APPENDIX C — ENVIRONMENTAL METHODS, DATA, AND METRICS

Environmental Analyses

MFLs determinations incorporate biological and topographical information collected in the field with hydrologic data collected from monitoring sites, hydrologic models, wetlands, and soils as well as land use/land cover and land ownership from GIS layers, aerial photography, and eco-hydrological information from scientific literature. This appendix describes the environmental methods, analyses, and assumptions used in the MFLs determination process for Johns Lake including field procedures such as site selection, field data collection, and data analyses, in addition to details and support for recommended MFLs metrics. Vegetation, soils, and elevation data were analyzed in conjunction with output from hydrologic and hydraulic models (see Appendix B for details of hydrologic analyses and model report) and scientific literature to develop a minimum hydrologic regime that protects the ecological structure and function of the Johns Lake system.

Field Methods

Preliminary Site Review

Familiarization with the field site began with a site history survey and a literature and data search. All pertinent information was compiled from St. Johns River Water Management District (SJRWMD) library documents, project record files, the hydrologic database, and SJRWMD Division of Surveying Services files. The Florida Natural Areas Inventory (FNAI) biodiversity matrix tool (http://www.fnai.org/) was queried for the presence of threatened or endangered species at potential sites. The literature and data search aimed to familiarize staff with site characteristics, locate important basin features, and assess prospective sampling locations. The types of information included:

- On-site and regional vegetation surveys and maps;
- Aerial photography (current 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.

Transect Site Selection

Ecological and environmental data were collected along linear transects, with many factors considered in when selecting transect locations. Transects are fixed sample lines across a water body or wetland and typically extend from uplands to open water. Elevation, soils, and vegetation were sampled along transects to characterize the distribution of soils and plant communities. These data were then compared to system hydrological data to determine the influence of flooding and drying events on soils and plant species or communities.

Data compiled during the site selection process were reviewed to familiarize staff with site characteristics, locate important basin features that needed to be evaluated, and assess prospective field transect locations. Potential transect locations at Johns Lake were initially identified from maps of wetlands, soils, topography, and land ownership. Specific transect site selection goals included:

- Establishing transects at sites where multiple wetland communities of the most commonly occurring types were traversed;
- Establishing transects that traverse unique wetland communities;
- Establishing transects that traverse shallow reaches (i.e., potentially sensitive to reduced water levels); and
- Establishing transects at locations where earlier MFLs field data were collected (if possible).

These goals help to ensure ecosystem protection of both commonly occurring and unique wetland ecosystems at Johns Lake. Transect characteristics were subsequently field-verified to ensure that prospective locations contained representative wetland communities, hydric soils, and reasonable upland access. Specific transect locations were chosen because they met the transect selection criteria and were deemed to be the best candidate locations (i.e., these transects are good representations of wetland communities found at Johns Lake). Individual transects are described below.

Field Data Collection

Field data collection procedures involved collecting vegetation, soils, and elevation data along multiple fixed transects across a hydrologic gradient (i.e., from uplands to open water). Transects were established in areas exhibiting transitions in vegetation communities and hydric soils with a marked hydrologic gradient. The main purpose in using transects, where the change in vegetation and soils was clearly directional, was to describe the maximum variations in vegetation elevation and composition that may occur at Johns Lake with hydrologic fluctuations.

<u>Vegetation Sampling Procedures</u>

Vegetation data were collected on each transect using the line-intercept method (Canfield 1941) at 1-foot (ft) intervals. This semi-quantitative method involves measuring the length (i.e., longitudinal location along the transect) of each individual plant that overlaps the transect line. All individual plants that intercepted the transect line were identified to species or the lowest possible taxon. This technique provides precise data on individual species' distribution (and elevation range, mean, etc.).

SJRWMD’s Wetland Vegetation Classification System (Kinser 2012) was used to standardize the names of wetland plant communities. Community boundaries are spatial localities where the degree of change in species composition is greatest (Fagan et al. 2003). In some instances, intermediate habitats termed “transition zones” were assigned when community boundaries exhibited characteristics of more than one adjoining community.

The spatial extent of plant communities, and transition zones among plant communities, was determined using reasonable scientific judgement aided by data collected from the line-intercept vegetation. Reasonable scientific judgement involves the ability to collect and analyze information using technical knowledge, 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.

Once the spatial extent of plant communities and transition zones were delineated, belt transect data were collected. The belt transect is a transect line of varying width (belt width) that forms a long, thin, rectangular plot divided into smaller sampling areas called quadrats (Bonham 2013). Quadrats within the belt transect correspond to the spatial extent of plant communities or transitions between plant communities. The belt transect width varies depending on the type of plant community to be sampled. For example, a belt width of 10 ft (5ft on each side of the transect line) is used for sampling herbaceous plant communities of a floodplain marsh (Figure C-1). A belt width of 50 ft (25 ft on each side of the line) is used to adequately characterize a forested community (e.g., hydric hammock, hardwood swamp). Plants were identified down to lowest possible taxon, and the percent cover of plant species were estimated if they occurred within the established belt width (i.e., quadrat) for the plant community under evaluation.

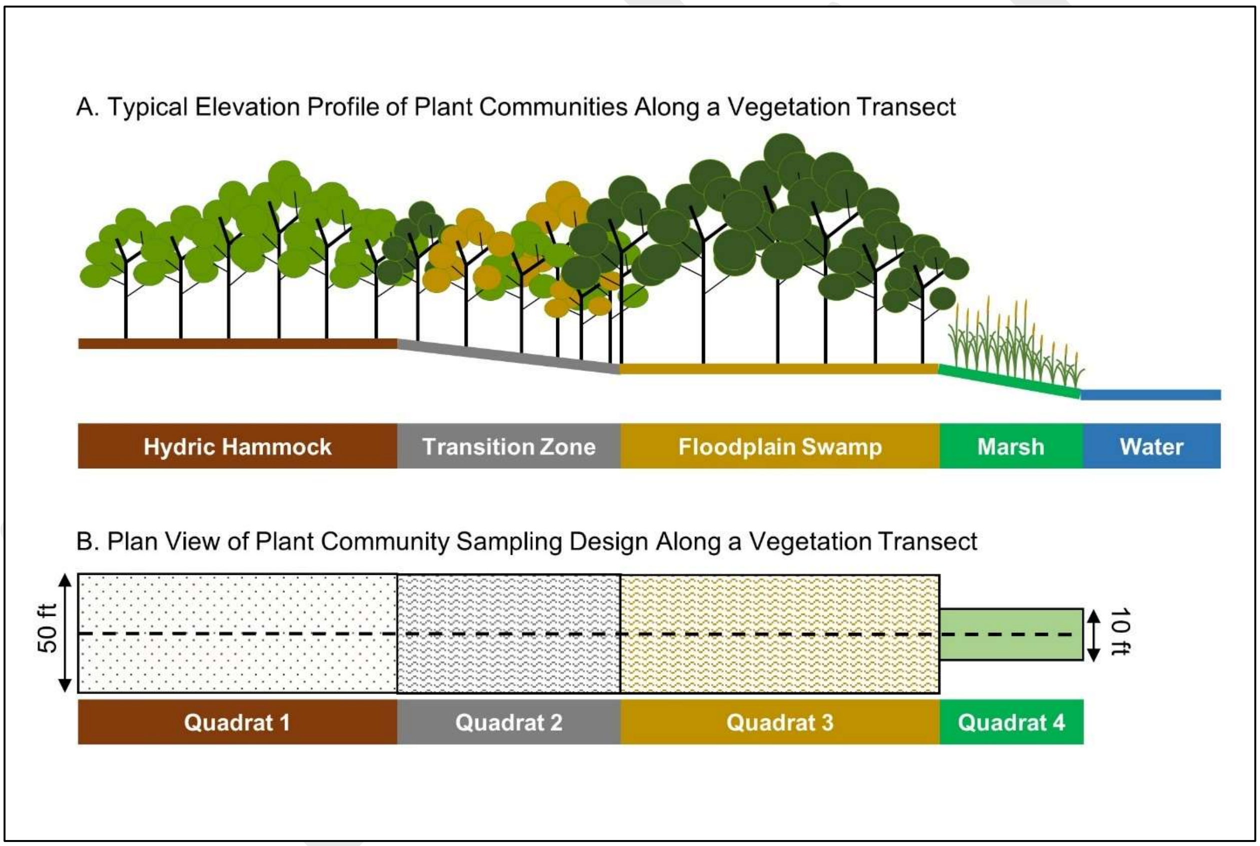


Figure C-1: Example of belt transect within forested and herbaceous plant communities.

Percent cover is defined as the vertical projection of a plant's crown or shoot area to the ground surface, expressed as a percentage of the quadrat area (Barbour et al. 1999). As a measure of plant distribution, percentage cover is often considered to be of greater ecological significance than density largely because percent cover gives a better measure of plant biomass than the number of individuals (Bonham 2013). The canopies of the plants inside the quadrat often overlap, so the total percent cover of plants in a single quadrat will frequently sum to more than 100%. Percent cover was estimated visually using cover classes, or ranges of percent cover, that standardize vegetation collection among observers (Mueller-Dombois and Ellenberg 1974; Bonham 2013). The cover classes and percent cover ranges were estimated using a modified Daubenmire scale (Daubenmire 1959; Bailey and Poulton 1968), where the lowest cover class is split between presence only and rare coverage (Table C-1).

Table C-1: Vegetation cover classes with class percent cover range, midpoint, and descriptor.

Cover Class	Percent Cover Range	Midpoint	Description
X	0 – 1	0.5	Present
1	1 – 5	3	Rare
2	5 – 25	15	Scattered
3	25 – 50	37.5	Numerous
4	50 – 75	62.5	Abundant
5	75 – 95	85	Codominant
6	95 – 100	97.5	Dominant

Elevation Survey Procedure

Once a given transect was established and vegetation data collected, the minimum vegetation necessary was trimmed to allow a line-of-sight along the length of the transect. Elevation measurements, recorded to the nearest hundredth of a foot, were surveyed at 1-m intervals on the ground along the length of the transect using a rod and transit level. Additional elevations were measured at obvious elevation changes, vegetation community changes, and soil changes. Elevations were calculated relative to a datum associated with established benchmarks near each transect. SJRWMD uses the North American Vertical Datum of 1988 (NAVD88) as its standard datum. All elevations referenced within this document were calculated relative to this datum.

Latitude and longitude data were also collected using a global positioning system (GPS) receiver at selected points along the length of each transect. These data were used to create accurate maps of transect locations, locate specific features along the transects, and facilitate recovering transect locations in the future.

Soil Sampling Procedures

The presence and depth of organic soils (histosols and histic epipedons) are the primary soil criteria used for the MFLs determination (whether event-based or exceedance-based). In addition to these organic soil indicators (i.e., A1 and A2), the extent of other hydric soil indicators (HI) observed along field transects is also documented. Soil profiles were described following standard Natural Resources Conservation Service (NRCS) procedures (USDA, NRCS 2018; Schoeneberger et al. 2012). Each soil horizon (layer with homogenous, distinctive properties) was generally described with respect to thickness, texture, Munsell color (Kollmorgen Corp. 1992), percent organic coating, and features (depletions, mottles, redox concentrations, inclusions, organic bodies, or any other notable feature).

Soil borings were taken along transects at two-meter intervals to sample all significant geomorphic features, landscape positions, and plant communities. Permanently flooded areas such as deep marshes are generally not sampled due to difficulty in obtaining samples. Soil series designations were compared to mapped NRCS soils, which are useful in MFL determinations when applying NRCS soil hydrologic data.

The procedure to document hydric soils includes:

- Digging a hole and describing the soil profile to a depth of 10-16 inches (in.) and using a completed soil description, specifying which hydric soil indicators have been matched;
- Performing a deeper soil examination where field indicators are not easily seen within 16 in of the soil surface. It is always recommended that soils be excavated and described as deep as necessary to make reliable interpretations and classification; and
- 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)

Environmental Transect Results and Discussion

Field Data

Elevation, vegetation, and soils data were collected at five environmental transects at Johns Lake (Table C-2; Figure C-2). This section describes transect locations and general information about each transect.

Table C-2: Location of field transects used for Johns Lake MFLs.

Transect	Latitude - Longitude (Begin)	Latitude - Longitude (End)	Location
1	28° 31' 19.92" N 81° 39' 38.88" W	28° 31' 19.92" N 81° 39' 38.52" W	177 meters north of Champagne Drive
2	28° 31' 30" N 81° 39' 41.76" W	28° 31' 30" N 81° 39' 38.88" W	563 meters north of Champagne Drive
3	28° 31' 45.48" N 81° 40' 38.64" W	28° 31' 44.04" N 81° 40' 37.56" W	48 meters south of Magnolia Point Blvd
4	28° 31' 44.76" N 81° 40' 33.60" W	28° 31' 44.04" N 81° 40' 35.40" W	80 meters south of Magnolia Point Blvd

Transect	Latitude - Longitude (Begin)	Latitude - Longitude (End)	Location
5	28° 31' 48" N 81° 40' 34.68" W	28° 31' 51.6" N 81° 40' 34.68" W	64 meters north of Magnolia Point Blvd

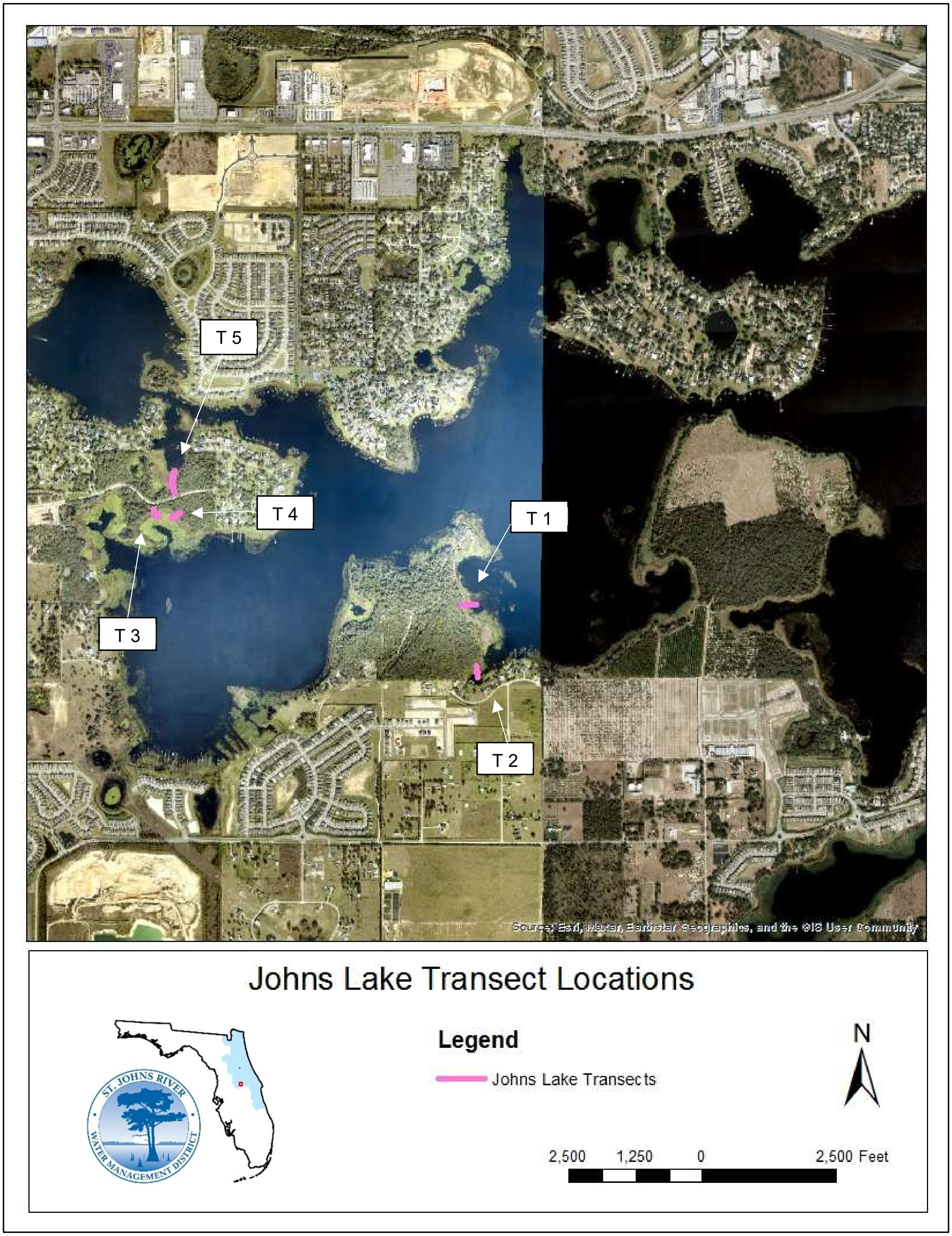


Figure C-2: Johns Lake environmental transects (T1-T5).

Transect 1

T1 Location

Transect 1 was located on the southeast side of Scrub Point Preserve, a 93-acre undeveloped peninsula on the south shore of Johns Lake, managed by the Lake County Water Authority. (Figure C-3). The transect begins in an upland area and extends 60 meters to the southeast, ending in open water. The elevation ranged from 98.1 ft NAVD88 to 84.5 ft NAVD88 at an average grade of 6.92% over the transect length. Transect 1 was surveyed by district staff on 4/27/2023 and 4/28/2023 with water levels reading 94.49 and 94.50 ft NAVD88, respectively.

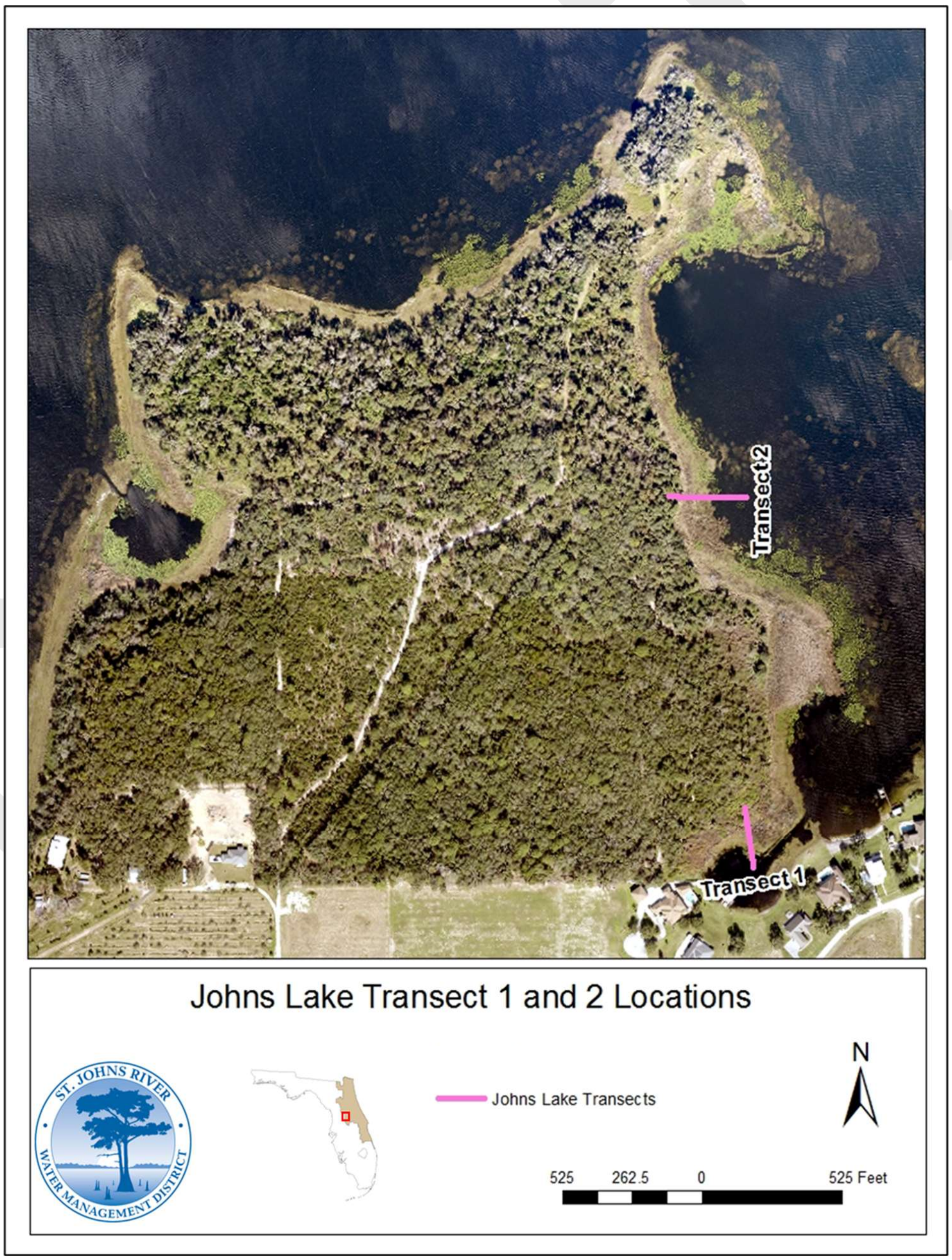


Figure C-3: Johns Lake Transects 1 and 2 locations.

<u>T1 Vegetation</u>

Transect 1 extended for a length of 60 m, traversing five distinct vegetation communities. At stations 0-10 m, the transect began in an upland (Upland Transition) noted by scattered saw palmetto (*Serenoa repens*). Moving downslope in a southeasterly direction for another 6 m, the vegetation community changed from one containing saw palmetto to one with numerous Carolina willow (*Salix caroliniana*) designated as the Salix Ecotone. The Salix Ecotone transitioned into a Salix Shrub Swamp (stations 16-27), followed by a shrub swamp co-dominated by buttonbush (*Cephalanthus occidentalis*) named Cephalanthus Shrub 2 (stations 27-35). This buttonbush shrub community differs from others found on the subsequent transects and is noted with the number 2 to differentiate it for metric analysis. A deep marsh (Deep Marsh) community occupied stations 35-56 with the transect terminating in open water in the final 4m (Figure C-4; Table C-3; Figure C-5; Table C-4).

The Upland Transition zone (stations 0-10) had no canopy but the mid-story and understory had dominant muscadine grape (*Vitis rotundifolia*) and numerous common persimmon (*Diospyros virginiana*). Saw palmetto, passionflower (*Passiflora incarnata*), and *Lantana strigocamara* were scattered. Saltbush (*Baccharis halimifolia*), Elliott's milkpea (*Galactia elliottii*), greenbrier (*Smilax auriculata*), Brazilian peppertree (*Schinus terebinthifolia*), and cabbage palm (*Sabal palmetto*) were rare.

The Salix Ecotone (stations 10-16) was adjacent to and downslope of the Upland Transition zone and had no canopy. Saltbush, dogfennel (Eupatorium capillifolium), Brazilian peppertree, Elliott's lovegrass (*Eragrostis elliottii*), and Carolina willow were numerous in the mid-story and understory. Muscadine grape, passionflower, maidencane (*Panicum hemitomon)*, American burnweed (*Erechtites hieraciifolius*), and para grass (*Urochloa mutica*) were scattered. Torpedo grass (*Panicum repens*), climbing hempvine (*Mikania scandens*), turkey tangle frog-fruit (*Phyla nodiflora*), ragweed (*Ambrosia artemisiifolia*), Virginia creeper (*Parthenocissus quinquefolia*), and herbwilliam (*Ptilimnium capillaceum*) were rare.

The Salix Shrub Swamp (stations 16-27) was adjacent to and downslope of the Salix Ecotone community. It had a dense canopy of Carolina willow that was dominant and shaded much of this zone. In the understory, torpedo grass was abundant, para grass was numerous, and buttonbush, Elliott's lovegrass, and maidencane were scattered. Saltbush, climbing hempvine, Virginia buttonweed (*Diodia virginiana*), turkey tangle frog-fruit, and dollarweed (*Hydrocotyle umbellata*) were rare.

Cephalanthus Shrub 2 (stations 27-35) was adjacent to and downslope of the Salix Shrub Swamp. It had no overstory, but a mid-story with codominant buttonbush, and numerous Carolina willow throughout. In the understory, torpedo grass was codominant, whitewater-lily (*Nymphaea odorata*) was scattered, and Virginia buttonweed and marsh grass (*Sporobolus bakeri*) were rare.

A floating deep marsh community (stations 35-56) was adjacent to and downslope of Cephalanthus Shrub 2. The understory consisted of abundant torpedo grass, numerous white water-lily, and rare buttonbush. Walter's sedge (*Carex striata*) was present.

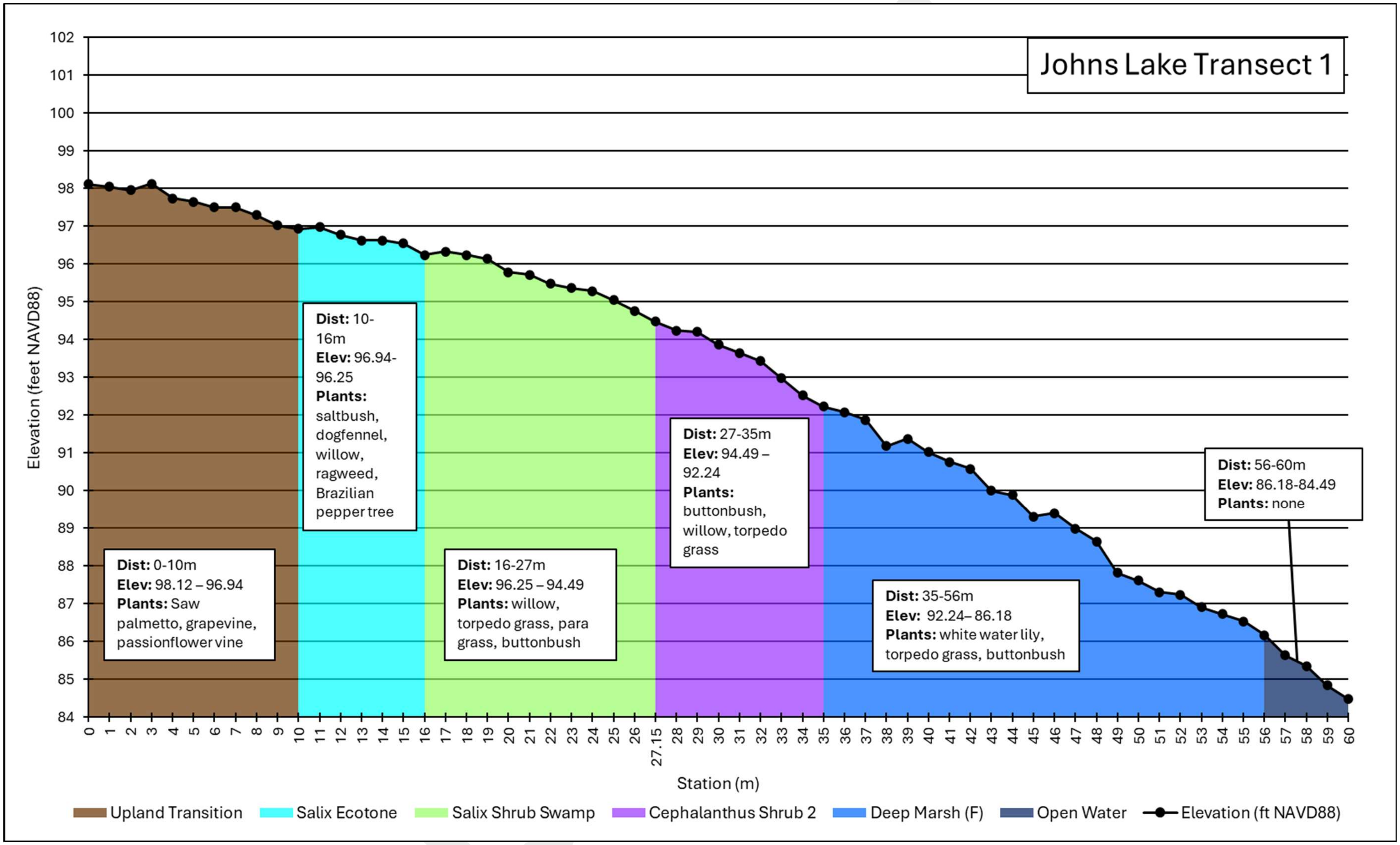
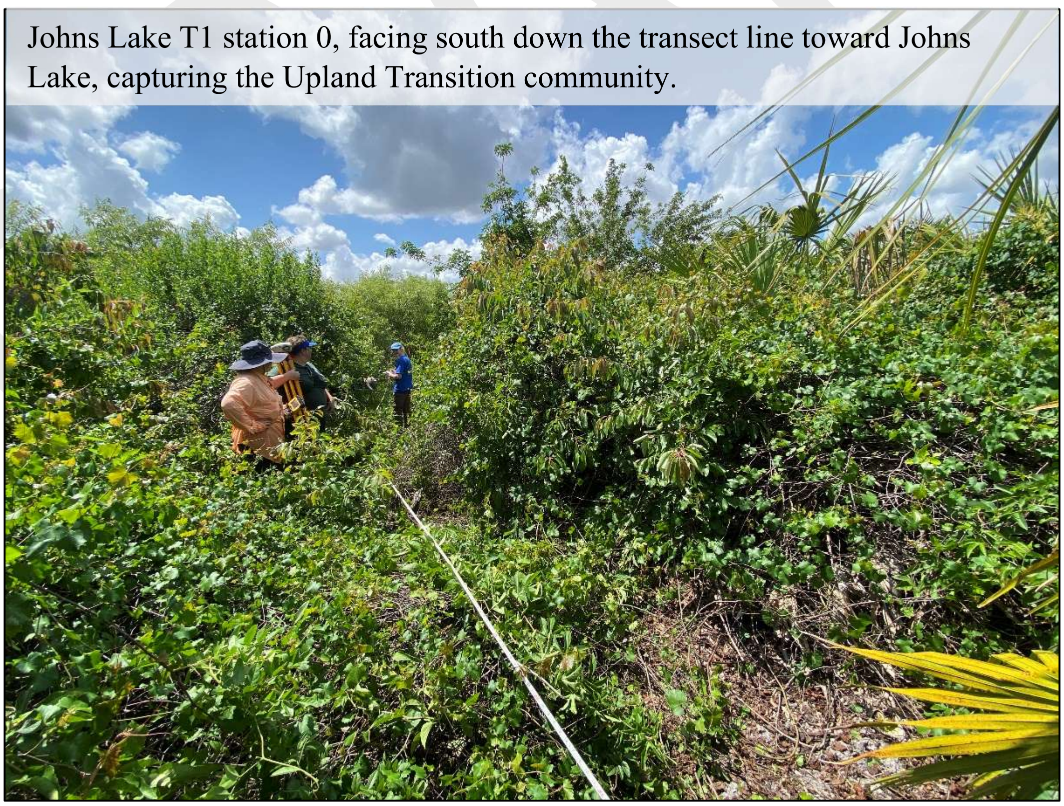


Figure C-4: Johns Lake Transect 1 topography and vegetation communities.

Table C-3: Johns Lake Transect 1 vegetation community statistics.

Transect 1 Vegetation Communities	Station Distance (m)	Elevation (ft NAVD88)			
		Mean	Median	Minimum	Maximum
Upland Transition	0-10	97.63	97.66	96.94	98.12
Salix Ecotone	10-16	96.68	96.63	96.25	96.94
Salix Shrub Swamp	16-27	95.65	95.72	94.49	96.25
Cephalanthus Shrub 2	27-35	93.52	93.66	92.24	94.49
Deep Marsh (F)	35-56	89.26	89.36	86.18	92.24
Open Water	56-60	85.3	85.36	84.49	86.18



Johns Lake T1 station 0, facing south down the transect line toward Johns Lake, capturing the Upland Transition community.

Figure C-5: Johns Lake Transect 1.

Johns Lake T1 station 11, facing west, capturing the Salix Ecotone community.

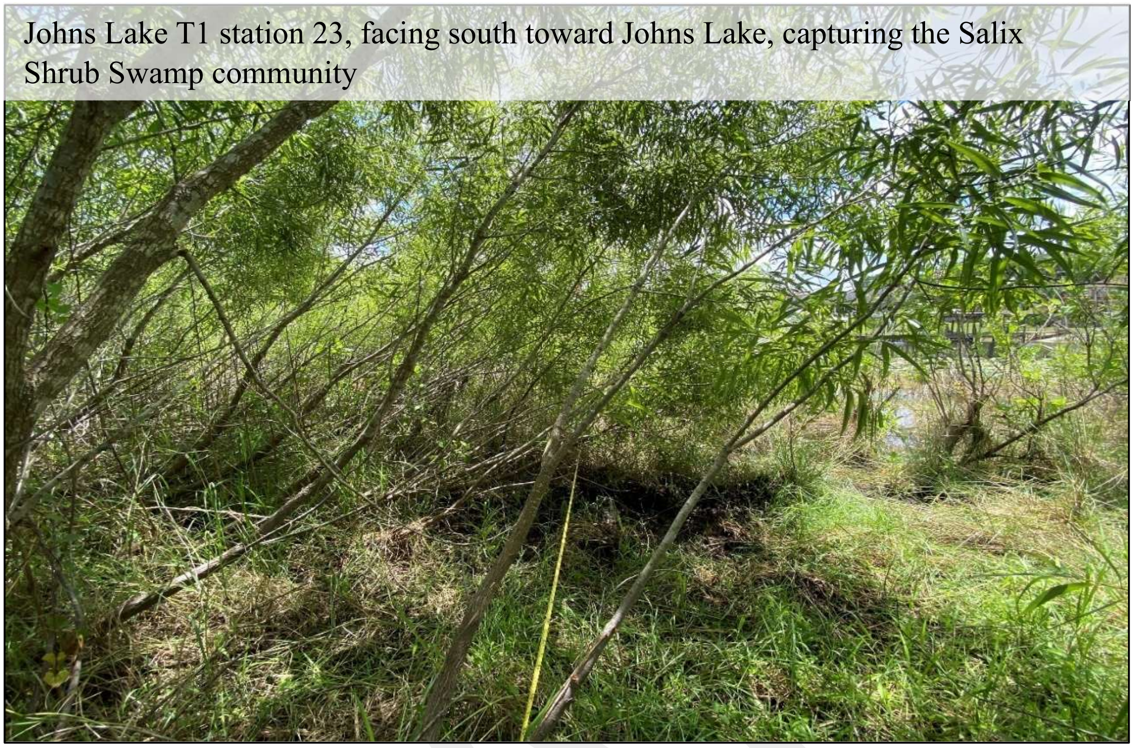


Figure C-5 continued: Johns Lake Transect 1

Johns Lake T1 station 35, looking south into the Deep Marsh (floating) with open water visible in the distance.

Figure C-5 continued: Johns Lake Transect 1

Table C-4: Vegetation species list with cover estimate and NWPL code for Transect 1.

Scientific Name	Common Name	Community[1]	UT	SE	SSS	CS2	DM
		Start (m)	0	10	16	27	35
		End (m)	10	16	27	35	56
		NWPL Code[2]	Plant Species Cover Estimates[3]				
Ambrosia artemisiifolia	ragweed	FACU		1	x		
Baccharis halimifolia	saltbush	FAC	1	3	1		
Bacopa monnieri	water hyssop	OBL			x		
Blechnum serrulatum	swamp fern	FACW			x		
Callicarpa americana	American beautyberry	FACU	x				
Carex striata	Walter's sedge	OBL					x
Cephalanthus occidentalis	buttonbush	OBL			2	5	1
Diodia virginiana	Virginia buttonweed	FACW			1	1	
Diospyros virginiana	common persimmon	FAC	3				
Eragrostis elliottii	Elliott's lovegrass	FACW		3	2		
Erechtites hieraciifolius	American burnweed	FAC	x	2			
Eupatorium capillifolium	dogfennel	FACU	x	3			
Galactia elliottii	Elliott's milkpea	FACU	1				
Galium tinctorium	stiff marsh bed straw	FACW		x	x		
Hydrocotyle umbellata	dollarweed	OBL			1		
Lantana strigocamara	lantana	FACU	2	x			
Leersia hexandra	southern cutgrass	OBL		x	1		
Ludwigia suffruticosa	shrubby primrose willow	OBL				x	
Lygodium microphyllum	climbing fern	FACW			x		
Mikania scandens	climbing hempvine	FACW		1	1	x	
Nymphaea odorata	white water-lily	OBL				2	3
Panicum hemitomon	maidencane	OBL	x	2	2	x	
Panicum repens	torpedo grass	FACW		1	4	5	4

Scientific Name	Common Name	Community[1]	UT	SE	SSS	CS2	DM
		Start (m)	0	10	16	27	35
		End (m)	10	16	27	35	56
		NWPL Code[2]	Plant Species Cover Estimates[3]				
Parthenocissus quinquefolia	Virginia creeper	FACU	x	1			
Passiflora incarnata	passionflower	FACU	2	2			
Persicaria hirsuta	hairy smartweed	OBL		x	x		
Phyla nodiflora	turkey tangle frog-fruit	FAC		1	1		
Ptilimnium capillaceum	herbwilliam	OBL		1			
Quercus virginiana	live oak	FACU	x				
Sabal palmetto	cabbage palm	FAC	1				
Salix caroliniana	Carolina willow	OBL		3	6	3	
Schinus terebinthifolia	Brazilian peppertree	FAC	1	3			
Serenoa repens	saw palmetto	FACU	2				
Smilax auriculata	greenbrier	FACU	1				
Solidago leavenworthii	Leavenworth's goldenrod	FAC		x	x		
Sporobolus bakeri	marsh grass	FACW		x	x	1	
Urena lobata	Caesar's weed	FAC		x			
Urochloa mutica	para grass	FACW		2	3		
Vigna luteola	hairy cowpea	FACW		x	x		
Vitis rotundifolia	muscadine grape	FAC	6	2			

[1]**Community:** UT = Upland Transition, SE = Salix Ecotone, SSS = Salix Shrub Swamp, CS2 = Cephalanthus Shrub 2, DM = Deep Marsh

[2]**NWPL** codes are taken from the National Wetland Plant List (NWPL; USDA NRCS 2016). Species not listed or almost always occur in non-wetlands under natural conditions are considered **Upland (UPL)**. **Facultative Upland (FACU) –** Plants usually occurring in non-wetlands but occasionally found in wetlands. **Facultative (FAC)** – Plants with similar likelihood of occurring in both wetlands and uplands. **Facultative Wet (FACW)** – Plants that typically exhibit their maximum cover in areas subject to surface water flooding and/or saturation but may also occur in uplands. **Obligate (OBL)** – Plants that are found or achieve their greatest abundance in an area that is subject to surface water flooding and/or saturation; rarely occur in uplands.

[3]**Plant Species Cover Estimates:** Areal extent of vegetation species along the transect within a given vegetation community where X=<1%, 1=1 to 5%, 2=5 to 25%, 3=25 to 50%, 4=50 to 75%, 5=75 to 95% and 6=95-100%.

T1 Soils

Mapped Soils: The NRCS's (websoilsurvey.nrcs.usda.gov) SSURGO (Soil Survey Geographic Database) data suggests that Cassia sand is the predominant soil map unit present at Transect 1 (Figure C-6). It is a sandy, siliceous, hyperthermic Oxyaquic Alorthod which is a very deep, somewhat poorly drained soil that formed in sandy marine deposits (Official Series Description - CASSIA Series (usda.gov)).

On-site Soil Descriptions: Soil profiles were collected at two-meter intervals along the transect and their hydric soil indicators (or lack thereof) were reported. Detailed descriptions were recorded at three stations along Transect 1: stations 2 (97.96 ft NAVD88), 22 (95.49 ft NAVD88) and 28 (94.25 ft NAVD88). Table C-5 presents the data gathered during these descriptions. Hydric soils were first encountered at station 22 with the indicators "Muck Presence (A8)" and "Stripped Matrix (S6)". Since this station's elevation was at 95.49 ft (ft)NAVD88, the presence of muck on the soil's surface suggests that the seasonal high-water table (SHWT) is at or above ground surface (AAGS) at this elevation (Table C-5).

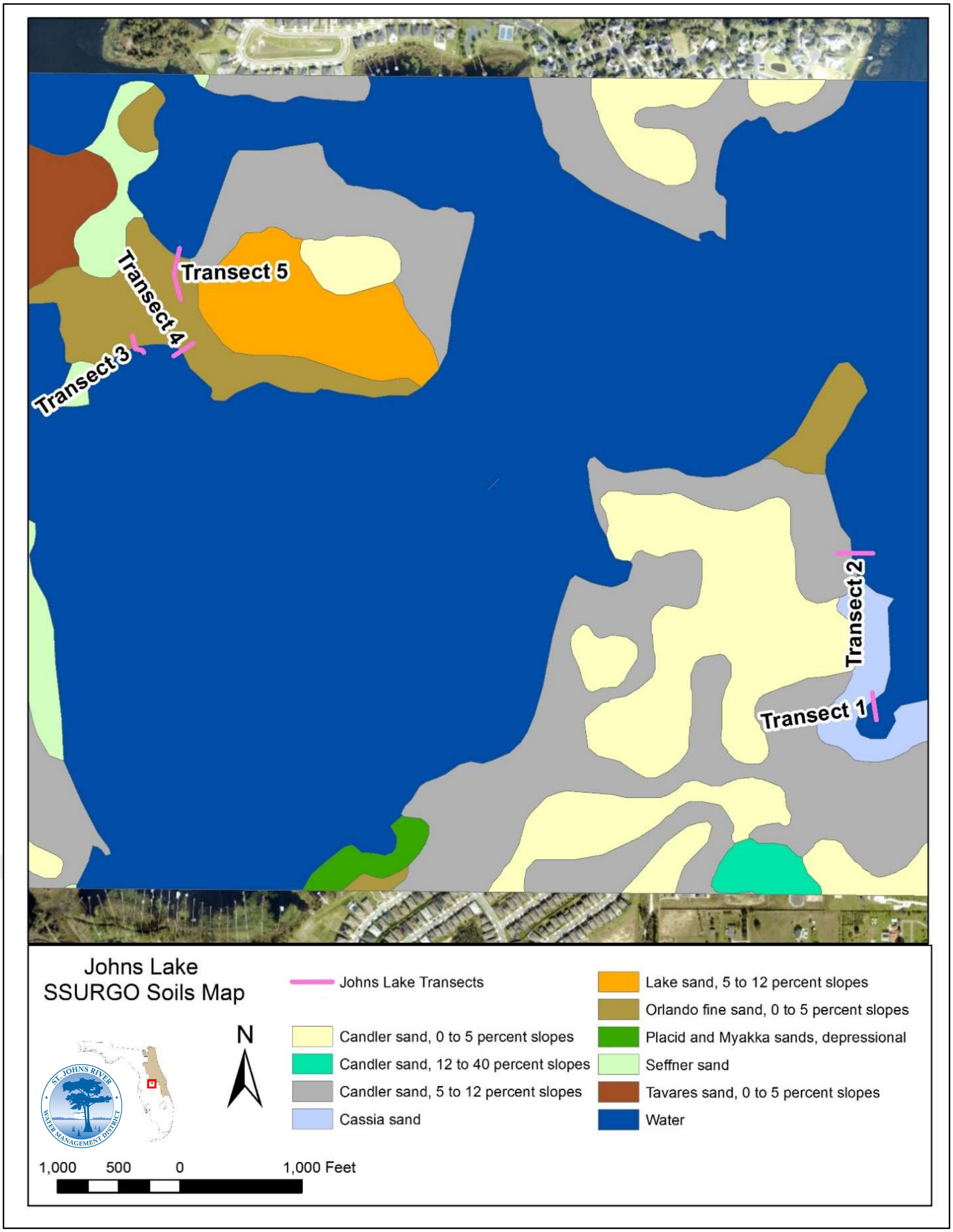


Figure C-6: SSURGO soil map of Johns Lake.

Table C-5: Johns Lake Transect 1 detailed soil descriptions.

Station (m) / Elevation (ft NAVD88)	Vegetation Community	Hydric Soil Indicator / SHWT (in. below surface)	Horizon	Depth (in.)	Matrix (Hue, Value/Chroma)	Texture	Notes
Station 2 97.96 ft	Upland Transition		A1	0-5.5	10YR 4/1	Sand	Mottle: 10YR 2/1, 10%, sharp round; Mottle: 10YR 6/1 20%, clear round
			A2	5.5-8	10YR 3/1	Sand	Organic carbon less than 50%; Mottle: 10YR 5/1, 25% clear round; Mottle: 10YR 4/1, 10%, clear round
			E1	8-10	10YR 4/1	Sand	Mottle: 10YR 2/1, 10%, clear round; Depletion: 10YR 5/1, 15%, clear round; Mottle: 10YR 6/1, 10%, clear round
		Seasonal High Water Table (SHWT) at 10"	E2	10-36	10YR 4/1	Sand	Mottle: 10YR 3/1, 10%, diffuse round; Depletion: 10YR 5/1, 20%, diffuse round
			Bh1	36-52	10YR 3/2	Sand	Depletion: 10YR 4/2, 10%, diffuse round
			Bh2	52-69	10YR 3/3	Sand	Depletion: 10YR 4/2, 5%, diffuse round
Station 22 95.49 ft	Salix Shrub Swamp	Muck Presence (A8) / At or Above Ground Surface (AAGS	Oa	0-0.5	10YR 2/1	Muck	None
			E	0.5-1.75	10YR 5/1	Sand	Mottle: 10YR 2/1, 10%, clear round; Depletion: 10YR 6/1, 10%, clear round
			Ab	1.75-2.75	10YR 2/1	Sand	Organic carbon: 60%; Mottle: 10YR 5/1 15% clear round; Depletion: 10YR 6/1, 2%, diffuse round
		Stripped Matrix (S6)	E1	2.75 - 5.5	10YR 5/1	Sand	Mottle: 10YR 3/1, 15%, clear round; Depletion: 10YR 6/1, 10%, diffuse round
			E2	5.5-7.75	10YR 3/2	Sand	Mottle: 10YR 2/1, 20%, clear round; Depletion: 10YR 4/2, 15%, diffuse round
		Dark Surface (S7)	A	7.75-10.5	10YR 2/1	Sand	Mottle: 10YR 3/2, 20%, clear round
			E	10.5-14.5	10YR 3/1	Sand	Organic carbon less than 50%; Mottle: 10YR 2/1, 15%, clear round; Depletion: 10YR 4/1, 25%, diffuse round
Station 28 94.25 ft	Cephalanthus Shrub 2	Muck Presence (A8), Polyvalue Below Surface (S8) / AAGS	Oa	0-1	10YR 2/1	Muck	None
			A	1-2	10YR 2/1	Sand	Organic carbon: 85%
		Stripped Matrix (S6)	E	2-3.5	10YR 4/1	Sand	Depletion: 10YR 5/1, 10%, diffuse round; Mottle: 10YR 2/1, 10%, diffuse round
			EA	3.5-8	10YR 3/1	Sand	Organic carbon less than 50%; Depletion: 10YR 5/1, 30%, diffuse round; Mottle: 10YR 2/1, 10%, diffuse round
			Ab	8-10	10YR 2/1	Sand	Organic carbon: 90%; Mottle: 10YR 4/1, 5%, clear round
			E	10-12	10YR 3/1	Sand	Organic carbon less than 50%; Mottle: 10YR 2/1, 20%, diffuse round; Depletion: 10YR 5/1. 20%, diffuse round

Transect 2

T2 Location

Transect 2 was located on the eastern side of Scrub Point Preserve. (Figure C-3). The transect began in a mesic hammock and extends 78 meters to the southeast, ending in open water. The elevation ranged from 99.32 ft NAVD88 to 86.39 ft NAVD88 at an average grade of 5.05% over the transect length. Transect 2 was surveyed by district staff on 5/4/2023, 5/16/2023, and 6/13/2023 and the water levels were 94.34, 94.12, and 93.91 ft NAVD88, respectively.

T2 Vegetation

Transect 2 traversed seven distinct vegetation communities. It began in a mesic hammock (0 m- 4 m), followed by three transitional communities. The buttonbush shrub community matched the one on Transect 1 (CS2). Transect 2 had two different deep marsh communities, one dominated by cattail situated just upslope of another which had numerous white water-lily. The transect terminated in open water in the final 4m (74 m- 78 m) (Figure C-7; Table C-6; Figure C-8; Table C-7).

Transect 2 began in a mesic hammock (0 m- 4 m) and featured dominant saw palmetto and co-dominant live oak (*Quercus virginiana*) which formed a thick canopy. Muscadine grape was scattered, Swamp bay (*Persea palustris*), Elliott's milkpea, and greenbrier were rare.

The second community (4 m- 11 m) was considered an upland transition zone between the mesic hammock community and the salix transitional zone below. Invasive Caesar's weed (*Urena lobata*), greenbrier, dogfennel, and muscadine grape were all scattered in this zone. Common persimmon, Elliott's milkpea, saw palmetto, black nightshade (*Solanum americanum*), Carolina willow, American burnweed, and para grass were rare.

The third community (11m – 20m) was a transition zone, called the salix ecotone. Carolina willow was abundant and had formed a canopy, shading the understory. In the understory, para grass was abundant. Torpedo grass and maidencane were numerous and saltbush, dogfennel, turkey tangle frog fruit, muscadine grape, Virginia buttonweed, and Caesar's weed were scattered. Le Conte's flatsedge (*Cyperus lecontei*), lanceleaf arrowhead (*Sagittaria lancifolia*), and southern cut grass (*Leersia hexandra*) were rare.

The fourth community (20m – 25m) was a cephalanthus ecotone with numerous buttonbush and codominant torpedo grass. This buttonbush community occurred at a higher elevation than "Cephalanthus 2" and the buttonbush here co-occurred with mostly facultative species, unlike the other buttonbush-dominated communities. Maidencane and Le Conte's flatsedge were scattered, and shrubby primrose willow (*Ludwigia suffruticosa*), pickerelweed (*Pontederia cordata*), southern cattail (*Typha domingensis*), and turkey tangle frog-fruit were rare.

The fifth community (25m – 31m) along Transect 2 is Cephalanthus Shrub 2, which we determined matched the fourth community on Transect 1. Buttonbush and torpedo grass were abundant in this community. Lanceleaf arrowhead was scattered and dollarweed was present.

The sixth community (31m – 39m) was a cattail deep marsh. There were numerous southern cattails, and some open water was visible between the cattail clumps. Torpedo grass was scattered and was the second most prevalent plant in this zone.

The seventh community (39m – 74m) was a floating deep marsh (Deep Marsh (F)) which was at a lower elevation than the cattail marsh. White water-lily was numerous, while spatterdock (*Nuphar advena*) and torpedo grass were both scattered. Southern cattail was present.

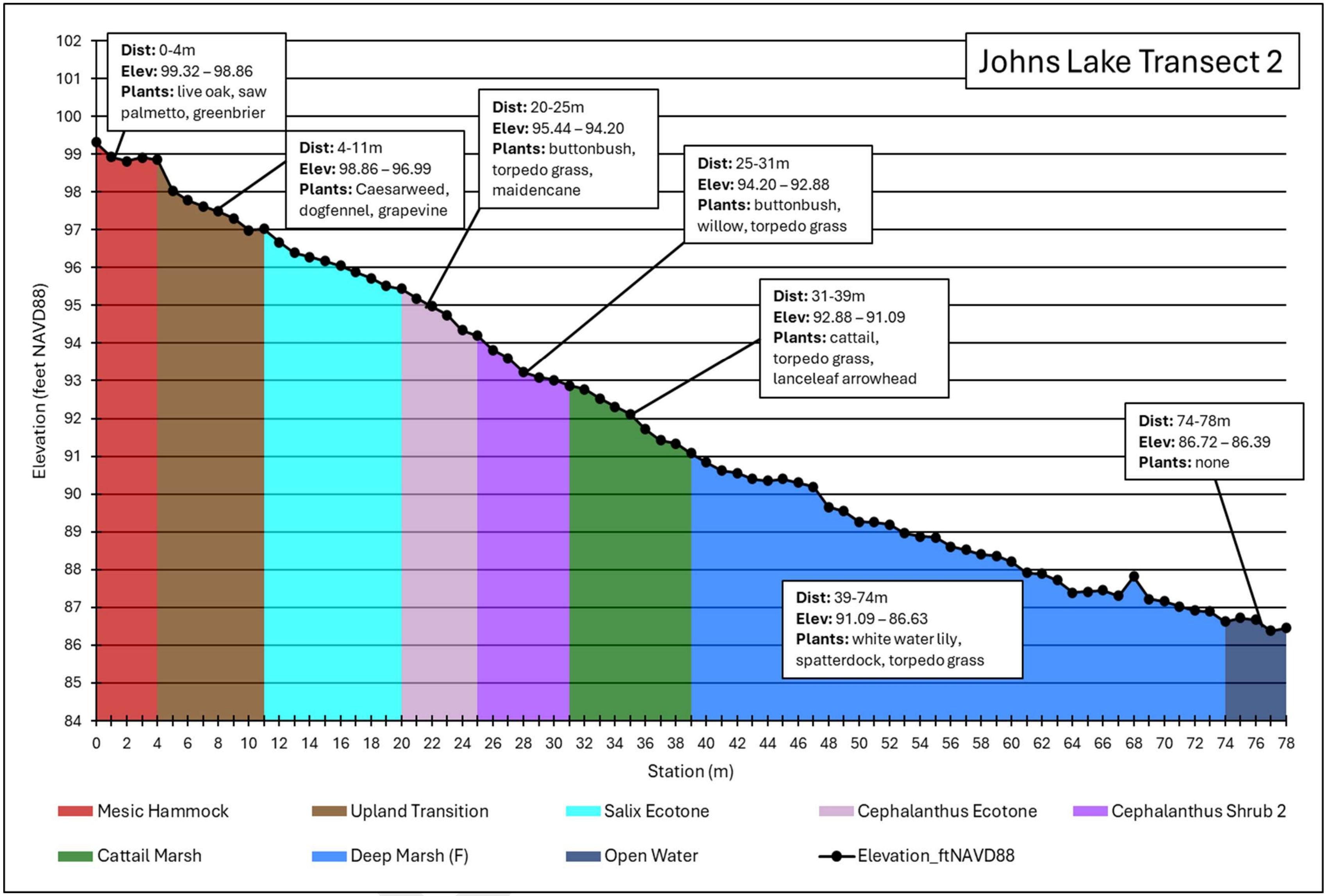


Figure C-7: Johns Lake Transect 2 with topography and vegetation communities.

Table C-6: Johns Lake Transect 2 vegetation community statistics.

Transect 2 Vegetation Communities	Station Distance (m)	Mean (ft NAVD 88)	Median (ft NAVD 88)	Min (ft NAVD 88)	Max (ft NAVD 88)
Mesic Hammock	0-4	98.96	98.91	98.86	99.32
Upland Transition	4-11	97.64	97.56	96.99	98.86
Salix Ecotone	11-20	96.12	96.11	95.44	97.03
Cephalanthus Ecotone	20-25	94.81	94.86	94.2	95.44
Cephalanthus Shrub 2	25-31	93.4	93.23	92.88	94.2
Deep Marsh - Typha	31-39	92.02	92.12	91.09	92.88
Deep Marsh - Floating	39-74	88.7	88.57	86.63	91.09

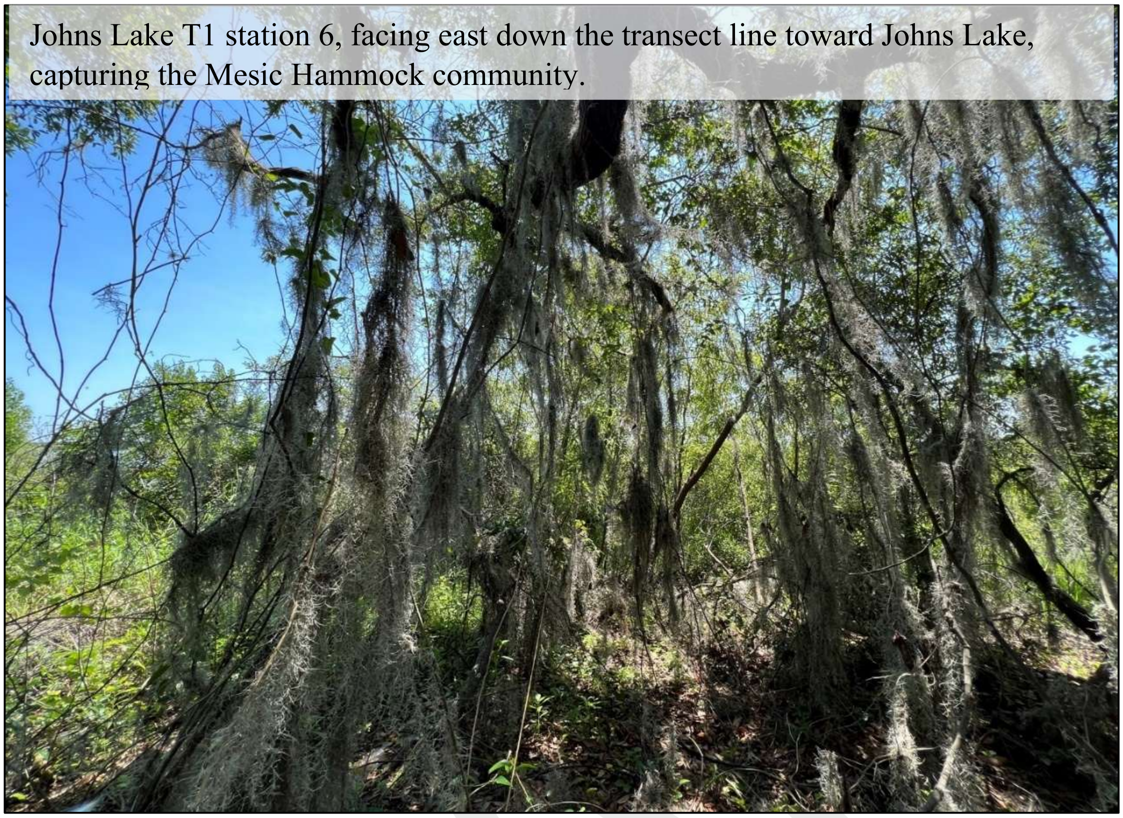
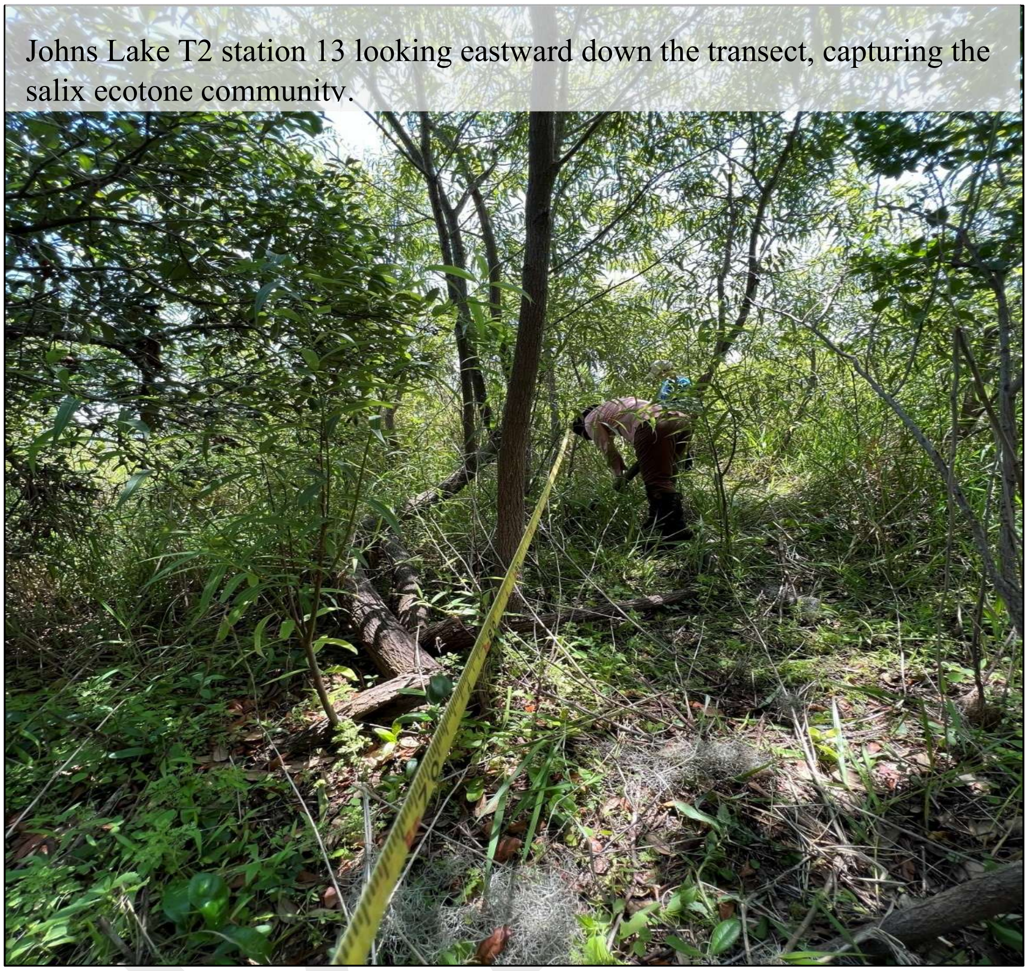


Figure C-8: Johns Lake Transect 2



Johns Lake T2 station 13 looking eastward down the transect, capturing the salix ecotone community.

Figure C-8 continued: Johns Lake Transect 2

Johns Lake T2 station 24, facing north capturing the cephalanthus ecotone community

Johns Lake T2 station 39, facing north showing the landward edge of the deep marsh floating community

Figure C-8 continued: Johns Lake Transect 2

Table C-7: Vegetation species list with cover estimate and NWPL code for Transect 2.

Scientific Name	Common Name	Community[1]	MH	UT	SE	CE	CS2	DMT	DMF
		Start (m)	0	4	11	20	25	31	39
		End (m)	4	11	20	25	31	39	74
		NWPL Code[2]	Plant Species Cover Estimates[3]						
Ambrosia artemisiifolia	ragweed	FACU			x				
Baccharis halimifolia	saltbush	FAC			2				
Callicarpa americana	American beautyberry	FACU		x					
Cephalanthus occidentalis	buttonbush	OBL				3	4		
Cirsium horridulum	bristle thistle	FAC		x	1				
Commelina diffusa	climbing dayflower	FACW			x				
Cornus foemina	stiff dogwood	FACW			x				
Cyperus haspan	haspan flatsedge	OBL				x			
Cyperus lecontei	Le Conte's flatsedge	FACW			1	2			
Diospyros virginiana	common persimmon	FAC		1	x				
Diodia virginiana	Virginia buttonweed	FACW		x	2	x			
Erechtites hieraciifolius	American burnweed	FAC		1	1				
Eupatorium capillifolium	dogfennel	FACU		2	2				
Galactia elliottii	Elliott's milkpea	FACU	1	1	1				
Hydrocotyle umbellata	dollarweed	OBL			1	x	x		
Hydrilla verticillata	waterthyme	OBL						x	
Leersia hexandra	southern cutgrass	OBL			1				
Ludwigia suffruticosa	shrubby primrose willow	OBL				1			
Mikania scandens	climbing hempvine	FACW		x	1	x			
Nuphar advena	spatterdock	OBL							2

Scientific Name	Common Name	Community[1]	MH	UT	SE	CE	CS2	DMT	DMF
		Start (m)	0	4	11	20	25	31	39
		End (m)	4	11	20	25	31	39	74
		NWPL Code[2]	Plant Species Cover Estimates[3]						
Nymphaea odorata	white water-lily	OBL							3
Panicum hemitomon	maidencane	OBL		x	3	2			
Panicum repens	torpedo grass	FACW			3	5	4	2	2
Persicaria hirsuta	hairy smartweed	OBL							
Persea palustris	swamp bay	FACW	1						
Phyla nodiflora	turkey tangle frog-fruit	FAC		x	2	1			
Pontederia cordata	pickerelweed	OBL				1			
Ptilimnium capillaceum	herbwilliam	OBL		x					
Quercus virginiana	live oak	FACU	5						
Sagittaria lancifolia	lanceleaf arrowhead	OBL			1	1	2	1	
Salix caroliniana	Carolina willow	OBL		1	4	1			
Serenoa repens	saw palmetto	FACU	6	1					
Smilax auriculata	greenbrier	FACU	1	2					
Solanum americanum	black nightshade	FACU		1	x				
Sporobolus bakeri	marsh grass	FACW				x			
Typha domingensis	southern cattail	OBL				1		3	x
Urena lobata	Caesar’s weed	FAC		2	2				
Urochloa mutica	para grass	FACW		1	4	x			
Vigna luteola	hairy cowpea	FACW		x	x				
Vitis rotundifolia	muscadine grape	FAC	2	2	2				

[1]**Community:** MH = Mesic Hammock, UT = Upland Transition, SE = Salix Ecotone, CE = Cephalanthus Ecotone, CS2 = Cephalanthus Shrub 2, DMT = Deep Marsh Typha, DMF = Deep Marsh Floating

[2]**NWPL** codes are taken from the National Wetland Plant List (NWPL; USDA NRCS 2016). Species not listed or almost always occur in non-wetlands under natural conditions are considered **Upland (UPL)**. **Facultative Upland (FACU) –** Plants usually occurring in non-wetlands but occasionally found in wetlands. **Facultative (FAC)** – Plants with similar likelihood of occurring in both wetlands and uplands. **Facultative Wet (FACW)** – Plants that typically exhibit their maximum cover in areas subject to surface water flooding and/or saturation but may also occur in uplands. **Obligate (OBL)** – Plants that are found or achieve their greatest abundance in an area that is subject to surface water flooding and/or saturation; rarely occur in uplands.

[3]**Plant Species Cover Estimates:** Areal extent of vegetation species along the transect within a given vegetation community where X=<1%, 1=1 to 5%, 2=5 to 25%, 3=25 to 50%, 4=50 to 75%, 5=75 to 95% and 6=95-100%.

T2 Soils

Mapped Soils: The NRCS's (websoilsurvey.nrcs.usda.gov) SSURGO (Soil Survey Geographic Database) data suggests that Candler sand, 5 to 12% percent slopes is the predominant soil map unit present at Transect 2 (Figure C-6). It is an excessively-drained, rapidly permeable hyperthermic, uncoated Lamellic Quartzipsamments soil that forms in eolian and marine sands.

On-site Soil Descriptions: Soil profiles were collected at two-meter intervals along the transect and their hydric soil indicators (or lack thereof) were reported. Detailed descriptions were recorded at three stations along Transect 2: stations 6 (97.78 ft NAVD88), 10 (96.99 ft NAVD88), and 24 (94.34 ft NAVD88). Table C-8 presents the data gathered during these descriptions. Hydric soils were first encountered at station 6 due to indicator S6, Stripped Matrix, occurring within the first six inches of the soil sample. The maximum SHWT observed on this transect was approximately 97.16 ft NAVD88 (Table C-8).

Table C-8: Johns Lake Transect 2 detailed soil descriptions.

Station (m) / Elevation (ft NAVD88)	Vegetation Community	Hydric Soil Indicator / SHWT (in. below surface)	Horizon	Depth (in.)	Matrix (Hue, Value/Chroma)	Texture	Notes
Station 6 97.78 ft	Mesic Hammock		Oe	+1-0	7.5YR 2.5/2	Mucky Peat	None
			A1	0-4	10YR 5/1	Sand	Mottle: 10YR 2/1, 30%, sharp round
			A2	4-7.5	10YR 4/1	Sand	Mottle: 10YR 2/1, 20%, sharp round; Mottle: 10YR 6/1, 15%, clear round
		Seasonal High Water Table (SHWT) at 7.5"	E1	7.5-14	10YR 5/1	Sand	Mottle: 10YR 3/1, 10%, diffuse round; Depletion: 10YR 6/1, 20%, diffuse round
			E2	14-32	10YR 4/1	Sand	Depletion: 10YR 5/1, 15%, diffuse round; Mottle: 10YR 3/1, 5%, diffuse round
			Bh1	32-39	10YR 2/2	Sand	None
			Bh2	39-46	7.5YR 2.5/2	Sand	Depletion: 10YR 4/3, 10%, diffuse round
			Bh3	46-59	7.5YR 3/3	Sand	Depletion: 7.5YR 4/2, 10%, diffuse round
			C	59-64	10YR 4/3	Sand	None
Station 10 96.99 ft	Upland Transition		Oe	+0.5-0	7.5YR 2.5/2	Mucky Peat	None
			A	0-5.5	10YR 4/1	Sand	Mottle: 10YR 6/1, 15%, clear round; Mottle: 10YR 2/1, 5%, sharp round; Mottle: 10YR 3/1, 15%, clear round
		Stripped Matrix (S6)	E1	5.5-10.5	10YR 4/1	Sand	Depletion: 10YR 5/1, 10%, diffuse round; Mottle: 10YR 3/1, 15%, diffuse round; Mottle: 10YR 6/1, 7%, clear round
			E2	10.5-13	10YR 5/1	Sand	Depletion: 10YR 6/1, 20%, diffuse round; Mottle: 10YR 3/1, 10%, diffuse round
Station 24 94.34 ft	Cephalanthus Transition	Muck Presence (A8), Polyvalue Below Surface (S8) / AAGS	Oa	0-1.5	10YR 2/1	Muck	None
		Stripped Matrix (S6)	E1	1.5 - 4.25	10YR 4/1	Sand	Mottle: 10YR 3/1, 30%, diffuse round; Depletion: 10YR 5/1, 10%, diffuse round; Mottle: 10YR 7/1, 5%, clear round
			E2	4.25 - 9	10YR 4/1	Sand	Mottle: 10YR 3/1, 20%, diffuse round; Depletion: 10YR 5/1, 25%, diffuse round
			E3	9-13.5	10YR 5/1	Sand	Depletion: 10YR 6/1, 30%, diffuse round; Mottle: 10YR 3/1, 10%, diffuse round

Transect 3

<u>T3 Location</u>

Transect 3 was located south of Magnolia Island Blvd on a peninsula extending into Johns Lake's west lobe (Figure C-9). The transect was 52m in length. This section of land is referred to as Magnolia Island, though it is not an island. Transect 3 is west of Transect 4 and southwest of Transect 5. This transect included two turns to follow the downslope gradient of the lake. At 29.5 m, the transect turned 62° to the east and continued until reaching 46 m, where it turned 52° to the west. It was 52m in length.

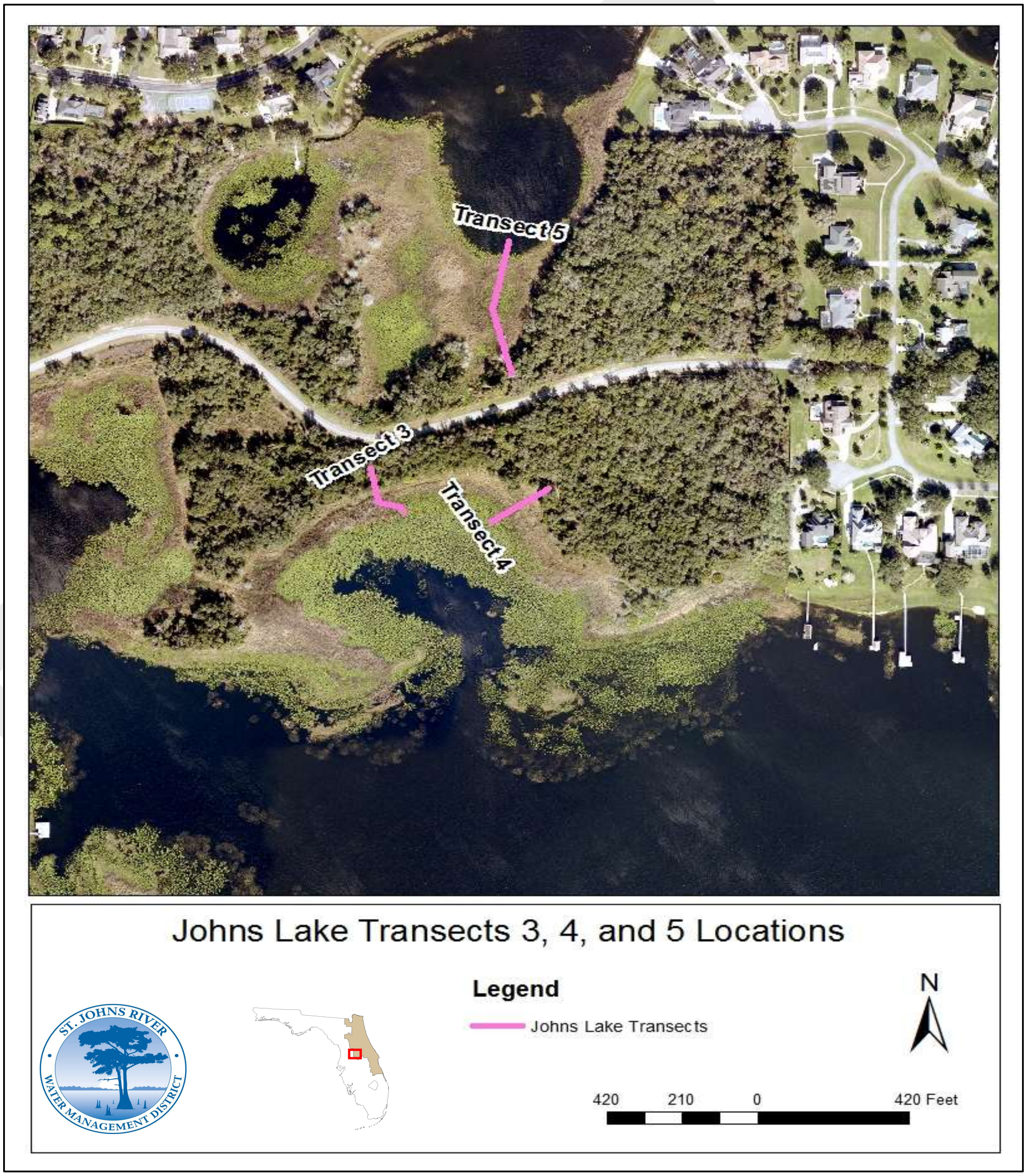


Figure C-9: Transects 3, 4, and 5 locations.

T3 Vegetation

Transect 3 began south of Magnolia Island Blvd and west of the Magnolia Island neighborhood in a mesic hammock community (stations 0-9). It traversed in a southerly direction across Ecotone 1 (stations 9-17), Ecotone 2 (stations 17-19), a shallow marsh (stations 19-23), a cattail marsh (stations 23-41), Cephalanthus Shrub 2 (stations 41-46), then ended in a deep marsh (stations 46-52) (Figure C-10; Table C-9; Figure C-11; Table C-10). This transect did not terminate in open water.

At Transect 3, the mesic hammock (stations 0-9) overstory vegetation included dominant live oak, numerous common persimmon, and scattered swamp bay. In the mid-canopy and understory of the mesic hammock, saw palmetto was abundant, and muscadine grape and greenbrier were scattered. Whip nutrush (*Scleria triglomerata*) and Elliott's milkpea were present.

The second community on Transect 3 was Ecotone 1 (stations 9-17). The overstory in Ecotone 1 was abundant live oak. Ecotone 1's mid-canopy and understory vegetation included co-dominant common persimmon and abundant muscadine grape. Greenbrier, Elliot's milkpea, and invasive Caesar's weed were all scattered. Saw palmetto was located at the beginning of this zone and was rare and maidencane was rare.

The third community on Transect 3 was Ecotone 2 (stations 17-19). Ecotone 2 has no overstory vegetation, but its mid-canopy and understory vegetation included numerous maidencane, St. Augustine grass (*Stenotaphrum secundatum*), and Elliott's milkpea. Climbing hempvine was scattered in this zone while common persimmon, dogfennel, torpedo grass, muscadine grape, greenbrier, American burnweed, blue maidencane (*Amphicarpum muehlenbergianum*), saltmarsh morning glory (*Ipomoea sagittata*), ragweed and alligatorweed (*Alternanthera philoxeroides*) were rare. Despite its short length, this zone had the highest vegetative species richness along Transect 3.

The fourth community was a shallow marsh (stations 19-23). The shallow marsh had no overstory vegetation, but its mid-canopy and understory vegetation was co-dominated by rush fuirena (*Fuirena scirpoidea*). This zone had scattered blue maidencane, torpedo grass, and maidencane. Elliott's milkpea, buttonbush, saltbush, southern cattail, and were rare in this zone.

The fifth community along this transect was a cattail marsh (stations 23-41). There was no overstory vegetation, but southern cattail was dominant in the mid-canopy and buttonbush was abundant.

The sixth community was a cephalanthus shrub, labeled Cephalanthus Shrub 2 (stations 41-46). This zone had no overstory vegetation, but buttonbush and white water-lily were co-dominant, and southern cattail was scattered.

The seventh and final community for which vegetation data was collected on Transect 3 was a floating deep marsh (stations 46-52). This zone had no overstory vegetation, and white water-lily was dominant while slim spikerush (*Eleocharis elongata*) was rare.

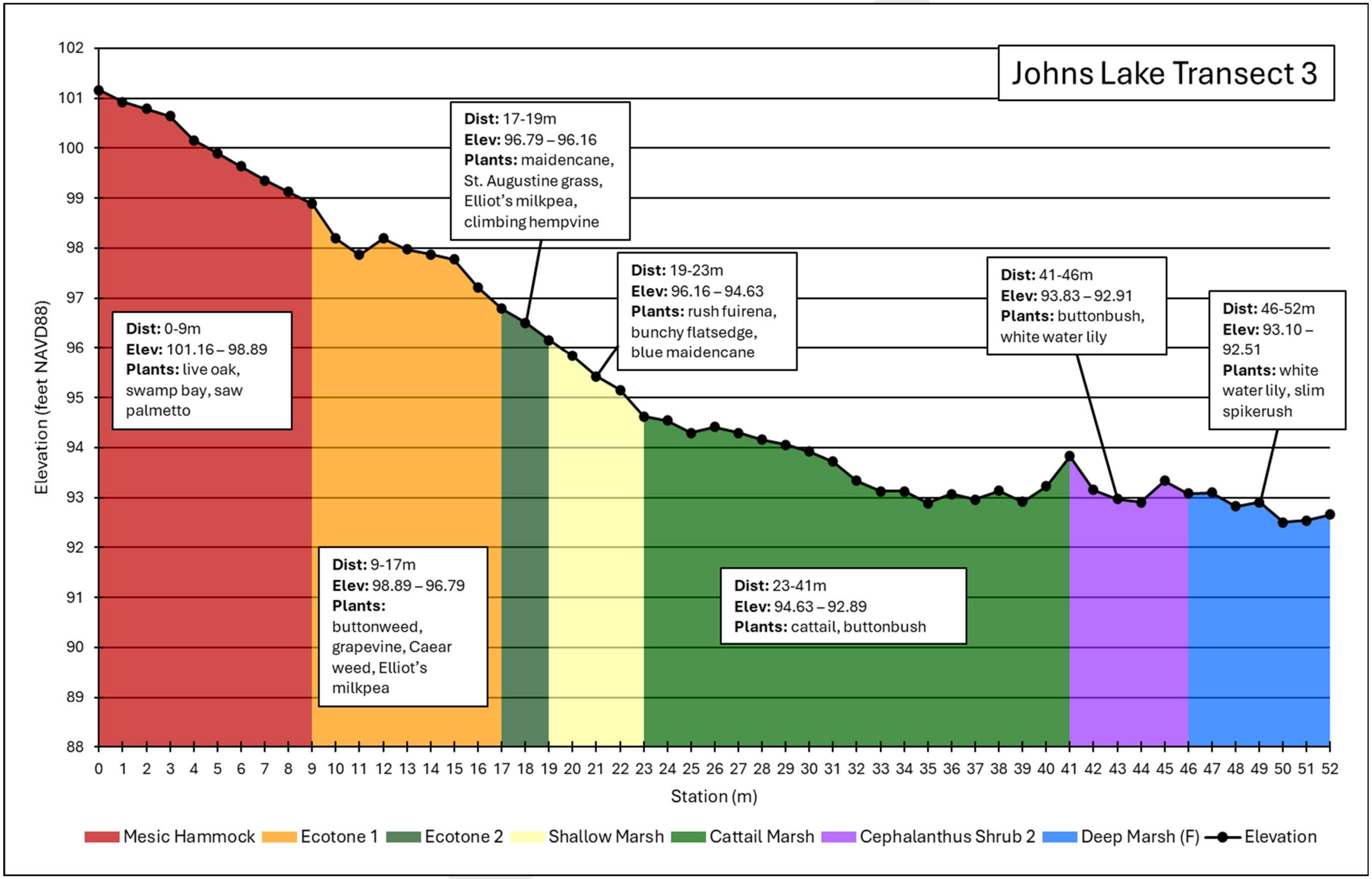
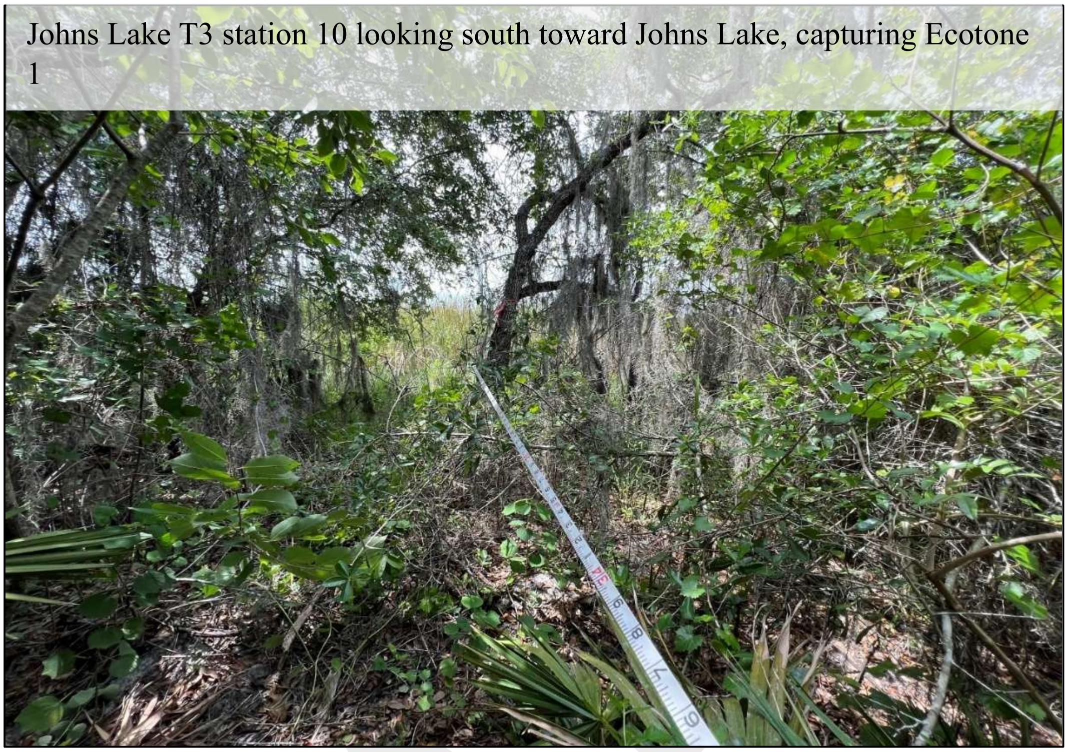


Figure C-10: Johns Lake Transect 3 with topography and vegetation communities.

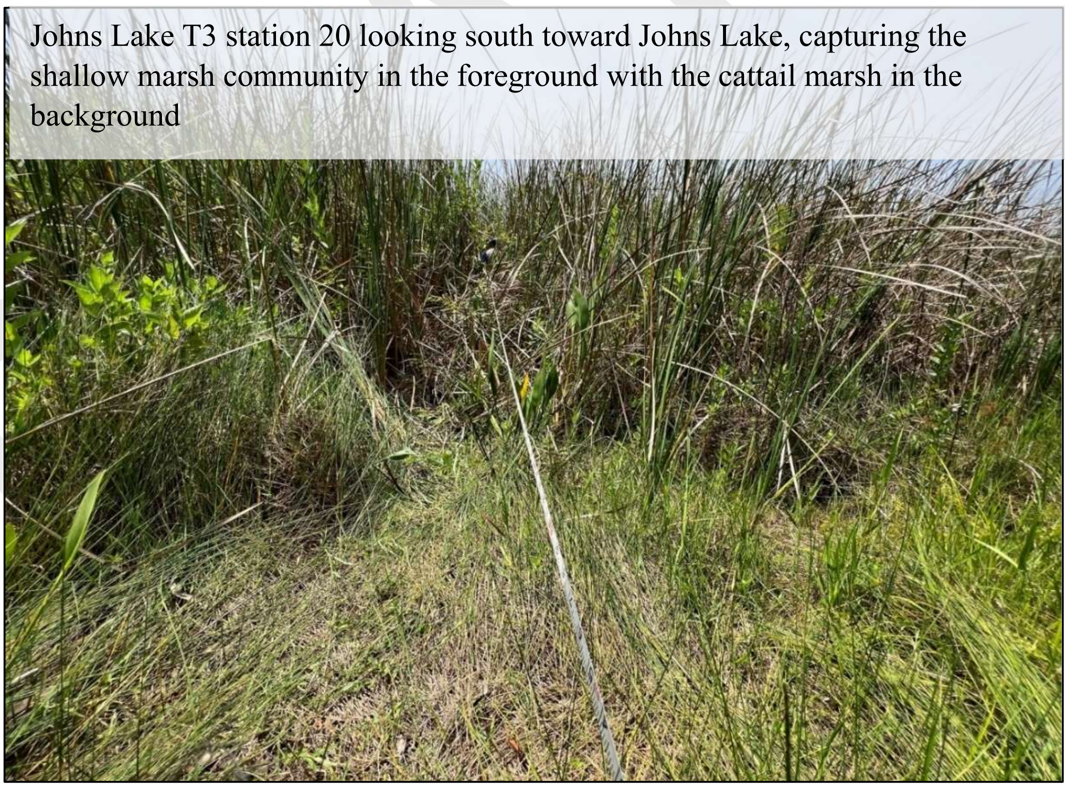
Table C-9. Johns Lake Transect 3 vegetation community statistics.

Transect 3 Vegetation Communities	Station Distance (m)	Mean (ft NAVD 88)	Median (ft NAVD 88)	Min (ft NAVD 88)	Max (ft NAVD 88)
Mesic Hammock	0-9	100.06	100.03	98.89	101.16
Ecotone 1	9-17	97.86	97.88	96.79	98.89
Ecotone 2	17-19	96.48	96.51	96.16	96.79
Shallow Marsh	19-23	95.44	95.43	94.63	96.16
Cattail Marsh	23-41	93.66	93.72	92.89	94.63
Cephalanthus Shrub 2	41-46	93.21	93.12	92.91	93.83
Deep Marsh - Floating	46-52	92.8	92.83	92.51	93.1

Figure C-11: Johns Lake Transect 3.



Johns Lake T3 station 10 looking south toward Johns Lake, capturing Ecotone 1



Johns Lake T3 station 20 looking south toward Johns Lake, capturing the shallow marsh community in the foreground with the cattail marsh in the background

Figure C-11 continued: Johns Lake Transect 3

Johns Lake T3 station 40 looking south toward Johns Lake, capturing the cattail marsh community

Johns Lake T3 station 52 looking east along the lakeshore of Johns Lake in the floating deep marsh community.

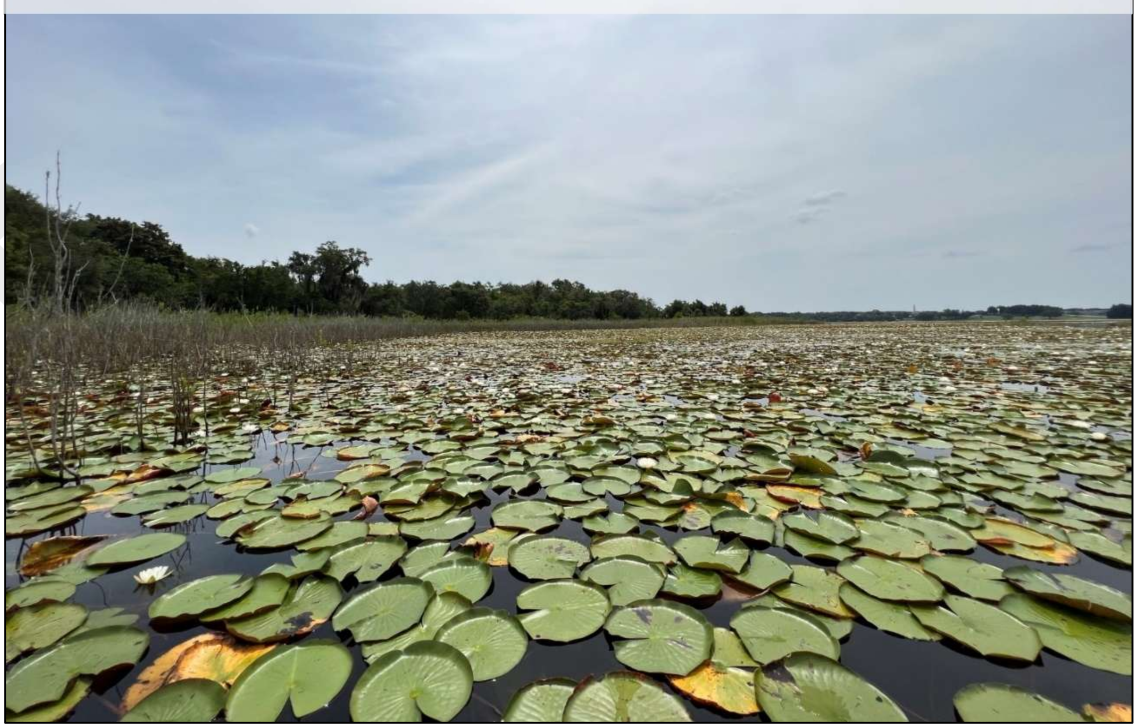


Figure C-11 continued: Johns Lake Transect 3

Table C-10: Vegetation species list with cover estimate and NWPL code for Transect 3.

Scientific Name	Common Name	Community[1]	MH	E1	E2	SM	CM	CS2	DMF
		Start (m)	0	9	17	19	23	41	46
		End (m)	9	17	19	23	41	46	52
		NWPL Code[2]	Plant Species Cover Estimates[3]						
Alternanthera philoxeroides	alligatorweed	OBL			1				
Ambrosia artemisiifolia	ragweed	FACU			1				
Amphicarpum muehlenbergianum	blue maidencane	FACW			1	2			
Baccharis halimifolia	saltbush	FAC				1			
Cephalanthus occidentalis	buttonbush	OBL			x	1	4	5	
Cyperus haspan	haspan flatsedge	OBL				x			
Cyperus lanceolatus	epiphytic flatsedge	FACW				x			
Cyperus polystachyos	bunchy flatsedge	FACW			x				
Diospyros virginiana	common persimmon	FAC	3	4	1				
Eleocharis elongata	slim spikerush	OBL							1
Erechtites hieraciifolius	American burnweed	FAC			1				
Eupatorium capillifolium	dogfennel	FACU			1				
Fuirena scirpoidea	rush fuirena	OBL				5			
Galactia elliottii	Elliott's milkpea	FACU	x	2	3	1			
Ipomoea sagittata	saltmarsh morning glory	FACW			1				
Ludwigia suffruticosa	shrubby primrose willow	OBL			x	x			
Mikania scandens	climbing hempvine	FACW			2				
Nymphaea odorata	white water-lily	OBL						5	6
Panicum hemitomon	maidencane	OBL		1	3	2			
Panicum repens	torpedo grass	FACW			1	2			
Persea palustris	swamp bay	FACW	2						

Scientific Name	Common Name	Community[1]	MH	E1	E2	SM	CM	CS2	DMF
		Start (m)	0	9	17	19	23	41	46
		End (m)	9	17	19	23	41	46	52
		NWPL Code[2]	Plant Species Cover Estimates[3]						
Persicaria hirsuta	hairy smartweed	OBL				x			
Phyla nodiflora	turkey tangle frog fruit	FAC			x	1			
Pontederia cordata	pickerelweed	OBL						x	
Quercus virginiana	live oak	FACU	6	4	x				
Sagittaria lancifolia	lanceleaf arrowhead	OBL				x			
Scleria triglomerata	whip nutrush	FACW	x	x					
Serenoa repens	saw palmetto	FACU	4	1					
Smilax auriculata	greenbrier	FACU	2	2	1				
Stenotaphrum secundatum	St. Augustine grass	FAC			3				
Typha domingensis	southern cattail	OBL				1	6	2	
Urena lobata	Caesar's weed	FAC		2	x				
Vitis rotundifolia	muscadine grape	FAC	2	4	1				

[1]**Community:** MH = Mesic Hammock, E1 = Ecotone 1, E2 = Ecotone 2, SM = Shallow Marsh, CM = Cattail Marsh, CS2 = Cephalanthus Shrub 2, DMF = Deep Marsh Floating

[2]**NWPL** codes are taken from the National Wetland Plant List (NWPL; USDA NRCS 2016). Species not listed or almost always occurring in non-wetlands under natural conditions are considered **Upland (UPL)**. **Facultative Upland (FACU) –** Plants usually occurring in non-wetlands but occasionally found in wetlands. **Facultative (FAC)** – Plants with similar likelihood of occurring in both wetlands and uplands. **Facultative Wet (FACW)** – Plants that typically exhibit their maximum cover in areas subject to surface water flooding and/or saturation but may also occur in uplands. **Obligate (OBL)** – Plants that are found or achieve their greatest abundance in an area that is subject to surface water flooding and/or saturation; rarely occur in uplands.

[3]**Plant Species Cover Estimates:** Areal extent of vegetation species along the transect within a given vegetation community where X=<1%, 1=1 to 5%, 2=5 to 25%, 3=25 to 50%, 4=50 to 75%, 5=75 to 95% and 6=95-100%.

T3 Soils

Mapped Soils: The NRCS's (websoilsurvey.nrcs.usda.gov) SSURGO (Soil Survey Geographic Database) data suggests that Orlando fine sand, 0 to 5 percent slopes is the predominant soil map unit present at Transect 3 (Figure C-6). It is a very deep, well-drained, rapidly permeable, siliceous, hyperthermic humic Psammentic Dystrudepts soil that formed in thick deposits of sandy marine or fluvial sediments.

On-site Soil Descriptions: Soil profiles were collected at two-meter intervals along the transect and their hydric soil indicators (or lack thereof) were reported. Detailed descriptions were recorded at three stations along Transect 3: stations 4 (100.16 ft NAVD88), 18 (96.51 ft NAVD88), and 24 (94.54 ft NAVD88). Table C-11 presents the data gathered during these descriptions. Hydric soils were first encountered at station 18 because indicator A6, Organic Bodies, was present. The maximum SHWT observed on this transect was approximately 99.41 ft NAVD88.

Table C-11: Johns Lake Transect 3 detailed soil descriptions.

Station (m) / Elevation (ft NAVD88)	Vegetation Community	Hydric Soil Indicator / SHWT (in. below surface)	Horizon	Depth (in.)	Matrix (Hue, Value/Chroma)	Texture	Notes
Station 4 100.16 ft	Mesic Hammock		Oe	+2.5-0	7.5 YR 2.5/2	Mucky Peat	None
			A	0-9	10YR 4/1	Sand	None
		Seasonal High-Water Table (SHWT at 9"	E	9-14	10YR 5/1	Sand	Depletion: 10YR 6/1, 15%, diffuse round
			Bh	14-32	10YR 2/2	Sand	None
			Ci	32-41	10YR 4/3	Sand	None
			Cg2	41-49	2.5Y 5/3	Sand	Depletion: 2.5Y 6/3, 10% diffuse round; Mottle: 10YR 3/3, 10%, diffuse round
			C	49-58	2.5Y 5/3	Sand	Depletion: 2.5Y 6/2, 25%, diffuse round; Redox concentration: 10YR 5/6, 15%, diffuse round
			Cg2	58-65	2.5Y 6/2	Sand	Mottle: 2.5Y 6/6, 40%, diffuse round
Station 18 96.51 ft	Ecotone 2	Organic Bodies (A6) / At or Above Ground Surface (AAGS	A	0-3	10YR 5/1	Sand	Mottle: 10YR 2/1, 30%, sharp round; Organic bodies: 10YR 2/1, 10%, mucky mineral
			E1	3-5	10YR 4/1	Sand	Mottle: 10YR 6/1, 10%, clear round; Mottle: 10YR 2/1, 20%, sharp round
		Stripped Matrix (S6)	E2	5-8.5	10YR 4/1	Sand	Depletion: 10YR 5/1, 10%, diffuse round; Mottle (dead root): 10YR 2/1, 10%, clear round
			E3	8.5-16	10YR 6/1	Sand	Depletion: 10YR 7/1, 20%, diffuse round; Mottle: 10YR 4/1, 7%, diffuse round

Station (m) / Elevation (ft NAVD88)	Vegetation Community	Hydric Soil Indicator / SHWT (in. below surface)	Horizon	Depth (in.)	Matrix (Hue, Value/Chroma)	Texture	Notes
Station 24 94.54 ft	Cattail Marsh	Muck Presence (A8), Polyvalue Below Surface (S8) / AAGS	Oa	0-0.25	10YR 2/1	Muck	None
		Stripped Matrix (S6)	E	0.25-2	10YR 5/1	Sand	Depletion: 10YR 6/1, 10%, diffuse round; Mottle: 10YR 3/1, 15%, diffuse round
			Oab	2-3	10YR 2/1	Muck	Inclusion: 10YR 4/1, sand, 10%; Inclusion: 10YR 2/1, sand, 10%
			E1	3-4.75	10YR 5/1	Sand	Depletion: 10YR 6/1, 20%, diffuse round; Mottle: 10YR 2/1, 15%, diffuse round; Mottle: 10YR 4/1, 10%, diffuse round
			E2	4.75-11.5	10YR 5/1	Sand	Depletion: 10YR 6/1, 30%, diffuse round; Mottle: 10YR 3/1, 10%, diffuse round
			E3	11.5-15	10YR 4/1	Sand	Depletion: 10YR 5/1, 15%, diffuse round' Mottle: 10YR 2/1, 15%, diffuse round

Transect 4

T4 Location

Transect 4 was located south of Magnolia Island Blvd on a peninsula that extends into the west side of Johns Lake's west lobe. This section of land is referred to as Magnolia Island, though it is not an island. The transect was 51 m in length and was surveyed on 5/30/2023. Transect 4 is east of Transect 3 and south of Transect 5 (Figure C-9).

T4 Vegetation

Transect 4 began south of Magnolia Island Blvd, east of Transect 3, and started in a mesic hammock community (stations 0-6). It traversed in a southerly direction across Ecotone 1 (stations 6-16), Ecotone 2 (stations 16-27), a shallow marsh (stations 27-30), Cephalanthus Shrub 1 (stations 30-40). The Cephalanthus Shrub 1 community was determined to be distinct from Cephalanthus Shrub 2, because it occurred at a higher elevation. This transect ended in Cephalanthus Shrub 2 (stations 40-51) and did not extend into open water (Figure C-12; Table C-12; Figure C-13; Table C-13).

At Transect 4, the mesic hammock (stations 0-9) overstory vegetation included codominant live oak, scattered myrtle oak (*Quercus myrtifolia*), and rare laurel oak (*Quercus laurifolia*). In the mid-canopy and understory of the mesic hammock, saw palmetto was abundant, while muscadine grape, greenbrier, shiny blueberry (*Vaccinium myrcinites*), and hemlock witchgrass (*Dicanthelium portoricense*) were scattered. Common persimmon, winged sumac (*Rhus copallinum*), and deerberry (*Vaccinium staminium*) were rare.

The second community on Transect 4 was Ecotone 1 (stations 6-16). This zone had no overstory vegetation, but blue maidencane was codominant in the understory. Hemlock witchgrass and grass-leaved rush (*Juncus marginatus*) were scattered. American burnweed, shortspike bluestem (*Andropogon brachystachyus*), and largeflower rose gentian (*Sabatia grandiflora*) were rare.

The third community was Ecotone 2 (stations 16-27). This zone had no overstory vegetation, but coinwort and Carolina redroot (*Lachnanthes caroliana*) were codominant in the understory. Marsh grass was numerous and blue maidencane, para grass, rush fuirena, and Muehlenberg's nutrush (*Scleria muehlenbergii*) were scattered. Buttonbush, wax myrtle (Morella cerifera), and maidencane were rare.

The fourth community was a shallow marsh (stations 27-30). Coinwort and rush fuirena were codominant in this zone and Carolina redroot was abundant. Muehlenberg's nutrush was scattered; blue maidencane, torpedo grass, and maidencane were rare.

The fifth community was Cephalanthus Shrub 1 (stations 30-40). There was no overstory, but the midstory was primarily buttonbush which was abundant, and the understory had numerous lanceleaf arrowhead, scattered marsh grass, and rare torpedo grass, dollarweed, and pickerelweed.

The sixth and final community for which vegetation species data was recorded on Transect 4 was Cephalanthus Shrub 2 (stations 40-51). This community had no overstory vegetation, but the mid-story and understory contained numerous buttonbush and codominant white water-lily.

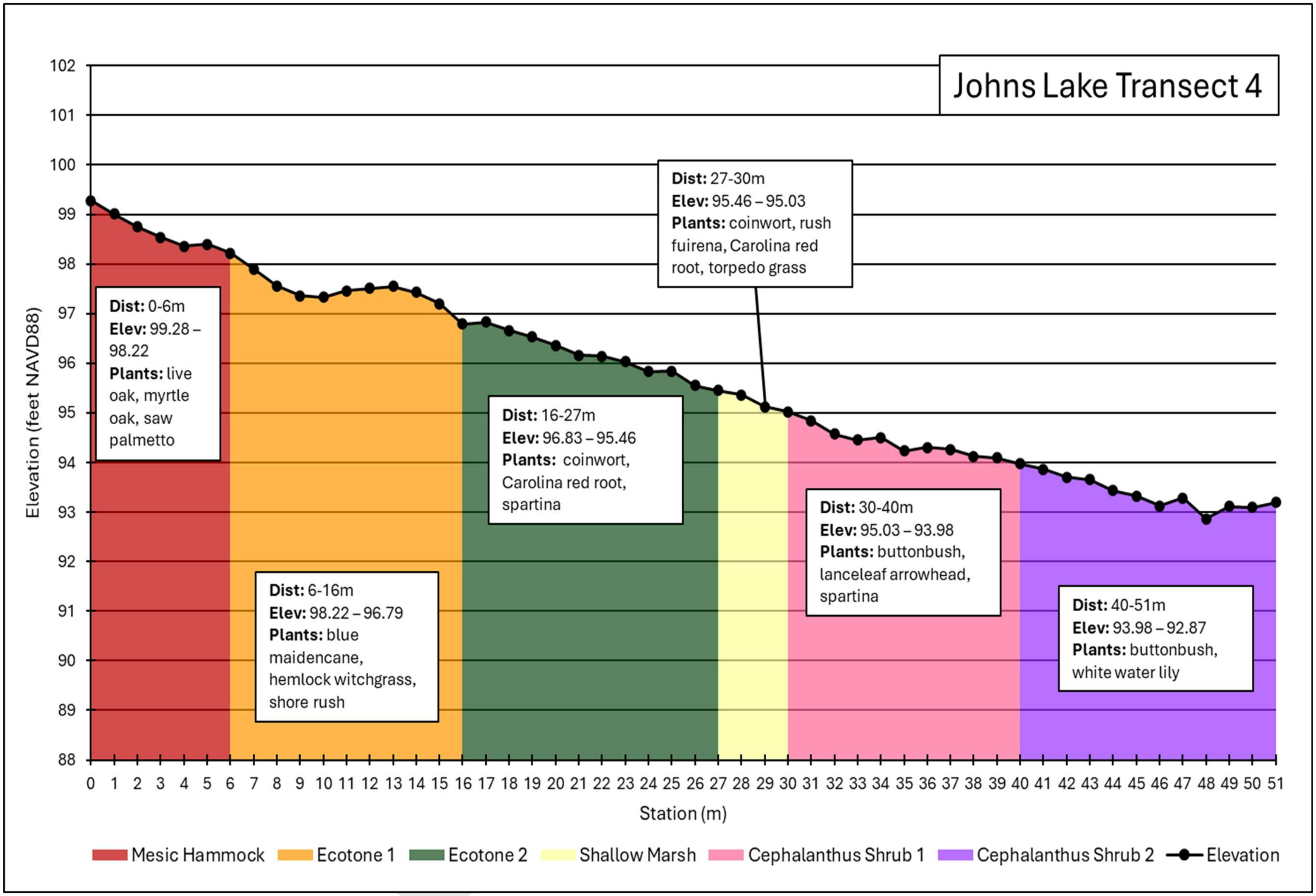


Figure C-12: Johns Lake Transect 4 with topography and vegetation communities.

Table C-12: Johns Lake Transect 4 vegetation community statistics.

Transect 4 Vegetation Community	Station Distance (m)	Mean (ft NAVD 88)	Median (ft NAVD 88)	Min (ft NAVD 88)	Max (ft NAVD 88)
Mesic Hammock	0-6	98.65	98.54	98.22	99.28
Ecotone 1	6-16	97.48	97.46	96.79	98.22
Ecotone 2	16-27	96.18	96.16	95.46	96.83
Shallow Marsh	27-30	95.24	95.25	95.03	95.46
Cephalanthus Shrub 1	30-40	94.4	94.31	93.98	95.03
Cephalanthus Shrub 2	40-51	93.39	93.31	92.87	93.98

Figure C-13: Johns Lake Transect 4.

Johns Lake T4 station 10 looking west toward Johns Lake in Ecotone 1

Johns Lake T4 station 20 looking west toward Johns Lake in Ecotone 2

Figure C-13: continued: Johns Lake Transect 4.

Johns Lake T4 station 30 looking south along the lakeshore of Johns Lake in the Cephalanthus Shrub 1 community.

Johns Lake T4 station 40 looking southwest down the transect, capturing the Cephalanthus shrub 2 community.

Figure C-13 continued: Johns Lake Transect 4.

Table C-13: Vegetation species list with cover estimate and NWPL code for Johns Lake Transect 4.

Scientific Name	Common Name	Community[1]	MH	E1	E2	SM	CS1	CS2
		Start (m)	0	6	16	27	30	40
		End (m)	6	16	27	30	40	51
		NWPL Code[2]	Plant Species Cover Estimates[3]					
Amphicarpum muehlenbergianum	blue maidencane	FACW	1	5	2	1		
Andropogon brachystachyus	shortspike bluestem	FAC		1				
Andropogon virginicus var. decipiens	broomsedge bluestem	FAC	x					
Centella asiatica	coinwort	FACW			5	5		
Cephalanthus occidentalis	buttonbush	OBL			1	x	4	3
Cyperus lanceolatus	epiphytic flatsedge	FACW		x				
Dicanthelium portoricense	hemlock witchgrass	FACU	2	2				
Diospyros virginiana	common persimmon	FAC	1		x			
Eleocharis elongata	slim spikerush	OBL						x
Emilia fosbergii	Florida tassleflower	UPL		x				
Erechtites hieraciifolius	American burnweed	FAC		1				
Eupatorium capillifolium	dogfennel	FACU		x				
Eupatorium leptophyllum	false fennel	FACW				x		
Fimbrystilis caroliniana	Carolina fimbry	OBL			x			
Fuirena scirpoidea	rush fuirena	OBL			2	5		
Hydrocotyle umbellata	dollarweed	OBL				x	1	
Ipomoea sagittata	saltmarsh morning glory	FACW			x			
Juncus marginatus	grass-leaved rush	FACW		2				
Lachnanthes caroliana	Carolina redroot	OBL		x	5	4		
Lyonia fruticosa	Coastal plain staggerbush	FACW	x					

Scientific Name	Common Name	Community[1]	MH	E1	E2	SM	CS1	CS2
		Start (m)	0	6	16	27	30	40
		End (m)	6	16	27	30	40	51
		NWPL Code[2]	Plant Species Cover Estimates[3]					
Morella cerifera	wax myrtle	FAC			1			
Nymphaea odorata	white water-lily	OBL						5
Panicum hemitomon	maidencane	OBL			1	1	1	
Panicum repens	torpedo grass	FACW			x	1	1	x
Pontederia cordata	pickerelweed	OBL					1	
Quercus laurifolia	laurel oak	FACW	1					
Quercus myrtifolia	myrtle oak	UPL	2					
Quercus virginiana	live oak	FACU	5					
Rhexia sp.	meadow beauty	FACW			1	x		
Rhus copallinum	winged sumac	UPL	1					
Rhynchospora fasicularis	fascicled beaksedge	FACW			x			
Sabatia grandiflora	largeflower rose gentian	FACW		1				
Sabal palmetto	cabbage palm	FAC			x			
Sagittaria lancifolia	lanceleaf arrowhead	OBL					3	
Scleria muehlenbergii	Muehlenberg's nutrush	OBL			2	2		
Scleria triglomerata	whip nutrush	FACW	x					
Serenoa repens	saw palmetto	FACU	4	x				
Smilax auriculata	greenbrier	FACU	2					
Sporobolus bakeri	marsh grass	FACW		x	3		2	x
Spergularia echinosperma	bristleseed sandspurry	OBL		x	x			
Urochloa mutica	para grass	FACW			2			
Vaccinium myrcinites	shiny blueberry	FACU	2					
Vaccinium staminium	deerberry	FACU	1					

Scientific Name	Common Name	Community[1]	MH	E1	E2	SM	CS1	CS2
		Start (m)	**0**	**6**	**16**	**27**	**30**	**40**
		End (m)	**6**	**16**	**27**	**30**	**40**	**51**
		NWPL Code[2]	**Plant Species Cover Estimates[3]**					
Vitis rotundifolia	muscadine grape	FAC	2					

[1]**Community:** MH = Mesic Hammock, E1 = Ecotone 1, E2 = Ecotone 2, SM = Shallow Marsh, CS1 = Cephalanthus Shrub 1, CS2 = Cephalanthus Shrub 2

[2]**NWPL** codes are taken from the National Wetland Plant List (NWPL; USDA NRCS 2016). Species not listed or almost always occur in non-wetlands under natural conditions are considered **Upland (UPL)**. **Facultative Upland (FACU) –** Plants usually occurring in non-wetlands but occasionally found in wetlands. **Facultative (FAC)** – Plants with similar likelihood of occurring in both wetlands and uplands. **Facultative Wet (FACW)** – Plants that typically exhibit their maximum cover in areas subject to surface water flooding and/or saturation but may also occur in uplands. **Obligate (OBL)** – Plants that are found or achieve their greatest abundance in an area that is subject to surface water flooding and/or saturation; rarely occur in uplands.

[3]**Plant Species Cover Estimates:** Areal extent of vegetation species along the transect within a given vegetation community where X=<1%, 1=1 to 5%, 2=5 to 25%, 3=25 to 50%, 4=50 to 75%, 5=75 to 95% and 6=95-100%.

T4 Soils

Mapped Soils: The NRCS's (websoilsurvey.nrcs.usda.gov) SSURGO (Soil Survey Geographic Database) data suggest that Orlando fine sand, 0 to 5 percent slopes is the predominant soil map unit present at Transect 4 (Figure C-6). It is a very deep, well-drained, rapidly permeable, siliceous, hyperthermic humic Psammentic Dystrudepts soil that formed in thick deposits of sandy marine or fluvial sediments.

On-site Soil Descriptions: Soil profiles were collected at two-meter intervals along the transect and their hydric soil indicators (or lack thereof) were reported. Detailed descriptions were recorded at three stations along Transect 4: stations 6 (98.22 ft NAVD88), 24 (95.84 ft NAVD88), and 32 (94.58 ft NAVD88). Table C-14 presents the data gathered during these descriptions. Hydric soils were first encountered at station 24 because indicator S8, Polyvalue Below Surface, was present. The maximum SHWT observed on this transect was approximately 96.18 ft NAVD88 (Table C-14).

Table C-14: Johns Lake Transect 4 detailed soils descriptions.

Station (m) / Elevation (ft NAVD88)	Vegetation Community	Hydric Soil Indicator / SHWT (in. below surface)	Horizon	Depth (in.)	Matrix (Hue, Value/Chroma)	Texture	Notes
Station 6 98.22 ft	Ecotone 1		A1	0-3	10YR 4/1	Sand	Mottle: 10YR 2/1, 35%, sharp round; Mottle: 10YR 5/1, 10%, sharp round; Inclusion: Mucky Peat, 7.5YR 2.5/2, 20%
			A2	3-9.5	10YR 5/1	Sand	Mottle: 10YR 2/1, 25%, sharp round; Mottle: 10YR 4/1, 15%, clear round
			A3	9.5-12	10YR 3/1	Sand	Organic carbon less than 50%; Mottle: 10YR 5/1, 30%, clear round; Mottle: 10YR 2/1, 10%, sharp round; Mottle: 10YR 6/1, 10%, clear round
			A4	12-24.5	10YR 3/1	Sand	Organic carbon less than 50%
		Seasonal High-Water Table (SHWT at 24.5"	E1	24.5-31	10YR 4/1	Sand	Depletion: 10YR 5/1, 15%, diffuse round
			E2	31-38	10YR 5/2	Sand	Depletion: 2.5Y 6/2, 20%, diffuse round
			E3	38-47	2.5Y 6/2	Sand	Depletion: 2.5Y 7/2, 10%, diffuse round
			C	47-70	2.5Y 7/2	Sand	None
Station 24 95.84 ft	Ecotone 2	Muck Presence (A8) / At or Above Ground Surface (AAGS	Oa	0-0.2	10YR 2/1	Muck	None
		Organic Bodies (A6)	A	0.2-1	10YR 3/1	Sand	Organic bodies: Mucky, 10%; Mottle: 10YR 2/1, 25%, sharp round; Mottle: 10YR 6/1, 25%, sharp round; Organic carbon less than 25%
			E	1-4.5	10YR 4/1	Sand	Mottle: 10YR 2/1, 20%, clear round; Depletion: 10YR 5/1, 7%, diffuse round
			Bh1	4.5-9	10YR 3/1	Sand	Organic carbon less than 50%; Mottle: 10YR 6/1, 5%, sharp round, Mottle: 10YR 2/1, 15%, clear round; Depletion: 10YR 4/1, 10%, clear round
		Polyvalue Below Surface (S8)	Bh2	9-14	10YR 2/1	Sand	Organic carbon: 80%; Mottle:10YR 5/1, 2%, clear round

Station (m) / Elevation (ft NAVD88)	Vegetation Community	Hydric Soil Indicator / SHWT (in. below surface)	Horizon	Depth (in.)	Matrix (Hue, Value/Chroma)	Texture	Notes
Station 32 94.58 ft	Cephalanthus Shrub 1	Muck Presence (A8) / AAGS	Oa	0-0.25	10YR 2/1	Muck	None
		Polyvalue Below Surface (S8)	A	0.25-1.5	10YR 4/1	Sand	Organic coating: 95%; Depletion: 10YR 5/1, 7%, diffuse round; Mottle: 10YR 2/1, 40%, sharp round
			Oab	1.5-2.5	10YR 2/1	Muck	Inclusion: 10YR 2/1, 20%, sand, organic coating: 95%
			Ab	2.5-4.5	10YR 2/1	Sand	Organic coating: 95%; Depletion: 10YR 4/1, 15%, clear round; Depletion: 10YR 6/1, 5%, clear round
		Stripped Matrix (S6)	E	4.5-7.25	10YR 4/1	Sand	Depletion: 10YR 5/1, 25%, diffuse round; Mottle: 10YR 2/1, 5%, clear round
			BE	7.25-10.5	10YR 2/2	Sand	Mottle: 10YR 2/1, 25%, diffuse round; Depletion: 10YR 5/2, 20%, diffuse round
			Bh	10.5-14.5	10YR 2/1	Sand	Organic coating: 65%

Transect 5

<u>T5 Location</u>

Transect 5 was located north of Magnolia Island Blvd and on a peninsula extending into the west side of Johns Lake's west lobe. This section of land is referred to as Magnolia Island, though it is not an island. Transect 5 is north of Transect 4 and northeast of Transect 3 (Figure C-9). This transect included one turn to follow the downslope gradient of the lake. At 56 m, the transect turned 29° to the east and continued until reaching its end at 115 m.

<u>T5 Vegetation</u>

Transect 5 began north of Magnolia Island Blvd and west of the Magnolia Island neighborhood in a mesic hammock community (stations 0-9). It traversed in a northerly direction across Ecotone 1 (stations 9-15), Ecotone 2 (stations 15-23), and Cephalanthus Shrub 3 (stations 23-33). Cephalanthus Shrub 3 is a distinct buttonbush community, because it occurs at a higher elevation than the other two buttonbush communities (Cephalanthus Shrub 1 and Cephalanthus Shrub 2). The fifth community was a shallow marsh (stations 33-56), followed by Cephalanthus Shrub 1 (stations 56-69), Sporobolus Shallow Marsh (stations 69-76), Ecotone 3 (stations 76-83), a Cattail Marsh (stations 83 – 98), a Deep Marsh (Floating) (stations 98-112) and ended in open water (stations 112-115) (Figure C-14; Table C-15; Figure C-15, Table C-16).

The first and most upslope community on Transect 5 was a mesic hammock (stations 0-9). It contained an overstory of abundant Darlington oak (*Quercus hemispherica*) and muscadine grape with numerous live oak. The mid-story and understory had abundant saw palmetto and rare sparkleberry (*Vaccinium arboreum*) and winged sumac.

The second community was Ecotone 1 (stations 9-15). This zone had an overstory of numerous live oak and Darlington oak with abundant muscadine grape. In the mid-story and understory, ragweed was numerous, saw palmetto and Caesar's weed were scattered, and greenbrier, herbwilliam, saltbush, American burnweed, wax myrtle, blue maidencane, common persimmon, maidencane, a member of the Scleria genus (Scleria sp.), and American beautyberry (*Callicarpa americana*) were scattered.

The third community was Ecotone 2 (stations 15-23). The overstory had rare live oak. In the mid-story and understory torpedo grass was codominant, and common persimmon, maidencane, Elliott's milkpea, and rosy camphorweed (*Pluchea baccharis*), (formerly *Pluchea rosea*)) were scattered. Blue maidencane, saltbush, lanceleaf arrowhead, cabbage palm, and Carolina redroot were rare.

The fourth community was Cephalanthus Shrub 3 (stations 23-33). No overstory was present in this zone, but the mid-story and understory had dominant buttonbush and numerous Carolina redroot. Additionally, torpedo grass and rosy camphorweed were scattered, while lanceleaf arrowhead and wax myrtle were rare.

The fifth community was a shallow marsh (stations 33-56). This zone had no overstory but had a mid-story and understory with abundant lanceleaf arrowhead, numerous torpedo grass and marsh grass, and scattered buttonbush and maidencane. Carolina redroot, pickerelweed, and hairy smartweed (*Persicaria hirsuta*) were rare.

The sixth community was Cephalanthus Shrub 1 (stations 56 – 69). There was no overstory but in the mid-story and understory, buttonbush and marsh grass were abundant, and maidencane was numerous. Pickerelweed was scattered and torpedo grass and white water-lily were rare.

The seventh community was a Sporobolus shallow marsh community (stations 69-76). This marsh had no overstory, but the mid-story and understory had codominant marsh grass and numerous white water-lily. Maidencane, pickerelweed, and buttonbush were scattered. Southern cutgrass, hairy smartweed and torpedo grass were present.

The eighth community was Ecotone 3 (stations 76-83). This community had no overstory. In the mid-story and understory, marsh grass was abundant, while broadleaf cattail (*Typha latifolia*) and white water-lily were numerous. Buttonbush was scattered and maidencane was rare.

The ninth community was a cattail marsh (stations 83-98). There was no overstory; its mid-story and understory had dominant broadleaf cattail and abundant white water-lily.

The tenth community was a floating deep marsh community (stations 98-112) with no overstory. This zone had codominant white water-lily as its only form of vegetation.

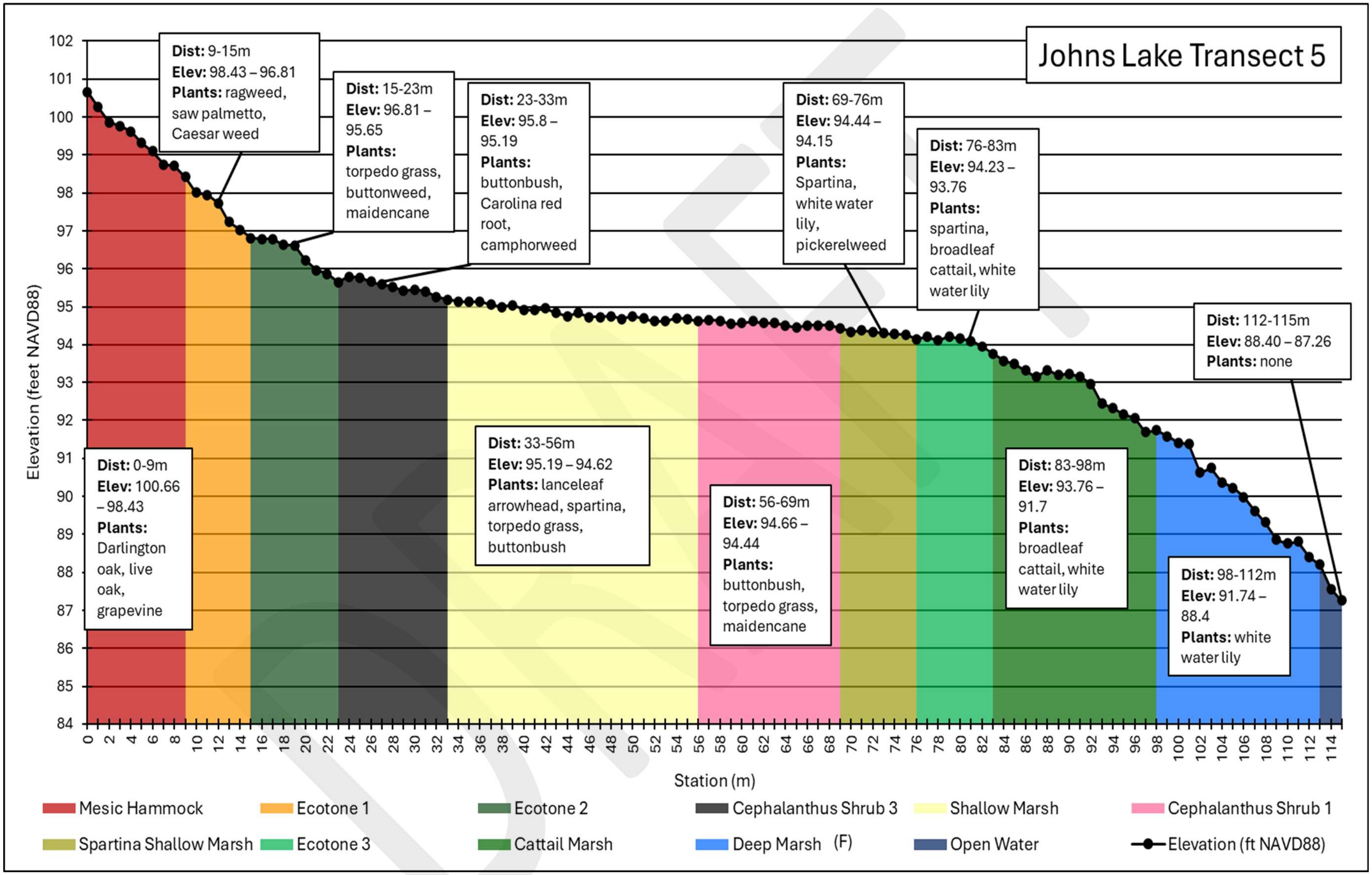


Figure C-14: Johns Lake Transect 5 with topography and vegetation communities.

Table C-15: Johns Lake Transect 5 vegetation community statistics.

Vegetation Community	Station Distance (m)	Mean (ft NAVD 88)	Median (ft NAVD 88)	Min (ft NAVD 88)	Max (ft NAVD 88)
Mesic Hammock	0-9	99.45	99.47	98.43	100.66
Ecotone 1	9-15	97.6	97.74	96.81	98.43
Ecotone 2	15-23	96.37	96.62	95.65	96.81
Cephalanthus Shrub 3	23-33	95.52	95.53	95.19	95.8
Shallow Marsh	33-56	94.85	94.8	94.62	95.19
Cephalanthus Shrub 1	56-69	94.55	94.56	94.44	94.66
Sporobolus Shallow Marsh	69-76	94.31	94.32	94.15	94.44
Ecotone 3	76-83	94.08	94.13	93.76	94.23
Cattail Marsh	83-98	92.85	93.15	91.7	93.76
Deep Marsh - Floating	98-112	90.12	90.23	88.4	91.74

Johns Lake T5 station 0 looking north toward Johns Lake in the Mesic Hammock community.

Johns Lake T5 station 10 looking north toward Johns Lake, capturing Ecotone 1

Figure C-15: Johns Lake Transect 5.

Johns Lake T5 station 20 looking north toward Johns Lake, capturing Ecotone 2 in the foreground and Cephalanthus Shrub 3 in the background

Johns Lake T5 station 30 looking north toward Johns Lake, capturing Cephalanthus Shrub 3

Figure C-15 continued: Johns Lake Transect 5.

Johns Lake T5 station 50 looking north toward Johns Lake, capturing the shallow marsh in the foreground and Cephalanthus Shrub 1 in the background

Johns Lake T5 station 60 looking north toward Johns Lake, capturing Cephalanthus Shrub 1

Figure C-15 continued: Johns Lake Transect 5.

Johns Lake T5 station 70 looking north toward Johns Lake, capturing the Sporobolus shallow marsh community.

Johns Lake T5 station 90 looking north toward Johns Lake, capturing the Cattail marsh in the foreground and the floating deep marsh in the background.

Figure C-15 continued: Johns Lake Transect 5.

Johns Lake T5 station 90 looking north toward Johns Lake, capturing the cattail marsh in the foreground and the floating deep marsh and open water in the background.

Figure C-15 continued: Johns Lake Transect 5.

Table C-16: Vegetation species list with cover estimate and NWPL code for Johns Lake Transect 5.

Scientific Name	Common Name	Community[1]	MH	E1	E2	CS3	SM	CS1	SSM	E3	CM	DMF
		Start (m)	0	9	15	23	33	56	69	76	83	98
		End (m)	9	15	23	33	56	69	76	83	98	112
		NWPL Code[2]	Plant Species Cover Estimates[3]									
Ambrosia artemisiifolia	ragweed	FACU		3								
Amphicarpum muehlenbergianum	blue maidencane	FACW		1	1							
Andropogon glomeratus	bushy bluestem	FACW			x	x	x					
Baccharis halimifolia	saltbush	FAC		1	1							
Callicarpa americana	American beautyberry	FACU		1								
Cephalanthus occidentalis	buttonbush	OBL				6	2	4	2	2		
Cyperus haspan	haspan flatsedge	OBL					x	x	x			
Cyperus lecontei	Le Conte's flatsedge	FACW			x							
Diospyros virginiana	common persimmon	FAC		1	2	x						
Eleocharis elongata	slim spikerush	OBL						x				
Eleocharis vivipara	viviparous spikerush	OBL					x					
Erechtites hieraciifolius	American burnweed	FAC		1								
Eupatorium leptophyllum	false fennel	FACW					x	x	x			
Fuirena scirpoidea	rush fuirena	OBL					1					
Galactia elliottii	Elliott's milkpea	FACU			2							
Gamochaeta antillana	delicate everlasting	UPL		x								
Hydrocotyle umbellata	dollarweed	OBL					x					
Juncus marginatus	grass-leaved rush	FACW		x								
Juncus polycephalos	manyhead rush	OBL			x							
Lachnanthes caroliana	Carolina redroot	OBL			1	3	1					
Leersia hexandra	southern cutgrass	OBL							x			
Mikania scandens	climbing hempvine	FACW				x	x					
Morella cerifera	wax myrtle	FAC		1		1						

Scientific Name	Common Name	Community[1]	MH	E1	E2	CS3	SM	CS1	SSM	E3	CM	DMF
		Start (m)	0	9	15	23	33	56	69	76	83	98
		End (m)	9	15	23	33	56	69	76	83	98	112
		NWPL Code[2]	Plant Species Cover Estimates[3]									
Nymphaea odorata	white water-lily	OBL					x	1	3	3	4	5
Panicum hemitomon	maidencane	OBL		1	2	x	2	3	2	1		
Panicum repens	torpedo grass	FACW			5	2	3	1	x			
Persicaria hirsuta	hairy smartweed	OBL				x	1		x			
Pluchea baccharis	rosy camphorweed	FACW			2	2						
Pontederia cordata	pickerelweed	OBL			x	x	1	2	2	x		
Ptilimnium capillaceum	herbwilliam	OBL		1								
Quercus hemispherica	Darlington oak	FACU	4	3								
Quercus virginiana	live oak	FACU	3	3	1							
Rhus copallinum	winged sumac	UPL	1									
Rhynchospora microcephala	smallhead beaksedge	FACW			x							
Sabal palmetto	cabbage palm	FAC			1							
Sagittaria lancifolia	lanceleaf arrowhead	OBL			1	1	4	x	x			
Scleria sp.	nutrush	FACW		2								
Serenoa repens	saw palmetto	FACU	4	2								
Smilax auriculata	greenbrier	FACU		1								
Sporobolus bakeri	marsh grass	FACW					3	4	5	4		
Typha latifolia	broadleaf cattail	OBL								3	6	
Urena lobata	Caesar's weed	FAC		2								
Vaccinium arboreum	sparkleberry	FACU	1	x								
Vitis rotundifolia	muscadine grape	FAC	4	4	x							

[1]**Community:** MH = Mesic Hammock, E1 = Ecotone 1, E2 = Ecotone 2, CS3 = Cephalanthus Shrub 3, SM = Shallow Marsh, CS1 = Cephalanthus Shrub 1, SSM = Sporobolus Shallow Marsh, E3 = Ecotone 3, CM = Cattail Marsh, DMF = Deep Marsh Floating

[2]**NWPL** codes are taken from the National Wetland Plant List (NWPL; USDA NRCS 2016). Species not listed or almost always occur in non-wetlands under natural conditions are considered **Upland (UPL)**. **Facultative Upland (FACU) –** Plants usually occurring in non-wetlands but occasionally found in wetlands. **Facultative (FAC)** – Plants with similar likelihood of occurring in both wetlands and uplands. **Facultative Wet (FACW)** – Plants that typically exhibit their maximum cover in areas subject to surface water flooding and/or saturation but may also occur in uplands. **Obligate (OBL)** – Plants that are found or achieve their greatest abundance in an area that is subject to surface water flooding and/or saturation; rarely occur in uplands.

[3]**Plant Species Cover Estimates:** Areal extent of vegetation species along the transect within a given vegetation community where X=<1%, 1=1 to 5%, 2=5 to 25%, 3=25 to 50%, 4=50 to 75%, 5=75 to 95% and 6=95-10

T5 Soils

Mapped Soils: The NRCS's (websoilsurvey.nrcs.usda.gov) SSURGO (Soil Survey Geographic Database) data suggest that Orlando fine sand, 0 to 5 percent slopes is the predominant soil map unit present at Transect 5 (Figure C-6). It is a very deep, well drained, rapidly permeable, siliceous, hyperthermic humic Psammentic Dystrudepts soil that formed in thick deposits of sandy marine or fluvial sediments.

On-site Soil Descriptions: Soil profiles were collected at two-meter intervals along the transect and their hydric soil indicators (or lack thereof) were reported. Detailed descriptions were recorded at four stations along Transect 5: stations 6 (99.10 ft NAVD88), 20 (96.23 ft NAVD88), 34 (95.15 ft NAVD88), and 70 (94.35 ft NAVD88). Table C-17 presents the data gathered during these descriptions. Hydric soils were first encountered at station 18 because indicator S6, Stripped Matrix, was present within the first 6 inches of the soil sample. The maximum SHWT observed on this transect was approximately 98.43 ft NAVD 88.

Table C-17: Johns Lake Transect 5 detailed soils descriptions.

Station (m) & Elevation (ft NAVD88)	Vegetation Community	Hydric Soil Indicator / SHWT (in. below surface)	Horizon	Depth (in.)	Matrix (Hue, Value/Chroma)	Texture	Notes
Station 6 99.1 ft	Mesic Hammock		Oe	+1-0	5YR 2.5/2	Mucky Peat	None
			A	0-8	10YR 4/1	Sand	Mottle: 10YR 2/1, 20%, sharp round; Depletion: 10YR 6/1, 15%, clear round
		SHWT at 8"	E	8-16.5	10YR 4/1	Sand	Mottle: 10YR 2/1, 10%, sharp round; Depletion: 10YR 5/1, 20%, diffuse round
			Bh1	16.5-34.5	10YR 2/2	Sand	None
			Bh2	34.5-38	10YR 3/2	Sand	None
			Bw	38-46	10YR 5/3	Sand	None
			Btg1	46-51.5	2.5Y 7/3	Sandy Clay Loam	Redox concentration: 10YR 6/8, 20%, diffuse round; Mottle: 2.5Y 4/1, 30%, sharp linear; Depletion: 2.5Y 8/1, 5%, diffuse round
			Btg2	51.5-59	2.5Y 7/3	Sandy Clay Loam	Depletion: 2.5Y 8/2, 20%, diffuse round; Mottle: 25Y 4/1, 15%, sharp linear
Station 20 96.23 ft	Ecotone 2	Polyvalue Below Surface (S8) / AAGS	A1	0-0.25	10YR 2/1	Mucky Mineral	None
			A2	0.25-4.5	10YR 4/1	Sand	Mottle: 10YR 2/1, 15%, sharp round; Depletion: 10YR 6/1, 20%, clear round
		Stripped Matrix (S6)	E	4.5-7	10YR 4/1	Sand	Mottle: 10YR 2/1, 10%, clear round; Depletion: 10YR 5/1, 10%, diffuse round
			BE	7-14	10YR 3/1	Sand	Organic carbon less than 50%; Mottle: 10YR 2/1, 10%, clear round; Depletion: 10YR 4/1, 15%, diffuse round; Depletion: 10YR 6/1, 7%, clear round

Station (m) & Elevation (ft NAVD88)	Vegetation Community	Hydric Soil Indicator / SHWT (in. below surface)	Horizon	Depth (in.)	Matrix (Hue, Value/Chroma)	Texture	Notes
			Bh	14-16.5	10YR 2/1	Sand	Organic carbon: 90%; Depletion: 10YR 3/1, 10%, clear round
Station 34 95.15 ft	Shallow Marsh	Muck Presence (A8), Polyvalue Below Surface (S8) / AAGS	Oa	0-0.5	10YR 2/1	Muck	None
			A	0.5-4	10YR 4/1	Sand	Mottle: 10YR 2/1, 20%, clear round; Depletion: 10YR 5/1, 5%, diffuse round
			E	4-7	10YR 4/1	Sand	Mottle: 10YR 2/1, 25%, clear round; Depletion: 10YR 5/1, 10%, diffuse round
			Bh	7-15	10YR 3/1	Sand	Organic coating less than 50%; Mottle: 10YR 2/1, 15%, diffuse round; Mottle: 10YR 5/1, 10%, clear round; Depletion: 10YR 4/1, 5%, diffuse round
Station 70 94.35 ft	Shallow Marsh (Sporobolus)	Muck Presence (A8), Polyvalue Below Surface (S8) / AAGS	Oa	0-1.5	10YR 2/1	Muck	None
			A	1.5-2	10YR 2/1	Sand	Organic coating: 95%
			AE	2-6.5	10YR 2/1	Sand	Organic coating : 80%; Depletion: 10YR 4/1, 15%, diffuse round; Depletion: 10YR 5/1, 25%, diffuse round
			Bh	6.5-14.5	10YR 2/1	Sand	Organic coating: 85%

Fish Data

The recreational value of Johns Lake for fishing is high. During the data collection period, most boaters encountered by district staff were fishers. The Florida Fish and Wildlife Conservation Commission (FWC) even chose Johns Lake as a location to release a tagged largemouth bass that was worth $5,000 if caught as part of their 2022 "Trophy Catch 10-Tag Celebration" (FWC 2022).

Largemouth bass that weigh 8 pounds or more can be weighed, photographed, and submitted to FWC's "Trophy Catch" program (license.gooutdoorsflorida.com/Angler/Home?id=1). The website lists 92 submissions from Johns Lake between 2013 and 2023 (Table C-18).

"Big Catch" (license.gooutdoorsflorida.com/Angler/Home?id=2) is a similar program in which anglers are recognized for catches weighing 8 pounds or more, but the species is not limited to largemouth bass (Table C-19). The website lists 19 submissions from Johns Lake between 2007 and 2022.

Table C-18: Fish Data from the Trophy Catch website.

Catch ID	Species	Lake	Date Caught	Fish Weight	Fish Length (in)	Fish Girth (in)
1203	Largemouth Bass	Johns Lake	3 Feb, 2013	12 lbs 8 oz	27.5	20
1291	Largemouth Bass	Johns Lake	11 Feb, 2013	12 lbs	27	21
1308	Largemouth Bass	Johns Lake	13 Feb, 2013	10 lbs	25	19
1409	Largemouth Bass	Johns Lake	24 Feb, 2013	10 lbs 4 oz	25.5	19
1486	Largemouth Bass	Johns Lake	8 Mar, 2013	11 lbs 10 oz	26	19.5
1540	Largemouth Bass	Johns Lake	13 Mar, 2013	10 lbs 5 oz	25	19.5
1555	Largemouth Bass	Johns Lake	15 Mar, 2013	11 lbs 15 oz	26	19.5
1568	Largemouth Bass	Johns Lake	3 Mar, 2013	10 lbs	27.5	20
1599	Largemouth Bass	Johns Lake	19 Mar, 2013	8 lbs 9 oz	24	18
1631	Largemouth Bass	Johns Lake	22 Mar, 2013	8 lbs 11 oz	24	18.25
1666	Largemouth Bass	Johns Lake	25 Mar, 2013	12 lbs 15 oz	28	20
1679	Largemouth Bass	Johns Lake	27 Mar, 2013	10 lbs 1 oz	24	20.25
1726	Largemouth Bass	Johns Lake	10 Feb, 2013	11 lbs 8 oz	26.5	20
1972	Largemouth Bass	Johns Lake	5 May, 2013	8 lbs 12 oz	24	18
1980	Largemouth Bass	Johns Lake	5 May, 2013	8 lbs 8 oz	24	17

Catch ID	Species	Lake	Date Caught	Fish Weight	Fish Length (in)	Fish Girth (in)
2011	Largemouth Bass	Johns Lake	9 May, 2013	10 lbs	26	18.5
2175	Largemouth Bass	Johns Lake	24 May, 2013	10 lbs 2 oz	26	18
2333	Largemouth Bass	Johns Lake	11 Jun, 2013	9 lbs 7 oz	24	19
2537	Largemouth Bass	Johns Lake	7 Jul, 2013	11 lbs 1 oz	26.5	
2556	Largemouth Bass	Johns Lake	11 Jul, 2013	10 lbs 8 oz	26	
4904	Largemouth Bass	Johns Lake	15 Jan, 2014	11 lbs 1 oz	27	19
4905	Largemouth Bass	Johns Lake	15 Jan, 2014	8 lbs 8 oz	24	
4909	Largemouth Bass	Johns Lake	16 Jan, 2014	9 lbs 1 oz	24	19
5543	Largemouth Bass	Johns Lake	11 Feb, 2014	10 lbs 10 oz	26.5	20
6257	Largemouth Bass	Johns Lake	1 Mar, 2014	8 lbs 13 oz	25	
6702	Largemouth Bass	Johns Lake	21 Feb, 2014	8 lbs 11 oz	24.125	
20094	Largemouth Bass	Johns Lake	15 Apr, 2015	11 lbs		
20301	Largemouth Bass	Johns Lake	8 May, 2015	10 lbs 9 oz	27	18
22310	Largemouth Bass	Johns Lake	31 Jan, 2016	11 lbs 15 oz	27.5	19
23253	Largemouth Bass	Johns Lake	30 Mar, 2016	8 lbs 5 oz	24	16.5
26930	Largemouth Bass	Johns Lake	29 Mar, 2017	8 lbs 5 oz		
27121	Largemouth Bass	Johns Lake	29 Apr, 2017	8 lbs 9 oz		
27227	Largemouth Bass	Johns Lake	10 May, 2017	8 lbs 1 oz	24.125	
29147	Largemouth Bass	Johns Lake	5 Apr, 2018	8 lbs 4 oz		18
29160	Largemouth Bass	Johns Lake	7 Apr, 2018	8 lbs 3 oz	25	
29610	Largemouth Bass	Johns Lake	9 Jun, 2018	8 lbs 15 oz	27	
29777	Largemouth Bass	Johns Lake	21 Jul, 2018	9 lbs 15 oz		
30262	Largemouth Bass	Johns Lake	2 Dec, 2018	9 lbs	27	18.5
30637	Largemouth Bass	Johns Lake	10 Feb, 2019	11 lbs 6 oz	26.5	
30654	Largemouth Bass	Johns Lake	16 Feb, 2019	9 lbs 4 oz		
30693	Largemouth Bass	Johns Lake	19 Feb, 2019	10 lbs 6 oz	25	

Catch ID	Species	Lake	Date Caught	Fish Weight	Fish Length (in)	Fish Girth (in)
30745	Largemouth Bass	Johns Lake	23 Feb, 2019	9 lbs 6 oz	25.5	18
30763	Largemouth Bass	Johns Lake	25 Feb, 2019	8 lbs 8 oz		
30764	Largemouth Bass	Johns Lake	25 Feb, 2019	10 lbs 11 oz	26	
30788	Largemouth Bass	Johns Lake	28 Feb, 2019	8 lbs 13 oz	24	18
30889	Largemouth Bass	Johns Lake	12 Mar, 2019	8 lbs 4 oz	24	17
30890	Largemouth Bass	Johns Lake	12 Mar, 2019	9 lbs 11 oz	26	17
31000	Largemouth Bass	Johns Lake	21 Mar, 2019	8 lbs 6 oz	26	18
31351	Largemouth Bass	Johns Lake	5 May, 2019	9 lbs 4 oz		
31389	Largemouth Bass	Johns Lake	11 May, 2019	10 lbs 7 oz		20.5
32509	Largemouth Bass	Johns Lake	18 Jan, 2020	8 lbs 6 oz	24	17
32565	Largemouth Bass	Johns Lake	24 Jan, 2020	11 lbs 3 oz	26	20
33032	Largemouth Bass	Johns Lake	15 Mar, 2020	10 lbs 4 oz	26	18
33052	Largemouth Bass	Johns Lake	7 Mar, 2020	9 lbs 2 oz		
33053	Largemouth Bass	Johns Lake	7 Mar, 2020	8 lbs 10 oz		
33806	Largemouth Bass	Johns Lake	2 May, 2020	9 lbs 11 oz	26	
34680	Largemouth Bass	Johns Lake	28 Aug, 2020	8 lbs 2 oz		
35437	Largemouth Bass	Johns Lake	6 Feb, 2021	9 lbs 12 oz	26.625	
35801	Largemouth Bass	Johns Lake	7 Mar, 2021	11 lbs 3 oz	26	19
36970	Largemouth Bass	Johns Lake	4 Aug, 2021	8 lbs 8 oz		
37403	Largemouth Bass	Johns Lake	10 Jan, 2021	10 lbs 9 oz		
37550	Largemouth Bass	Johns Lake	26 Nov, 2021	12 lbs 5 oz	26.5	20.5
37652	Largemouth Bass	Johns Lake	13 Dec, 2021	10 lbs 3 oz	25.5	19.5
37937	Largemouth Bass	Johns Lake	15 Jan, 2022	8 lbs 1 oz		
37972	Largemouth Bass	Johns Lake	20 Jan, 2022	10 lbs 15 oz	25.5	20
38099	Largemouth Bass	Johns Lake	2 Feb, 2022	8 lbs 11 oz	24	18
38100	Largemouth Bass	Johns Lake	2 Feb, 2022	8 lbs 7 oz		

Catch ID	Species	Lake	Date Caught	Fish Weight	Fish Length (in)	Fish Girth (in)
38260	Largemouth Bass	Johns Lake	15 Feb, 2022	8 lbs 8 oz	23.5	17.5
38262	Largemouth Bass	Johns Lake	15 Feb, 2022	8 lbs 14 oz	24	18
38297	Largemouth Bass	Johns Lake	17 Feb, 2022	8 lbs 10 oz	24	18
38459	Largemouth Bass	Johns Lake	28 Feb, 2022	11 lbs 4 oz	26.5	19.5
38659	Largemouth Bass	Johns Lake	15 Mar, 2022	8 lbs 3 oz	23.5	18
38660	Largemouth Bass	Johns Lake	15 Mar, 2022	8 lbs 8 oz	24.5	17
38670	Largemouth Bass	Johns Lake	15 Mar, 2022	8 lbs 5 oz		
39057	Largemouth Bass	Johns Lake	10 Apr, 2022	9 lbs 1 oz		
39401	Largemouth Bass	Johns Lake	14 May, 2022	8 lbs 1 oz		
39424	Largemouth Bass	Johns Lake	15 May, 2022	8 lbs 6 oz		
39517	Largemouth Bass	Johns Lake	23 May, 2022	8 lbs	24	16
39616	Largemouth Bass	Johns Lake	2 Jun, 2022	8 lbs 7 oz		
39662	Largemouth Bass	Johns Lake	6 Jun, 2022	8 lbs 4 oz	24	17.5
39775	Largemouth Bass	Johns Lake	22 Jun, 2022	8 lbs		
39854	Largemouth Bass	Johns Lake	1 Jul, 2022	8 lbs		
40788	Largemouth Bass	Johns Lake	29 Jan, 2023	11 lbs 12 oz	27	20
40795	Largemouth Bass	Johns Lake	26 Jan, 2023	10 lbs 4 oz		
40811	Largemouth Bass	Johns Lake	26 Jan, 2023	8 lbs 5 oz	25.375	
41070	Largemouth Bass	Johns Lake	24 Feb, 2023	8 lbs 8 oz		
41505	Largemouth Bass	Johns Lake	24 Mar, 2023	11 lbs 4 oz	27	19
41506	Largemouth Bass	Johns Lake	24 Mar, 2023	8 lbs	23.5	
41511	Largemouth Bass	Johns Lake	24 Mar, 2023	9 lbs 14 oz		
41712	Largemouth Bass	Johns Lake	5 Apr, 2023	8 lbs 4 oz	23	18.5
41904	Largemouth Bass	Johns Lake	3 May, 2023	8 lbs 3 oz		
42510	Largemouth Bass	Johns Lake	2 Sep, 2023	8 lbs 13 oz	26	18

Table C-19: Fish Data from the Big Catch website.

Catch ID	Species	Lake	Date Caught	Fish Weight	Fish Length (in)	Fish Girth (in)
1948	Largemouth Bass	Johns Lake	28 Apr, 2013	10 lbs 9 oz	25.5	17
6176	Largemouth Bass	Johns Lake	28 Feb, 2014	9 lbs 2 oz	25.25	
17310	Largemouth Bass	Johns Lake	6 Jan, 2007	9 lbs 3 oz	25	17.5
17313	Largemouth Bass	Johns Lake	13 Jan, 2007	8 lbs	24.5	16.5
17314	Largemouth Bass	Johns Lake	13 Jan, 2007	10 lbs 8 oz	26.5	18
17320	Largemouth Bass	Johns Lake	27 Jan, 2007	11 lbs	27	18
18074	Largemouth Bass	Johns Lake	10 Apr, 2010	10 lbs	27	17
19187	Longnose Gar	Johns Lake	11 Feb, 2015		54	
19316	Black Crappie	Johns Lake	24 Feb, 2015		14	
20560	Black Crappie	Johns Lake	4 Jun, 2015		14.25	
20586	Black Crappie	Johns Lake	3 Jan, 2015		14	
22241	Largemouth Bass	Johns Lake	31 Jan, 2016	8 lbs	23	
23942	Largemouth Bass	Johns Lake	21 May, 2016	8 lbs 3 oz		
27744	Largemouth Bass	Johns Lake	25 Apr, 2017	9 lbs	25	
28339	Largemouth Bass	Johns Lake	30 Dec, 2017	8 lbs 15 oz		
29597	Largemouth Bass	Johns Lake	3 Mar, 2018	8 lbs 3 oz	26	
33992	Largemouth Bass	Johns Lake	31 May, 2020	8 lbs 8 oz		
36156	Largemouth Bass	Johns Lake	6 Apr, 2021	8 lbs 1 oz	25	
38985	Largemouth Bass	Johns Lake	3 Apr, 2022	8 lbs 12 oz		

MFL METRICS

Event-Based Approach

Wetland and aquatic species and hydric soils require a minimum frequency of critical hydrologic events for long-term persistence. The hydrologic range of flooding and drying events are required to fulfill many life-history requirements of wetland communities (Euliss et al. 2004; Murray-Hudson et al. 2014). This hydrologic range, known as hydroperiod, is often described as the inter-annual and seasonal pattern of water level resulting from the combination of water budget and storage capacity (Welsch et al. 1995). Hydroperiod is also a primary driver of wetland plant distribution and composition, hydric soils type and location, and to a lesser degree, freshwater fauna (Foti et al. 2012; Murray-Hudson et al. 2014).

Wetland hydroperiods vary spatially and temporally and consist of multiple components, including: magnitude, duration, return interval, rate of change, and timing (Poff et al. 1997). However, because the latter two are thought to be a function of climate, only the first three are a focus of the SJRWMD event-based approach. Magnitude and duration components define the critical ecological events that affect species at an individual level (i.e., individual organisms). The return interval of an event is a function of variations in climate and/or water withdrawal. By comparing the current frequency of ecologically critical events to the recommended minimum frequency, the SJRWMD event-based method determines the amount of water available, or needed for recovery, within a given ecosystem under different water withdrawal conditions.

Varying flooding and drying events are necessary to maintain the extent, composition, and function of wetland and aquatic communities. Native wetland and aquatic communities have adapted to and are structured by this natural variability (Poff et al. 1997; Richter et al. 1997; Murray-Hudson et al. 2014). Because of the role of hydroperiod in structuring and maintaining wetland and aquatic communities, the SJRWMD MFLs approach is centered on protecting a minimum number of flooding events or preventing more than a maximum number of drying events for a given ecological system.

For example, the long-term maintenance of the maximum extent of a wetland may require an infrequent flooding event of sufficient duration and return interval to ensure that upland species do not permanently shift downslope into that wetland. In addition to flooding events, some aspects of wetland ecology (e.g., plant recruitment, soil compaction, nutrient mineralization) depend on drying events, as long as they do not occur too often. Because hydroperiods vary spatially and temporally (Mitsch and Gosselink 2015), multiple MFLs are typically used to address and protect different portions of a system's natural hydrologic regime (Figure C-16; Neubauer et al. 2008). For many systems, SJRWMD sets three MFLs: a minimum frequent high (FH), a minimum average (MA), and a minimum frequent low

(FL) flow and/or water level. In some cases (e.g., for sandhill-type lakes) a minimum infrequent high (IH) and/or minimum infrequent low (IL) may also be set.

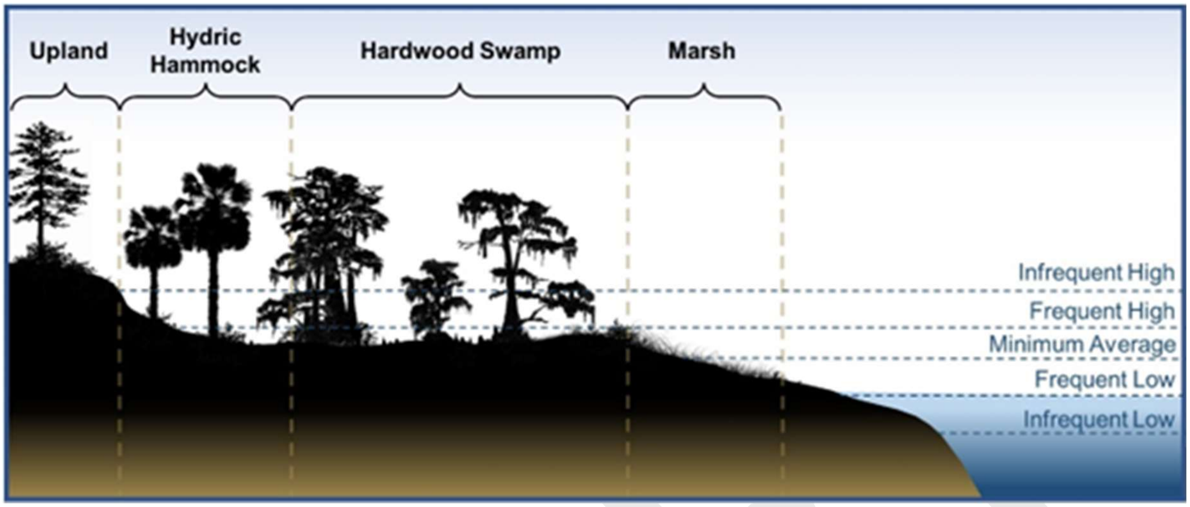


Figure C-16: Conceptual drawing showing the five most common minimum flows and/or levels developed using SJRWMD's event-based approach.

Surface Water Inundation/Dewatering Signatures (SWIDS)

MFLs minimum hydrological events have three primary components: magnitude, duration, and return interval. Magnitude and duration define biologically relevant events, while the return interval of an event is the manageable component (Neubauer et al. 2008). For example, if a 30-day flooding event of the maximum elevation of a shallow marsh has an annual probability of exceedance of 33%, then the event is interpreted as occurring 33 times in 100 years or on a 3-year return interval. These statistics are long-term averages that may be decreased in the case of flooding events or increased in the case of dewatering events until some threshold is reached where an important ecological process or function is significantly harmed.

One of the techniques used to identify these thresholds is known as “Surface Water Inundation/Dewatering Signatures” (SWIDS). The SWIDS approach provides a guide for determining the maximum change in the return interval of a given event (with duration held constant) that could occur while still maintaining a given ecological process or function. However, they must be used with caution since other variables can be responsible for maintaining the feature of interest besides the stage of the water body (e.g. seepage from uplands, fire, disturbance history). The collection of SWIDS from a set of similar water bodies provides a range of hydrologic conditions that support an ecological feature of interest.

Once data from similar water bodies within SJRWMD are compiled, SWIDS are derived from frequency analysis of long-term simulated or observed stage data. Using these data, hydroperiod tables are developed for MFLs water bodies. Hydroperiod tables include exceedance (flooding) and non-exceedance (drying) probabilities for specific key elevations over a range of durations. The former are typically used to evaluate return intervals for the FH while the latter are typically used to evaluate return intervals for the FL. Average non-exceedance probabilities are typically used to evaluate return intervals for the MA. Key elevations may be maximum, average, or minimum elevations for particular wetland plant communities, common wetland species, and hydric soil indicators.

Being conceptually strong, the SWIDS approach currently provides the best estimate of return intervals for MFLs events,However, often results in an extensive range of frequencies for a given event. This large range can introduce uncertainty in the recommended minimum frequency for specific MFL events. To address this concern, SJRWMD updated the SWIDS approach in 2023 (Deschler *et al.* 2023) and 2024 (Shadik *et al.* in prep) to tailor frequency calculations more specifically to individual metrics (e.g., hydrological, soil-related, hydroecological). In this process, SWIDS return intervals are still calculated based on observed hydroperiods of organic soils, vegetation species, or community type, but the determination of suitable sites for comparison is refined. Suitable sites for comparison are considered those that share hydrologic and landscape characteristics that may influence local ecological patterns.

Transect Quadrat-level Cluster Approach – A Bottom-up Method for Vegetation and Community Frequencies

A bottom-up approach aimed at grouping individual transect quadrats based on local landscape and vegetation similarities was developed to reduce event frequency ranges (uncertainty) in the SWIDS analysis. The MFLs SWIDS process aims to inform recommended and protective event frequencies and durations for species and communities based on hydrological trends across MFL sites. Therefore, additional data describing local-scale (transect quadrat-level) influences on hydrology were necessary.

First, a dataset of all lakes with adopted and in-progress MFLs was compiled for which belt transect, community-level species coverages were available. Twenty-nine MFL lakes, including Johns Lake, had the required species coverage data available. This dataset includes site and community identification information, the MFL report-labelled community designation, the full community composition, and minimum, mean, and maximum community elevations converted to NAVD88 elevations. For each transect quadrat defined in this dataset, a series of variables were calculated including the quadrat slope, percent exceedance of the mean elevation of the quadrat, and the prevalence index (PI) of quadrat vegetation.

Quadrat slope was included as a variable to characterize water movement, or permanence within an area. Areas at a given elevation with a relatively low slope may result in wetter vegetation communities compared to areas at the same elevation but with a higher slope (i.e., low slopes may increase water ponding while higher slopes may increase runoff potential). Failing to consider a community’s slope could result in comparing a wet community found at a high elevation, which is only wet due to its low slope, with a similar wet community found at a low elevation, thereby increasing uncertainty in frequency determination. Other variables may be included in future analyses to help further characterize water movement or permanence at a site.

The influence of water level fluctuation on an individual quadrat community is characterized using the percent exceedance of the mean quadrat elevation. The percent exceedance is the amount of time an elevation is equaled or exceeded by the surface waterbody calculated from the full period of record (POR) available before the MFL was set.

The PI is an average weighted index used to characterize the hydrologic preference of vegetation. This method was originally developed by Wentworth et al. (1988) and is used for vegetation analysis by federal agencies to delineate wetlands (Reed 1988; Gage and Cooper 2010). The system assigns ecological index values (1 – 5) for five plant indicator status categories (obligate, facultative wetland, facultative, facultative upland, and non-wetland, respectively) based on their probability to occur in a wetland (Figure C-17). Although many variables may influence the composition of vegetation communities, PI provides a way to condense the composition down to the variability caused by moisture availability.

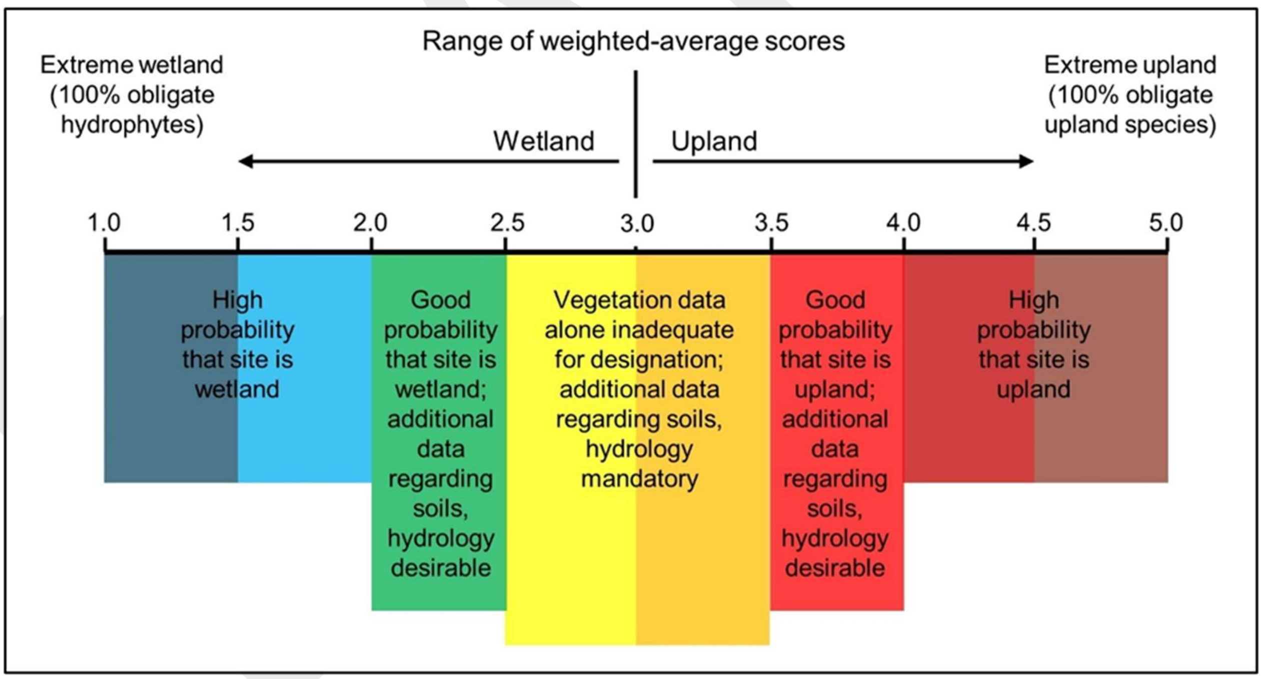


Figure C-17: Range of hydrologic preference (Prevalence Index) for vegetation communities based on species coverage. Adapted from Wentworth et al. (1988).

The quadrat-level dataset of PI, slope, and percent exceedance of mean elevation was standardized to z-scores, and then analyzed with Principal Components Analysis (PCA)

(Table C-20). PCA axes were then clustered into significant groups using Ward's method of hierarchical clustering with significance tests.

Ward's method of hierarchical clustering, which minimizes variance among sites within a group while maximizing variance between groups (Ward 1963; Murtagh and Legendre 2014), was used to identify quadrats with similar hydrologic and landscape characteristics. The number of significant clusters in the dataset was defined using the "NbClust" package in R (Charrad et al. 2014). Thirty different cluster significance tests are available in this package; the number of clusters used in analysis is the number of clusters over two supported by the greatest number of significance tests. All analyses were completed for Johns Lake using R version 4.1.1 (R Core Team 2021).

Ward's D cluster of PCA axes resulted in 4 groups (Tables C-20 and C-21). Group 1 includes the "wettest" quadrats based on mean PI and has the highest mean percent exceedance with a lower mean slope. Group 2 has a medium percent exceedance, the highest PI, and a medium slope. The quadrats within group 2 tend to be more ecotones and transitional areas. Group 3 had the largest slope with midlevel PI and a medium percent exceedance. Group 4 has the lowest mean slope and percent exceedance with a midlevel PI. Overall, group 4 exhibits high variability across the vegetation and exceedances

PCA groups were then used as constraints in species-based or community-based return interval calculations. For example, when calculating a return interval for buttonbush at Johns Lake, only quadrats with a species cover class of 3 or above were considered. A cover class of 3 or above was used in species-specific calculations because it represents a species coverage of at least 25% within a quadrat. Smaller cover classes were avoided to reduce the possibility of species occurrence due to microtopographical variations or spatial heterogeneity within a vegetation community.

Multiple quadrats may be present with buttonbush at a cover class of at least a 3 (Table C-21), and it is possible that variations in local landscape variables separated the quadrats into more than one group in the PCA. If this occurred, the group with the most quadrats at Johns Lake with buttonbush at or above a cover class of 3 was used for the return interval calculation. In this case, the majority of quadrats at Johns Lake with buttonbush at or above a cover class of 3 were in Group 4, so this group was chosen for the return interval calculation (Tables C-21 and C-22).

SWIDS analyses were updated using only the quadrats in Group 4 for which corresponding data for buttonbush with a species cover class of 3+ also existed. For example, if a quadrats in Group 4 did not have buttonbush with a species cover class of 3 or above, it would be removed from the analysis.

After return intervals were calculated for each site included in the PCA cluster, the final site return interval was calculated by taking the mean + standard error of all observed return intervals. A mean + standard error is used for an exceedance return interval calculation while a mean – standard error is used for a non-exceedance return interval calculation. Here, a mean+standard error was used for the buttonbush return interval calculation because it is an exceedance metric. Taking the mean + standard error of all observed return intervals incorporates an allowance for natural community/species fluctuation that occurs with climatic variability through time or that may be occurring due to factors not considered.

When calculating a community-based metric, species cover classes don't play a role, and the comparison group is the group with the most quadrats of the target community at the MFL site. For example, when calculating a return interval for shrub swamp at an MFL site, if the majority of shrub swamp quadrats at the MFL site are in Group 3, the return interval is calculated using all quadrats in Group 3.

A community-based metric was not calculated for Johns Lake. This was because the communities around this highly developed, sandhill lake did not have typical community boundaries, like the shallow marsh–deep marsh boundary, which lend themselves to community-based SWIDS analyses.

Table C-20: Mean quadrat values of PCA input variables for vegetation-based metrics.

Group	PI	Slope	Percent Exceedance
Group 1	1.33	1.57	83.27
Group 2	2.98	3.00	34.09
Group 3	1.72	5.35	39.73
Group 4	1.72	1.36	28.19

Table C-21: All sites in the SWIDS dataset which have quadrats at MFL lakes with buttonbush at a cover class of 3 or above. Out of 41 quadrats with sufficient buttonbush cover, 20 are in Group 4.

Quadrat Name	Report Labeled Community	PI	Slope (degrees)	% Exceedance of mean elevation	PCA Group
Melrose_T2d_2011	Shrub Swamp	1.96	3.43	100	Group 1
Kerr_T3f_2014	Shrub Swamp	1.71	0.22	79.7	Group 1
Kerr_T4c_2012	Shrub Swamp	1.49	1.03	79.1	Group 1
Kerr_T7d_2012	Shrub Swamp	1.40	0.74	72.9	Group 1
Gore_T1a	Shrub Swamp	1.49	0.76	96.9	Group 1
Pierson_T1b_2000	Bay Swamp	1.57	1.99	63.9	Group 1
Pierson_T1c_2000	Mixed Hardwood Swamp	1.74	0.53	58.8	Group 1
Prevatt_T1c_2022	Transitional Shrub	1.57	3.00	62.4	Group 1
Prevatt_T2d_2022	Shrub Swamp	1.79	1.62	73.3	Group 1
Prevatt_T2e_2022	Shallow Marsh	1.29	2.87	85.1	Group 1
Prevatt_T3e_2022	Cephalanthus Shrub	1.29	1.10	79.7	Group 1
EastCrystalLake_T2h_2024	Shallow Marsh	1.00	2.53	79.7	Group 1
EastCrystalLake_T2j_2024	Shallow Marsh	1.00	1.17	82.1	Group 1
Prevatt_T1d_2022	Shrub Swamp	2.15	1.24	74.2	Group 2
Prevatt_T1m_2022	Shrub Swamp	2.11	0.95	74.2	Group 2
Johns_T1d_2023	Shrub Swamp - Cephalanthus w/floating veg	1.40	4.87	35	Group 3
Johns_T2d_2023	Transition - Cephalanthus	1.62	4.30	18	Group 3
Johns_T2e_2023	Shrub Swamp - Cephalanthus w/floating veg	1.36	3.81	36	Group 3
WestCrystalLake_T3l_2023	Shrub Swamp	1.47	2.74	41	Group 3
WestCrystalLake_T4e_2024	Shrub Swamp	1.06	3.18	47.5	Group 3
WestCrystalLake_T4f_2024	Shallow Marsh	1.00	3.87	63.3	Group 3
ThreeIsland_TAd	Shallow Marsh	1.11	0.73	50.4	Group 4
Johns_T3e_2023	Cattail Marsh	1.00	1.68	33.3	Group 4
Johns_T3f_2023	Cephalanthus w/floating veg	1.00	3.19	37.4	Group 4
Johns_T4e_2023	Cephalanthus w/ Sporobolus	1.14	1.82	21.8	Group 4
Johns_T4f_2023	Cephalanthus w/floating veg	1.00	1.75	36.1	Group 4
Johns_T5d_2023	Cephalanthus w/mixed species	1.21	1.06	11.3	Group 4
Johns_T5f_2023	Cephalanthus w/ Sporobolus	1.36	0.29	21.1	Group 4
Prevatt_T2c_2022	Transition	1.15	2.58	58.9	Group 4
Colby_TCd_2005	Shallow Marsh	1.03	0.97	48.9	Group 4
Colby_TDc_2005	Shallow Marsh	1.18	1.00	44.3	Group 4

Quadrat Name	Report Labeled Community	PI	Slope (degrees)	% Exceedance of mean elevation	PCA Group
WestCrystalLake_T1i_2023	Shallow Marsh	1.37	1.35	39.5	Group 4
WestCrystalLake_T1j_2023	Shrub Swamp	1.87	0.38	31.4	Group 4
WestCrystalLake_T1k_2023	Shallow Marsh	1.00	0.61	38	Group 4
WestCrystalLake_T1l_2023	Shrub Swamp	1.00	1.44	42.6	Group 4
WestCrystalLake_T2e_2023	Shrub Swamp	1.82	0.18	36.5	Group 4
WestCrystalLake_T2f_2023	Shallow Marsh	1.19	0.29	36.5	Group 4
WestCrystalLake_T3e_2023	Transitional Shrub	1.09	2.37	35.2	Group 4
WestCrystalLake_T3f_2023	Shallow Marsh	1.00	1.47	45.7	Group 4
EastCrystalLake_T1c_2024	Shrub Swamp	1.19	1.36	55.7	Group 4
EastCrystalLake_T2f_2024	Shallow Marsh	1.00	1.48	68.6	Group 4

Table C-22: At Johns Lake, six quadrats were grouped by the PCA into Group 4 and three quadrats were grouped into Group 3. Since the majority were in Group 4, other quadrats in that group were used in the Return Interval calculation.

Transect	Quadrat Name	Buttonbush Cover Class	Group Number
1	Johns_T1d_2023	5	3
2	Johns_T2d_2023	3	3
2	Johns_T2e_2023	4	3
3	Johns_T3e_2023	4	4
3	Johns_T3f_2023	5	4
4	Johns_T4e_2023	4	4
4	Johns_T4f_2023	3	4
5	Johns_T5d_2023	6	4
5	Johns_T5f_2023	4	4
Majority Group			4

Event Based Metrics

Frequent High #1 (FH-1)

The recommended frequent high #1 (FH-1) level for Johns Lake is 94.1 ft NAVD88, with an associated exceedance duration of 30 continuous days and a return interval of 1.6 years (approximately 63 events per 100 years on average). The minimum FH level is defined as "…a chronically high surface water level or flow with an associated frequency and duration that allows for inundation of the floodplain at a depth and duration sufficient to maintain wetlands functions” (Rule 40C-8.021, Florida Administrative Code (*F.A.C.*).

Every transect surveyed at Johns Lake had at least one quadrat with buttonbush at a coverage of 3 or above. Buttonbush is frequently encountered around lakes throughout the SJRWMD (Ware 2000) and is valuable for providing habitat and erosion control around lakes. This frequent high exceedance metric ensures that flooding events occur often enough to prevent significant harm from occurring to buttonbush communities around Johns Lake.

<u>Magnitude</u>

The FH-1 level of 94.1 ft NAVD88 equals the average elevation of the buttonbush communities from all Johns Lake quadrats with buttonbush at a cover class of 3 (25-50%) or above (Table C-23). The goal of the recommended FH-1 level is to maintain the spatial extent and functions of the buttonbush community and seasonally inundated wetlands at Johns Lake. The FH level represents a high lake stage that generally occurs during moderate high water events and typically results in inundated wetlands with ecological benefits. Maintaining water levels at this average elevation will promote inundation and/or saturation conditions sufficient to support this and other hydrophytic (i.e., obligate) plant species. This will also prevent a permanent downward shift of the buttonbush and other wetlands communities.

Table C-23: Mean elevation of quadrats where buttonbush reached a cover class of 3 or above.

Transect	Community Name	Cover Class	Mean Elevation
1	Cephalanthus Shrub 2	5	93.52
2	Cephalanthus Ecotone	3	94.81
2	Cephalanthus Shrub 2	4	93.40
3	Cattail Marsh	4	93.66
3	Cephalanthus Shrub 2	5	93.21
4	Cephalanthus Shrub 1	4	94.40
4	Cephalanthus Shrub 2	3	93.39
5	Cephalanthus Shrub 3	6	95.51
5	Cephalanthus Shrub 1	4	94.55
Average			94.1

The recommended FH level provides inundation or saturation within the buttonbush communities at Johns Lake for a frequency and duration sufficient to maintain this community's spatial extent. Schneider and Sharitz (1986) reported that short-term flooding events are important for redistributing plant seeds within aquatic habitats. A floodplain plant community's species composition and structural development are influenced by the timing and duration of floods occurring during the growing season (Huffman 1980). Floods affect reproductive success as well as plant growth. The resulting anaerobic soil conditions within wetland communities eliminate upland plant species that have invaded during low water events and favor hydrophytic vegetation, which are tolerant of longer periods of soil saturation This level also allows sufficient water depths for fish and other aquatic organisms to feed and spawn on the lake floodplain. As water levels rise, large areas of the floodplain become inundated, increasing the amount of habitat available to aquatic organisms (Light et al. 1998). Bain (1990) and Poff et al. (1997) have reported that connecting the lake and floodplain are extremely important to animal productivity, because . the floodplain provides feeding and spawning habitat (Guillory 1979; Ross and Baker 1983) and refugia for juvenile fishes (Finger and Stewart 1987). Similar benefits likely result from flooding the buttonbush communities at Johns LakeInundation of the floodplain is also necessary for the exchange of particulate organic matter and nutrients (McArthur 1989; Hill and Cichra 2005). 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, serve as food for larger fauna. 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).

Duration

The duration component of the FH-1 is a minimum of 30 days continuously flooded at or above 94.1 ft NAVD88. A 30-day continuous flooding event represents a sufficient period of soil saturation or inundation to protect the structure and functions of seasonally flooded wetland plant communities (Hill et al. 1991). The 30-day flooding duration roughly corresponds to the durations of saturation that define the upper boundaries of many wetlands. From a regulatory standpoint, the U.S. Army Corps of Engineers (USACE) uses durations of saturation between 5% and 12.5% of the growing season in most years as the standard in their wetland delineation manual (USACE 1987). Given the year-round growing season in Florida, this corresponds to durations of 18 to 46 days. However, the National Research Council (NRC 1995) has recommended a shorter duration hydroperiod to define wetland hydrology: saturation within 1 ft of the soil surface for a duration of 2 weeks (14 days) or more during the growing season in most years.

As the life cycles of many fishes are related to seasonal water level fluctuations, particularly annual flood patterns (Guillory 1979), several months of flooding should be provided to ensure fish nesting success and give access to the floodplain (Knight et al. 1991).

Schneider and Sharitz (1986) reported that short-term flooding events are important for redistributing plant seeds within aquatic habitats. A floodplain plant community's species composition and structural development are influenced by the timing and duration of floods occurring during the growing season (Huffman 1980). Floods affect reproductive success as well as plant growth. The resulting anaerobic soil conditions within wetland communities eliminate upland plant species that have invaded during low water events and favor hydrophytic vegetation, which are tolerant of longer periods of soil saturation. Therefore, this seasonally flooded wetland's hydrophytic structure and diversity are maintained (Ahlgren and Hansen 1957; Menges and Marks 2008; Mace 2015). Return Interval

The return interval for the Johns Lake FH-1 was based on a SWIDS analysis of buttonbush quadrats with a species cover class of 3 or above (see Surface Water Inundation/Dewatering Signatures (SWIDS) section above for description of SWIDS). The SWIDS analysis for Johns Lake was conducted using hydrologic signatures for communities most similar to the Johns Lake buttonbush-dominated communities.

Five other MFL lakes (6 sites in total when including Johns Lake) had buttonbush quadrats similar to Johns Lake and were clustered into Group 4 using the cluster analysis (Tables C-21 and C-22). The cluster analysis, as described above in the Transect Quadrat-Level Cluster Approach-A Bottom-up Method for Vegetation and Community Frequencies section, was conducted to minimize the SWIDS event frequency range and thereby reduce uncertainty when determining a recommended minimum return interval for the FH. The buttonbush quadrats from these 6 MFL sites were included in the calculation of the FH return interval, resulting in a mean+SE of 1.6 years (~63 times in a century on average) (Table C-25). The average 30-day exceedance is 71.5% with an exceedance range of 36.5% (Table C-25; Figure C-18).

A 30-day FH-1 event was also calculated using the buttonbush quadrats from all the MFL lakes that had buttonbush quadrats with a species cover class of 3 or above without using the cluster analysis. This calculation results in an event frequency of 1.3 years (~77 times in a century on average) (Table C-24; Figure C-19), an average 30-day exceedance of 82.8%, and an exceedance ranges of 48.1%.

The cluster analysis resulted in a change in exceedance range from 48.1% without the cluster analysis to 36.5% with the cluster analysis (Tables C-24 and C-25 and Figures C-18 and C-19), resulting in a reduction of 11.6%. Since the return interval calculated using the cluster analysis yielded a smaller exceedance range and analyzed only sites with buttonbush quadrats similar to Johns Lake, its value was used.

Table C-24: Return intervals for all MFL lakes having buttonbush quadrats with a species cover class of 3 or above without using the cluster analysis. The range of return intervals is larger when quadrats are not grouped using the cluster analysis.

Lake	30-Day Duration % Exceedance	Return Interval (yr)
Colby	70.4	1.42
East Crystal	91.5	1.09
Gore	100.0	1.00
Johns	77.5	1.29
Kerr	87.5	1.14
Melrose	100.0	1.00
Pierson	97.2	1.03
Prevatt	88.3	1.13
Three Island	63.9	1.56
West Crystal	51.9	1.93
Range		0.93
Mean		1.26
Standard Error (SE)		0.09
Mean + SE		1.3

Table C-25: Return intervals for the MFL lakes clustered into Group 4 using the cluster analysisbuttonbush communities with a coverage of 3 or above for Group 4 (based on PCA results) quadrats. The recommended return interval for Johns Lake is the mean return intervalRI plus standard error.

Lake	30-Day Duration % Exceedance	Return Interval (yr)
Colby	70.4	1.42
East Crystal	86.1	1.16
Johns	77.5	1.29
Prevatt	81.5	1.23
Three Island	63.7	1.57
West Crystal	49.6	2.02
Range		0.86
Mean		1.45
Standard Error (SE)		0.12
Mean + SE		1.6

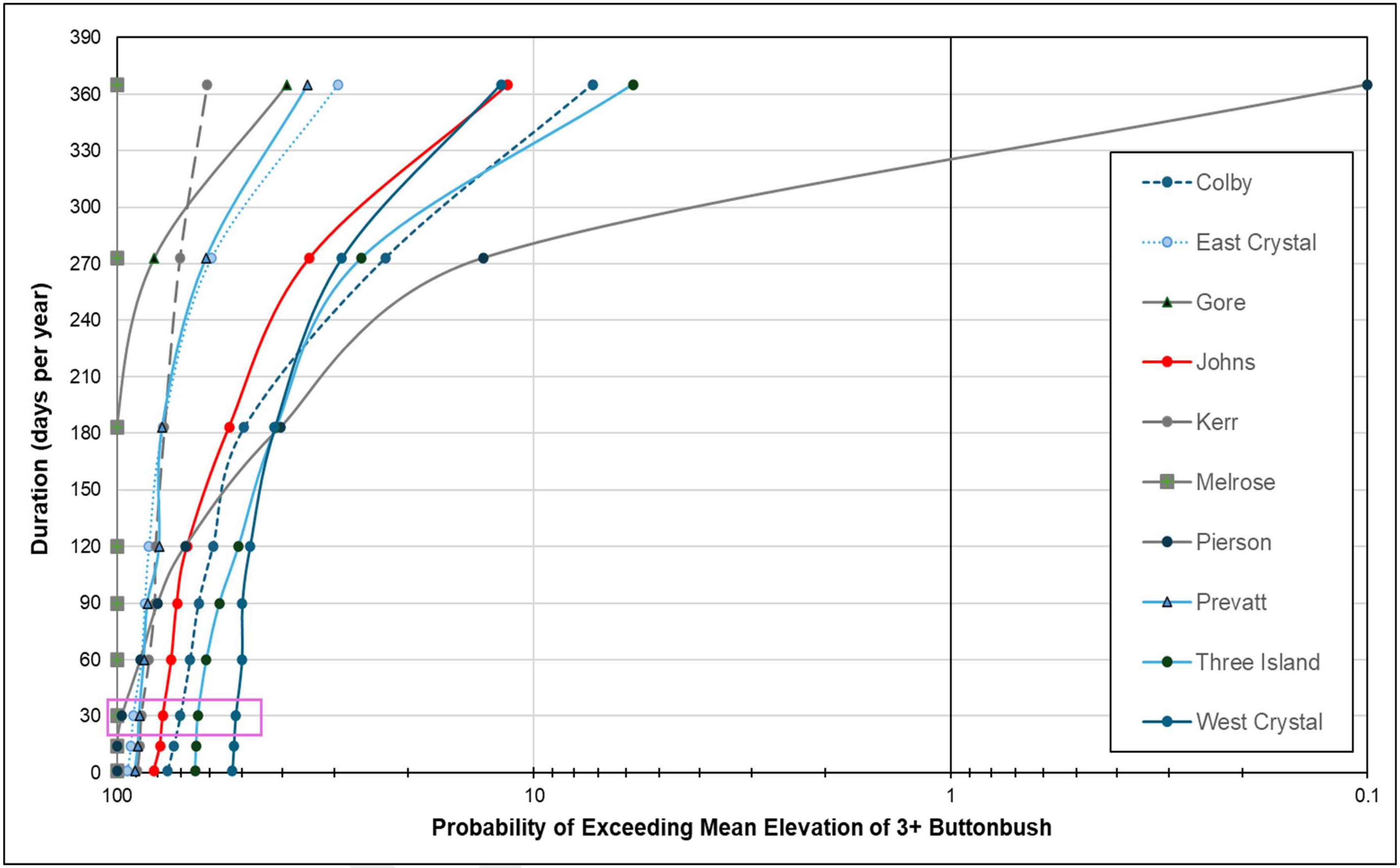


Figure C-18: Hydrologic signatures for all MFL lakes having buttonbush quadrats with a species cover class of 3 or above without using the cluster analysis.

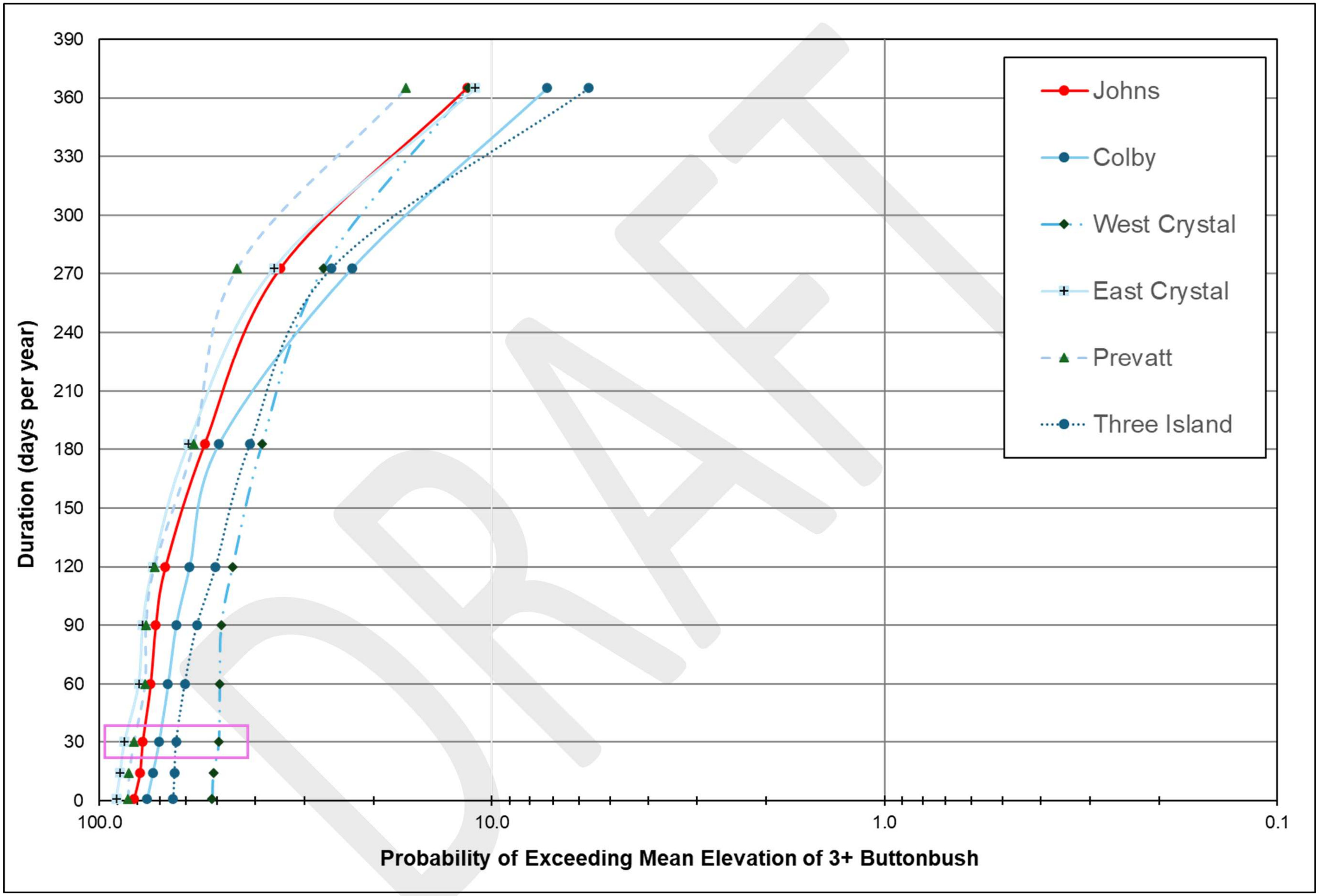


Figure C-19: Hydrologic signatures of the MFL lakes clustered into Group 4 using the cluster analysis.

Frequent High #2 (FH-2)

The second minimum FH recommended for Johns Lake is an elevation of 90.4 ft NAVD88, with a corresponding flooding duration of 60 continuous days between January 1st and May 31st, and a return interval of 3 years (i.e., 33 out of 100 years, on average).

Fishing for largemouth bass (and other game species) is a very important recreational value at Johns Lake. The purpose of this FH is to protect this regionally important bass fishery. The general indicator of protection for this metric is maintaining sufficient water depths within floating deep marsh vegetation communities during the spawning season, to ensure successful recruitment of largemouth bass. Declines in natality or increases in juvenile mortality over extended periods, due to loss of spawning and refugia habitat, could substantially reduce Johns Lake's largemouth bass population. Therefore, The purpose of the FH-2 is to ensure that water withdrawals do not reduce the frequency of flooding events in floating deep marsh habitats to a degree that significantly harms largemouth bass spawning and recruitment, as recommended by FWC biologists (E.J. Nagid, FWC, pers. comm. 2023).

This FH will provide protection for inundation events that occur during the largemouth bass spawning season, from the beginning of January until the end of May (Nagid 2022). The specific indicator of protection is a water depth of at least 1 ft above the average lakebed elevation of floating deep marsh communities, for a minimum of 60 continuous days during the January to May spawning season, measured at multiple representative field transects around Johns Lake.

The FH-2 is an inundation threshold that is meant to protect and maintain the following ecological structure and functions:

- maintenance of hydrophytic vegetation, mainly white water-lily (*Nymphaea odorata*) and spatterdock (*Nuphar advena*);
- protection of spawning habitat for largemouth bass and other fish species; and
- protection of forage habitat and refugia for bass and other aquatic species.

<u>Magnitude</u>

The FH level of 90.4 ft. NAVD88 equals the average elevation measured at multiple transects where the vegetated community is dominated by deep marsh floating plants (e.g., white water-lily and spatterdock). Since these floating plants provide refugia for spawning game fish, protecting average floating deep marsh elevations ensures strong year classes of these fish, especially young-of-the-year (YOY) largemouth bass.

Average floating deep marsh elevations were measured at three of five transects around Johns Lake (Table C-26). The average for Transects 3 and 4 could not be determined due to a lack of minimum floating deep marsh elevations.

Table C-26: Average elevations of the floating deep marsh (DMF) at Johns Lake.

Deep Marsh Elevations (ft NAVD88)	
Transect	DM(F) Avg Elev
1	89.3
2	88.7
3	*
4	*
5	90.1
Average	**89.4**

*Average omitted due to the inability to obtain minimum DMFelevation at transect

After averaging the average elevation of floating deep marsh at transects 1, 2 and 5, one foot was added to ensure adequate spawning depth for largemouth bass and other game fish (Stuber et al. 1982; Strong et al. 2010). This additional foot of depth will provide sufficient inundation of the average floating deep marsh elevation, creating habitat for largemouth bass, black crappie, etc, during the spawning season. A minimum of one foot of depth in the floating deep marsh also creates sufficient forage habitat and refugia for the survival of juvenile and YOY game fish (E.J. Nagid, FWC, pers. comm. 2023). Maintaining a floating deep marsh with white water-lily and spatterdock at Johns Lake is preferred for its structure because deep marsh habitats composed mainly of cattail thickets, can be too dense for fry and the open water leaves them more vulnerable to predation.

Duration

This FH includes a duration of 60 continuous days over a five-month period between January 1st and May 31st This duration and time of year are based on studies suggesting that largemouth bass spawning in Central Florida occurs during this time (Nagid 2022). Rogers and Allen (2009) noted that hatch dates began as early as December in south Florida lakes, January to February in central Florida lakes, and early March in north Florida lakes. The latest hatch occurred in May from south and central Florida lakes, while in north Florida the latest hatch occurred in June.

Predation causes significant mortality in early life stages of largemouth bass, and inundation of the floating deep marsh provides vital refugia for these fish. While small, YOY and juvenile largemouth bass remain in shallow water, relying on dense vegetation for food and cover.

A minimum flooding duration of 60 continuous days between January 1st and May 31st is sufficiently long to produce a strong year class of largemouth bass (Nagid 2022). An added benefit is that this duration will also be protective for other members of the sunfish family (e.g., black crappie, bluegill, redear, and warmouth) because it brackets significant portions of their spawning seasons. (E.J. Nagid, FWC, pers. comm. 2023).

Return Interval

Research suggests that largemouth bass require a strong year class approximately once every three to four years to maintain stable populations (Miranda et al. 1984; Nagid et al. 2015; E.J. Nagid, FWC, pers. comm. 2023).

Research on the effects of reservoir drawdown frequency on largemouth bass recruitment suggests that high water years that occur every three years after drawdowns are best for strong year class production in largemouth bass (Nagid et al. 2015). A strong year-class is typically produced the year following a reservoir drawdown, and largemouth bass YOY and juvenile densities and growth rates increase significantly for up to three years after drawdown (Moyer et al. 1995; Allen and Tugend 2002; Dotson et al. 2015; Nagid et al. 2015).

However, studies also note that refugia, usually in the form of aquatic macrophytes, is important for largemouth bass survival during spawning and early development. Therefore, maintaining the minimum frequency of sufficient depths to protect this refugia is critical. Based on this, and consultation with FWC biologists, a return interval of 3 years was selected for this FH.

Hydroperiod Tool Approach

Per Rule 62-40.473, *F.A.C.*, water management districts are directed to consider a suite of environmental values, also called water resource values (WRVs), when setting MFLs. One of these WRVs is "*fish and wildlife habitats and the passage of fish*". Typically, SJRWMD addresses this WRV through event-based metrics that are developed to maintain the long-term persistence and integrity of wetland communities.

As seen in sandhill lakes, where stable wetlands are absent and rapid water level fluctuations produce highly ephemeral communities, an alternative approach to event-based metrics is considered. Despite the unstable nature of these wetland communities, they harbor diverse wetland plant and animal communities that, while unstable (i.e., their locations move over the decades due to climate-driven lake fluctuation), are worth protecting from significant harm due to water withdrawals.

In an effort to ensure that MFLs developed for Johns Lake will adequately protect all relevant ecological and human-use values, it was deemed prudent to develop other metrics to augment the event-based criteria described above using the recently developed "hydroperiod tool" approach. The hydroperiod tool was developed with the South Florida Water Management District (SFWMD) and the University of Texas (Austin), to work with ESRI's ArcMap© and ArcPRO and has been used to set MFLs for other lakes in SJRWMD (Sutherland et al. 2021)..

The hydroperiod tool uses a Geographic Information System (GIS) to estimate the areal extent of different fish, wildlife, and recreational habitats and how they change with lake level change. Over recent years, since the start of data collection for Lake Prevatt in 2021, SJRWMD staff observed major fluctuations in shallow and deep marsh communities in response to large water level fluctuations. As communities move downslope during periods of drought, their areal coverage (e.g. total acreage) and habitat volume also change. in the areal extent of nearshore habitat are related to the combined effect of changing water level and specific lake bathymetry. For example, if "habitat" is defined as portions of the lake with depths ranging from 1 to 2 feet, the areal extent of this habitat will vary with water level and be a function of lake shape and slope (Figure C-21). Water level fluctuations may cause major changes in shallow and deep marsh communities. For example, as communities move downslope during periods of drought, their areal extent and volume also change. Lake bathymetry may also affect Tthe areal extent of habitats. For example, the areal extent of some habitats may be minimal at high elevations characterized by steep banks and extensive at lower elevations characterized by low slope due to a large flat shelf or lake bottom.

The hydroperiod tool functions primarily with raster (grid-based) representations of the environment in which elevation values from a Digital Elevation Model (DEM are subtracted from an interpolated water surface elevation on a grid cell-by-grid cell basis, producing a new raster surface containing elevation or depth of water for each grid cell (Figure C-21). The DEM for Johns Lake was developed in a three-part process using LIDAR-derived contours (from Lake County in 2006 and Orange County from 2004-2008), bathymetric survey data from MFLs staff in 2020 and 2021, and "Heads up" digitized aerial photographs from 1984 and 2014 (see Appendix A for more information).

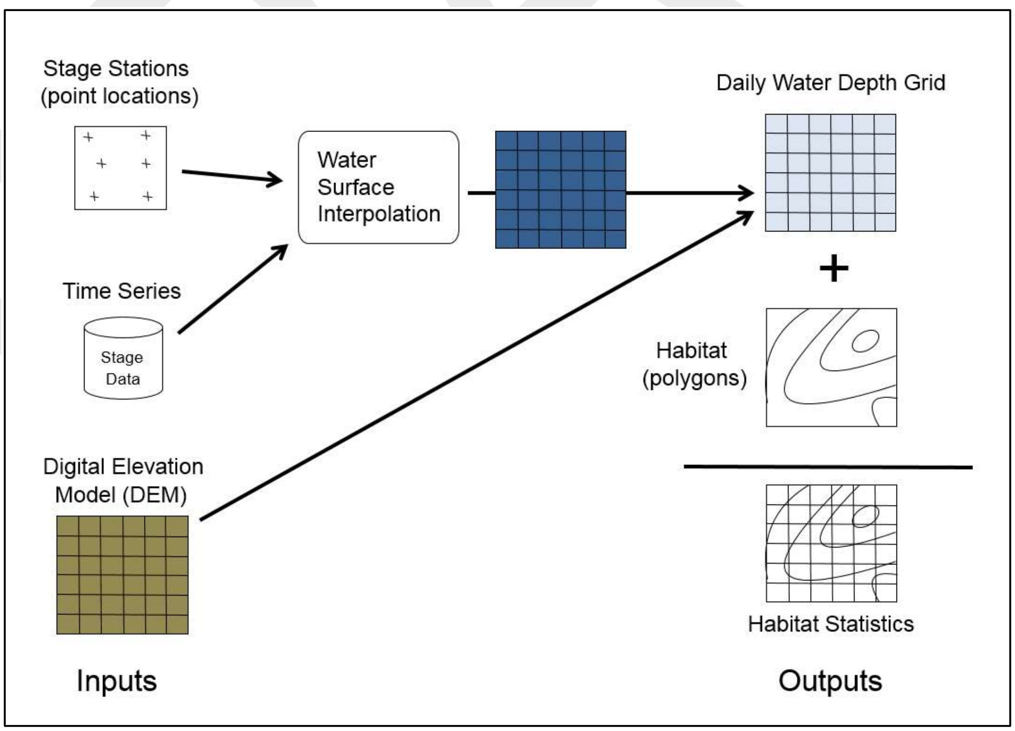


Figure C-20: Conceptual diagram of the hydroperiod tool used to estimate the relationship between lake stage and habitat area.

Average Habitat Area

Average area was calculated for each fish and wildlife habitat, for each day in the POR, using the stage/habitat area relationship derived from the hydroperiod tool and the simulated water surface elevations for the no-pumping condition. The MFLs condition for fish and wildlife habitat metrics equals a 15% reduction in average habitat area under the no-pumping condition (i.e., habitat area averaged across the entire no-pumping condition lake level timeseries). Assessment of habitat metrics is then simply the comparison of the average habitat area under the no-pumping condition to the average habitat area under the current-pumping condition (see Appendix D (MFLs Assessment)for more details).

Impact Threshold

Nearshore wetland communities at Johns Lake change in location and areal extent as lake levels fluctuate naturally (i.e., due to changes in climate). However, these communities can also change in extent due to water withdrawal. Therefore, it was deemed important to understand the relationship between lake level decline and a habitat's change in areal extent to understand whether water withdrawal has caused (or will cause) the areal extent of nearshore habitat to decline beyond an acceptable threshold.

The significant harm threshold used for this metric is a 15% reduction in the areal extent (acreage) of different habitats (see following sections for habitat descriptions) from the No-pumping condition. Other water management districts have used a 15% reduction of habitat availability as a significant harm threshold for MFLs (Munson and Delfino 2007). Also, this threshold has been peer reviewed and has been the basis for numerous adopted MFLs (see SJRWMD MFLs for Brooklyn and Geneva or SWFWMD MFLs for Crystal River, Gum Slough, Chassahowitzka River, and Homosassa River, among others). While many MFLs using this threshold are for flowing systems, a 15% reduction in habitat has previously been used as a critical threshold for lakes and is based on bird species richness studies (Hoyer and Canfield 1994; Leeper et al. 2001; Emery et al. 2009). This threshold is also within the range (10 to 33%) of percent allowable change documented in other studies (Munson and Delfino 2007). Setting a minimum allowable hydrologic condition for a given metric does not imply that this impact threshold will occur, but that the metric will be assessed to ensure that the minimum condition is always exceeded.

As noted in previous peer review of hydroperiod tool-based MFLs, this threshold has been supported by others, including Shaw et al. (2005) who states that *"… changes in available habitat due…occur along a continuum with few inflections or breakpoints where the* *response dramatically shifts.",* and therefore *"…loss or reduction in a given metric occurs incrementally …and in the absence of any clear statutory guidance* [they] *believe that the use of a 15 percent for loss of habitat is reasonable and prudent."*

Water Resource Values (WRVs) Impact Assessment

As noted above, Rule 62-40.473, *F.A.C.*, directs water management districts to consider a suite of WRVs, which are ecological and human-centric lake functions that the District aims to protect, when setting MFLs. Each applicable WRV was analyzed using Tthe hydroperiod tool and was assessed using a significant harm threshold of 15% change in areal extent (*see Appendix E for more details*). None of the assessments for the applicable WRVs indicated a 15% change in areal extent, so they are considered protected by the MFL condition.

Hydroperiod Tool Metrics

Nearshore Habitats

The nearshore environment (littoral zone) within Johns Lake provides habitat for numerous wildlife species, including wading birds (SJRWMD staff observations). The shallow littoral zone fringing the lake provides valuable habitat for various life stages, including refugia and forage habitat for aquatic invertebrates and small-bodied fishes. These areas also provide important reproductive habitat for fish, amphibians, and reptiles and forage habitat for wading birds.

Four nearshore habitats (emergent marsh, large wading bird forage, small wading bird forage, and sandhill crane nesting) were defined for this analysis. Habitats are areas within the nearshore environment with specific depth ranges and are based on water level requirements of plant and animal species known to inhabit the area (Figure C-22; Neubauer 1994; SJRWMD staff observations). These habitats were chosen to ensure that multiple portions of the nearshore environment were evaluated, in case one or more were particularly sensitive to water level change. Each habitat described below was evaluated using the hydroperiod tool to determine the amount of water level decline is associated with a 15% reduction in habitat extent (acres), relative to the long-term average no-pumping condition.

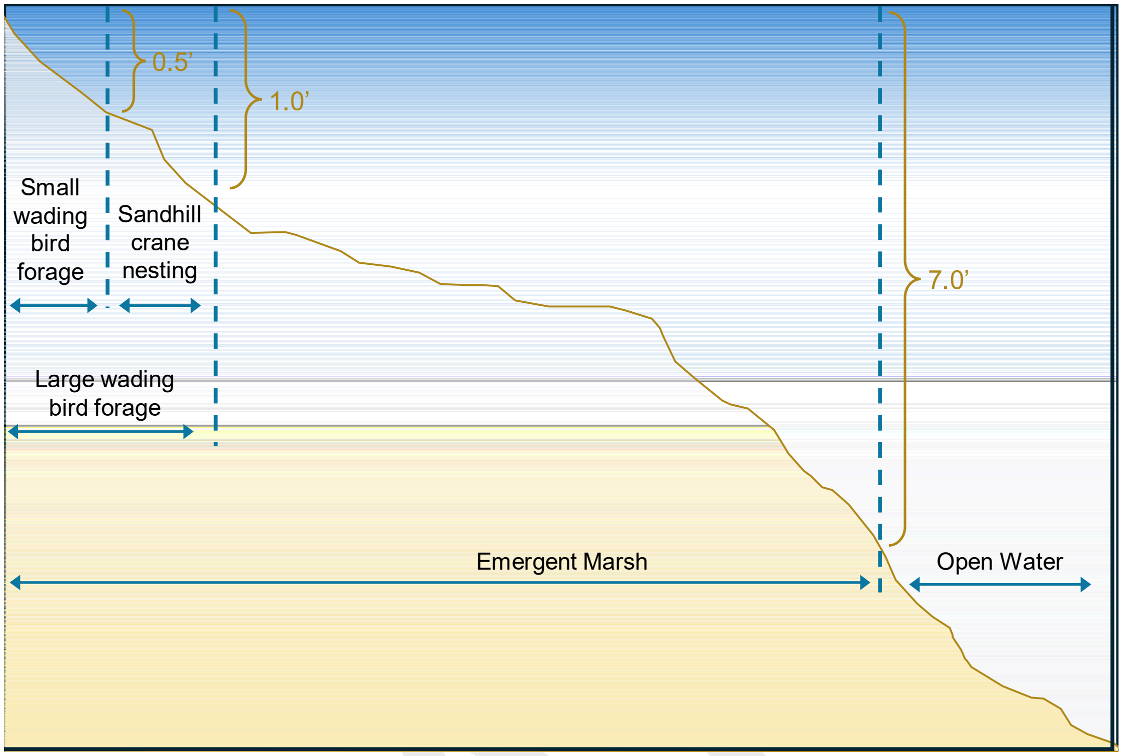


Figure C–21: Nearshore habitats and water depth ranges used in fish and wildlife habitat analyses.

Emergent Marsh Habitat

The littoral zone at Johns Lake includes both shallow and deep marsh habitats, with woody wetland shrubs (e.g., buttonbush). Shallow marsh vegetation is dominated by various nutsedges (*Cyperus spp.*), maidencane, pickerelweed, rush fuirena, torpedo grass , and marsh grass. Deep marsh habitats are dominated by southern cattail, broadleaf cattail, white water-lily, and torpedo grass. The vegetation data collected at Johns Lake indicate that deep marsh plants regularly grow up to seven feet deep at this site. A maximum depth of 7 ft was used based on the known depth ranges for species inhabiting these communities, so the emergent marsh habitat depth range used for this analysis is 0.1 to 7 ft.

Large Wading Bird Forage Habitat

Water depth is critical to wading bird habitat (Bancroft et al. 2002; Pierce and Gawlik 2010; Lantz et al. 2011). Forage success of long-legged wading bird species (e.g., great egret (*Casmerodius albus*) and great blue heron (*Ardea herodias*)) can be constrained by their leg length (Powell 1987), and typically forage in vegetation in water less than or equal to 10–12 inches (Kushlan and Kushlan 1979; Kushlan et al. 1985; Bancroft et al. 1990). Therefore, the depth range used to prevent a significant shift in forage habitat for large wading birds, is 0 to 1 ft.

Small Wading Bird Forage Habitat

Short-legged wading birds (little blue heron (*Egretta caerulea*), snowy egret (*E. thula*), ibis (glossy: *Plegadis falcinellus*; white: *Eudocimus albus*), etc.) require shallower habitat (~0.5 ft) for suitable foraging (Kushlan and Kushlan 1979; Kushlan et al. 1985). The depth range used, to prevent a significant change to forage habitat for small wading birds, is 0 to 0.5 ft.

Sandhill Crane Nesting Habitat

The Florida sandhill crane (*Grus canadensis* pratensis) typically nests in shallow herbaceous wetlands, dominated by maidencane, pickerelweed, rush and/or smartweed (*Polygonum* spp.; Stys 1997). The shallow marshes at Johns Lake provide nesting and forage habitat for sandhill cranes and other birds. A sandhill cranes was observed nesting in the shallows near Transect 1 shortly before data collection began (Figure C-23). Average water depths for suitable sandhill crane nesting ranges from approximately 0.5 to 1 ft (Stys 1997). This is the depth range used for evaluation of this habitat metric.

Figure C-22: Sandhill crane standing near a nest, south of Transect 1. Photo taken 3/3/2023.

<u>Recreation Habitats</u>

In addition to fish and wildlife habitat WRV, Rule 62-40.473, *F.A.C.*, also mandates consideration of other environmental values and beneficial uses. One of these WRVs is "recreation, in and on the water," the purpose of which is to protect water depths necessary for various recreational activities (e.g., fishing, swimming, etc.). Recreation in and on Johns Lake is an important beneficial use, both historically and currently.

Lake Area

The average lake surface area metric provides protection from significant change to aesthetic and scenic values. Maintaining the scenic value of a lake is often not a function of preserving water depth, but rather surface area. In other words, even very shallow areas across a lake add to the overall water coverage and scenic value and, reduce exposed areas.

Preventing significant change to the lake surface area will ensure that the amount of exposed shoreline does not increase significantly. Studies have shown that shoreline exposure due to low water levels is perceived as a primary impact to the aesthetic value of lakes (Hoyer et al. 2006; Kashian and Winden 2015), and can negatively affect lakeshore property value (Loomis and Feldman 2003).

In addition to aesthetics, lake surface area is also positively correlated with species richness and is a key component of the SWFWMD Species Richness Standard (Hoyer and Canfield 1994; Emery et al. 2009). This metric is similar to the species richness metric, in that it sets an allowable change to lake surface area. However, SWFWMD's metric is only calculated for the P50 lake surface area. Because of the differential sensitivity to pumping across the entire range of lake levels, using a P50 lake surface area criterion would likely not capture large changes to surface area that occur at water levels lower than the median.

Average lake surface area was calculated for each day in the POR, using the stage/area relationship derived from the hydroperiod tool and the simulated water surface elevations for the no-pumping condition. The MFLs condition for this metric equals a 15% reduction in the average lake surface area under the no-pumping condition (i.e., lake surface area averaged across the entire no-pumping condition lake level timeseries).

Canoe Depth

The purpose of this criterion is to prevent a significant change, due to water withdrawal and relative to no-pumping conditions, to minimum depths that allow for canoe/kayak passage around Johns Lake.

The paddling area for this metric is based on a depth offset. The offset (20") was chosen based in part on a 2004 environmental value assessment conducted on the St. Johns River that reported the draft of small flat-bottomed jon boats of 16 ft or less to be usually 1.5 ft or less (HSW 2006). The boat depth suggested by the HSW study is also consistent with an FDEP study that suggests that a minimum of 20" water depth is required for protecting bottom vegetation damage from paddling and boat prop actions. This study was conducted to determine the likelihood of "paddle gouging" of submerged vegetation within the Wekiva River basin by canoeists and boat propellers (FDEP 1990). The minimum paddling depth (20") chosen for the Johns Lake MFL is also consistent with canoe paddling depths used by the Suwannee River Water Management District in MFL determinations as well as in the Lake Prevatt MFL.

Open Water Area

An open-water metric has been developed to protect recreation opportunities and deep water habitats that provide important refuge habitat for fish and other organisms, especially during periods of low water. Open water is defined, for this metric, as those areas of the lake greater than or equal to 5 ft deep. The majority of emergent and floating-leaved plants at Lake Prevatt grow in water ranging in depths from 0 to 7 ft.

In many water bodies, aquatic organisms require refuge from drought. Although droughts are natural phenomena, water withdrawal can mimic and exacerbate drought and drying of aquatic ecosystems (Magoulick and Kobza 2003). Drought refugia are especially important for fish. During periods of low water (whether from drought and/or pumping) decreasing volumes of water can force organisms to concentrate into smaller areas and may cause increases in the extremes of abiotic conditions (e.g., high temperature and low dissolved oxygen) (Magoulick and Kobza 2003). The concentration of fish in drought refugia results in competition for space and resources, increasing exposure to predation (e.g., from birds and other fish) and disease (Lowe-McConnell 1975; Magoulick and Kobza 2003; Matthews and Marsh-Matthews 2003; Lennox et al. 2019).

As lakes recede, fish and other organisms move from shallow nearshore habitats to deeper areas (Gaeta et al. 2014). These open-water deep areas within lakes are more resistant than shallow areas to water level decline and thus provide critical refugia for fish and other species (White et al. 2016). Deep areas in lakes provide direct protection for fish from both predation (e.g., avian predators) and high temperatures. Deeper, cool water refugia are important habitats for game fish species throughout Florida. The open-water area metric will help prevent significant harm by protecting important thermal refuge, especially during summer and prolonged drought periods (Lennox et al. 2019).

Water level decline due to drought and/or withdrawal can also negatively affect lake water quality, indirectly affecting fish and other organisms. As lake levels decline, remaining refuge areas become warmer, have higher solar irradiation, and have increased concentrations of nutrients (Lennox et al. 2019). These factors can lead to the increased potential for excessive algal growth and decreased water quality. The open-water metric generally also protects a lake from increased eutrophication due to wind-driven mixing. The open-water metric will benefit Johns Lake water quality by reducing the potential for an increase in these negative effects.

Drought-related reductions in habitat area/volume, increased physical and chemical extremes, and increased negative biotic interactions (i.e., predation and competition) naturally occur in aquatic ecosystems (Magoulick and Kozba 2003; Humphries and Baldwin 2003). However, human-induced alterations, including water level declines due to water withdrawal (Magoulick and Kozba 2003), can exacerbate these stressors (Lennox et al. 2019), In addition to protecting ecological functions and values, the open-water metric will also help minimize the negative effects of water level decline on recreational uses and water quality at Johns Lake.

This metric is also largely recreation-based to allow for enough water clearance for motorized watercraft activities. Open water is defined, for this metric, as those areas of the lake greater than 7 ft deep. This depth was chosen because during the period of observation, two deep marsh vegetation species at Johns Lake, white water-lily and spatterdock, grew in dense patches to an average water depth of 7 ft (Table C-27). The maximum growing depth for white water-lily observed at Johns Lake, which is the dominant floating plant in Johns Lake, is also supported by scientific literature (Sinden-Hempstead 1985).

The MFLs condition for the open-water metric equals a 15% reduction in the average open-water area (lake area > 7 ft deep) under the no-pumping condition (i.e., open-water area averaged across the entire no-pumping condition lake level time series). As discussed above, using a 15% reduction in the average area is reasonable and prudent (Shaw et al. 2005; Cardno 2018). As with the fish and wildlife habitat metrics, assessment of the open-water metric is simply the comparison of the allowable average open-water area (15% reduction of area under no-pumping condition) to the average open-water area under the current-pumping condition (*see Appendix D (MFLs Assessment) for more details*).

Table C-27: Maximum depths of the floating deep marsh (DMF)-open water border on Transects 1-5 at Johns Lake.

Transect	Final DMF Station (m)	DMF Lowest Elevation (ft NAVD88)	Date of Survey	Water Level (ft NAVD88)	Max Growing Depth (ft)
1	56	86.18	4/27/2023	94.50	8.32
2	74	86.63	6/13/2023	93.91	7.28
3	52	92.66	5/30/2023	94.12	*
4	51	93.20	5/30/2023	94.12	*
5	112	88.40	6/13/2023	93.91	5.51
Average		**87.07**			**7.04**

*Transects 3 and 4 did not extend to open water, so the maximum depth of floating plants on these transects was not determined. Therefore, these elevations were omitted from the calculation of the average maximum growing depth.

Hydroperiod Tool Metric Results

Nearshore Fish and Wildlife Habitat Metrics

At Johns Lake, the four fish and wildlife habitats have varying trends relating to water levels. Shallow water metrics including mall wading bird forage habitat (0.1 – 0.5 ft), large wading bird forage habitat (0.1 – 1.0 ft), and Sandhill crane nesting habitat (0.5 – 1.0 ft), all peak in maximum area around 87 ft NAVD88. Emergent marsh habitat (0.1 – 7.0 ft) peaks at 89 ft NAVD88 (Figure C-24).

The occasional exposure of these lower elevations is especially important in this system as Johns Lake is within the wood stork (*Mycteria americana*) Core Foraging Area (CFA) and is used by numerous other wading bird species as a foraging habitat. Low water habitats concentrate forage fish into shallow pools, facilitating foraging for wading bird species.

Recreation and Lake Area Metrics

Recreation and lake area metrics (Lake Area, Open Water, and Canoe Depth) have similar trends as they all continue increasing with the lake stage (Figure C-23). This makes their stage-area curves different from the other habitat types, which generally increase as water level is reduced.

Allowable Area Reduction

For all HT metrics, the average areal extent in acres is determined based on the long-term No-pumping lake level. The average acreage for each habitat type is reduced by 15% from the No-pumping condition, and that determines the potential MFLs condition (Table C-28).

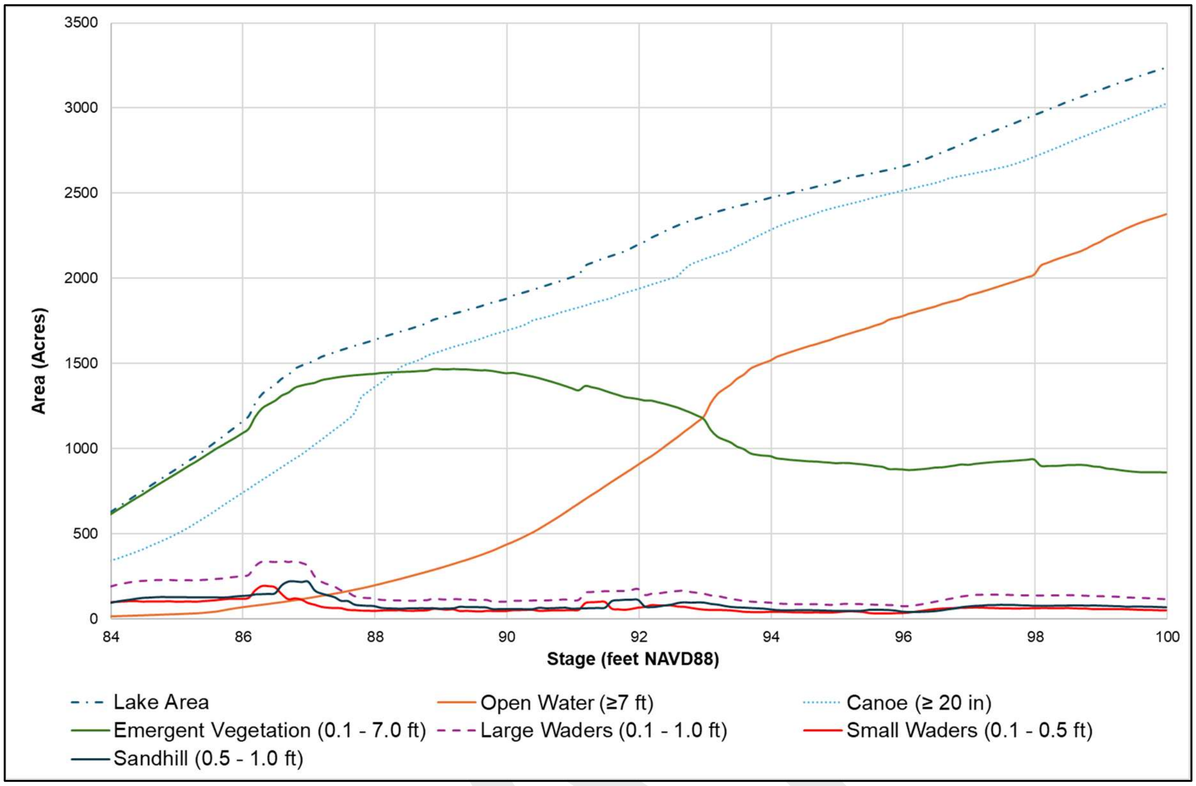


Figure C-23: Stage-Area curves of the hydroperiod tool metrics which were assessed at Johns Lake.

Table C-28: Percent change and acre change from the No-Pumping Condition to the potential MFLs Condition.

Environmental Criterion	NP Condition Average Area (acres)	Minimum Metric Condition (15% reduction from NP condition) (acres)
Small wading bird forage habitat	46	39.1
Large wading bird forage habitat	105.5	89.7
Sandhill crane nesting habitat	59.5	50.5
Emergent marsh habitat (≤7 ft)	993.3	844.3

Environmental Criterion	NP Condition Average Area (acres)	Minimum Metric Condition (15% reduction from NP condition) (acres)
Canoe depth (≥ 20 in)	2299.1	1954.2
Lake area (≥ 0.1 ft)	2488.5	2115.2
Open-water area (≥7 ft)	1495.2	1270.9

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