:

Stationary Survival:

Missing Whale:

Disappearing Act:

Time of Death:

Cause of Death:

Shrimp-Tastrophe:

Turtle Danger:

Turtle Danger Part 2:

Alternative Energy:

Methanogen:

So Much Algae:

Stressed Coral:

Casting Shade:

Ecology in General

Welcome to the Forested Lagoon:

Predicting the Future of Cliffside Oasis/Saving Cliffside Oasis:

Missing Whale:

Displaced Reef:

Shrimp-Tastrophe:

Turtle Danger Part 2:

Boom Cause:

Alternative Energy:

Reef Decision:

So Much Algae:

Stressed Coral:

Casting Shade:

Appendices

Appendix A – Questions

Appendix B – General Notes and Bugs Found

Appendix C – Conversation Log

Conversation Tracker

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