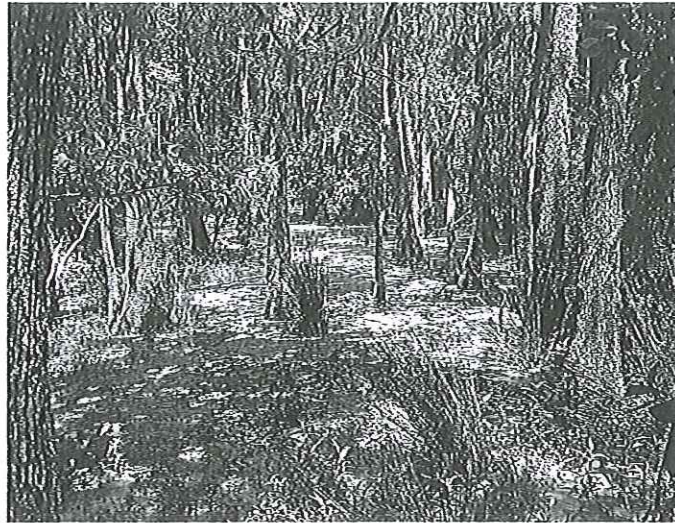


Mid-year Report Reclaimed Water for Wetlands

**Cypress Conservancy
Whooping Crane Conservancy
Hilton Head Island, South Carolina**



Prepared July 25, 2012 for
Hilton Head Public Service District
Hilton Head Island, South Carolina



Boulder, Colorado

Table of Contents

1. Introduction	3
2. Data Summary	5
Hydrology	5
Wetland Vegetation	10
Wetland Wildlife	12
3. Photographs.....	14
4. Conclusions and Recommendations	16

Tables

2-1. Monthly Rainfall	5
2-2. Monthly Reclaimed Water Influent Loading.....	5
2-3. Surface Water Characteristics	9
2-4. Plant Species Recorded	10
2-5. Nuisance Plant Species	11
2-6. Macro-invertebrate Assay	12

Figures

2-1. Total Water Received in Project Wetlands.....	6
2-2. Inches of Total Water: Cypress Conservancy	7
2-3. Inches of Total Water: Whooping Crane Conservancy.....	8

1. Introduction

Reclaimed Water (RCW) is the process of recycling advanced-treated, domestic-source wastewater in native freshwater wetlands. This environmentally sustainable technology was developed On Hilton Head Island in 1980*. Since 1986, the Hilton Head Public Service District RCW project has: restored and enhanced the old growth wetlands, rejuvenated the central watersheds, replenished wildlife habitat—including refuge for endangered and threatened species, and maintained high surface water quality in the community.

This report presents the results from semiannual biological monitoring in the Cypress Conservancy and Whooping Crane Conservancy RCW projects. These aquatic communities are located in Hilton Head Plantation on northeastern Hilton Head Island. Ballantine Environmental Resources conducted biological monitoring data the week of May 1, 2012. This period represents a sample of the “growing season” for vegetation.

Cypress Conservancy (Cypress) is a forest with hardwoods and the last large stand of rare bald and pond cypress trees on Hilton Head Island. This freshwater wetland encompasses 50.8 acres in two cells. RCW was introduced into the 36-acre western cell of Cypress in 1991.

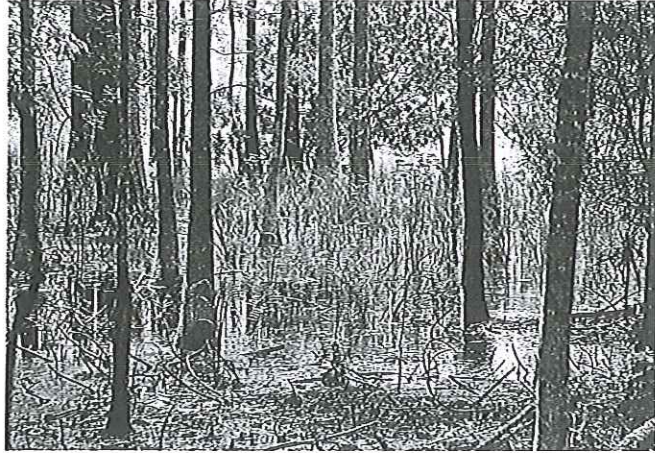


PLENTIFUL HABITAT provides feeding opportunities for wading birds in Cypress Conservancy. *Photo: Marianne Ballantine*

* Ballantine Environmental Resources, Inc. created the concept for the first RCW-wetland project in the U.S. This and five more projects were brought on line in the next two decades. Hilton Head PSD operates four projects on the Island.

Whooping Crane

Conservancy (Whooping Crane) is a 115-acres hardwood forest system. In 1986, the RCW project was put into operation in the northern cell (68 acres) of this freshwater wetland.



GREEN TREE RESERVOIR: Whooping Crane Conservancy.

Environmental Monitoring

The monitoring protocol complied with requirements in Hilton Head Public Service District's NPDES (National Pollution Discharge Elimination System) Permit: SCDHEC No. SC0046191). BER collected data at permanent stations on transects in these "project wetlands" that receive RCW. Data includes hydrology, vegetation, and macro-invertebrate samples in the project wetlands. This Growing Season Report provides a summary of our research findings with images, tables, figures, conclusions and recommendations.

DEFINITIONS

Hydrology is the scientific study of the properties, distribution, and effects of water on the earth's surface, sub-surface and atmosphere. The primary value of reclaimed water is that it enhances the natural hydrology of wetlands.

Macro-invertebrates are animals lacking a backbone and large enough to identify without magnification. Reclaimed water enhances habitat for macro-invertebrates, which are a "prey organism" consumed by larger animals such as fish, frogs, lizards, and birds.

National Pollutant Discharge Elimination System (NPDES): A national program under Section 402 of the U.S. Clean Water Act for regulation of discharges of pollutants from point sources to waters of the United States, such as wetlands. NPDES categorizes RCW as a "non-conservative,"—mitigated by natural biodegradation in the wetlands.

The next monitoring will take place in November—the "dormant season" for vegetation. Data from this study will be included in the 2012 Annual Monitoring Report, due in February 2013.

Data Summary

WETLAND HYDROLOGY

Table 2-1: Monthly Rainfall: January-June 2012
 Hilton Head Plantation Reclaimed Water Project

Month	Actual Rain	40-Year Average Rain
January	0.53	3.74
February	2.60	3.42
March	6.78	4.04
April	0.35	2.95
May	3.45	3.70
June	4.09	4.99
Total	17.80	22.84

Rainfall is expressed in inches. Hilton Head PSD measured precipitation at the Royal James Plant near the project wetlands. 40-year average ("historical norm") data: SC. Water Resources Commission (1991).

Rainfall was below-average in the first half of 2012. Total precipitation was 22% lower than the historical norm for five months in the first half of the year. This "dry spring" trend has continued through the past decade.

Table 2-2: Monthly RCW Influent Loading in Acre-inches: January-June 2012
 Hilton Head Plantation Reclaimed Water Project

Month	Cypress	W. Crane	Total
January	7.78	9.07	58.94
February	1.08	5.26	16.85
March	11.14	13.03	6.34
April	4.04	3.21	24.17
May	0	0	4.24
June	0.92	3.41	0
Total	25.00	33.98	58.94

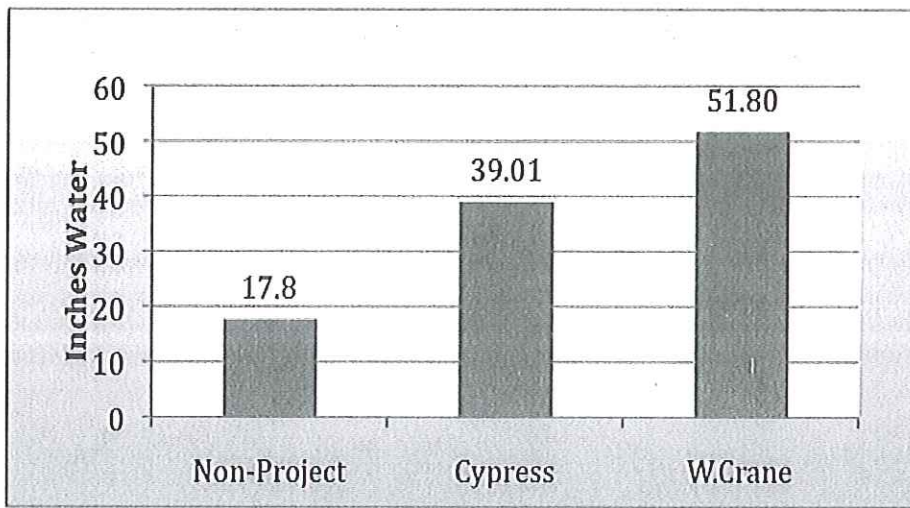
Sources: Loading in MG: Hilton Head Public Service District: Cypress=24.3 MG; Whooping Crane=62.7 MG. Conversion to acre-inches: Ballantine Environmental Resources, Inc. Totals are rounded.

As the season grew drier, the PSD directed most of the RCW to contracting golf courses. In May and June, virtually no rain fell, causing incipient (early) drought conditions—and high irrigation demand island-wide. This trend has recurred over the past five years, or more.

For wetlands, an inch of water is not much. Cypress received 28% of the influent—24.3 million gallons (MG). This volume was equal to (27.9 million gallons)—equal to 2.4 acre-feet, or one-quarter inch of water per day.

Whooping Crane received 72% of the influent (67.23MG). This volume was equal to 5.6 acre-feet, an average of just one-third inch daily.

**Figure 2-1: Total Water Received in Project Wetlands
Reclaimed Water plus Rainfall
Hilton Head Plantation Reclaimed Water Project: January – June 2012**



“Total water” is precipitation plus RCW measured in acre-inches for a monitoring period.
“Non-project wetlands” are other Hilton Head Island wetlands that do not receive RCW.

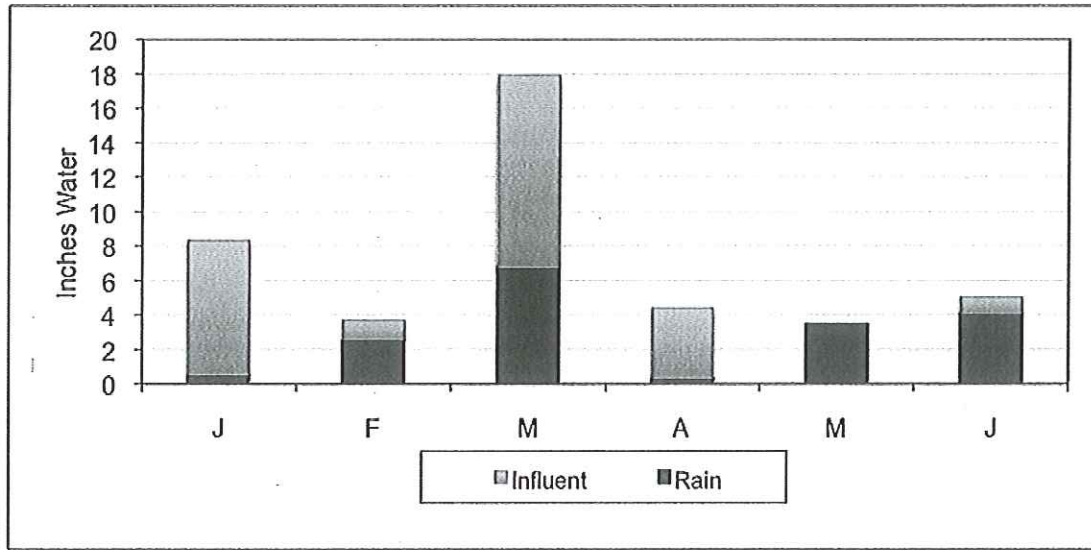
Total water loading exceeded rainfall in the wetlands in the first half of 2012. This has been the pattern of flow over nearly the past decade. In 2012, the project wetlands received a large surplus of water January through March: this trend has continued over the past 5-6 years.

Non-project wetlands—Hilton Head Island wetlands that are not part of reclaimed water operations—received less than three inches of water (only rain) per month, January-June. This trend continues the impact of incipient (early) drought that has affected lower South Carolina in the first six months of 2012. In the month preceding this report, normal rainfall returned to Hilton Head Island.

Cypress received approximately 39 inches (3.3 acre-feet) of total water during the six-month period. This volume was 119% more water than non-project wetlands received on Hilton Head Island. **Whooping Crane** received the equivalent of 4.3 acre-feet of total water. This volume was nearly three times more water than non-project wetlands on Hilton Head Island received during the six-month period.

NOTE: *Whooping Crane Conservancy is a deeper, larger basin than Cypress Conservancy or any other wetland on Hilton Head Island. This is why it is such a good location for reclaimed water storage.*

Figure 2-2: Inches of Total Water
Cypress Conservancy Project Wetland: January-June 2012
(Average monthly rainfall = 3.8 inches)



Reclaimed enhanced Cypress Conservancy in the first half of 2012.

Figure 2-2 shows that from January to June of 2012, RCW plus rainfall exceeded average monthly precipitation in four months. As a result, surface water habitat was more widespread in this wetland.

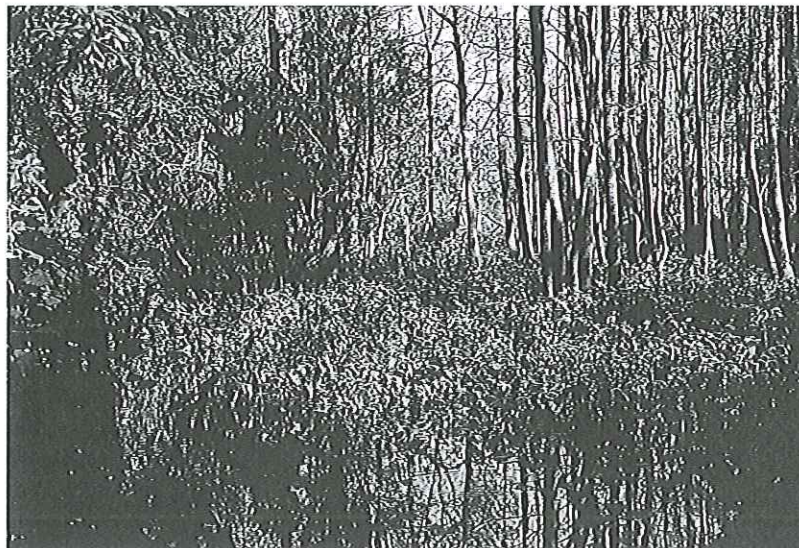


Photo by Marianne Ballantine

Figure 2-3: Inches of Total Water
Whooping Crane Conservancy Project Wetland: January-June 2012
(Average monthly rainfall = 3.8 inches)

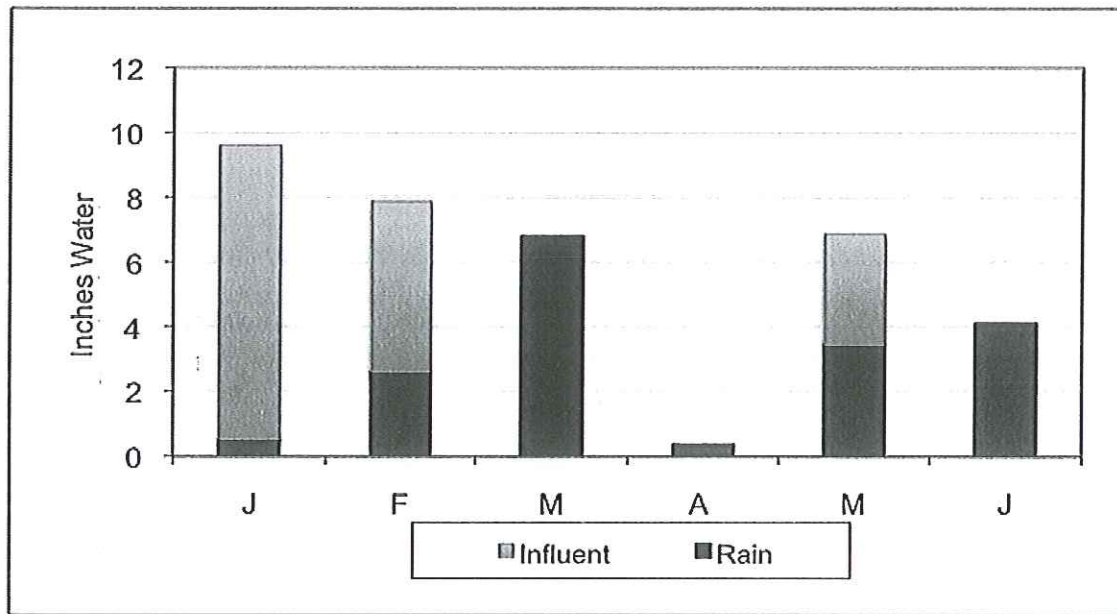


Photo by Todd Ballantine

Total water loading in Whooping Crane enhanced wetland hydrology for most of the period. RCW inflow exceeded the average monthly rainfall (3.8") in five of six months. As in Cypress, the Whooping Crane project retained shallow surface water. This "summer pond" habitat supported a diversity of macro-invertebrates, fish, amphibians and birds.

Left: White ibis feed in the center of Whooping Crane Conservancy.

Table 2-3
Surface Water Characteristics
Cypress Conservancy and Whooping Crane Conservancy
Growing Season 2012

Data	Cypress	W. Crane
Condition	Mostly Inundated	Inundated
Percent Coverage	75%	100%
Average Depth	3.9"	6.1"
Most Common	0", 2", 3"	8"
Deepest Water	13"	8"
Color	Brown	Brown
Characteristic	Tannic	Tannic

From deep water to puddles—the impact of “dry-down.”

Cypress Conservancy was covered with deeper water than in past years. 2012 has been a year without *dry-down*—approximately 6 months in which RCW releases are not allowed under SCDHEC permit conditions. This year, the wetland returned to its true historic state:

- Water covered the lower central and northern sector.
- Water was deepest in the center of the wetland.
- The higher, southeastern end of the wetland had no water.
- The water was tannic—the color of “black tea”—stained by acids leaching from submerged foliage.
- Plant life and was significantly richer in the inundated areas.
- Wildlife was most active in the water-covered sectors. This includes species from the smallest midges to the wading birds and raptors.
- The permanent resident red-shouldered hawk was once again patrolling the forest, protecting its high-tree nest territory.

In **Whooping Crane**, the larger and deeper basin:

- The wetland was entirely water-covered.
- The average water level was lower than in years past: coverage ranged from 1-8 inches. The most common depth was 7 inches.
- Typical water: clear to tannic.
- Perennial plant life—floating and marsh vegetation—was widespread. Shrubs and grasses are colonizing shallower areas exposed by dry weather and lower flow of RCW.

WETLAND VEGETATION

PARAMETERS FOR VEGETATION MONITORING

Observed in the Growing Season 2012 and the Baseline (1998)

Cypress Conservancy and Whooping Crane Conservancy

- **Vegetation Strata Measured: Canopy (C), Shrub-Groundcover (S/Gc)**
- **Diversity:** The total number of plant species measured in monitoring stations.
- **Dominance:** The percent basal area (C) or areal cover (S/Gc) of individual species, per transect station and averaged for the wetland, as a percent of 100 percent (all species).
- **Density:** The percent of live stems of individual species, per wetland, as a percent of 100 percent (density of all species).
- **Frequency:** The number of stations on which an individual species occurred, per wetland, as a percentage of 100 percent (total of all stations on which all species occurred).
- **Importance Value (I. Value):** The sum of relative dominance, relative density, and relative frequency. Values were calculated for individual species, monitoring stations, and as an average for the project wetland. Importance Values are calculated in the Annual Monitoring Report.
- **Nuisance species:** Invasive, exotic, and other problematic plant species that have the potential to degrade the wetland. Nuisance species were tracked according to relative dominance and I. Value.
- **Endangered and threatened species:** Federal and/or South Carolina listed plant species, if observed, were tracked according to Importance Value.

Table 2-4
Plant Species Recorded
 Cypress Conservancy and Whooping Crane Conservancy
 Growing Season 2012

Canopy	Shrub-Groundcover	
Bald Cypress	Baggy Knees Grass	Marsh Fern
Blackgum	Blueflag Iris	Mosquito Fern
Loblolly Pine	Bur Marigold	Netted Chainfern
Pond Cypress	Creeping Primrose	Saw Palmetto
Red Bay	Duckmeat	Sawgrass
Red Maple	Duckweed	Virginia Chainfern
Sweet-gum	Fanwort	Walter's Sedge
	Fetterbush	Water Pennywort
	Frog's Bit	Water Pepper
	Highbush Blueberry	Water Net
	Lizard's Tail	Wax Myrtle
	Maidencane	Wolffia

Summary of Vegetation Response to Reclaimed Water

Cypress:

- Species diversity declined by 21%.
- The number of canopy species decreased minimally, due to die-off by pond pine (one tree) several years ago.
- Groundcover diversity dropped by 19%. This change reflects coverage by surface water, and the lingering impact of recent dry-down, which caused dieback in one-third of the wetland.
- Other causes for change (Table 2-4) included past drought and dry-down periods.

Whooping Crane:

- Species diversity dropped by 30%.
- The number of canopy species decreased with die-off of red bay during the drought of 1998-2002.
- The number of groundcover species decreased due to coverage by water and in some areas, ecological succession (species replacement over time).
- The surplus of total water supported floating species such as duckweed, which provided the highest amount of cover, density, and importance value (see Table 2-5).

Endangered or Threatened Plants

No endangered or threatened plant species inhabited the Whooping Crane RCW project.

Nuisance Plant Species

The table, below, summarizes the change in relative dominance and importance value of nuisance species since the baseline-growing season.

Table 2-5

Nuisance Species in Cypress and Whooping Crane Project Wetlands - 2012

Species	Wetland	% Relative Cover		Importance Value	
		1998	2012	1998	2012
Common Cattail	Whooping Crane	10.3	0	14.0	0
Maidencane	Cypress	11.8	0	46.0	0

No nuisance species observed in 2012: Cattail and maidencane did not inhabit the monitoring stations in 2012. Cattail was limited by shade and deep water. Maidencane died back due to the dry conditions in Cypress since 1998.

WETLAND WILDLIFE

Macroinvertebrates

**Table 2-6: Macro-invertebrate Assay
 Cypress and Whooping Crane Project Wetlands
 Growing Season 2012**

Species	Cypress	Whooping Crane	Frequency
Ant – Little Black	X		O
Centipede (<i>Narceus</i>)		X	O
Dragonfly – Green Darner	X	X	U
Dragonfly – Sift Long-winged Skimmer		X	O
Fly – Marsh	X	X	C
Midge – Chironomid	X	X	C
Green Midge	X	X	C
Mosquito – Golden Saltmarsh	X	X	N
Scud (Amphipod)		X	C
Wasp – Paper			U
Water Treader		X	C
Total: 2012 Growing Season	6	9	<i>Average: O-C</i>
Baseline 1998	9	9	

Frequency key:

N = Numerous (>75% of stations)

C = Common (51%-75% of stations)

O = Occasional (26% - 50% of stations)

U = Uncommon (1% - 25% of stations)

Analysis: The depth and distribution of surface water cover controlled the number of macroinvertebrates in the wetlands. Three-quarters of the Cypress wetland was covered with water. This condition was beneficial to the often-observed dominant invertebrates in this community. **Whooping Crane** was entirely water-covered. Table 2-7 shows the clear benefit of water for invertebrates: one-third more observed species than in Cypress.

OBSERVED SPECIES ARE ONLY A SAMPLE of the totality of macro-invertebrates (species that lack a backbone but are large enough to see without magnification) in the RCW wetlands. Water nourishes the entire aquatic community—from the ground to the rarely explored forest canopy. These habitats, and the world of nature in-between, benefit significantly from RCW inflow.

Fish

We observed fish activity in the Cypress and Whooping Crane wetlands. As in past years, we identified the indicator species, eastern mosquitofish. This small fish arrives on the feet and legs of the abundant wading birds (egrets, herons, ibises, and wood storks) that inhabit the wetlands. Eastern mosquitofish

(Gambusia affinis) serves as evidence that ecological conditions and fisheries habitat are either improving or degrading.

Observed Vertebrates

Cypress: American crow, great egret, green treefrog, northern cardinal, snowy egret, white ibis, red-winged blackbird, white-tailed deer, and wood duck.

Whooping Crane: American crow, Carolina wren, great blue heron, great egret, green treefrog, osprey, red-shouldered hawk, white ibis, yellow-crowned night heron, and yellow-rumped warbler.

Endangered or Threatened Species

We observed no Federal or South Carolina listed (endangered or threatened) wildlife species in either wetland. However, the bald cypress and pond cypress trees in Cypress Conservancy should be considered locally endangered species on Hilton Head Island. Currently the Town of Hilton Head Island does not have such designations for vegetation or wildlife.

3. Photographs of Wetland Monitoring Areas

Photos by Marianne and Todd Ballantine

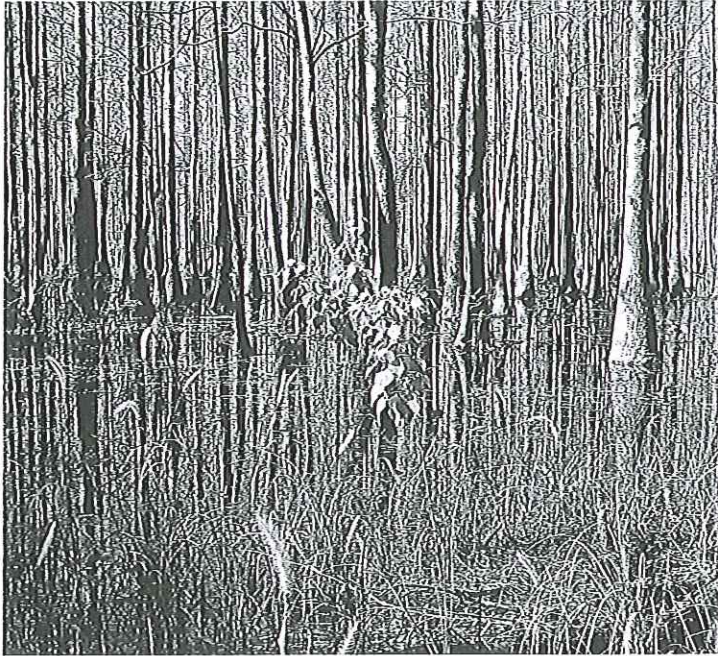
Cypress Conservancy



A WORLD OF GREEN: Cypress Conservancy comes to life when it receives water. Fish were prevalent in this pool.

Photo: Marianne Ballantine

Whooping Crane Conservancy



SPREADING FOREST
Blackgum trees stand tall on the perimeter of Whooping Crane Conservancy. Eventually this productive habitat will cover all but the deep center of the wetland.

Photo: Marianne Ballantine

SHADOW IN THE WATER: The American alligator is the "keystone species" in Whooping Crane Conservancy. It is a predator, but it creates holes and channels that benefit birds, amphibians, reptiles, mammals and insects.

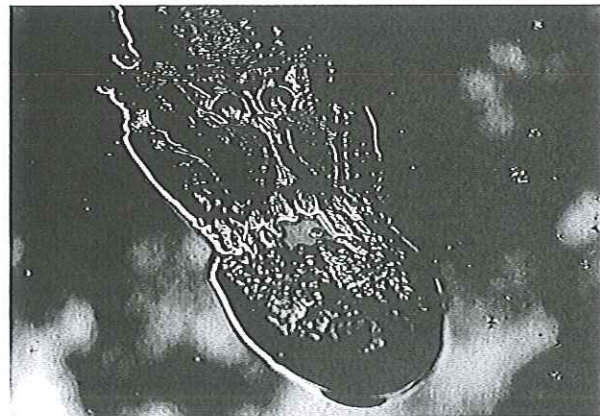


Photo: Todd Ballantine

4. Conclusions and Recommendations

Overview

This report has described environmental conditions in two large freshwater wetlands that receive reclaimed water (RCW). The RCW technology is the process of recycling advanced-treated, domestic-source wastewater in native freshwater wetlands on Hilton Head Island, South Carolina. The project wetlands are located in the western sector on Hilton Head Plantation. RCW operations have continued since 1986. As a result of monitoring in the 2012 growing season, as well as over a duration of 26 years, we are pleased to offer the following conclusions about the environmental conditions in the wetlands; and recommendations for managing these projects.

Conclusions

- Although these wetlands are nearly continuous, they are ecologically distinct and receive a different schedule of RCW flow. *Cypress Conservancy* (Cypress) is smaller and has a different forest association: a composite of extremely rare bald and pond cypress, and swamp blackgum trees.
- For millennia these wetland trees have adapted for growth in standing water, as well as the natural wet-dry cycles on Coastal South Carolina.
- The Cypress wetland is subject to “dry-down,” a SCDHEC rule, under the NPDES Permit, mandating no RCW flow during the growing-season, every three years. This wetland has suffered a significant loss of trees due to lack of water in the wetland.
- *Whooping Crane Conservancy* (Whooping Crane) is larger and has a more mature forest with large, old growth hardwood trees. This wetland is covered by water year-round. It is in the same watershed as Cypress Conservancy. Yet the Whooping Crane project has never been subject to dry-down, and has lost fewer trees than the Cypress forest.
- The shrub-groundcover community is more rich and diverse in Whooping Crane. As a result, the volume and diversity of wildlife—from reptiles,

amphibians and birds to invertebrates that are the basis of the food web—is more diverse in Whooping Crane.

- Each wetland supports a variety of wildlife in the tree canopy. Most significant: these trees are used by migratory and nesting Neotropical migratory songbirds as well as hawks, owls, bald eagles and colonial wading birds—egrets herons, ibises. *These species must have water in the wetland as a defense against predators.*

Recommendations

- Continue the schedule of semiannual biological monitoring in these wetlands. The critical focus should be how the RCW wetlands' values and functions will fare if drought and the dry-down requirement continue.
- Although there may be resistance at SCDHEC, we strongly believe that dry-down should be permanently eliminated in Cypress. It has been an impact, not a benefit. The changes in climate—recurring drought and rising temperatures—have altered the historic temperature and rainfall patterns on which the dry-down concept was based. Ballantine Environmental Resources can help Hilton Head PSD negotiate the elimination of dry-down.
- Dormant season monitoring for this year will take place in November of 2012.
- We will submit the Annual Biological Monitoring Report for 2012 to Hilton Head Public Service District in February 2013.

Thank you for the confidence in our work and the opportunity to serve the PSD. Please contact Ballantine Environmental Resources if you have any questions about this report.



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