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Physical and Vegetative Characteristics of Floating Islands

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ABSTRACT

Due to variable biomass and volume among floating islands (or tussocks), efficiency of management is often difficult to predict before activities occur. Objectives were to identify major types of floating islands based on dominant vegetation, and to evaluate physical and vegetative characteristics of each type. In October 1997, analysis of 116 floating islands on Orange Lake, Florida revealed five major types: 1) Cuban bulrush (*Scirpus cubensis* Poepp. and Kunth.) and water pennywort (*Hydrocotyle* spp.); 2) grasses; 3) bur marigold (*Bidens* spp.), cattail (*Typha latifolia* L.), and smartweed (*Polygonum* spp.); 4) facultative (plants that occur in wetlands and uplands); and 5) pickerelweed (*Pontederia cordata* L.). In November 1997, three floating islands per type were examined to evaluate size, composition and coverage of plant taxa, and depth and composition of the floating mat. Large overlap in characteristics among types revealed that definitive physical properties for each type did not exist. A more meaningful grouping emphasized the two types of floating mats that were observed: 1) deeper mats containing larger amounts of organic matter in addition to plant roots (mud tussocks), which were generally dominated by larger plant taxa, and 2) shallower mats composed primarily of plant roots with little or no organic matter (floating-type tussocks), which were generally dominated by smaller plant taxa. Dominant vegetation can be used to distinguish between the two types of tussocks and, thus, may aid in planning floating island removal activities and selecting work sites.

Key words: tussocks, sudds, habitat enhancement, lake restoration.

INTRODUCTION

Floating islands, also known as tussocks, floatons, or sudds (Alam et al. 1996, Haller 1996), are common in many Florida lakes and across the world (Kaul and Zutshi 1966, Trivedy et al. 1978, Sasser et al. 1995, 1996). Floating islands are composed of native or exotic plants growing on a buoyant mat consisting of plant roots and organic matter (detritus). This definition includes small (less than 0.01 ha) free-floating islands and extensive, stationary, vegetated mats which may cover hundreds of hectares of water. Although floating islands often contain floating aquatic plant species such as water hyacinth (*Eichhornia crassipes* (Mart.) Solms.) and frog's-bit (*Limnobium spongia* (Bosc.) Steud.), they are not made up entirely of floating aquatic vegetation.

Interest in floating islands in Florida lakes has recently increased due to problems associated with their accumulation along shorelines, which may block lake-access points (docks and boat ramps), interfere with recreation and navigation, and shade out and displace desirable submersed and emergent vegetation (Hujik 1994, Mallison and Hujik 1999). Water below extensive stands of floating islands is often low in dissolved oxygen and high in organic matter, thus water quality is poor for fisheries habitat (Alam et al. 1996). Extensive growth of floating islands can also degrade wildlife habitat (Mallik 1989). Unmanaged floating islands play a role in succession from open water to marshes and swamps (Huffman and Lonard 1983, Lieffers 1984, Mallik 1989). Consequently, lake management agencies are interested in methods of removing floating islands to promote expansion of desirable, rooted vegetation and thereby enhance fish and wildlife habitat and water quality (Hujik 1994, Hulon et al. 1998, Mallison and Hujik 1999).

Efficiency of floating island removal techniques (area harvested/time) is influenced by the amount of material per area (biomass or volume) to be removed. Removing mud tussocks, which contain large amounts of sediment and organic matter in the floating mat, may require 2-3 times the effort and cost as removing an equal area of floating islands composed primarily of floating vegetation (Hujik 1994, Mallison and Hujik 1999). Haller (1996) reported that the size and biomass of floating islands vary greatly. Those composed of plants with more extensive root systems retain more water and sediment, and consequently, have more biomass. Although actual weights of floating island are variable, the relative weights of those dominated by common plant taxa were reported by Haller (1996): water hyacinth < frog's-bit and Cuban bulrush (*Scirpus cubensis* Poepp. and Kunth.) < cattail (*Typha latifolia* L.) < water primrose (*Ludwigia* spp.) < pickerelweed (*Pontederia cordata* L.) < willow (*Salix* spp.) and maple (*Acer* spp.). Using dominant vegetation (easily-obtained information) to identify different types of floating islands (in terms of the amount of material) could aid in determining appropriate removal techniques and predicting efficiencies and costs associated with floating island removal.

The objectives of this study were to: 1) generate a list of plant taxa present on Orange Lake floating islands, 2) identify the major types of Orange Lake floating islands based on

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dominant vegetation taxa and communities, and 3) characterize and compare each major type in terms of size, dominant vegetation taxa and coverages, and depth and composition of the floating mat.

STUDY AREA

Orange Lake (5,080 hectares) is located in Alachua County, Florida. Aerial coverage of floating islands was approximately 800 ha during this study. Floating islands have been present in Orange Lake for more than 100 years (Clark and Reddy 1998). Floating island management has been limited to small-scale removal or relocation of floating islands to maintain navigation and access in canals and boat ramps. Vegetation growing on floating islands included floating plants such as water hyacinth and frog's-bit, emergent plants such as pickerelweed and cattail, and plants that are generally found on land along shorelines such as willow and maple trees.

METHODS

An analysis of 116 floating islands was conducted on Orange Lake in October 1997 and included inspection of all free-floating islands along the northeast shoreline between Cross Creek and River Styx. For each floating island, the canopy coverage of all major plant taxa (defined as those with ≥10% coverage) was visually estimated to the nearest 10%. The plant with the highest coverage (excluding understory plants) was considered dominant. When plants grew in association or had similar growth characteristics, they were grouped as follows: all floating islands dominated by one or more facultative (occur in wetlands and uplands) or facultative-wetland (achieve greatest abundance in wetlands but also may occur in uplands) plant were combined into the "facultative" type of floating island (Gilbert et al. 1995). Cuban bulrush and water pennywort *Hydrocotyle* spp., which have a similar growth pattern (lateral growth of floating stems and runners into open water), were lumped into the "Cuban bulrush and water pennywort" type. The two obligate-wetland (occur in habitats generally inundated with water or with soils saturated with water (Gilbert et al. 1995)) grasses, American cupscale grass (*Sacciolepis striata* (L.) Nash.) and maidencane (*Panicum hemitomon* Schult.), were lumped into the "grasses" type. Bur marigold (*Bidens* spp.), cattail, and smartweed (*Polygonum* spp.) frequently occurred in association (apparent community) and were consequently classified as a single type ("bur marigold, cattail, and smartweed"). "Pickerelweed" was the only type defined by a single species.

Characterization sampling of each major type of floating island was conducted in November 1997. Three floating islands of each type were systematically selected by examining every third floating island of each type, as follows: The length and width of each floating island was measured to the nearest 0.5 m. Height of the tallest dominant plant was measured to the nearest 0.5 m. Mature dominant plants were dug out of the floating mat with a shovel, and composition of the floating mat (live-root and organic-matter content) was visually estimated to the nearest 25%. At one meter intervals along one half the length of the long axis, a minimum of three and a maximum of five stations was chosen for each floating island. At each station, all plants within a 20-cm by 50-cm frame were identified and coverage estimated following Daubenmire (1959). Also at each station, a fish measuring board was punched through the floating mat, rotated 90 degrees, and pulled up snug to the bottom of the mat to measure mat depth (in cm) from the bottom to the top. Analysis of variance was used to test for differences in floating-mat depth among types of floating islands, and least squares means to determine which types differed from each other (SAS Institute Inc. 1985). A Bonferroni adjustment was used to correct significance level for multiple comparisons (alpha divided by number of comparisons).

RESULTS AND DISCUSSION

Twenty-nine plant taxa were identified on Orange Lake floating islands (Table 1). Most (21 taxa) were classified as obligate wetland plants. Six were facultative or facultative-wetland plants. Some taxa (aster (*Aster* spp.), sawgrass (*Cladium jamaicense* Crantz.), and arrow arum (*Peltandra virginica* (L.) Schott and Endl.)) were observed on floating islands outside of the sampling area. Several plant species identified by Clark and Reddy (1998) in Orange Lake floating and rooted wetlands (included floating islands and rooted emergent communities) were not found during this study.

Twenty plant taxa occurred at major coverage (≥10%) on at least one of the 116 floating islands (Table 2). The most common plant was water pennywort, which occurred at a coverage of ≥10% on 111 (96%) of the floating islands, and a coverage of ≥50% percent on 95 (82%) of them. Due to the regularity of water pennywort occurring at high canopy coverage (≥50%) but growing understory to larger plant taxa, it was excluded as a factor in defining types unless it was the only plant with ≥50% coverage (i.e., only considered dominant when larger plants were not growing over the top of it). The three other plant taxa that occurred at a coverage of ≥10% on at least half of the floating islands were bur marigold (59% of the floating islands), pickerelweed (59%), and Cuban bulrush (50%).

Although many plant taxa occurred on many different floating islands, division of floating islands into recognizable types based on the dominant vegetation was possible. Out of 116 floating islands surveyed, 101 (87%) could be categorized into one of five major types based on dominant vegetation (Figure 1). The most common type of floating island was pickerelweed, with 35 floating islands (30% of the sample). Cuban bulrush and water pennywort, and bur marigold, cattail, and smartweed floating islands were the next most abundant types at 27% and 15% of the sample, respectively.

Characterization sampling revealed considerable overlap in the composition and coverage of plant taxa among floating island types (Table 3). Within-group mean coverage of water pennywort was ≥23% for all types. Within-group mean coverage of American cupscale grass, bur marigold, and Cuban bulrush was ≥10% on three of the five types. Size of floating islands, as reported by Haller (1996), was highly variable (range 16-247 m^2), and was not related to type or dominant vegetation. The composition of floating mats was approximately 50% live root and 50% organic matter for facultative and pickerelweed floating islands and portions of bur mari-

TABLE 1. PLANT TAXA, FREQUENCY OF OCCURRENCE AT ≥10% COVERAGE (PERCENT OF TOTAL NUMBER (116) OF FLOATING ISLANDS), AND HABITAT RANKING (FAC = FACULTATIVE, FACW = FACULTATIVE WETLAND, OBL = OBLIGATE WETLAND, AND VINE = VINE, FROM GILBERT ET AL. (1995)) FOR VEGETATION OBSERVED ON ORANGE LAKE FLOATING ISLANDS, OCTOBER AND NOVEMBER 1997.

Scientific name	Common name	Percent frequency	Habitat ranking
Hydrocotyle spp.	water pennywort	96	OBL
Bidens spp.	bur marigold	59	OBL
Pontederia cordata L.	pickerelweed	59	OBL
Scirpus cubensis Poepp. and Kunth.	Cuban bulrush	50	OBL
Polygonum spp.	smartweed	38	OBL
Typha latifolia L.	cattail	29	OBL
Ludwigia spp.	water primrose	25	FACW
Limnobium spongia (Bosc.) Steud.	frog's-bit	22	OBL
Panicum hemitomon Schult.	maidencane	22	OBL
Sagittaria spp.	arrowhead	14	OBL
Andropogon virginicus L.	broom sedge	13	FAC
Amaranthus australis (Gray) Sauer.	southern amaranth	11	OBL
Eupatorium capillifolium (Lam.) Small.	dog fennel	10	FAC
Sacciolepis striata (L.) Nash.	American cupscale grass	7	OBL
Solidago fistulosa Mill.	goldenrod	5	FACW
Decodon verticillatus (L.) Ell.	swamp loosestrife	4	OBL
Thelyperis thelypteroides (Michx.) J. Holub	marsh fern	3	FACW
**Colocasia esculenta* (L.) Schott	wild taro	3	OBL
Eleocharis baldwinii (Torr.) Chapm.	road-grass	3	OBL
Salix spp.	willow	2	OBL
**Alternanthera philoxeroides* (Mart.) Groseb.	alligatorweed	0	OBL
Cyperus spp.	umbrella sedge	0	FACW
Mikania scandens (L.) Willd.	climbing hempvine	0	VINE
Nuphar luteum L. Sibth. and Smith	spatterdock	0	OBL
**Pistia stratiodes* L.	water lettuce	0	OBL
Salvinia spp.	water fern	0	OBL
Scirpus californicus (Meyer) Steud.	giant bulrush	0	OBL
Sium suave	water parsnip	0	OBL
Stachys spp.	hedge nettle	0	—

*Exotic.

TABLE 2. NUMBER OF FLOATING ISLANDS PER TYPE CONTAINING ≥10% COVERAGE OF EACH PLANT TAXA, ORANGE LAKE, FLORIDA, OCTOBER 1997. PERCENT OF TOTALS IN PARENTHESES.

	Floating island type						
Plant taxa	Bur marigold, cattail, and smartweed	Cuban bulrush and water pennywort	Facultative	Grasses	Pickerelweed	Undefined	Total
Water pennywort	17 (100)	30 (97)	11 (79)	8 (100)	34 (97)	11 (100)	111 (96)
Bur marigold	12 (71)	17 (55)	11 (79)	4 (50)	23 (66)	2 (18)	69 (59)
Pickerelweed	8 (47)	16 (52)	3 (21)	2 (25)	35 (100)	5 (45)	69 (59)
Cuban bulrush	9 (53)	22 (71)	6 (43)	3 (38)	14 (40)	4 (36)	58 (50)
Smartweed	10 (59)	10 (32)	2 (14)	4 (50)	14 (40)	4 (36)	44 (38)
Cattail	10 (59)	8 (26)	4 (29)	4 (50)	8 (23)	0 (0)	34 (29)
Water primrose	4 (24)	6 (19)	10 (71)	1 (13)	6 (17)	2 (18)	29 (25)
Frog's-bit	3 (18)	13 (42)	2 (14)	2 (25)	3 (9)	4 (36)	27 (23)
Maidencane	3 (18)	6 (19)	0 (0)	5 (63)	7 (20)	4 (36)	25 (22)
Arrowhead	5 (29)	4 (13)	2 (14)	0 (0)	3 (9)	2 (18)	16 (14)
Broom sedge	4 (24)	2 (6)	7 (50)	0 (0)	1 (3)	1 (9)	15 (13)
Southern amaranth	3 (18)	4 (13)	0 (0)	0 (0)	5 (14)	1 (9)	13 (11)
Dog fennel	3 (18)	1 (3)	8 (57)	0 (0)	0 (0)	0 (0)	12 (10)
American cupscale grass	1 (6)	1 (3)	0 (0)	4 (50)	2 (6)	0 (0)	8 (7)
Goldenrod	0 (0)	1 (3)	4 (29)	0 (0)	1 (3)	0 (0)	6 (5)
Swamp loosestrife	1 (6)	2 (6)	0 (0)	0 (0)	1 (3)	1 (9)	5 (4)
Marsh fern	0 (0)	0 (0)	3 (21)	0 (0)	1 (3)	0 (0)	4 (3)
Road-grass	0 (0)	2 (6)	1 (7)	0 (0)	0 (0)	0 (0)	3 (3)
Wild taro	1 (6)	1 (3)	0 (0)	0 (0)	0 (0)	1 (9)	3 (3)
Willow	0 (0)	1 (3)	0 (0)	0 (0)	1 (3)	0 (0)	2 (2)
Total number of islands	17	31	14	8	35	11	116

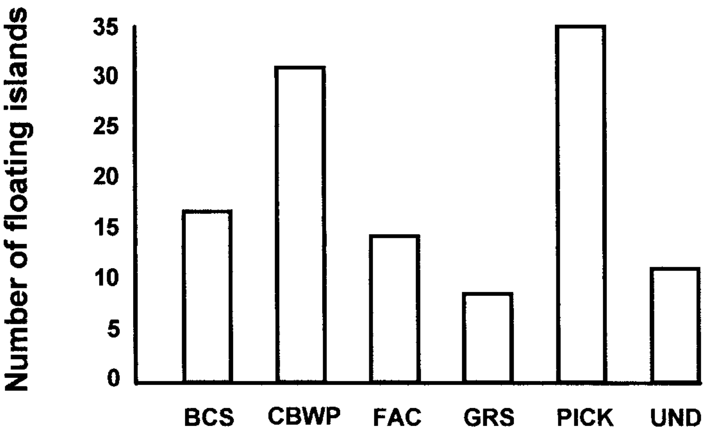

Figure 1. Frequency of occurrence of major types of floating islands on Orange Lake, Florida, October 1997. BCS = Bur marigold, cattail, and smartweed type of floating island; one of these taxa dominant with coverage ≥50%. CBWP = Cuban bulrush and water pennywort type of floating island; Cuban bulrush dominant with coverage ≥50% or water pennywort the only plant with coverage ≥50%. FAC = Facultative type of floating island. Combined coverage of facultative and facultative-wetland taxa ≥50%, and one of these taxa dominant or co-dominant with coverage ≥40%. GRS = Grasses type of floating island; American cupscale grass or maidencane dominant with coverage ≥50%. PICK = Pickerelweed type of floating island; pickerelweed dominant with coverage ≥50%. UND = Undefined floating islands; combination of above types (6), or dominated by arrowhead (1), frog's-bit (3), swamp loosestrife (1), or wild taro (1) with coverage ≥50%.

gold, cattail, and smartweed floating islands that were dominated by cattail. The composition of floating mats was approximately 75% live root and 25% organic matter for grasses, Cuban bulrush and water pennywort floating islands, and portions of bur marigold, cattail, and smartweed floating islands that were dominated by bur marigold or smartweed. The mean depth of the floating mat was significantly different among types ($P < 0.01$) (Figure 2). The mean mat depth of pickerelweed floating islands was greatest (50 cm) and significantly more ($P < 0.05$) than that of bur marigold, cattail, and smartweed; grasses; and Cuban bulrush and water pennywort floating islands. The mean mat depth of Cuban bulrush and water pennywort floating islands was smallest (24 cm) and significantly less ($P < 0.05$) than that of grasses, facultative, and pickerelweed floating islands.

These results indicate that defining types of floating islands based on dominant vegetation is possible. However, in terms of management, a more meaningful grouping would emphasize the amount of material, which is better described by floating mat characteristics. There were two types of floating mats observed in this study: deeper floating mats containing larger amounts of organic matter in addition to plant roots (mud tussocks), and shallower floating mats comprised primarily of plant roots and little or no organic matter (floating-type tussocks). Mud tussocks were dominated by larger plant taxa (rooting forms) including pickerelweed, cattail, water primrose, arrowhead (*Sagittaria* spp.), broom sedge

TABLE 3. MEAN PERCENT COVERAGE OF PLANT TAXA FOUND DURING CHARACTERIZATION SAMPLING ON THREE FLOATING ISLANDS PER TYPE (TOTAL OF 15 FLOATING ISLANDS), ORANGE LAKE, FLORIDA, NOVEMBER 1997.

	Floating island type					
Plant taxa	Bur marigold, cattail, and smartweed	Cuban bulrush and water pennywort	Facultative	Grasses	Pickerelweed	Total
Water pennywort	46	54	62	23	69	51
Bur marigold	18	5	42	3	31	20
Pickerelweed	<1	5	2	22	63	19
Cuban bulrush	5	57	5	10	13	18
American cupscale grass	18	0	18	21	1	12
Maidencane	0	1	0	61	0	12
Smartweed	18	7	13	2	3	9
Water primrose	<1	1	38	1	2	9
Dog fennel	0	0	38	0	0	8
Cattail	33	0	1	0	0	7
Arrowhead	13	0	7	0	0	4
Frog's-bit	1	7	1	1	10	4
Broom sedge	0	0	13	0	0	3
Climbing hempvine	6	1	1	0	0	2
Goldenrod	0	0	5	0	0	1
Alligatorweed	0	1	0	0	0	<1
Southern amaranth	1	0	0	1	0	<1
Wild taro	0	0	0	0	1	<1
Umbrella sedge	0	0	2	0	0	<1
Road-grass	0	0	1	0	0	<1
Spatterdock	0	1	2	0	0	<1
Water parsnip	0	0	0	0	1	<1
Hedge nettle	0	0	0	2	0	<1
Total number of taxa	12	11	17	11	9	22

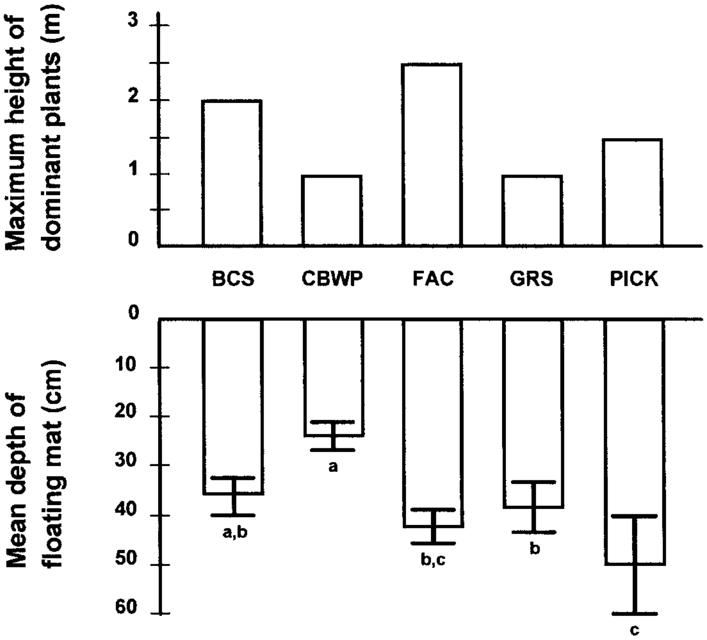

Figure 2. Maximum height of dominant plant taxa and mean depth of the floating mat (bars represent ±2 SEs) for three floating islands per type, Orange Lake, Florida, November 1997. Types of floating islands: BCS = Bur marigold, cattail, and smartweed; CBWP = Cuban bulrush and water pennywort; FAC = Facultative; GRS = Grasses; and PICK = Pickerelweed. Types with the same letter were not significantly different from each other in depth of the floating mat.

(*Andropogon virginicus* L.), dog fennel (*Eupatorium capillifolium* (Lam.) Small.), goldenrod (*Solidago fistulosa* Mill.), marsh fern (*Thelyperis thelypteroides* (Michx.) J. Holub), wild taro (*Colocasia esculenta* (L.) Schott), and willow and maple trees. This included facultative and pickerelweed types of floating islands and cattail-dominated areas of bur marigold, cattail, and smartweed floating islands. Floating-type tussocks were dominated by smaller taxa, including American cupscale grass, maidencane, water pennywort, Cuban bulrush, frog's-bit, and smartweed. This included grasses and Cuban bulrush and water pennywort types of floating islands, and smartweed-dominated areas of bur marigold, cattail, and smartweed floating islands. Mud tussocks had a greater amount of material (deeper mats and larger plant taxa) than floating-type tussocks. Dominant vegetation can be used to distinguish between the two types of tussocks, which may aid in predicting efficiencies of tussock removal activities and establishing boundaries for work areas.

Understanding the successional development of floating islands may lead to more effective lake management strategies that are designed to reduce or prevent their expansion and formation. Removal during an early stage of formation when the amount of material is presumably lowest (floating-type tussocks) may greatly improve the efficiency of removal techniques or maintenance control. Future research could analyze successional patterns of individual floating islands to determine if floating-type tussocks develop into mud tussocks, and if so, to determine the time frame for succession. Such successional patterns were apparent in previous studies by Huffman and Lonard (1983) and Mallik (1989). This information may reveal the amount of time available for removing floating islands at an earlier successional stage (i.e., before development into larger floating islands that are more costly to remove). This could maximize long-term project cost efficiencies and the amount of area that may be enhanced, and provide a time frame during which activities may occur.

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