South Florida Science Museum
Everglades Lab- Water Quality Program Curriculum

PROGRAM DESCRIPTION

The Everglades or "River of Grass" is a unique ecosystem unlike any other in the world. Forming around 17,000 years ago, the Everglades have sustained a variety of wildlife and native life for just as long. Until recently the Everglades have been an untouched pristine ecosystem in Florida. Sugarcane farms and other agricultural endeavors in addition to draining in some areas have had detrimental effects that are threatening the very existence of this unique ecosystem. Farming in surrounding areas has led to serious water quality issues as well. The quality of the water is a key factor for the health of native fauna and flora that flourish in this area. In this lab, students will test different water samples using the same techniques scientists utilize in the field. Students will be presented with water polluted with fertilizers, oil, dirt and other forms of debris which they will then have to clean and filter as best as possible.

SUNSHINE STATE STANDARDS

Grades 3-5:

SC.3.N.1.1: Raise questions about the natural world, investigate them individually and in teams through free exploration and systematic investigations, and generate appropriate explanations based on those explorations.
SC.4.E.6.3: Recognize that humans need resources found on Earth and that these are either renewable or nonrenewable.
SC.4.E.6.6: Identify resources available in Florida (water, phosphate, oil, limestone, silicon, wind, and solar energy).
SC.4.L.16.2: Explain that although characteristics of plants and animals are inherited, some characteristics can be affected by the environment.
SC.4.L.17.4: Recognize ways plants and animals, including humans, can impact the environment.
SC.5.L.15.1: Describe how, when the environment changes, differences between individuals allow some plants and animals to survive and reproduce while others die or move to new locations.

Grades 6-8:

SC.6.E.7.7: Investigate how natural disasters have affected human life in Florida.
SC.7.E.6.6: Identify the impact that humans have had on Earth, such as deforestation, urbanization, desertification, erosion, air and water quality, changing the flow of water.

Grades 9-12:

SC.912.L.17.11: Evaluate the costs and benefits of renewable and nonrenewable resources, such as water, energy, fossil fuels, wildlife, and forests.
SC.912.L.17.19: Describe how different natural resources are produced and how their rates of use and renewal limit availability.
SC.912.L.17.16: Discuss the large-scale environmental impacts resulting from human activity, including waste spills, oil spills, runoff, greenhouse gases, ozone depletion, and surface and groundwater pollution.

SC.912.L.17.17: Assess the effectiveness of innovative methods of protecting the environment.
SC.912.L.17.18: Describe how human population size and resource use relate to environmental quality.
SC.912.L.17.20: Predict the impact of individuals on environmental systems and examine how human lifestyles affect sustainability.
SC.912.L.18.12: Discuss the special properties of water that contribute to Earth's suitability as an environment for life: cohesive behavior, ability to moderate temperature, expansion upon freezing, and versatility as a solvent.
SC.912.N.4.2: Weigh the merits of alternative strategies for solving a specific societal problem by comparing a number of different costs and benefits, such as human, economic, and environmental.

MATERIALS
Students will be working in groups of 4…
- 10 Coffee Filters per group
-1 Cheese Cloth per group
-1 Metal Screen Filter per group

-2 50 mL Test Tubes per group
    -1 with water and fertilizer
    -1 with dirt, oil, iron filings to represent heavy metals
-1 Small Colored Test Tube per group
-Nalgene Container with DI Water
-2 Jars per group

-Phosfree
-Enviro-bond
-Oil
-Phosphate Testing Strips
-Nitrate Testing Strips
-pH Testing Strips
-Potting Soil
-Salt
-Salinity Refractometer
-Plastic Spoons
-Iron Filings

VOCABULARY
Pollutant: The introduction of a contaminant into the environment that causes instability, harm or disorder to the surrounding ecosystem.
Nitrates: Nitrates (NO_3) in water systems can cause oxygen depletion and lead to eutrofication. The major routes of entry are from municipal and industrial wastewater, septic tanks, feed lot discharges, animal wastes (including birds and fish) and discharge from car exhaust.

Phosphates: The overall cause of excess phosphates in the Everglades is due to the agricultural farmland around it. Runoff water from agricultural sites are enriched with phosphates which in turn, flows through the Everglades. Nutrient-rich waters can actually help the aquatic life but too much is detrimental to its survival.
Chlorine: A very effective way of killing bacteria. Chlorine is used in the Everglades to combat fecal coliforms that are found on the surface. Chlorine is also found in tap water to clean bacteria.
Fecal Coliforms: Fecal Coliform bacteria are relatively harmless microorganisms that live in large numbers in the intestines of humans and warm-blooded animals. These microorganisms help with the digestion of food. A well known kind of coliform is Escherichia coli or E. coli. These coliforms are only associated with the fecal material of warm-blooded animals. The presence of this in the water supply indicates that the water has been contaminated with the fecal material of man or other animals.
pH: The measure of how acidic or basic a solution is.
Salinity: The amount of salt in a solution.
Agricultural runoff: The water that runs off from the farmland and seeps into other bodies of water or soil.

SCRIPT
Good morning/afternoon everyone. My name is _____ and I am from the South Florida Science Museum. I am here today to talk to you all about pollution in the Everglades. We will first talk about different contaminants in the water and then towards the end I will give you water that you will dirty up with different pollutants like oil, fertilizer, dirt and some others and you will have to try your best to clean it up. We will be testing for different things like phosphate/nitrate levels with equipment that scientists use in the field. How clean will you get your water? It is harder than you might think. To start I have a power-point that I would like to show you that better explains what pollutants are, where they come from, and how they enter the water table.

***Slide 1*: Everglades Lab, an Investigation on Polluted Waters.**
-Show the first slide and explain that the pictures are of the Everglades or River of Grass.

***Slide 2:* What is Pollution?**
-Ask the students what they think pollution is…When they are done giving their answers…
-Pollution is any sort of contaminant that causes harm or instability to an ecosystem. Generally this means that if that chemical or contaminant is not supposed to be there, it is a pollutant. There are many different types of pollution including but not limited to air, water and soil pollution. When we release something into the atmosphere we are polluting the air. When we release something into the water, we are polluting that source and when we dump or bury things in the dirt we pollute that area as well. For this lab we are not going to talk about pollution in the air or dirt. We are just focusing on water.

***Slide 3:* Where Does It All Come From?**

-Water pollution comes from many different sources. Can you think of any off the top of your head? (*Get answers from class before continuing*.) Much of the pollution that is present in water comes from our homes. We never really think too much about pouring things down the drain but things like shampoos, soaps, medicines, bleach, laundry detergents all pollute our waters. Other major sources for pollution (especially in the Everglades) occur when agricultural runoff enters canals and eventually dumps into the Everglades water system. The water from agricultural farmland is rich in nutrients like phosphates and nitrates which might sound like it would be helpful. This however is not the case since the native flora or plant life from the Everglades survives naturally with little nutrients.

Slide 4: **Everglades Pollution**

-The nutrient enriched water entering the Everglades has posed a problem for the native plant and animal life for the past few decades. These waters are a haven for species such as cattails which are not native to the Everglades. These plants, as well as others, are now taking over at an alarming rate; so much so that the state of Florida is now embarking on a $1.3 billion mission to clean up the unique river of grass. The plan is that the state would buy some farmland; some of this land would be converted into reservoirs which would filter pollutants from the water before it even enters the Everglades system. Not everyone is happy about this, however, and this plan has caused many legal battles between the Federal government, state government, farmers and environmentalists.

Slide 5: **Everglades Pollution**

-And if it isn't bad enough, there are other forms of pollution that are threatening the Everglades. Toxic levels of mercury have been found all the way from the Arthur R. Marshall Loxahatchee National Park in northern Palm Beach County all the way down to the Everglades National Park in Dade County. The problem with mercury is that it is known to do something called bioaccumulation. This means that the levels grow when moving up the food chain. For instance, if tiny fish have high levels of mercury and a larger animal eats nothing but these fish, the predator will accumulate these levels of mercury in their system. Then if a larger animal eats the previous he will have even larger numbers and so on. Mercury is so toxic that wildlife officials are urging people not to eat fish that have been caught in the Everglades for fear that people would get sick. Think about where we are in the food chain and how much mercury we would be ingesting. This has actually happened before in a town called Minamata, Japan about fifty years ago.

Slide 6: **Minamata Disaster**

-The Minamata Disaster is a well known example of how toxic levels of mercury affect life in the surrounding areas. Fifty years ago, Minamata was a small fishing community in Southwest Japan. A chemical factory owned by the Chisso Corporation was built in 1908 to initially produce fertilizers but then branched out in later years to produce a myriad of other harmful chemicals like acetylene, acetaldehyde, acetic acid and vinyl chloride among others. This factory quickly became one of the most advanced in all of Japan. But with all of their advancements, no one thought twice about dumping the

chemicals and their waste products into the Minamata Bay. Obvious to us now but not back then, these chemicals had a huge negative impact on the environment. Many of the fisheries and fishermen began noticing a reduction in the number of fish that were being caught. The Chisso factories must have had an inkling that they may be the cause because in 1926 and again in 1943 compensation agreements with these fisheries had been reached.

-The factory started its production of acetaldehyde in 1932 and by 1951 production of this chemical had jumped to about 600 tons per year which at the time was over 50% of Japan's total output for this chemical. To make this chemical, a chemical reaction utilizing mercury sulfate as a catalyst was needed. Because of this reaction, small amounts of organic mercury called methyl mercury was produced and dumped into the waters of the bay as industrial waste. Over the many years, this compound was released unchecked until people living in the areas started noticing strange things.

Slide 7: **Minamata Disaster**

Being a fishing community; much of the food eaten in and around this area came from the bay. People began noticing strange behavior from cats. People saw them convulsing, seizing, and dying. Crows were seen falling from the sky and fish were laying dead on the surface of the water. Soon this strange behavior was being seen in humans as well. When tests were done to check levels of mercury in humans, those affected had levels of 700 ppm or higher. People living outside this community had levels of about 4ppm. These people were ingesting extremely high levels of toxic mercury. The disease crippled and eventually killed over 1,700 people. This happened about fifty years ago but as of March 2001, there were still about 500 people still living with this crippling disorder. All of this was caused by a chemical factory that didn't care about the industrial waste was dumping into the bay.

Slide 8: **Water Testing**

-As you have probably already figured out, testing different water sources is of up most importance in order for this to never happen again. You can tell a factory they aren't allowed to dump their waster into the waters surrounding their factory but do you think they always listen? Furthermore do you think people can police a factory 24 hours a day to make sure they aren't doing anything illegal? No. This is where water testing comes into play. The Minamata Disaster is an extreme example of how waters can become polluted but there are other sources of pollution that need to be checked regularly. Some things that are tested for in water include phosphate and nitrate (fertilizer) levels, pH, greases like oil or gasoline, metals and many others. In a few minutes we will be testing some water samples for these types of pollutants.

Slide 9: **Lab Time**

-Now it is time for you to be the environmental scientists and test water that I give you or water that you have brought from home or school for such things like fertilizers, pH and alkalinity.

At this time pass out jars with clean water and pass out an orange 50mL test tube with water that contains fertilizers. Have the students pour the fertilizer water into their

jar of clean water. Explain to them that this is representing agricultural runoff from farms. Have the students test the water samples by giving them the appropriate testing strips. The phosphate test takes about 3 minutes and the nitrate test takes about a minute. Have the students test their water and when done ask them if there are pollutants in their water.

-Now that we have testing the water for fertilizers and pH levels I have another test tube that I am going to give you that will represent water from street runoff. What types of pollutants do you think will be present in this water? (oil, metals, gas, debris, dirt, etc)

At this time pass out the other 50mL test tube with the simulated street runoff water. This water contains oil, dirt, and iron filings. Have the students pour this mixture into their jar that contains their already polluted water.

-Now it is time for the fun part. As you can all see, your jar is really dirty, you all know that there are fertilizers present and now there are even more things like oil, dirt, debris like sticks and metal in your jar. This is a problem that many scientists face. HOW DO WE CLEAN THIS? I have a few materials here that I am going to give you and you need to find the best way to remove these pollutants. To remove the oil we have a special polymer called Envirobond. This polymer soaks up oil but leaves the water behind. Very ingenious! We also have many different types of filtration methods that will filter out more of the pollutants and chemicals that can neutralize the fertilizers. I am going to leave it up to you to decide what you think the best way to remove these things from the water. I would suggest however that you remove the oil first with the Envirobond polymer. After that it is up to you. At the end of the lab we are going to see which group did the best job at cleaning their water.

Let the students experiment to see which way is best to clean their water. They can use any or all of the materials included in this lab.

-Good job class, now that you have cleaned the water do you notice any differences? *The water should be clear blue now instead of murky and dark.* Now that you have cleaned the water of oils and debris it is time to try and neutralize the fertilizer chemicals.

Pass out the phos-free

-Now with the test tube I just gave you add and mix it into your water.

-Pass out another set of testing strips to the students and ask them to test the water again for those chemicals. Give them about 5 minutes to complete this part of the lab.

-Did everyone notice a change in the amount of fertilizer in the water? The chemical we just added is the same thing people use in their pools to combat algae (which is caused by and excess amount of phosphorus.) The water you have in front of you isn't necessarily totally clean and ok to drink but do you all see that you were able to clean it up?

-These are some of the questions and problems that scientists have to deal with on a daily basis. How do we clean the water…Much of the time chemicals cannot be added to water sources because that poses another problem. We used this chemical to clean this pollutant but now there is this chemical in the water…How are we going to clean that up? Adding chemicals to the water is not always the answer. It can help solve some problems but may pose other risks to the environment and to people.

-The purpose of this lab was to show you all some of the steps that are required when trying to test and clean water samples and although we added some chemicals to the water, do you all see that it is noticeably cleaner? You all did a great job and I hope you had a lot of fun with this lab and as you now know, cleaning water is not as easy as you may have once thought.

*Here's something to do as a class.

-I am going to give you a fecal coliform test to test water that is around your school. Choose wisely as you can only choose from one source.

1. Collect water sample to be tested in small vial
2. With dropper, measure 1 cc of water (40 drops/cc)
3. Carefully remove cap of lactose broth tube and add water
4. Keep tube in upright position and in a warm area for 24 hours.
5. If after 24 hours the broth is still purple, coliforms are not present. If after 24 hours the broth is green or yellow, then coliforms are present and this would indicate that waste from the intestinal tract has been emptied in the water source.

*If the test is negative, it does not mean that the water is safe, because there are other tests which have not been done.