Experiment Overview

We conducted three experiments for our research project.

Experiment 1:	"Oxygen Study" investigated the properties of oxygen.
Experiment 2:	"Aquatic Plant Photosynthesis Study" demonstrated that aquatic plants produce oxygen.
Experiment 3:	"Dead Zone Study" we invested how regions of water with very low dissolved oxygen are formed.
~~Experiment 4:~~	~~We had planned to do a DNA extraction experiment but ran out of time.~~

From these experiments, we learned more about how aquatic plants produce dissolved oxygen. This dissolved oxygen is important for animals to live. While marine mammals and sea birds breathe air from that atmosphere, many aquatic animals use dissolved oxygen for respiration. Respiration is the process by which animals convert oxygen and food into carbon dioxide, water, and the energy they need to move and stay warm. Sometimes dissolved oxygen is consumed more rapidly than it is produced. When this happens, a dead zone is formed in the ocean or estuary. The ecosystem of a dead zone is fine for jelly fish and worms, but not good for fish, crabs, and many other animals who move away or die.

Experiment Title: “Oxygen Study”

Purpose: To investigate the properties of oxygen.

Background/Literature:
Many science books tell us that oxygen reacts with metals to form rust or oxidation at the surface and that fire needs oxygen to burn. Oxygen reacts quickly and readily with other substances.

Oxygen is important to animals because they need it to metabolize food. According to the dictionary, ‘respiration’ is the oxidative process occurring within living cells by which the chemical energy of organic molecules is released in a series of metabolic steps involving the consumption of oxygen and the liberation of carbon dioxide and water. All animals use respiration to live, and all animals require oxygen for that. Some animals have lungs to breath, and oxygen is transferred to blood in the lungs. The blood is pumped around to the cells by the heart. Some animals, like insects, get oxygen to their cells through a series of air-filled tubes called tracheae. Aquatic animals take in dissolved oxygen through gills.

Procedure:

To show that fire needs oxygen to burn, we put a clear cover over a small, burning votive candle. Within less than a minute, the flame had consumed so much of the oxygen that the fire went out.

To observe oxidation or rust of metal, we looked at different metal surfaces of aluminum, steel, and silver. We could see the discoloration and sometimes feel the texture differences where there was rusting or oxidation.

Conclusions:

We have been able to observe chemical reactions that involve oxygen in the metals around us and in fire.

Experiment Title: “Aquatic Plant Photosynthesis Study”

Purpose: To study about photosynthesis of aquatic plants.

Background/Literature:
This experiment plan is written in ‘Science Nature Guides: Oceans and Rivers’ by Dr. Frances Dipper and published by Thunder Bay Press, 1996.

Plants get energy to live from the Sun. During photosynthesis, plants use carbon dioxide gas (CO2) and gives off oxygen gas (O2). Some of the oxygen made by water plants becomes dissolved in the water which is breathed by animal though their body surfaces or gills. Some of the oxygen comes out of solution. It forms bubbles that eventually rise to the surface and are released into the air.

Procedure:

Create an aquatic ecosystem with a way to collect gas released. We carefully put a test tub over the end of a glass funnel and rested it on the bottom of a bowl of water. We did this for two test tube and glass funnel sets. Under one funnel, we placed an aquarium plant. Under the other funnel we placed a plastic aquarium plant for a control. We observed the gas collected in the test tubes. This procedure is the same as the one in Dr. Dipper’s book, except that we added having a control of a plastic plant.

Results:
Over two weeks we watched the gas collecting in the tubes. There was a small bubble above the plastic control plant because its plastic leaves formed nucleation sites and dissolved gases came out of solution and formed bubbles. When these bubble got big enough they broke away from the plastic plant and rose to the top of the tube. After about a week, there were no more bubbles on the plastic plant.

There was a much bigger gas bubble above the live aquatic plant. Its leaves also formed nucleation sites and dissolved gases in the water came out of solution. But after a week, there was still gas collecting above the aquatic plant. This gas is probably the oxygen being produced by the plant through photosynthesis.

Conclusions:

Just like green plants around us, aquatic plants use photosynthesis to produce energy, oxygen and food. The plants do not consume the oxygen and it is released. Some oxygen is released into the atmosphere.

Experiment Title: "Dead Zone Study"

Purpose: To study how dead zones form.

Background/Literature:
We researched in books to find out what dead zones are and why they form.

A dead zone is a region of hypoxic water. Hypoxic water is water that has less than 2.2 mg per liter of dissolved oxygen. While not called a dead zone, a region of reduced oxygen at 5 mg per liter is still dangerous for many species of fish and animals.

Too much fertilizer in the ocean causes rapid algae growth. The abundance of plant life is not consumed by animals and dies. Overgrowth of the algae and plankton at the surface prevents sunlight from reaching oxygen producing plants lower in the water. The dead plants and algae fall to the ocean floor and decompose. Bacteria use oxygen at the ocean floor to decompose the plants. The oxygen isn't replenished at the rate it is consumed, and is soon depleted and not available to other animals that need dissolved oxygen in the water to breath.

Oxygen added to water comes from wind driven waves, mixing waters, and plants. Global climate impacts the wind and fresh water mixing. Pollution can kill plants and animals and or reduce the light plants receive. The ecosystem all plays a role in maintaining the oxygen levels of the water. All these factors cause a dead zone to form.

Procedure:

Create 4 environments of water ecosystems. Each ecosystem has:

- 2 snails
- 1 banana plant and 1 spiral plant
- 1 nutrient tablet Seachem™ Flourish Tabs™
- Aquarium gravel
- Fresh tap water

Ecosystem	Variables
Normal/Control	Control
Oil Slick Light	Covered with bucket that modeled light through an oil slick
Algae Bloom Light	Covered with a green translucent plastic bucket it to limit light similar to an algae bloom above
Four Times Fertilizer Amount	3 extra nutrient tablets – 4 times the recommended amount of nitrogen

We started on October 17. On November 10, we took water sample to be tested for dissolved oxygen and nitrate concentrations [after 25 days]. We analyzed the differences between the ecosystems after 25 days. On November 15, we took pictures through a digital microscope of the plants and animals.

Experiment Results:

Table 1: Before and After Photos

Ecosystem	October 17	November 15
Normal/ Control		
Oil Slick Light		
Algae Bloom Light		
Four Times Fertilizer Amount		

Table 2: Dissolved Oxygen in water collected November 10. ***Thank you to ChemServe of Milford [Jay Crystal] for doing the DO measurements*****.**

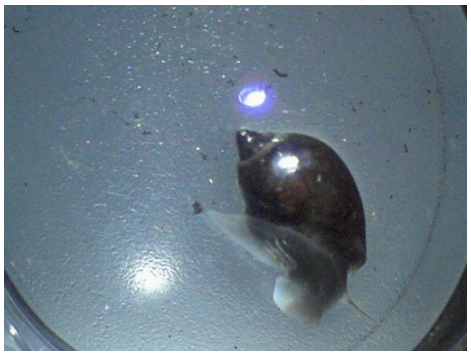
Ecosystem	Measured Dissolved Oxygen
Normal/Control	8.38 mg/L
Oil Slick Light	8.06 mg/L
Algae Bloom Light	7.62 mg/L
Four Times Fertilizer Amount	6.82 mg/L

Table 3: Visual Observations on November 15.

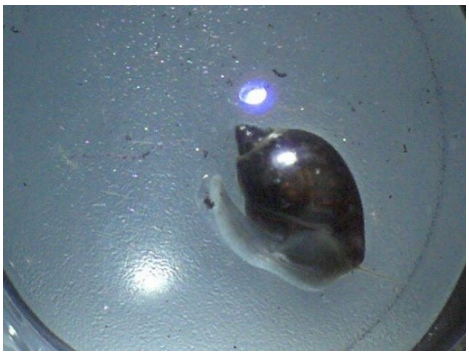
Ecosystem	Description
Normal/Control	The normal ecosystem smelled ok. The plants looked healthy although there were dead leaves. Both snails were still alive. There was about a tablespoon of fertilizer tablet and dead stuff at the bottom in the gravel.
Oil Slick Light	The stems of the banana plant leaves were growing everywhere and popped out. We think they were trying to find sunlight. The banana plant leaves weren't as green or dark green; they were more pale green, orange, and brownish. Most of the spiral plant died. One of the snails died. The water smelled rotten.
Algae Bloom Light	The water was very clear. The plants were alive but leaves were browner. The snails were alive and healthy looking. The water was stinky smelling like cereal.
Four Times Fertilizer Amount	The water looked murky and brownish red. It smelled very bad. The plants looked unhealthy. There was more dead stuff and fertilizer tablet at the bottom in the gravel. There appeared to be more plant growth in the water from the fertilizer. There were snail eggs on the side. The snails looked very healthy.

Snail Health Observations

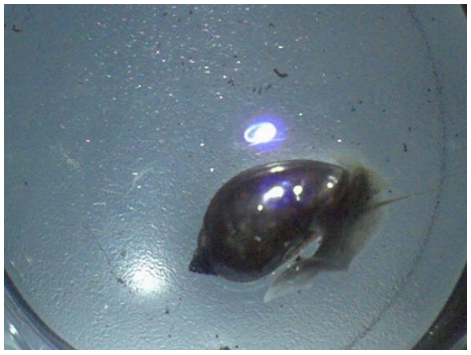
There were healthy snails in each ecosystem.



10x Snail Upside-Down Emerges

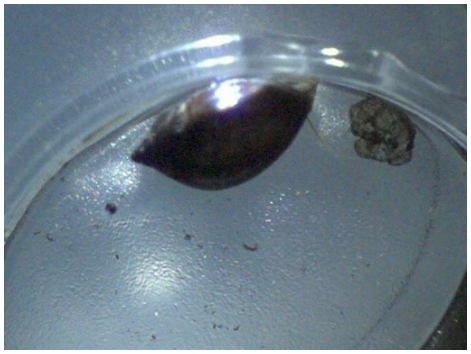


10x Using Foot For Orientation

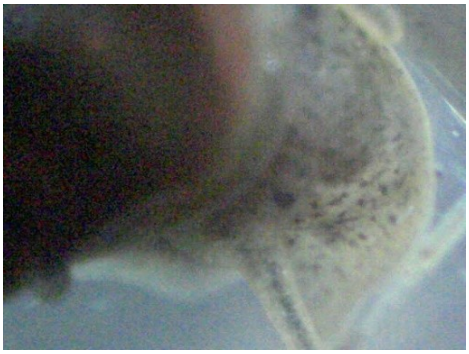


10x Flipping Over

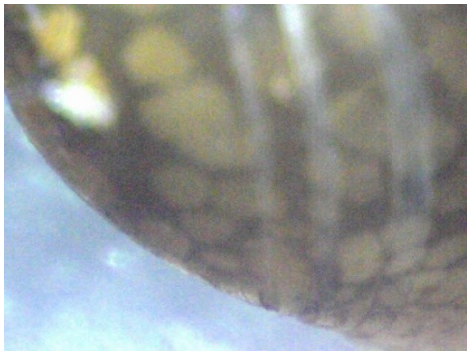
10x Crawling On Floor



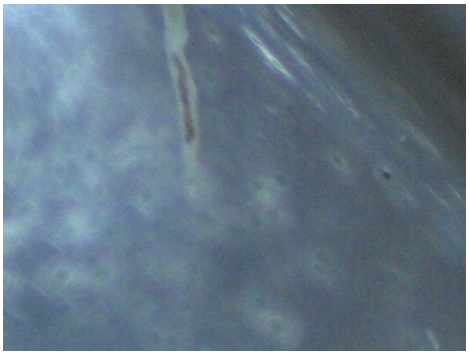
10x Crawling Toward Egg Bunch #1



60x Head Showing Eye

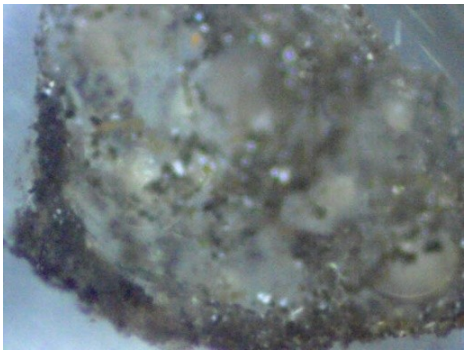


60x Shell

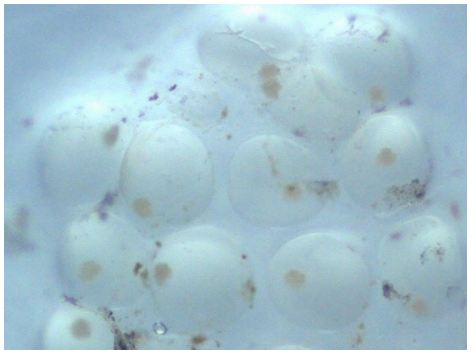


60x Parasite That Left The Snail

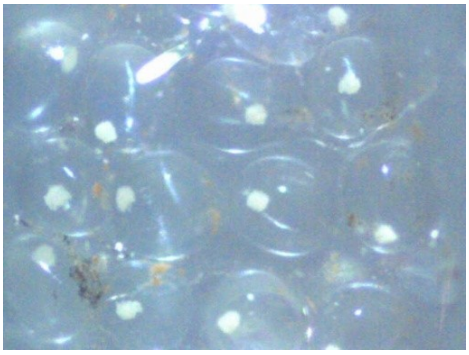
10x Snail Eggs From The Algae Bloom Lighting Ecosystem



60x Parasite Leaving Snail (Note microbe in upper right corner)



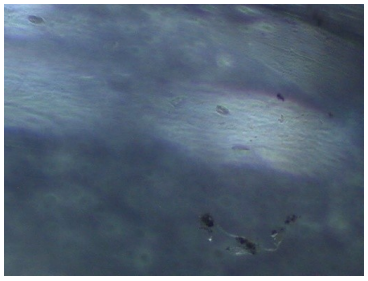
60x Snail Eggs From The 4x Fertilizer Nutrient Rich Ecosystem (Backlit)

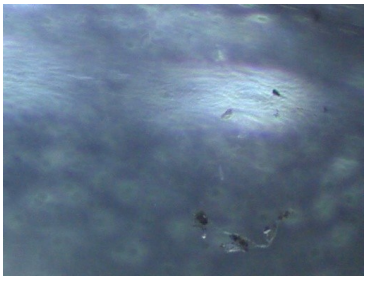


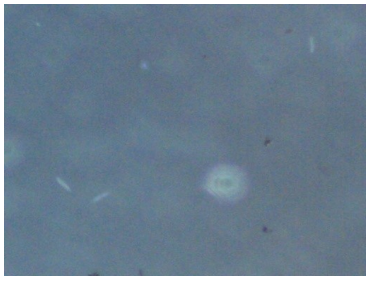
60x Snail Eggs From The 4x Fertilizer Nutrient Rich Ecosystem (Toplit)

Microbe Observations

There were microbes in each ecosystem. Here are some pictures at 60x. There were different sizes and shapes. Some were circular and flat. Others were long and tubular.

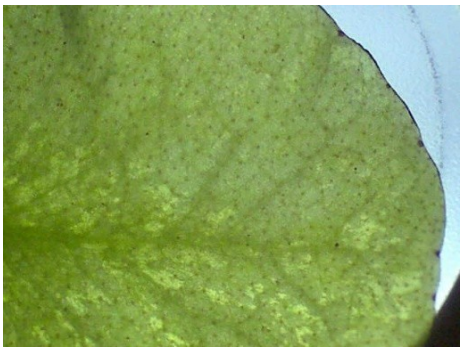






Plant Observations

Here are some pictures of the leaves of the banana plants at 10x. There was only one banana plant leaf for the Green Algae Lighting system and it was curled, new, and pale. The leaves in the oil slick lighting were very pale and brownish. The normal and 4x fertilizer ecosystem banana plant leaves were quite similar in color, shape, size, and texture.



Ecosystem: Normal/Control

Ecosystem: 4x Fertilizer

Ecosystem: Green Algae Lighting

Ecosystem: Oil Slick Lighting

The Banana Plants, November 17

Table 4: Measurements of Plant Life

	Normal/ Control	Oil Slick Light	Algae Bloom Light	Four Times Fertilizer Amount
Number of Live Spiral Plant Stems (Nov 17)	6	1	1	2
Number of Dead Spiral Plant Stems (Nov 17)	1	6	6	5
Number of Banana Plant Leaves (Nov 17)	5	4	1	4
Lengths of Stem/Leaves in inches (Nov 17)	3, 3.5, 4, 4, 2	4.25, 9.75, 5, 5	3	4, 4.5, 4, 6.5
Average Banana Plant Stem/Leaf Length	3.3 inches	6 inches	3 inches	4.75 inches

Conclusions:

We investigated the factors that cause a dead zone to form. The factors that cause a dead zone to form are:

1) Increased oxygen consumption by the bacteria responsible for decomposing dead material.
2) Decreased oxygen production due to plants dying.
3) Decreased oxygen production due to plants not receiving enough sunlight.
4) Decreased amounts of oxygen introduced into the system by wind and water mixing.

We were able to show that when too much fertilizer is added to an aquatic system, the oxygen levels go down. We were able to show that when aquatic systems receive less sunlight, the dissolved oxygen level is lower.

Our observations of two different plant species, the spiral grass and the banana plant, show that changes in the ecosystem affect different plant species in different ways. The spiral grass was extremely sensitive to changes in lighting. When there was only green lighting, the banana plant almost completely died. When there was reduced lighting, the banana plant tried to find light for its leaves by growing long winding stems.

The Gulf of Mexico must smell really bad if dead zones smell really bad and the Gulf has a dead zone!