Florida wetland ecosystems and phytoremediation

Lesson plan by Morgan Byron and Jennifer Eells

At the end of this lesson, students will be able to:

- Define a wetland ecosystem and its inputs and outputs; be able to compare and contrast this with terrestrial ecosystems
- Explain the phytoremediation process in the context of ecosystem services; be able to define ecosystem services and give examples of others
- Identify threats to estuarine and marine ecosystems in Florida and beyond. Be able to give examples of ways these threats can be mitigated.

ACTIVITIES

In the classroom:

- Create a list of ecosystems that can be classified as wetland/marine/estuarine and those that are terrestrial in nature. Explain the characteristics that go into describing different types of ecosystems and the criteria for this term (versus other ecological terms like community, population, habitat, etc.). Focus on differences between these types of ecosystems, as well as the similarities – this is not only about water.
- Discuss biodiversity in these different ecosystem types, thinking about different life stages and immigration/emigration of species (many insects use water for immature stages but not others; frogs and turtles may breed in wetlands but not remain there; wetland birds and other vertebrates may forage in a wetland area but not roost there).
- Show students the SEEP (photos or webcam footage) and discuss the fact that it is manmade and what this means about the ecosystem (Do students get the impression it is "not natural"? Is there a place for manmade ecosystems? Why do they think someone would go through the effort of creating an ecosystem like this?).
- Introduce the topic of ecosystem services: ecologically-vital processes that contribute to the lives of humans. These services cannot be properly valued economically, but some estimates are astronomically high (in the trillions of dollars). Linking this to the idea of biodiversity and renewable/non-renewable resources, emphasize the role of ecosystem series as irreplaceable. For example, trees in forests that supply the oxygen we breathe; wetland ecosystems and tree roots that soak up runoff water from our paved roads and cities; the invaluable beauty of nature and its effects on mood and well-being; pollinators, like bees and wasps, that make large-scale agriculture possible. Many more examples exist, students may even come up with their own. Older or more advanced students may read research articles on this topic, such as this (Nature 1997).

In NATL:

- Tour SEEP and explain the process of phytoremediation focusing on the inputs and outputs. Ask students if they can think of any other ways pollution is mitigated by nature or other processes and what would happen if areas like SEEP did not exist. Brainstorm other ecosystem services provided by this area.
- Have students talk about the biodiversity of the area: plants, birds, insects, etc. Use aquatic collecting equipment to look for small fish and aquatic immature insects. Discuss the seasonality of SEEP – how many animals use this area but may not be present there year-round. Ask students if there are any animals they expected to see in this area but did not see – have them discuss potential reasons for not seeing this species (the area is too small, it is not the right time of year, the animal is cryptic or hiding, etc.).

ASSESSMENTS

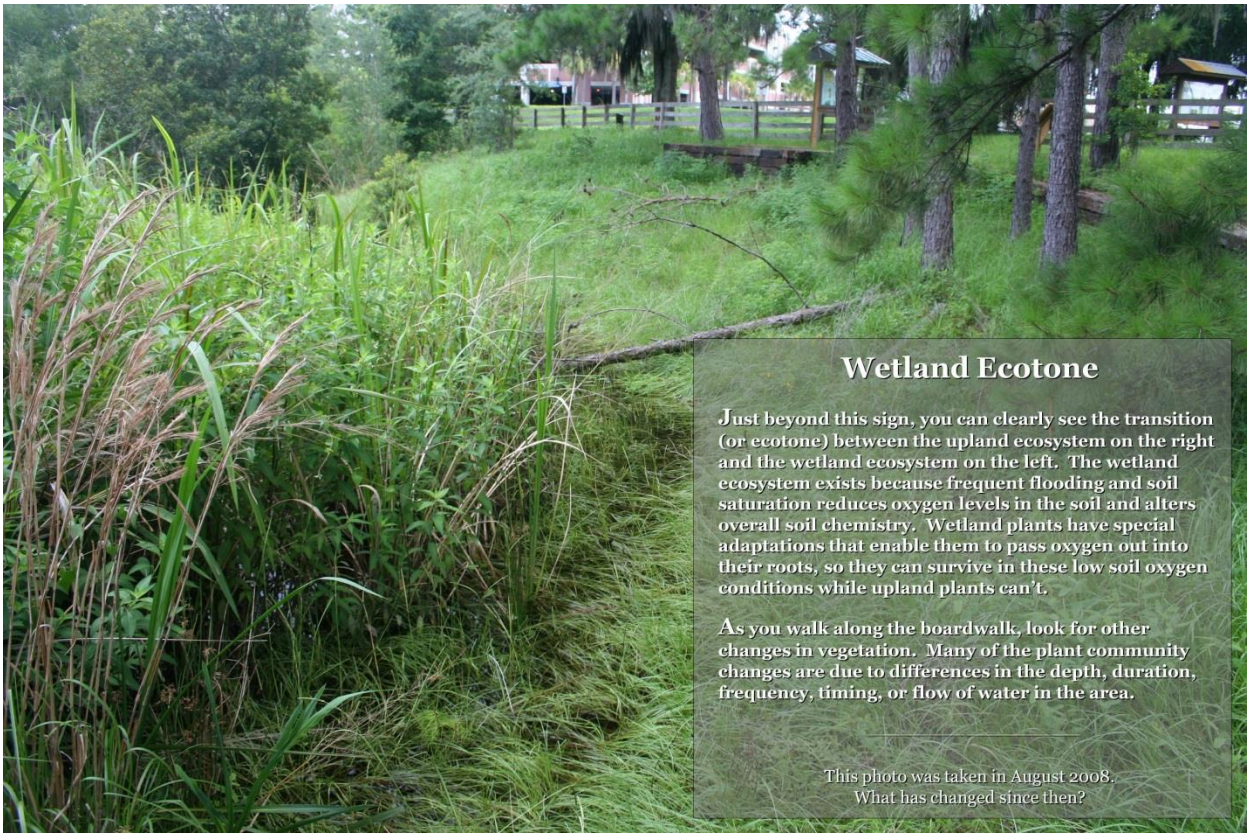
- Traditional tests can focus on definitions of ideas and recognition of topics, asking students to define wetlands, ecosystem services, biodiversity, etc.
- More involved essay-type questions can be about explaining ecosystem services, asking the students to choose one and write about what they think their local community would be like if that ecosystem service was absent or had to be maintained by non-natural means.
- A group project for more creative students or those in an ecology-focused class could be to make a mock-up of a design similar to that seen in SEEP. After all, SEEP was the product of a project drafted by members of the Wetlands Club at UF decades ago. This can be similar, but at a real-life location in their school or neighborhood, or a complete sky-is-the-limit no-budget exercise, depending on how creative an answer the teacher is willing to accept.

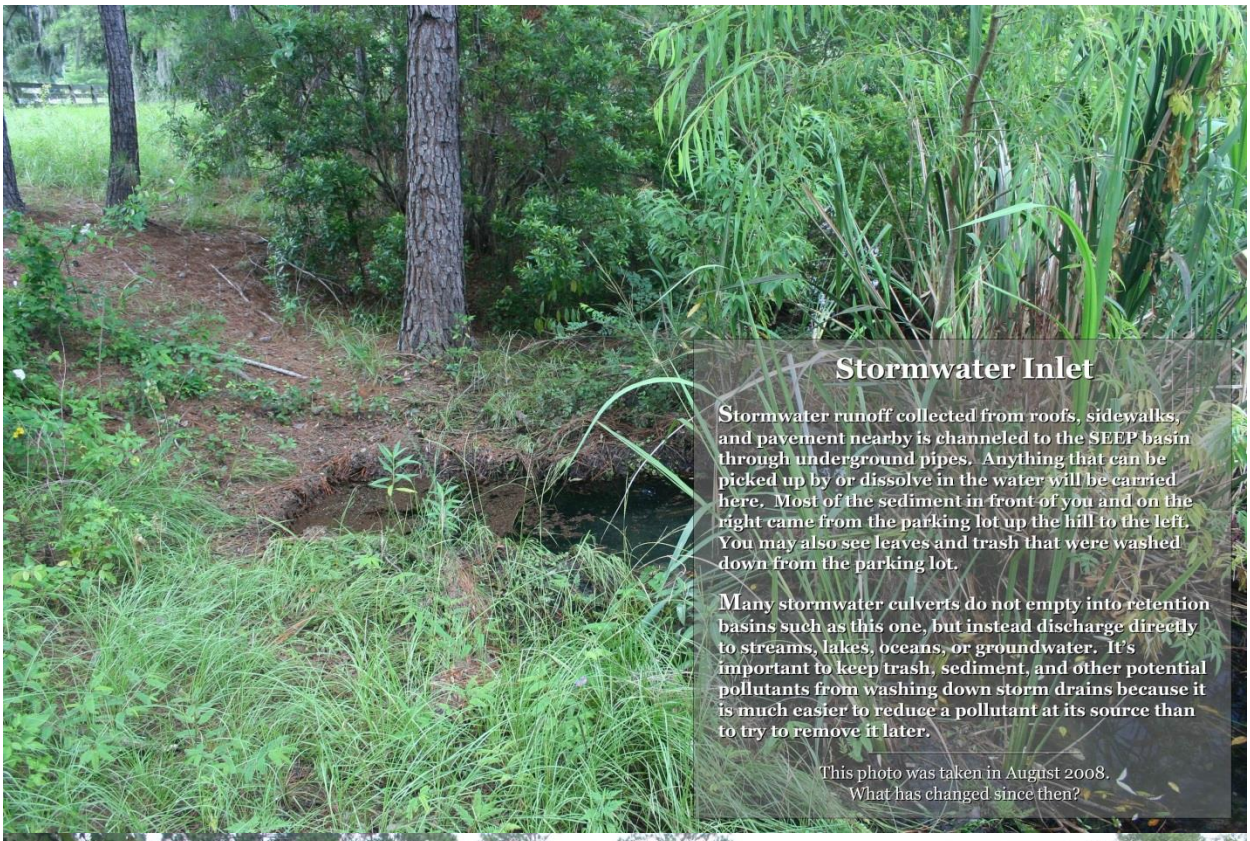
INFO

The Stormwater Ecological Enhancement Project (SEEP) is a manmade wetlands created with the purpose of cleaning the water that flows into the area from nearby parking lots and roads, making it suitable for natural life. The area was a simple retention area for this water runoff, until 1995, when students in a course titled Ecosystems of Florida designed plans that resulted in what is now known as the SEEP. The major difference between a typical retention basin and a manmade wetland is the effort made to populate the area with species typical of a natural wetland ecosystem. A major goal of a manmade wetland is to use wetland plant species to perform phytoremediation, the process by which plants help to purify polluted water. For the SEEP in particular, this meant planting Florida wetland species of plants and designing the series of basins and pools to not only move water in a way to encourages phytoremediation, but also act as a welcoming habitat to animals.

The typical plant species found in wetland ecosystems – both naturally occurring and manmade – include tree and shrub species like water hickory (*Carya aquatica*), pond cypress (*Taxodium ascendens*), bald cypress (*Taxodium distichum*), swamp dogwood (*Cornus foemina*), red maple (*Acer rubrum*), swamp bay (*Persea palustris*), wax myrtle (*Myrica cerifera*), and dahoon (*Ilex cassine*). Other notable plant species include iris (*Iris* spp.), alligatorflag (*Thalia geniculata*), broadleaf cattail (*Typha latifolia*) and southern cattail (*Typha domingensis*), as well as two important invasive aquatic plants, hydrilla (*Hydrilla verticillata*) and parrotfeather (*Myriophyllum aquaticum*). Animal species include alligators, several types of turtles and frogs, a few fish species, and many wading and migratory birds.

Below are the series of signs that can be found (in this order) along the SEEP trail. These signs explain each step of the phytoremediation process along with some insight on the topography, design, and history of the SEEP itself.





Stormwater Inlet

Stormwater runoff collected from roofs, sidewalks, and pavement nearby is channeled to the SEEP basin through underground pipes. Anything that can be picked up by or dissolve in the water will be carried here. Most of the sediment in front of you and on the right came from the parking lot up the hill to the left. You may also see leaves and trash that were washed down from the parking lot.

Many stormwater culverts do not empty into retention basins such as this one, but instead discharge directly to streams, lakes, oceans, or groundwater. It's important to keep trash, sediment, and other potential pollutants from washing down storm drains because it is much easier to reduce a pollutant at its source than to try to remove it later.

This photo was taken in August 2008.
What has changed since then?

Treatment Forebay

The area beyond this sign is the "forebay" of this enhanced stormwater basin. It is designed to capture most of the particulate matter that is suspended in the incoming water. These particles are one of the main pollutants in stormwater runoff and often contain, or have attached to them, heavy metals, fertilizers, oil, grease, bacteria, and viruses. By slowing the flow of stormwater, many of these particles will settle to the bottom where they will be broken down, thereby improving water quality.

About 85% of the stormwater entering SEEP passes through the forebay and most of the particulate pollution is removed in this area.

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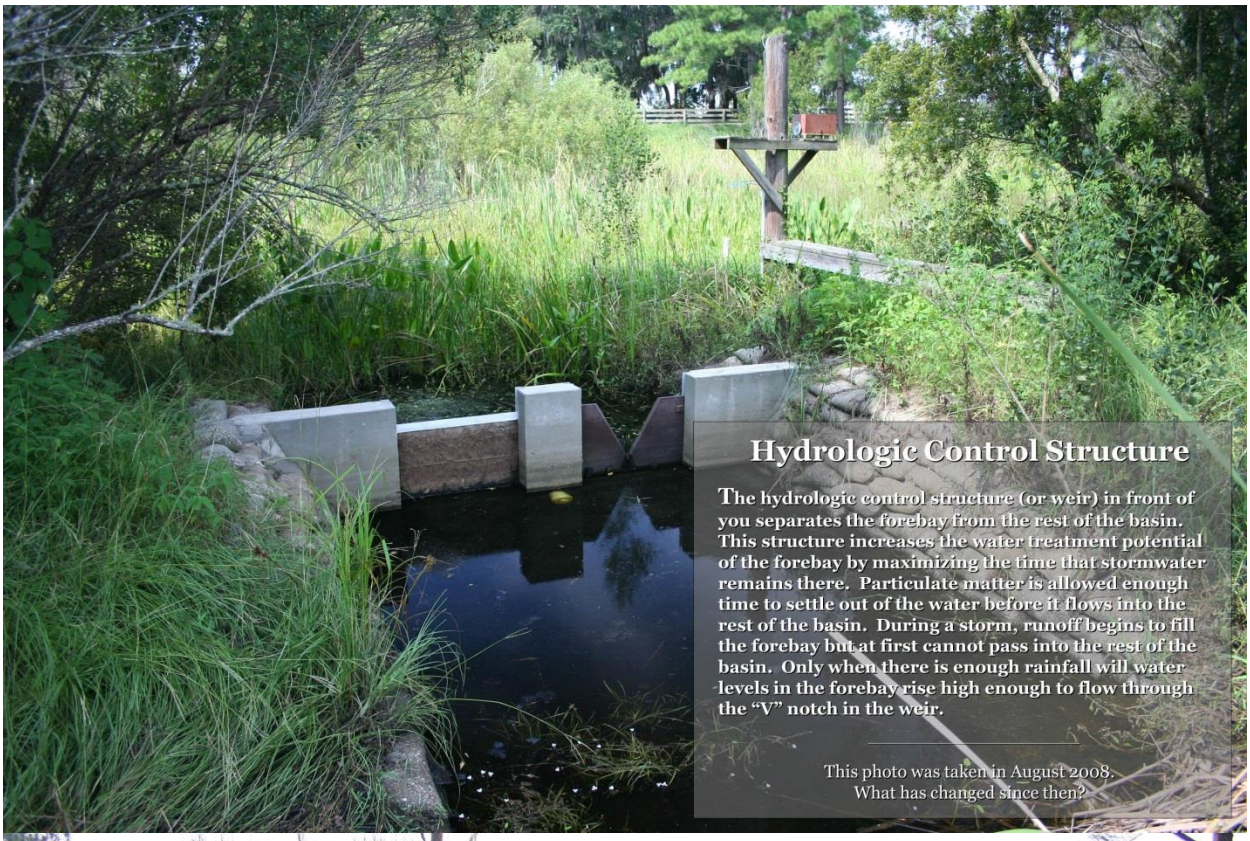

Hydrologic Control Structure

The hydrologic control structure (or weir) in front of you separates the forebay from the rest of the basin. This structure increases the water treatment potential of the forebay by maximizing the time that stormwater remains there. Particulate matter is allowed enough time to settle out of the water before it flows into the rest of the basin. During a storm, runoff begins to fill the forebay but at first cannot pass into the rest of the basin. Only when there is enough rainfall will water levels in the forebay rise high enough to flow through the "V" notch in the weir.

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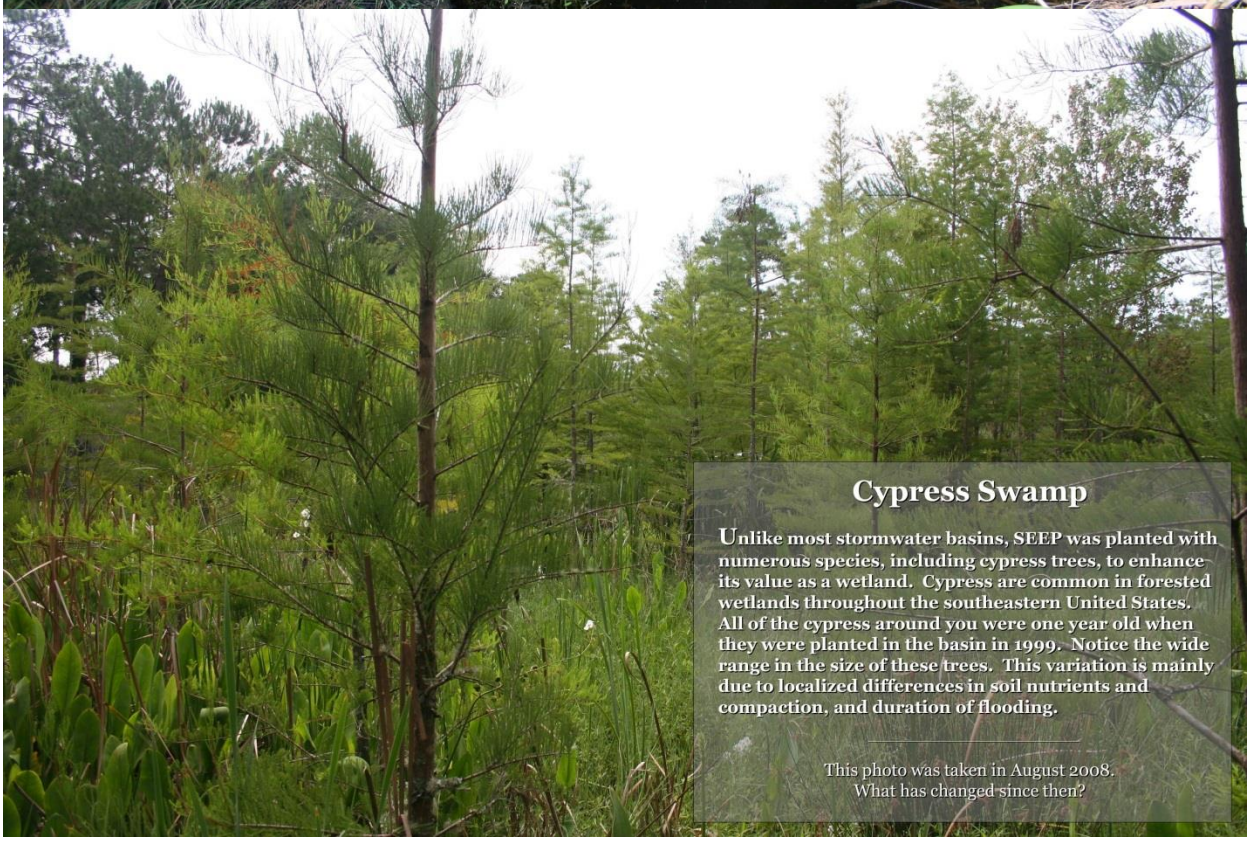
What has changed since then?



Cypress Swamp

Unlike most stormwater basins, SEEP was planted with numerous species, including cypress trees, to enhance its value as a wetland. Cypress are common in forested wetlands throughout the southeastern United States. All of the cypress around you were one year old when they were planted in the basin in 1999. Notice the wide range in the size of these trees. This variation is mainly due to localized differences in soil nutrients and compaction, and duration of flooding.

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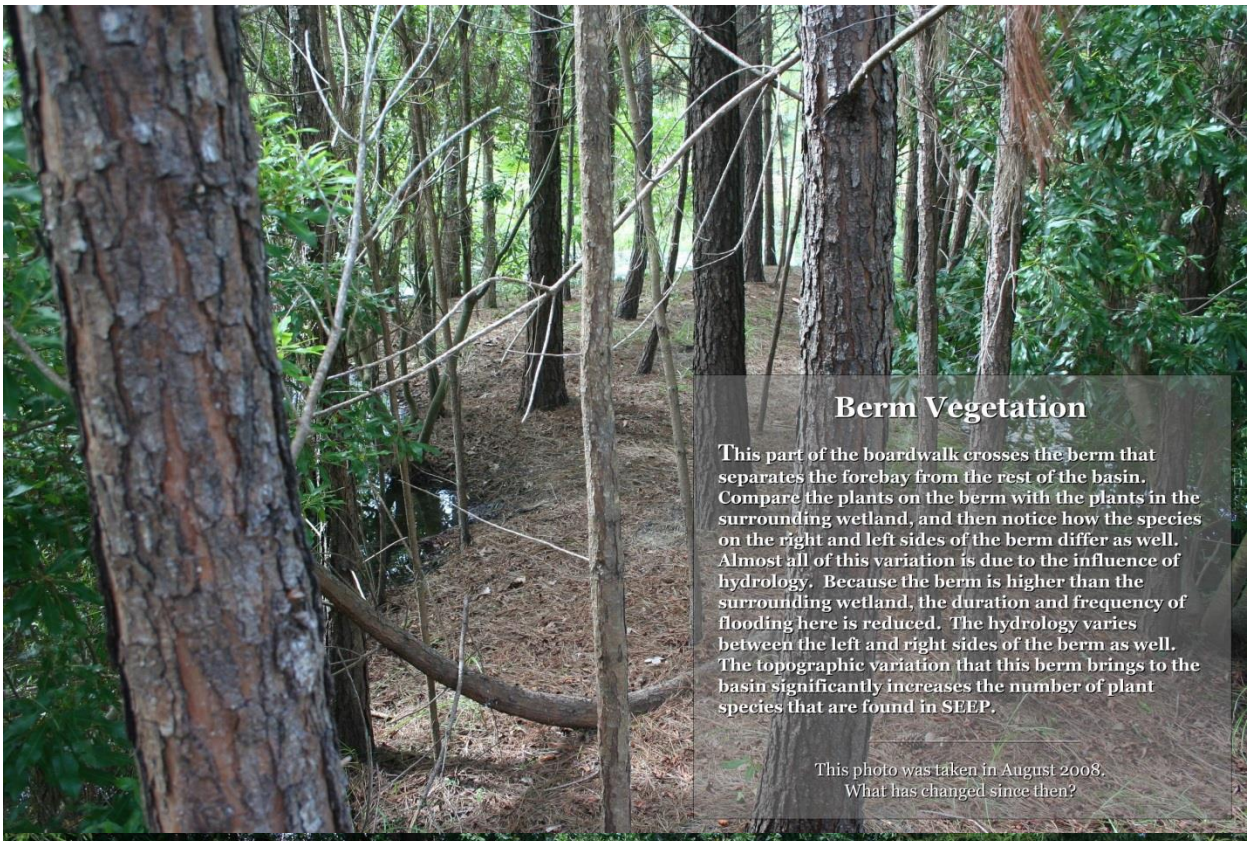

Berm Vegetation

This part of the boardwalk crosses the berm that separates the forebay from the rest of the basin. Compare the plants on the berm with the plants in the surrounding wetland, and then notice how the species on the right and left sides of the berm differ as well. Almost all of this variation is due to the influence of hydrology. Because the berm is higher than the surrounding wetland, the duration and frequency of flooding here is reduced. The hydrology varies between the left and right sides of the berm as well. The topographic variation that this berm brings to the basin significantly increases the number of plant species that are found in SEEP.

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What has changed since then?

Cattail Marsh

The area in front of you has the highest nutrient load of the entire basin. During storms, a large culvert hidden by the trees on the far bank channels water from the UF Cultural Plaza parking lot into the basin. The dominant plants in this area are cattails (*Typha domingensis*). Cattails are native, but are often considered a nuisance because they can crowd out other native vegetation when excess nutrients are present. However, cattails remove excess nutrients from the water and help improve water quality downstream so that cattails and other nutrient loving plants are less likely to grow in the rest of the basin.

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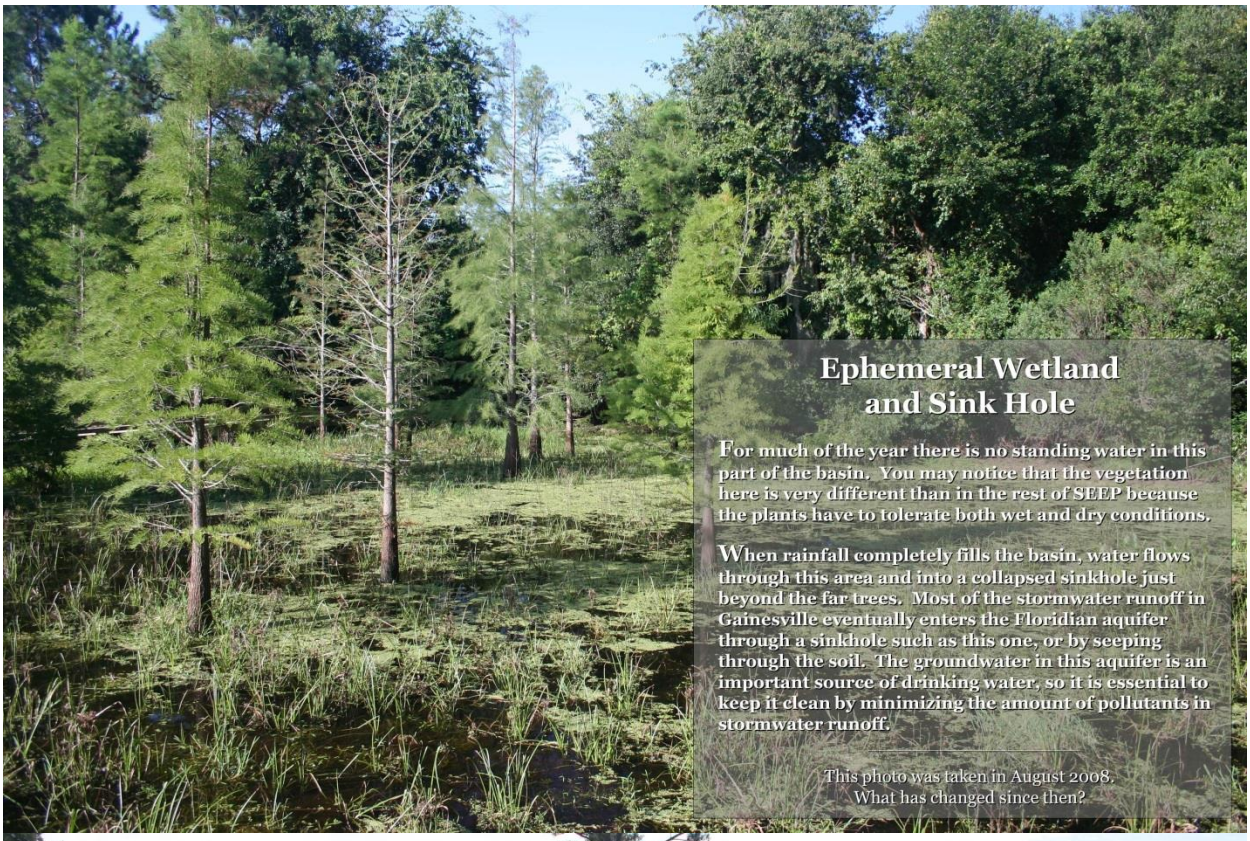

Ephemeral Wetland and Sink Hole

For much of the year there is no standing water in this part of the basin. You may notice that the vegetation here is very different than in the rest of SEEP because the plants have to tolerate both wet and dry conditions.

When rainfall completely fills the basin, water flows through this area and into a collapsed sinkhole just beyond the far trees. Most of the stormwater runoff in Gainesville eventually enters the Floridian aquifer through a sinkhole such as this one, or by seeping through the soil. The groundwater in this aquifer is an important source of drinking water, so it is essential to keep it clean by minimizing the amount of pollutants in stormwater runoff.

This photo was taken in August 2008.
What has changed since then?

Shallow Treatment Marsh and Compacted Soils

Stormwater leaving the forebay travels through the shallow marsh in the foreground. Additional nutrients are removed from the water by the plants in this area before it enters the pond.

The shortest cypress trees in the basin are to the left and right of this sign. During the recontouring of SEEP in 1998, a road used to haul soil from the pond to the berm ran through this area. Soil compaction resulting from the heavy trucks still stunts growth of these trees today. In addition to impacting plant growth, soil compaction throughout the watershed caused by vehicles, lawn mowers, animals, foot traffic, etc. can increase the amount and rate of stormwater runoff.

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Water Flow in the Basin

Unlike most stormwater basins, the ecologically enhanced design of SEEP regulates water flow internally, redirects flow using berms, and creates deep water pools. This complexity increases plant and animal habitat, as well as water treatment potential. When it rains, the forebay rapidly fills with water and slowly releases cleaner water into the rest of the basin. The water then flows through the shallow marsh for further treatment and eventually enters the pond in front of you.

This photo was taken in August 2008.
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Wildlife

Wading birds, such as White Ibis, Snowy Egrets, and Little Blue Herons (immature pictured here), often use the SEEP basin. When water levels are low in the late winter and early spring, fish, amphibians, and insects become concentrated in the shallow areas and are easy prey for these birds. Migrating song birds also use the mix of shrubs and marsh for cover and foraging. Many species of reptiles and amphibians frequent the pond during different times of the year. The value of stormwater basins as wildlife habitat is another reason to ensure that the water entering them is of good quality.

This photo was taken in August 2008.

CAUTION!
ALLIGATOR NESTING AREA

Female alligators are very protective of their nest and young, and can be extremely aggressive towards intruders.

One or more alligators may be found in SEEP year-round, so visitors should stay on the boardwalk and designated trails. Alligator nesting generally occurs between June and July with eggs hatching about 2 months after laying. Female alligators have been known to stay with their young for several months after they hatch, making the period to be extra cautious last from May through October.

An alligator nested in SEEP in 2001, 2003, and 2009 (each year at a different location). If you see an alligator that appears to be guarding a nest, **stay away!** (but please report its location to natl@ufl.edu).

Algal Blooms

Depending on the season, the area in front of you can be dry, full of clear water, filled with submerged plants, or covered with floating algae. Algal blooms are common in the spring when water levels rise and nutrients, such as nitrogen and phosphorous, leach from dead marsh vegetation and sediment. Although sometimes unsightly, the algal growth helps to remove excess nutrients from the water, thereby reducing the chance that they will pass out of the basin and into the environment. Preventing nutrients and other contaminants from entering stormwater runoff helps prevent algal blooms.

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Self-Organizing System
Prior to enhancement in 1997, there were only 32 species of plants in the basin. Today, there are over 120 species. Initially, only a few individuals of many native species were planted as seed sources. Since then, the SEEP ecological community has been allowed to sort itself out by distributing seeds naturally throughout the basin and by recruiting new plants. Allowing the basin to self-organize keeps management costs and maintenance needs minimal.
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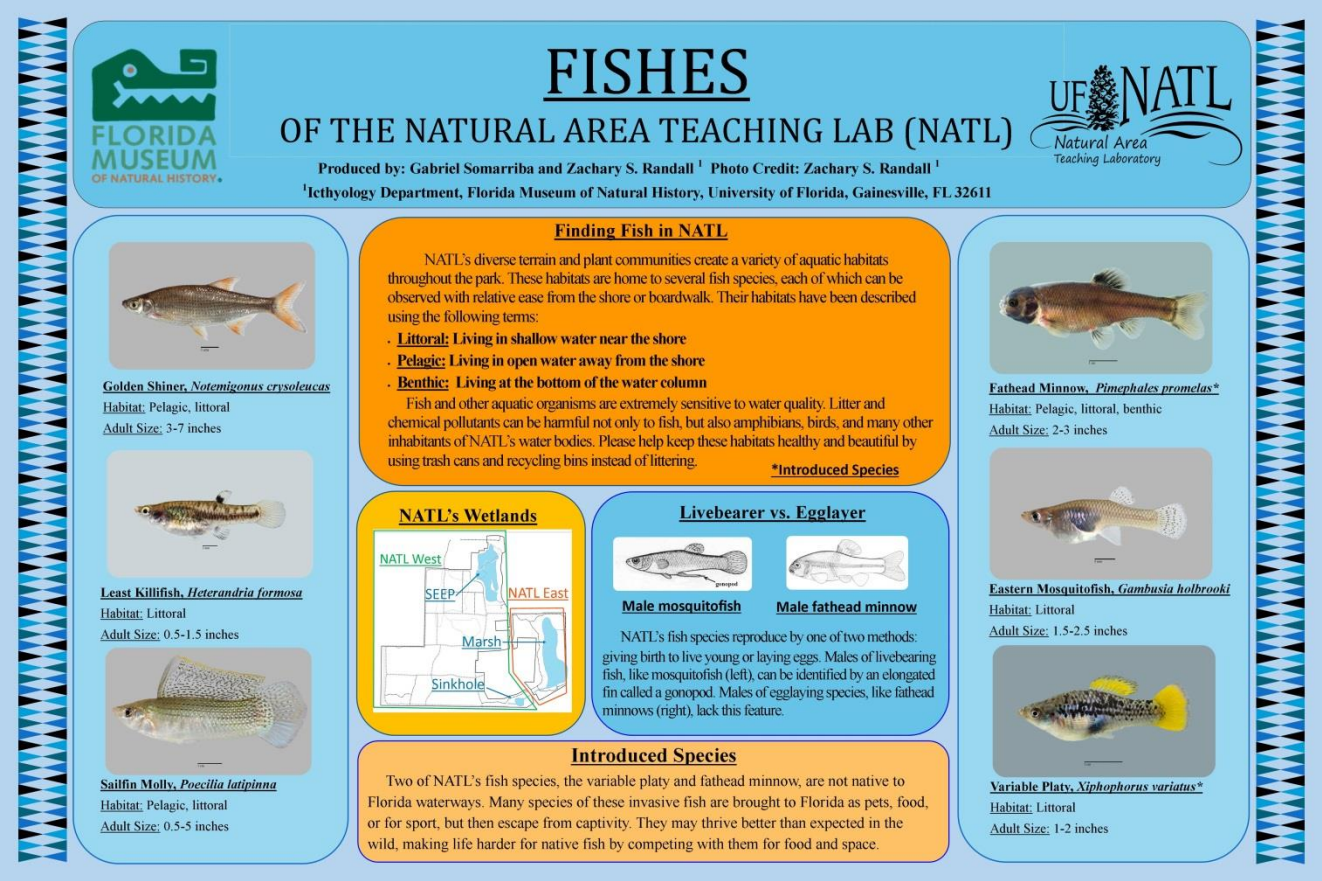
The sign below (created by a student as part of the NATL Minigrant Program) gives a detailed explanation of each of the fish species found throughout NATL. These fish were caught and identified from wetland areas other than the SEEP, such as the swamp regions and ephemeral pools in NATL-east.



More information on the animals and plants recorded in NATL can be found on the Natural Area Teaching Lab website in the Biota section: http://natl.ifas.ufl.edu/biota/