LAKE TECUMSEH WEIRS VEGETATIVE MONITORING PLAN AND PRE-WEIR ESTABLISHMENT MONITORING RESULTS

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Partners for Fish and Wildlife Program
Virginia Field Office
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INTRODUCTION

The U.S Fish and Wildlife Service proposes to construct submerged weirs across two non-natural drainage canals that connect Lake Tecumseh with Asheville Bridge Canal in order to reduce turbidity discharge to Back Bay estuary, enhance habitat for aquatic wetland species, restore natural wetland hydrology to maintain legacy forests, and increase the number of days recreational boats can utilize the lake. Water quality and water level data from 2008 indicated the weirs would prevent the lower two-thirds of the wind tidal depth range from draining from the lake thereby preventing the release of a portion of two thousand tons of silt discharged annually. The project will provide an additional 193 days of recreational boating that otherwise are unavailable due to insufficient water depth. The magnitude of wind tidal fluctuations and drainage within the lake will be decreased by ninety percent after placement of the weirs.

All elevations in this report are to NAVD88 datum. The invert of the weirs will be at elevation +1.0 feet. Average high water in the lake is +1.1 feet and ranges from -.74 to +1.8 feet with an overall mean of +0.5 feet (2008-2009 data). The weirs will not increase the seasonal high depth or frequency of flooding. However, they will increase the baseline water depth by up to 5.5 inches in several low elevation wetlands where prolonged flooding up to elevation +0.7 feet currently occurs. The reason for the existing near permanent inundation of these wetlands is theorized to be high groundwater table and topography.

Expected wetland effects of the weirs include reducing the magnitude of human induced wind tides by ninety percent, a reduction in subsurface drainage of wetlands within the lake basin, an increase in baseline flood depth of some low wetlands adjacent to the lake, and the mortality of some understory saplings that include red maple, sweetgum, and wax myrtle due to intolerance to prolonged flooding. Mortality of understory red maple is considered desirable. The forest is experiencing a change in community type from bald cypress to one dominated by red maple due to drainage by wind tides and the weirs are expected to maintain the presence of bald cypress as a dominant canopy species.

The legacy forested wetlands consists primarily of bald cypress, swamp tupelo, swamp cottonwood, and red maple, many of which exceed one hundred years of age. These trees established long before the introduction of wind tidal flooding in 1969 and possess physical and chemical adaptations for tolerating prolonged flooding. However, due to the potential for unforeseen secondary impacts to these wetlands, the U.S. Fish and Wildlife Service is performing annual vegetation monitoring as required by regulatory permit(s). This monitoring report establishes the site locations, methodology, and pre-weir site results as part of this regulatory requirement.

LITERATURE REVIEW

Searches resulted in no published literature on the effects to vegetation of converting wind tidally influenced wetlands to non-tidal hydrology. However, depth of flooding, species type, and tree diameter were reported as the most significant variables of tree mortality in a permanently flooded floodplain forest in Florida (Harms et al, 1980). Trees with a diameter of five inches or less experienced the greatest mortality and two percent

of trees flooded to an average depth of eight inches experienced mortality which was equal to the rate of death in an adjacent non-impounded forest. Mortality increased to seventeen percent at an average depth of 27.6 inches and forty-one percent at a depth of 31.5 inches. Typical species included bald cypress, swamp tupelo, and red maple. Competition among overstory species was reduced in a permanently flooded Louisiana swamp up to one meter deep, enhancing the growth of existing bald cypress and water tupelo (Conner et al, 1981). Flood-intolerant trees were reduced and the presence of shrubs and aquatic plants increased. The 180-acre Lago Mar tract on the opposite side of the canal south of Lake Tecumseh was hydrologically restored in 2000. Recent qualitative monitoring of the site documented a thirty percent reduction in small diameter red maple and the re-establishment of bald cypress in forests formerly dominated by the species before logging and drainage occurred.

These studies suggest the forests adjacent to Lake Tecumseh that will receive up to an additional 5.5 inches of water on a semi-permanent basis will not be negatively impacted and the overstory trees consisting primarily of bald cypress will benefit from reduced competition by red maple. The data contained in this report indicate the understory species are primarily red maple (56%) while the older age cohort consists of bald cypress. This suggests wind tidal conditions are competitively selecting for red maple which eventually will become the dominant canopy type replacing the legacy forest of bald cypress. Bald cypress require extended periods of sustained flooding to reduce interspecific competition and maintain pure or mixed stands with swamp tupelo, another flood tolerant species. During infrequent droughts soils become exposed sufficiently to permit cypress seedlings to establish before flooding returns. The introduction of wind tides by the creation of Asheville Bridge Canal eliminated both sustained flooding and drought associated drawdowns under which Lake Tecumseh's legacy forests were established. Unlike bald cypress, hydrological alteration provided favorable conditions for red maple establishment. The weirs will help restore the original non-tidal hydrology to the lake and surrounding wetlands.

PURPOSE

Monitoring is to document pre-weir conditions and ensure the proposed weirs are not having an undesirable or unexpected secondary impact on wetlands located between the Hampton Roads Sanitation District's property and the Dam Neck property/Rainey Point. Undesirable effects would be a change in vegetative community type such as the conversion of forested wetland to open water, the conversion of emergent wetlands to open water, or the loss of one wetland type to another.

DESCRIPTION OF WETLANDS

The extent of wetlands associated with the weirs is estimated at a total of 104 acres (Figure 1). Sixty-six acres of these wetlands are forested or scrub/shrub and thirty-eight acres are herbaceous marsh. The elevation of these wetlands ranges from a low of 0.3 feet to a high of 1.5 feet. Hydrology monitoring beginning in February 2008 indicated these wetlands flood up to 1.2 feet deep with an average depth of 0.6 feet (n=3815). Flooding ranges between elevations 0.2 and 1.4 feet NAVD88.

METHODS

Eight permanent monitoring plots, each measuring ten square meters, were established in wetlands affected by the weirs and demarcated with PVC poles (Figure 1). An additional control plot (C-1) was located in tidal wetlands south of Lake Tecumseh in an area not affected by the weirs. Plots were sampled once before weir establishment between September 28-30, 2009 and will be sampled once per year thereafter between July and August for a period of five years. During each sampling event water depth, species, number of live and dead tree stems, and percent canopy cover will be recorded. In addition, herbaceous cover will be monitored by taking three replicate one-meter square sub-samples within each permanent plot for a total of twenty-four sub-plots. Percent cover and presence of dominant herbaceous species will be estimated within each meter square sub-plot. Water depth will be recorded in the center of each subplot. Photo documentation of all subplots and at corners of plots will be collected.

REPORTING AND SUCCESS CRITERIA

Annual written monitoring reports detailing the results of the previous and current years sampling will be provided to the Norfolk District Corps and posted to the U.S. Fish and Wildlife Service Lake Tecumseh webpage within 90 days of completing data collection.

The project will be determined to not have an adverse or secondary impact to affected wetlands if no net loss of wetlands occurs. If an unexpected or undesirable impact to wetlands occurs the invert of the secondary weir will be reduced by a commensurate amount based on the type of impact and location of the impact. Examples of undesirable effects and net loss of wetlands includes conversion of vegetated wetlands to open water and the mortality over baseline of significant numbers of flood tolerant tree species including mature bald cypress, water tupelo, and swamp tupelo. Death of understory red maple, sweetgum, wax myrtle, and pines by prolonged inundation is acceptable for historical reasons previously discussed and for the purpose of reducing competition with the legacy forest established before the human introduction of wind tides. Composition of trees bearing ages that obviously exceed the dredging of Asheville Bridge Canal (~40 years) suggests the hydrology of these wetlands have been altered sufficiently to permit red maple, sweetgum, wax myrtle, and pines to increase in abundance over historical levels. The weirs will mimic pre-dredging hydrology more closely by reducing below grade drainage.

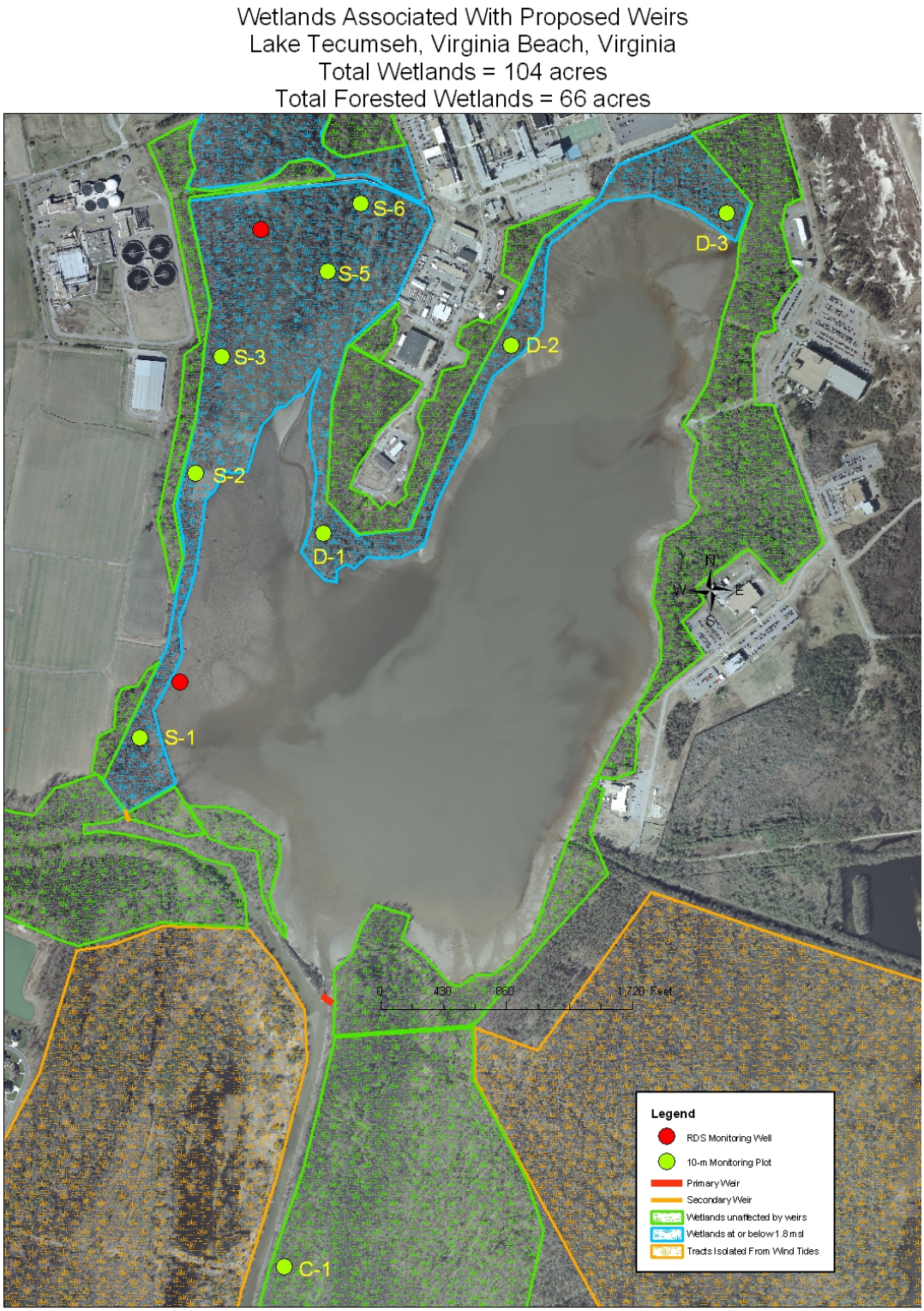


Figure 1. Monitoring Plot Location Map, Lake Tecumseh, Virginia Beach, Virginia. Hydrology of area within blue polygon will be affected by the proposed weirs.

PRECONSTRUCTION MONITORING RESULTS

All data was collected between September 28-30, 2009.

Ten-Meter Square Plots: Eight tree and shrub species were recorded in the eight permanent monitoring plots and one control plot (Table 1). The most abundant species encountered in the Lake Tecumseh plots were red maple, bald cypress, and wax myrtle, respectively (Figure 2). Red maple dominated the younger age cohort. Overall stem mortality was nearly 29% and the highest mortality was recorded in red maple (Figure 3).

Table 1. Pre-weir Trees and Shrubs Recorded between September 28-30, 2009, at Lake Tecumseh, Virginia Beach, Virginia.

Tree and Shrub Species List
Bald Cypress (*Taxodium distichum*)
Swamp Tupelo (*Nyssa sylvatica*)
Red Maple (*Acer rubrum*)
Sweetgum (*Liquidambar styraciflua*)
Wax Myrtle (*Myrica cerifera*)
Loblolly Pine (*Pinus taeda*)
Baccharis (*Baccharis halimifolia*)
Swamp Cottonwood (*Populus heterophylla*)

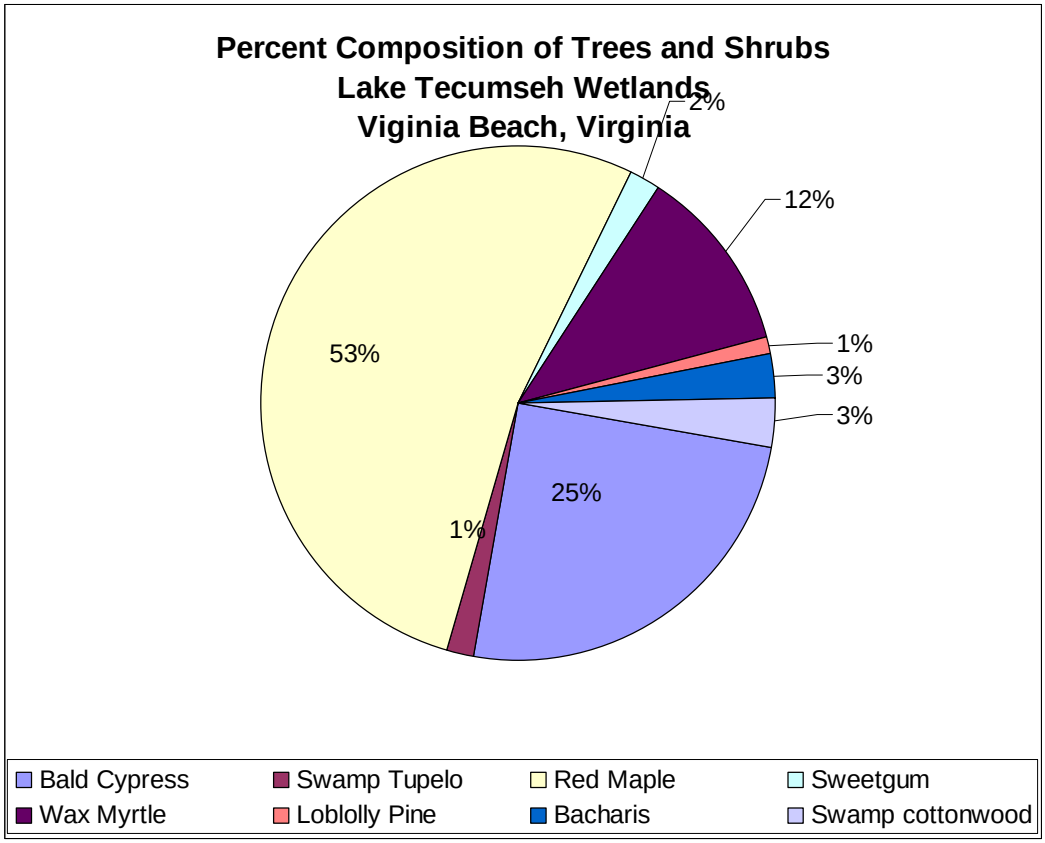


Figure 2. Pre-Weir Tree and Shrub Composition within treatment plots, September 28-30, 2009, Lake Tecumseh, Virginia Beach, Virginia

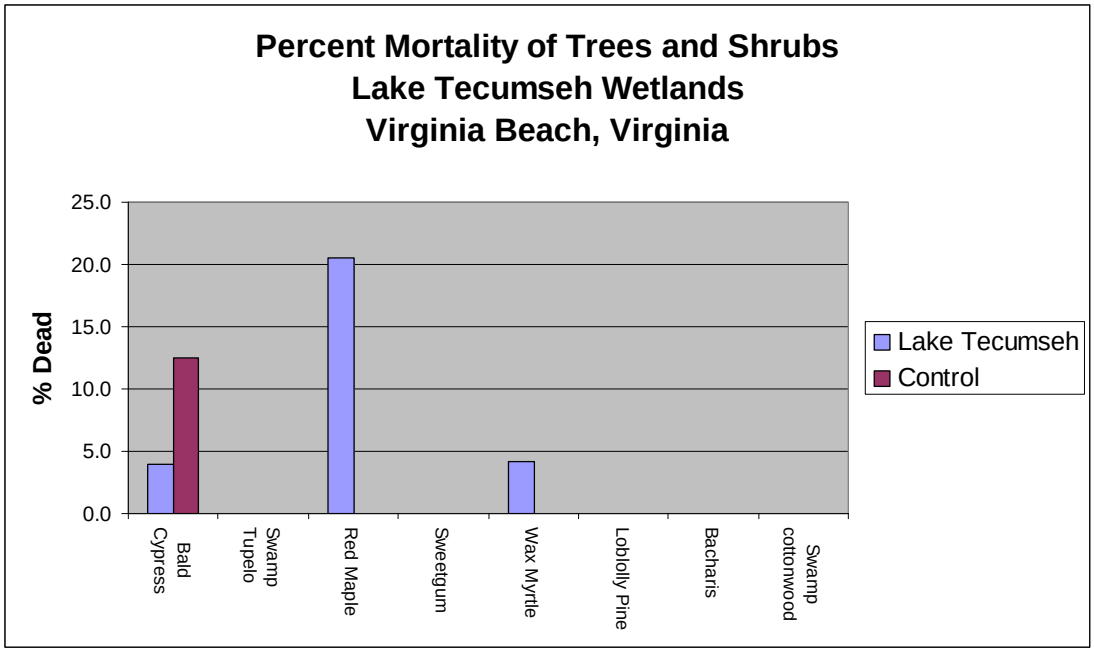


Figure 3. Pre-weir tree and shrub mortality within treatment and control plots, September 28-30, 2009, Lake Tecumseh, Virginia Beach, Virginia

Four species were recorded in the control plot (Figure 4). The most abundant species were red maple and bald cypress. Overall stem mortality was 12.5% and occurred exclusively in bald cypress (Figure 3).

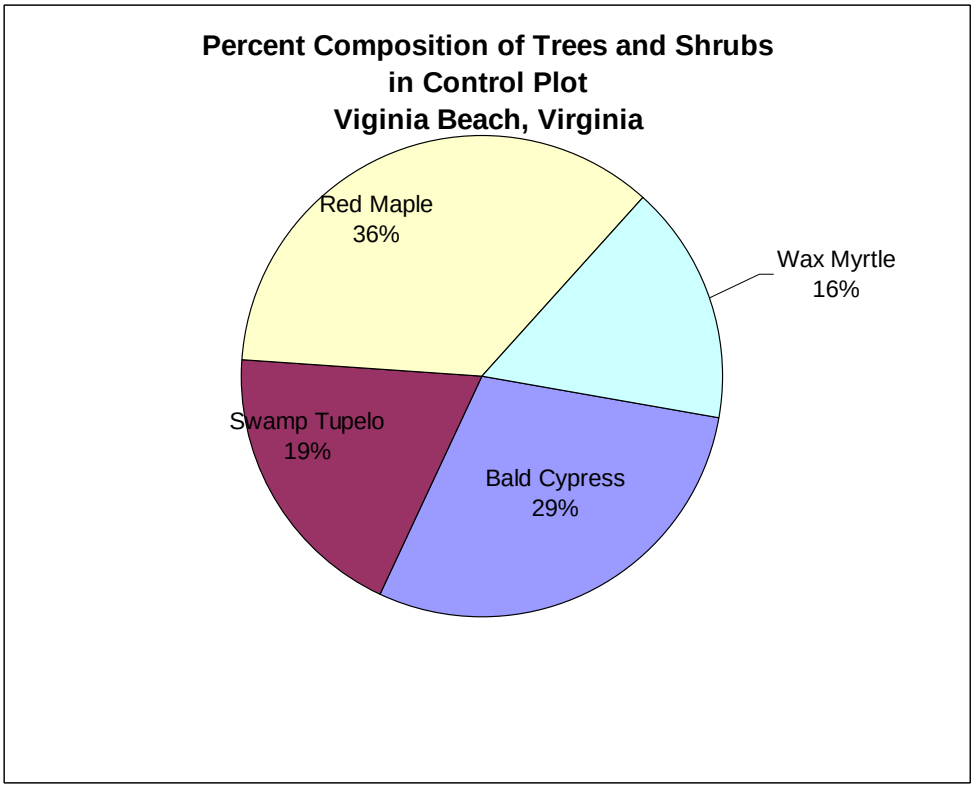


Figure 4. Pre-Weir Tree and Shrub Species Composition within Control Plot, September 28-30, 2009, Asheville Bridge Canal, Virginia Beach, Virginia

One-Meter Square Sub-Plots: Twenty-five herbaceous species were recorded in the twenty-four permanent one-meter subplots (Table 2). Tearthumb (*Polygonum arifolium*), Rice Cutgrass (*Leersia oryzoides*), *Carex sp.* and one unidentified species of Poeacea had the highest average percent cover of one meter herbaceous plots sampled in Lake Tecumseh. Cover of the remaining twenty-one species recorded consisted of two percent or less of the plots. Overall average cover of the subplots equaled twenty-four percent.

Table 2. Average percent cover of herbaceous species recorded in one-meter subplots within Lake Tecumseh between September 28-30, 2009, Virginia Beach, Virginia.

Herbaceous Species List	Aver. %
Tearthumb (*Polygonum arifolium*)	9.4
Rice Cutgrass (*Leersia oryzoides*)	6.1
Carex sp.	4.3
Poeacea (single unidentified specie)	4
Lizard's Tail (*Saururus cernuus*)	1.8
Arrow Arum (*Peltandra virginica*)	1
Swamp loosestrife (*Decodon verticilliatus*)	1
Marsh Fleabane (*Pluchea foetida*)	<1
Primrose Willow (*Ludwigia sp.*)	<1
St. John's Wart (*Hypericum perforatum*)	<1
Big Cordgrass (*Spartina cynosuroides*)	<1
Wild Angelica *(Angelica sp.*)	<1
Soft Rush (*Juncus effusus*)	<1
Royal Fern (*Osmunda regalis*)	<1
Virginia day-flower (*Commelina virginica*)	<1
Pennywort (*Hydrocotyle sp.*)	<1
Cattail (*Typha sp.*)	<1
Smartweed (*Polygonum sp.*)	<1
Poison Ivy (*Rhus toxicodendron*)	<1
Goldenclub (*Orontium aquaticum*)	<1
Spongeplant (*Limnobium spongia*)	<1
Common Reed (*Phragmites australis*)	<1
Mallow (*Hibiscus rocheutos*)	Control
Catbrier (*Smilax sp.*)	Control
Wild Rose (*Rosa carolina*)	Control

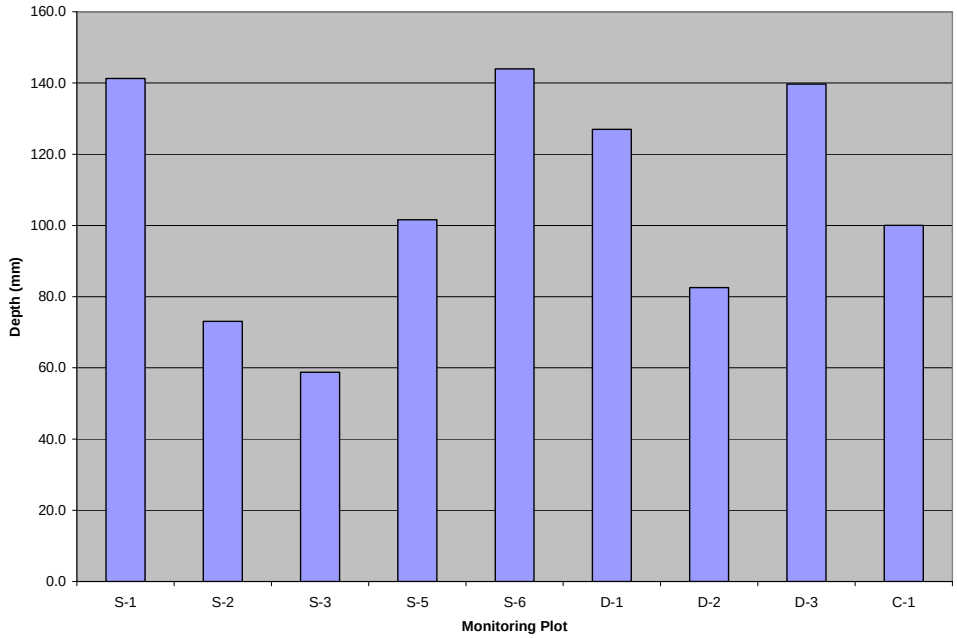
Nine herbaceous species were recorded in the control one-meter square subplots (Table 3). Phragmites was the only dominant species encountered covering 45% of the subplots. The remaining eight species covered one percent or less of the area sampled.

Table 3. Average percent cover of herbaceous species recorded in one-meter control subplots between September 28-30, 2009, Virginia Beach, Virginia.

Herbaceous Species List	Aver. %
Common Reed (*Phragmites australis*)	45
Carex sp.	<1
Lizard's Tail (*Saururus cernuus*)	<1
Arrow Arum (*Peltandra virginica*)	<1
Royal Fern (*Osmunda regalis*)	<1
Pennywort (*Hydrocotyle sp.*)	<1
Catbrier (*Smilax sp.*)	<1
Wild Rose (*Rosa carolina*)	<1
Mallow (*Hibiscus rocheutos*)	<1

Average water depth in the Lake Tecumseh plots ranged from 59-144 millimeters (Table 4). Average water depth in the control plot equaled 100 millimeters. During monitoring water surface was at elevation 1.0 feet NAVD88 which is equal to the proposed weir height.

Table 4. Average water depth within permanent vegetation monitoring plots between September 28-30, 2009, Lake Tecumseh, Virginia Beach, Virginia. Note system is wind tidal and data is useful in relative comparison of inundation among plots.



Species Area Curve: The total number of species recorded with increasing area surveyed indicate an adequate number of ten-meter plots and one-meter sub-plots were sampled in order to adequately represent vegetation at the project site (Figures 5 and 6).

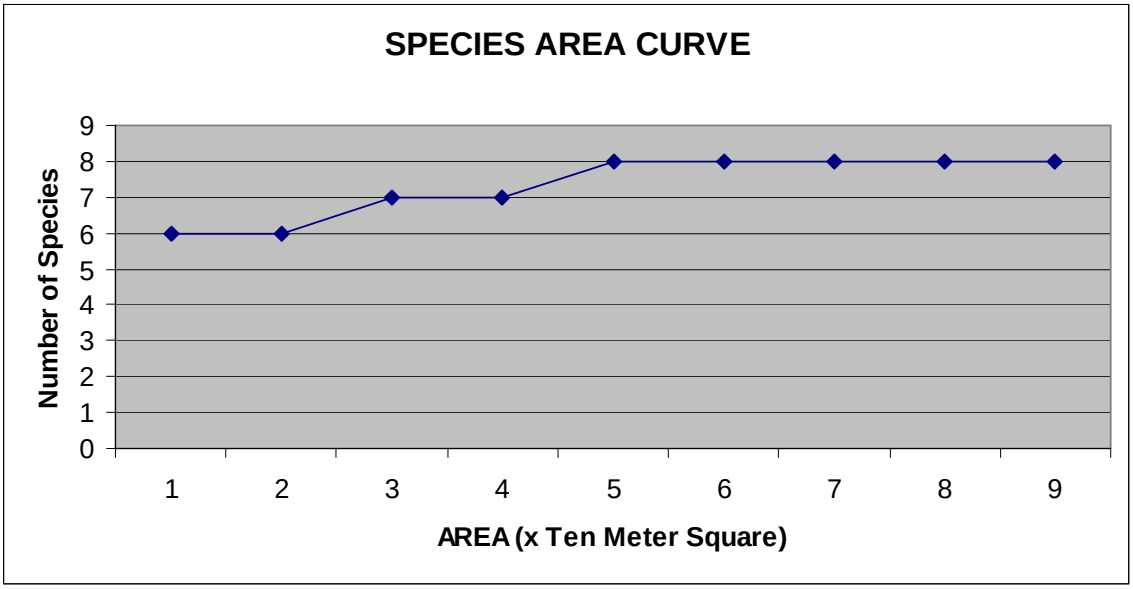


Figure 5. Total number of tree and shrub species recorded in the area sampled, Lake Tecumseh, Virginia Beach, Virginia.

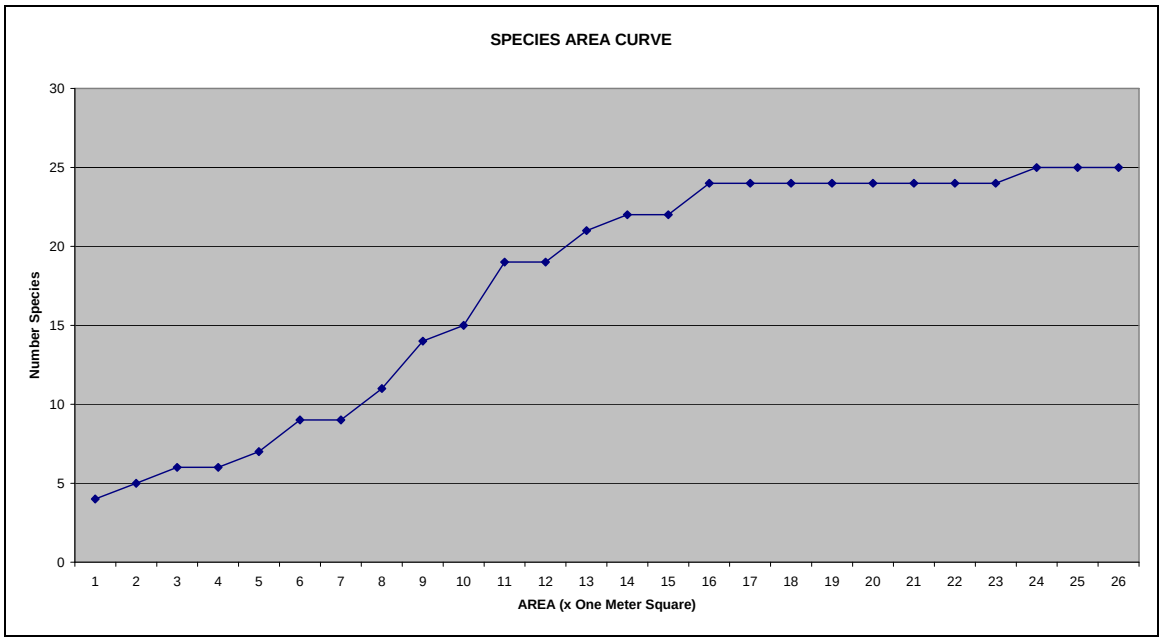


Figure 6. Total number of herbaceous species recorded in the area sampled, Lake Tecumseh, Virginia Beach, Virginia.

A vegetative survey of the spoil berm recorded common privet, microstegium, smilax, loblolly pine, bald cypress, common persimmon, black cherry as dominant species. Disturbance to existing bald cypress and one large loblolly pine will be avoided during the proposed berm stabilization activities.

DISCUSSION

The single unidentified species of Poeacea will be indentified during subsequent monitoring events when the inflorescence can be obtained.

The data establishes unfavorable conditions to vegetative cover and abundance currently exists within the forest plots. Just two species (tearthumb and rice cutgrass) out of the twenty-five herbaceous species recorded exhibited more than five percent cover. In addition, mortality equaled twenty-one percent in red maple and four percent (12.5% in the control plot) in bald cypress. Limited light availability may be a more of a factor than flooding on herbaceous vegetation. A herbaceous marsh under three inches of permanent inundation within the monitoring area exhibited profuse vegetative growth with 100% cover. However, mortality was commonly observed in small diameter red maple up to twenty-five feet in height located adjacent to the lake's shore. Thus, observed vegetative cover and tree mortality may be the result of existing frequent inundation of wetlands by wind tides and/or shade (all subplots were located under tree canopy). Over five years of hydrology monitoring in Lake Tecumseh indicate frequency and duration of inundation is greatest between May and September resulting in flood stress during the vegetative growing season.

Composition and abundance of trees and shrubs within the treatment and control plots were similar with the exception of swamp tupelo. Unlike red maple, swamp tupelo and bald cypress associated with Lake Tecumseh tend to occur in more pure stands and monitoring plots were not located in any stands of swamp tupelo. Mortality in red maple (21%) was higher than the overall tree mortality reported in hydrologically unaltered wetlands by Harm 1980 as was mortality of bald cypress (12.5%) in the control plot. This may reflect the higher flood stress exerted upon vegetation in highly dynamic wind tide systems. We assume flooding is more frequent and of greater depth and duration during years of dynamic weather patterns producing more southerly wind. Calmer years would reduce the severity of flooding allowing seedlings to establish that later succumb to flooding. In addition, wind tides produce more frequent flooding with less duration year after year regardless of precipitation. The majority of floods occur throughout the growing season so flood stress on vegetation is ever present. Upon establishment of the weirs flooding would not occur during the growing season in drought years without precipitation and will mimic a precipitation based hydrologic regime more closely.

REFERENCES CITED

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Harms, W. R., Schreuder, H. T., Hook, D. D., and Brown, C. L., 1980. The Effects Of Flooding On The Swamp Forest in Lake Ocklawaha, Florida. Ecology