Ecological Assessment of the

Wekiva River

Seminole, Lake & Orange Counties

Sampled January & September 1999

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Bureau of Laboratories

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Introduction

The Wekiva watershed lies northwest of Orlando, in the northern portion of Orange County, eastern Lake county and the southwestern portion of Seminole County. The majority of this watershed is situated within the Central Florida Ridges and Uplands subecoregion of the Southern Coastal Plain, draining the western portion of the Orlando Ridge (White 1970, Griffith *et al*. 1994). This sand hill karst area is characterized by xeric hills and solution basins, with thick, acidic, sandy soils, which are moderately to excessively drained (Griffith *et al*. 1994). Just downstream from the confluence of the Little Wekiva River and the Wekiva River, the total drainage basin consists of approximately 157 square miles.

The Wekiva was one of the first systems where Ecosystem Management efforts were initiated. Friends of the Wekiva River, a very active citizens group, stays involved with efforts to preserve and improve the area. In their most recent report, they pointed out that the Little Wekiva River continues to receive untreated stormwater from urban areas in Orange and Seminole Counties. Topping the list of their recommendations was the continued monitoring of the groundwater and surface water quality, and the continuation of efforts to identify and control causes of adverse impacts to humans and natural ecosystems in the basin (Friends of the Wekiva River, 1992).

Environmental concerns in this watershed are primarily associated with urban stormwater runoff, erosion, and streambed alterations. Land use in the 57 square mile Little Wekiva drainage basin is predominantly urban (80%), with agricultural (4%), and natural (16%) land uses also represented (Eric Pluchino, FDEP, pers. com.). Cumulative land use , situated in the Wekiva River downstream of the confluence with the Little Wekiva, includes urban (40%), wetlands (32%), upland forests (17%), and agriculture (7%).

For this study, biological, physical, chemical, and habitat information was collected from six stations in the Wekiva River (Sites A through F), one station in the Little Wekiva River, and three associated creeks/stream stations (Blackwater Creek, Yankee Lake Outlet Stream & Rock Springs Run). These ten sites were selected to assess the effects of human activities in the watershed (*e.g*., numerous stormwater inputs from residential, commercial, and municipal land uses).

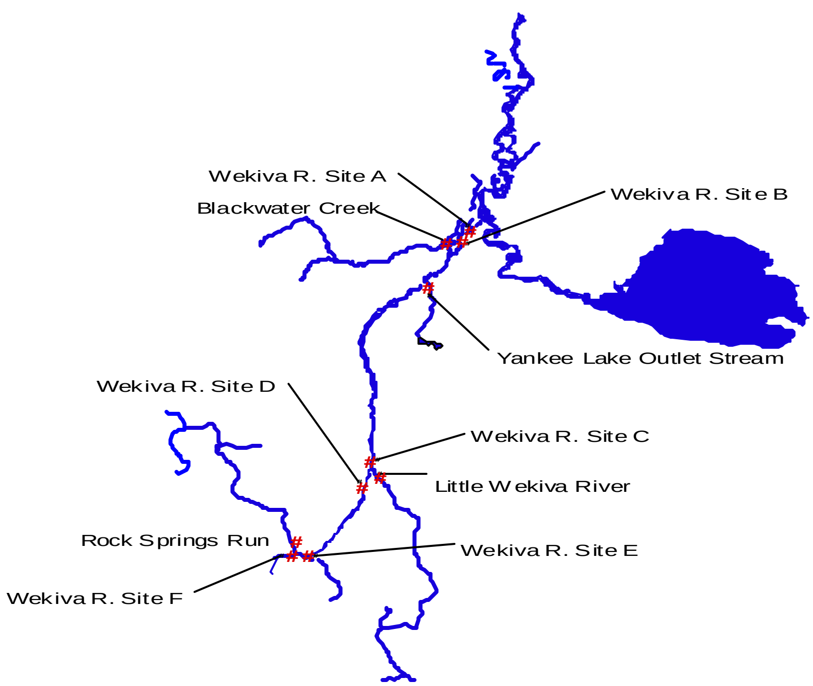

Figure 1: Overview Map

Methods

Habitat quality was determined for each station during an *in situ* assessment (FDEP, 2000b). Supplemental physical/chemical data were also collected on the study sites. Additionally, nutrient analyses were performed for each site. Methods used for all chemical analyses are on file at the Tallahassee DEP Chemistry Laboratory.

Benthic macroinvertebrate communities were evaluated at all 10 sites. Invertebrates were collected from multiple substrates (*e.g*., snags, leaf packs, vegetation) using discrete dip net sweeps (FDEP 2000a). Phytoplankton was sampled at all 10 sites by subsurface grabs. Chlorophyll *a* was also determined for phytoplankton communities. Algal Growth Potential tests, using *Selenastrum capricornutum* as the test organism, followed Miller *et al*. (1978).

Measurements of Community Health

Several different measurements of macroinvertebrate and algal community health have been employed to determine the effects of a discharge. These are briefly discussed here.

Habitat: Eight attributes known to have potential effects on the stream biota were evaluated and scored, with 20 possible points for each factor. Based on the sum of these individual scores, overall habitat quality is assigned to one of four categories: Optimal (120-160 points); Suboptimal (100-119 points); Marginal (80-99 points); and Poor (0-79 points).

Taxa richness: Stress tends to reduce the number of different types of organisms present in a system, although moderate nutrient enrichment may sometimes be correlated with increased algal taxa richness.

Shannon-Weaver diversity: This index is specified in the Florida Administrative Code as a measure of biological integrity. Low diversity scores are undesirable. They represent conditions where only a few organisms are abundant, to the exclusion of other taxa. Excessive numerical dominance of a single type of organism (a high % contribution of the dominant taxon) is a related measure which is also associated with disturbance.

Numbers of pollution sensitive taxa: Some organisms become rare or absent as the intensity or duration of disturbance increases. For example, the Florida Index assigns points to stream-dwelling macroinvertebrates based on their sensitivity to pollution (Ross 1990). A site with a high Florida Index score is considered healthy. Species sensitivity data from other sources, such as Hulbert (1990), Hudson *et al*. (1990), Lenat (1993), Farrell (1992), Chang *et al*. (1992), and Whitmore (1989), are used as appropriate.

Ephemeroptera/Plecoptera/Trichoptera Index: This index is the sum of the number of larval EPT taxa (mayflies, stoneflies, and caddisflies) present. Higher EPT values are associated with healthier systems.

Community structure: Substantial shifts in the proportions of major groups of organisms, compared to reference conditions, may indicate degradation. In marine systems, an increase in the % tubificid oligochaetes, a decrease in the % pelecypods, and a decrease in the number of polychaete taxa are all considered indicators of disturbance (Engel *et al*. 1994).

Algal biomass: High algal biomass (algal density or chlorophyll *a*) implies nutrient stress. A decreased diatom to blue-green algae ratio is often indicative of nutrient enriched conditions in flowing streams.

Trophic composition/feeding guilds: Disturbance can shift the feeding strategies of invertebrates. In Florida, for example, pollution may be responsible for reducing the numbers of filter-feeders (FDEP, 1994) and shredders (EA Engineering, 1994).

The Stream Condition Index for Florida (SCI) is a composite macroinvertebrate metric (Barbour *et al*., 1996). The SCI assigns points to a variety of parameters, depending on how closely each parameter approaches an expected reference condition.

Results and Discussion

Habitat quality was high among all the sites sampled (Figure 4). All of the sites had habitat scores of 131 points or more, placing them in the optimal range. Based upon the habitat assessment, the largest potential habitat problem was smothering from sand and silt.

Macroinvertebrate Parameters	January 1999 Sampling										
Station	Wekiva R. Site A	Blackwater Creek	Blackwater Creek (dup)	Wekiva R. Site B	Yankee Lake Outlet	Wekiva R. Site C	Little Wekiva River	Wekiva R. Site D	Wekiva R. Site E	Rock Springs Run	Wekiva R. Site F
STORET	20010125	20010341	20010341	20010438	20010344	20010126	20010343	20010103	20010377	20010342	20010431
SCI	33	33	33	31	23	33	31	33	27	31	31
Peninsula Evaluation	excellent	excellent	excellent	excellent	good	excellent	excellent	excellent	excellent	excellent	excellent
Number of Taxa	40	36	37	51	19	57	61	49	29	39	44
Number of Ephemeroptera	1	7	5	5	0	5	6	2	1	4	4
Number of Plecoptera	0	0	0	0	0	0	0	0	0	0	0
Number of Trichoptera	8	6	7	6	3	6	6	10	2	7	6
EPT Index	9	13	12	11	3	11	12	12	3	11	10
% Contribution Dominant Taxa	14.29	12.58	7.87	24.35	30.85	7.6	7.78	9.09	24.31	12.5	11.93
Florida Index	16	22	22	26	13	25	24	19	12	18	20
% Diptera	51.7	46.36	44.88	54.02	2.99	47.37	54.07	49.35	7.64	30.63	44.04
Total Number Chironomidae	16	12	13	17	4	23	27	19	5	8	16
% Filterer-Feeders	19.73	22.85	28.74	27.52	23.88	15.5	17.41	17.21	9.72	16.25	13.76
Physical-Chemical Data											
Station	Wekiva R. Site A	Blackwater Creek	Blackwater Creek (dup)	Wekiva R. Site B	Yankee Lake Outlet	Wekiva R. Site C	Little Wekiva River	Wekiva R. Site D	Wekiva R. Site E	Rock Springs Run	Wekiva R. Site F
Habitat Assessment	135	141	141	141	129	132	134	131	146	138	134
Avg. Sample Depth (m)	0.6	0.6	0.6	0.4	0.1	0.8	0.7	1	0.9	0.2	0.2
Secchi (m)	1.2	1.2	1.2	0.8	0.2	1.5	1.4	2	1.7	0.5	0.4
Specific Conductivity (umho/cm)	350	510	510	756	2210	311	342	311	296	270	317
Dissolved Oxygen (mg/L)	7.8	7.6	7.6	7.4	7.8	6.5	6.6	6.4	6.4	8.7	3.4
pH (SU)	7.55	7.37	7.37	7.54	7.48	7.44	7.43	7.5	7.57	7.7	7.48
Temperature (deg. C)	19	14.3	14.3	14.8	15.1	15.6	15.4	15.5	18.4	15.5	21.6
Nutrient data											
Station	Wekiva R. Site A	Blackwater Creek	Blackwater Creek (dup)	Wekiva R. Site B	Yankee Lake Outlet	Wekiva R. Site C	Little Wekiva River	Wekiva R. Site D	Wekiva R. Site E	Rock Springs Run	Wekiva R. Site F
Ammonia (mg/L)	0.026	0.059	0.059	0.046	0.02	0.01 BDL	0.014	0.016	0.01 BDL	0.01 BDL	0.01 BDL
Nitrate-Nitrite (mg/L)	0.46	0.42	0.42	0.56	0.04	1	0.32	1.1	1.2	1.1	1.3
TKN (mg/L)	0.55	0.65	0.65	0.39	0.38	0.25	0.27	0.26	0.19	0.15	0.14
Total Phosphorus (mg/L)	0.092	0.042	0.042	0.097	0.03	0.11	0.15	0.1	0.096	0.089	0.12
Algal Growth Potential (mg dry wt/L)	8.5	0.7	0.7	4.6	0.1	1.8	9.8	7.4	7	3.7	6.1

Figure 2: Results from January Sampling

Smothering could have future effects on the invertebrates, especially at higher water levels.

Dissolved oxygen ranged from 3.4 mg/L at Site F to 8.7 mg/L at Rock Springs Run. All sites, except for Wekiva River Site F, complied with the dissolved oxygen Class III surface water standard of 5.0 mg/L. Water pH was close to neutral at all stations (between 7.3 SU and 7.7 SU), with conductivity ranging from 270 µmhos/cm at Rock Springs Run to 2210 µmhos/cm at Yankee Lake Outlet. Temperature ranged between 14.3 C and 18.4 C (Figure 2).

Nitrate-nitrite enrichment was observed at all of the sites except Yankee Lake Outlet. These concentrations ranged from 0.32 mg/L at the Little Wekiva River Site to 1.3 mg/L at Wekiva River Site F. The nitrate-nitrite concentrations at the Little Wekiva River Site, the Blackwater Creek Site and sites A & B of the Wekiva River were higher than those found in 80% of other Florida streams. Nitrate-nitrite values at Wekiva River Site C exceeded the values found in 90% of other Florida streams. The Rock Springs Run Site and Wekiva River Sites E and F exceeded the values found in 95% of other Florida streams for nitrate-nitrite. The sites with the most elevated nitrate-nitrite values (Rock Springs Run and Wekiva River Sites C, D, E & F) receive significant groundwater inputs. Nutrient concentrations in these spring waters are often elevated, based upon data from the Groundwater Information System (GWIS). For example, total phosphorus in these spring waters generally ranges from 0.1 mg/L to 0.2 mg/L and the majority of the nitrate-nitrite values exceed 1.0 mg/L. Other authors have demonstrated that human activities in the recharge areas of Floridan Aquifer springs have led to substantial nitrate-nitrite contamination in groundwater discharging from them (Jones and Upchurch 1994, Jones *et al*. 1996). Therefore, spring inputs appeared to be the source of the excessive nitrate-nitrite at Rock Springs Run and Wekiva River Sites C, D, E & F. The lower

Physical-Chemical Data	September 1999 Sampling									
Station	Wekiva R. Site A	Blackwater Creek	Wekiva R. Site B	Yankee Lake Outlet	Wekiva R. Site C	Little Wekiva River	Wekiva R. Site D	Wekiva R. Site E	Rock Springs Run	Wekiva R. Site F
STORET	20010125	20010341	20010438	20010344	20010126	20010343	20010103	20010377	20010342	20010431
Specific Conductivity (umho/cm)	654	434	722	2340	272	257	274	265	234	293
Dissolved Oxygen (mg/L)	5.6	6.4	6.6	5.5	4.7	4.6	4.2	4.6	6.9	2.7
pH (SU)	7.4	7.4	7.7	7.5	7.4	7.4	7.4	7.6	7.7	7.6
Temperature (deg. C)	26	24.6	26.4	25.3	25	25.5	24.8	24	24.6	23.8

Nutrient Data										
Station	Wekiva R. Site A	Blackwater Creek	Wekiva R. Site B	Yankee Lake Outlet	Wekiva R. Site C	Little Wekiva River	Wekiva R. Site D	Wekiva R. Site E	Rock Springs Run	Wekiva R. Site F
Ammonia (mg/L)	0.019	0.026	0.01 BDL	0.044	0.016	0.018	0.014	0.013	0.011	0.011
Nitrate-Nitrite (mg/L)	0.3	0.49	0.35	0.039	0.8	0.26	0.8	0.96	0.96	0.49
TKN (mg/L)	0.56	0.86	0.38	0.45	0.2	0.45	0.19	0.18	0.17	0.15
Total Phosphorus (mg/L)	0.093	0.048	0.1	0.043	0.11	0.15	0.11	0.091	0.083	0.11
Algal Growth Potential (mg dry wt/L)	20.4	20.7	28.8	0.4	46.6	18.4	53.9	58.9	53.3	14.1

Figure 3: Results from September Sampling

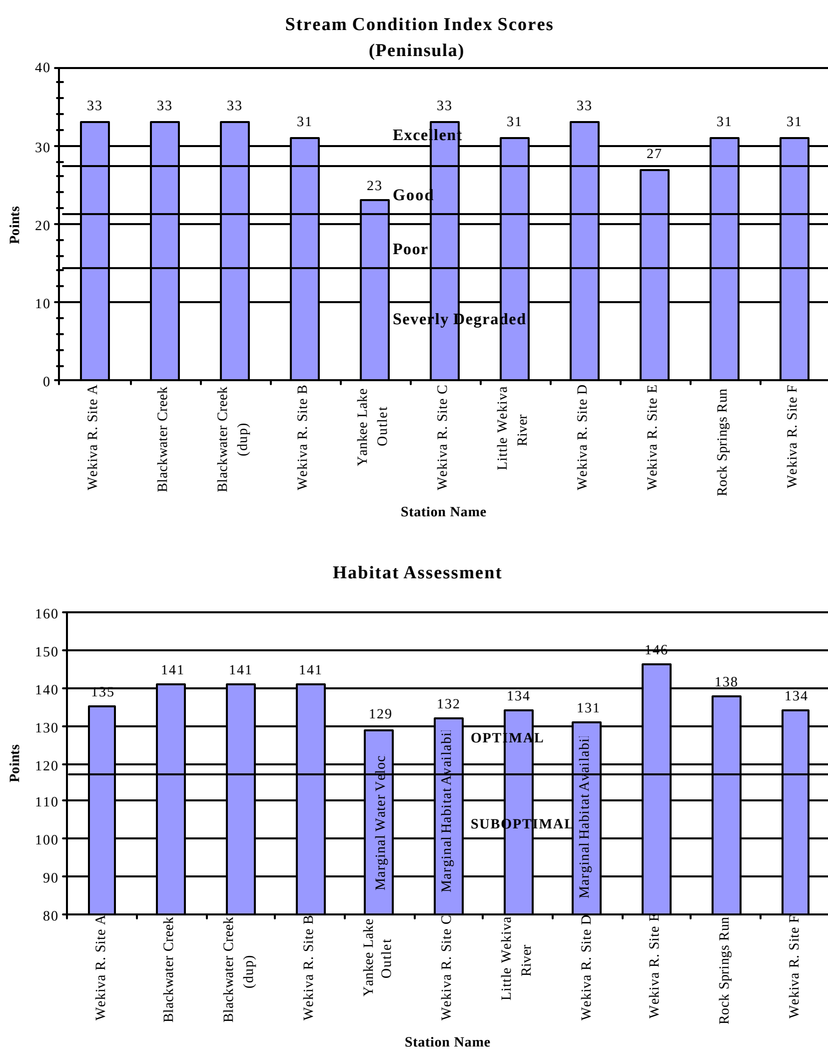

Figure 4: Habitat and SCI Scores

nitrate-nitrite concentration at Wekiva River Sites A & B is the result of dilution from increased surface water run-off.

Ammonia and total Kjeldahl nitrogen at all of the sites was lower than the concentrations found in 50% of other Florida streams (0.08 mg/L & 1.00 mg/L, respectively). Total phosphorus was highest at the Little Wekiva Site (0.15 mg/L), which was slightly above the 50th percentile (0.13 mg/L) for Florida streams.

Algal growth potential (AGP) exceeded the 5 mg dry wt/L "problem threshold" (Raschke and Schultz, 1987) at Wekiva River Sites A, D, E, F and the Little Wekiva River. The AGP ranged from 6.1 mg dry wt/L at Wekiva River Site F to 9.8 mg dry wt/L at the Little Wekiva River Site (Figure 2). Sites with the most elevated AGP values appeared to coincide with those having the highest nitrate-nitrite levels. The AGP values throughout the basin suggest that undesirable algal or macrophyte growth may occur where other conditions (*e.g.*, longer water residence time) are more conducive to algal growth. Observations of habitats at the Wekiva River

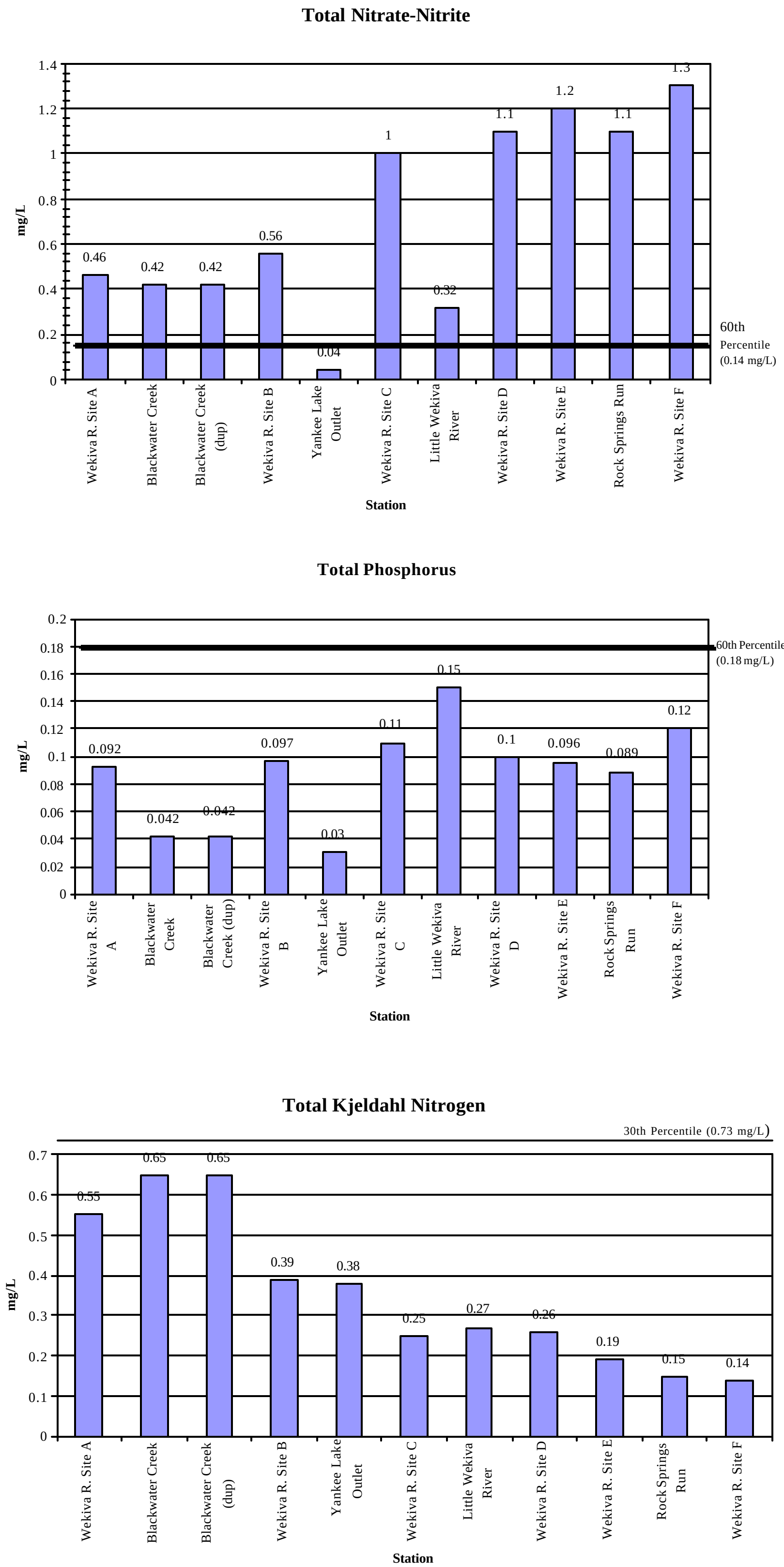

Figure 6: Selected Nutrient Data

sites revealed an abundance of the filamentous blue-green alga Lyngbia sp. These algae were attached to various substrates including the eel-grass (Vallisineria americana) which is a primary component of the native macrophyte community of the river. Infestation of invasive aquatic plants or increased abundance of attached algae could have long term negative impacts on the eel-grass community.

Further water chemistry sampling was conducted in September of 1999 (Figure 3). Results for ammonia, nitrite-nitrate, Kjeldahl nitrogen and total phosphorus were nearly identical to the January sampling. Algal growth potential results, however, were much higher for the September samples. Only one site, Yankee Lake Outlet (0.4 mg dry wt/L), was below the "problem threshold" of 5 mg dry wt/L. It is possible that unidentified factors that inhibited algal growth during the January sampling event were not present in September, hence, the higher AGP values with similar nutrient concentrations.

Macroinvertebrate sampling at all ten stations throughout the watershed consisted of the 20 dipnet sweep method for calculation of the Stream Condition Index (SCI). Using this standard qualitative method, the number of total taxa ranged from a high of 61 at the Little Wekiva River Site, to a low of 19 at the Yankee Lake Outlet Site (Figure 2). Based upon the current SCI, one expects to find a minimum of 27 taxa at an unimpaired site in the Florida peninsula.

An EPT Index of 4 or higher is usually found in a healthy peninsular stream. With the exception of the Wekiva River Site E and Yankee Lake Outlet, all stations exceeded this value. A minimum Florida Index score of 9 points is expected for an unimpaired peninsular stream. Florida Index values for all 10 sites exceeded this score, ranging from 12 at Wekiva River Site E to 26 at Wekiva River Site B.

The Stream Condition Index is a composite of seven different measures of macroinvertebrate community structure and function, including the parameters mentioned in the preceding paragraph. The SCI ranged from a low of 23 points at Yankee Lake Outlet, to a high of 33 at Wekiva River Sites A, C, D and Blackwater Creek (Figure 2). Based on the SCI, all sites except the Yankee Lake Outlet Site received an "excellent" rating. Yankee Lake Outlet was in the "good" category. The lower SCI score at Yankee Lake Outlet probably was related to the high conductivity (2210 umhos/cm) found at the site. Conductivity at the site exceeded the 1275 umhos/cm Class III Surface Water Standard, which may be due to natural "salt" springs in the area.

Conclusions

Based on the SCI, all sites except for Yankee Lake Outlet were rated as having "excellent" macroinvertebrate communities. Yankee Lake Outlet was in the "good" category, probably due to high (naturally occurring?) conductivity found there. Habitat quality was high among all the sites sampled (131 points or more), placing them in the "optimal" range. Based upon the habitat assessment, the largest potential habitat problem was smothering from sand and silt.

Water quality sampling demonstrated nitrate-nitrite enrichment at all of the sites except Yankee Lake Outlet. These concentrations ranged from 0.32 mg/L at the Little Wekiva River Site to 1.3 mg/L at Wekiva River Site F. These concentrations were higher than those found in 80% of other Florida streams. All other parameters (TKN, TP, NH3, etc.) were below the 50th percentile for Florida streams. Water quality measurements were confirmed during the September sampling event.

Algal growth potential (AGP) exceeded the 5 mg dry wt/L "problem threshold" (Raschke and Schultz, 1987) at Wekiva River Sites A, D, E, F and the Little Wekiva River. The AGP ranged from 6.1 mg dry wt/L at Wekiva River Site F to 9.8 mg dry wt/L at the Little Wekiva River Site. AGP results were even higher during the September sampling event. Sites with the most elevated AGP values appeared to coincide with those having the highest nitrate-nitrite levels. The AGP values throughout the basin suggest that undesirable algal or macrophyte growth may occur downstream in the St. Johns River (such as in Lakes Beresford and Dexter) where other conditions (*e.g*., longer water retention time) are more conducive to algal growth .

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