Eco-columns Lab -
A Long Term Ecology Investigation

PURPOSE:
The purpose of this investigation is to create a simulated stable ecosystem that can be sustained for several months in an effort to understand how biotic and abiotic factors interact and to see how one type of ecosystem impacts other ecosystems.

Part 1: Setup your eco-column
1. Gather all materials.
2. See Diagram Handout for cutting, cap drilling, and bottle assembly instructions.
3. As you assemble your eco-column, be sure to record what you put in each chamber and how much (measured or weighed). Also, jot some notes on how you assembled your column so you can write instructions for "other scientists" who want to duplicate your work in order to compare results.
4. First identify what you are trying to discover through the creation of your eco-column. Look over the demonstration and assembly diagram to understand each chamber.
5. Decide what components to include in each section (which organisms, type of soil, etc.) See the list on the backside of this page for ideas.
6. Construct an eco-column according to the diagram on the back of this paper.
7. Add soil, sand, and gravel, plants etc. to the aquatic and terrestrial chambers as instructed in class.
8. Add leaf litter, grass clippings, and a banana peel, etc. to the decomposition chamber as instructed in class.
9. Add clean gravel and a clean fist-sized rock the aquatic chamber, and then volumetrically calibrate the aquatic chamber at 100-ml intervals as pond water is added.
10. After the aquatic chamber has reached equilibrium, add aquatic fauna.
11. After the plants in the terrestrial chamber are growing successfully, add terrestrial fauna to the terrestrial chamber.
12. Write a hypothesis for each of the three habitats: aquatic, decomposition, and terrestrial.
13. Draw a diagram of your eco-column and identify the biotic and abiotic factors present in each habitat.
14. Draw the (potentially connected) food webs you anticipate taking place within your eco-column. Make every effort to identify the species you have added as specifically as possible. If an organism is unidentifiable, include a drawing of it (you may use the microscopes to help with this).

Part 2: Observation and Data Collection
Each week you will make observations of your eco-column. Each observation should include:
- The date of your measurement
- The number of days your eco-column has been running
- pH, Temperature, Dissolved oxygen content of the aquatic chamber
- Qualitative observations (turbidity, plant growth, decomposition rate, fish status, odor)
- Additional measurements as conducted (analysis of NPK content, etc.)

Part 3: Lab Report
Part of the scientific method involves disseminating what you have learned.
- You will do this in the form of a lab write-up following the lab report rubric and guidelines I have given you.
- Make sure to keep good records during the investigation so that you are not missing anything when it comes time to write.
IDEAS FOR CHAMBER COMPONENTS:

Terrestrial Chamber:

Soil:
- You will probably want a mixture of planter mix and soil. For the soil, consider what types you have available between your group members.
  - Do you want dry and rocky?
  - Sandy?
  - Soil that has had plants growing in it recently?

Seeds:
- Since you have a small growing space, think small in terms of your plants. Fast growing plants like beans are out. Read the seed packets in the classroom as you think about what to plant. A few seedlings may be available.

Decomposition Chamber

Organic Matter:
- Some mix of leaves, grass, planter mix and easily decomposed food such as fruit (no citrus, no peels) should constitute the material in this chamber.
- Consider what fraction you think each of these components should be.

Insects:
- You should be able to support a number of insects in your decomposition chamber. Insects like Drosophila (fruit flies) can fly back and forth between the terrestrial and decomposition chambers and help degrade the food.
- What other insects or organisms can you think of to include?
- Do you want to put them in the terrestrial or decomposition chamber?

Aquatic Chamber:

Water:
- Not all water is the same.
  - Do you want to include fresh tap water?
  - Old tap water?
  - Distilled water?
  - Fish tank water?
  - Pond water?
  - What is your reasoning?

Solid material:
- Choose gravel or sand or a mix to go in the bottom of your aquatic chamber

Organisms:
- Anacharis (water plants) are available to go in your aquatic chamber.
- Animals such as fish and snails will have to be added later, once the plants have been in the chamber for about a week. Why can’t you add the animals in right away?
- Be especially careful to limit the number of larger organisms in this chamber as you will not open it to add food.
- Add only the number of consumers you think this chamber can support.
Step 1:
Cut the top off of a bottle and the top and bottom off of another bottle. Tape the two bottles together using clear packaging tape. Add marks to indicate every 100 milliliters (measure this using a graduated cylinder and regular water).

Step 2:
Cut the bottom off of a bottle and the top and bottom off of another bottle. Turn the first bottle upside down and tape the two bottles together using clear packaging tape. Drill small holes in the bottle cap. Attach the terrestrial chamber to the aquatic chamber.

Step 3:
Turn the bottle upside down and drill small holes in the bottom of the bottle. Drill one hole in the bottle cap large enough to fit a straw. Attach the decomposition chamber to the terrestrial chamber.

This chamber is optional and can be added later. Be sure to add small holes to the top of the decomposition chamber and invert the bottle upside down as shown above.
ECO-COLUMN LAB REPORT REQUIREMENTS

The following are more detailed instructions for your eco-column write-up. Except for drawing and labels, your write up should be typed (double spaced).

1. **Write a hypothesis for each of the habitats (aquatic, decomposition, terrestrial).**
   - Your hypothesis should state what you think will happen in each one of these ecosystems.
   - You should briefly describe why you think this will be the case.
   - Put in hypothesis section of report.

2. **Draw a diagram of your eco-column and identify the biotic and abiotic factors present in each habitat.**
   - Your eco-column has a unique structure. Draw a diagram that shows your eco-column and what is in each habitat: Aquatic, Terrestrial and Decomposition.
   - You can list the biotic and abiotic factors along the side or in separate paragraphs.
   - You must include WHY you chose each of these factors.

3. **Draw the (potentially connected) food webs you anticipate taking place within your eco column.**
   - Make every effort to **identify the species** you have added as specifically as possible. If an organism is unidentifiable, still include a drawing of it. Give the scientific name if at all possible. Binomial nomenclature is best (most unique) plus common name. Example: *Elodea canadensis* is the scientific name for the aquatic plant whose common name is Pondweed.
   - **Draw each organism** in a circle. Label your organism with its common name under the circle.
   - **Identify the role** of each organism by putting one of the following letters just beneath the name of the organism:
     - A Autotroph
     - H Heterotroph
       - 1=primary; 2=secondary; 3=tertiary, etc.
     - D decomposer
     - S scavenger
   - **Draw the energy arrows.**
     - These lines should go from the energy source towards the organism that gets that energy. For example from the sun to algae in the water (if you chose pond water), or from a secondary consumer to a tertiary consumer that eats it.
   - **Within your food web(s), circle three separate food chains.**
     - For these food chains, label at least two levels of consumers and the overall trophic levels.
MORE INFORMATION FOR YOUR ECO-COLUMN WRITE-UP

- Write out an explanation and diagram of your experimental setup. Be sure to identify all of the abiotic and biotic factors in each of your three habitats.
- Make sure to include all your weekly observations as raw data. All such observations should be properly dated. Also, make sure to include the date when you set up your eco-column, and the dates and descriptions when changes were made. Identify the number of days your eco-column has been in operation.
- Identify the pH, temperature, dissolved oxygen, nitrate, and phosphate content of your aquatic habitat and the point during the experiment when those measurements were taken.
- You should also have comparison data from other eco-columns in the classroom. Look for such things as plant growth, decomposition rate, and water turbidity.

Conclusion and analysis: this is the most important part of the report.

- You should identify food chains and food webs in each of your habitats. Identify any biogeochemical cycles that are present.
- Try to figure out how the three habitats have affected each other. Answer the question: why are there such large differences between the eco-columns in the classroom?
- Make sure to identify the roles of the various biotic factors such as decomposers, producers, consumers, etc.
- Identify changes that occurred in your eco-column, such as the water going from murky to clear in the aquatic habitat, and why such changes occurred and their implications as far as the health of the ecosystem is concerned.
- Compare your artificial ecosystem to real ones outside the classroom. How are they similar? How are they different? Was your eco-column a closed system or an open system or something in-between and how does that affect it?
- What kinds of niches were available to the various organisms and did you notice any instances of competitive exclusion occurring? Did you observe the law of tolerance in action? What were the limiting factors in your habitats?
- Was there any form of succession taking place in your eco-column or in the eco-columns of other students?
- Plant life seemed to have a difficult time in the terrestrial habitats. Why do you think this was so?
- Various colors sprang up in several of the habitats? There were splatches of red and black on the sand and gravel in the aquatic habitats. Yellow, white, and beige goo and fuzz seemed to invade several of the decomposition habitats. What do you think was causing all these various color changes?
- Please comment about the stability and sustainability of the various eco-columns in the classroom. Do some eco-columns appear to be more stable than others? Why is this so?
Here are some examples of conclusions and observations that students may make in the analysis part of their eco-column reports.

- Decomposition in the aquatic chamber increases turbidity which reduces incoming light and decreases plant photosynthesis.
- If the fish and snails die, then there will be less carbon dioxide available for the plants.
- The carbon cycle was demonstrated by the absorption of carbon dioxide by plants and their eventual decomposition.
- The hydrologic cycle could be observed and was driven by the temperature in the classroom.
- The eco-column was a good example of the delicate balance between abiotic and biotic factors.
- Fungus and bacteria in the decomposition chamber help break down organic matter into inorganic nutrients.
- Abiotic factors such as soil and air serve as nutrients for biotic factors.
- Several food chains were observed such as light to plants to protists to fish to decomposers.
- Net primary productivity is not high enough to maintain a complex, viable ecosystem.
- The fish die when the dissolved O₂ level falls below 5ppm.
- Real ecosystems are more complex and thus more resilient than the "artificial" eco-column.
- A limiting factor for the fish was the amount of DO₂ in the water.
- High levels of nitrates in the water led to eutrophication.
- Low pH levels will affect the viability of the eco-column.