Mounts Botanical Garden
of Palm Beach County

Teacher Guide

Ambassadors of the Wetlands

Grade 10

The goal of the Ambassador of the Wetlands program is to introduce high school students to the Everglades ecosystem and the critical role that water plays in the overall health and well being of all who live here. Through hands on activities in the classroom and visits to real wetlands ecosystems, students will see first hand the work that is being done to preserve the health of the Everglades. Through education, we can all do our part to ensure that this unique ecosystem found nowhere else on earth will be here for future generations.

This packet includes activities and information that will be helpful in preparing your students for their classroom visits, their time at Mounts Botanical Garden and their Everglades experience.

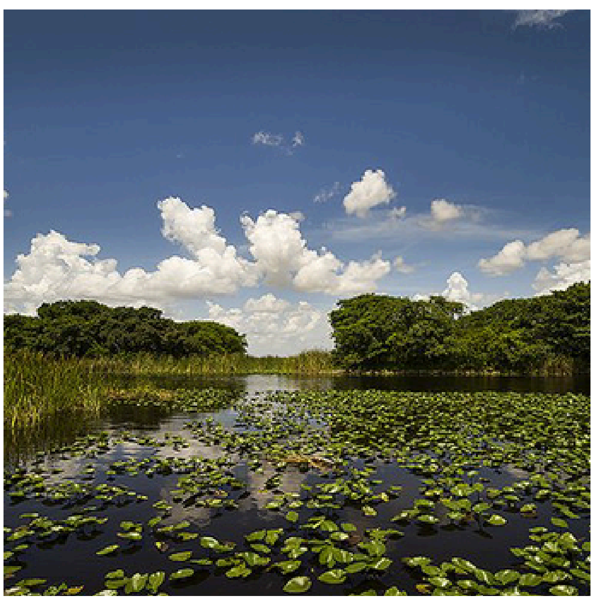
The Ambassador of the Wetlands program is made possible through funding from the Community Foundation of Palm Beach and Martin Counties, representing the John D. and Catherine T. MacArthur fund. It is designed to in-spire civic responsibility and a sense of stewardship over our natural resources.

In South Florida, when we talk about natural resources it all comes down to

WATER....

Everglades Wetlands

The wetlands of the Florida Everglades cover most of southern Florida, starting near Lake Okeechobee reaching all the way to the Florida Bay on the southernmost coast. Also known as the "River of Grass," the wetlands of the Florida Everglades are a very slow moving shallow river dominated by sawgrass marsh. In its southward course, the water passes through diverse habitats including cypress swamps, wet prairie, and mangroves.



The water that flows through the Everglades ecosystem provides critical resources to people. It improves water quality by filtering out pollutants and absorbing excess nutrients, replenishing our aquifers, and reducing flooding.

In order to be classified as a wetland, an area must have two main characteristics:

1. Poorly drained soils, also known as **hydric soils.**
2. Be home to a unique diversity of wildlife and vegetation specifically adapted to thrive in wet environments.

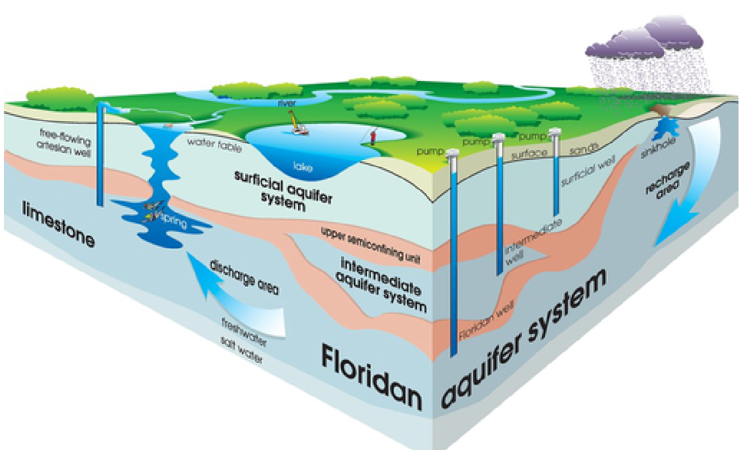
Why are Wetlands Important?

FLOOD CONTROL

South Florida is one of the wettest areas in the country, typically averaging about 4.5 feet of rainfall each year, most of it falling in less than a four month span in late summer. Without the wetlands, South Florida would experience flooding during heavy periods of rain and water shortages during the drier seasons. Wetlands act as a water regulator, holding water and distributing it slowly over a period of time.

CLEANING THE WATER

Without wetlands, water would flood areas during heavy rainfall and cause water to become stagnant or runoff into low lying areas or lakes and canals. This water would carry with it any pollutants and sediments it comes across. By slowing down the flow of water and discharging it over a period of time, wetlands act as a filter, allowing nutrient eating plants to remove excess nutrients and giving time for the suspended sediments and associated pollutants to settle out.



RECHARGING OUR AQUIFERS

Underground aquifers supply South Florida with 90% of its drinking water. Wetlands slow down the movement and distribution of water, giving it time to trickle through the limestone to recharge our aquifers. The Biscayne Aquifer, which is recharged primarily by the Florida Everglades, is one of the most productive aquifers in the world.

HABITATS

The wetlands also provide critical habitats to thousands of species including dozens of plant and animal species that are threatened or endangered.

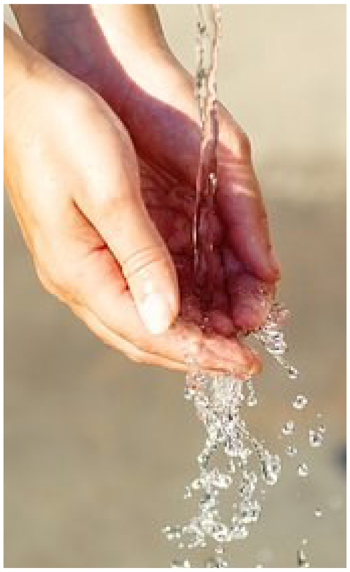
Over the past 100 years, humans have altered the Everglades ecosystem's delicate balance. Canals were dug to divert water from the wetlands to the ocean in order to dry up areas for urban development and farming. This left unfavorable environments for plants and animals specially adapted for the wetland's nutrient and mineral poor environments. Since the Everglades is a naturally low-nutrient system, small amounts of additional nutrients can upset the ecological balance. Fertilizer runoff from highly populated urban areas and farms continually deposited agricultural chemicals high in nutrients, such as phosphorus and nitrogen, into the low nutrient ecosystem where the native plants and animals were unable to adapt.

As the wetlands deteriorated:

- 68 plant and animal species became threatened or endangered.
- The number of breeding wading birds dropped by 90%.
- Seagrasses in Florida Bay died off.
- Fish species began to decline.

Something had to be done because the Everglades ecosystem was in danger of reaching an alternative stable state.

C.E.R.P.



By the 1980s scientists, environmentalists and the National Park Service realized the health of the Everglades was declining rapidly and that something needed to be done to correct the problems.

Historically, over 450 billion gallons of water per year flowed southward into Everglades National Park across what is now the Tamiami Trail. By the year 2000, the amount of water flowing southward had been cut nearly in half, and only 260 billion gallons were now flowing along this path.

THE SOLUTION?

C.E.R.P.: The Comprehensive Everglades Restoration Plan. It was enacted by the U.S. Congress in 2000 for the restoration of the Everglades Ecosystem in southern Florida. It is the result of 10 years of planning by scientists, policy makers and public stakeholders and uses the best possible science to restore the flow of freshwater to the natural system. At a cost of 10.5 billion dollars and a 35+ year timeline, it is the largest environmental restoration project ever undertaken in the U.S.

THE GOAL?

Not just supplying more water to the ecosystem, but getting the water right!

Q Q T D

The solutions to Everglades Restoration can be framed by four interrelated factors: **QUANTITY, QUALITY, TIMING, and DISTRIBUTION (QQTD).**

The principal goal of restoration is to deliver the right amount of water, of the right quality, to the right places, and at the right time. The comprehensive plan consists of over 60 components that work together to accomplish these hydrologic improvements.

QUANTITY

According to US Geological Survey; on average, 1.7 BILLION gallons of water that once flowed through the ecosystem are wasted each day through discharges to the ocean or gulf. C.E.R.P. plans are to capture this water and store it in new reservoirs and treatment areas to be released when needed. Of the water captured by the plan, 80% will go to the environment and 20% will be used to enhance urban and agricultural water supplies.

QUALITY

Excess phosphorous, mercury, and other contaminants harm the region's surface and ground water. The Plan will greatly improve the quality of water being released into the Everglades by first directing the water to storage reservoirs and Stormwater Treatment Areas (STAs). STAs are also called constructed wetlands and over 45,000 acres of them are removing excess nutrients and cleaning the water through green technology; using plants that absorb excess nutrients in the water and store them in their leaves or in the soil.

TIMING

Alternating periods of flooding and drying, called hydroperiods, are natural and vital to the historical functioning of the Everglades Ecosystem. The timing of water held in reservoirs and released into the ecosystem now more closely matches natural patterns to mimic natural rainfall patterns and is reducing damage done by too much or too little fresh water in areas where the proper water levels are vital to the health and well being of nesting birds, plants animals and shoreline erosion.

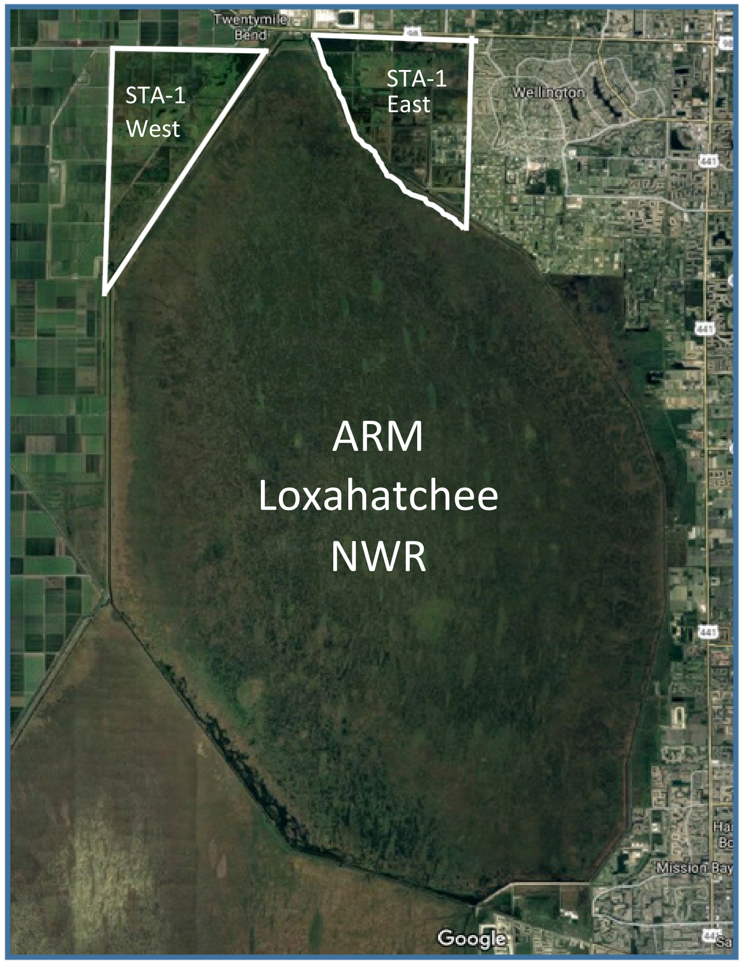
DISTRIBUTION

The movement of water is the final factor in the Plan's equation. Over 50% of the original Everglades have been lost to urban and agricultural development. The remainder has been separated by roads, canals, and levees. The Plan will remove more than 240 miles of levees and canals to improve the connectivity of natural areas and to enhance sheetflow.

We will be visiting the Arthur R. Marshall Loxahatchee National Wild Refuge on our field trip. There is a special area you will see that is an integral part of the future of Everglades Conservation. LILA stands for Loxahatchee Impoundment Landscape Assessment. It is a working, 80-acre model of the Everglades ecosystem. This living laboratory gives scientists opportunities to apply restoration techniques on a small, controlled scale before implementation in the 1.7 million acre Everglades ecosystem.

STA's and ARM Loxahatchee NWR

Arthur R. Marshall Loxahatchee National Wildlife Refuge (ARM Loxahatchee NWR) is the only remnant of the northern Everglades in Palm Beach County and is home to 220 square miles of Everglades habitat. Northwest of the Refuge is the Everglades Agricultural Area, which consists of 700,000 acres of farmland. Over the past 20 years, Florida has invested 1.8 billion dollars in phosphorous control programs resulting in 57,000 acres of Stormwater Treatment Areas (STA's).

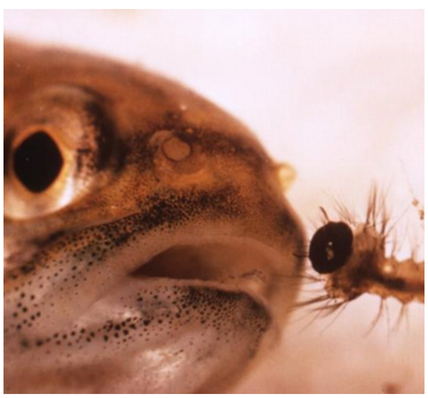


These constructed wetlands use native and non-native phosphorous eating plants to filter out excess nutrients, resulting in the removal of nearly 5,400 metric tons of phosphorous in water flowing to the Everglades. As you can see by the satellite map, two STA's are located just north of ARM Loxahatchee NWR. These constructed wetlands, totaling 11,500 acres, catch the southern flow of water coming from the agricultural areas to the north before they reach the refuge. The Agricultural community is working in conjunction with the highly managed STA's to help reduce phosphorous runoff into the Refuge. Farmers are successfully implementing Best Management Practices (BMP) on their farms which includes monitoring their individual farm discharge waters for flow volume and phosphorous concentrations. By the time the water is released into the refuge much of the excess nutrients will have been removed through green technology.

Testing the Waters

Every year, scientists and technicians make nearly 30,000 visits to water quality monitoring systems in the Everglades. They take water samples and test for nutrient levels to make sure they are meeting water quality standards. These tests are essential for keeping track of levels in real time, but they do not show whether the ecosystem itself has a healthy biodiversity and is sustaining a healthy population of native plants and animals, so this is not the only method used to determine water quality in the Everglades.

Scientists also use macroinvertebrates as an indicator of water quality in the wetlands. Benthic macroinvertebrates are organisms that live underwater and they can be found in virtually all water bodies. Scientists can collect these organisms and identify the different species present.



They can then be categorized using the **Pollution Tolerance Index.** Based on the number of macroinvertebrates present and where they occur on the Index, scientists can determine the health of the aquatic environment they live in.

High numbers of pollution sensitive organisms indicates that the water is of good quality and able to sustain a diverse population of plants and animals. On the other hand, if mostly pollution tolerant organisms are found, it is an indication that pollution is present and more sensitive organisms cannot survive in the current water conditions.

Things to check out!

- One of the major building blocks of the Everglades food chain is periphyton. Watch this CPALMS video about the importance of periphyton to the Everglades ecosystem. http://www.cpalms.org/Public/PreviewResourcePrespectiveVideo/
- Watch this CPALMS video about aquatic invertebrates in the Everglades. http://www.cpalms.org/Public/PreviewResourceUpload/Preview/130722

Fun Facts:

The Everglades is:

- Home to wildlife and habitats found nowhere else on Earth!
- 2X the size of the state of New Jersey!
- Home to 13 endangered and 10 threatened species!
- The largest designated wilderness in the eastern U.S.!
- The only place in the world where alligators and crocodiles co-exist!
- A World Heritage Site, a Biosphere Reserve, and a Wetland of International Significance!

Over 50% of threatened or endangered species in the U.S. rely on wetlands for their survival!

Currently, Stormwater Treatment Areas treat enough water each year to cover the island of Manhattan with 54 feet of water!

One out of every 3 Floridians (21 million people) relies on the Everglades for their water supply!!

Program Objectives

At the end of the Program, students will be able to:

1.) Define the following vocabulary words:

- Benthic Macroinvertebrates
- C.E.R.P.
- Periphyton
- Dichotomous Key
- Predaceous
- Pollution Tolerance Index
- Exoskeleton
- Biomonitoring

2.) Analyze the contents of water collected from the wetlands.

3.) Compare and contrast macroinvertebrates collected from Mounts wetlands and the Everglades.

4.) Identify causes of pollution in the Everglades and explain how STA's are being used to help remove excess nutrients in the watershed.

5.) Explain Q.Q.T.D. and how it relates to restoration in the Everglades.

6.) Explain the importance of collecting macroinvertebrates as a source for determining water quality in the wetlands environment.

7.) Differentiate between pollution tolerant and pollution intolerant on the Pollution Tolerance Index.

8.) Plan how to conserve water in and around your home and school.

Florida State Standards

English Language Arts:

Strand LAFS.910.SL:Standards for Speaking and Listening

Cluster 1: Comprehension and Collaboration

Cluster 2: Presentation of Knowledge and Ideas
1.1, 1.3, 2.4

Strand LAFS.910.L: Language Standards *Cluster 3: Vocabulary Acquisition and Use* 3.1, 3.6

Strand LAFS.910.RST: Reading Standards for Literacy in Science and Technical Subjects

Cluster 1: Key Ideas and Details

Cluster 2: Craft and Structure

Cluster 3: Integration of Knowledge and Ideas

1.3, 2.4, 2.5, 2.6, 3.7, 3.8, 3.9

Strand LAFS.910.WHST: Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects

Cluster 1: Text Types and Purposes

Cluster 2: Production and Distribution of Writing

Cluster 3: Research to Build and Present Knowledge

1.1, 2.4, 3.7, 3.9

Social Studies:

Strand SS.912.G: Geography

Standard 3: Understand the relationship between Earth's ecosystems and the populations that dwell within them.

Standard 5: Understand how human actions can impact the environment.

3.1, 3.2, 3.3, 3.4, 3.5, 5.1, 5.2, 5.6

Mathematics:

Domain-Subdomain MAFS.912.S-IC: Statistics and Probability: Making inferences and Justifying Conclusions

Cluster 1: Summarize, represent, and interpret data on a single count or measurable variable.
Cluster 2: Summarize, represent, and interpret data on two categorical and quantitative variables.
1.1, 2.3, 2.4, 2.6

Domain-Subdomain MAFS.912.S-MD: Statistics and Probability: Using Probability to Make Decisions

Cluster 1: Calculate expected values and use them to solve problems.
1.2, 1.4

Science:

Body of Knowledge SC.912.L: Life Science

Standard 14: Organization and Development of Living Organisms
Standard 15: Diversity and Evolution of Living Organisms
Standard 17: Interdependence

14.6, 15.1, 15.3, 15.7, 17.2, 17.3, 17.4, 17.6, 17.8, 17.12, 17.13, 17.14, 17.16, 17.17, 17.18, 17.20

Body of Knowledge SC.912.L.17 Nature of Science

Standard 1: The Practice of Science

Standard 4: Science and Society

1.1, 1.4, 1.6, 4.1, 4.2

Definitions
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Algae – Simple plants that can range from microscopic (microalgae) to large seaweeds (macroalgae). Microalgae include cyanobacteria, green, brown, and red algae. Macroalgae include giant kelp which grow over 100 feet in length.

Arthropod – an invertebrate animal having bilateral symmetry, segmented body, hard exoskeleton, jointed legs, many pairs of limbs.

Autotrophs – any organism capable of self-nourishment by using inorganic materials as a source of nutrients and using photosynthesis or chemosynthesis as a source of energy, as most plants and certain bacteria and protists.

Benthic – of, relating to, or occurring at the bottom of a body of water.

Bilateral Symmetry – a basic body plan in which the left and right side of the organism can be divided into approximate mirror images of each other.

Biogeochemical – dealing with the relationship between the geochemistry of a given region and its flora and fauna, including the circulation of such elements as carbon and nitrogen between the environment and the cells of living organisms.

Bioindicator – an organism whose status in an ecosystem is analyzed as an indication of the ecosystem's health.

Biomass – the amount of living matter in a given habitat, expressed either as the weight of organisms per unit area or as the volume of organisms per unit volume of habitat.

Biomonitoring (Biological Monitoring) - the use of organisms to assess changes in and health of the environment.

Best Management Practices (BMP) - practical, cost-effective actions that agricultural producers can take to conserve water and reduce the amount of pesticides, fertilizers, animal waste and other pollutants entering our water resources.

Carnivore – an animal, or plant, that feeds on other animals.

Consumer – an organism, usually an animal, that feeds on plants or other animals.

Copepod – any of numerous tiny marine or freshwater crustaceans of the order

Copepoda, lacking compound eyes or a carapace and usually having six pairs of limbs on the thorax, some abundant in plankton and others parasitic on fish.

Crustacean – an arthropod of the large, mainly aquatic group of crustacea, such as crab, lobster, shrimp, or barnacle.

Definitions
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Decapod – a crustacean in the order Decapoda, having five pairs of walking legs, including shrimp and crayfish.

Detritus – the organic debris formed from the decay of organisms.

Detritivore – an organism that uses organic waste as a food source.

Dichotomous Key – a key based on a series of choices between alternative characteristics used to help identify objects and organisms.

Ecosystem – a biological community of interacting organisms and their physical environment.

Eutrophication – excessive richness of nutrients in a lake or other body of water, frequently due to runoff from the land, which causes dense growth of plant life and death of animal life from lack of oxygen.

Exoskeleton – a hard, protective outer body covering of an animal, such as an insect or crustacean.

Geochemistry – the science dealing with the chemical changes in and the composition of the earth's crust.

Habitat – the natural home or environment of an animal, plant, or other organism.
Herbivore – an animal that feeds only on plants. In a food chain, herbivores are primary consumers.

Indicator Species – an organism whose presence, absence, or abundance, reflects a specific environmental condition.

Invertebrate – without a backbone.

Keystone Species – a species on which other species in an ecosystem largely depend, such that if it were removed, the ecosystem would change drastically.

Larva – the immature, wingless, feeding stage of an insect that undergoes complete metamorphosis. It differs greatly in appearance from its adult stage.

Lotic – inhabiting or situated in rapidly moving fresh water.

Macrophyte – a plant large enough to be seen with the naked eye.

Macro – large in scale, can be seen with the naked eye.

Definitions
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Marsh – an area of low-lying land that is flooded in wet seasons, and typically remains waterlogged at all times.

Micro – extremely small, usually unable to be seen with the naked eye.

Microphyte – a microscopic plant, too small to see with the naked eye.

Monotypic – having only one type or representative, especially (of a genus) containing only one species.

Oligotrophic – (of a lake) characterized by a low accumulation of dissolved nutrient salts, supporting but a sparse growth of algae and other organisms, and having high oxygen content owing to the low organic content.

Nymph – the immature form of an insect that does not pass through a pupal stage.

Nymphs usually resemble adults but are smaller and lack fully developed wings.

Omnivore – an animal that eats both plants and animals.

Opportunistic – (of a plant or animal) able to spread quickly in a previously unexploited habitat.

Organism – a living thing made up of one or more cells and able to carry on the activities of life.

Periphyton – the community of tiny organisms, as protozoans, hydras, insect larvae, and snails, that lives on the surfaces of rooted aquatic plants.

Phosphorous – a nonmetallic element of the nitrogen family.

Physiochemical – relating to physiological chemistry (physiology = consistent with the normal functioning of an organism).

Pollution Tolerance Index (PTI) – a means of measuring stream or river quality based on indicator organisms and their pollution tolerance levels.

Predaceous – predatory. Habitually hunting other animals for food.

Primary Consumer – organisms that feed on primary producers. They are always herbivores.

Definitions
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Prokaryotic – any cellular organism that has no nuclear membrane, no organelles in the cytoplasm except ribosomes, and has its genetic material in the form of single continuous strands forming coils or loops, characteristic of all organisms in the kingdom Monera, as the bacteria and blue-green algae.

Scavenger – an animal that feeds on dead organisms.

Secondary Consumer – organisms that feed on primary consumers. They can either be carnivores or omnivores.

Siphon – a tubular animal part through which air or water is taken in or expelled.

Species – regarded as the basic category of biological science, a group of organisms having many characteristics in common and ranking below a genus.

Stoichiometry – the calculation of the quantities of chemical elements or compounds involved in chemical reactions.

Tertiary Consumers – an animal that obtains its nutrition by eating primary and secondary consumers. Usually carnivores but can also be omnivores.

Tolerance Level – the amount of pollution an organism can handle before dying or moving to another habitat.

Trophic – of or relating to nutrition; concerned in nutritive processes.

Watershed – a land area that channels rainfall to creeks, streams, and rivers, and eventually flow to outflow points such as reservoirs, bays, and the ocean.

Water Year – a term commonly used to describe a time period of 12 months for which precipitation levels are measured.

Wetland – an area of land that is saturated with water either permanently or seasonally.