An Evaluation of the Biological Health of Lake Powell, Walton/Bay Counties, Florida

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ABSTRACT: Biological and Physiochemical assessments were performed on Lake Powell, (Walton, Bay Counties, FL) in the summer of 2003 and spring of 2004. The biological condition of Lake Powell, was determined by evaluating the habitat conditions of the lakeshore, surveying the littoral plant and macrobenthic invertebrate assemblages, analyzing a suite of chemical parameters which measure the levels of nutrients and pollutants in the water, and measuring characteristics of the bottom sediment of the lake. These results were compared to FL DEP study conducted in 2000 (Payne and Butts, 2001). Overall water quality in Lake Powell was similar to levels measured in 2000. However, a decrease in habitat quality, a significant shift in sediment grain size and organic content, and a near complete collapse in the macrobenthic community show that biological impairment in Lake Powell has occurred since 2000.

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Introduction

Lake Powell, a large coastal dune lake (approx. 660 acres), and a designated Florida Outstanding Waterbody has had a central role in the development of Northwest Florida. Camp Helen State Park, which occupies the peninsula between Lake Powell and the Gulf of Mexico has been occupied by Humans for over 4,000 years and is the site of numerous archaeological sights. Geologically a freshwater lake (Tesar, 1996; FDEP, 1997), Lake Powell has been an estuarine environment for the last 100 years due to the manipulation of Phillip's Inlet (FDEP, 1997). Activity within the Lake Powell watershed has been intense during the last 140 years. Uses of Lake Powell, previously known as Lake Ocala, include a salt works operated by the Confederacy, a school was established in the late 1800's near Phillip's Inlet, and several resorts operated from the 1920's through 1987 (FL DEP 1997). Currently Lake Powell is affected by the maintenance of Phillip's Inlet and the development pressure within the watershed. Business interests continue to view Lake Powell as an attractive setting for the development of varied urban venues, i.e. golf courses, a marina, and housing developments. Conservationists seek to preserve the archaeological and historical significance of the area as well as well as to safeguard the valued, rare, and endangered biological sanctuary for freshwater and marine life and as a place to enjoy the natural surroundings of the Florida Panhandle.

Coastal dune lakes are a very rare and endangered habitat type that is unique and endemic to the northern coast of the Gulf of Mexico, occurring in the Gulf Coastal Lowlands (lake region 75-01) (Griffith, et al. 1997). At least five such lakes in Walton County have been designated as "imperiled globally because of extreme rarity" by the Florida Natural Areas Inventory (FNAI 2002). They serve as an interface not only

between the terrestrial and aquatic environments, but also between freshwater and marine environments as well. Coastal Dune Lakes serve as important breeding, nursery, and nesting grounds for many bird species and commercially important marine fish. The protected shores of these dune lakes provides habitat for invertebrate food, shelter, and protection from harsh physical conditions.

Geologically young, the Panhandle's Coastal Dune Lakes are between 2,000 and 10,000 years old. They are found near the coast (within 2 miles), many have extensive dune systems (up to 500 ft. wide and 10-30 foot high ridges), and they have an intermittent connection with the Gulf of Mexico. The intermittent connection with the Gulf of Mexico is a defining character of these lakes and dominates the biological interactions within. Encroaching saltwater affects both the terrestrial and aquatic communities of the lake. Terrestrial communities are limited by the high salinity of the water, wave action, and sand substrate, resulting in a less diverse xeric scrub community that can withstand variable conditions. Aquatic communities are also limited to reduced plant and animal diversity by oligotrophic nutrient conditions, and a varying salinity gradient. Although many of these lakes are estuarine, increased saltwater from storm surges can cause a shift from soft, acid, and tannic water to a more marine like environment with higher pH and hardness.

Coastal Dune Lakes are particularly sensitive to nutrient enrichment and consequently are very susceptible to eutrophication. Therefore it is imperative that any activities on or near the lake and in the surrounding watershed pay careful attention to preventing and eliminating the release of nutrients and sediments into the ecosystem. Without careful planning and such protection, these lakes will change from clear,

oligotrophic, natural, and aesthetically pleasing waterbodies into turbid, polluted waterbodies that have little biological value and will be a source of complaint by homeowners.

In an effort to protect the biological integrity of Lake Powell, Lakewatch, the Choctawhatchee Bay Alliance, the Florida Dept. of Environmental Protection and the Walton County Extension service have been monitoring nutrient conditions within the lake. Increasing phosphorus levels have been measured by Environmental Services, Incorporated (ESI) since May 2000 at several sampling stations within the lake (Figure 1). Of special concern is the rate at which Phosphorus has increased since surveys began in recent years. In a three year period, (1999-2002), Total Phosphorus levels at least doubled every year at all ESI stations, with Station 1 increasing 13.7 times from 15 ug/L to 205 ug/L during this time period (Table 1). CBA and Lakewatch monitored a similar trend of rapidly increasing Total Phosphorus levels within Lake Powell. During the same time period, average Total Phosphorous levels increased from 40.8 ug/L for the years 1999-2001 to 128 ug/L for the year of 2002 (Figure 2), the highest Total Phosphorous measurement (542 ug/L) was recorded on 2/17/2002, approx. 35X greater then average values in 1999 when monitoring began. Additionally, there was a large increase in turbidity monitored throughout the lake in March 2003. (Figure 3) These reports coupled with increasing nutrient levels monitored by ESI sampling led to an intensive sampling event by the FL Dept. of Environmental Protection.

METHODS

To determine the cause and scope of the elevated nutrient levels in Lake Powell, an examination of the lake's habitat quality, floral assemblage, water quality, and bottom sediments was conducted on 16 July, 2003. A follow up survey consisting of a habitat assessment, macro-invertebrate collection, water quality, and bottom sediment collection was conducted on 6 April, 2004. These examinations were conducted by Frank Butera and Wesley Keller of the FL DEP and Phillip Ellis of the Choctawhatchee Basin Alliance. Derrick Atkins collected a duplicate sample for independent analysis concurrently with the DEP sampling on the initial 2003 sampling period. All sampling methods followed FL Dept. of Environmental Protection Standard Operation Procedures.

Prior to sampling, Lake Powell was divided into 12 equal quadrats for surveying purposes. These quadrats aid the investigator in collecting a representative sample throughout the entire lake and allow the investigators to accurately measure the location of specific characters within the lake (see Figure 4). The same sampling quadrats were utilized for both the 2003 and 2004 sampling sessions.

A habitat assessment of Lake Powell was conducted during both the summer 2003 and spring 2004 surveys according to FL DEP SOPS (FL DEP 2004a). This method measures the habitat quality for a specific water body by measuring specific habitat characteristics on a numbered scale by a DEP habitat assessment certified biologist. Results between 2000, 2003, and 2004 samples were compared and are discussed.

The littoral plant assemblage was surveyed in the 2003 sampling session only. A quick survey of the littoral plants in 2004 showed no differences in assemblage structure between the two years. The plant assemblage was described by individually surveying

each lake quadrat by visual inspection and collection via a Frodus sampler. Unknown plants were brought back to the lab for identification and verification. Plant assemblage quality was determined by averaging the sum of Coefficient of Conservatism values, calculating a Floristic Quality Value (FQI), and identifying exotic and nuisance species.

Aquatic Macro Invertebrates were collected in Spring 2004 only, using a Petite Ponar at each of the 12 lakes sections in depths from 2 – 4 meters of water when possible. Sample material collected was preserved in a pH buffered 10% Formaldehyde solution. FDEP SOP's were followed in the analysis of the macro invertebrate assemblage collected in this sample (FL DEP, 2004c,d). For enumeration, the sample was thoroughly mixed and then placed in a 24-square grid pan where all aquatic macroinvertebrates were removed from the entire sample. The macorinvertebrates were then used to measure the health of the invertebrate community.

Water Quality samples were collected at a central location to measure whole lake attributes and at six additional points throughout the lake to look for within lake differences. These locations were East arm, Lakewatch Bay Powell 1, Northeast Arm, Golf Cart Bridge, West Branch and Below Highway 98 (Fig. 4). Physical chemical parameters included: Secchi Depth, surface, middle, and bottom measurements via hydrolab of dissolved oxygen, temperature, pH, specific conductivity, and salinity. Water samples were collected at the surface to determine color, Turbidity, Chlorophyll-*a*, nutrients, (NH_3, Un-ionized NH_3, NO_2-NO_3, Tot N, TKN, Tot Phos., Ortho Phos.), Algal Growth Potential, Total and Fecal Coliform Bacteria.

The lake substrate was analyzed for Organic Fraction, Sediment Grain Size, Pesticides, and BNA metal examination by deploying a petite ponar in 2-4 m deep water

when possible. These samples (12) were then composited into a whole lake sample. A separate sediment sample was collected and analyzed for the Golf Course Bridge station.

RESULTS AND DISCUSSION

Habitat Assessment

The habitat condition of Lake Powell has degraded from a score in the fair category in 2000, (99 points), to a score in the marginal category in both 2003, (75 points), and 2004, (82 points). The results from all three habitat assessments, 2000, 2003, and 2004 survey are listed on Table 2. Habitat evaluations in 2003 and 2004 were nearly identical with an increase in seven points recorded in the 2004 spring survey compared to the summer 2003 survey. The difference in scores between the 2003 and 2004 surveys is due to an increase in Secchi Depth during the spring 2004 sample. This difference is likely a seasonal effect, and results from the 2003 and 04 surveys are similar enough, that only the survey from 2003 is discussed here. Points were reduced in the 2003 surveys in three categories, secchi depth (10 of 20 points possible), Bottom Substrate Quality (3 of 20), and Littoral Buffer Zone (8 of 20). (Table 2).

Secchi disk depth decreased from 3.1m in 2000 to 1.0 m in 2003, and then increased to 3.0 m in 2004 (Table 2). The difference in Secchi Disk Depth correlates with changes in color during the three surveys. Color measurements were significantly lower in the spring samples taken in 2000 (15 PCU) and 2004 (30 PCU) then in the summer 2003 sample (150 PCU) (Table 5). Color is a measure of substances in solution after the removal of suspenoids (US Dept. Interior, 1968) and is often influenced by season (Mitsch and Gosselink, 1993). Lake Powell drains several upstream swamps, which are sources of tannins and other substances in the water. The 2003 survey was conducted in mid July when biological decomposition is high, this coupled with abundant and frequent rainfall likely resulted in flushing more substances from the swamps into the

lake. In contrast, during the spring nutrients are utilized by the plants in the upstream marsh for growth, reducing the amount materials available to the lake. Additionally, the 2000 survey was conducted during a drought period, which would further reduce the volume of materials entering Lake Powell.

Riparian buffer zones were not adequately vegetated along the entire margin of Lake Powell, most notably on the western side of the golf course (Figure 5). The western edge of the golf course has the most poorly protected riparian zones of the facility. As an example, a description of the lakefront from the western side of the golf course follows. In some areas, the buffer strip starts at the edge of the golf course, of which the first 8-10' is cleared with exposed soil. Adjacent to the bare strip is a sparsely vegetated steep slope to the waters edge, approximately 20'. This slope was vegetated by small palm trees, Yaupon Holly, and other shrubs and crisscrossed with gaps of bare soil and paths from people or animals walking down to the waters edge. This riparian buffer zone is inadequate, and does not provide sufficient protection of erosion of soils, chemicals, and nutrients from the surrounding land into the water.

Overall, habitat conditions at Lake Powell have degraded since surveyed in 2000 by Randall Payne. Research by ecologists has shown that a 30-foot non-sloped buffer provides minimal service for sediment removal. To be effective in protecting water and habitat quality Riparian Buffer Zones should be at least 100 feet across and to enhance Riparian wildlife, buffer zones should be greater than 300 feet across (Wegner 1999).

Littoral Plant Assemblage Survey

Twenty-seven taxa were recorded with *Juncus effusus* as the dominant species throughout the lake, *Spartina alternifora*, and *Ruppia maritima* were also common along

the southern shores of the lake. Three exotic species of plants were found within the lake Mean High Water Mark, *Panicum repens* (Torpedo grass), *Albizia julibrissin* (Mimosa trees) and *Sapium sebiferum* (Chinese Tallow Trees). Two native plants not recorded in previous lake surveys include *Typha lattifolia* (Cat-Tail) and *Eupatorium capillifolium* (Dog Fennel). Monitoring the status of these plants should be carefully watched as both of these plants have been used as indicators of disturbed systems and are often found in eutrophic conditions; both are also listed as nuisance species in several guides (Hoyer et al. 1996). A shift in dominance from *Juncus effusus* to *Typha lattifolia* would indicate that increasing nutrient levels are affecting Lake Powell on a system level. Taxa found in previous surveys that were absent in this survey include *Persea palustris, Holodule wrightii,* and *Scirpus americanus*. For a complete species list please see Table 7.

Lakefront property along the golf course encompassed four lake sections of the study (sections 9-12). Lake sections 9 and 12 overlap lake front property that is adjacent to the golf course, however sections 10 and 11 reside completely within the golf course property. I compared the plant assemblages for the lake sections that reside entirely within the golf course (sections 10, 11) to the plant assemblages that do not reside along the golf course (sections 1-8); lake sections that overlapped the edges of the golf course (sections 9,12) were not used in this comparison. Average plant taxa per section decreased from 11 taxa per segment for non golf course sections to 8 taxa per segment for golf course only segments (Table 6). No exotic plant taxa were observed in Golf Course encompassing segments.

An Average Coefficient of Concordance Value was calculated for the Whole Lake Assemblage (all 12 quadrats), the Non-Golf Course Bordering Sections (quadrats 1-

8) and for the Golf Course Bordering Sections (10-11). A Single Factor ANOVA test revealed that there was no significant difference ($P > 0.5$) between the Whole Lake Assemblage (5.03), Non-Golf Course Assemblage (5.03) and the Golf Course Assemblage (5.67). Table 6.

Aquatic Macroinvertebrate Survey

Benthic macroinvertebrate assemblages were characterized in Lake Powell on 6 April 2004. The collection was obtained from the sublittoral zone from depths ranging from 2 to 4 meters. A total of 13 taxa were recovered during this study. The community structure consisted of 60 individuals among the 13 taxa. All the organisms recovered suggested an estuarine environment.

The dominant three taxa, comprising 70 percent of the collection, were mud/silt dwellers. All three taxa were detritivorous polychaetous annelids, namely *Leitoscoloplos fragilis*, *Streblospio benedicti*, and Capitellidae (*Capitella sp.*). On 8 March, 2000 a study not unlike the present study was conducted in Lake Powell. During March 2000, those previously mentioned annelids comprised only 20 percent of the fauna. This suggests a significant shift in community structure in Lake Powell from years 2000 to 2004.

This shift in community structure is further identified by the loss of the estuarine clam *Anomalocardia* from 51 percent of fauna in March 2000 to 1.6 percent in April 2004. This common clam prefers a sandy substrate and the dramatic loss of this species in 2004 suggests a shift in habitat type, possibly from sand/silt to organic mud.

Overall, the benthic community declined from 1,495 individuals representing 27 species collected in 2000; compared to 60 Individuals representing 13 species collected in

2004, (Figures 6,7). This represents a 96 percent reduction in individuals (biomass) and a 52 percent reduction in total taxa. Changes in habitat quality and substrate composition appear to be correlated with the community shift and decline in Benthic abundance observed in Lake Powell between March 2000 and April 2004.

Water Quality

Physical-Chemical

Physical-Chemical Parameters included dissolved oxygen, pH, specific conductivity, and water temperature. These parameters were measured using a Hydrolab for bottom, middle, and surface depths at 11 locations within Lake Powell. Dissolved Oxygen values were in violation of Class III water quality standards at all sampling sites and values decreased quickly from surface (avg. 4.54 mg/L) to bottom (avg. 0.39 mg/L). Secchi disk readings were reduced compared to the 2000 survey, with measurements recording between 1.0 and 1.2 meters at 10 of 12 stations. The two exceptional readings were to the bottom and taken in shallow water (<1m). Color values recorded in a reconnaissance survey July 3, 2003 (400, 500 PCU) and the intensive survey July 16, 2003 (150 PCU for 2 stations) were elevated compared to the 2000 survey (15 PCU). These elevated levels are likely due to high rainfall experienced in the region during the late spring and early summer of 2003. On March 20, 2003, the Choctawhatchee Basin Alliance measured a turbidity spike at two of three Walton County sampling stations. Turbidity levels were measured at 70 NTU for station 2 and 67.20 for station 3, a 903% and 766% increase in turbidity over background levels. (Figure 3) This event was a violation of Class III Water Quality standards. Turbidity levels had returned to background levels by both July surveys.

Nutrients

Regular monitoring of nutrient levels by Choctawhatchee Basin Alliance and Environmental Services Inc. have shown a trend of increasing Total Phosphorus and TKN levels from 2000 thru February 2003. Nutrient parameters measured included NH_3, NO_2-NO_3, TKN, Tot. P, and Ortho-Phosphate, these values were than compared against State of Florida Class III Water Quality Standards (DEP 1996). Measurements of NH_3, NO_2-NO_3, Total P, and Ortho-Phosphate were similar to values measured in the 2000 survey. A value exceeding Class III Water Quality Standards (0.0046 *u*g/L) was calculated for Unionized NH_3 at the lake center sampling location for the 2003 survey. By 2004, this value had dropped to 0.00079 ug/L, and was no longer in violation of Class III water quality standards. This survey indicates that TKN (0.54 mg/L) and Total Nitrogen (0.579) were the only nutrient parameters that demonstrated an increase since the 2000 survey (TKN 0.34 mg/L; Tot N 0.038 mg/L). Recent unpublished data from ESI indicates that Tot. P levels peaked in the latter months of 2002 (0 .18 mg/L) and as of May 2003 was continuing to decrease (0.07mg/L). (Figure 1)

Productivity

Chlorophyll A, Algal Growth Potential (AGP) and the Trophic State Index (TSI) are measured as an indicator of productivity in aquatic systems; a high reading by these tests can indicate eutrophic conditions. Chlorophyll A levels increased from undetectable, measured at the lake center in 2000, to 6.4 *u*g/L at the lake center and 8.4 *u*g/L at the golf cart bridge locations in 2003. AGP was measured at 0.223 mg D Wt/L (lake center) and 0.239 mg D Wt/L (golf cart); these values are slightly higher than measurements in 2000 (0.209 mg/ D Wt/L). The TSI was calculated for both the Lake

Center (43.96) and Golf Cart Bridge (46.65) of the 2003 survey, and for the 2000 survey (25.11). All three current TSI values are below "problem thresholds" and indicate that the lake is Phosphorus limited. The difference between the 2000 sampling year and 2003 sampling season are attributable to the difference in color. The Chlorophyll A and AGP tests indicate that productivity within the lake has been increasing since the 2000 survey.

Bacteriological samples were collected for the presence of Total and Fecal Coliform bacteria. Values for both of these parameters were low and do not indicate unhealthy conditions.

Sediment survey

The quality and character of lake sediments are determined by three tests, 1) a qualitative sediment characterization 2) a quantitative determination of sediment particle size classes (%), and 3) determining the organic fraction of the substrate. The sediment character of Lake Powell has changed significantly from conditions measured in 2000. Historically Coastal Dune Lakes, including Lake Powell, are sand bottomed lakes with minority components of silt/clay and CPOM. In 2003 the lake bottom was almost entirely composed of mud/muck/silt with noticeable anaerobic bacterial activity. (Table 8). Sediment particle size classes have drastically shifted to smaller grain size since 2000 (Table 8). In 2000, the sediment particles of 0.25-0.5mm were the dominant size class at 49%, with the smallest class (< 0.063m) accounting for 3.04 % of the sediment. In the 2003 sediment sample, the smallest sediment particle size class, (<0.063mm) dominated the sample accounting for 65.7% of the substrate (Fig. 8). The percent organic fraction of the sediment increased from 0.61% in 2000 to 11% in 2003 (Fig. 9). These changes are possibly due to an increase in run-off from local construction projects, organic debris

from lawn maintenance, and increased biological productivity in the lake and surrounding waters. No pesticides or metals were detected in the sediment substrate.

CONCLUSION

The results of this survey indicate that Lake Powell is suffering from impaired biological conditions. Specifically, the benthic community of the lake has crashed and is severely limited in both species diversity and individual abundance. The collapse of the benthic community, combined with degraded habitat condition, the colonization of two disturbance tolerant plant species, and a drastic change in sediment character suggests that ecological system wide changes are taking effect in Lake Powell. Although there appears to be improving conditions monitored during the 2004 survey compared to 2003, these are likely due to differences caused by seasonality.

To restore the biological integrity of Lake Powell actions need to be taken which will reduce and eliminate both sediment and nutrient sources into the system, along with a reconsideration of water level management practices currently being utilzed by local governments. Sediment and nutrient sources include fertilizers from new construction projects, lawn and golf course maintenance must be practiced in such a way that fertilizer run off is minimized or eliminated when possible. This is especially important while establishing new lawn areas in construction zones, when the seepage of nutrients through the sand into the lake is most prevalent. Although costly, septic tanks should also be replaced with a sewer system. The reduction of sediment into the watershed requires an added emphasis on maintaining and enforcing strong erosion control programs in construction sites within the entire watershed. Several streams feed Lake Powell, all of which carry sediment into the water body. Therefore it is as important to eliminate sedimentation into the feeder streams as it is to prevent sedimentation from occurring at the lake front. Additionally, the establishment of an effective riparian buffer zone and

strong storm water controls around the entire lake must be vigorously pursued. Well-vegetated buffers around the lake act as a sediment, nutrient, and chemical filter, trapping and utilizing these products before they enter the water body. Lastly, the return to more natural hydrologic conditions at Lake Powell should be implemented and the strict maintenance of the current hydrological regime for Lake Powell must be reconsidered. Allowing the water level in Lake Powell to rise higher than current practices, would allow for a less frequent, but more natural and vigorous exchange between Lake Powell and the Gulf of Mexico. This may also have an added benefit for the recruitment of fishes into the system as well.

Fig. 1 Total Phosphorus, Lake Powell, ESI Station A-E, Station Avg., and DEP Lake Center

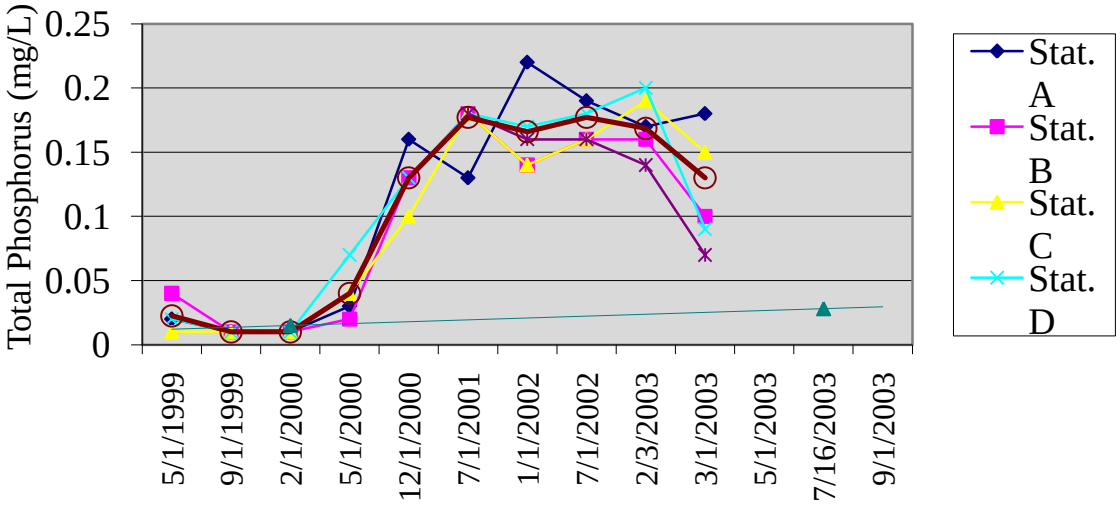


Table 1. Total Phosphorus (µg/L) increases at ESI Monitoring Stations.

Phosporphorus	AVG 1999	AVG 2000	AVG 2001	AVG 2002
ESI Stat. A	15	66.67	130	205
ESI Stat. B	25	53.33	180	150
ESI Stat. C	10	50	180	1850
ESI Stat. D	15	70	180	175
ESI Stat. E			180	160
ESI Stat. F			200	100
ESI Stat. G			190	95

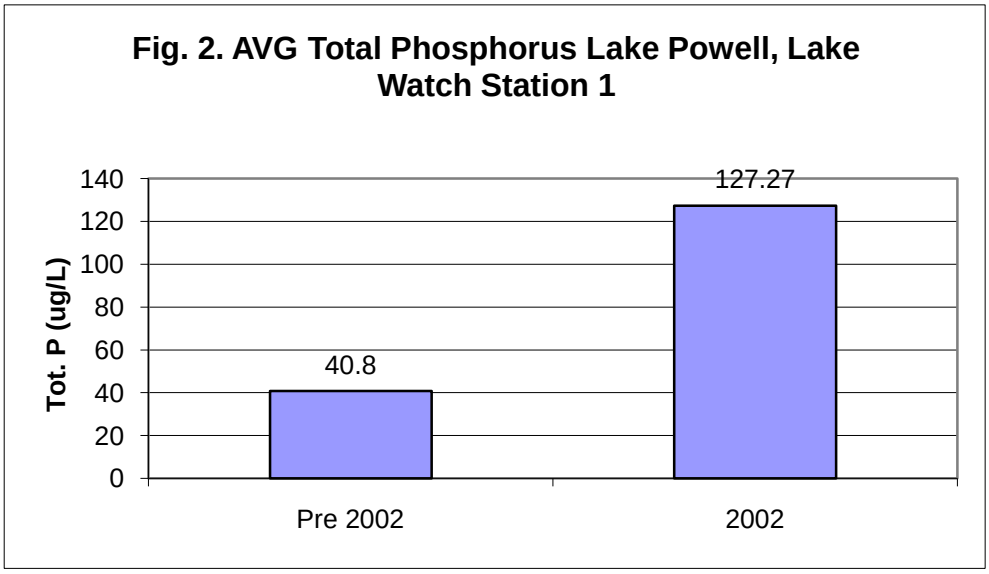


Fig. 2. AVG Total Phosphorus Lake Powell, Lake Watch Station 1
Tot. P (ug/L)
140
120
100
80
60
40
20
0
40.8
127.27
Pre 2002
2002

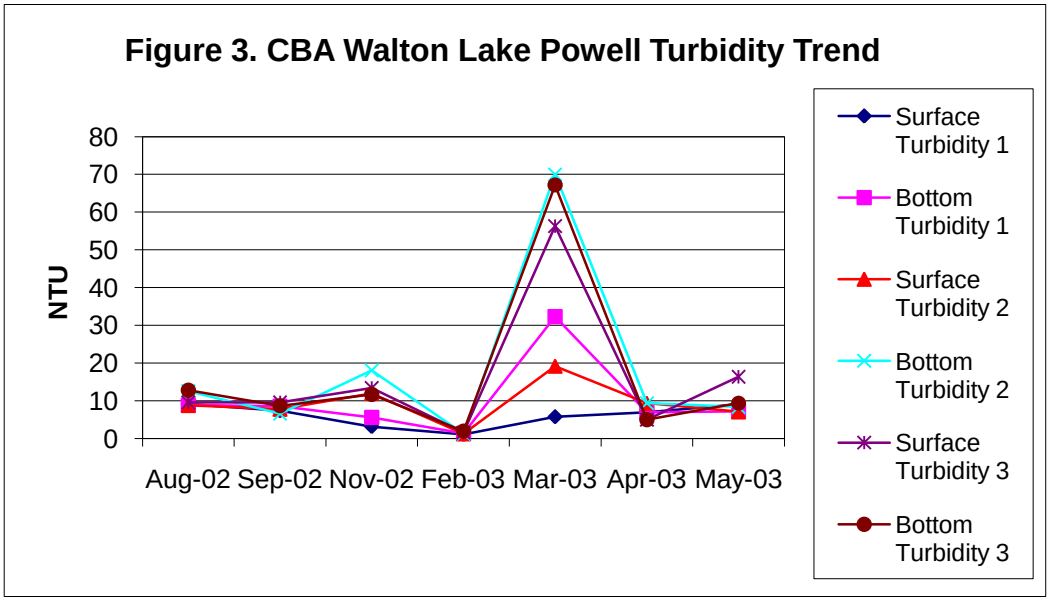


Figure 3. CBA Walton Lake Powell Turbidity Trend
NTU
80
70
60
50
40
30
20
10
0
Aug-02 Sep-02 Nov-02 Feb-03 Mar-03 Apr-03 May-03
Surface Turbidity 1
Bottom Turbidity 1
Surface Turbidity 2
Bottom Turbidity 2
Surface Turbidity 3
Bottom Turbidity 3

Figure 4. Map of Lake Powell, Bay Co. FL, and Sampling Stations.

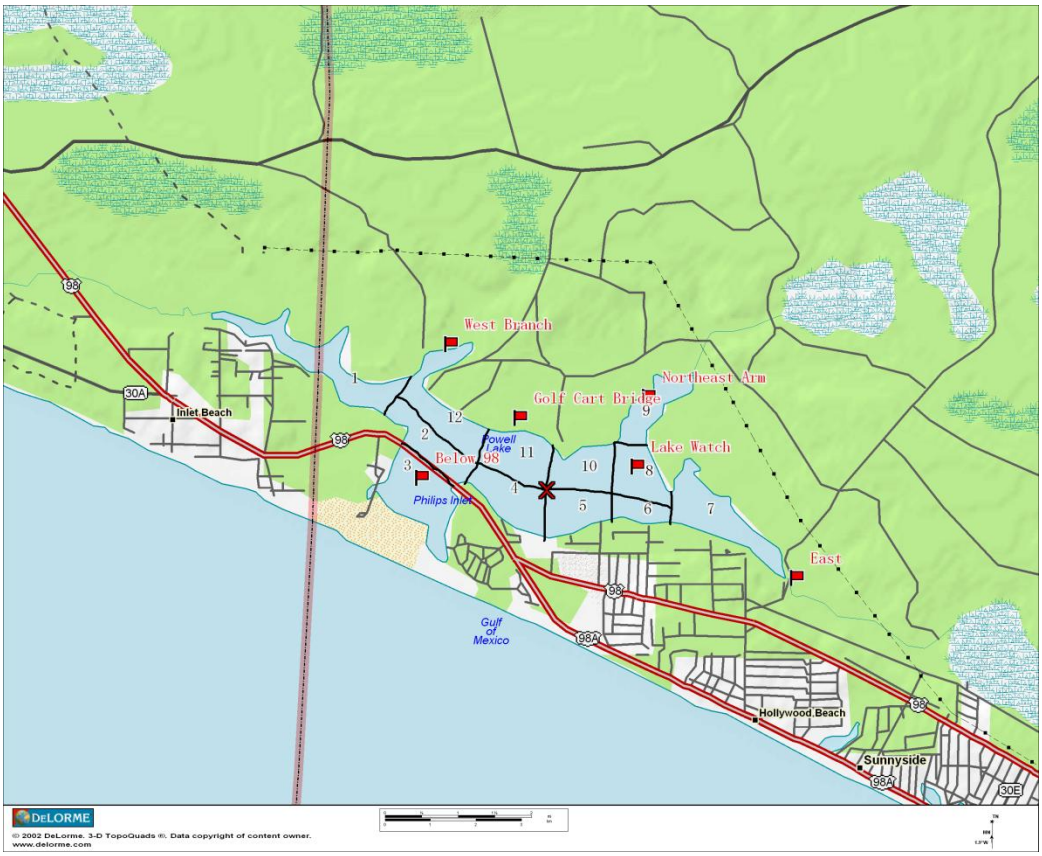


Figure 5. Inadequate Riparian Buffer Zone along Lake Powell. Photo is east side of Section 12, July 16, 2003 by F. Butera

Table 2. Comparison of Habitat Assessment Scores for Lake Powell, measured 8 March, 2000; 16 July, 2003; and 6 April, 2004

Habitat Assessment Scores	2000	2003	2004	Possible Points
Hydrology	Sur. inflow & outflow present	Sur. inflow & outflow present	Sur. inflow & outflow present	
Color	Very clear, uncolored water	Dark, discolored water, >40 PCU	Tannic < 20 PCU	
Secchi	16	10	15	20
Veg. Quality	20	17	17	20
Stormwater Inputs	15	13	13	20
Bottom Substrate Quality	5	3	5	20
Lakeside Adverse Human Alterations	15	13	13	20
Littoral Buffer Zone	16	8	8	20
Adverse Watershed Land Use	12	11	11	20
Total	99	75	82	140
Percentage	71%	54%	59%	100%
Category	Sub-Optimal	Marginal	Marginal	

Figure 6. Taxa Diversity. Macroinvertebrate Taxa at Lake Powell; 2000, 2004.

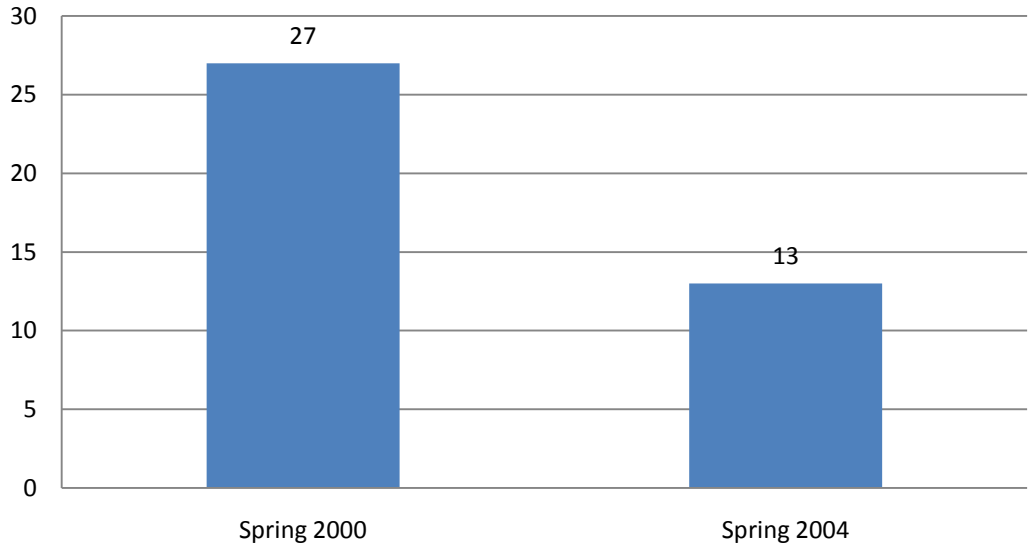


Figure 7. Macroinvertebrate Abundance. Lake Powell; 2000, 2004

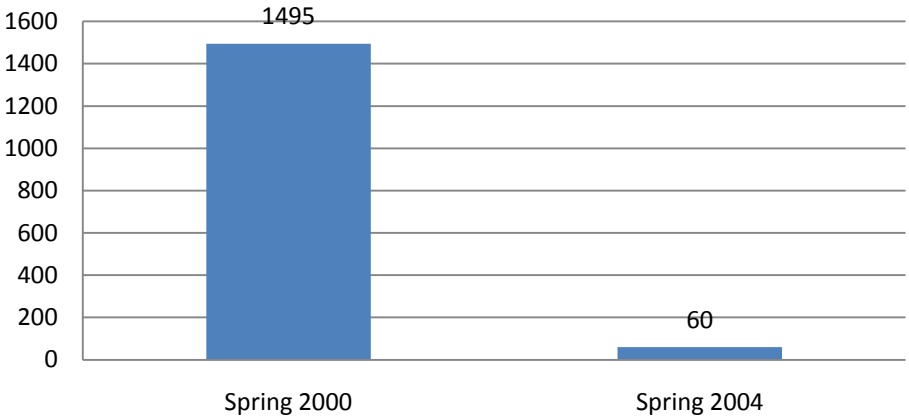


Table 3. Differences in Taxa Richness of Macroinvertebrates at Lake Powell, Bay Co. FL 2000 and 2004 Survey

Taxa present	2000	2004
Almyracuma spp.	1	
Amygdalum papyrium	1	1
Ampelisca abdita	1	1
Ampelisca vadorum	1	
Anomalocardia auberiana	1	1
Armandia agilis		1
Bowmaniella floridana	1	
Capitellidae		1
Capitella capitata	1	
Cerithiopsis sp.		1
Edotea montosa	1	
Eteone heteropoda	1	
Grandidierella bonnieroides	1	
Hargeria rapax	1	
Haustorius spp.	1	
Hobsonia florida	1	
Leitoscoloplos fragilis	1	1
Mediomastus ambiseta	1	
Mysidopsis almyra	1	
Neanthes succinea	1	
Nemertea	1	1
Oxyurostylis smithi	1	1
Parandalia americana	1	
Pectinaria gouldi	1	1
Rangia cuneata	1	
Retusa sp.		1
Sigambra tentaculata	1	
Solen viridis	1	
Strepblospio benedicti	1	1
Tagelus plebeius	1	
Tellinidae		
Tetrastemma candidum	1	
Travisia hobsonae		1
Total	27	13

Table 4. Differences in abundance of Marine Macroinvertebrates at Lake Powell using FL DEP Petite Ponar Sampling Grab.

Taxa	2000	2004
Almyracuma spp.	18	
Ampelisca abdita	216	5
Ampelisca vadorum	27	
Amygdalum papyrium	16	1
Anomalocardia auberiana	769	1
Armandia agilis		1
Bowmaniella floridana	2	
Capitella capitata	86	
Capitellidae		8
Cerithiopsis sp.		1
Edotea montosa	3	
Eteone heteropoda	1	
Grandidierella bonnieroides	1	
Hargeria rapax	1	
Haustorius spp.	1	
Hobsonia florida	21	
Leitoscoloplos fragilis	21	22
Mediomastus ambiseta	13	
Mysidopsis almyra	1	
Neanthes succinea	2	
Nemertea	3	1
Oxyurostylis smithi	3	1
Parandalia americana	1	
Pectinaria gouldi	7	3
Rangia cuneata	1	
Retusa sp.		2
Sigambra tentaculata	11	
Solen viridis	1	
Strepblospio benedicti	198	12
Tagelus plebeius	55	
Tellinidae		1
Tetrastemma candidum	16	
Travisia hobsonae		1
Total	1495	60

Table 5. Comparison of Water Quality Parameters at Lake Powell

	Lake Center	Lake Center	Golf Cart Bridge	
Test	3/8/2000	7/16/2003	7/16/2003	Units
Physical Chemistry				
Temperature	21.43	29.28	32.59	° C
pH	7.47	7.41	7.37	SU
Dissolved Oxygen	7.92	5.34	6.96	mg/L
Specific Conductivity	31400	25800	17700	*u*mhos/cm
Color	15	150	150	Pt-Co
Turbidity	0.5	1	2	NTU
Alkalinity	58	59	50	mg $CaCO_3$/L
Secchi Depth	3.1	1	too bottom	meters
Nutrients				
Total Nitrogen	0.038	0.579	0.611	mg/L
Ammonia	0.1	0.22	0.052	mg-N/L
Nitrate + Nitrite	0.004	0.039	0.011	mg-N/L
Kieldahl Nitrogen	0.034	0.54	0.6	mg-N/L
Un-Ionized Ammonia	0.00013	0.0046	0.00129	ug/L
Ortho diss. Phosphate	0.006	0.004	0.004	mg/L
Total Phosphate	0.015	0.028	0.031	mg-P/L
Productivity				
Chlorophyll-A	1	6.4	8.4	*u*g/L
Algal Growth Potential	0.209	0.223	0.239	mg Dry Wt/L
TSI	25.11	43.96	46.65	
Bacterialogical				
Total Coliform	10	16	70	#/100 ml
Fecal Coliform	2	10	20	#/100 ml

Table 6. Comparison of Plant Assemblages of Whole Lake, Sections Not Bordering Golf Course, and Sections Bordering Golf Course for Lake Powell, July 16, 2003

Parameter	Whole lake Sects. 1-12	Non-Golf Sects. 1-8	Golf Course Sects. 10-11
Avg. Taxa per Section	10	11	8
Sections with Exotics	3	3	0
Exotics per section	0.42	0.63	0
Total Taxa	27	27	10
Herb Taxa	15	15	6
Wood Taxa	12	12	4
Exotic Taxa	3	3	0
Average C of C	5.03 *	5.03 *	5.67 *
FQI	20.12	20.12	16.04

* No significant difference, $p > .05$

Table 7. List of Plant Species Observed at Lake Powell, Bay County, FL. July 16, 2003.

		Lake Section												
	Taxa	1	2	3	4	5	6	7	8	9	10	11	12	Common Name
1	*Phragmites australis*		1		1	1	1	1				1	1	
2	*Hibiscus grandiflora*	1					1	1		1			1	
3	*Sagitaria* spp.	1											1	
4	*Salix spp.*	1				1								
5	*Sapium sebiferum*						1	1						**Exotic** Popcorn Tree
6	*Typha lattifolia*	1						1				1		
7	*Baccharis* spp.	1	1	1	1		1	1	1	1	1	1	1	
8	*Cliftonia monophylla*	1												
9	*Cyrilla racemiflora*	1						1						
10	*Ilex vomiteria*	1		1	1			1	1	1	1		1	
11	*Toxicodendron* spp.	1											1	Sumac
12	*Lyonia* spp.	1												
13	*Magnolia virginiana*	1					1							
14	*Myrica cerifera*	1		1		1	1	1	1	1	1	1	1	
15	*Albizia julibrissin*					1	1							**Exotic** Mimosa
16	*Cladium jamaicense*	1			1	1	1	1	1	1	1	1	1	
17	*Ipomoea purpera*				1			1					1	Morning Glory
18	*Juncus roemerianus*	D	D	D	D	D	D	D	D	D	D	D	D	
19	*Spartina alterniflora*		1	1	1	1	1	1	1	1	1		1	
20	*Sesbania* spp.	1						1		1				
21	*Quercus laevis*							1						Turkey Oak, up bank.
22	*Eupatorium fistulosum*							1						
23	*Ruppia maritima*		1	1	1	1				1	1			
24	*Panicum repens*			1										**Exotic** Torpedoe Grass
25	*Salicornia* spp.			1										
26	*Uniola paniculata*			1	1									Sea Oats
27	*Pinus elliotii*	1	1	1	1	1	1	1	1	1	1	1	1	
	Total	16	6	10	10	9	11	16	7	10	8	7	12	

Table 8. Composite Lake Sediment Parameters Measured for Lake Powell on 8 March, 2000 and 16 July, 2003

Lake Powell, Center of Lake March 8, 2000			Lake Powell, Center of Lake July 16, 2003			Lake Powell, Golf Cart Bridge July 16, 2003		
Drop #	Sediment Type	depth drop	Drop #	Sediment Type	depth drop	Drop #	Sediment Type	depth drop
1	silt/clay, AN	2.7	1	muck - AN	2.5	1	sand, silt	0.6
2	sand, silt/clay, AN	2.95	2	muck - AN	3.3			
3	sand, silt/clay, AN	2.8	3	muck - AN	3.1			
4	sand, silt/clay	2.6	4	muck - AN	2.5			
5	sand, silt/clay, CPOM, AN	2.8	5	sand, silt	2.2			
6	sand, silt/clay, CPOM, AN	3.0	6	muck - AN	2.7			
7	sand, silt/clay, AN	2.15	7	sand, silt	1.2			
8	sand, silt/clay, AN	2.5	8	muck - AN	2.6			
9	silt/clay, AN	2.3	9	muck - AN	2.6			
10	sand, silt/clay, CPOM, AN	2.1	10	muck - AN	3.1			
11	sand, silt/clay, AN	2.8	11	muck - AN	3.2			
12	sand, silt/clay, CPOM, AN	2.9	12	muck - AN	2.0			
Class	Sediment Particle Size, %	Percent	Class	Particle Size, %	Percent	Class	Particle Size, %	Percent
1	% >2.0 mm	0.48	1	% >2.0 mm	0.13	1	% >2.0 mm	0.15
2	% 0.5-2.0 mm	10.9	2	% 0.5-2.0 mm	1.98	2	% 0.5-2.0 mm	30.3
3	% 0.25-0.5 mm	60.8	3	% 0.25-0.5 mm	6.77	3	% 0.25-0.5 mm	49.1
4	% 0.125-.025 mm	19.6	4	% 0.125-.025 mm	8.23	4	% 0.125-.025 mm	16.8
5	% 0.063-1.25 mm	1.06	5	% 0.063-1.25 mm	17.3	5	% 0.063-1.25 mm	0.86
6	% < 0.063 mm	7.64	6	% < 0.063 mm	65.7	6	% < 0.063 mm	3.04
Sediment % Organic		0.63%	Sediment % Organic		11.00%		Sediment % Organic	0.61%

* AN abbreviation for Anaerobic Conditions.

Figure 8. Comparison of Sediment Composition at Lake Powell, 2000 and 2003 Surveys

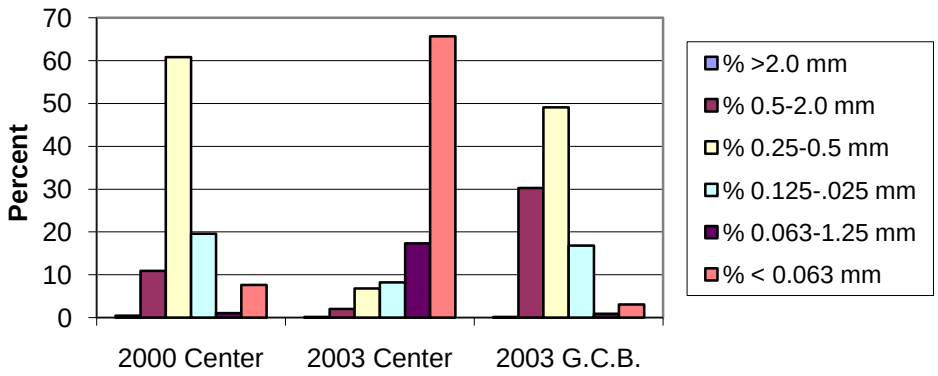
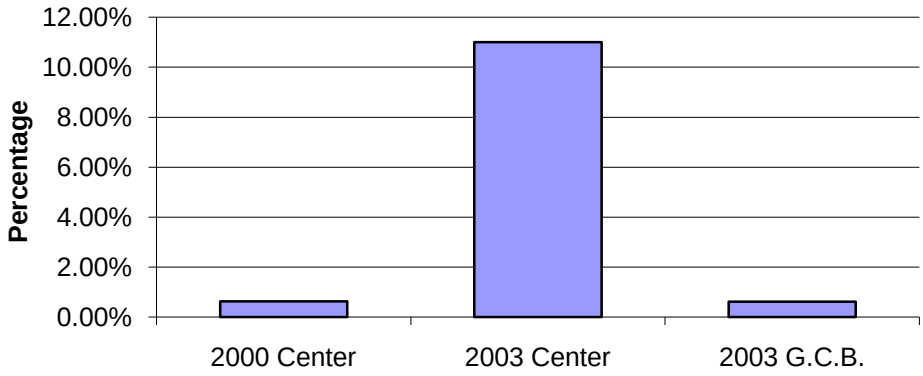


Figure 9. Comparison of Percent Organic Fraction in Sediment, Lake Powell, 2000 and 2003 Surveys



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LWD 04-04-06 WEIRS will not Must C

Sample ID 32355

ELFs 11-02-05 FB

ELF Complete

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL PROTECTION

PHYSICAL/CHEMICAL CHARACTERIZATION FIELD DATA SHEET (5-10-96)

SUBMITTING AGENCY CODE: / SUBMITTING AGENCY NAME:	STORET STATION NUMBER:	DATE (M/D/Y):	TIME	RECEIVING BODY OF WATER:
	32030038	7-16-03	9:49	Gulf Mexico

REMARKS:	COUNTY:	LOCATION:	FIELD ID/NAME:
	Walton/Bay	Lake Powell - Center	

RIPARIAN ZONE/INSTREAM FEATURES

Predominant Land-Use in Watershed (specify relative percent in each category): Golf

Forest/Natural	Silviculture	Field/Pasture	Agricultural	Residential	Commercial	Industrial	Other (Specify)
X 5	5	~~60~~		X 60			~~30~~

Local Watershed Erosion (check box): None ☐ Slight ☒ Moderate ☐ Heavy ☐

Local Watershed NPS Pollution (check box): No evidence ☐ Slight ☐ Moderate potential ☐ Obvious sources ☒

Width of riparian vegetation (m) on least buffered side: ***List & map dominant vegetation on back***

Artificially Channelized ☐ no ☐ recent, severe ☐ some recovery ☐ mostly recovered, more sinuous

Artificially Impounded ☒ yes

High Water Mark: ____ (m above present water level) + ____ (present depth in m) = ____ (m above bed)

Typical Width (m)/Depth (m) /Velocity (m/sec) Transect

m wide

m/s ↓ m deep | m/s ↓ m deep | m/s ↓ m deep

Canopy Cover % : Open : ☒ Lightly Shaded (11-45%): ☐ Moderately Shaded (46-80%): ☐ Heavily Shaded: ☐

SEDIMENT/SUBSTRATE

Sediment Odors: Normal: ☐ Sewage: ☐ Petroleum: ☐ Chemical: ☐ Anaerobic: ☒ Other: ☐ ____

Sediment Oils: Absent: ☒ Slight: ☐ Moderate: ☐ Profuse: ☐

Sediment Deposition: Sludge: ☐ Sand smothering: none / slight / moderate / severe Silt smothering: none / slight / (moderate) / severe Other: Muck

Substrate Types	% coverage	# times sampled	method	Substrate Types	% coverage	# times sampled	method
Woody Debris (Snags)				Sand			
Leaf Packs or Mats				Mud/Muck/Silt			
Aquatic Vegetation				Other:			
Rock or Shell Rubble				Other:			
Undercut banks/Roots				***Draw aerial view sketch of habitats found in 100 m section***			

WATER QUALITY	Depth (m):	Temp. (°C):	pH (SU):	D.O. (mg/l):	Cond. (µmho/cm) or Salinity (ppt):	DO %		Secchi (m):
Top	0.1	29.28	7.41	5.34	25181 (15.26)	73.3		1.0
Mid-depth	1.9	28.90	7.39	2.01	36197 (22.89)	2.01		
Bottom	3.02	27.87	7.44	0.12	37922 (24.07)	1.8		

System Type : Stream: ☐ (1st - 2nd order / 3rd - 4th order / 5th - 6th order / 7th order or greater) Lake: ☒ Wetland: ☐ Estuary: ☐ Other: ☐ ____

Water Odors (check box): Normal: ☒ Sewage: ☐ Petroleum: ☐ Chemical: ☐ Other: ☐ ____

Water Surface Oils (check box): None: ☐ Sheen: ☒* Globs: ☐ Slick: ☐ *near boat ramp (pellets)

Clarity (check box): Clear: ☒ Slightly turbid: ☐ Turbid: ☐ Opaque: ☐

Color (check box): Tannic: ☒ Green (algae): ☐ Clear: ☐ Other: ☐ ____

Weather Conditions/Notes:
- Sunny, hot
- Water level down ≈ 18" last 2 weeks
- Very rainy summer

Abundance:	Absent	Rare	Common	Abundant
Periphyton	☐	☐	☒	☐
Fish	☐	☐	☒	☐
Aquatic Macrophytes	☐	☐	☒	☐
Iron/sulfur Bacteria	☒	☒	☐	☐

SAMPLING TEAM:	SIGNATURE:	DATE:
Frank Butera, Wes Keller, Phillip Ellis	Frank J. Butera	7-16-03

APPENDIX II

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
LAKE HABITAT ASSESSMENT FIELD DATA SHEET *(11-29-99)*

STORET STATION NUMBER:	DATE (M/D/Y):	LAKE NAME:	FIELD ID/NAME:
32030038	7-16-2003	Lake Powell	

ECO-REGION:	COUNTY:	SAMPLING LOCATIONDESCRIPTION:	LAKE SIZE:
75-01	Bay / Walton	Lake Powell- Center	657

Parameter				
Hydrology	No surface inflow or outflow present, very long water residence time, groundwater seepage dominates ☐	Surface water inflow present, but flow is rare, moderate to long water residence time ☐	Surface water inflow and outflow present (or outflow only), sometimes with visible flow, short water residence time ☐	Impounded, hydrology of sytstem artificially controlled ☒
Color	Very clear, uncolored water (benthic sampling appropriate) ☐	Water somewhat tannin stained (benthic sampling appropriate) ☐	Dark, discolored water (water color 40 PCU or higher) ☒	Visibility extremely reduced due to high color ☐
	Optimal	**Suboptimal**	**Marginal**	**Poor**
Secchi 10	Secchi > 3 m | Secchi (m): 20 19 18 17 16	3 m | 1.8 | 1.5 | 1.3 | 1.1 | 1.6 | 0.9 | 0.8 | 0.7 | 0.6: 15 14 13 12 11 10 9 8 7 6		0.5 | 0.4 | 0.3 | 0.2 | 0.1: 5 4 3 2 1
Vegetation Quality 17	Diverse, expected native vegetation (emergent or submersed), less than 5% nuisance taxa Low Diversity Estuarine 20 19 18 (17) 16	Mostly expected native plants, but moderate growths (6%-20% of lake) of nuisance macrophytes, or more than 50% of lake covered with plants 15 14 13 12 11	Large masses (21%-40%) of nuisance macrophytes (e.g,, Hydrilla, hyacinth, cattail, etc.) or algal mats 10 9 8 7 6	Lake choked (>40%) with nuisance macrophytes (duckweed, water hyacinth, etc.) or algal mats, or few plants present at all (e.g., herbicide spraying) 5 4 3 2 1
Stormwater Inputs 13	Stormwater enters system via sheet flow over native vegetation 20 19 18 17 16	Some direct stormwater inputs (ditches, streams, pipes) but good BMPs in place 15 14 (13) 12 11	Moderate direct inputs of stormwater (ditches, streams, pipes) but few BMPs in place 10 9 8 7 6	Much direct input of stormwater (ditches, streams,pipes) and no or ineffective BMPs in place 5 4 3 2 1
Bottom Substrate Quality 3	Diverse mixture of sand, shell hash, detritus, with small amounts of CPOM /mud/muck. SAV may be present. 20 19 18 17 16	Mixture of sand or clay and detritus with higher % CPOM/mud/muck content. SAV may be present. 15 14 13 12 11	Moderate layer of CPOM /mud/muck, or hard-packed sand only, or moderate algal growth (mats or Chara) on bottom 10 9 8 7 6	Thick deposits of fine detritus and anaerobic muck/mud, or algal growth or nuisance plants (Hydrilla) cover bottom 5 (4) 3 2 1
Lakeside Adverse Human Alterations 13	Very few man-made structures, roads, or other disturbance adjacent to lake (<10%) 20 19 18 17 16	Moderate disturbance visible (structures, roads or other), 10%-49% lakeside affected 15 14 (13) 12 11	Many structures, roads or other human disturbance visible (50%-70% lakeside affected) 10 9 8 7 6	Highly developed or disturbed (>70% of lakeside affected) 5 4 3 2 1
Littoral Buffer Zone 8	Expected native vegetation between uplands and littoral zone, greater than 90% of shore with >18 m buffer 20 19 18 17 16	89% -51% of shoreline with >18 m buffer 15 14 13 12 11	50% -30% of shoreline with >18 m buffer 10 (9) 8 7 6	< 29% of shoreline with >18 m buffer 5 4 3 2 1
Adverse Upland Land Use 11	Score the potential effects from adverse human land uses, based on a continuum of amount and type, with least to most adverse as follows: Native vegetation, Silviculture, Pasture or citrus, Low Density Residential, Row Crops, Commercial, High Density Urban, Industrial, Golf Course, Construction 5 4 3 2 1 20 19 18 17 16 15 14 13 12 (11) 10 9 8 7 6			

Total Score 75 | COMMENTS: 140 Top of Marginal - Northeast side of lake to be heavily developed in near future

ANALYSIS DATE: 7-16-2003 | ANALYST: F Burton, W Keller, P Ellis | SIGNATURE: Fred J. [illegible]

APPENDIX III

Waterbody: Lake Powell - Center	Date: 7-16-03	County: Walton/Bay	Storet Number: 32030038
Analyst: F Butera, W Keller P. Ellis, [illegible]		Signature: Frank Butera	

HERBACEOUS SPECIES	1	2	3	4	5	6	7	8	9	10	11	12
Alternanthera philoxeroides												
Azolla caroliniana												
Bacopa caroliniana												
Bacopa monnieri												
Bidens spp.												
Brachiaria mutica												
Brasenia schreberi												
Cabomba caroliniana												
Canna flaccida												
Canna spp. (exotic)												
Carex spp.												
Casuarina spp.												
Ceratophyllum demersum												
Ceratopteris thalictroides												
Chara spp.												
Cicuta mexicana												
Cladium jamaicense	X			X	X	X	X	X		X	X	
Colocasia esculenta												
Crineum americanum												
Cyperus alternifolius												
Cyperus articulatus												
Cyperus prolifer												
Cyperus spp. (other natives)												
Decodon verticillatus												
Echinochloa spp.												
Echinochloa spp. (exotic)												
Echinodorus cordifolia												
Egeria densa												
Eichhornia crassipes												
Eichhornia spp.												
Eleocharis cellulosa												
Eleocharis equisetoides												
Eleocharis interstincta												
Eleocharis spp., subm./flo.												
Eriocaulon spp.												
Filamentous algae												
Filamentous Lyngbya												
Fontinalis spp.												
Fuirena spp.												
Habenaria repens												
Hydrilla verticillata												
Hydrocotyle spp.												
Hygrophila polysperma												
Hymenachne amplexicaulis												
Hymenocallis spp.												

HERBACEOUS SPECIES	1	2	3	4	5	6	7	8	9	10	11	12
Hypericum spp.												
Ipomoea aquatica												
Ipomoea fistulosa Purple				X			X					
Juncus effusus												
Juncus repens												
Juncus roemerianus	X	X	X	X	X	X	X	X	X	X	X	X
Juncus spp. (other)												
Lachnanthes caroliana												
Leersia hexandra												
Lemna / Spirodela spp.												
Limnobium spongia												
Limnophila sessiliflora												
Ludwigia arcuata												
Ludwigia octovalvis/peruviana												
Ludwigia palustris/repens												
Ludwigia spp. (other)												
Luziola fluitans (syn: Hydrochloa)												
Mayaca fluviatilis												
Melaleuca quinquenervia												
Micranthemum glomeratum												
Micranthemum umbrosum												
Mikania scandens												
Mimosa pigra												
Myriophyllum aquaticum												
Myriophyllum heterophyllum												
Myriophyllum laxum												
Myriophyllum pinnatum												
Myriophyllum spicatum												
Najas filifolia												
Najas guadalupensis												
Najas marina												
Najas minor												
Nasturtium officinale												
Nelumbo lutea												
Nitella spp.												
Nuphar luteum												
Nymphaea mexicana												
Nymphaea odorata												
Nymphaea spp. (exotic)												
Nymphoides aquatica												
Osmunda cinnamomea												
Osmunda regalis												
Orontium aquaticum												
Panicum hemitomon												
Panicum repens				X								
Sesbania sp.	X						X		X			
Cyperus sp.							X					
Eupatorium							X					

Waterbody: Lake Powell	Date: 7-16-03	County: Bay	Storet Number: 32030038
Analyst: Frank Butera / Wes Keller		Signature: Frank Butera	

HERBACEOUS SPECIES	1	2	3	4	5	6	7	8	9	10	11	12
Paspalidium geminatum												
Paspalum distichum												
Paspalum repens												
Peltandra spp.												
Pennisetum spp.												
Phragmites australis		X		X	X		X				X	X
Pistia stratioides												
Pluchea spp.												
Polygonum densiflorum												
Polygonum hydropiperoides												
Polygonum spp., (other natives)												
Pontederia cordata												
Pontederia rotundifolia												
Potamogeton diversifolius												
Potamogeton illinoensis												
Potemogeton pectinatus												
Potamogeton pusillus												
Proserpinaca spp.												
Rhynchospora spp.												
Ricca fluitans												
Ricciocarpus natans												
Ruppia maritima		X	X	X	X				X	X		
Sabatia spp.												
Sacciolepis striata												
Sagittaria kurziana												
Sagittaria lancifolia												
Sagittaria latifolia												
Sagittaria sub./gram./stag.		X										
Utricularia spp.	X						X	X	X			X
Spartina sp.	X											
[illegible]			X		X							
Salicornia spp.			X									

HERBACEOUS SPECIES	1	2	3	4	5	6	7	8	9	10	11	12
Salix spp.	X				X							
Salvinia minima												
Salvinia spp. (exotic)												
Sapium sebiferum						X	X					
Saururus cernuus												
Schinus terebinthifolius												
Scirpus americanus/pugens												
Scirpus californicus/validus												
Scirpus cubensis												
Scirpus spp. (other natives)												
Solanum tampicense												
Sparganium americanum												
Spartina alterniflora			X		X		X	X				
Spartina bakeri												
Thalia geniculata												
Triadenum spp.												
Typha spp.	X						X				X	
Utrichularia floridana												
Utrichularia foliosa												
Utrichularia gibba												
Utrichularia inflata												
Utrichularia purpurea												
Vallisneria americana												
Wedelia trilobata												
Wolffia spp.												
Wolffiella spp.												
Zizania aquatica												
Zizaniopsis milacea												
Utricularia purpurea			X									

WOODY SPECIES	1	2	3	4	5	6	7	8	9	10	11	12
Acer rubrum												
Baccharis spp.	X			X		X	X	X	X	X	X	
Cephalanthus occidentalis												
Clethra alnifolia												
Cliftonia monophylla	X											
Cyrilla racemiflora	X						X					
Fraxinus spp.												
Gordonia lasianthus												
Ilex cassine												
Itea virginica												
Ilex vomitoria	X						X	X	X	X	X	
Smilax	X											

WOODY SPECIES	1	2	3	4	5	6	7	8	9	10	11	12
Leucothoe racemosa												
Lyonia spp.	X											
Magnolia virginiana	X											
Myrica cerifera	X				X	X	X	X	X	X	X	
Nyssa sylvatica var. biflora												
Pinus elliottii	X		X	X	X		X		X		X	
Salix spp.												
Taxodium ascendens												
Taxodium distichum												
Nyssa sylvatica					X							

Lake Powell Intensive Survey 16-Jul-03
GPS: N:30°16'22.7" X W:85°58'29.2"
Storet:
Sampling Team: Frank Butera, Wesley Keller, Phillip Ellis

Hydroloab Recordings

Location	Depth	Temp.	Sp. Cond	D.O.	% Oxy	Salinity	Secchi	pH
Trad.	0.1m	29.38	25181	5.34	73.3	15.26	1.0m	7.41
Trad.	1.9	28.90	36157	2.01	28.6	22.89		7.39
Trad.	3.0m	27.87	37922	1.8 ←→ 2.12		24.07		7.44
East	0.2 29.34	←→ 28	25853	1.57	17.9	15.77		6.82
East							0.6m	
East	.9m	30.24	27414	.65	9.6	16.71		6.86
Lake Watch	.45	30.33	24202	5.26	73.9	14.69		7.27
Lake Watch	1.25	29.49	32511	0.97	15.0	20.58	1m	7.08
Lake Watch	2.34	27.7	36856	0.15	2.2%	22.88		7.33
Northeast	.45	30.24	25022	5.12	74.7	14.94		7.26
Northeast	1.22	30.28	30321	1.79	26.9	18.77	1M	7.11
2.66 Northeast	2.25	28.17	36078	0.22	4.7	22.74		7.23
Golf Cart		32.59		6.96	99.6	10.58		7.37
Golf Cart							T3 Bottom	
Golf Cart								
West	.34	32.86	20953	5.76	89.0	12.58		7.37
West	1.89	28.39	36776	.28	4.5	23.23	1M	7.45
816'49.7 West	1.06	28.95	34168	.28	4.1	21.52		7.30
59'13.0 Below 98	.32	30.56	31221	5.16	75.6	19.40		7.73
Below 98	3.16	28.55	38468	.28	4.7	24.48	1.2M	7.58
Below 98	1.59	29.20	35716	3.74	54.6	23.71		7.85
Segment 10	.42	31.33	23305	5.99	86.4	13.48		7.44
" "	1.12	29.51	33939	2.96	43.8	21.41	1M	7.56
" "	2.13	28.81	36564	1.15	17.1	23.13		7.38
Segment 11 Top	.49	30.66	28173	.42	7.3	18.40	1m	7.59
Bottom	3.15	28.30	38134	.19	3.1	24.23		7.48
Mid	1.57	29.15	35358	3.09	35.2	22.32		7.50
Sec1	.39	30.75	29341	2.03	30.1	17.83		
	2.22	28.14	37054	.15	2.6	23.49	1.2m	7.17
	1.17	29.09	34164	1.16	21	21.75		7.47
4w 2.6 M								7.43
Sec2	.40	30.61	30774	4.88	74.1	18.63	1.2m	7.71
	2.93	28.66	38267	.57	9.4	24.33		7.56
	1.58	29.32	35718	3.47	49.2	22.56		7.29
5	No reading						11m	
Cond. values								
like to drop off Lake								

APPENDIX V

DEP-SOP-001/01
Form FD 9000-2 (June 1, 2001)

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
COMPOSITE LAKE SAMPLING SHEET (< 1000 ACRES)

Storet: 32020088 **County:** Bay/Walton Sample ID 32355

Date: 7-16-03	Name of Lake: Lake Powell	Gear used: PONAR (Petite)	EKMAN	OTHER
Comments:				

Drop #	Depth (m)	Sediment Type (circle all that apply)	Drop #	Depth (m)	Sediment Type (circle all that apply)
1	2.5	sand, silt/clay, CPOM, muck, (SAV) A	7	1.2	(sand), (silt/clay), CPOM, muck, SAV
2	3.3	sand, silt/clay, CPOM, (muck), SAV A	8	2.55	AN sand, silt/clay, CPOM, (muck), SAV
3	3.1	sand, silt/clay, CPOM, (muck), SAV A	9	2.6	AN sand, silt/clay, CPOM, (muck), SAV
4	2.5	A sand, silt/clay, CPOM, (muck), SAV	10	3.1	AN sand, silt/clay, CPOM, (muck), SAV
5	2.2	(sand), (silt/clay), CPOM, muck, (SAV)	11	3.2	A sand, silt/clay, CPOM, (muck), SAV
6	2.7	sand, silt/clay, CPOM, (muck), SAV AN	12	2.2	A sand, silt/clay, CPOM, (muck), SAV

CPOM = coarse particulate organic matter; SAV = submerged aquatic vegetation

Paste map here and show location of each dredge drop and where water chemistry parameters were collected.

ELFs 11-03-05 FB

FDEP-SOP-001/01: Form FD 9000-3 (June 1, 2001)

PHYSICAL/CHEMICAL CHARACTERIZATION FIELD SHEET

SUBMITTING AGENCY CODE: / SUBMITTING AGENCY NAME:	STORET STATION NUMBER:	DATE (M/D/Y):	TIME	RECEIVING BODY OF WATER:
	32036438	4/6/04		Gulf Mexico

REMARKS:	COUNTY:	LOCATION:	FIELD ID/NAME:
	Walton	Lake Powell - Center	

RIPARIAN ZONE/STREAM FEATURES

Predominant Land-Use in Watershed (specify relative percent in each category):

Forest/Natural	Silviculture	Field/Pasture	Agricultural	Residential	Commercial	Industrial	Other (Specify)
✓	✓			✓			✓ Golf

Local Watershed Erosion (check box): None ☐ Slight ☒ Moderate ☐ Heavy ☐

Local Watershed NPS Pollution (check box): No evidence ☐ Slight ☐ Moderate potential ☐ Obvious sources ☒

Width of riparian vegetation (m) On least buffered side: <1.0

List & map dominant Vegetation on back

Artificially Channelized ☐ no ☐ recent, severe ☐ some recovery ☐ mostly recovered

Artificially Impounded ☒ yes more sinuous

Typical Width (m) Depth (m)/Velocity (m/sec) Transect

m wide

m/s m/s m/s

High Water Mark: [ ] + [ ] = [ ]

(m above present water level) (present depth in m) (m above bed)

m deep m deep m deep

Canopy Cover % : Open: ☒ Lightly Shaded (11-45%): ☐ Moderately Shaded (46-80%): ☐ Heavily Shaded: ☐

SEDIMENT/SUBSTRATE

Sediment Odors: Normal: ☐ Sewage: ☐ Petroleum: ☐ Chemical: ☐ Anaerobic: ☒ Other: ☐

Sediment Oils: Absent: ☒ Slight: ☐ Moderate: ☐ Profuse: ☐

Sediment Deposition: Sludge: ☐ Sand Smothering: none moderate slight severe Silt smothering: none moderate slight severe Other: Muck

Substrate Type	% coverage	# times sampled	method	Substrate Types	% coverage	# times sampled	method
Woody Debris (Snags)				Sand		2	Ponar
Leaf Packs of Mats				Mud/Muck/Silt		10	Ponar
Aquatic Vegetation				Other:			
Rock or Shell Rubbie				Other:			
Undercut banks/Roots				***Draw aerial view sketch of habitats found in 100 m section***			

WATER QUALITY	Depth (m):	Temp. (°C):	pH (SU):	D.O. (mg/l):	Cond. (umho/cm) Or Salinity (ppt):	SpC		Secchi (m):
Top	0.1	21.4	7.77	10.27	157.3	36800		3.4
Mid-depth	1.6	21.33	7.7	13.17	156.4	34300		
Bottom	3.3	20.98	7.52	5.66	93.2	24.1		

System Type: Stream: 1st-2nd order 5th – 6th order 3rd-4th order 7th order or greater Lake: ☒ Wetland: ☐ Estuary: ☐ Other: ☐

Water Odors (check box): Normal: ☒ Sewage: ☐ Petroleum: ☐ Chemical: ☐ Other: ☐

Water Surface Oils (check box): None: ☒ Sheen: ☐ Globs: ☐ Slick: ☐

Clarity (check box): Clear: ☒ Slightly turbid: ☐ Turbid: ☐ Opaque: ☐

Color (check box): slight Tannic: ☒ Green (algae): ☐ Clear: ☐ Other: ☐

Weather Conditions/Notes: Sunny.

Abundance:	Absent	Rare	Common	Abundant
Periphyton	☐	☐	☐	☐
Fish	☐	☐	☐	☐
Aquatic Macrophytes	☐	☐	☐	☐
Iron/sulfur Bacteria	☐	☐	☐	☐

SAMPLING TEAM: Frank Butera, Wes Keller

SIGNATURE:

DATE: 4/6/04

APPENDIX VII

DEP-SOP-001/01: Form FD 9000-6

STATE OF FLORIDA, DEPARTMENT OF ENVIRONMENTAL PROTECTION

Lake Habitat Assessment Field Sheet

STORET STATION NUMBER: 32D360038	DATE (M/D/Y): 4-6-2004	LAKE NAME: Lake Powell - Center	FIELD ID / NAME:
ECO-REGION:	COUNTY: Walton	SAMPLING LOCATION/DESCRIPTION:	LAKE SIZE: 660

PARAMETER		Optimal	Suboptimal	Marginal	Poor
Hydrology		No surface inflow or outflow present, very long water residence time, groundwater seepage dominates ☐	Surface water inflow present, but flow is rare, moderate to long water residence time ☐	Surface water inflow and outflow present (or outflow only), sometimes with visible flow, short water residence time ☒	Impounded, hydrology of system artificially controlled ☐
Color		Very clear, uncolored water (benthic sampling appropriate) ☐	Water somewhat tannin stained (benthic sampling appropriate) ☐	Dark, discolored water (water color 20 PCU or higher) ☒	Visibility extremely reduced due to high color ☐
Secchi	16	Secchi >3 m / Secchi(m)	3 | 2.6 | 2.2 | 1.8 | 1.4	1.0 | 0.9 | 0.8 | 0.7 | 0.6	0.5 | 0.4 | 0.3 | 0.2 | 0.1
		Or VOB: 20 | 19 | 18 | (17) | 16	(15) | 14 | 13 | 12 | 11	10 | 9 | 8 | 7 | 6	5 | 4 | 3 | 2 | 1
Vegetation Quality	17	Diverse, expected native vegetation (emergent or submersed), less than 5% nuisance taxa	Mostly expected native plants, but moderate growths (6%-20% of lake) of nuisance macrophytes, or more than 50% of lake covered with plants	Large masses (21%- 40%) of nuisance macrophytes (e.g., Hydrilla, hyacinth, cattail, etc.) or algal mats	Lake choked (>40%) with nuisance macrophytes (duck-weed, hyacinth, etc.) or algal mats, or few plants present at all (e.g., plants removed)
		20 | 19 | 18 | (17) | 16	15 | 14 | 13 | 12 | 11	10 | 9 | 8 | 7 | 6	5 | 4 | 3 | 2 | 1
Stormwater Inputs	13	Stormwater enters system via sheet flow over non-cultivated and/or natural vegetation	Some direct stormwater inputs (ditches, pipes, cultivated vegetation < 10%) but good BMPs in place	Moderate direct inputs of stormwater (ditches, pipes, cultivated vegetation 11%-50%) but few BMPs in place	Much direct input of stormwater (ditches, pipes, cultivated vegetation > 51%) and no or ineffective BMPs in place
		20 | 19 | 18 | 17 | 16	15 | 14 | (13) | 12 | 11	10 | 9 | 8 | 7 | 6	5 | 4 | 3 | 2 | 1
Bottom Substrate Quality	5	Diverse mixture of sand, detritus, with small amounts of CPOM/mud/muck. SAV may be present	Mixture of sand or clay and detritus with higher % CPOM/mud/muck content. SAV may be present	Moderate layer of CPOM/ mud/muck, or hardpacked sand only, or moderate algal growth (mats or Chara) on bottom	Thick deposits of CPOM, or fine detritus and anaerobic muck/mud/silt, or algal growth or nuisance plants (Hydrilla) cover bottom
		20 | 19 | 18 | 17 | 16	15 | 14 | 13 | 12 | 11	10 | 9 | 8 | 7 | 6	(5) | 4 | 3 | 2 | 1
Lakeside Adverse Human Alternations	13	Very few man-made structures, roads, or other disturbance adjacent to lake (<10%)	Moderate disturbance visible (structures, roads or other), 10%-49% lakeside affected	Many structures, roads or other human disturbance visible (50%-70%) lakeside affected)	Highly developed or disturbed (>70% of lakeside affected)
		20 | 19 | 18 | 17 | 16	15 | 14 | (13) | 12 | 11	10 | 9 | 8 | 7 | 6	5 | 4 | 3 | 2 | 1
Upland Buffer Zone	8	Expected native vegetation between uplands and littoral zone, greater than 90% of shore with >18 m buffer	89%-51% of shoreline with >18m buffer or >75% with 10m to 18m buffer	50%-30% of shoreline with >18m buffer or 50%-74% with 10m to 18m buffer	< 29% of shoreline with >18m buffer
		20 | 19 | 18 | 17 | 16	15 | 14 | 13 | 12 | 11	10 | 9 | (8) | 7 | 6	5 | 4 | 3 | 2 | 1
Adverse Watershed Land Use	11	Score the potential effects from adverse human land uses, based on a continuum of amount and type, with least to most adverse as follows: Native vegetation, Silviculture, Pasture or Citrus, Low Density Residential, Row Crops, Commercial, High Density Residential, Urban, Industrial			
		20 | 19 | 18 | 17 | 16	15 | 14 | 13 | 12 | (11)	10 | 9 | 8 | 7 | 6	5 | 4 | 3 | 2 | 1

TOTAL SCORE: 82	COMMENTS: 82/140 = 59%

ANALYSIS DATE: 4/6/04	ANALYST: F Butler	SIGNATURE:

Revision Date: February 1, 2004

APPENDIX VIII

DEP-SOP-001/01
Form FD 9000-2 (June 1, 2001)

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
COMPOSITE LAKE SAMPLING SHEET (< 1000 ACRES)

Storet: 32D34138 **County:** Walton / Bay

Date: 4-6-04	Name of Lake:	Gear used:	PONAR	EKMAN	OTHER
Comments:					

Drop #	Depth (m)	Sediment Type (circle all that apply)	Drop #	Depth (m)	Sediment Type (circle all that apply)
AN 1	2.8	sand, silt/clay, CPOM, muck, SAV AN	7 AN	2.7	sand, silt/clay, CPOM, muck, SAV AN
AN 2	3.5	sand, silt/clay, CPOM, muck, SAV AN	8 SI/CLAN	2.7	sand, silt/clay, CPOM, muck, SAV SI/CL AN
AN 3	3.4	sand, silt/clay, CPOM, muck, SAV AN	9 AN	2.7	sand, silt/clay, CPOM, muck, SAV AN
AN 4	3.2	sand, silt/clay, CPOM, muck, SAV AN	10 AN	3.2	sand, silt/clay, CPOM, muck, SAV AN
5	2.4	sand, silt/clay, CPOM, muck, SAV	11 AN	3.4	sand, silt/clay, CPOM, muck, SAV AN
6	2.1	sand, silt/clay, CPOM, muck, SAV	12	3.4	sand, silt/clay, CPOM, muck, SAV

CPOM = coarse particulate organic matter; SAV = submerged aquatic vegetation

Paste map here and show location of each dredge drop and where water chemistry parameters were collected.