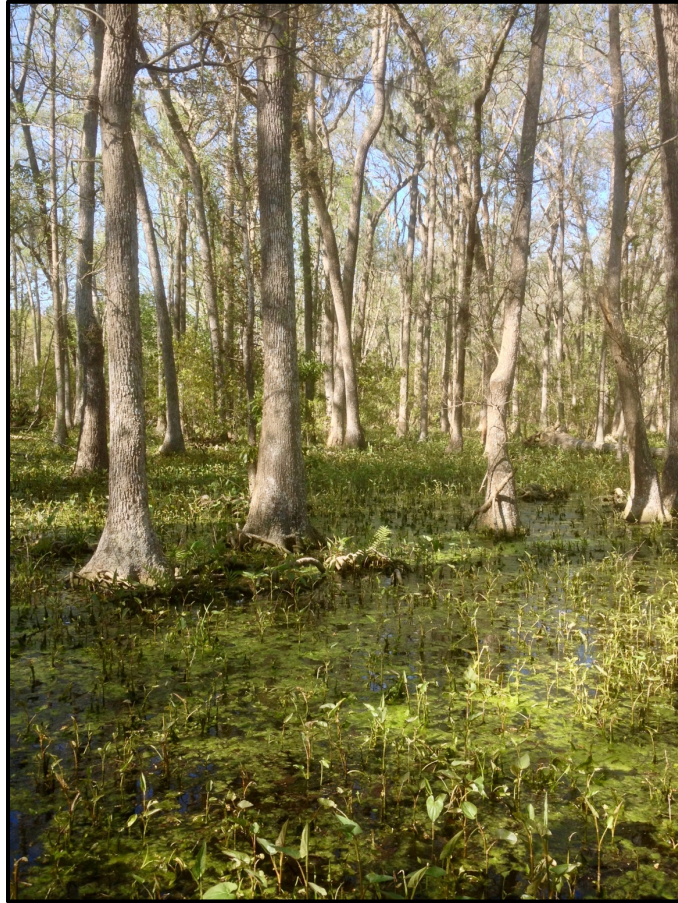


**PALMETTO HALL  
RECYCLED WATER PROJECT  
Hilton Head Public Service District  
Hilton Head Island, South Carolina**

**2016-2017 BIENNIAL BIOLOGICAL MONITORING REPORT**

**Boulder, Colorado  
March, 2018**



**Ballantine**  
ENVIRONMENTAL RESOURCES

# Contents

1. Introduction.....	4
2. Geographic Location.....	4
2.1 Site Description.....	5
Figure 2.1. Location Maps .....	6
Figure 2.2. Forest (“Wooded”) Wetland .....	7
Figure 2.3. Golf Course (“Grassy”) Wetland .....	8
3. Monitoring Methodology.....	9
3.1. Monitoring Schedule.....	9
3.2 Monitoring Data.....	9
3.3. Reports .....	10
4. Monitoring Results by NPDES Parameters .....	11
Parameter A. Hydroperiod.....	11
Parameter B. Canopy Species.....	12
Parameter C. Shrub and Groundcover Species.....	13
Parameter D. Nuisance Plant Species.....	14
Parameter E. Exceeding the Threshold of Concern: Canopy.....	14
Parameter F. Exceeding the Threshold of Concern: Shrub and Groundcover..	15
Parameter G. Natural Causes.....	16
Parameter H. Benthic Macro-Invertibrates.....	16
Parameter I. Fish.....	16
Parameter J. Endangered or Threatened Species.....	16
Parameter K. No Discharge Period in the Wetland.....	17
5. Conclusions and Recommendations .....	18
6. Glossary .....	19
7. Wetland Vegetation Inventory .....	21
8. Wetland Wildlife Inventory .....	24
9. References.....	32

List of Figures

2-1. Location Map .....	6
2-2. Site Map: Forest Wetland.....	7
2-3. Site Map: Golf Course Wetland .....	8

# 1. Introduction

**THIS BIENNIAL REPORT** analyzes results from two-years of biological monitoring of Recycled Water (RW), projects in the Palmetto Hall community, Hilton Head Island, South Carolina. The Hilton Head Public Service District (“HHPSD”) discharged RW (advanced-treated domestic dechlorinated influent) into two freshwater wetlands in the Palmetto Hall community: the Forest Wetland (“Wooded Wetland” in permit documents) and the Golf Course Wetland (“Grassy Wetland” in permit documents). The following report describes scientific findings during the period from January 1, 2016 through December 31, 2017. The PSD has discharged RW in the wetlands since the late 1990s.

The National Pollution Discharge Elimination System (NPDES) Permit (No. SC0046191) requires specific biological monitoring parameters for the Palmetto Hall RW projects. The S.C. Department of Health and Environmental Control (SCDHEC) modified the permit on October 24, 2005. The permit revised maximum and RW loading totals, monitoring for vegetation, and the scientific report schedule. In compliance with the permit, and to maintain the ecological database, this report presents monitoring results for the ecological parameters: dry-down (no-flow) periods, weather effects, ecological change, wildlife and other changes exceeding the “threshold of concern,” whether ecological or operational.

Consistent with the (NPDES) permit specifications, the following monitoring results are compared with conditions in the 1999 Baseline monitoring results (reported February 1, 2000). This report includes the site description, methodology summary, monitoring results, conclusions and recommendations, references and appendices.

## 2. GEOGRAPHIC LOCATION

The RW projects are located in the private 750-acre residential and golf community of Palmetto Hall, on lower, northeastern Hilton Head Island, in southern Beaufort County, South Carolina (Figure 2-1). Palmetto Hall features two golf courses: the Arthur Hills Course and Robert Cupp Course. The RW projects are located in natural (not manmade) wetlands contiguous to these facilities (Figure 2-2). See the Annual and Baseline Report for 1999 for a detailed description of the physical and biological conditions of the projects. Figure 2-1 Forest wetland boundaries have not changed. However, the native

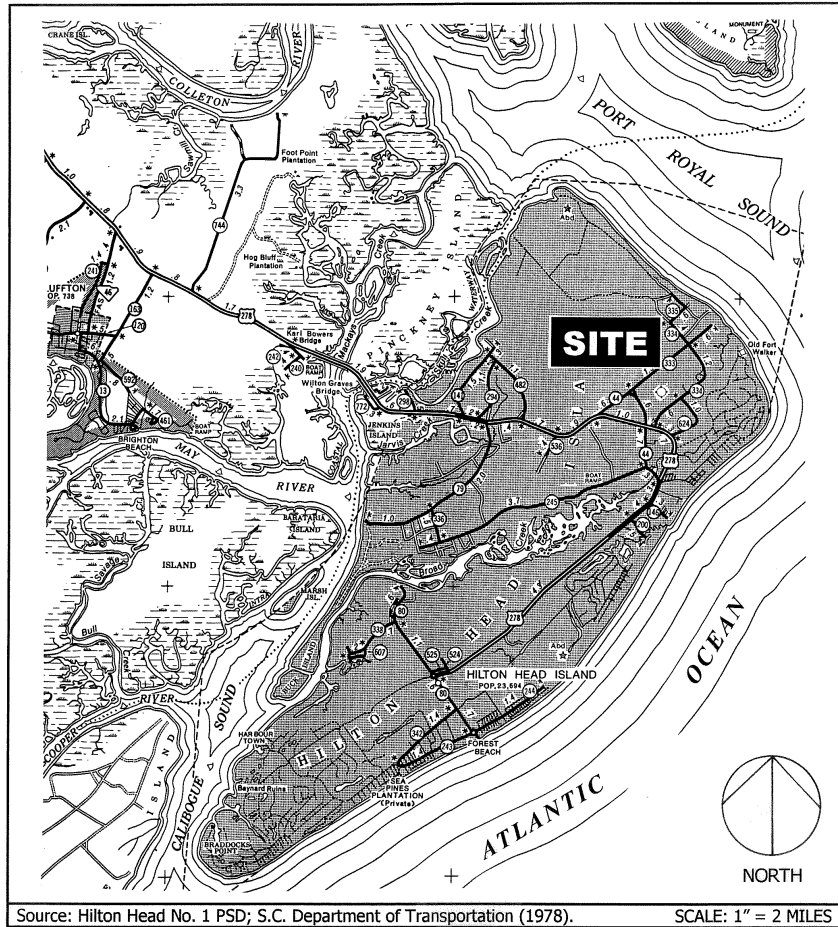
wetlands interior communities *have* changed since the Baseline monitoring. The wetlands *have* changed more rapidly through ecological succession since the Baseline. The supply of RW has enhanced the rate of succession and vegetation growth—especially trees—since the Baseline. In contrast, the wetlands have been impacted by climate change effects including drought and flooding. This has impacted biodiversity of plant and wildlife. But regular RW flow has been a stabilizing resource supporting ecological succession and biological diversity. The sustainable RW program has been in operation for the Hilton Head Public Service District since 1986—and in Palmetto Hall since 1999. RW is processed and distributed by Hilton Head Public Service District in two, large freshwater wetlands -- Forest and Golf Course to (1) provide additional uptake of water and nutrients; (2) eliminate discharges to other waters, such as tidal streams; and (3) enhance the natural hydrology and ecological conditions of the receiving wetlands, which have been impacted by land development and climate change. This report describes that climate-driven impacts continue in this RW project area.

For more information see the original Baseline report for this Project, contact Hilton Head Public Service District, or Ballantine Environmental Resources.

## **2.1 Site Description**

The Forest Wetland (Figure 2-2) is 98 acres in area with significant long-term water storage capacity and wildlife value. One inch of water throughout this wetland is equal to 2.7 million gallons. The average elevation is 10-15 feet MSL. The linear wetland is part of the watershed drainage via percolation and slow overland flow toward Port Royal Sound. The hydric soils on the northern wetland edge, adjacent to Sedge-fern Drive, are the eastern edges of the lower wetland that store groundwater at a high level through most of the year. The Golf Course Wetland (Figure 2-3) is a palustrine-emergent marsh and palustrine-successional mixed pine-flatwood forest. A significant resource, in this wetland is the largest remaining sawgrass community on Hilton Head Island. The wetland has a seasonally and artificially flooded and/or saturated water regime. A header at the southern, upper end of the wetland discharges RW via low aerial spray. Sheet-flow moves through the wetland in a north-easterly direction, then turns to the southeast, and finally may discharge into the nearby Forest Wetland.

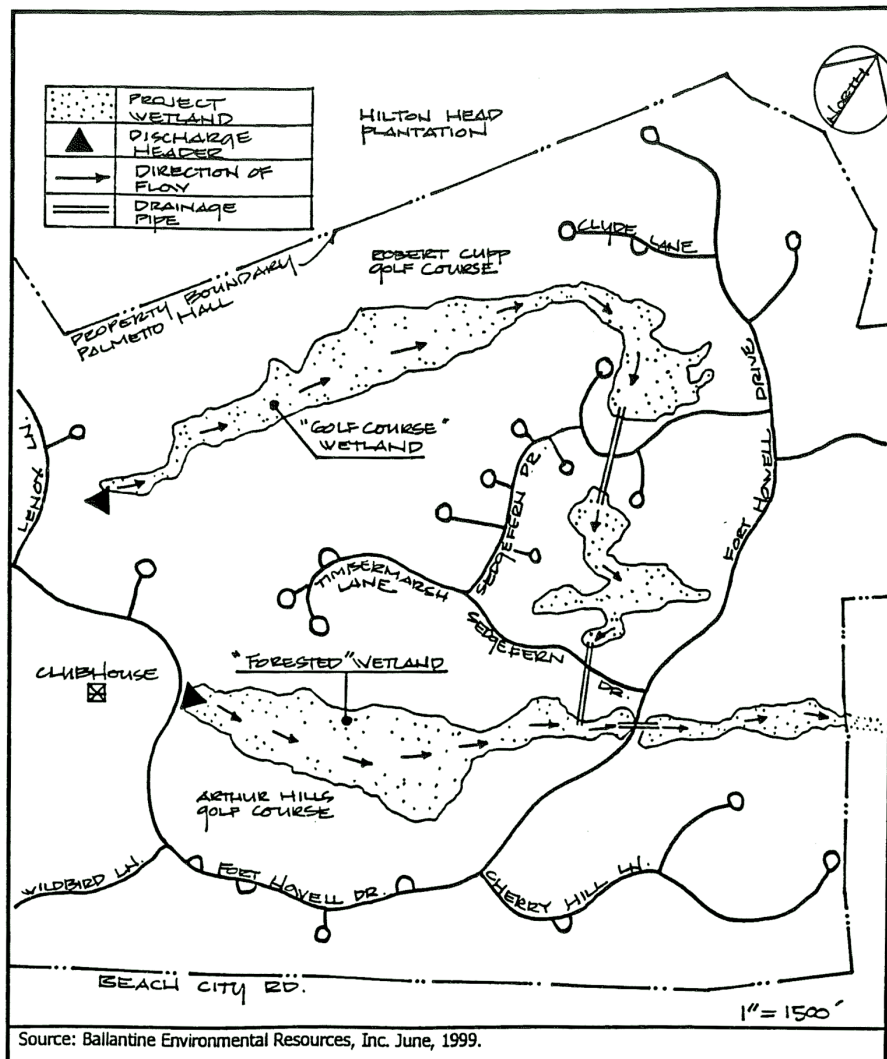
Figure 2-1. Location Maps



Source: Hilton Head No. 1 PSD; S.C. Department of Transportation (1978).

SCALE: 1" = 2 MILES

## 2-2 Site Map: Forest Wetland

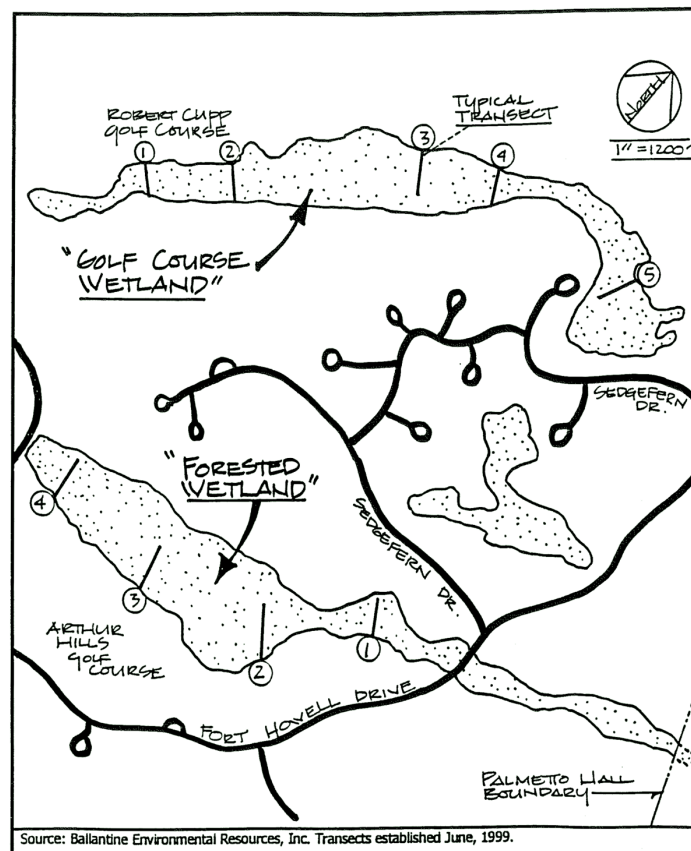


This map shows the site/location of the two project wetlands on northern Hilton Head Island. Notice the proximity to Port Royal Sound. This area is associated with a prehistoric shoreline and wetland. Soils in the area are often "hydric"—easily saturated or inundated in rainstorms or floods.

This linear basin has an average elevation of 10-15 feet mean sea level (MSL). It is a virgin old-growth hardwood forest association with most trees 50 to > 100 years in age—or technically: a palustrine-forest, bottomland hardwood community with a

seasonally and artificially-flooded water regime. RW is discharged by aerial spray from a header at the western end of the wetland. One inch of RW throughout this wetland is equal to 2.4 million gallons. Since the Baseline, Ballantine Environmental Resources has consulted and conducted scientific measurement and reporting in compliance with the SCDHEC NPEDS permit for this RW project, our monitoring has reported data for the overall ecological condition, hydrology, vegetation, wildlife, and any other factors that may or do impact the RW Project. The Conclusions and Recommendations assess the status of the wetlands and provide guidance for operational modifications, if practical, or justified environmentally.

### 2-3. Golf Course Wetland



Sheet-flow drains in an eastward direction through the wetland, then through downstream off-site wetlands, on its way to Port Royal Sound (Figure 2-3).

## 3. Monitoring Methodology

### 3-1. MONITORING SCHEDULE

As stipulated by the NPDES Permit No.SC0046191, Ballantine Environmental Resources monitored the project wetlands biennially in 2016 and 2017. We monitored hydrology, vegetation, and wildlife.

Of note, in the period between the two monitoring cycles, Hilton Head Island was impacted by Hurricane Matthew (October, 2016). The fallen debris from this storm interrupted the normal monitoring schedule. Monitoring was implemented in growing season of 2017.

### 3-2. MONITORING DATA

We used the line-transect and quadrat intercept method of data collection. In the Forest and Golf Course Wetland projects we maintain transects spanning the width of each wetland. Permanent sampling quadrat stations are established at equidistant point intercepts on the transects. Figures 2-2 and 2-3 show the location of monitoring transects in the project wetlands.

Our collected field data includes:

- *Water depth* measured at each station.
- *Vegetation* measured at each station. We recorded the diversity, dominance, and density of canopy species in cen-acre (1/100 acre) quadrats. In the shrub and groundcover stratum, we measured species diversity, dominance, and density in mil-acre (1/1,000 acre) stations.
- *Wildlife*: We identified macro-invertebrates (benthic, aerial and other) in stations and along transects. We recorded fish species identified visually in appropriate habitats at stations. We also identified indicator vertebrates visually or physically (by vocalizations, “sign,” tracks, or trails).
- *Significant impacts*: We documented wetland impacts from natural causes. Such impacts include flood, drought, storms, plant disease, invasive or “nuisance” species, and wildlife activity, as well as human impacts (e.g., trash

dumping, mowing, vegetation removal, ditching or filling, or vandalism were also noted.

- A detailed description of monitoring methods and calculations is provided in the “Palmetto Hall Reclaimed Water Project Description” (April 15, 1999), included in the Annual and Baseline Report.

### **3-3. REPORTS**

The current SCDHEC NPDES permit requires biennial reports. However, as needed by Hilton Head PSD, Ballantine Environmental Resources provides additional monitoring, updates, outreach publications, and site investigation about the two RW projects.

This *Biennial Biological Monitoring Report* compares data collected in the growing and dormant seasons of 2016-2017 with conditions in the Baseline, according to parameters ascribed by the SCDHEC. We submit all reports to the Hilton Head PSD, which forwards the information to SCDHEC and other stakeholders.

## 4. Monitoring Results

### NPDES Wetland Parameters

2016-2017

#### **PALMETTO HALL RECYCLED WATER PROJECT** **Hilton Head Island, SC**

NPDES Permit No. No.SC0046191

S.C. DHEC Monitoring Parameters

Forest Wetland and Golf Course Wetland

Palmetto Hall, Hilton Head Island, South Carolina

2016-2017 Conditions Compared with The 1996 Baseline Year

Todd Ballantine, Lead Environmental Scientist,

Ballantine Environmental Resources, Boulder Colorado

### **Parameter A.** **Hydroperiod**

#### **A-1. Biennial RW loading averaged annually compared to 40-year average rainfall and the Baseline.**

The 40-year average rainfall, or “hydroperiod” for Hilton Head Island is 51 inches per year (acre-inches). This is the Baseline against which to compare the sum of annual RW loading plus rainfall in inches as recorded by HHPSD. In 2016-2017 the Golf Course and Forest Wetlands received above-average rainfall: 7% above the historical 50-year mean.

Over the two-year monitoring period, the project area received 87 acre-inches of RW, distributed as 74 acre-inches in the Forest Wetland and 11 inches in the Golf Course Wetland.

**A-2. Depth of water in the RW wetlands.** The average depth of water in the Forest Wetland was 3 inches, similar to the depth in the Baseline (2.8 inches). The deepest water was 12 inches in the center channel of this bottomland system. Approximately 60 percent of the wetland was inundated—compared to 83 percent coverage in the Baseline.

In the Golf Course Wetland, the average depth was less than 1 inch—shallower than in the Baseline (8 inches). The only surface water we observed

was a shallow (3 inches) channel trickling down the center portion of the wetland in a westerly direction.

**A-3. Distribution of Water in the Wetlands.** Surface water covered 50 percent of the ground in the Forest Wetland and <5% percent of the Golf Course wetland. In the Forest Wetland standing, water appeared to be of long duration. In the Golf Course wetland the only water was of short duration—in the above mentioned channel.

**A-4. Hydrology Compared to the Baseline.** Surface water was less widespread and shallower than in the Baseline in each wetland. The effect of SCDHEC mandated dry-down (no flow) periods has substantially lowered the ground water tables in each wetland.

## **Parameter B. Canopy Species**

**B-1. Basal Area of Trees.** In the Forest Wetland, the basal area of trees declined by 15% or less due to windthrow from Hurricane Matthew. As was observed in other wetlands, trees facing the North-Northwest exposure were most vulnerable to blow-down. The interior of the wetland is still populated by mature hardwoods such as swamp blackgum and red maple. The density of these trees baffled the strong winds and protected the inner forest.

On the Golf Course wetland, pine trees were vulnerable in exposed areas and were felled by storm winds. These trees were removed prior to our latest monitoring. Windfall of other trees offered a beneficial mass of branches and limbs on the perimeter of this wetland. This debris provides shelter habitat for songbirds, reptiles, and amphibians.

**B-2. Density of Canopy Trees.** Basal area, related to tree density, dropped in the wetlands due to the hurricane. The average decline in the Forested wetland was 10-15%, likewise in the Golf Course wetland.

**B-3. Importance Value.** In order of importance value, an ecological standard of productivity, trees of the wetlands are: swamp blackgum, red maple, sweetgum, water oak, loblolly pine, pond pine and Carolina willow.

**Parameter C.**  
**Shrub and Groundcover Species**  
**Averaged for the wetland and compared to the Baseline**

**C-1. Species Diversity.** Compared to and since the Baseline, species diversity declined moderately in all strata due to the hurricane. We estimate that this decline was a range of 10-20%. However, the decline did not impact the wetland function for storing and filtering RW. The declines in groundcover will be mitigated by regrowth hastened by more sunlight reaching the ground.

**C-2. Total Cover of Dominant Species.** Dominant trees, described above currently provide the approximated cover:

- Forest wetland: 85% cover
- Golf Course wetland: 45% cover

**C-3. Importance Value.** This parameter is the comparative sum of relative dominance, (maximum 100 points), density (maximum 100 points), frequency (maximum 100 points) and wildlife habitat (maximum 100 points)—rated on an optimum score of 400 points. The Forest Wetland Importance Value has been reduced to 350, fundamentally due to the effects of Hurricane Matthew. The Golf Course wetland: due to recurring dry-down, hurricane, and low flow of RW this wetland has declined to a score of 150. Dieback of the rare sawgrass community is a primary impact in this wetland.

### **Parameter D. Nuisance Plant Species**

Nuisance plant species occur almost entirely when there is a decline in one parameter of the wetland. In the case of Palmetto Hall, nuisance grasses and invasive pines have degraded formerly rare sawgrass wetlands. Additionally, as a result of recurring drought, dry down, and hurricane flooding, the sawgrass marsh has declined almost 100%. It appears that this wetland will undergo shrub growth followed by invasion of loblolly pine. This change is natural but the lost sawgrass marsh cannot be replicated or restored. Addition of RW will not bring the sawgrass marsh back, we predict. With the exception of pines, we have not observed the invasion or recurrence of invasive plant species described in previous reports.

### **Parameter E. Exceeding the Threshold of Concern: Canopy**

The Gulf Course Wetland was damaged by the hurricane causing tree fall and loss of limbs on the windward side. This community is undergoing ecological succession from a mixed forest-marsh to a more dense pine flatwood association. This emerging pineland is less biologically diverse. The Forest Wetland had less damage to trees due to its geographic position. The density of hardwood trees provided a form of “safety in numbers” for the dense, mature swamp blackgum forest. The primary tree loss was due to the hurricane as expressed above, but overall, the forest remains vibrant and productive.

**Parameter F.  
Exceeding the Threshold of Concern:  
Shrub and Groundcover**

The Forest shrub and groundcover suffered very little damage due to the protective nature of the dominant hardwood trees. This community is highly resilient. The Golf Course wetland was exposed to wind and water depredation. The primary example of the impact was flooding and sedimentation in the former sawgrass marsh which declined substantially by storm flooding and sedimentation.



Dieback of the Salt Marsh Community in the Golf Course Wetland.

### **Parameter G. Natural Causes**

The natural causes of change in the wetlands, in order of prevalence were: isolated tree fall, stormwater flooding, sedimentation, dieback of rare species (sawgrass), and alteration of drainage patterns in the wetlands.

### **Parameter H. Benthic Macro-Invertebrates**

In the Forest Wetland, we saw fewer species and smaller populations of fish and macro invertebrates, possibly due to the severity of storms and disruption of habitat and impact of dry-down. However, the prevalence of debris in the wetland is likely to offer new cover and breeding areas for fish and invertebrates. In the Golf Course Wetland, the low water and clusters of blown-down cover also will offer new habitat for invertebrates but less so for fish until the dry-down requirement is suspended.

### **Parameter I. Fish**

The fish populations will take longer to recover from storm damage. Fish species reported in prior reports are primarily insectivorous. With the regeneration of the population of invertebrates, fish population should recover--as long as there is sufficient water in the wetlands. We observed a lower number of wading birds hunting fish in the pools of the Forest Wetland and ponds of the Golf Course Wetland. This is an indication of habitat alteration due to storm damage and low water.

### **Parameter J. Endangered or Threatened Species**

In the course of monitoring the Palmetto Hall wetlands, we observed no federally or state of South Carolina-listed endangered or threatened wildlife

species in the Palmetto Hall RW wetlands. These species are: Heel-spitter clam, Northern myotis bat, and Red Knot.

### **Parameter K. No Discharge Period In the Wetland**

From 2016 to 2017 the Golf Course Wetland received only 8% of available RW water. The prolonged dry-down reduced habitat diversity and productivity significantly. The Forest Wetland received a more regular monthly supply of RW. Habitat was not impacted by dry-down in this wetland.



Sturdy swamp blackgums in The Forest Wetland

# Conclusions and Recommendations

## CONCLUSIONS

This Biennial Report analyzed the results from biological monitoring in 2016 through 2017 of RW operations in the Palmetto Hall Forest and Golf Course Wetlands. Comparison of the two-years' data with conditions in the baseline year 1999 leads to the following conclusions:

1. Hurricane Matthew has had a continuing impact on the wetlands.
2. The most impacted wetland has been the Golf Course component.
3. The Golf Course Wetland is in transition and has become less ecologically productive. Without more regular supply of RW water, this wetland will mature as a drier pineland.
4. Both wetlands will recover slowly due to the scale of the disruption of the storms, however, the Forest Wetland is more mature, deeper and larger. This community should recover much more quickly.

## RECOMMENDATIONS

1. Operational changes are recommended: To rectify significant natural and human impacts, eliminate the rigid dry-down mandate and instead, apply dry-down only as a flexible alternative to benefit the ecology of the wetland, rather than stress it. This action will; (1) help sustain critical functions of the wetlands, including water quality enhancement sought by the U.S. Clean Water Act; (2) preserve critical habitat for protected international migratory wildlife, such as the songbirds and raptors that currently use the wetlands.
2. Continue to detail specific impacts of climate change on the RW wetlands. This is vital to assure the success of the RW project.
3. Hilton Head PSD should continue its successful outreach program to educate customers and the general public about the valuable Recycled Water Program pioneered on Hilton Head Island.

## 6. Glossary

**Adsorption** Accumulation of liquids or solids on the surface of leaves.

**Basal Area** The cross-sectional area of a tree trunk measured in square inches or square feet at 4.5 feet above ground.

**Biennial** A duration of two years.

**Bottomland** A low terrain that contains freshwater or a high water table.

**Climate Change** Any significant change in the measures of climate lasting for an extended period of time. Climate change includes major changes in temperature, precipitation, or wind patterns, among others, that occur over several decades or longer.

**Colonial Wading Birds** Herons, egrets and ibises and other long-legged water birds that nest in dense communities called "rookeries."

**Cover** The degree to which above-ground portions of vegetation cover the ground surface. Also called areal cover.

**Dominance** The measure of a plant species compared with other species, based on areal cover (groundcover) and caliper inches converted to basal area (trees).

**Density** The number of individuals of a species per unit area.

**Dry-down** A mandated period in which no Recycled Water flows into a wetland.

**Drought** A period of abnormally low rainfall that affects growing or living conditions.

**Ecological Succession** The process in which communities of plant and animal species in a particular area are replaced over time by a series of different and more complex communities.

**Endangered Species** A species of plant or animal that is in danger of going extinct.

**Emergent Plant** A plant with its lower part underwater and its upper part, usually leaves and flowers, above the water surface.

**Evapotranspiration** The process in which water is changed into vapor by atmospheric pressure, wind, humidity, solar radiation, and released through plant leaves and bark.

**Flyway** A globally fixed route along which birds (e.g., songbirds and waterfowl) migrate.

**Frequency** The distribution of individuals of a plant species in an area.

**Growing Season** The portion of the year that is frost-free.

**Habitat** A place where a plant or animal lives. A productive habitat provides sufficient food, cover and water.

**Hardwood** A broad-leaved tree such blackgum, red maple, or sweet gum.

**Hydrology** The properties, distribution and circulation of water.

**Hydroperiod** The average annual cycle of rainfall of a location.

**Importance Value** The relative influence of a plant species in a plant community, obtained by summing relative dominance, density and frequency.

**Indicator Species** A species that indicates whether an ecosystem is vibrant or degrading.

**Keystone Species** A species that affects other species in a community.

**Macro-Invertebrate** An animal species lacking a backbone and which can be seen without the aid of optical magnification.

**Neotropical** The geographic region including Central and South America.

**NPDES** National Pollution Discharge System permit under the Clean Water Act.

**Old-growth Forest** A forest community with large trees for the site and species type; multiple canopy layers; and wide spacing between trees. Example: the Palmetto Hall Forest Wetland.

**Palustrine** A freshwater community. Example: Palmetto Hall Golf Course Wetland.

**Recycled Water** Advanced-treated domestic water discharged into wetlands to restore ecological functions, values, wildlife habitat, and human recreation opportunities. Formerly named "reclaimed water."

**Surface Plant** A species of vegetation that keeps leaves above the surface of the water.

**Wetland** An area that is inundated or saturated by surface or ground water at a frequency and duration to support vegetation adapted to saturated or flooded soil.

7. Wetland Vegetation  
Inventory of Observed Plant Species:  
1999-Present

**FOREST WETLAND**

<u>Common Name</u>	<u>Scientific Name</u>
Blackgum	<i>Nyssa biflora</i>
Broomsedge Bluestem	<i>Andropogon virginicus</i>
Bur Marigold	<i>Bidens laevis</i>
Button Bush	<i>Cephalanthus occidentalis</i>
Carolina Willow	<i>Salix caroliniana</i>
Climbing Hempweed	<i>Mikania scandens</i>
Cushion Moss	<i>Leucobryum glaucum</i>
Creeping Primrose	<i>Ludwigia palustris</i>
Dog Fennel	<i>Eupatorium capillifolium</i>
Duckweed	<i>Lemna minor</i>
Duckweed	<i>Lemna vadiiviana</i>
False Nettle	<i>Boehmeria cylindrica</i>
Fetterbush	<i>Lyonia lucida</i>
Floating Bladderwort	<i>Utricularia inflata</i>
Frog's Bit	<i>Limnobium spongia</i>
Gallberry	<i>Ilex glabra</i>
Grass-leaved	<i>Sagittaria graminea</i>
Highbush Blueberry	<i>Vaccinium corymbosum</i>
Lizard Tail	<i>Saururus cernuus</i>
Loblolly Pine	<i>Pinus taeda</i>
Maidencane	<i>Panicum hemitomon</i>
Marsh Pennywort	<i>Hydrocotyle umbellata</i>
Mosquito Fern	<i>Azolla caroliniana</i>
Netted Chainfern	<i>Woodwardia areolata</i>
Pickereelweed	<i>Pontederia cordata</i>
Persimmon	<i>Diospyros virginiana</i>
Poison Ivy	<i>Toxicodendron radicans</i>
Pond Pine	<i>Pinus serotina</i>
Primrose Willow	<i>Ludwigia peruviana</i>
Red Bay	<i>Persea borbonia</i>
Red Bay/Swamp Red Bay	<i>Persea palustris</i>
Red Maple	<i>Acer rubrum</i>
Red-root	<i>Lachnanthes caroliniana</i>
Royal Fern	<i>Osmunda regalis</i>
Shade Mudflower	<i>Micranthemum umbrosum</i>

Southern Blueflag Iris	<i>Iris versicolor</i>
Spanish Moss	<i>Tillandsia usneiodes</i>
Sweet Gum	<i>Liquidambar styraciflua</i>
Switch Grass Panicum	<i>Panicum virgatum</i>
Virginia Chainfern	<i>Woodwardia virginica</i>
Walter's Sedge	<i>Carex walteri</i>
Water Net	<i>Hydrodictyon</i> sp.
Water Pennywort	<i>Hydrocotyle ranunculoides</i>
Water Pepper	<i>Polygonum hydropiperoides</i>
Waxmyrtle	<i>Myrica cerifera</i>
Wingstem	<i>Verbesina occidentalis</i>
Wolffia (Water Meal)	<i>Wolffia punctata</i>
Yellow Cyperus	<i>Cyperus flavescens</i>

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**Total: 47 Species**

### GOLF COURSE WETLAND

<u>Common Name</u>	<u>Scientific Name</u>
Black-Gum	<i>Nyssa biflora</i>
Blue-green Algae	<i>Lyngbya</i> sp.
Bracken Fern	<i>Pteridium aquilinum</i>
Broomsedge Bluestem	<i>Andropogon virginicus</i>
Bur marigold	<i>Bidens laevis</i>
Carolina Willow	<i>Salix caroliniana</i>
Cattail (Tall)	<i>Typha latifolia</i>
Chinese Tallowtree	<i>Sapium sebifera</i>
Cinnamon Fern	<i>Osmunda cinnamomea</i>
Climbing Hempweed	<i>Mikania scandens</i>
Cushion Moss	<i>Leucobryum glaucum</i>
Dahoon Holly	<i>Ilex cassine</i>
Duckweed	<i>Lemna vadiviana</i>
False Nettle	<i>Boehmeria cylindrica</i>
Fetterbush	<i>Lyonia lucida</i>
Floating Bladderwort	<i>Utricularia inflata</i>
Gallberry	<i>Ilex glabra</i>
Giant Cane	<i>Arundinaria gigantea</i>
Giant Plume Grass	<i>Erianthus gigantea</i>
Loblolly Pine	<i>Pinus taeda</i>
Maidencane	<i>Panicum hemitomon</i>
Marsh Pennywort	<i>Hydrocotyle umbellata</i>
Mosquito Fern	<i>Azolla caroliniana</i>
Netted Chainfern	<i>Woodwardia areolata</i>
Persimmon	<i>Diospyros virginiana</i>
Pickerelweed	<i>Pontederia cordata</i>
Plume Grass	<i>Setaria magna</i>

Poison Ivy	Toxicodendron radicans
Red Maple	Acer rubrum
Red Bay	Persea borbonia
Red-root	Lachnanthes caroliniana
Royal Fern	Osmunda regalis
Saw Palmetto	Serenoa repens
Sawgrass	Cladium jamaicense
Sedge sp.	Carex sp.
Smartweed (Dense-flower)	Polygonum densiflorum
Soft Rush	Juncus effusus
Southern Blueflag Iris	Iris versicolor
Spanish Moss	Tillandsia usneiodes
Swamp Dewberry	Rubus hispidus
Swamp Knotweed	Polygonum hydropiperoides
Virginia Chainfern	Woodwardia virginica
Virginia Creeper	Parthenocissus quinquefolia
Water Milfoil	Myriophyllum sp.
Water Net Algae	Hydrodictyon sp.
Water Pennywort	Hydrocotyle ranunculoides
Water Spider Orchid	Habenaria repens
Waxmyrtle	Myrica cerifera
Wolffia (Water Meal)	Wolffia punctata

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**Total: 48 Species**

**8. Wetland Wildlife**  
**Inventory of Observed Animal Species: 1999-Present**

**FOREST WETLAND**

Common Name: \_\_\_\_\_ Scientific Name:

VERTEBRATES

**Amphibians: 4 Species**

Green Treefrog	<i>Hyla cinerea</i>
Southern Dusky Salamander	<i>Desmognathus auriculatus</i>
Southern Chorus Frog	<i>Pseudracis nigrata</i>
Southern Leopard Frog	<i>Rana sphenoccephala</i>

**Birds: 29 Species**

American Robin	<i>Turdus migratorius</i>
Barred Owl	<i>trix varia</i>
Blue Jay	<i>Cyanocitta cristata</i>
Carolina Chickadee	<i>Parus carolinensis</i>
Carolina Wren	<i>Thyrothorus ludovicianus</i>
Chuck-Will's Widow	<i>Caprimulgus carolinensis</i>
Common Crow	<i>Corvus brachyrhynchos</i>
Common Grackle	<i>Quiscalus quiscula</i>
Downy Woodpecker	<i>Picoides pubescens</i>
Eastern Phoebe	<i>ayornis phoebe</i>
Gray Catbird	<i>Dumetella carolinensis</i>
Great Blue Heron	<i>Ardea herodias</i>
Great Egret	<i>Casmerodius albus</i>
Green-backed Heron	<i>Butorides striatus</i>
Northern Cardinal	<i>Cardinalis cardinalis</i>
Osprey	<i>Panodiun haliaetus</i>
Pileated Woodpecker	<i>Dryocopus pileatus</i>
Red-bellied Woodpecker	<i>Melanerpes carolinus</i>
Red-shouldered Hawk	<i>Buteo lineatus</i>
Red-tailed Hawk	<i>Buteo jamaicensis</i>
Rufous-sided Towhee	<i>Pipilo erythrophthalmusi</i>
Snowy Egret	<i>Egretta thula</i>
Tufted Titmouse	<i>Parus bicolor</i>
Turkey Vulture	<i>Cathartes aura</i>
Yellow-bellied Sapsucker	<i>Sphyrapicus varius</i>
Yellow-rumped Warbler	<i>Dendroica coronata</i>
Wood Duck	<i>Aix sponsa</i>
Wood Stork	<i>Mycteria americana</i>
White Ibis	<i>Eudocimus albus</i>

### **Fish: 1 Species**

Eastern Mosquitofish

*Gambusia affinis*

### **Mammals: 4 Species**

Eastern Gray Squirrel  
Raccoon  
White-tailed Deer  
hiltonensis

*Sciurus carolinensis*  
*Procyon lotor*  
*Odocoileus virginianus*

### **Reptiles: 6 Species**

American Alligator  
Five-lined Skink  
Green Anole  
Southern Black Racer  
Eastern Cottonmouth  
Northern Copperhead

*Alligator mississippiensis*  
*Eumeces fasciatus*  
*Anolis carolinensis carolinensis*  
*Coluber constrictus priapus*  
*Agkistrodon piscovorus*  
*Agkistrodon contrortrix-mokasen*

### **Macro-Invertebrates**

#### **Arachnids: 16 Species**

Black and Yellow Argiope Spider  
Brown Daddy-long-legs  
Carolina Wolf Spider  
Comb-footed Spider  
Chigger (Harvestmite)  
Dwarf Spider  
Forest Wolf Spider  
Golden Silk Spider  
Jumping Spider  
Mabel Orchard Spider  
Sheetweb Spider  
Six-spotted Fishing Spider  
Thin-legged Wolf Spider  
Water Mite  
Water Spider  
White Micranthena Spider

*Argiope aurantia*  
*Phalangium opilio*  
*Lycosa carolinensis*  
*Anelosimus studiosus*  
*Trombicula* sp.  
*Ostearius melonopyius*  
*Lycosa gulosa*  
*Nephila clavipes*  
*Metaphidippus galathen*  
*Leucauge mabelae*  
*Linyphiinnia* sp.  
*Dolomedes triton*  
*Pardosa* sp.  
*Hygrobates* sp.  
*Argyronera aquatica*  
*Micranthena mitrata*

### **Copepods: 2 Species**

Calanoid Copepod  
Diaptomus Copepod

Copepoda sp.  
Diaptomus sp.

### **Crustaceans: 2 Species**

Isopod  
Scud

Asellus sp.  
Hyaella azteca

### **Diplopods: 2 Species**

Millipede  
Millipede

Sirobolid sp.  
Platydesmid sp.

### **Insects: 46 Species**

American Dagger Moth  
Angular-winged Katydid  
Black-faced Skimmer Dragonfly  
Black Salt marsh Mosquito  
Broad-shouldered Water Strider  
Brown Daddy-long-legs  
Chironomid midge  
Common Water Strider  
Crane Fly  
Creeping Water Bug  
Deerfly  
Earwig  
Elmid Beetle  
Field Cricket  
Fire Ant  
Golden Salt marsh Mosquito  
Green Clearwing Dragonfly  
Green Darner Dragonfly  
Green Midge  
Green Water Strider  
Katydid  
Marsh Fly  
Mydas Fly  
Mud Dauber Wasp  
Leaf Beetle  
Leafhopper  
Long-legged Fly  
Love Bug  
Nessus Sphinx Moth  
Northern Katydid  
Palamedes Swallowtail Butterfly

Acronicta americana  
Microcentrum retinerve  
Libellul cyanea  
Aedes taeniorynchus  
Microvelia borealis  
Phalngium opiolo  
Chironomid sp.  
Gerris remigis  
Tipula sp.  
Pelocoris sp.  
Chrysops sp.  
Foricula sp.  
Stenelms lateralis  
Gryllus pennsylvanicus  
Solenopsis gominata  
Aedes sollicitans  
Erythemis simpliciollis  
Ajax junius  
Tanytarsus sp.  
Gerris sp.  
Pseudophyllinae sp.  
Tetanocera sp.  
Mydas clavatus  
Sceliphron caementarium  
Donacia sp.  
Cicallid sp.  
Dolichoplus longipennis  
Plecia nearctica  
Amphion nessus  
Pterophylla camefolia  
Pterourus palamedes

Periodical Cicada  
Planthopper  
Scarab Beetle  
Southern House Mosquito  
Small Whirligig Beetle  
Southern Spread-wing Damselfly  
Summer Mosquito  
Tree-hole Mosquito  
Water Boatman  
Water Lily Leaf Beetle  
Water Strider – Broad-shouldered  
Water Strider  
Water Treader  
White Fly  
Widow Dragonfly  
Yellow Jacket

Magiccada sp.  
Delphacid sp.  
Scarabaedid sp.  
Culex pipiens quinquefasciatus  
Gyrinus sp.  
Lestes australis  
Aedes atlanticus  
Aedes triseriatus  
Corixa sp.  
Donacid sp.  
Microvelia borealis  
Gerris marginatus  
Mesovelia mulsanti  
Aleyrodid sp.  
Libellula lucoasa  
Vespula sp.

**Isoptera: 1 Species**

Eastern Subterranean Termite

Reticulitermes flavipes

**Mollusca: 1 Species**

Hairy Wheel Snail

Gyraulus hirsutus

**Tadpole Shrimp: 1 Species**

Tadpole Shrimp

Triops longicaudatus

**Water Fleas: 1 Species**

Water Flea

Daphnia pulex

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**Total: 110 Species**

## GOLF COURSE WETLAND

Common Name: \_\_\_\_\_

Scientific Name: \_\_\_\_\_

### VERTEBRATES

#### **Amphibians: 1 Species**

Green Treefrog

*Hyla cinerea*

#### **Birds: 37 Species**

American Black Duck

*Anas rubripes*

American Coot

*Fulica americana*

American Robin

*Turdus migratorius*

Anhinga

*Anhinga anhinga*

Bald Eagle

*Haliaeetus leucocephalus*

Black-crowned Night Heron

*Nycticorax violacea*

Blue Jay

*Cyanocitta cristata*

Carolina Chickadee

*Parus carolinensis*

Carolina Wren

*Thyrothorus ludovicianus*

Cedar Waxwing

*Bombycilla cedrorum*

Common Crow

*Corvus brachyrhynchos*

Common Grackle

*Quiscalus quiscula*

Common Yellow-shafted Flicker

*Colaptes auratus*

Eastern Bluebird

*Sialia sialis*

Great Blue Heron

*Ardea herodias*

Great Crested Flycatcher

*Myiarchus crinitus*

Great Egret

*Casmerodius albus*

Great Horned Owl

*Bubo virginianus*

Green-backed Heron

*Butorides striatus*

Moorhen (Common Gallinule)

*Gallinula chloropus*

Northern Cardinal

*Cardinalis cardinalis*

Osprey

*Panodiun haliaetus*

Peregrine Falcon

*Falco peregrinus*

Pileated Woodpecker

*Dryocopus pileatus*

Red-bellied Woodpecker

*Melanerpes carolinus*

Red-winged Blackbird

*Agelaius phoeniceus*

Red-shouldered Hawk

*Buteo lineatus*

Ruby-throated Hummingbird

*Archilochus colubris*

Rufous-sided Towhee

*Pipilo erythrophthalmusi*

Snowy Egret

*Egretta thula*

Tufted Titmouse  
Turkey Vulture  
Yellow-billed Cuckoo  
Yellow-rumped Warbler  
Wood Duck  
Wood Stork  
White Ibis

Parus bicolor  
Cathartes aura  
Coccyzus americanus  
Dendroica coronata  
Aix sponsa  
Mycteria americana  
Eudocimus albus

#### **Fish: 1 Species**

Eastern Mosquitofish

Gambusia affinis

#### **Mammals: 4 Species**

Eastern Gray Squirrel  
Raccoon  
River Otter  
White-tailed Deer  
hiltonensis

Sciurus carolinensis  
Procyon lotor  
Lutra canadensis  
Odocoileus virginianus-

#### **Reptiles: 4 Species**

American Alligator  
Eastern Cottonmouth  
piscovorus  
Green Anole  
Yellow-bellied Slider

Alligator mississippiensis  
Agkistrodon piscivorus-  
  
Anolis carolinensis carolinensis  
Chrysemys scripta scriptai

#### Macro-Invertebrates

#### **Arachnids: 9 Species**

American Dog Tick  
Forest Wolf Spider  
Dwarf Spider  
Golden Silk Spider  
Pirate Wolf Spider  
Red Freshwater Mite  
Six-spotted Fishing Spider  
Wasp Spider  
Water Mite

Dermacento variabilis  
Lycosa gulosa  
Mycriphantinae sp.  
Nephila clavipes  
Pirata piraticus  
Limnocharus americana  
Dolomedes triton  
Halcti sp.  
Hygrobatas sp.

#### **Crustaceans: 4 Species**

Scud  
Scud

Gammarus fasciatus  
Hyaella asteca

Sow Bug  
Water Flea

**Insects: 35 Species**

American Dagger Moth  
Black Carpenter Ant  
Black Fly  
Black Salt marsh Mosquito  
Citrine Forktail Damselfly  
Chironomid Midge  
Condyllostylid Long-legged Fly  
Common Water Strider  
Crawling Water Beetle  
Deerfly  
Eastern Malaria Mosquito  
Eastern Tent Moth  
Field Cricket  
Green Clearwing Dragonfly  
Green Darner Dragonfly  
Green Midge  
House Fly  
Leaf Beetle  
Lightning Bug  
Marsh Fly  
Meadow Grasshopper  
Net-winged Damselfly  
Pale Bluet Dragonfly  
Periodical Cicada  
Plant Bug  
Planthopper  
Red Skimmer Dragonfly  
Shore Fly  
Southern House Mosquito  
Spotless Nine-spotted Ladybug  
  
Swift Long-winged Skimmer  
Thrip  
Water Scorpion  
Water Strider – Broad-shouldered  
Whirligig Beetle

*Oniscus asellus*  
*Daphnia pulex*

**Insects: 36 Species**

*Aconicta americana*  
*Camponotus pennsylvanicus*  
*Simulium* sp.  
*Aedes taeniorhynchus*  
*Ischnura hastata*  
*Chironomid* sp.  
*Condyllostylid* sp.  
*Gerris remigis*  
*Peltodytes lengi*  
*Chrysops* sp.  
*Aedes quidrimaculatus*  
*Malicosma americanum*  
*Gryllus pennsylvanicus*  
*Erythemis simplicollis*  
*Anax junius*  
*Tanytarsus* sp.  
*Musca domestica*  
*Donacia* sp.  
*Lampyrid* sp.  
*Tetanocera* sp.  
*Convuphalinae* sp.  
*Argia* sp.  
*Enallagma hastata*  
*Magiciudadada* sp.  
*Mirid* sp.  
*Delphacid* sp.  
*Libellula saturata*  
*Ephyrdid* sp.  
*Culex pipiens quinquefasciatus*  
*Coccinella novemnota*  
*franciscana*  
*Pachydiplax longipennis*  
*Thysanoptera* sp.  
*Ranatra* sp.  
*sMicrovelia borealis*  
*Dineutes americanas*

**Isoptera: 1 Species**

Eastern Subterranean Termite

*Reticulitermes flavipes*

**Worms: 2 Species**

Earthworm  
Flatworm

*Lumbricus terrestris*.  
*Dugesia tigrina*

**Mollusks: 3 Species**

Hairy Wheel Snail  
Little Pond Snail  
Winkle Snail

*Gyraulus hirsutus*  
*Amnicola limnosa*  
*Viviparus intertextus*

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**Total: 100 Species**

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