APPENDIX C — ENVIRONMENTAL ANALYSES, METHODS AND DATA

Environmental Analyses

MFLs determinations incorporate biological, soils, and topographical information collected in the field with information from the scientific literature to develop minimum levels. This section describes the methods used in the MFLs determination process for Sylvan Lake, including field procedures such as site selection and field data collection, data analyses, and levels determination criteria. Vegetation, soils, and elevation data were analyzed in conjunction with data from a hydrologic model (see Appendix B for details of hydrological analyses and model report) and scientific literature in order to develop a minimum hydrologic regime that protects the ecological structure and function of Sylvan Lake. Additional descriptions of MFLs methods are located in the MFLs Methods Manual (SJRWMD, 2006) and MFLs methods paper (Neubauer et al., 2008).

Field Methods

Transect Site Selection

Many factors are considered in the selection of field transect sites. Transects are fixed sample lines across a lake or wetland, and typically extend from open water to uplands. Elevation, soils, and vegetation are sampled along transects in order to characterize the distribution of soils and plant communities. These data are then compared to system hydrological data to determine the influence of flooding and drying events on soils and plant species or communities.

Field site selection typically begins with the implementation of a site history survey and data search. All relevant available existing information is identified and assembled through data searches of District library documents, project record files, the hydrologic database, and the District Division of Surveying Services files. The data collected typically includes one or more of the following:

- On-site and regional vegetation surveys and maps;
- Aerial photography (existing and historical);
- Remote sensing (vegetation, land use, etc.) and topographic maps;
- Soil surveys, maps and descriptions;
- Hydrologic data (hydrographs and stage duration curves);
- Environmental, engineering, or hydrologic reports;
- Topographic survey profiles; and
- Occurrence records of rare and endangered flora and fauna.

These data/information sources are reviewed to familiarize the investigator with site characteristics, locate important basin features that needed to be evaluated, and assess prospective sampling locations.

Potential transect locations at Sylvan Lake were initially identified from maps of wetlands, soils, and topography. Specific transect site selection goals included:

- Establishing transects at sites where multiple wetland communities of the most commonly occurring types were traversed.
- Selecting multiple transect locations with common wetland communities among them.
- Establishing transects that traverse unique wetland communities.

Transect characteristics were subsequently field verified to ensure that the transect locations contained representative wetland communities, hydric soils, and reasonable upland access. These goals help to ensure ecosystem protection of commonly occurring and unique wetland ecosystems at Sylvan Lake. The original field investigation at Sylvan Lake occurred in May and June 2005. Vegetation and soils elevations were verified in 2017, 2018 and 2020 (see Results section below for more details). All previously identified types of information were considered in the selection of field transect sites at Sylvan Lake. Individual transect site selection criteria for the final three transects are described in the Results and Discussion section below.

Field Data Collection

The field data collection procedure for MFLs determinations involves gathering information and collecting elevation, soils, and vegetation data along fixed transects, across a hydrologic gradient. Transects are typically established in areas where there are changes in vegetation and soils, and the hydrologic gradient was marked (typically from open water to uplands; SJRWMD 2006). The main purpose in using transects in these situations, where the change in vegetation and soils is clearly directional, is to describe maximum variations, that are related to change in hydrology, over the shortest distance in the minimum time (Martin and Coker 1992).

<u>Site Survey</u>

Upon selection of a transect site at Sylvan Lake, vegetation was trimmed to allow a line-of-sight along the length of the transect. A measuring tape was then laid out along the length of the transect. Elevation measurements were recorded at various length intervals (5 ft, 10 ft, and 20 ft) to adequately characterize the topography and transect features. Additional elevations were also measured, to ensure the inclusion of obvious elevation changes, vegetation community changes, soil changes, high water marks, and the bases of trees.

Latitude and longitude were collected with a global positioning system (GPS) receiver at selected points along the length of the Sylvan Lake transects. These data will be used to accurately locate specific features along each transect and facilitate recovering transect locations in the future.

Soil Sampling Procedures

Detailed soil profiles were described along each transect to gain an understanding of past and present hydrologic, geologic, and anthropogenic processes that have occurred, resulting in the observed transect soil features. Soil profiles were described following standard Natural Resources Conservation Service (NRCS) procedures (USDA, NRCS 2002). Each soil horizon (unique layer) was generally described with respect to texture, thickness, Munsell color (Kollmorgen Corp., 1992), structure, consistency, boundary, and presence of roots.

The primary soil criteria considered in the MFLs determination are the presence and depth of organic soils (histosols and histic epipedons), as well as the extent of hydric soils observed along the field transects (SJRWMD 2006). The procedure to document hydric soils included:

- Removing all loose leaf-matter, needles, bark, and other easily identified plant parts to expose the soil surface; digging a hole and describing the soil profile to a depth of at least 20 in. and, using the completed soil description, specifying which hydric soil indicators have been matched.
- Performing deeper examination of soil where field indicators are not easily seen within 20 in. of the surface. (It is always recommended that soils be excavated and described as deeply as necessary to make reliable interpretations and classification.)
- Paying particular attention to changes in microtopography over short distances, since small elevation changes may result in repetitive sequences of hydric/nonhydric soils and the delineation of individual areas of hydric and nonhydric soils may be difficult (Hurt et al. 1998).

Additional soil sampling procedures are documented in the MFLs Methods Manual (SJRWMD 2006).

Vegetation Sampling Procedures

SJRWMD's Wetland Vegetation Classification System (Kinser, 1996) was used to standardize the names of wetland plant communities sampled in MFLs fieldwork and in developing reports documenting the MFLs determination. This vegetation classification system was developed using photo-interpretation of aerial photographs and is also used to create SJRWMD wetland maps.

The spatial extent of plant communities or transition zones (i.e., ecotones) between plant communities was based on field data collection (described below) and reasonable scientific judgment. Reasonable scientific judgment involves the ability to collect and analyze information using technical knowledge, and personal skills and experience to serve as a basis for decision making (Gilbert et al. 1995). In this case, such judgment was based upon field observations of relative abundance of dominant plant species, occurrence and distribution of soils and hydric soil indicators, and changes in land slope or elevation along the hydrologic gradient. Plant communities and transition zones were delineated along a specialized line transect called a belt transect. A belt transect is a line to form a long, thin, rectangular plot divided into smaller sampling areas called quadrats that correspond to the spatial extent of plant communities or transitions between plant communities (Figure 1). The belt transect width will vary depending upon the type of plant community to be sampled (SJRWMD, 2006). For example, a belt width of 10 ft (5 ft on each side of the transect line) may suffice for sampling herbaceous plant communities of a floodplain marsh. However, a belt width of 50 ft (25 ft on each side of the line) may be required to adequately represent a forested community (e.g., hardwood swamp, Figure 1).

Plants were identified and the percent cover of plant species was estimated if they occurred within the established belt width for the plant community under evaluation (quadrat). Percent cover is defined as the vertical projection of the crown or shoot area of a plant to the ground surface and is expressed as a percentage of the quadrat area. Percent cover as a measure of plant distribution is often considered as being of greater ecological significance than density, largely because percent cover gives a better measure of plant biomass than the number of individuals. The canopies of the plants inside the quadrat will often overlap each other, so the total percent cover of plants in a single quadrat will frequently sum to more than 100% (SJRWMD, 2006).

Percent cover was estimated visually using cover classes (ranges of percent cover). The cover class and percent cover ranges (Table 1) are a variant of the Daubenmire method (Mueller-Dombois and Ellenberg, 1974) and are summarized in SJRWMD's MFLs Methods Manual (SJRWMD, 2006). Plant species, plant communities, and percent cover data were recorded on field vegetation data sheets. The data sheets were formatted to facilitate data collection in the field and, also, computer transcription.

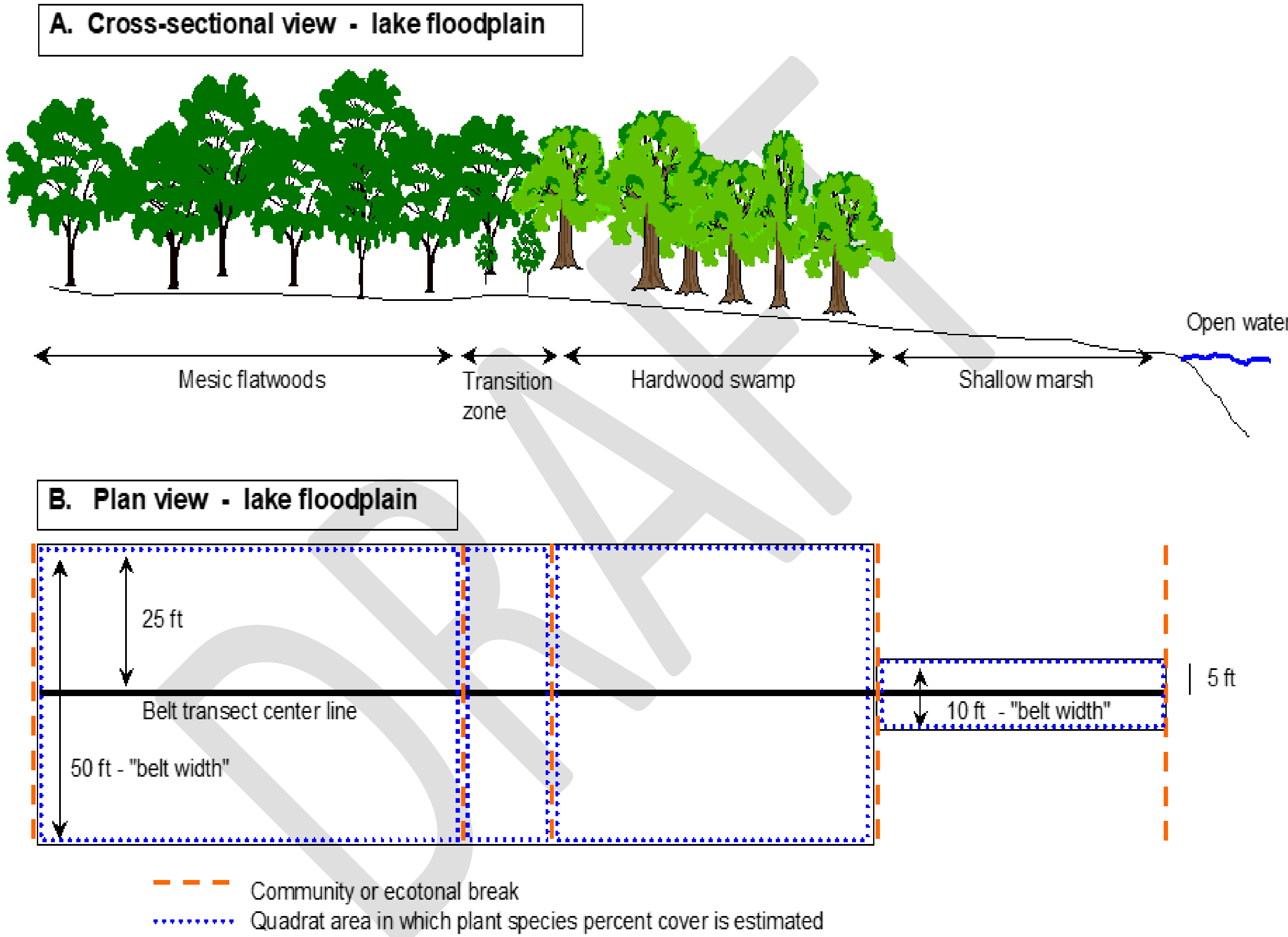

Figure 1. Belt transect through forested and herbaceous plant communities

Table 1. Summary of cover classes and percent cover ranges

Cover Class	Percentage Cover Range	Descriptor
0	< 1 %	Rare
1	1–10 %	Scattered
2	11–25 %	Numerous
3	26–50 %	Abundant
4	51–75 %	Co-dominant
5	> 75 %	Dominant

Surface Water Inundation/Dewatering Signatures (SWIDS)

SJRWMD event-based MFLs are composed of magnitude, duration, and return interval components. Magnitude and duration components define biologically relevant events. The return interval of events is the manageable component (Neubauer et al., 2008). For example, if a 30-day flooding event of a field elevation of interest (e.g., maximum elevation of shallow marsh) had an annual probability of exceedance of 33%, then the event is interpreted as occurring during 33 in 100 years or a 3-year return interval, on average.

Annual maximum and minimum series stage frequency analyses of long-term stage data or modeled stage data were utilized to provide probabilities (Gordon et al., 1992) of flooding/dewatering events for wetland plant communities and organic soil indicators at various locations within SJRWMD. Because ground elevations are transformed to durations and probabilities, comparisons of like plant communities or soils indicators from different systems at different landscape elevations resulted in quantitative hydrologic signatures called surface water inundation/dewatering signatures (SWIDS). The mean, minimum, and maximum elevations of vegetation communities and soil indicators were used for SWIDS analysis (Neubauer et al., 2004; Neubauer et al., 2008).

SWIDS of vegetation communities provide a hydrologic range for each community, with a transition to a drier community on one side of the range and a transition to a wetter community on the other side. These hydrologic signatures provide a target for

MFLs determinations that are focused on vegetation community protection criteria, and provide an estimate of how much the return interval or probability of a flooding or dewatering can be shifted at a specified duration and still maintain a vegetation community within its observed hydrologic range.

In the SWIDS analysis, a boxplot is utilized to show the range of the probabilities of flooding (exceedance) or dewatering (non-exceedance) events of selected durations for different plant community elevations (i.e., maximum, mean, and minimum elevations) occurring at different water bodies. The boxplot (Figure 2a; a.k.a., box and whiskers plot) displays what, in statistics, is called the “five-number summary” (Krishnamurty et al., 1995). These five numbers consist of the 1) minimum data value; 2) the first quartile, which sets the limit of the lowest 25% of the data; 3) the median (50th percentile); 4) fourth quartile, which sets the limit of the highest 25% of the data; and 5) the maximum data value. The length of the “box” is the “inter-quartile range,” the difference between the 75th and 25th percentiles. Fifty percent of the data values occur within the inter-quartile range. The horizontal line extending from the box to the left, called a “whisker,” represents the largest 25% of data values. This whisker extends to the maximum data value. The “whisker” extending from the box to the right represents the smallest 25% of data values. This whisker extends to the minimum data value. The vertical line inside the “box” marks the median of the data values. In summary, the boxplot is a simple graphical tool to show the shape of the data distribution, its location of central tendency, and variability.

A boxplot schematic for flooding event probabilities is shown in Figure 2b. In this case, drier conditions are shown to the right of the median, terminating with the driest community included in the study, and wetter conditions are shown to the left of the median, terminating in the wettest community included in the study.

A similar boxplot schematic for dewatering event probabilities is shown in Figure 2c. In this case, wetter conditions are shown to the right of the median, terminating in the wettest community included in the study, and drier conditions are shown to the left of the median, terminating in the driest community included in the study.

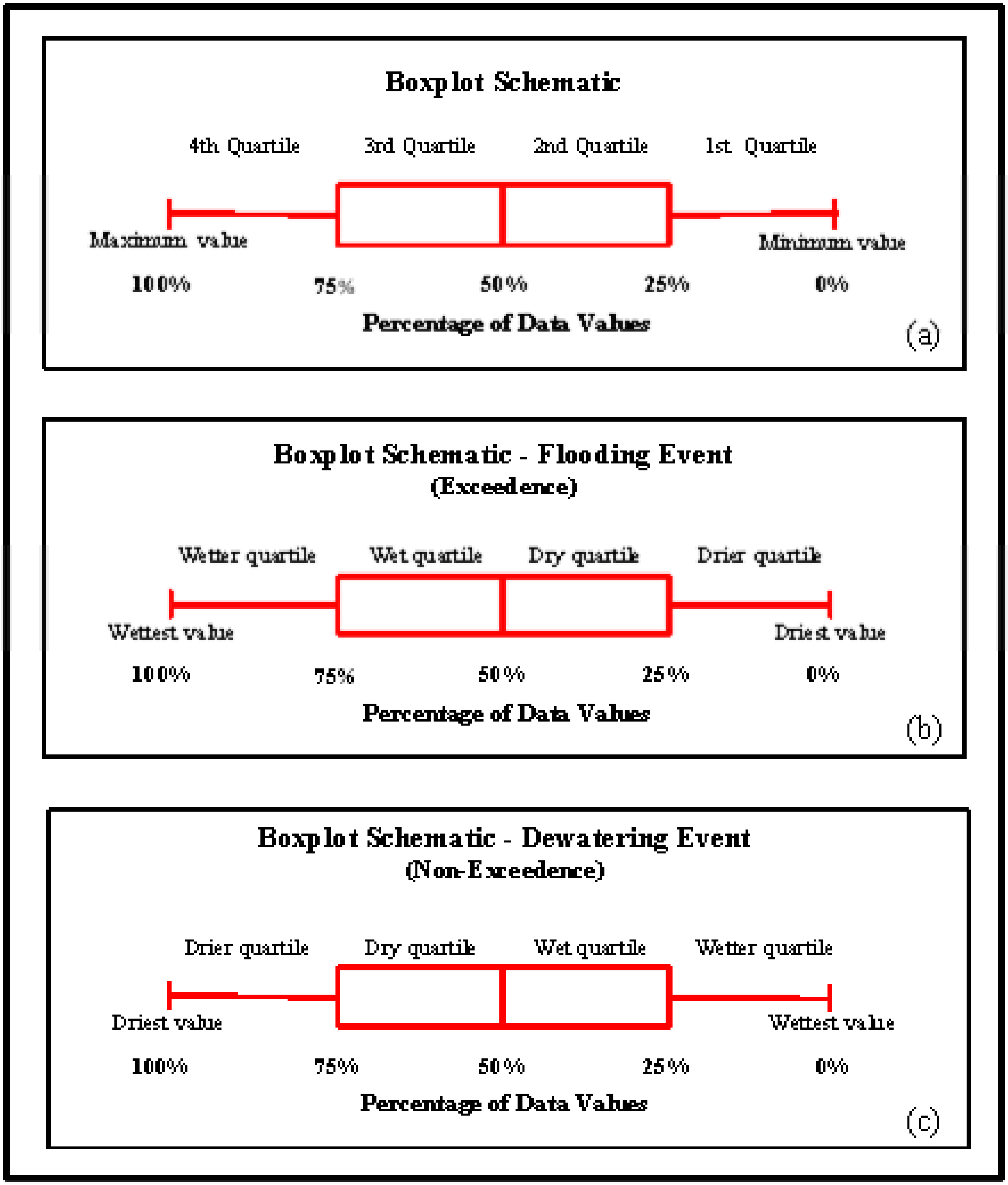

Figure 2. Boxplot schematics (a) General boxplot; (b) Flooding (exceedance) event boxplot; (c) Dewatering (non-exceedance) event boxplot

DATA ANALYSIS

The primary analysis of soils, vegetation and elevation data collected at Sylvan Lake consisted of performing basic statistics using a computer spreadsheet (e.g., Excel). Descriptive statistics were calculated for the elevations of the vegetation communities and specific hydric soil indicators. These elevations were then analyzed with hydrological data (Appendix B) to understand the existing and minimum required hydroperiods for different environmental metrics.

Elevation data were also graphed for each transect to illustrate the elevation profile for all communities delineated between open water and the upland community. The locations of vegetation communities along each transect, along with a list of dominant species, statistical results and soils information, were labeled on each transect elevation profile. Transect profiles and data table are provided in the Results and Discussion section below.

RESULTS AND DISCUSSION

The reevaluation of minimum levels for Sylvan Lake involved collection of elevation, soils, and vegetation field data at three original transect locations in 2005 (Figure 3), and multiple supplementary locations in 2020. The first sections describe vegetation and soils data collected in 2005, followed by results from more recent field work conducted in 2018 and 2020 to verify original vegetation and soils locations.

Field Data Collection—Transect 1

The original (2005) Transect 1 was located on the southeast shore of Sylvan Lake (Figure 3). This transect site was established in order to characterize the extent of organic soils (i.e., histic epipedon and histosols), and shallow marsh and aquatic bed wetland plant communities at this location.

Mapped vegetation for Sylvan Lake, based on remote sensing techniques and vegetation community designations by SJRWMD, was different from the wetland vegetation that is currently at this lake. The SJRWMD wetland map shows that Transect 1 should begin in a shallow marsh area followed by a bayhead/baygall community and ending with a shallow marsh community that extends to open water (Figure 3). However, as discussed above, the vegetation communities delineated and identified along transect 1 during field work (Figures 4 and 5) differ markedly from SJRWMD's mapped vegetation communities (Figure 3).

SJRWMD staff and consultant staff (JEA Inc.) collected vegetation and soils data, and SJRWMD's Division of Surveying Services staff collected elevation data. Elevations on Transect 1 were determined from a bench loop based on SJRWMD benchmark identification (ID) 05-17-617-0 (53.646 ft NGVD) and reference mark ID 05-17-617-1 (53.696 ft NGVD).

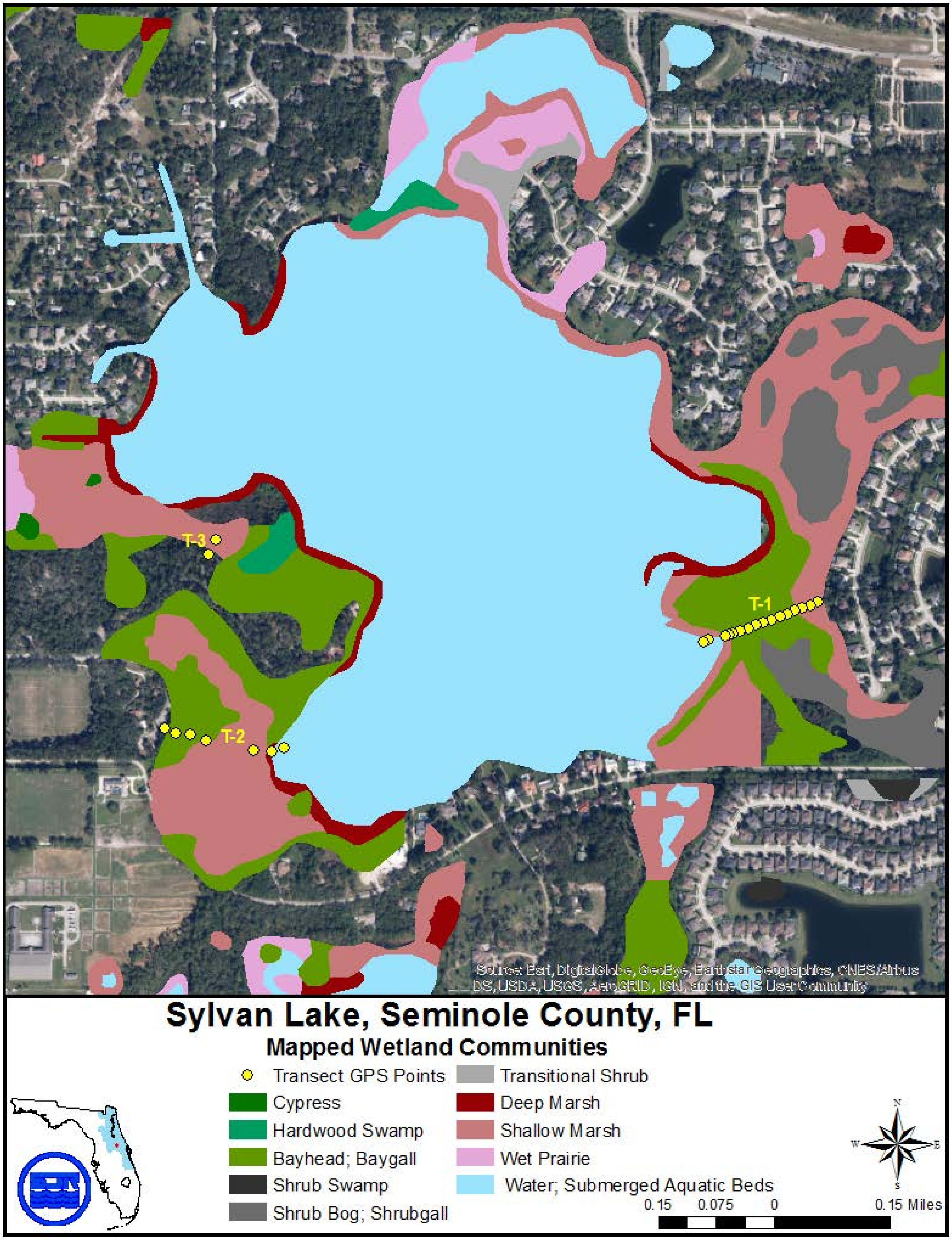

Figure 3. Sylvan Lake mapped wetland communities; yellow dotted lines indicate approximate location of original (2005) field transect locations.

Figure 4a. Sylvan Lake Transect 1 at station 75; Transitional shrub community

Figure 4b. Sylvan Lake Transect 1 at station 250; Shallow marsh/shrub swamp

Figure 4c. Sylvan Lake Transect 1 at station 350; Shallow marsh/shrub swamp

Figure 4d. Sylvan Lake Transect 1 at station 592; Deep Marsh and shallow marsh at lake edge

Figure 4e. Sylvan Lake Transect 1; Water stressed and dead pines

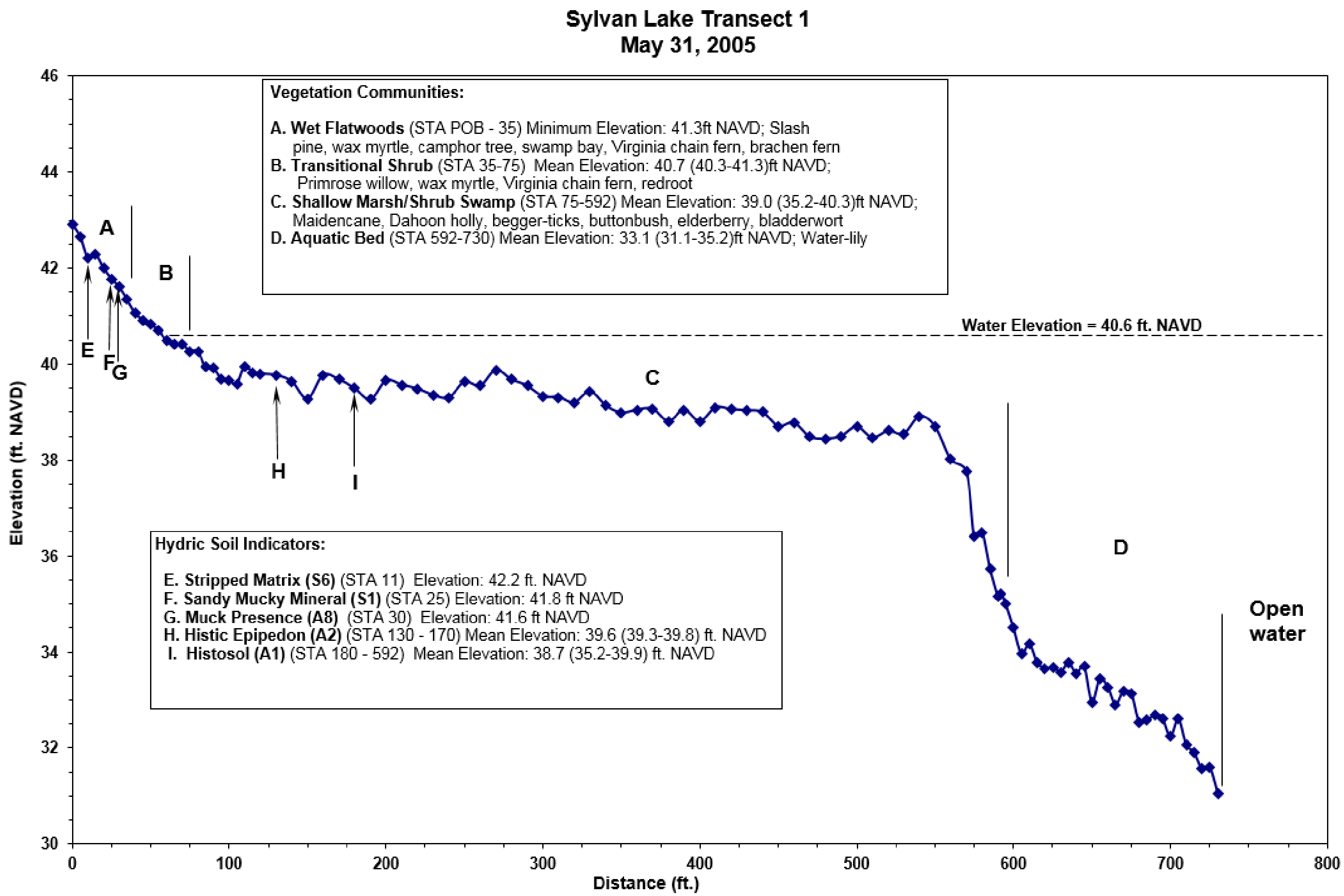

Figure 5. Sylvan Lake Transect 1 topography with ecological communities

Vegetation at Transect 1

Transect 1 traversed 730 ft in a westerly direction from the wet flatwoods (point-of-beginning [POB] to station 35), through a transitional shrub (stations 35–75), a shallow marsh/shrub swamp mix (stations 75–592), an aquatic bed (stations 592–730), and terminated in the open water of the lake (station 730) (Figures 4 and 5; Table 2). The following discussion summarizes the dominant plant species found in the plant communities delineated on Transect 1 and the percent cover of each species within the community. A complete list of plant species observed on Transect 1 is listed in Table 3.

The wet flatwoods (stations POB–35) overstory vegetation included abundant slash pine (*Pinus elliottii*); numerous camphor tree (*Cinnamomum camphora*) and swamp bay (*Persea palustris*); and scattered southern red cedar (*Juniperus silicicola*) and water oak (*Quercus nigra*). The mid-canopy vegetation included numerous wax myrtle (*Myrica cerifera*) and scattered muscadine grape (*Vitis rotundifolia*). The understory vegetation included abundant blackberry (*Rubus betulifolius*); numerous Virginia chain fern (*Woodwardia virginica*) and bracken fern (*Pteridium aquilinum*); and scattered cinnamon fern (*Osmunda cinnamomea*). The wet flatwoods community was dominated by upland (UPL) and facultative wetland (FAC) plant species, however, facultative wet (FACW) and obligate (OBL) wetland plant species also occurred (Table 3).

The transitional shrub (stations 35–75) vegetation included abundant primrose willow (*Ludwigia peruviana*); and scattered wax myrtle, Virginia chain fern, redroot (*Lachnanthes caroliniana*), and fireweed (*Erechtites hieracifolia*). The transitional shrub community was dominated by OBL, FAC, and FACW wetland plant species, however, UPL plant species also occurred (Table 3).

The shallow marsh/shrub swamp community (stations 75–592) overstory vegetation included scattered red maple (*Acer rubrum*), sweetbay (*Magnolia virginiana*), swamp tupelo (*Nyssa sylvatica v. biflora*), and bald cypress (*Taxodium distichum*). The mid-canopy vegetation included numerous buttonbush (*Cephalanthus occidentalis*) and scattered dahoon holly (*Ilex cassine*) and Virginia willow (*Itea virginica*). The understory vegetation included abundant maidencane (*Panicum hemitomon*) and begger-ticks (*Bidens mitis*); numerous Ludwigia (*Ludwigia leptocarpa*), common salvinia (*Salvinia rotundifolia*), and bladderwort (*Utriculari biflora*); and scattered saw grass (*Cladium jamaicense*), fragrant flagsedge (*Cyperus odoratus*), spikerush (*Eleocharis* sp.), water lily (*Nymphaea odorata*), and smartweed (*Polygonum hirsutum*). The shallow marsh community was dominated by OBL plant species, however, FACW, FAC, and UPL plant species also occurred (Table 3).

Waterward of the shallow marsh/shrub swamp community, Transect 1 traversed an aquatic bed community (stations 592–730). The aquatic bed was dominated by water lily, an OBL wetland plant species (Table 3).

Table 2. Sylvan Lake Transect 1 (2005) vegetation community elevation statistics

Vegetation Community	Stations Distance (ft)	Mean (ft NAVD)	Median (ft NAVD)	Min (ft NAVD)	Max (ft NAVD)	N
Wet flatwoods	POB–35	-	-	41.3	-	-
Transitional shrub	35–75	40.7	40.7	40.3	41.3	9
Shallow marsh/shrub swamp	75–592	39.0	39.2	35.2	40.3	60
Aquatic bed	592–730	33.1	33.2	31.1	35.2	29

ft NAVD = feet North American Vertical Datum
N = the number of elevations surveyed for each community

Table 3. Plant species, FWDM wetland indicator status, and estimated species occurrence for each plant community type occurring on Transect 1 (2005) at Sylvan Lake, Seminole County, FL.

Scientific Name	Common Name	Vegetation Community[2]				
		Name	WF	TS	SM	AB
		Start (ft)	0	35	75	592
		Stop (ft)	35	75	592	730
		FWDM Code[1]	Plant Species Cover Estimates[3]			
Acer rubrum	Red Maple	FACW			1	
Andropogon virginicus	Broomsedge	FAC	0			
Bidens mitis	Begger-ticks	OBL			3	
Blechnum serrulatum	Swamp Fen	FACW			0	
Boehmeria cylindrica	Smallspike false-nettle	OBL			0	
Cephalanthus occidentalis	Buttonbush	OBL			2	
Cinnamomum camphora	Camphor tree	UPL	2			
Cladium jamaicense	Sawgrass	OBL			1	
Cyperus odoratus	Fragrant flatsedge	FACW			1	
Decodon verticillatus	Swamp loosestrife	OBL			0	
Eleocharis sp.	Spikerush	OBL			1	
Erechtites hieracifolia	Fireweed	FAC	0	1		
Eupatorium capillifolium	Dog Fennel	FAC	0	0		
Gordonia lasianthus	Loblolly bay	FACW			0	
Hydrocotle sp.	Pennywort	OBL			1	
Ilex Cassine	Dahoon holly	OBL			1	
Itea virginica	Virginia willow	OBL			1	
Juniperus silicicola	Southern red cedar	UPL	1			
Lachnanthes caroliniana	Redroot	FAC	0	1		
Lemna sp.	Duckweed	OBL			1	
Ludwigia leptocarpa	Ludwigia	OBL			2	
Ludwigia peruviana	Primrose willow	OBL		3		
Magnolia virginiana	Sweetbay	OBL			1	
Mikania scandens	Climbing hemp-weed	UPL		1	1	
Myrica cerifera	Wax myrtle	FAC	2	1	1	
Nymphaea odorata	Water-lily	OBL		0	1	4
Nyssa sylvatica var. biflora	Tupelo, swamp	OBL			1	
Osmunda cinnamomea	Cinnamon fern	FACW	1			
Osmunda regalis	Royal fern	OBL		0		
Panicum hemitomon	Maidencane	OBL			3	
Peltandra virginica	Arrow-arum	OBL			0	
Persea palustris	Swamp bay	OBL	2	0		
Pinus elliottii	Slash pine	UPL	3			
Polygonum hirsutum	Smartweed	OBL			1	
Pontederia cordata	Pickerelweed	OBL			1	
Pteridium aquilinum	Braken Fern	UPL	2			
Quercus nigra	Water Oak	FACW	1			
Rubus betulifolius	Blackberry	FAC	3			
Sagittaria lancifolia	Arrowhead	OBL			1	
Salvinia rotundifolia	Common salvinia	OBL			2	
Sambucus canadensis	Elderberry	FAC	0			
Scirpus cubensis		verify			1	
Smilax auriculata	Greenbrier	UPL	1			
Taxodium distichum	Bald cypress	OBL			1	
Urena lobata	Ceasar weed	UPL	0			
Utricularia biflora	Bladderwort	OBL			2	
Vitis rotundifolia	Muscadine grape	UPL	1	1	1	
Woodwardia virginica	Virginia chain fern	FACW	2	1		

1 FWMD code indicator categories established in The Florida Wetlands Delineation Manual (Gilbert et al. 1995):
UPL = Upland plants that occur rarely in wetlands but occur almost always in uplands

FAC = Facultative plants with similar likelihood of occurring in both wetlands and uplands
FACW = Facultative wet plants that typically exhibit their maximum cover in areas subject to surface water flooding and/or soil saturation but may also occur in uplands
OBL = Obligate plants that are found or achieve their greatest abundance in an area, which is subject to surface water flooding and/or soil saturation; rarely uplands

2 Plant community abbreviations:
WF = Wet Flatwoods (stations 0-35)
TS = Transitional Shrub (stations 35-75)
SM = Shallow Marsh (stations 75-592)
AB = Aquatic Bed (592-730)

3 Plant Species Cover Estimates: Areal extent of vegetation species along transect within a given community where 0 = <1%
(rare); 1 = 1-10% (scattered); 2 = 11-25% (numerous); 3 = 26-50% (abundant); 4 = 51-75% (codominant); 5 = >75% (dominant)

4 Floating vegetation

<u>Soils at Transect 1</u>

Soil series were mapped (Figure 6) as Basinger, Samsula, and Hontoon soils within the wet flatwoods and transitional shrub communities, and Brighton, Samsula, and Sanibel mucks within the upper end of the shallow marsh/shrub swamp community at Transect 1 (Figure 6). Soils sampled at Transect 1 (Table 7-9) varied from the SSURGO map delineation due to the map scale.

Twenty soil stations were evaluated along Transect 1. Soil characteristics transitioned from indicators of periodic saturation in the upper 6 in., to indicators of frequent inundation, to indicators of nearly permanent inundation. This hydrologic transition was reflected in changes in the thickness of muck, where muck varied from 3 in. thick at station 30 to greater than 52 in. thick at station 330. Five soil series were noted at Transect 1: Valkaria, Basinger, Sanibel, Samsula, and Terra Ceia. A Valkaria soil was identified at station 10 in the wet flatwoods community. Valkaria soils are poorly or very poorly drained with a water table depth within 0–12 in. of the soil surface for 2 to 6 months during most years. During periods of extended rainfall, the water table is at the surface for a few days to 3 months. During dry seasons, the water table may be as deep as 30 in. below the surface.

Basinger soil was observed at station 30 in the wet flatwoods community. Basinger soils are poorly or very poorly drained with a water table within 12 in. of the soil surface for 2 to 6 months during most years. The water table recedes to depths of 12–30 in. below the soil surface for more than 6 months in most years. Depressional areas of Basinger soils are covered with standing water for 6 to 9 months or more in most years.

Sanibel soil was observed at station 85 in the shallow marsh/shrub swamp community. Sanibel soils are very poorly drained and have a water table at depths within 10 in. of the soil surface for 6 to 12 months during most years. Water is above the surface for periods of 2 to 6 months during wet seasons (USDA, NRCS 2003).

Two histosols, soils that have more than half of the upper 32 in. dominated by organic material, were sampled within the shallow marsh/shrub swamp community. Samsula soil was observed at station 160 and Terra Ceia muck at station 330. These histosols are very poorly drained with a water table at or above the soil surface except during extended dry periods. Areas on floodplains are flooded for long durations (USDA, NRCS 2003).

Five hydric soil indicators were noted along Transect 1—stripped matrix (S6), mucky mineral (A7), muck presence (A8), histic epipedon (A2), and histosol (A1) (Table 4, Figure 5). The hydric soil indicator, stripped matrix, was observed at station 11 within the wet flatwoods community at an elevation of 42.2 ft NAVD. This soil indicator is at the base of a rather steep elevation gradient and may be maintained by groundwater seepage. The hydric soil indicators, mucky mineral and muck presence, occurred at station 25 (41.8 ft NAVD) and station 30 (41.6 ft NAVD), respectively, within the Transitional Shrub community. These hydric indicators occurred upslope of mature dead slash pines located near station 40 at elevations between 40.8 and 41.1 ft NAVD. The hydric indicator histic epipedon occurred within the shallow marsh/shrub swamp community at stations 130 (39.8 ft NAVD) to 170 (39.7 ft NAVD). Deeper organics (histosols) occurred at station 180 (39.5 ft NAVD) and waterward along Transect 1.

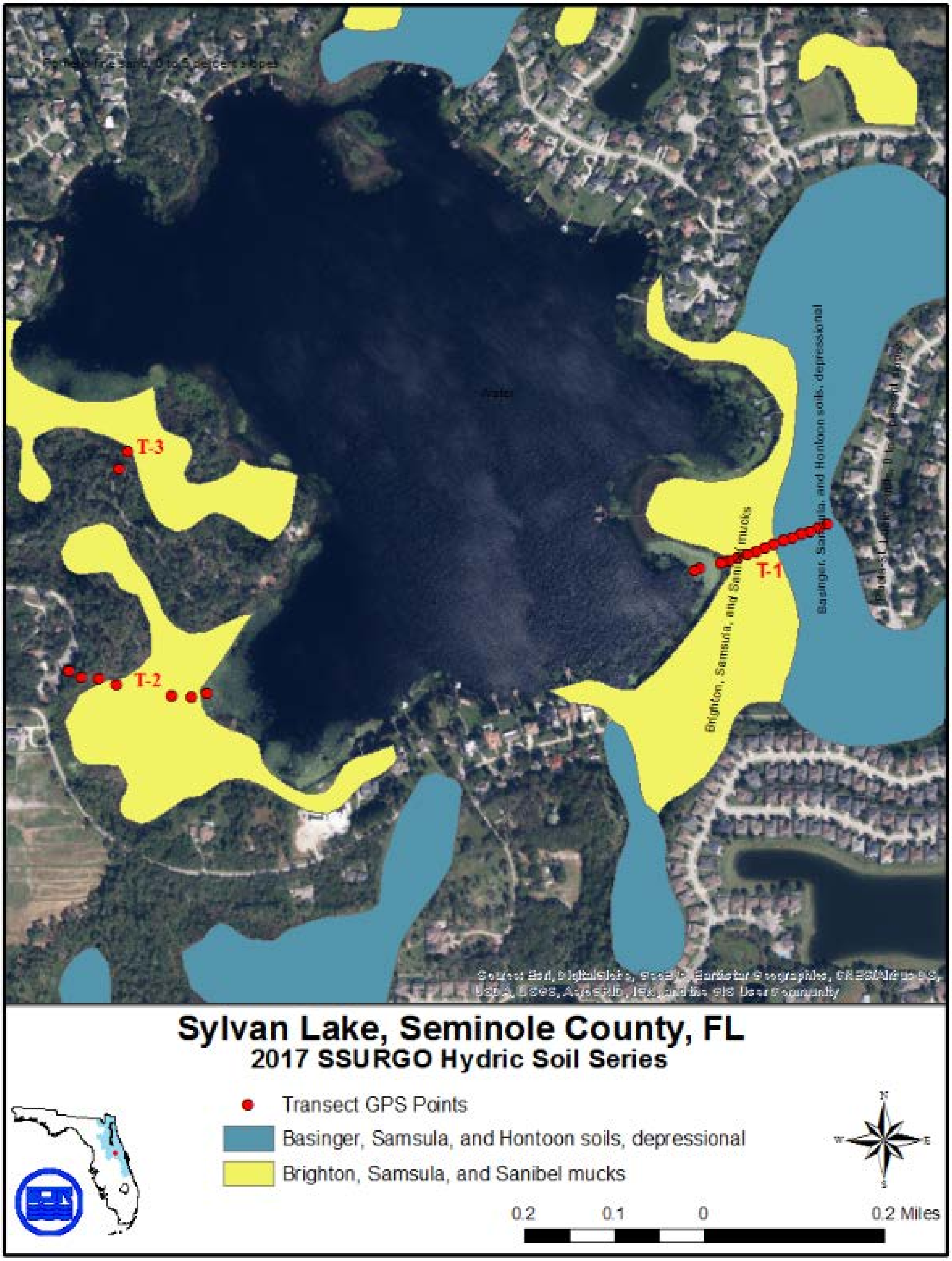

Figure 6. Sylvan Lake mapped hydric soil series showing sampling transect locations

Table 4. Locations and descriptions of hydric soil indicators on Transect 1 at Sylvan Lake

Hydric Soil Indicator	Station (ft)	Elevation (ft NAVD)	Vegetation Community	Description and Hydrologic Conditions
S6 – Stripped matrix	11	42.2	Wet flatwoods	A layer starting within 6 in. of the surface in which iron/manganese oxides and/or organic matter have been stripped from the matrix, exposing the primary base color of the soil materials. The stripped areas and translocated oxides and/or organic matter form a diffuse splotchy pattern of two or more colors. Stripped matrix has seasonal high saturation within 6 in. of the soil surface and is routinely used to delineate hydric soils throughout Florida (Carlisle and Hurt, 2000) and is, therefore, generally near the wetland-upland interface. Seasonal high saturation is the highest-expected annual elevation of saturation in a soil and is usually confirmed by observation of water in an unlined bore hole or the correlation of redoximorphic features with probable saturation (Carlisle and Hurt 2000).
A7 – 5cm mucky mineral	25	41.8	Transitional shrub	A mucky modified mineral surface layer at least 2 in. thick starting within 6 in. of the soil surface (USDA, NRCS 2003). Mucky mineral has a seasonal high saturation at the surface or inundation above the soil surface (Carlisle and Hurt, 2000).
A8 – Muck presence	30	41.6	Shallow marsh/shrub swamp	A layer of muck of any thickness that occurs within the upper 6 in. of the soil surface and contains a color value of 3 or less and chroma 1 or less. This indicator is used in land resource regions U, V, and Z (USDA, NRCS 2003). Muck presence has a seasonal high saturation at the surface or inundation above the soil surface (Carlisle and Hurt, 2000).
A2 – Histic epipedon	130	39.8	Shallow marsh/shrub swamp	A surface organic layer that is 8–16 in. thick. The required organic carbon content in the histic epipedon depends on clay content (USDA, NRCS 2003). Histic Epipedon has a seasonal high saturation at the surface or inundation above the soil surface (Carlisle and Hurt, 2000).
A1 – Histosol	180	39.5	Shallow marsh/shrub swamp	A soil that has organic soil material in more than half of the upper 80 cm (32 in.) or that is of any thickness if overlying rock. Histosols have seasonal high saturation at or above the soil surface (Carlisle and Hurt, 2000).

ft NAVD = feet North American Vertical Datum

Table 5. Soil description from transect 1-station 10

Station Point 10				
Soil Classification Valkaria				
Hydric Soil Indicator S6. Stripped matrix				
Horizon	**Depth**	**Color**	**Soil Texture**	**Soil Description**
A1	0 - 6	10YR 2/1 - Black	Fine Sand	
A2	6 - 8	10YR 2/1 - Black	Fine Sand	~10% 10YR 6/1
Eg	20 - 26	10YR 4/1 - Dark gray	Fine Sand	~25% 10YR 7/1
B/E	26 - 37	10YR 4/2 - Dark grayish brown	Fine Sand	~30% 10YR 4/1
C	37 - 61+	10YR 5/3 - Brown	Fine Sand	

Table 6. Soil description from transect 1-station 30

Station Point 30				
Soil Classification Basinger				
Hydric Soil Indicator A7. Mucky Mineral, A8. Muck Presence				
Horizon	**Depth**	**Color**	**Soil Texture**	**Soil Description**
Oa	0 - 3	N 2.5/ - Black	Fine Sand	muck presence
A1	3 - 6	N 2.5/ - Black	Mucky Fine Sand	Mucky Mineral
A2	6 - 8	10YR 2/1 - Black	Fine Sand	~10% 10YR 7/1
E	8 - 17	10YR 5/1 - Gray	Fine Sand	~25% 10YR 3/1 + 10YR 7/1
Bh1	17 - 22	10YR 2/2 - Very dark brown	Fine Sand	
Bh2	22 - 44	10 4/2 Dark grayish brown	Fine Sand	
C	44 - 59+	10 YR 5/2 Grayish brown	Fine Sand	

Table 7. Soil description from transect 1-station 85

Station Point 85				
Soil Classification Sanibel				
Hydric Soil Indicator A2. Histic Epipedon				
Horizon	**Depth**	**Color**	**Soil Texture**	**Soil Description**
Oa	0 - 8	N 2.5/ - Black	Muck	
A1	8 - 22	10YR 2/1 - Black	Fine Sand	~25% 10YR 6/1
A2	22 -45	10YR 3/2 - Very dark grayish brown	Fine Sand	
C	45 - 60+	10YR 5/3	Fine Sand	

Table 8. Soil description from transect 1-station 200

Station Point 200				
Soil Classification Samsula				
Hydric Soil Indicator A1. Histosol				
Horizon	**Depth**	**Color**	**Soil Texture**	**Soil Description**
Oa	0 - 27	N2.5/ - Black	Muck	Histosol
A	27 - 52	10YR 2/1 - Black	Fiine sand	~20% 10YR 4/1
Eg	52+	10YR 4/1 - Dark gray	Fiine sand	~20% 10YR 2/1, ~5% 10YR 6/1

Table 9. Soil description from transect 1-station 330

Station Point 330				
Soil Classification Terra Ceia				
Hydric Soil Indicator A1. Histosol				
Horizon	**Depth**	**Color**	**Soil Texture**	**Soil Description**
Oa	0 - 52+	7.5YR 3/3 - Dark brown	Muck	Histosol

Field Data Collection—Transect 2

Transect 2 was located on the southwest shore of Sylvan Lake (Figure 3). This transect site was established in order to characterize the extent of organic soils (i.e., histic epipedon and histosols) and shallow marsh and aquatic bed wetland plant communities at this location.

Mapped vegetation, based on remote sensing techniques and vegetation community designations by SJRWMD, show that Transect 2 should begin in an upland area followed by a bayhead/baygall community which then turns into shallow marsh and ends with a deep marsh community that extends to open water (Figure 3). In actuality, the vegetation communities delineated and identified along transect 2 during field work, differ from SJRWMD's mapped vegetation communities shown in Figure 3.

SJRWMD staff and consultant staff (JEA Inc.) collected vegetation and soils data, and SJRWMD's Division of Surveying Services staff collected elevation data. Elevations on Transect 2 were determined from a bench loop based on SJRWMD benchmark identification (ID) BM 945-15-02 (43.8385 ft NGVD) established from a bench loop from DEP ID T 468 1997 (48.6390 ft NGVD).

<u>Vegetation at Transect 2</u>

Transect 2 traversed 730 ft in an east-southeast direction from mesic flatwoods (stations POB–70), through a wet flatwoods (stations 70–120), transitional shrub swamp (stations 120–200), a shallow marsh (stations 200–255), a deep marsh (stations 255–540), a shallow marsh (stations 540–650), an aquatic bed (stations 650–730), and terminated in the open water of the lake (station 730) (Figures 7 and 8; Table 10). The following discussion summarizes the dominant plant species in the plant communities delineated on Transect 2 and the percent cover of each species within the community. A complete list of plant species observed on Transect 2 is listed in Table 11.

The mesic flatwoods (stations POB–70) overstory vegetation included abundant slash pine and scattered scrub live oak (*Quercus geminata*), myrtle oak (*Quercus myrtifolia*), and water oak. The mid-canopy vegetation included scattered tar-flower (*Befaria racemosa*), inkberry (*Ilex glabra*), rusty lyonia (*Lyonia ferruginea*), fetterbush (*Lyonia lucida*), wax myrtle, and highbush blueberry (*Vaccinium corymbosum*). The understory vegetation included abundant saw palmetto (*Serenoa repens*); numerous dangleberry (*Gaylussacia tomentosa*); and scattered shiny blueberry (*Vaccinium myrsinites*). The mesic flatwoods community was dominated by UPL and FACW plant species, however, FAC and OBL wetland plant species also occurred (Table 11).

The wet flatwoods (stations 70–120) overstory vegetation included abundant slash pine and numerous water oaks. The mid-canopy vegetation included scattered tar-flower, fetterbush, and highbush blueberry. The understory vegetation included scattered redroot (*Lachnanthes caroliniana*), maidencane, and saw palmetto. The wet flatwoods community was dominated by UPL and FACW plant species, however, FAC and OBL wetland plant species also occurred (Table 11).

The transitional shrub (stations 120–200) overstory vegetation included co-dominant Dahoon holly and abundant slash pine. The mid-canopy included scattered swamp bay and water oak. The understory vegetation included scattered bloodroot, maidencane, and common salvinia. The transitional shrub community was dominated by OBL, FACW, and UPL plant species (Table 11).

The shallow marsh community (stations 200–255) overstory vegetation included dead slash pine and dahoon holly. The understory vegetation included abundant maidencane and water lily; numerous bladderwort; and scattered buttonbush, torpedo grass, and common salvinia. The shallow marsh community was dominated by OBL and FACW plant species (Table 11).

The deep marsh community (stations 255–540) included co-dominant water lily; numerous bladderwort; and scattered arrowhead (*Sagittaria lancifolia*), maidencane, torpedo grass, and spadderdock (*Nuphar luteum*). The deep marsh community was dominated by OBL and FACW plant species (Table 11).

The shallow marsh community (stations 540–650) included abundant saw grass; numerous buttonbush, bald cypress, and arrowhead; and scattered water lily, maidencane, torpedo grass, bladderwort, spatterdock, and pickerelweed (*Pontederia cordata*). The shallow marsh community was dominated by OBL and FACW plant species (Table 11).

Waterward of the shallow marsh community, Transect 1 traversed an aquatic bed community (stations 540–730). The aquatic bed was dominated by water lily and scattered spatterdock, both OBL plant species (Table 11).

Figure 7a. Sylvan Lake Transect 2 at station 0 facing landward; Mesic flatwoods

Figure 7b. Sylvan Lake Transect 2 at station 0 facing waterward; Mesic flatwoods

Figure 7c. Sylvan Lake Transect 2 at station 70; Waterward edge of mesic flatwoods

Figure 7d. Sylvan Lake Transect 2 at station 320 facing NW landward; Deep marsh

Figure 7e. Sylvan Lake Transect 2 at station 320 facing SE; Deep marsh

Figure 7f. Sylvan Lake Transect 2 near station 730; Aquatic bed and shallow marsh

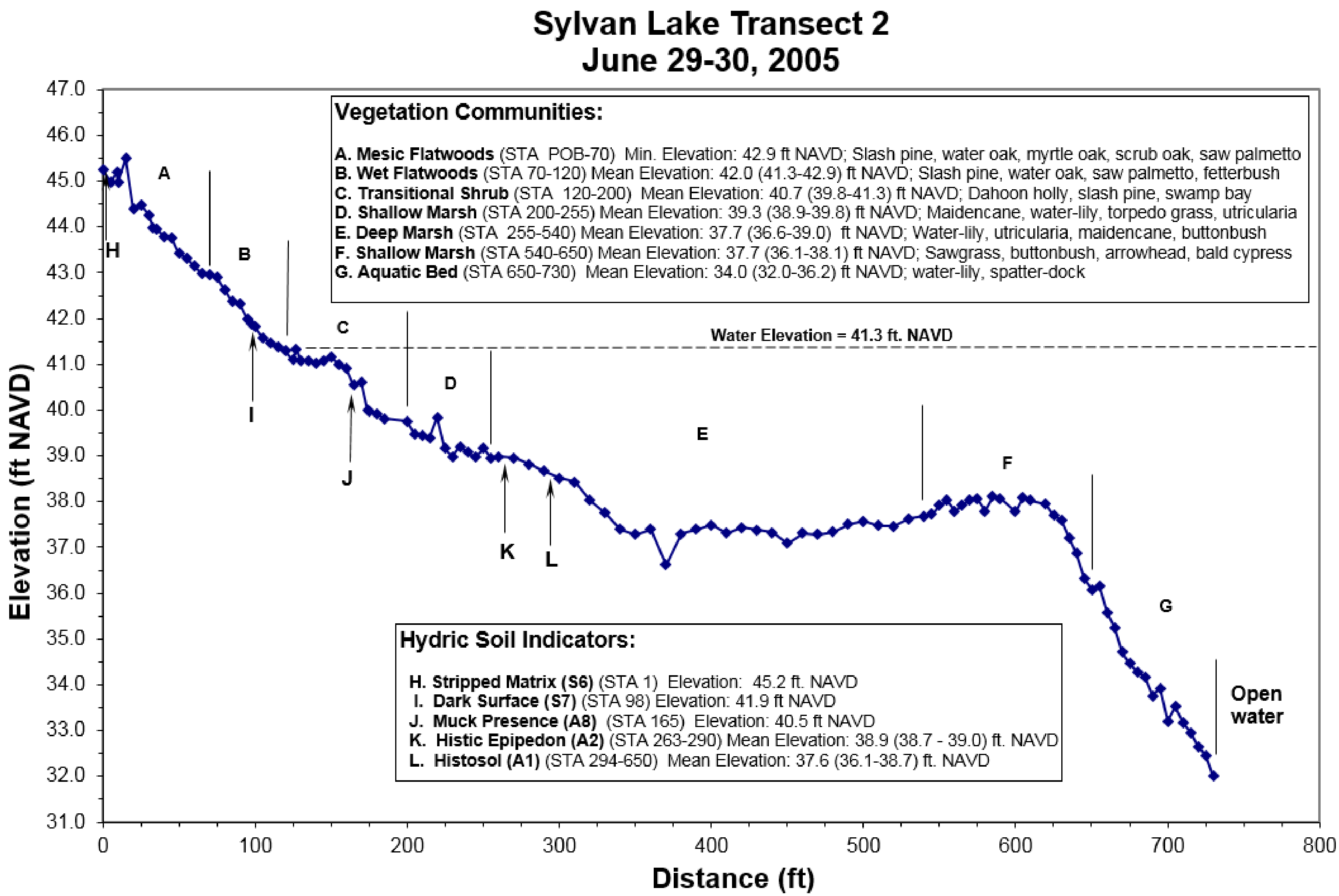

Figure 8. Sylvan Lake Transect 2 topography with ecological communities

Table 10. Sylvan Lake Transect 2 (2005) vegetation community elevation statistics

Vegetation Community	Stations Distance (ft)	Mean (ft NAVD)	Median (ft NAVD)	Min (ft NAVD)	Max (ft NAVD)	N
Mesic flatwoods	POB–70	-	-	42.9	-	-
Wet flatwoods	70–120	42.0	41.9	41.3	42.9	12
Transitional shrub	120–200	40.7	41.0	39.8	41.3	17
Shallow marsh	200–255	39.3	39.2	38.9	39.8	12
Deep marsh	255–540	37.7	37.5	36.6	39.0	30
Shallow marsh	540–650	37.7	37.8	36.1	38.1	21
Aquatic bed	650–730	34.0	33.9	32.0	36.2	17

ft NAVD = feet North American Vertical Datum
N = the number of elevations surveyed for each community

Table 11. Plant species, FWDM wetland indicator status, and estimated species occurrence for each plant community type occurring on Transect 2 (2005) at Sylvan Lake, Seminole County, FL.

Scientific Name	Common Name	Vegetation Community[2]							
		Name	MF	WF	TS	SM	DM	SM	AB
		Start (ft)	0	70	120	200	255	540	650
		Stop (ft)	70	120	200	255	540	650	730
		FWDM Code[1]	Plant Species Cover Estimates[3]						
Asimina sp.	Pawpaw	**verify**	0						
Befaria racemosa	Tar-flower	UPL	1	1					
Boehmeria cylindrica	Smallspike false-nettle	OBL				0		1	
Cephalanthus occidentalis	Buttonbush	OBL				1	1	2	
Cladium jamaicense	Sawgrass	OBL					1	3	
Cyperus odoratus	Fragrant flatsedge	FACW						1	
Eleocharis sp.	Spikerush	OBL						1	
Gaylussacia tomentosa	Dangleberry	UPL	2						
Gordonia lasianthus	Loblolly bay	FACW				0			
Habenaria sp.	Rein orchid	FACW						0	
Hydrocotyle sp.	Pennywort	OBL						1	
Ilex cassine	Dahoon holly	OBL			4				
Ilex glabra	Inkberry	UPL	1						
Lachnanthes caroliniana	Redroot	FAC		1	1				
Ludwigia leptocarpa	Ludwigia	OBL						1	
Ludwigia peruviana	Primrose willow	OBL				0		1	
Lyonia ferruginea	Rusty lyonia	UPL	1						
Lyonia lucida	Fetterbush	FACW	1	1					
Mikania scandens	Climbing hemp-weed	UPL						1	
Myrica cerifera	Wax myrtle	FAC	1						
Nuphar luteum	Spatter-dock	OBL					1	1	1
Nymphaea odorata	Water-lily	OBL				3	4	1	4
Nymphoides aquatica	Floatingheart	OBL				0	1		
Panicum hemitomon	Maidencane	OBL	1	1	1	3	1	1	
Panicum repens	Torpedo grass	FACW				1	1	1	

Persea palustris	Swamp bay	OBL	0		1				
Pinus elliottii	Slash pine	UPL	3	3	3				
Pluchea sp.	Camphor-weed	FACW						1	
Pontederia cordata	Pickerelweed	OBL						1	
Quercus geminata	Scrub live oak	UPL	1						
Quercus myrtifolia	Myrtle oak	UPL	1						
Quercus nigra	Water oak	FACW	2	2	1				
Sagittaria lancifolia	Arrowhead	OBL					1	2	
Salvinia rotundifolia	Common salvinia	OBL			1	1			
Serenoa repens	Saw palmetto	UPL	4	1	0				
Taxodium distichum	Bald cypress	OBL						2	
Typha latifolia	Cattail	OBL						1	
Utricularia biflora	Bladderwort	OBL				2	2	1	
Vaccinium corymbosum	highbush blueberry	FACW	1	1					
Vaccinium myrsinites	Shiny blueberry	UPL	1						
Woodwardia virginica	Virginia chain fern	FACW			0				

1 FWMD code indicator categories established in The Florida Wetlands Delineation Manual (Gilbert et al. 1995):
- UPL = Upland plants that occur rarely in wetlands but occur almost always in uplands
- FAC = Facultative plants with similar likelihood of occurring in both wetlands and uplands
- FACW = Facultative wet plants that typically exhibit their maximum cover in areas subject to surface water flooding and/or soil saturation but may also occur in uplands
- OBL = Obligate plants that are found or achieve their greatest abundance in an area, which is subject to surface water flooding and/or soil saturation; rarely uplands

2 Plant community abbreviations:
- MF = Mesic Flatwoods (stations 0-70)
- WF = Wet Flatwoods (stations 70-120)
- TS = Transitional Shrub (stations 120-200)
- SM = Shallow Marsh (stations 200-255)
- DM = Deep Marsh (stations 255-540)
- SM = Shallow Marsh (stations 540-650)
- AB = Aquatic Bed (650-730)

3 Plant Species Cover Estimates: Areal extent of vegetation species along transect within a given community where 0 = <1% (rare); 1 = 1-10% (scattered); 2 = 11-25% (numerous); 3 = 26-50% (abundant); 4 = 51-75% (codominant); 5 = >75% (dominant)

4 Floating vegetation

<u>Soils at Transect 2</u>

Soils were mapped as Myakka and Eau Gallie fine sands (non-hydric soil series) within the wet flatwoods and transitional shrub communities, and Brighton, Samsula, and Sanibel mucks within the deep marsh and shallow marsh communities at Transect 2 (Figure 6). Field sampled soils sampled at Transect 2 varied from the SSURGO map delineation due to the map scale.

Twenty-two soil stations were evaluated along Transect 2. Soil characteristics transitioned from indicators of periodic saturation in the upper 6 in., to indicators of frequent inundation, to indicators of nearly permanent inundation. The transition from upland soils and plant communities to wetland soils and plant communities was abrupt in the first 120 ft. A stripped matrix was located at station 1 and is often associated with wetland boundaries in Florida. Soil saturation in the upper 120 ft of the transect may be influenced by seepage and runoff from the adjacent parking area. Beyond station 120, the soils gradually transitioned to deep organics (histosol) at station 294. Hydric soil indicators observed along Transect 2 were Stripped Matrix (S6), Dark Surface (S7), Muck Presence (A8), Histic Epipedon (A2) and Histosol (A1) (Table 12 and Figure 8).

Three soil types—Immokalee, Smyrna, and Myakka soils—were observed on Transect 2. The deep organic soils could not be classified due to the depth of water covering the soils. Immokalee soil was observed at station 35 in the mesic flatwoods vegetative community. Immokalee soil is poorly to very poorly drained sandy soil with a water table at depths of 6 in.–18 in. below the soil surface for 1 to 4 months during most years. Depressional areas of Immokalee soil are covered with standing water for 6 to 9 months or more in most years (USDA, NRCS 2003).

Smyrna soils were observed at station 105 in the wet flatwoods vegetative community and are poorly to very poorly drained with a water table within 18 in. of the soil surface for 1 to 4 months in most years and within 12–40 in. below the soil surface for more than 6 months. In the rainy season, the water table rises above the surface briefly. In depressions, water stands above the surface for 6 to 9 months or more in most years.

Myakka soils were observed at station 180 in the transitional shrub vegetative community and are nearly level and poorly drained. During most years, these soils have a seasonal high water table within 12 in. of the surface for 1 to 4 months (USDA, NRCS 2003).

The hydric indicator stripped matrix occurred at station 1 (45.2 NAVD) in the mesic flatwoods community. The hydric indicator dark surface occurred at station 98 (41.9 ft NAVD) in the wet flatwoods community. The hydric indicator muck presence occurred at station 165 (40.5 ft NAVD) within the transitional shrub community. These hydric indicators occurred upslope of numerous dead mature slash pines and dahoon hollies located near stations 180–200 at elevations between 39.9 ft and 39.7 ft NAVD. The hydric indicator histic epipedon occurred within the deep marsh community at stations 263 (39.0 ft NAVD) to 292 (38.7 ft NAVD). Deeper organic soils (histosols) occurred at station 294 (38.7 ft NAVD) and waterward along Transect 2.

Table 12. Locations and descriptions of hydric soil indicators on Transect 2 at Sylvan Lake

Hydric Soil Indicator	Station (ft)	Elevation (ft NAVD)	Vegetation Community	Description and Hydrologic Conditions
S6 – Stripped matrix	1	45.2	Mesic flatwoods	A layer starting within 6 in. of the surface in which iron/manganese oxides and/or organic matter have been stripped from the matrix, exposing the primary base color of the soil materials. The stripped areas and translocated oxides and/or organic matter form a diffuse splotchy pattern of two or more colors. Stripped matrix has seasonal high saturation within 6 in. of the soil surface and is routinely used to delineated hydric soils throughout Florida (Carlisle and Hurt 2000) and is, therefore, generally near the wetland-upland interface. Seasonal high saturation is the highest expected annual elevation of saturation in a soil and is usually confirmed by observation of water in an unlined bore hole or the correlation of redoximorphic features with probable saturation (Carlisle and Hurt 2000).
S7 – Dark surface	98	41.9	Wet flatwoods	A layer 4 in. or thicker starting within the upper 6 in. of the soil surface that is predominately black. The matrix color value is 3 or less and chroma is 1 or less. At least 70 percent of the visible soil particles must be covered, coated, or similarly masked with organic material. The matrix color of the layer below the dark layer has a chroma of 2 or less (USDA, NRCS 2003). Dark Surface has a seasonal high saturation within 6 in. of the soil surface (Carlisle and Hurt 2000).
A8 – Muck presence	165	40.5	Transitional shrub	A layer of muck of any thickness that occurs within the upper 6 in. of the soil surface and contains a color value of 3 or less and chroma 1 or less. This indicator is used in land resource regions U, V, and Z (USDA, NRCS 2003). Muck presence has a seasonal high saturation at the surface or inundation above the soil surface (Carlisle and Hurt 2000).
A2 – Histic epipedon	263	39.0	Deep marsh	A surface organic layer that is 8–16 in. thick. The required organic carbon content in the histic epipedon depends on clay content (USDA, NRCS 2003). Histic Epipedon has a seasonal high saturation at the surface or inundation above the soil surface (Carlisle and Hurt 2000).
A1 – Histosol	294	38.7	Deep and shallow marshes	A soil that has organic soil material in more than half of the upper 80 cm (32 in.) or that is of any thickness if overlying rock. Histosols have seasonal high saturation at or above the soil surface (Carlisle and Hurt 2000).

Table 13. Soil description from transect 2-station 35

Station Point 35				
Soil Classification Immokolee				
Hydric Soil Indicator S6. Stripped matrix				
Horizon	**Depth**	**Color**	**Soil Texture**	**Soil Description**
A1	0 - 2	10YR 2/1 - Black	Fine Sand	salt and peper
A2	2 - 6	10YR 3/1 - Very dark gray	Fine Sand	~5% 10YR 6/1 beginning at 5" BNG
A3	6 - 9	10YR 3/1 - Very dark gray	Fine Sand	~20% 10YR 6/1, Stripped matrix
Eg1	9 - 21	10YR 5/1 - Gray	Fine Sand	~20% 10YR 6/1
Eg2	21 - 43	10YR 6/1 - Gray	Fine Sand	~10% 10YR 2/1
Bh1	43 - 51	10YR 3/2 - Very dark grayish brown	Fine Sand	
Bh2	51 - 56+	10 4/2 - Dark grayish brown	Fine Sand	~30% 10YR 3/1

Table 14. Soil description from transect 2-station 105

Station Point 105				
Soil Classification Smyrna				
Hydric Soil Indicator S7. Dark Surface				
Horizon	**Depth**	**Color**	**Soil Texture**	**Soil Description**
A	0 - 4	10YR 2/1 - Black	Fine Sand	Dark surface
E	4 - 15	10YR 4/1 - Dark gray	Fine Sand	~20% 10YR 6/2
Bh1	15 - 25	10YR 3/2 - Very dark grayish brown	Fine Sand	
Bh2	25 - 42	10YR 3/3 - Dark brown	Fine Sand	
Bh3	42 - 50+	10YR 5/4 - Yellowish brown	Fine Sand	

Table 15. Soil description from transect 2-station 180

Station Point 180				
Soil Classification Myakka				
Hydric Soil Indicator S7. Dark Surface, A8. Muck Presence				
Horizon	**Depth**	**Color**	**Soil Texture**	**Soil Description**
Oa	0 - 1	N2.5/ - Black	Fine Sand	Muck presence
A	1 - 13	10YR 2/1 - Black	Fine Sand	Dark surface
E	13 - 22	10YR 4/1 - Dark gray	Fine Sand	
Bw1	22 - 37	10 4/2 - Dark grayish brown	Fine Sand	
Bw2	37 - 42	10YR 4/4 - Dark yellowish brown	Fine Sand	
E'	42 - 45+	10YR 4/1 - Dark gray	Fine Sand	

Field Data Collection—Transect 3

Transect 3 was located on the west shore of Sylvan Lake (Figure 3). This transect site was established in order to characterize the extent of the transitional shrub swamp and upland plant communities at this location.

Mapped vegetation, based on remote sensing techniques and vegetation community designations by SJRWMD, show that Transect 3 should begin in an upland area and end in a shallow marsh (Figure 3). In actuality, the vegetation communities delineated and identified along transect 3 during field work, differ from SJRWMD's mapped vegetation communities shown in Figure 3.

SJRWMD staff and consultant staff (JEA Inc.) collected vegetation and soils data, and SJRWMD's Division of Surveying Services staff collected elevation data. Elevations on Transect 3 were determined from a bench loop based on SJRWMD benchmark identification (ID) 05-17-616-0 (42.6331 ft NGVD) and reference mark ID 05-17-616-1 (46.4531 ft NGVD). The following describes field collected vegetation and soils data at Transect 3.

<u>Vegetation at Transect 3</u>

Transect 3 traversed 100 ft in a northerly direction from a mesic hammock (stations POB–16), through a wet flatwoods (stations 16–28), transitional shrub swamp (stations 28–81), a shallow marsh (stations 81–93), and terminated in a deep marsh at station 100 (Figures 9 and 10; Table 16). The following discussion summarizes the dominant plant species in the plant communities delineated on Transect 3 and the percent cover of each species within the community. A complete list of plant species observed on Transect 3 is listed in Table 17.

The mesic hammock (POB–station 16) overstory vegetation included numerous laurel oak, scrub live oak, and slash pine and scattered swamp bay. The mid-canopy vegetation included numerous myrtle oak and scattered highbush blueberry. The understory vegetation included scattered saw palmetto, shiny blueberry, and bracken fern. The mesic hammock community was dominated by UPL and FACW plant species, however, FAC and OBL wetland plant species also occurred (Table 17).

The wet flatwoods (stations 16–28) overstory vegetation included scattered slash pine, dahoon holly, and water oaks. The mid-canopy vegetation included numerous myrtle oaks and swamp bay. The understory vegetation included scattered bracken fern and shiny blueberry. The wet flatwoods community was dominated by UPL and FACW plant species, however, one OBL wetland plant species also occurred. The transitional shrub (stations 28–81) overstory vegetation included abundant dahoon holly and scattered swamp bay. The understory vegetation included scattered numerous water lily and maidencane and scattered primrose willow, marsh purslane (*Ludwigia repens*), buttonbush, begger-ticks, and dogfennel

(*Eupatorium capillifolium*). The transitional shrub community was dominated by OBL and FACW plant species (Table 17).

The shallow marsh community (stations 81–93) overstory vegetation included scattered dahoon holly. The understory vegetation included abundant maidencane and scattered water lily and common salvinia. The shallow marsh community was dominated by OBL plant species (Table 17).

Waterward of the shallow marsh community, Transect 3 entered a deep marsh community (station >93). The vegetation included co-dominant water lily and scattered maidencane, OBL plant species (Table 17).

Figure 9a. Sylvan Lake Transect 3 at station 0; Mesic hammock

Figure 9b. Sylvan Lake Transect 3 at station 50 facing N; Shallow marsh and deep marsh

Figure 9c. Sylvan Lake Transect 3 at station 85 facing North; Deep Marsh

Figure 9d. Sylvan Lake Transect 3 at station 93; Shallow marsh

Figure 9e. Sylvan Lake Transect 3 at station 93; Shallow Marsh

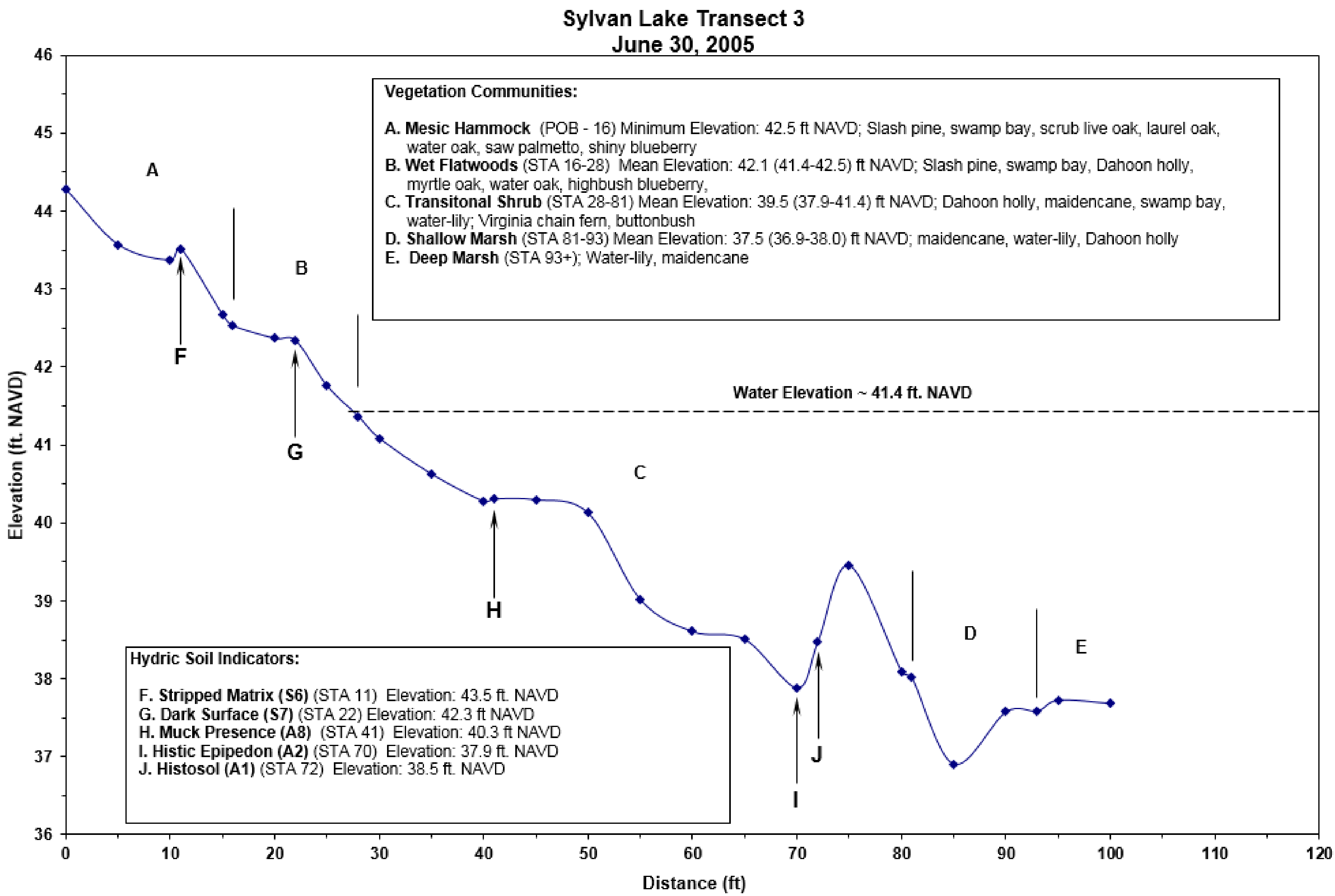

Figure 10. Sylvan Lake Transect 3 topography with ecological communities

Table 16. Sylvan Lake Transect 3 (2005) vegetation community elevation statistics

Vegetation Community	Stations Distance (ft)	Mean (ft NAVD)	Median (ft NAVD)	Min (ft NAVD)	Max (ft NAVD)	N
Mesic hammock	POB–16	-	-	42.5	-	-
Wet flatwoods	16–28	42.1	42.3	41.4	42.5	5
Transitional shrub	28–81	39.5	39.5	37.9	41.4	15
Shallow marsh	81–93	37.5	37.6	36.9	38.0	4

ft NAVD = feet North American Vertical Datum
N = the number of elevations surveyed for each vegetation community

Table 17. Plant species, FWDM wetland indicator status, and estimated species occurrence for each plant community type occurring on Transect 3 (2005) at Sylvan Lake, Seminole County, FL.

Scientific Name	Common Name	Vegetation Community[2]					
		Name	MH	WF	TS	SM	
		Start (ft)	0	16	28	81	>93
		Stop (ft)	16	28	81	93	
		FWDM Code[1]	Plant Species Cover Estimates[3]				
Bidens mitis	Begger-ticks	OBL			1		
Boehmeria cylindrica	Smallspike false-nettle	OBL			1		
Cephalanthus occidentalis	Buttonbush	OBL			1		
Eupatorium capillifolium	Dog fennel	FAC			1		
Ilex cassine	Dahoon holly	OBL		1	3	1	
Ludwigia peruviana	Primrose willow	OBL			1		
Ludwigia repens	Marsh purslane	OBL			1		
Nymphaea odorata	Water-lily	OBL			2	1	4
Panicum hemitomon	Maidencane	OBL			2	3	1
Persea palustris	Swamp bay	OBL	1	2	1		
Pinus elliottii	Slash pine	UPL	2	1			
Pontederia cordata	Pickerelweed	OBL			0		
Pteridium aquilinum	Braken fern	UPL	1	1			
Quercus geminata	Scrub live oak	UPL	2				
Quercus laurifolia	Laurel oak	FACW	2				
Quercus myrtifolia	Myrtle oak	UPL	2	2			
Quercus nigra	Water oak	FACW	1	1			
Salvinia rotundifolia	Common salvinia	OBL			1	1	
Serenoa repens	Saw palmetto	UPL	1				
Triadenum virginicum	Marsh St. John's-wort	OBL			1		
Vaccinium corymbosum	highbush blueberry	FACW	1	1			
Vaccinium myrsinites	Shiny blueberry	UPL	1	1			
Vitis rotundifolia	Muscadine grape	UPL	2	2			
Woodwardia virginica	Virginia chain fern	FACW			1		

1 FWMD code indicator categories established in The Florida Wetlands Delineation Manual (Gilbert et al., 1995):
UPL = Upland plants that occur rarely in wetlands but occur almost always in uplands
FAC = Facultative plants with similar likelihood of occurring in both wetlands and uplands
FACW = Facultative wet plants that typically exhibit their maximum cover in areas subject to surface water flooding and/or soil saturation but may also occur in uplands
OBL = Obligate plants that are found or achieve their greatest abundance in an area, which is subject to surface water flooding and/or soil saturation; rarely uplands
2 Plant community abbreviations:
MH = Mesic Hammock (stations 0-16)
WF = Wet Flatwoods (stations 16-28)
TS= Transitional Shrub (stations 28-81)
SM = Shallow Marsh (stations 81-93)
3 Plant Species Cover Estimates: Areal extent of vegetation species along transect within a given community where 0 = <1%
(rare); 1 = 1-10% (scattered); 2 = 11-25% (numerous); 3 = 26-50% (abundant); 4 = 51-75% (codominant); 5 = >75% (dominant)
4 Floating vegetation

<u>Soils at Transect 3</u>

Distinct soil changes occurred along Transect 3 as determined from the five sampling stations (Table 19-22). A transition from a periodically saturated soil to consistently saturated soil occurred along Transect 3. Hydric soil indicators observed along Transect 3 included Stripped Matrix (S6), Dark Surface (S7), Muck Presence (A8), histic epipedon (A2) and histosol (A1) (Table 18 and Figure 10).

Stripped matrix (S6), the landward extent of hydric soil indicators, was observed at station 11 within the mesic hammock community at an elevation of 43.5 ft NAVD. This soil indicator is at the base of a rather steep elevation gradient and may be maintained by seepage. The hydric indicator dark surface occurred at station 22 (elevation 42.3 ft NAVD) in the wet flatwoods community. The hydric indicator muck presence occurred at station 41 (elevation 40.3 ft NAVD) within the transitional shrub community. The hydric indicators histic epipedon and histosols occurred within the transitional shrub community at stations 70 (elevation 37.9 ft NAVD) and 72 (elevation 38.5 ft NAVD), respectively.

Table 18. Locations and descriptions of hydric soil indicators on Transect 3 at Sylvan Lake

Hydric Soil Indicator	Station (ft)	Elevation (ft NAVD)	Vegetation Community	Description and Hydrologic Conditions
S6 – Stripped matrix	11	43.5	Mesic flatwoods	A layer starting within 6 in. of the surface in which iron/manganese oxides and/or organic matter have been stripped from the matrix, exposing the primary base color of the soil materials. The stripped areas and translocated oxides and/or organic matter form a diffuse splotchy pattern of two or more colors. Stripped matrix has seasonal high saturation within 6 in. of the soil surface and is routinely used to delineate hydric soils throughout Florida (Carlisle and Hurt 2000) and is, therefore, generally near the wetland-upland interface. Seasonal high saturation is the highest-expected annual elevation of saturation in a soil and is usually confirmed by observation of water in an unlined bore hole or the correlation of redoximorphic features with probable saturation (Carlisle and Hurt 2000).

S7 – Dark surface	22	42.3	Wet flatwoods	A layer 4 in. or thicker starting within the upper 6 in. of the soil surface that is predominately black. The matrix color value is 3 or less and chroma is 1 or less. At least 70 percent of the visible soil particles must be covered, coated, or similarly masked with organic material. The matrix color of the layer below the dark layer has a chroma of 2 or less (USDA, NRCS 2003). Dark Surface has a seasonal high saturation within 6 in. of the soil surface (Carlisle and Hurt 2000).
A8 – Muck presence	41	40.3	Transitional shrub	A layer of muck of any thickness that occurs within the upper 6 in. of the soil surface and contains a color value of 3 or less and chroma 1 or less. This indicator is used in land resource regions U, V, and Z (USDA, NRCS 2003). Muck presence has a seasonal high saturation at the surface or inundation above the soil surface (Carlisle and Hurt 2000).
A2 – Histic epipedon	70	37.9	Transitional shrub	A surface organic layer that is 8–16 in. thick. The required organic carbon content in the histic epipedon depends on clay content (USDA, NRCS 2003). Histic Epipedon has a seasonal high saturation at the surface or inundation above the soil surface (Carlisle and Hurt 2000).
A1 – Histosol	72	38.5	Transitional shrub	A soil that has organic soil material in more than half of the upper 80 cm (32 in.) or that is of any thickness if overlying rock. Histosols have seasonal high saturation at or above the soil surface (Carlisle and Hurt 2000).

Table 19. Soil description from transect 3-station 8

Station Point	8			
Soil Classification	Myakka			
Hydric Soil Indicator	S6. Stripped matrix			
Horizon	**Depth**	**Color**	**Soil Texture**	**Soil Description**
A1	0 - 6	10YR 4/1 - Dark gray	Fine Sand	
A2	6 - 9	10YR 3/1 - Very dark gray	Fine Sand	~30% 10YR 6/1
Eg1	9 - 12	10YR 6/1 - Gray	Fine Sand	10YR 2/1 streaking
Eg2	12 - 27	10YR 5/1 - Gray	Fine Sand	~15% 10YR 7/1
Bh1	27 - 38	10YR 3/1 - Very dark gray	Fine Sand	~20% 10YR 4/1
Bh2	38 - 47	7.5YR 2.5/2 - Very dark brown	Fine Sand	~10% 7.5YR 3/3
Bh3	47 - 61+	7.5YR 3/3 - Dark brown	Fine Sand	

Table 20. Soil description from transect 3-station 20

Station Point 20				
Soil Classification Myakka				
Hydric Soil Indicator S7. Dark Surface S6. Stripped Matrix				
Horizon	**Depth**	**Color**	**Soil Texture**	**Soil Description**
A1	0 - 3	10YR 2/1 - Black	Fine Sand	Dark Surface
A2	3 - 6	10YR 2/1 - Black	Fine Sand	~10% 10YR 7/1
Eg1	6 - 24	10YR 4/1 - Dark gray	Fine Sand	~30% 10YR 6/1
Eg2	24 - 36	10YR 5/1 - Gray	Fine Sand	~20% 10YR 6/1 + ~10% 10YR 2/1
Bh1	36 - 48	10 4/2 - Dark grayish brown	Fine Sand	w/ 10YR 3/1 + 10YR 5/2
Bh2	32 - 40	10 4/2 - Dark grayish brown	Fine Sand	
Bh3	40 - 53+	10YR 3/3 - Dark brown	Fine Sand	

Table 21. Soil description from transect 3-station 35

Station Point 35				
Soil Classification Myakka				
Hydric Soil Indicator A7. Mucky Mineral, S7.Dark Surface, S6. Stripped Matrix				
Horizon	**Depth**	**Color**	**Soil Texture**	**Soil Description**
A1	0 - 1	N 2.5/ - Black	Mucky Fine Sand	Mucky Mineral
A2	1 - 3	N 2.5/ - Black	Fine Sand	Dark surface
A3	3 - 5	10YR 4/1 - Dark gray	Fine Sand	~10% 10YR 6/1, Stripped matrix
Eg1	5 - 7	10YR 5/1 - Gray	Fine Sand	~30% 10YR 7/1
Eg2	7 - 28	10YR 6/1 - Gray	Fine Sand	~20% 10YR 7/1 + ~10% 10YR 4/1
Bh1	28 - 32	10 4/2 - Dark grayish brown	Fine Sand	w/ ~10% 10YR 3/1 + ~10% 10YR 5/2
Bh2	32 - 40	10 4/2 - Dark grayish brown	Fine Sand	
Bh3	40 - 53+	10YR 3/3 - Dark brown	Fine Sand	~10% 10YR 5/3

Table 22. Soil description from transect 3-station 73

Station Point 73				
Soil Classification Sanibel				
Hydric Soil Indicator A2. Histic Epipedon				
Horizon	**Depth**	**Color**	**Soil Texture**	**Soil Description**
Oa	0 - 8	N 2.5/ - Black	Muck	
A1	8 - 15	10YR 2/1 - Black	Mucky fine sand	~10% 10YR 7/1
E	15 - 40	10YR 4/1 - Dark gray	Fine Sand	~25% 10YR 6/1
Bh	40 - 50+	7.5YR 3/3 - Dark brown	Fine Sand	

Verification of Organic Soils Elevations

Location and characterization of organic soils was determined at Sylvan Lake in 2005. As part of the current MFLs determination, the location of organic soils was examined in 2018 and 2020 to determine whether the location of organic soils identified in 2005 had changed.

Higher than average water levels have persisted at Sylvan Lake since 2017, originally coinciding with high rainfall from Hurricane Irma. Organic soils examined in 2005 are currently submerged and unavailable for detailed re-examination using a sharpshooter shovel and auger. Because of this, other methods have been used to verify the location of soils identified in 2005.

Because organic soils have been inundated since 2017, examinations were made using a soil probe in 2018 and Russian Peat Corer in 2020. Examinations were performed to determine Oa horizon depth and elevation (ft NAVD88) to ascertain if significant change has occurred since 2005. Samples excavated using the Russian Peat Corer in December of 2020 were collected and examined for loss on ignition (LOI) organic matter content to verify field determinations of soil texture.

Organic Soil Probing (2018)

Submerged organic soils were examined at Sylvan Lake in 2018 using a soil probe. The soil probe was pushed through the organic horizon until hitting refuse. Soil horizon depths and elevations were recorded at multiple locations at the original (2005) transect locations (Figures 11, 12 and 13).

Transect 3:

A strong linear relationship ($R^2 = 0.97$) was observed between elevation and organic soil depth at transect 3 (Figure 11, Table 23). The marsh community at transect 3 appears to be protected from wave action by a berm to the North and East. Examination of aerial images shows that while this area is protected, it is hydrologically connected to Lake Sylvan. The data observed in 2005 shows A2 (histic epipedon) occurring at a lower elevation than what was observed in 2018 while A1 (histosol) occurs at roughly the same elevation as observed in 2018. Transect 3 extends 100 ft from the uplands down into the deep marsh and includes deep organic soils at stations 70 to 72. Probing was performed adjacent to and on Transect 3, capturing a broader picture of the organic soil elevations present, relative to what was observed in 2005. Deep organic soils were observed at and above the elevations described in 2005. This provides evidence that no loss of organic soils has occurred since 2005 in the area adjacent to transect 3.

Transect 2:

No distinct relationship could be determined from the organic soil elevations and depths present at transect 2 through probing in 2018 (Figure 12, Table 24). This may be due to wave action re-distribution, the presence of the boardwalk adjacent to the transect, or a combination of these factors. The organic soil depths were shallower and elevations lower in 2018 relative to 2005. This is not likely due to subsidence as no other evidence of subsidence was observed (exposed roots, concretions, upland encroachment etc.). The boardwalk is extensively damaged, and this may coincide with recent

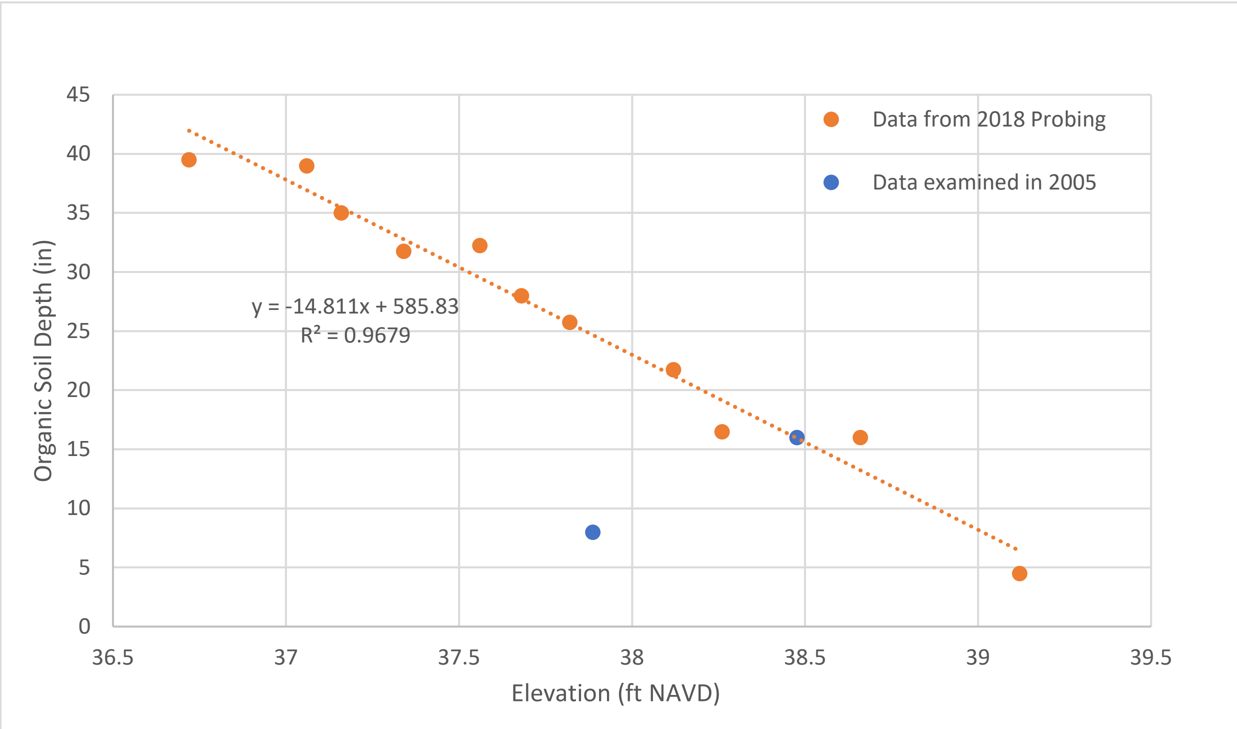

Figure 11. Organic soil depths and elevations examined in 2005 and 2018 at transect 3.

storm events that would lead to the redistribution of the organic soils observed in 2005. The data collected in 2018 does not provide evidence of subsidence.

Transect 1:

Comparable to transect 2, no distinct relationship can be inferred from the organic soil depths and elevations at transect 1 (Figure 14, Table 25). Transect 1 also has an adjacent boardwalk and may have been affected by redistribution of organic soils due to storm events. No evidence of subsidence was observed in 2018 at transect 1.

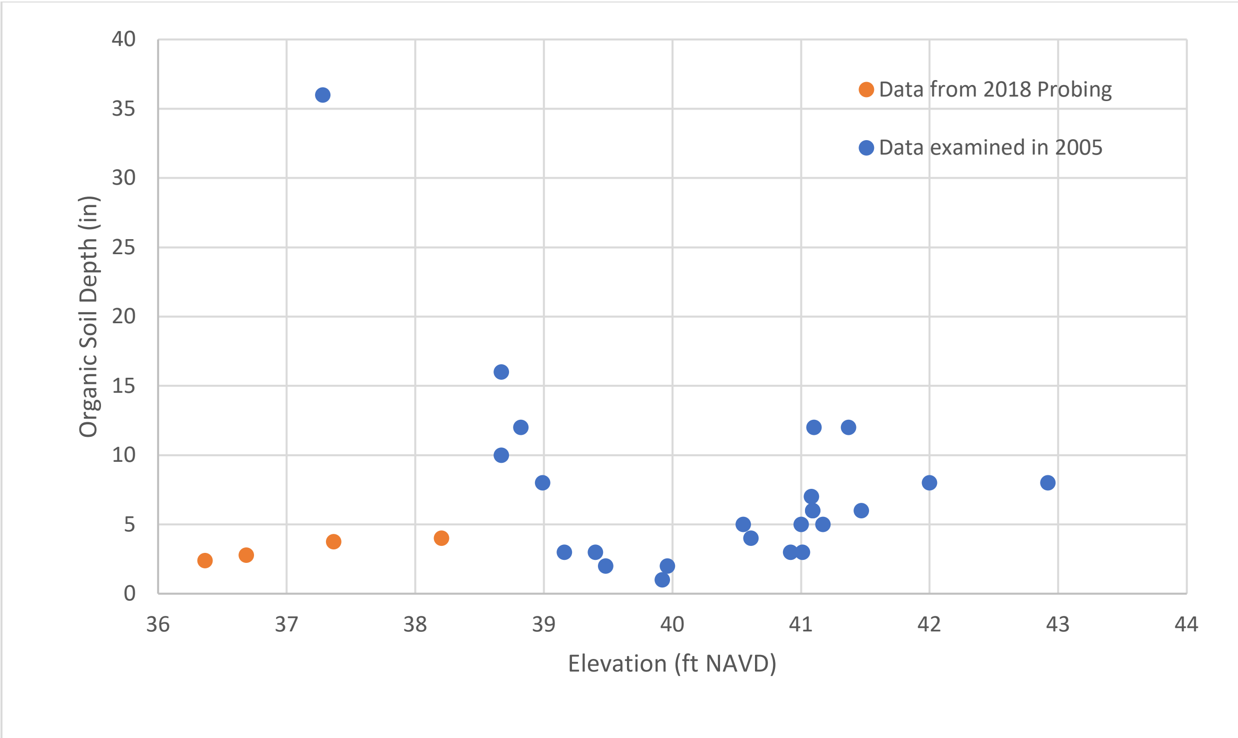

Figure 12. Organic soil depths and elevations examined in 2005 and 2018 at transect 2.

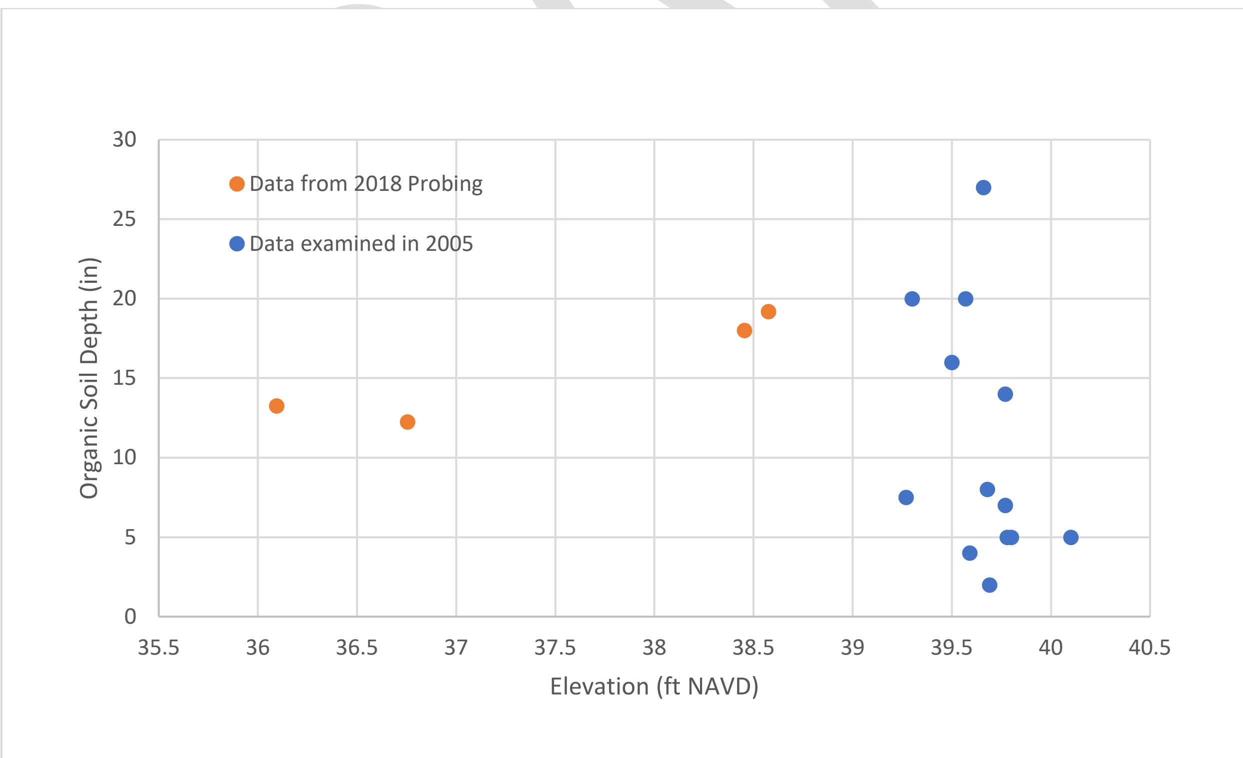

Figure 13. Organic soil depths and elevations examined in 2005 and 2018 at transect 1.

Table 23. Organic soil depths and elevations from data collected at transect 3 in 2005 and 2018

Transect 3					
2005			2018		
Station	**Elevation NAVD88**	**Muck Depth (in)**	**Station**	**Elevation NAVD88**	**Muck Depth (in)**
70	37.9	8	56	39.1	4.5
72	38.5	16	62	38.7	16
			65	38.3	16.5
			70	38.1	21.75
			75	37.8	25.75
			80	37.7	28
			85	37.6	32.25
			90	37.3	31.75
			95	37.2	35
			100	37.1	39
			110	36.7	39.5

Table 24. Organic soil depths and elevations from data collected at transect 2 in 2005 and 2018

Transect 2					
2005			2018		
Station	Elevation NAVD88	Muck Depth (in)	Station	Elevation NAVD88	Muck Depth (in)
73	42.9	8	n/a	38.2	4
95	42.0	8	n/a	37.4	3.75
110	41.5	6	n/a	36.7	2.78
115	41.4	12	n/a	36.4	2.4
125	41.1	12			
130	41.1	6			
135	41.1	6			
140	41.0	3			
145	41.1	7			
150	41.2	5			
155	41.0	5			
160	40.9	3			
165	40.6	5			
170	40.6	4			
175	40.0	2			
180	39.9	1			
205	39.5	2			
215	39.4	3			
250	39.2	3			
292	38.7	10			
263	39.0	8			
281	38.8	12			
294	38.7	16			
350	37.3	36			

Table 25. Organic soil depths and elevations from data collected at transect 1 in 2005 and 2018

Transect 1					
2005			2018		
Station	Elevation NAVD88	Muck Depth (in)	Station	Elevation NAVD88	Muck Depth (in)
83	40.1	5	n/a	36.8	12.25
95	39.7	2	n/a	36.1	13.25
106	39.6	4	n/a	38.5	18
120	39.8	5	n/a	38.6	19.2
125	39.8	5			
130	39.8	14			
150	39.3	7.5			
160	39.8	7			
170	39.7	8			
180	39.5	16			
200	39.7	27			
210	39.6	20			
240	39.3	20			

Russian Peat Corer (2020)

Submerged organic soils were examined in multiple locations at Sylvan Lake in December 2020 using a Russian Peat Corer (Figure 14). A Russian Peat Corer was inserted into organic soils until the resistance of a mineral soil horizon was felt. This profile was then captured and excavated for examination (Figures 15-20). Excavated profiles were collected and sent to the Extension Soils Testing Laboratory (ESTL) at the University of Florida for Loss-On-Ignition (LOI) organic matter content determination (Table 26). Elevations at which the landward extent of A2 was observed in 2005 (Histic Epipedon; 37.89 ft NAVD) along with higher and lower elevations were examined. Samples from higher elevations than the landward extent of A2 that were determined to be sandy textured were not sent to the ESTL. Data collected in 2005, 2018, and 2020 is presented together in Figure 21.

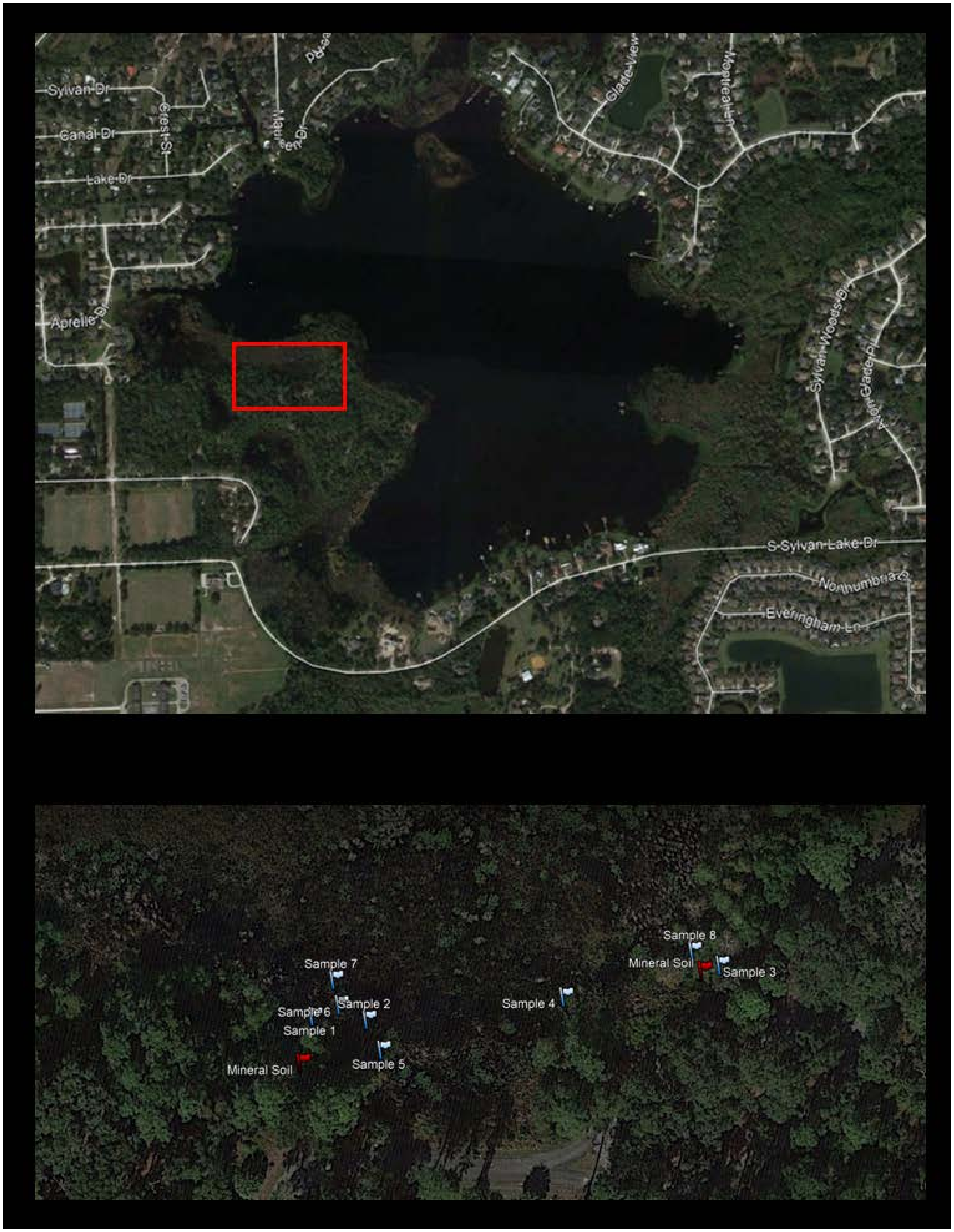

Figure 14. Top photo: red box represents Russian Peat Corer sampling locations; Bottom photo: red flags represent locations without deep organic soils; white flags are areas with deep organic soils.

Figure 15. Sample 1: Soil profile collected adjacent to transect 3 at an elevation of 39.12 ft (NAVD88) showing 8.5” of Oa horizon (A2 Histic Epipedon).

Figure 16. Sample 3: Soil profile collected adjacent to transect 3 at an elevation of 39.10 ft (NAVD88) showing 8.5” of Oa horizon (A2 Histic Epipedon).

Figure 17. Sample 4: Soil profile collected adjacent to transect 3 at an elevation of 39.06 ft (NAVD88) showing 10.5” of Oa horizon (A2 Histic Epipedon).

Figure 18. Sample 5: Soil profile collected adjacent to transect 3 at an elevation of 38.52 ft (NAVD88) showing 14” of Oa horizon (A2 Histic Epipedon).

Figure 19. Sample 6: Soil profile collected adjacent to transect 3 at an elevation of 38.34 ft (NAVD88) showing over 16” of Oa horizon (A1 Histosol).

Figure 20. Sample 7: Soil profile collected adjacent to transect 3 at an elevation of 37.96 ft (NAVD88) showing over 16” of Oa horizon (A1 Histosol).

Table 26. Elevation, location, organic soil depth, loss on ignition organic matter content, and organic carbon at peat corer sampling locations containing >8" of organic soil.

Sample	Elevation of Sample ft NAVD	Lattitude	Longitude	Organic Soil Depth	LOI OM Content	OC Content
1	39.12	28.8038	81.38511	8.5	87.85	51.08
2	39.12	28.80379	81.38499	8.5	72.00	41.86
3	39.1	28.80387	81.3842	10	79.04	45.95
4	39.06	28.80382	81.38435	10.5	84.34	49.03
5	38.52	28.80373	81.38496	14	85.72	49.84
6	38.34	28.80382	81.38505	16+	92.19	53.60
7	37.96	28.80387	81.38506	16+	93.59	54.41
8	37.96	28.8039	81.38426	14	92.65	53.87

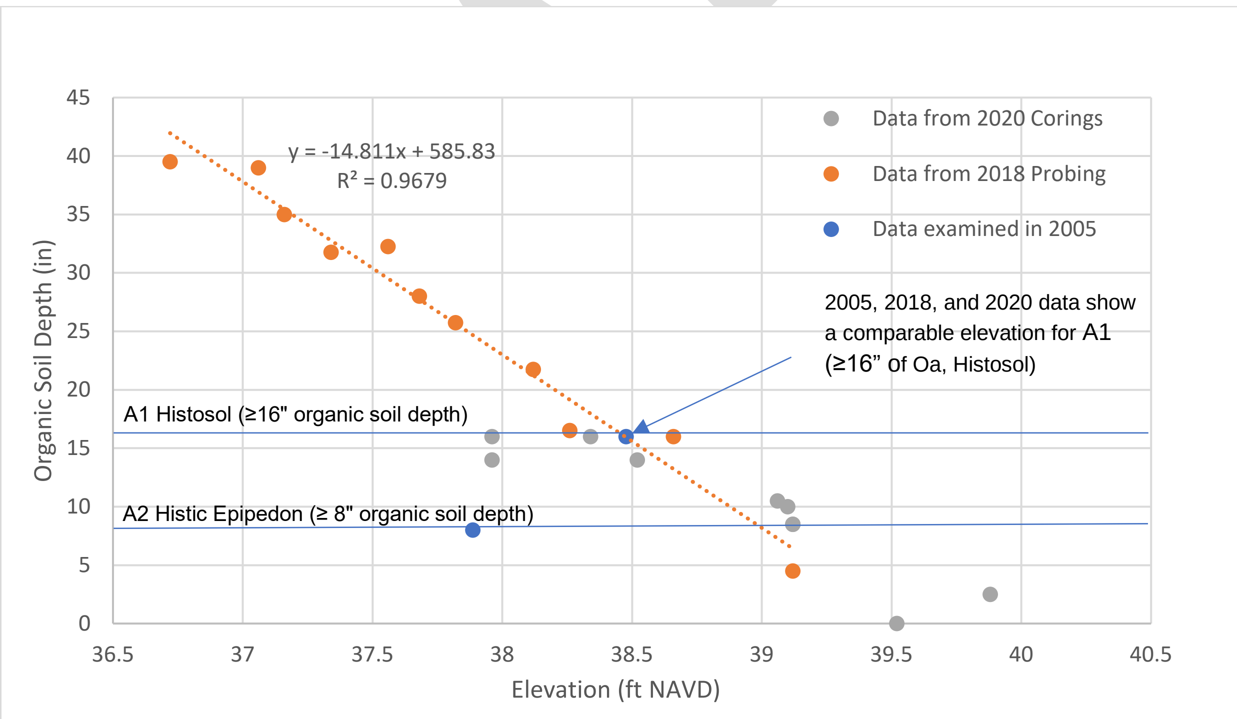

Figure 21. Data at and adjacent to transect 3 from 2005, 2018, and 2020 combined. The datapoints corresponding to 16" of organic soil depth were likely deeper, however the peat corer was only inserted to a depth of 16". In addition to the samples included in Table 26, samples observed containing <8" of organic soil are included.

Conclusions

Soil examinations (probing and LOI samples) and site observations made in 2018 and 2020 confirm that the location of organic soils has not changed significantly from 2005 through December 2020.

Due to slow muck accretion rates (roughly 0.03” per year; Ingebritsen et al., 1999) and no observable evidence of subsidence, any variation in organic soil elevation observed among sampling dates is likely due to redistribution from wave action. More detailed confirmation of the 2005, 2018, and 2020 data can be performed in the future with a sharpshooter shovel and auger, when water levels are lower and conducive to using these techniques.

Literature Cited

Ingebritsen, S.E., McVoy, C., Glaz, B., Park, W., 1999, Florida Everglades: Subsidence threatens agriculture and complicates ecosystem restoration, in Galloway, D., Jones, D.R., and Ingebritsen, S.E., eds., Land Subsidence in the United States: U.S. Geological Survey Circular 1182, p. 95-106. pubs.usgs.gov/circ/circ1182/pdf/12Everglades.pdf

Verification of Transitional Shrub Community Elevations

Sylvan Lake transitional shrub communities elevations were verified in November 2020. This additional field work was conducted to ensure that elevations used for the minimum frequent high (FH) were based on current data. Vegetation was characterized along nine transects, six of which overlapped with the original (2005) locations of transect 1 and 2 (Figures 22 and 23). Transitional shrub elevation data were also collected at three new locations (T4 on Figures 22 and 23).

Mean transitional shrub elevation (40.2 ft; Table 27) based on data collected in 2020 was 0.1 ft lower than the mean elevation from 2005 (40.3 ft). The wetland species used to characterize the transitional shrub communities were more consistent (i.e., more similar species across transects) in 2020, relative to 2005. The transitional shrub communities (based on 2020 data) extend from the hydric flatwoods boundary (i.e., lower edge of mature slash pine) to the waterward boundary of dahoon holly (*Ilex cassine*). Other species within the transitional shrub included salt bush, wax myrtle, swamp bay, slash pine sapplings and buttonbush. Recent high water levels have also resulted in the upslope movement of wetter species within the understory and shallows of the transitional shrub community, including scattered pickerelweed, sawgrass, and spatterdock.

Because the species composition was generally more consistent across transects, the elevation data collected in 2020 is thought to better represent the transitional shrub community at Sylvan Lake. Therefore, the mean transitional shrub elevation from 2020 will be the basis of the FH magnitude for the Sylvan Lake reevaluation (see below for more details on the FH). It is worth noting that using the 2020 data does not significantly change the magnitude of this minimum level; the mean elevation for this community only changed by 0.1 ft.

Table 27. Transitional shrub community elevations (ft; NAVD88), based on original reevaluation field work conducted in 2005 and recent verification field work conducted in 2020.

	Transitional Shrub Communities Elevation (ft; NAVD 88)			
Transect	**Mean**	**Median**	**Minimum**	**Maximum**
2005 T1	40.7	40.7	40.3	41.3
2005 T2	40.7	41	39.8	41.3
2020 T2 (average of 3 transects)	40.1	40.3	39.3	40.8
2005 T3	39.5	39.5	37.9	41.4
2020 T3 (average of 3 transects)	40.3	40.2	39.4	41.3
2020 T4 (average of 3 transects)	40.2	40.2	39.4	41.2
Average of all transects	**Mean**	Median	Min	Max
2005 transects	**40.3**	40.4	39.3	41.3
2020 transects	**40.2**	40.3	39.4	41.1

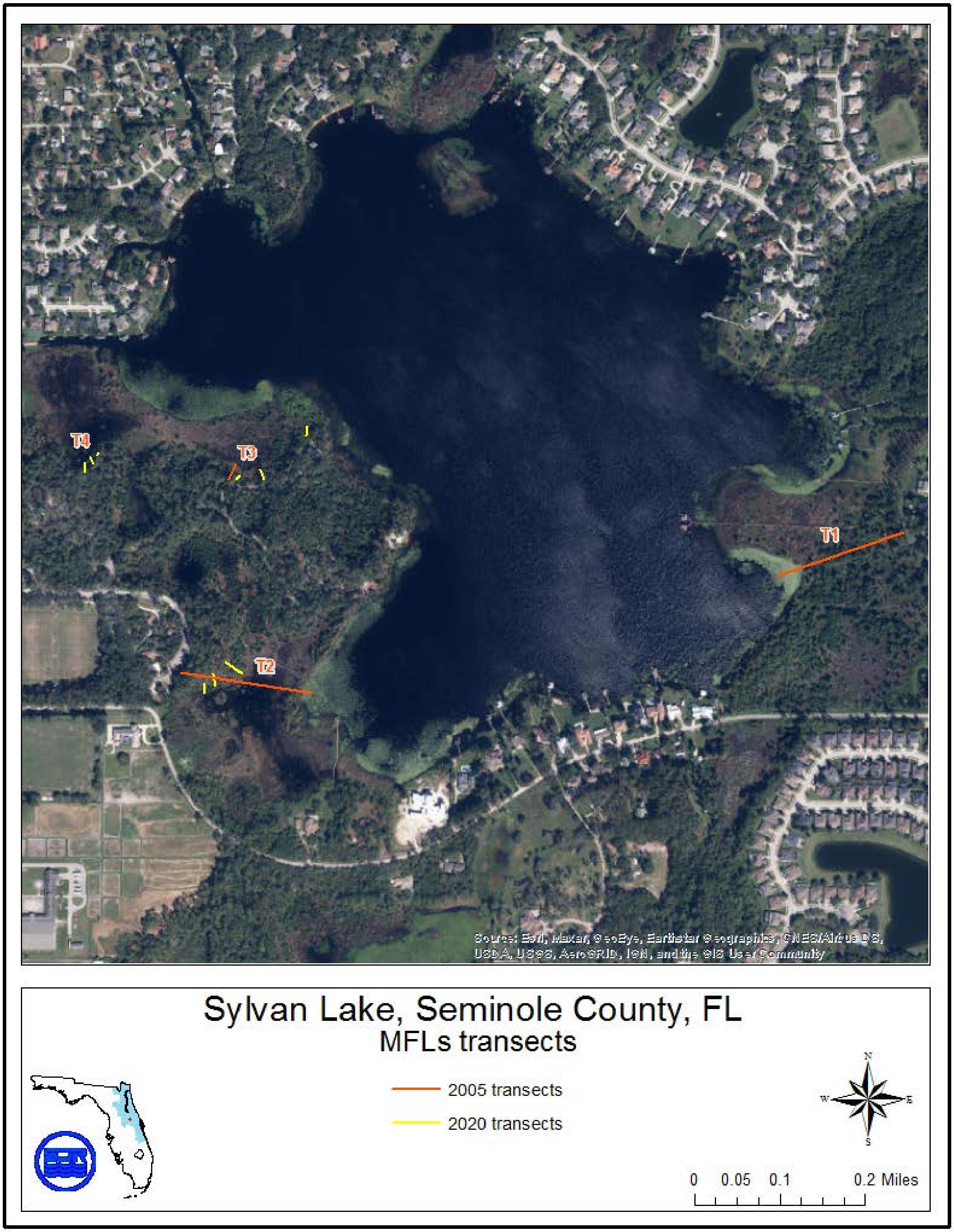

Figure 22. Location of recent (2020) field transects (yellow) and original reevaluation (2005) field transects (red). The 2020 transects were used to verify transitional shrub swamp locations..

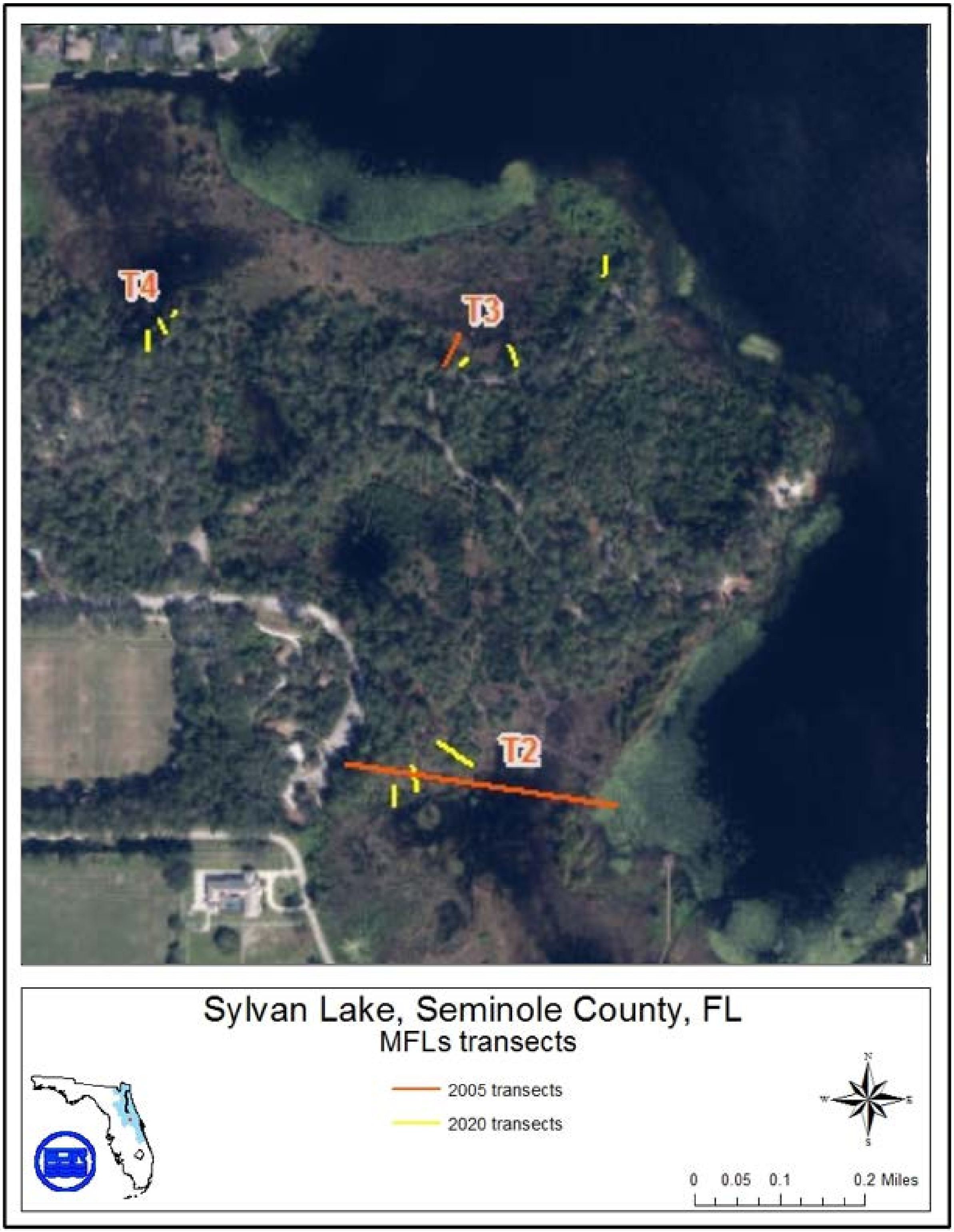

Figure 23. Close up of recent (2020) transect locations (yellow) and original reevaluation (2005) transect locations (red).

MINIMUM LEVELS FOR SYLVAN LAKE

Sylvan Lake is located within a region characterized by sandhill solution basins. However, it is not typical of this lake class in that it has extensive contiguous regularly flooded wetlands with deep organic soils. For this reason, three minimum levels are recommended for Sylvan Lake. The following sections describe the criteria and rationale for the development of minimum lake levels for Sylvan Lake.

SWIDS Update – Recommended Event Frequencies (or Return Intervals)

The SWIDS approach often results in a large range of frequencies for a given event; see section above for background on the SWIDS approach. This large range can introduce uncertainty when recommending a minimum frequency for specific MFL events and is of concern for both the district and the Lake Sylvan peer reviewers (HSW; see Appendix F for peer review comments).

To address this concern, a cluster analysis was conducted in an effort to reduce the range of event frequencies (i.e., potential uncertainty) that were used as the basis for recommended minimum events for Sylvan Lake. Updating the SWIDS approach to reduce uncertainty first involved selecting hydrological variables used in previous analyses to explain variance between groups of lakes in the district (Epting et al 2008). In addition to these hydrological variables, a suite of landscape and aquifer connection parameters were selected to aid in the grouping of sites (Table 28). In an effort to be consistent across sites, hydrological parameters used in the PCA were calculated based on twenty years of water level data collected prior to vegetation data collection for each site. Twenty years (antecedent to vegetation data collection) was the longest possible period of record (POR) available for all sites. Periods of record were of similar timeframes, with starting years varying from 1999 to 2015. Twenty years of antecedent data should be sufficient to correspond to the transitional shrub and shallow marsh locations estimated at the time of MFLs development for each water body.

A cluster analysis was performed to identify lake groups with similar hydrological and landscape characteristics. Ward's Method of hierarchical clustering was used, which minimizes variance between sites within a group while maximizing variance between groups. The twenty-nine lakes analyzed were grouped into three distinct clusters (Figure 24). Lake Sylvan was in a group of twelve lakes that were generally characterized by 1) higher than average water level range (relative to the other lakes analyzed); 2) lower than average water level symmetry; 3) high connection to the UFA; 4) high depth to water table; and 5) high soil permeability.

Table 28. PCA parameters and values for twenty-nine central Florida lakes, including Sylvan Lake. Skewness and kurtosis were calculated for 4-week lake stage change distribution. MCF (maximum cumulative fluctuation) index is a measure of connection to the UFA.

Site	Water Level Range			Water Level Symmetry		Landscape Drainage Class			UFA connection		Depth to Water Table (ft)	Soil Permeability		
	Lower (P80-P50) (ft)	Upper (P50-P20) (ft)	Total (P90-P10) (ft)	Skewness	Kurtosis	High	Medium	Low	Pearson's R	MCF		High	Moderate	Low
Apshawa	1.9	3.3	6.4	0.2	2.0	76.9	5.2	11.6	0.9	4.7	3.3	85.8	0.0	0.0
Banana	1.7	1.4	4.2	0.7	0.6	34.8	26.8	17.8	0.9	3.7	1.4	75.4	17.3	0.0
Bowers	2.1	0.9	4.5	0.2	0.9	52.9	13.9	18.8	0.9	2.6	2.0	75.3	3.2	0.0
Cherry	1.1	0.7	3.1	0.5	0.5	26.8	33.8	30.8	0.8	5.0	3.2	81.7	1.1	1.8
Como	2.1	1.5	4.6	0.6	0.5	50.1	21.1	22.7	0.9	3.9	1.4	81.9	13.3	0.0
Cowpen	1.3	1.9	6.4	1.9	9.0	22.5	47.4	20.2	0.9	5.7	3.1	80.6	0.0	0.0
Daugharty	1.8	1.3	5.7	1.6	4.7	15.4	33.2	19.8	0.9	5.8	1.4	36.4	7.1	0.0
Davis	2.5	1.4	5.6	0.8	2.3	2.7	64.3	29.0	0.8	5.9	1.2	92.3	4.8	0.0
Dias	0.4	0.3	1.1	1.0	2.6	27.0	33.3	37.3	0.9	1.3	1.2	78.9	14.3	0.0
Emma/Lucy	1.2	0.6	3.2	1.2	4.8	45.0	31.7	4.0	0.8	3.7	3.1	85.5	4.9	0.0
Emporia	2.8	2.2	6.4	0.9	1.6	17.2	64.3	17.4	0.8	6.8	1.4	93.9	0.0	0.0
Gore	1.0	0.4	2.2	1.1	1.8	0.0	2.8	95.3	0.7	2.0	0.7	80.1	15.8	0.0
Hires	1.3	1.8	6.0	-1.0	10.9	8.8	19.3	24.7	0.9	7.4	1.4	6.7	13.2	0.0
Hopkins	1.4	1.0	3.6	0.8	1.7	56.1	24.5	19.2	1.0	5.7	1.0	89.5	10.4	0.0
Kerr	1.7	1.2	4.0	0.5	1.4	62.1	14.2	18.7	0.8	4.4	0.9	88.6	0.7	0.0
L. Como	2.3	2.4	5.8	2.0	11.1	66.0	13.8	12.2	0.9	6.0	1.6	92.0	0.0	0.0
Louisa	1.1	0.9	2.9	1.1	1.8	46.3	2.7	48.0	0.9	5.6	3.4	56.9	15.7	0.0
Nicotoon	0.9	0.7	3.0	1.3	3.5	71.4	9.6	6.6	1.0	4.0	2.0	90.3	0.0	0.0
Purdom	1.7	0.5	3.1	0.7	2.0	2.3	51.7	32.5	0.9	2.4	1.2	52.8	37.0	0.0
Savannah	0.5	0.5	1.5	1.3	8.9	13.8	30.7	48.6	0.8	2.6	1.0	47.4	32.3	0.0
Smith	2.3	2.0	5.7	1.1	1.7	69.1	5.0	15.0	0.8	3.5	2.1	82.4	0.0	0.0
South	0.9	0.8	2.3	0.5	0.5	16.8	10.6	71.5	0.9	1.4	0.5	94.0	3.0	0.0
Swan	3.0	1.4	6.2	0.3	1.4	19.4	64.2	11.7	0.9	5.6	3.4	99.7	0.0	0.0
Sylvan	1.8	2.2	4.9	1.0	5.4	17.8	43.2	38.6	0.9	5.3	1.4	97.5	0.0	0.0
Tarhoe	3.4	2.1	8.0	2.3	11.1	22.0	29.2	39.2	0.9	6.8	1.3	87.2	2.3	0.0
Trone	2.8	1.7	5.7	0.9	1.0	38.8	33.9	15.5	0.9	4.7	1.4	97.6	0.0	0.0
Up. Louise	1.6	0.7	3.2	0.4	2.7	0.0	53.8	40.3	0.8	5.0	1.2	94.6	1.5	0.0
Weir	1.1	1.2	3.3	0.6	0.0	41.5	23.0	32.8	0.6	3.2	2.0	84.9	4.6	0.6
Winona	0.8	2.0	3.8	0.5	1.1	38.4	50.3	9.1	0.6	9.1	1.5	91.9	0.0	0.0

SWIDS analyses were updated using only the lakes in the Sylvan Lake group for which there also exists corresponding ecological data. For example, not all lakes in the Sylvan Lake group have transitional shrub swamp data, and so only those lakes in the appropriate group that have the appropriate ecological data were used. The goal of the lake classification analyses was to reduce uncertainty by reducing the range in event frequencies. This assumed that grouping lakes based on hydrological variables, connection to the UFA, soil characteristics, etc, would result in smaller frequency ranges, making the determination of appropriate minimum event frequencies more apparent.

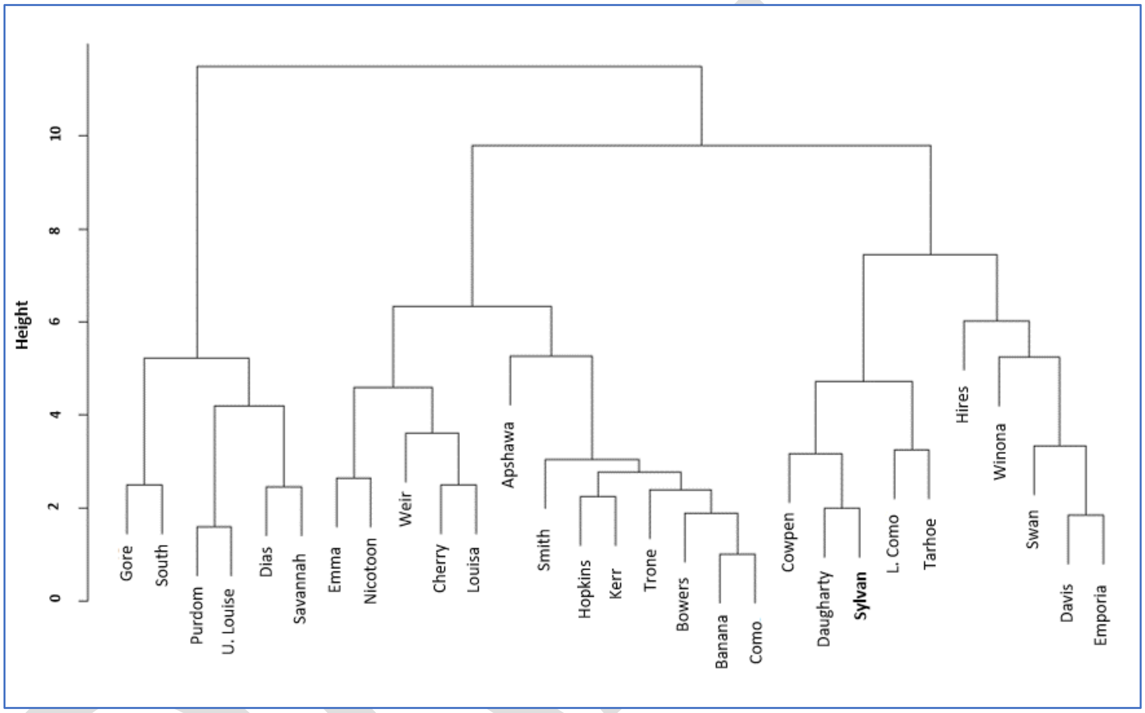

Figure 24. Cluster analysis dendrogram showing three groups.

The lake classification process resulted in a modest reduction in frequency range (relative to using all sites), with the largest difference associated with the FL, then the FH, and finally the MA (Table 29). While the grouping did not result in a really small range in event frequencies, the resulting central tendencies (mean plus/minus standard error) provides a more appropriate recommendation for a minimum frequency (i.e., relative to using all sites) because it is based on sites with similar hydrological and landscape characteristics.

Table 29. Mean, range and difference between exceedance and non-exceedance percentages, based on calculating SWIDS for 29 central Florida lakes versus only those lakes within the Sylvan Lake cluster, as determined by the lake classification analysis; presented for all three MFLs (i.e., FH, MA and FL).

	Frequent High		Minimum Average		Frequent Low	
	Mean Exceedance (%)	Exceedance Range (%)	Mean Exceedance (%)	Exceedance Range (%)	Mean Exceedance (%)	Exceedance Range (%)
All 29 Sites	43.8	80.1	31.9	51.0	12.3	42.9
Sites in Sylvan Cluster	38.9	54.2	43.2	31.7	7.3	9.0
Difference	4.9	25.9	11.3	19.3	5	33.9

Minimum Frequent High (FH) Level

The minimum frequent high (FH) for Sylvan Lake is a minimum hydrological event with a magnitude of 40.2 ft NAVD, an associated flooding duration of 30 continuous days, and a minimum return interval of 5.2 years (i.e., approximately 19 events per 100 years, on average); these individual FH components are discussed below. The purpose of the FH is to ensure frequent inundation in seasonally flooded wetlands, sufficient to maintain species composition, vegetative structure, and associated ecological functions.

The FH level of 40.2 ft NAVD equals the average elevation of the transitional shrub communities from Transects 2, 3 and 4 surveyed in 2020 (see Table 24 and Figures 22 and 23 above). As discussed above, the transitional shrub elevations determined in 2005 were evaluated in November 2020. Transect 1 was deemed no longer appropriate due to recent disturbance (i.e., mowing of upper end of transect area). At T2, T3 and T4 (*note:* T4 was added in 2020) vegetation and elevation data were collected at three short transects per area (i.e., a total of 9 short transects) to determine whether the mean elevation of the transitional shrub community (i.e., the basis of the FH) had shifted up or downslope. The mean elevation of transitional shrub communities at Sylvan Lake changed very little from 2005 (40.3 ft NAVD) to 2020 (40.2 ft NAVD). The stability of these communities during that time period is consistent with the small change in water levels, between the mean pre-2005 water level of 38.3 ft (NAVD88) and the mean pre-2020 water level of 38.5 ft (NAVD88). The 2020 field verification resulted in a very small change to the FH magnitude (a reduction of 0.1 ft from 40.3 to 40.2 ft NAVD; Table 24).

Soil sampling in 2005 in the transitional shrub communities on all transects identified surface organic layers ranging in depth from a surface film to 2 inches. Such surface organic layers are formed by saturation/inundation of the soil surface during periods of normal or above normal rainfall and are, therefore, indicative of a seasonal high-water table (Carlisle and

Hurt, 2000) or a seasonal flooding frequency. Additionally, the FH level also results in a soil water table that is approximately 1 ft below the upland edge of the transitional shrub communities at Sylvan Lake (i.e., 41.1 ft NAVD; Table 24). This corresponds well with the water table depths described for the hydric soils, Basinger and Smyrna, observed near the upland edge of the transitional shrub communities on Transects 1 and 2, respectively (Figures 5, 6 and 8). Both of these soils are poorly drained, with a water table generally within 18 in. of the soil surface for 2 to 6 months during most years, and the water table generally recedes to within 12–40 in. of the soil surface for more than 6 months in most years.

The duration component of the FH is a minimum of 30 days continuously flooded at or above 40.2 ft. NAVD88 (magnitude described above). Maintaining water levels for this duration at the average elevation of transitional shrub communities will promote inundation and/or saturation conditions sufficient to support hydrophytic (i.e., obligate, facultative wet, and facultative) plant species (Ahlgren and Hansen, 1957; Menges and Marks, 2008; Mace, 2015), thus preventing a permanent downward shift of the transitional shrub and other wetland communities.

For many MFLs lakes, the minimum FH elevation corresponds to an event whose purpose is to ensure that wetland communities are flooded frequently, and is typically associated with a flooding return interval (RI) of 2 to 3 years. However, those return intervals are typically associated with the protection of communities that are further downslope than a transitional shrub community; a 2-3 yr RI is often used to protect a hardwood swamp community. At Sylvan Lake there is minimal hardwood swamp area, but there does exist a consistent transitional shrub community around a significant portion of the lake. Hence the use of this upslope wetland community as the basis for the FH. Using the standard 2 or 3 year return interval for this drier community would have been inappropriate.

Therefore, the return interval for the Sylvan Lake FH was based on a SWIDS analysis of wetland vegetation communities (Neubauer et al. 2004, 2007; see above for description of SWIDS). The SWIDS analysis for Sylvan Lake was conducted using hydrologic signatures for transitional shrub communities at 12 lakes within the SJRWMD(Figure 25). Cluster analysis, described above, was conducted to minimize SWIDS event frequency range, and thereby reduce uncertainty when determining a recommended minimum return interval for the FH (as well as MA and FL). This analysis resulted in a change in event frequency range from 80.1%, based on using all twenty-nine lakes, to 54.2% when using only lakes in the Sylvan Lake group (Table 29; Figure 26). Based on this analysis, the recommended minimum return interval for the Sylvan Lake FH is 5.2 years (exceedance frequency of 19.3%), which equals the mean (plus standard error) of return intervals for lakes within the Sylvan Lake cluster, as determined by the cluster analysis (Table 30).

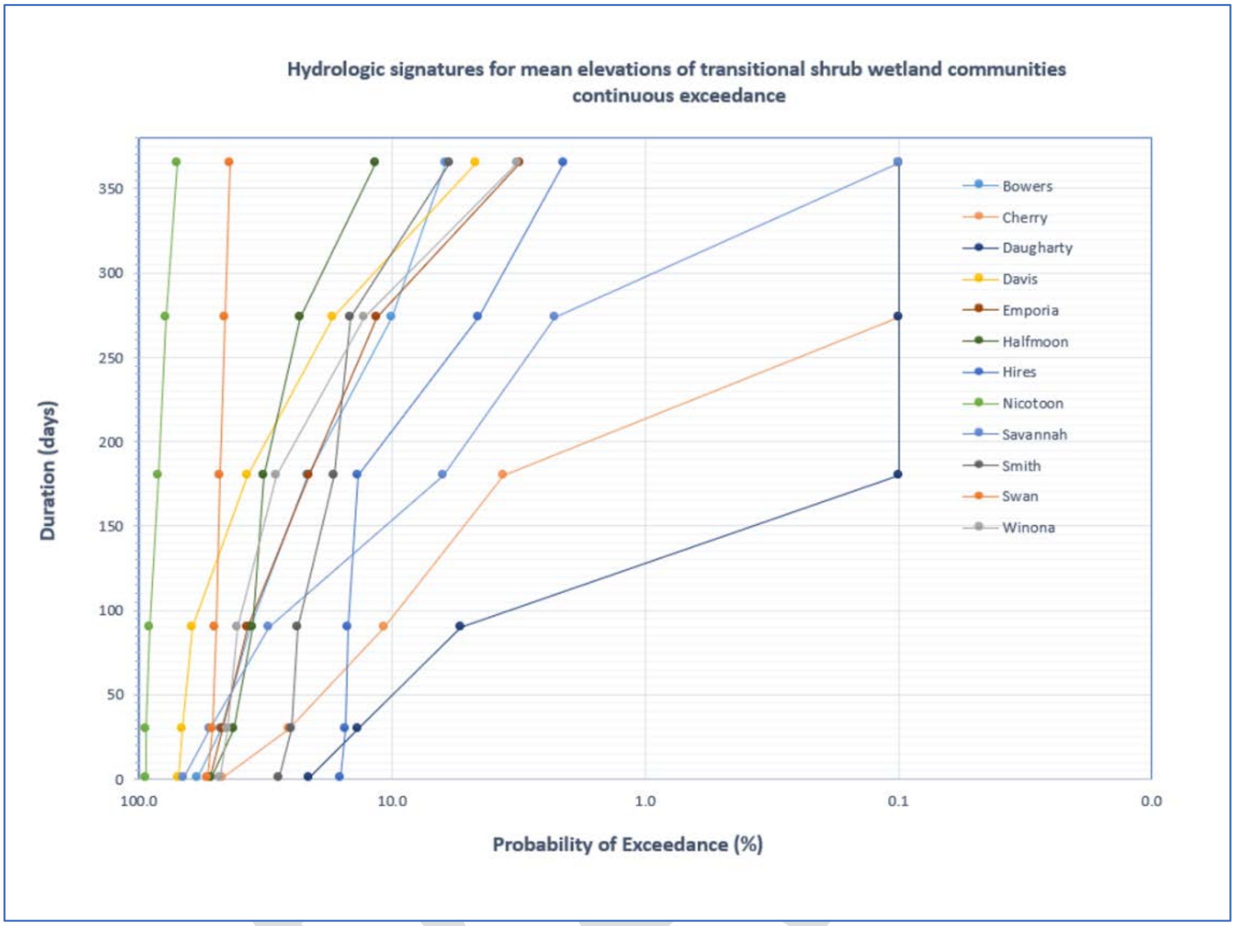

Figure 25. SWIDS plot showing distribution of hydrologic signatures for continuous exceedance elevations (of various durations) for mean elevations of transitional shrub wetland communities for lakes in Central Florida.

Frequent high water levels are necessary to maintain the structure and functions of the contiguous wetlands at Sylvan Lake. High water levels of the recommended duration and frequency will conserve the vegetation composition and structure, and the character and ecological functions of the hydric soils within the transitional wetland communities at Sylvan Lake.

Schneider and Sharitz (1986) reported that short-term flooding events are important to the redistribution of plant seeds within aquatic habitats. The species composition and structural development of floodplain plant communities are influenced by the timing and duration of

Table 30. Percent exceedance and return intervals for lakes within the Sylvan Lake group, determined by the lake classification analysis, including mean and mean plus/minus standard error.

Frequent High			Minimum Average			Frequent Low		
Site	Exceedance (%)	Return Interval (yr)	Site	Non-exceedance (%)	Return Interval (yr)	Site	Non-exceedance (%)	Return Interval (yr)
Davis	67.7	1.5	Daugharty	26.8	3.7	Davis	8.5	11.8

Emporia	47.0	2.1	Davis	58.6	1.8	Emporia	11.7	8.5
Daugharty	13.6	7.4	Emporia	52.9	1.9	Daugharty	6.4	15.6
Hires	15.2	6.6	Cowpen	34.5	2.9	Swan	2.7	36.9
Swan	51.0	2.0	-	-	-	-	-	-
mean	**38.9**	**3.9**	**mean**	**43.2**	**2.6**	**mean**	**7.3**	**18.2**
mean + SE		**5.2**	**mean - SE**		**2.1**	**mean - SE**		**11.8**

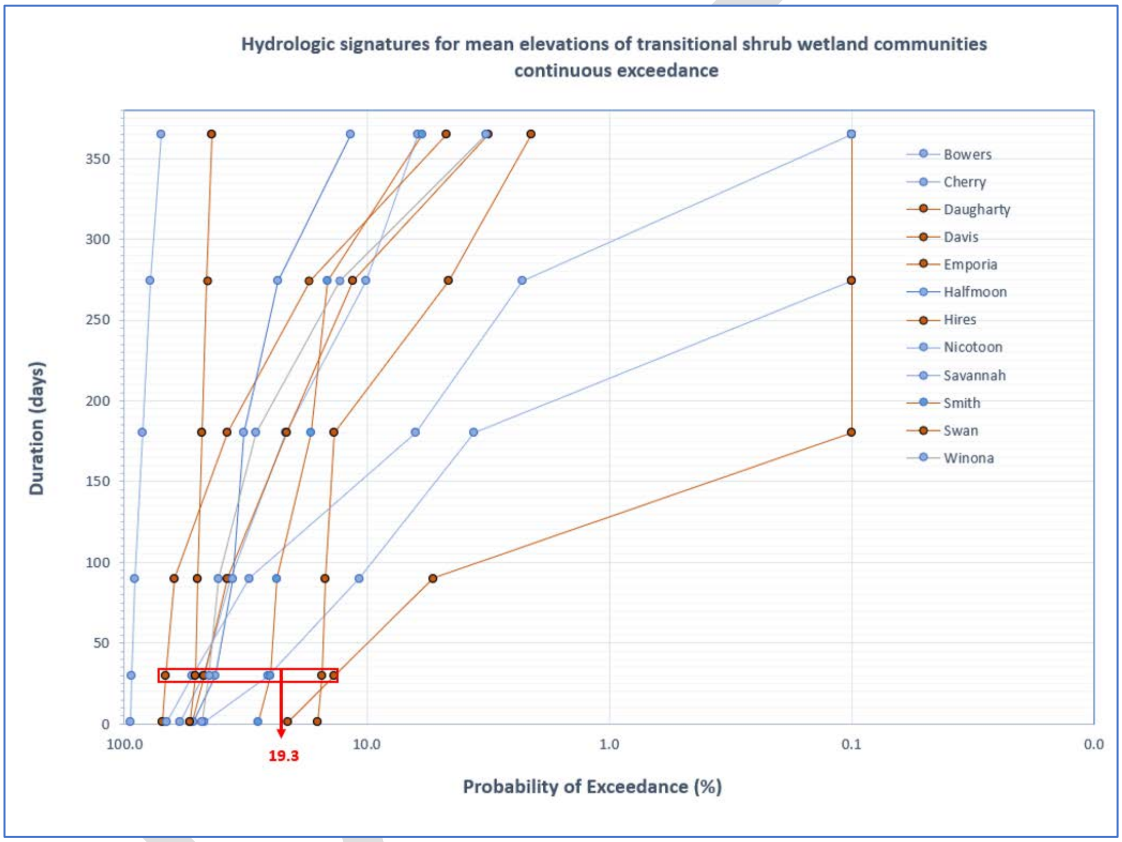

Figure 26. SWIDS plot showing hydrologic signatures for continuous exceedance elevations (of various durations) for mean elevations of transitional shrub wetland communities for lakes in Sylvan cluster (brown symbols) and lakes not in Sylvan cluster (blue symbols). The red box depicts the range of lakes in Sylvan cluster, and the red arrow depicts the mean plus standard error of this group (19.3% exceedance).

floods occurring during the growing season (Huffman, 1980). Floods affect reproductive success, as well as plant growth. The resulting anaerobic soil condition within the wetland communities favors hydrophytic vegetation, tolerant of longer periods of soil saturation, and eliminates upland plant species that have invaded during low water events. The FH provides for inundation or saturation sufficient to support the obligate, facultative wet, and facultative wetland plant species within the Sylvan Lake wetland communities (Tables 3, 11, and 17). The recommended level, with associated temporal component, is the minimum necessary to protect the spatial extent and functions of the seasonally flooded wetland communities. The frequent high event will allow sufficient water depths for fish and other aquatic organisms to feed and spawn on the floodplain of the lake. The minimum frequent high level provides for saturation and/or shallow flooding of the minimum elevations of the transitional shrub communities on Sylvan Lake. It also provides flooding and/or saturation of the maximum elevation of the shallow marsh/shrub swamp communities on Sylvan Lake, areas dominated by OBL wetland plant species, and deeper flooding of the deep marsh community (white water lily and spatterdock) to a mean depth of approximately 2.5 ft.

Inundation of the floodplain is also necessary for the exchange of particulate organic matter and nutrients (McArthur 1989). Flooding events redistribute and concentrate organic particulates (i.e., decomposing plant and animal parts, seeds, etc.) across the floodplain (Junk et al., 1989). This organic matter is assimilated by bacteria and invertebrate populations (Cuffney, 1988), which, in turn, serves as food for larger fauna.

The aquatic fauna habitat is greatly expanded when Sylvan Lake inundates the contiguous floodplain wetlands. Surface water connections of the lake to the floodplain are extremely important to animal productivity (Bain, 1990; Poff et al., 1997). When the floodplains are flooded, many fish migrate from the lake to the inundated wetland areas for spawning and feeding. As water levels continue to rise, the amount of vegetative structure available to aquatic organisms increases greatly as large areas of floodplain are inundated (Light et al., 1998). The life cycles of many fish are related to seasonal water level fluctuations, particularly the annual flood pattern (Guillory, 1979). The floodplain provides feeding and spawning habitat (Guillory, 1979; Ross and Baker, 1983) and refugia for juvenile fishes (Finger and Stewart, 1987). The FH water level component may be exceeded during wet years and may not occur during dry years; most fish and other aquatic fauna are adapted to year-to-year variations of the natural hydrologic regime.

Additionally, lake water quality may be improved significantly as water flows through the floodplain wetlands. Lake floodplains, especially those with extensive shallow marshes, function as an important filter/sink for dissolved and suspended constituents (Wharton et al., 1982).

Minimum Average (MA) Level (37.9 ft NAVD)

The minimum average (MA) level for Sylvan Lake is 37.9 ft NAVD, with an associated mean non-exceedance duration of 180 days, and a return interval of 1.7 years. The MA approximates a typical (i.e., central tendency; long-term median) stage that protects wetland soils and other functions and values. At the MA level, substrates may be exposed during non-flooding periods of typical years, but the substrate remains saturated. The MA level corresponds to a water level that is expected to occur, on average, every one to two years for about 6 months during the dry season (Rule 40C-8.021(15), *F.A.C.*

The MA level of 37.9 ft NAVD equals a 0.3 ft soil water table drawdown from the average ground surface elevation of the histic epipedon and histosols in the shallow marshes/shrub swamps and/or deep marshes observed in 2005 at Transects 1 - 3 (38.2 ft NAVD) and verified in 2020 (see above for details of organic soils verification). Histic epipedon and histosols are deep organic soils, indicative of long-term soil saturation or inundation. The long-term average drawdown of no more than 0.3 ft will ensure saturated soil conditions in Sylvan Lake's deep organic soils.

A drawdown of no more than 0.3 ft below mean surface elevation of deep organic soils has been used as a criterion to protect muck soils in other MFLs determinations and was developed based on the minimum hydrology needed to protect peat soils in the Everglades (Stephens, 1974). Studies of marshes in the Upper St. Johns River Basin (Brooks and Lowe, 1984; Hall, 1987) determined that this 0.3 ft depth below the soil surface in deep organic soils corresponds to a water level exceeded approximately 60% of the time. Studies of the Wekiva River system found this hydrologic condition can also be expressed as the low stage, occurring, on average, every 1 to 2 years, with a duration of less than or equal to 180 days (Hupalo et al., 1994).

The MA return interval is the minimum signature based on a SWIDS analysis of the mean elevation of the extent of histic epipedon/histosol (deep organic soils) minus 0.3 ft (Neubauer et al. 2004, 2008). A SWIDS analysis was completed for the mean elevation deep organic soils at 20 lakes in the SJRWMD (Figure 27). A minimum return interval of 1.7 years (~59 times per century, on average) is consistent with that used for the MA in other adopted MFLs for sandhill lakes. This return interval also results in an exceedance of approximately 50% for the elevation of mean organic soils (see WRVs section in main report, and Appendix E for more details). Using a mean (plus standard error) for the Sylvan Lake cluster (i.e., as is used for the FH and FL) would result in deep organic soils being inundated over 75% of the time. Studies show that the minimum hydrology required to maintain organic soils (Appendix E; Osborne et al. 2014) is closer to 50% exceedance. The recommended 1.7-yr return interval results in mean elevation of deep organic soils being inundated for 50% of the time. For this reason, a more standard 1.8-year return interval (non-exceedance frequency of 58.6%) is recommended for the MA (Figure 28).

An intermediate, or minimum average, water level is required to maintain the water table, on average, near the soil surface of floodplain wetlands. Topographic gradients result in a complex continuum of hydrologic and soil (edaphic) factors across the lake floodplain. A critical point on the topographic gradient occurs at the elevation where anoxic soil conditions prevail for sufficient periods to exclude upland plant species. Plants and soils at or below this elevation require saturation of the upper soil horizon for a significant portion of each year. However, constant flooding of wetlands is inappropriate. The seeds of many species of wetland plants require a dewatered but moist soil surface for germination (Van der Valk, 1981).

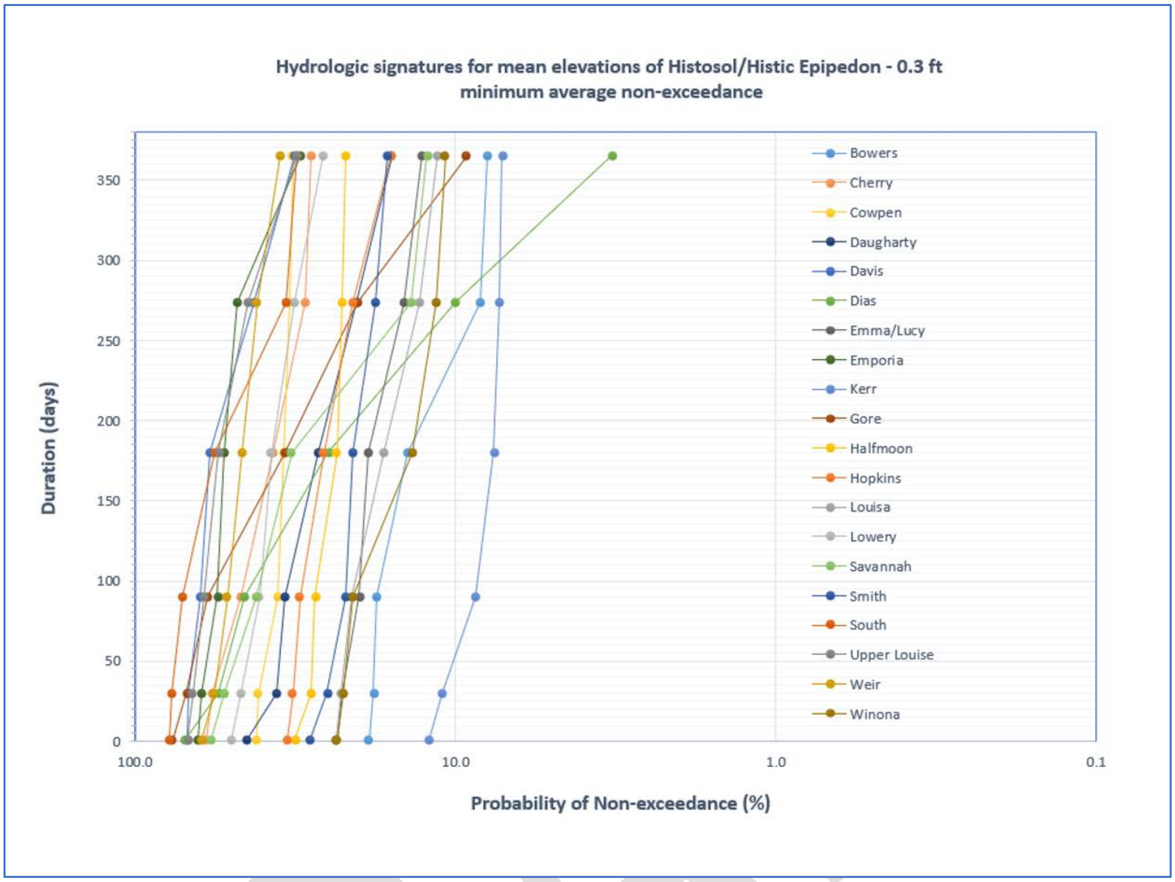

Figure 27. SWIDS plot showing distribution of hydrologic signatures for average non-exceedance elevations (of various durations) for mean elevations of deep organic soil elevations for lakes in Central Florida.

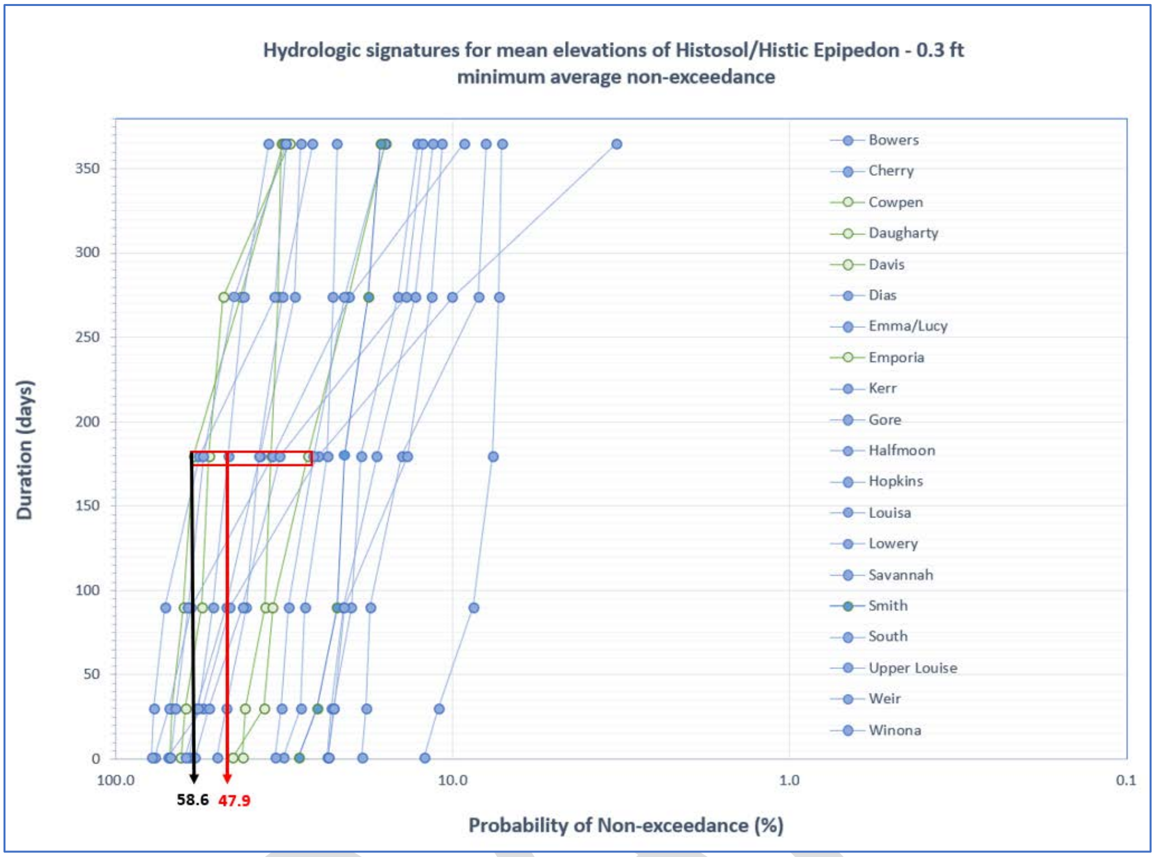

Figure 28. SWIDS plot showing distribution of hydrologic signatures for average non-exceedance elevations (of various durations) for mean elevations of deep organic soil elevations for lakes in Sylvan cluster (brown symbols) and lakes not in Sylvan cluster (blue symbols). The red box depicts the range of lakes in Sylvan cluster, the red arrow depicts the mean minus standard error (47.9%) non-exceedance, and the black arrow depicts the recommended minimum (58.6%) non-exceedance of this group.

Minimum Frequent Low (FL) Level (35.7 NAVD)

The minimum frequent low (FL) for Sylvan Lake is composed of an elevation of 35.7 ft NAVD with an associated continuously not exceeded duration of 120 days, at a maximum return interval of 11.8 years. The FL level is defined as "… a chronically low surface water level that generally occurs only during periods of reduced rainfall. This level is intended to prevent deleterious effects to the composition and structure of floodplain soils, the species composition and structure of floodplain biotic communities, and the linkage of aquatic and floodplain food webs" (Rule 40C-8.021(10), *F.A.C.*). The FL level represents a low lake stage that generally occurs during moderate droughts and which results in dewatered wetlands.

Limited dry periods are associated with ecological benefits (see below), but can be harmful if they occur too often. The FL for Sylvan Lake was developed to prevent an excessive number of drying events, with the primary goal of protecting shallow and deep marsh habitats along with their associated ecological functions and values. The FL magnitude equals the average minimum elevation of shallow marsh habitat surveyed in 2005 at Transects 1 and 2. The resulting elevation is 35.7 ft. NAVD. Minimum shallow marsh elevations were spot checked in 2017 (i.e., surveyed using a Topcon auto level) and were found to be very similar (i.e., within 0.1 ft) of the 2005 mean minimum levels. This result is consistent with the 2020 survey of transitional shrub community elevations, which only changed 0.1 ft from 2005 to 2020 (see details above).

The presence of deep organic soils (≥8 in. thick, histic epipedon and histosols) at Sylvan Lake are indicative of long-term soil saturation or inundation. Typically, where extensive organic soils occur, the FL level criterion is based upon an average organic soil water table drawdown of 20 in. (i.e., 1.7 ft). The 1.7-ft factor is derived from the mean of the range of dry-season water tables (10–30 in.) reported for many organic soils occurring within the District (e.g., USDA, SCS 1987, 1990), and supported from studies of seasonally flooded freshwater marshes (ESE Inc. 1991). The recommended FL elevation (35.7 ft NAVD) will result in a water level offset from deep organic soils that is towards the low end of this range (30 in.). Given the sandhill lake characteristics of Sylvan Lake this increased offset is deemed sufficient as a secondary metric based on protection of organic soils. The primary support for the FL elevation component remains the boundary between shallow and deep marsh.

The FL duration is a minimum of 120 days for this continuously non-exceeded (drying) event. This corresponds to the length of a normal dry season in central Florida between the end of winter rains and the start of the summer rainy season. This duration will allow for seed germination and providing adequate time for regeneration and growth of shallow marsh wetland plants to a height able to survive a next flood event (Ware, 2003), while also providing sufficient depths to maintain the ecological integrity of deep marsh habitats.

The FL return interval for Sylvan Lake is based on a SWIDS analysis of mean minimum elevations of 14 shallow marsh communities in the SJRWMD (Figure 29). The lake classification analysis (described above) resulted in a change in event frequency range from 42.9%, based on using all twenty-nine lakes, to 9.0% when using only lakes in the Sylvan Lake group (Table 29; Figure 30).

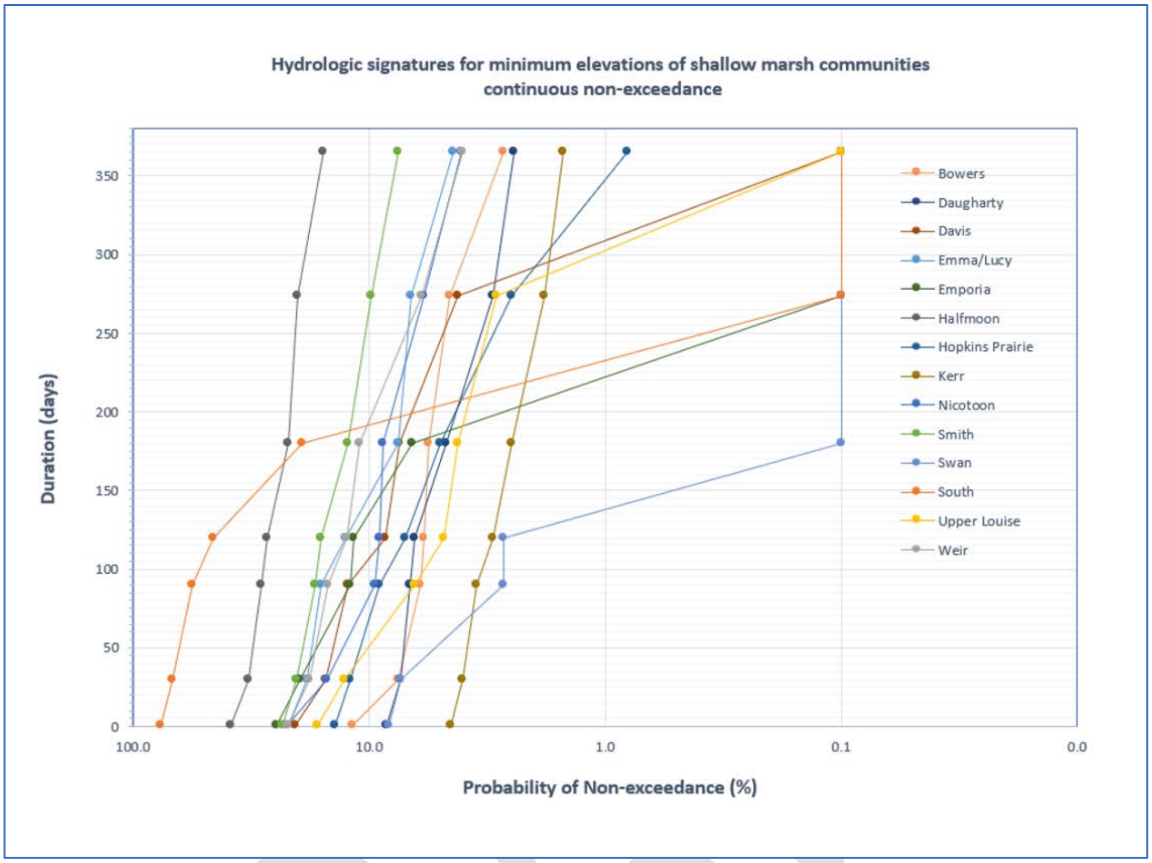

Figure 29. SWIDS plot showing distribution of hydrologic signatures for continuous non-exceedance elevations (of various durations) for minimum elevations of shallow marsh communities for lakes in Central Florida.

This return interval ensures a hydrologic signature adequate to maintain the shallow marsh plant communities and the associated deep organic soils. The FL return interval is expected to prevent a permanent downhill shift of shallow marsh plant communities or a permanent net loss of deep marsh and open water habitats.

The FL level of 35.7 ft NAVD allows nearly complete dewatering of the emergent wetlands at Sylvan Lake every 11.8 years (over the long-term), while maintaining flooded conditions across the lakeshore aquatic beds and the lower elevations of the shallow marsh communities. Low water levels in wetlands are a natural consequence of drought and have ecological benefits. Drawdown conditions enable seeds of emergent wetland plants to germinate from the soil seed banks of the floodplain. Seeds of many wetland plant species require exposed soils in order to germinate (Van der Valk, 1981). Exposing the floodplain and the upper littoral zone of the lake for suitable durations maintains the composition of emergent plant species and increases plant diversity. Upland plant species are able to invade the floodplain and become established during low water events. When these species die in response to rising water, their biomass becomes a significant substrate for bacterial and

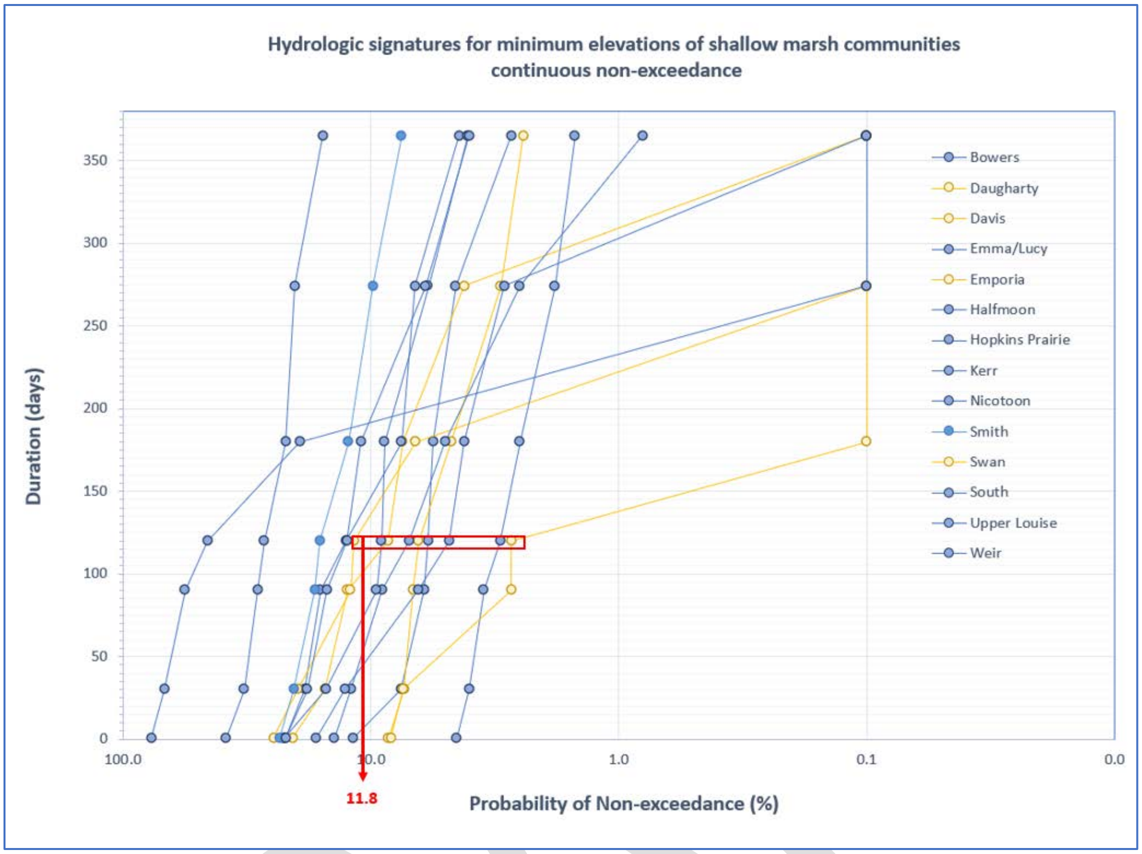

Figure 30. SWIDS plot showing distribution of hydrologic signatures for continuous non-exceedance elevations (of various durations) for minimum elevations of shallow marsh communities for lakes in Sylvan cluster (brown symbols) and lakes not in Sylvan cluster (blue symbols). The red box depicts the range of lakes in Sylvan cluster, the red arrow depicts the mean minus standard error (11.8%) non-exceedance of this group.

fungal growth, which becomes a critical food source for invertebrate collector-gathering and collector-filtering guilds (Cuffney, 1988).

At the FL level component of 35.7 ft NAVD, shallow ponding will occur at the lower elevations in the shallow marshes/shrub swamps, while maintaining inundation across all deep marsh habitats. Shallow ponding will provide aquatic refugia for small fish, amphibians, and small reptiles. Aquatic habitats connected to the open water of Sylvan Lake are of crucial importance to fishes and invertebrates of the floodplain. Additionally, as water levels recede across the shallow marshes/shrub swamps at Sylvan Lake, ideal water depths for wading bird foraging will occur. Wading birds can only forage in relatively shallow water. Great egrets need water depths of less than ~12 in. and smaller herons and other wading birds need depths of less than 6 in. Dropping water levels cause fish to be concentrated in isolated pools throughout the shallow marshes/shrub swamps. Birds effectively exploit these concentrations (Bancroft et al., 1990).

Low water levels will also allow for the decomposition and/or the compaction of flocculent organic sediments. Aerobic microbial breakdown of the sediment begins with receding water levels, releasing nutrients, thereby stimulating primary production. Sunlight also heats, dries, and compacts sediment into firm substrates. Normally, upon reflooding, conditions are improved for fish nesting and foraging since the marsh surface has consolidated, structural cover has increased, and forage resources (terrestrial and aquatic invertebrates) are abundant (Kushlan and Kushlan, 1979; Merritt and Cummins, 1984).

By maintaining deep marsh and open water habitats, the Sylvan Lake FL will also help to protect recreational and aesthetic values, thereby preserving property values and economic benefits to the surrounding communities. In addition to promoting higher plant diversity, preservation of deep marsh and open water habitats can also increase the diversity of fish and other aquatic species. Fish are known to prefer an intermediate mixture of open water and littoral habitat (Wiley et al. 1984, Aho et al. 1986, Trebitz and Nibbelink 1996, Miranda and Pugh 2011). In particular, a lack of deep habitats and open water can reduce both the abundance and diversity of game fish species (Colle and Shireman 1980, Allen and Tugend 2002, SFWMD 2011).

REFERENCES

Bain, M.B., ed. 1990. *Ecology and Assessment of Warmwater Streams: Workshop Synopsis.* Wash., D.C.: U.S. Fish Wildlife Serv., Biol. Rep. 90(5.44).

Bancroft, G.T., S.D. Jewell, and A.M. Strong. 1990. *Foraging and nesting ecology of herons in the lower Everglades relative to water conditions*. Final Report. West Palm Beach, FL.: South Florida Water Management District, Environmental Sciences Division.

Brooks, J.E., and E.F. Lowe. 1984. *U.S. EPA Clean Lakes Program, Phase I. Diagnostic-Feasibility Study of the Upper St. Johns River Chain of Lakes. Volume II—Feasibility Study*. Technical pub. SJ84-15. Palatka, Fla.: St. Johns River Water Management District.

Carlisle, V., and G.W. Hurt, eds. 2000. *Hydric Soils of Florida Handbook*. 3rd ed., p. 319. Revised March 2000. Gainesville: Florida Association of Environmental Soil Scientists.

Cuffney, T.F. 1988. Input, Movement and Exchange of Organic Matter Within a Subtropical Coastal Blackwater River-Floodplain System. *Freshwater Biology* 19:305–20.

Epting, R.J., C.P. Robison, and R.C. Reddi. 2008. Gauge record hydrologic statistics: indicators for lake classification. *Environmental Bioindicators* 3: 193-204.

[ESE Inc.] Environmental Science Engineering Inc. 1991. *Hydroperiods and Water Level Depths of Freshwater Wetlands in South Florida: A Review of the Scientific Literature.* Final report. Prepared for the South Florida Water Management District, West Palm Beach, Fla.

Finger, T.R., and E.M. Stewart. 1987. Response of Fishes to Flooding Regime in Lowland Hardwood Wetlands. In *Community and Evolutionary Ecology of North American Stream*

Fishes, W.J. Matthews and D.C. Heins, eds., p. 86–92. Norman, Okla.: Univ. of Oklahoma Press.

Gilbert, K.M., J.D. Tobe, R.W. Cantrell, M.E. Sweeley, and J.R. Cooper. 1995. *The Florida Wetlands Delineation Manual.* Tallahassee: Florida Department of Environmental Protection.

Gordon, N.D., T.A. McMahon, and B.L. Finlayson. 1992. *Stream Hydrology—An Introduction for Ecologists*, p. 526. New York: Wiley.

Guillory, V. 1979. Utilization of an Inundated Floodplain by Mississippi River Fishes. *Florida Scientist* 42(4):222–28.

Hall, G.B. 1987. *Establishment of Minimum Surface Water Requirements for the Greater Lake Washington Basin* Technical pub. SJ87-1 Palatka, Fla.: St. Johns River Water Management District.

Huffman, R.T. 1980. *The Relation of Flood Timing and Duration to Variation in Selected Bottomland Hardwood Communities of Southern Arkansas*, p. 22. Misc. paper EL-80-4. Vicksburg, Miss.: U.S. Army Engineer Waterways Experiment Station.

Hupalo, R.B., C.P. Neubauer, L.W. Keenan, D.A. Clapp, and E.F. Lowe. 1994. *Establishment of Minimum Flows and Levels for the Wekiva River System.* Technical pub. SJ94-1. Palatka, Fla.: St. Johns River Water Management District.

Hurt, G.W., P.M. Whited, and R.F. Pringle, eds. 1998. *Field Indicators of Hydric Soils in the United States*. Version 4.0. Lincoln, Nebr.: U.S. Department of Agriculture, Natural Resources Conservation Service in cooperation with the National Technical Committee for Hydric Soils, Fort Worth, Tex.

Junk, W.J., P.B. Bayley and R.E. Sparks. 1989. The Flood Pulse Concept in River-Floodplain Systems. In *Proceedings of the International Large River Symposium*, D.P. Dodge, ed. Can. Spec. Publ. Fish. and Aquat. Sci.

Kinser, P. 1996 (unpublished). Wetland Vegetation Classification System. Internal document. St. Johns River Water Management District, Palatka, Fla.

Kollmorgen Corp. 1992 (revised). *Munsell Soil Color Charts*. Newburgh, N.Y.: Macbeth, a Division of Kollmorgen Instruments Corp.

Krishnamurty, G.B., P.Kasovia-Schmitt, and D.J. Ostroff. 1995. *Statistics: An Interactive Text for the Health and Life Sciences*. Jones & Bartlett Publishers, Boston, MA

Kushlan, J.A., and M.S. Kushlan. 1979. Observations on Crayfish in the Everglades, Florida. *Crustaceana Suppl.* 5:116–20.

Light, H.M., M.R. Darst, and J.W. Grubbs. 1998. *Aquatic Habitats in Relation to River Flow in the Apalachicola River Floodplain, Florida.* Professional paper 1594. Tallahassee, Fla.: U.S. Geological Survey.

Martin, K., and P. Coker. 1992. *Vegetation Description and Analysis: A Practical Approach*, p. 363. New York: Wiley.

McArthur, J.V. 1989. Aquatic and Terrestrial Linkages: Floodplain Functions. In *Proceedings of the Forested Wetlands of the United States; July 12–14, 1988*, D.D. Hook and L. Russ, eds.,

p. 107–16. Gen. tech. report SE-50. Asheville, N.C.: U.S. Forest Service, Southeastern Forest Experiment Station.

Merritt, R.W., and K.W. Cummins. 1984. *An Introduction to the Aquatic Insects of North America*. 2nd ed. Dubuque, Iowa: Randal/Hunt Publishing Co.

Mueller-Dombois, D., and H. Ellenberg. 1974. *Aims and Methods of Vegetation Ecology*, p. 547. New York: Wiley.

Neubauer, C.P., C.P. Robison, and T.C. Richardson. 2004. Using Magnitude, Duration, and Return Interval to Define Specific Wetlands Inundation/Dewatering Signatures in Northeast Florida. In *Society of Wetlands Scientists, 25th Anniversary Meeting Program.* July 18–23, 2004, Seattle, Wash. Abstract 20.5:179.

Neubauer Neubauer, C.P., C.P. Robison, T.C. Richardson, and P. Valentine-Darby. 2007 (draft). A Method for Defining Surface Water Inundation/Dewatering Signatures for Plant Communities. (In preparation.) St. Johns River Water Management District, Palatka, Fla.

Neubauer, C.P., G.B. Hall, E.F. Lowe, C.P. Robison, R.B. Hupalo, and L.W. Keenan. 2008. Minimum flows and levels method of the St. Johns River Water Management District, Florida, USA. *Environmental Management* 42(6): 1101-1114.

Osborne, T.Z., A.M.K. Bochnak, B. Vandam, S. Duffy, L. Keenan, K.S. Inglett, P.W. Inglett, and D. Sihi. 2014. *Hydrologic effects on soil stability – loss, formation and nutrient effects*. Final Report submitted to St. Johns River Water Management District. University of Florida Wetland Biochemistry Laboratory.

Poff, N.L., J.D. Allan, M.B. Bain, J.R. Karr, K.L. Prestegaard, B.D. Richter, R.E. Sparks, and J.C. Stromberg. 1997. The Natural Flow Regime—A Paradigm for River Conservation and Restoration. *Bioscience* 47(11):769–84.

Ross, S.T., and J.A. Baker. 1983. The Response of Fishes to Periodic Spring Floods in a Southeastern Stream. *American Midland Naturalist* 109(1):1–14.

Schneider, R.L., and R.R. Sharitz. 1986. Seed Bank Dynamics in a Southeastern Riverine Swamp. *American Journal of Botany* 73(7):1022–30.

Stephens, J.C. 1974. Subsidence of Organic Soils in the Florida Everglades—A Review and Update. In *Environments of South Florida*, *Memoir 2*, P.J. Gleason, ed. Miami, Fla.: Miami Geological Society.

[SJRWMD] St. Johns River Water Management District. 2006 (draft.). Minimum Flows and Levels Methods Manual. G.B. Hall, C.P. Neubauer, and C.P. Robison, eds. St. Johns River Water Management District, Palatka, Fla.

[USDA, NRCS] U.S. Dept. of Agriculture, Natural Resources Conservation Service. 2002 (revised). *Field Indicators of Hydric Soils in the United States, vers. 4.0.* G.W. Hurt, P.M. Whited, R.F. Pringle, eds. Lincoln, Nebr.: U.S. Dept. of Agriculture, NRCS, in cooperation with the National Technical Committee for Hydric Soils, Fort Worth, Tex.

[USDA, NRCS] U.S. Dept. of Agriculture. 2003. *Official Soil Series Descriptions*. Prepared by Soil Survey Staff, U.S. Dept. of Agriculture, NRCS, Soil Survey Division, Lincoln, Nebr. Accessed on NRCS Web site at *http://ortho.ftw.nrcs.usda.gov/cgi-bin/osd/osdname.cgi*.

[USDA, SCS] U.S. Dept. of Agriculture, Soil Conservation Service. 1987. *Hydric Soils of the United States.* Wash., D.C.: U.S. Dept. of Agriculture, SCS, National Technical Committee for Hydric Soils.

[USDA, SCS] U.S Dept. of Agriculture, Soil Conservation Service. 1990. *Soil Survey of Seminole County, Florida.* G.W. Schellentrager and G.W Hurt, eds., p. 134. Wash., DC.: U.S Dept. of Agriculture, SCS, in cooperation with Univ. of Florida Soil and Water Science Dept., Gainesville, Fla

Van der Valk, A.G. 1981. *Succession in Wetlands: A Gleasonian Approach*. Ecology 62:688–96.

Wharton, C.H., W.M. Kitchens, and T.W. Sipe. 1982. *The Ecology of Bottomland Hardwood Swamps of the Southeast: A Community Profile.* FWS/OBS-81/37. Wash., D.C.: Fish and Wildlife Serv., Office of Biological Serv.