Executive Summary

The purpose of this investigation was to determine if human activities within the watersheds of Peters Creek, Mill Log Creek, and Bradley Creek were negatively affecting water quality or the health of receiving water biota. Six sites were sampled (on 26 and 28 January 1998) for biological, habitat, and physical/chemical parameters.

All six sites in the study scored in the "optimal" category for habitat assessment. Of the parameters measured during this study, habitat smothering (with sand) was the factor which potentially could exert negative influences on aquatic fauna. Erosion from unpaved roads was one observed sediment source.

Dissolved oxygen concentrations complied with Class III water quality standards for all sites. Specific conductance was moderately elevated in Mill Log Creek.

No metals or organic compounds were detected at levels which exceeded Class III water quality standards.

Algal growth potential exceeded the 5 mg dry wt/L "problem threshold" at both Mill Log Creek sites (42.79 mg dry wt/L at CR 739B and 11.51 mg dry wt/L at CR 209), Bradley Creek (23.31 mg dry wt/L), and Peters Creek at the "dam" (19.80 mg dry wt/L). These stations drained an area used for dairy and cattle activities.

Phytoplankton chlorophyll *a* was undetected in the stream stations. Apparently, factors such as water velocity or light penetration (color, canopy cover) precluded phytoplankton blooms from occurring in these streams, although such effects may occur farther downstream in the St. Johns River.

Nutrient enrichment was observed in the watershed, appearing to originate

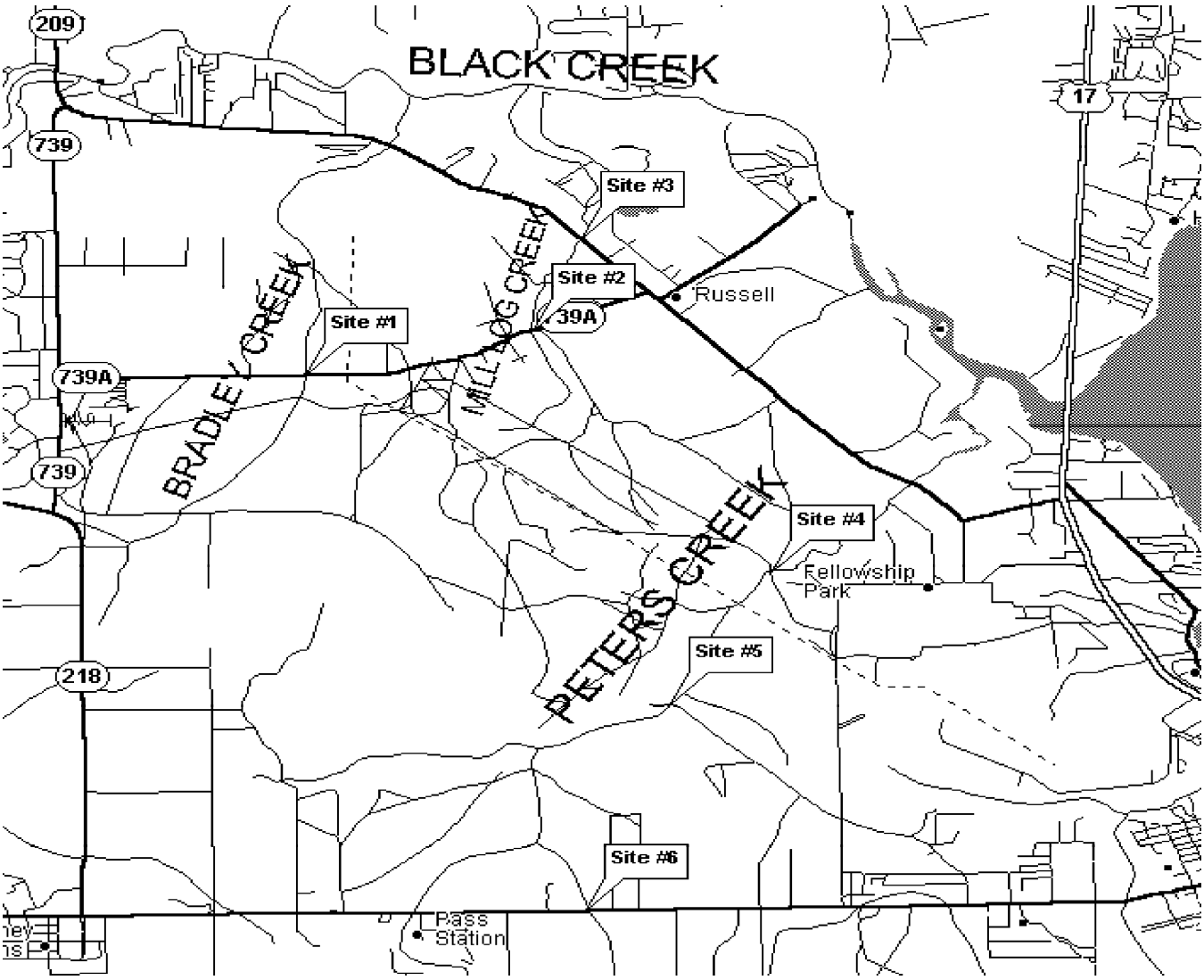


Figure 1. Overview of study area

from land used for dairy farming and cattle operations. Water at Mill Log Creek at CR 739B had excessive concentrations of ammonia, nitrate-nitrite , and phosphorus. Nitrate-nitrite levels at at Bradley Creek were elevated. Phosphorus enrichment was also observed Mill Log Creek at CR 209.

Bradley Creek, and all three Peters Creek stations received an "excellent" Stream Condition Index rating for macroinvertebrate health. Mill Log Creek received a "poor" rating at CR 739B (closest to the dairy and cattle lands) improving to the "good" category at CR 209. It appears that this improvement in water quality was due to dilution with water from other small tributaries between the two locations.

Introduction

The Peters Creek watershed is an approximately 26 square mile drainage basin located northwest of Green Cove Springs, in Clay County. Peters Creek, which receives flow from Mill Log Creek and Bradley Creek, is a tributary of Black Creek. The general direction of flow in the Peters Creek drainage basin is from the south to the north. The majority of this watershed is situated within the Sea Island Flatwoods of the Southern Coastal Plain, draining the eastern portion of the Trail Ridge (White 1970, Griffith et al. 1994). This geographical subregion contains upland plains of longleaf pine/ turkey oak woods, marshes, swamps, flatwoods, and lakes. The soils are characterized generally as somewhat poorly to poorly drained spodosols.

There are several human activities in the basin that are of concern. As Peters Creek flows north under SR 16, it flows alongside the western perimeter of Rosemary Hill Landfill. Downstream and immediately adjacent to the landfill, the creek flows between two commercial cattle operations: Green Ag Dairy on the eastern bank, and beef cattle pastures on the western bank of the creek. The creek then flows through a sparse residential area, under CR 209, at which point the density of residential land uses increases. The creek then joins Black Creek.

The approximately 5 square mile Mill Log Creek watershed drains primarily dairy cattle pastures of the Sandridge Farms Dairy. Mill Log Creek originates south of CR 739B, flowing north under CR 209, and along the western border of Solite Industries (formally a mining operation producing aggregate) before joining Black Creek.

The Bradley Creek watershed (approximately 8 square miles) drains primarily dairy cattle pastures from Wisteria Farms Dairy, and land used for silviculture on the eastern reaches. Land in the western portion of the basin is used for silvicultural and residential purposes. Residential development appears to be increasing in the area of County Roads 739B and 218, eastward towards Bradley Creek.

Methods

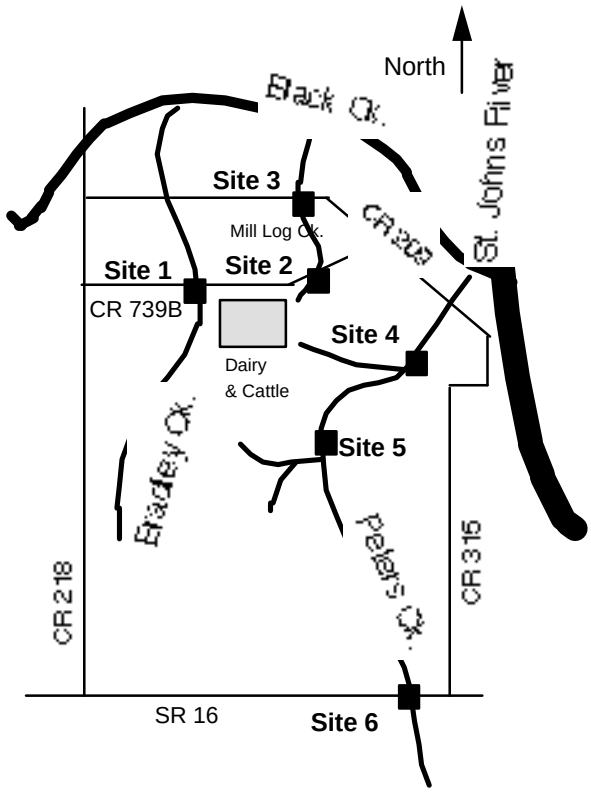
The focus of this investigation was to determine if human activities within the basin were affecting the health of receiving water biota by collecting biological, habitat, and physical/ chemical information from selected streams in the Peters Creek drainage basin.

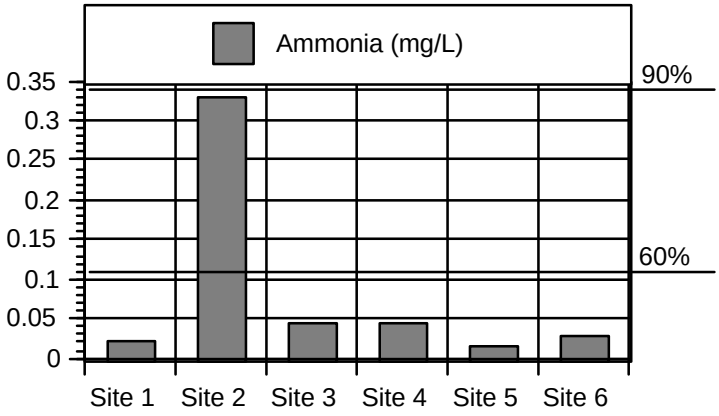
Site Descriptions

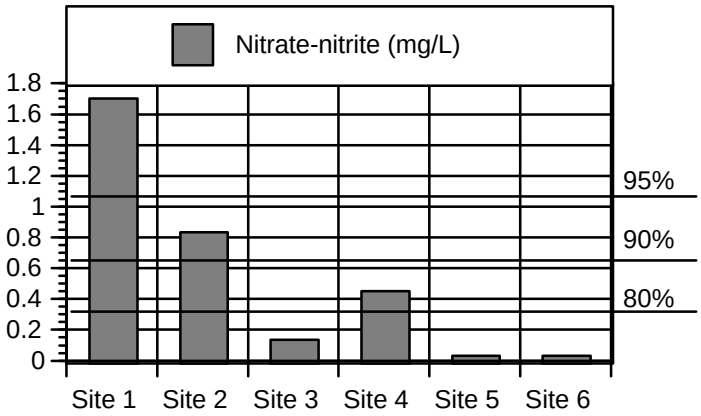
Station 1 was located in Bradley Creek at CR 739B, downstream of the bridge. From its headwaters, south to CR 739B, this site drains the pastures from Wisteria Farms Dairy. Another influence from the westerly direction of the creek is new residential development. However, there still remains a large tract of silviculture and natural forest between the new residential development and the creek. The sampling point was downstream (due to access) of the bridge approximately 200 yards to eliminate any bridge influence.

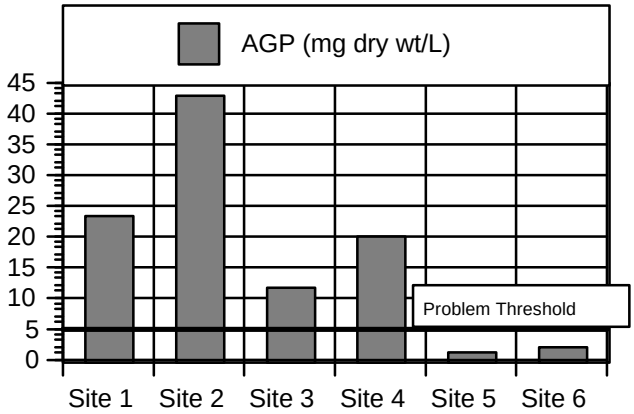
Station 2 was in Mill Log Creek at CR 739B, upstream of the bridge. This site drains an area of dairy pasture from Sandridge Farms Dairy. The sampling point was upstream of the bridge, just after the creek flowed under the fence of Sandridge Farms property.

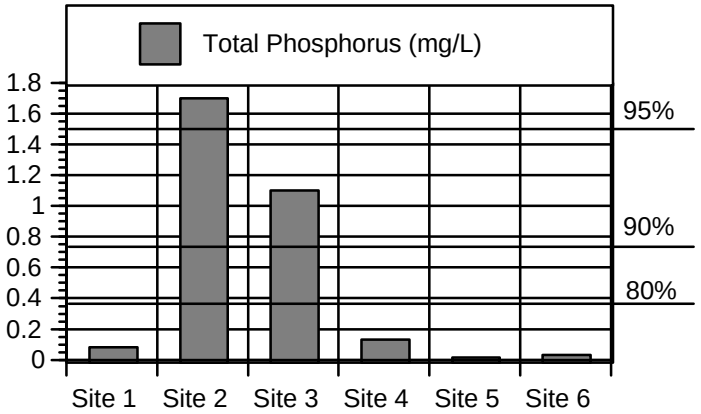
Figure 2: Selected physical/chemical parameters at study sites.











Station 3 was situated in Mill Log Creek at CR 209. This site is located downstream of site 2 and closer to Black Creek. The sampling point was located approximately 100 yards upstream of the bridge.

Station 4 was located in Peters Creek at the "dam" (as known locally). This site was downstream of the Rosemary Hill Landfill, Green Ag Dairy, Sandridge Farms Dairy, Wisteria Dairy, and the beef cattle pastures on the westerly side of the creek. This site was accessed from the Green Ag Dairy property from a dirt road that crosses over the creek (via culverts) and leads to the other dairy farms. The site was located 100 m downstream of the culverts.

Station 5 was in Peters Creek at Rosemary Hill Road, located immediately upstream of the Rosemary Hill Landfill. Land use upstream of the site is primarily silvicultural, residential, with some pastures and row crops. The sampling point was located approximately 150 m upstream of the bridge.

Station 6 was located in Peters Creek at State Road 16, in the uppermost area of the drainage basin. The possible human influences here include RGC Mineral Sands Mining Operations, sparse private residential areas), fairgrounds, and mostly large tracts of silviculture.

On 26 January 1998, Mill Log Creek at County Road 209 and three stations on Peters Creek (at State Road 16, at Rosemary Hill Road, and downstream of the "dam") were sampled. Two days later, Bradley Creek and Mill Log Creek at County Road 739B were sampled.

Benthic macroinvertebrate communities were evaluated by collecting invertebrates from multiple substrates (e.g., snags, leaf packs, vegetation) using 20 discrete dip net sweeps (FDEP 1996, Biology Section Standard Operating Procedure #BA-7). The resulting samples were brought back to the laboratory for identification under the dissecting microscope. A physical/chemical characterization (FDEP 1996b, BA-17) and habitat assessment (FDEP 1996b, BA-18) were also performed at each study site.

Explanation of Measurements of Community Health

Selected measurements of macroinvertebrate community health were employed to assess a site. These are briefly discussed here.

Habitat Assessment: Seven attributes known to have potential effects on the stream biota were evaluated and scored, with 20 points possible for each factor. Based on the sum of these individual scores, overall habitat quality is assigned to one of four categories: Optimal (105-140 points); Suboptimal (70-104 points); Marginal (35-69 points); and Poor (0-34 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.

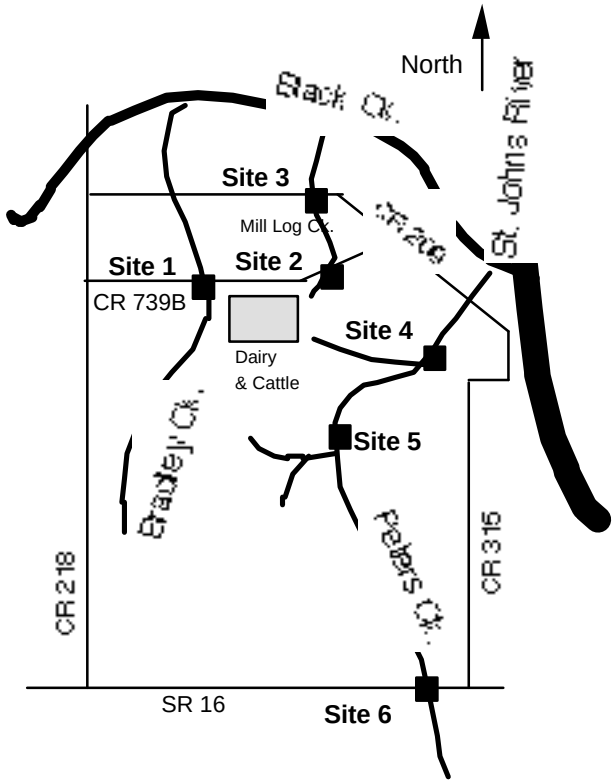
Numbers of pollution sensitive taxa: Some organisms become rare or absent as the intensity or duration of disturbance increases. For example, the Florida Index assigns points to stream-dwelling macroinvertebrates based on their sensitivity to pollution (see Ross 1990). A site with a high Florida Index score is considered healthy.

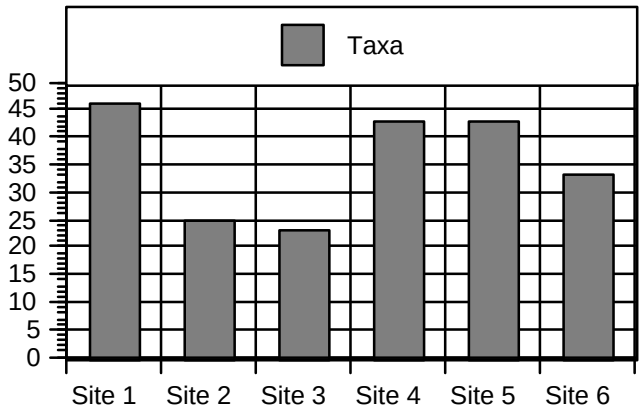
Ephemeroptera/Plecoptera/Trichoptera Index: This index is the sum of the number of EPT taxa present. Higher EPT values are associated with healthier systems.

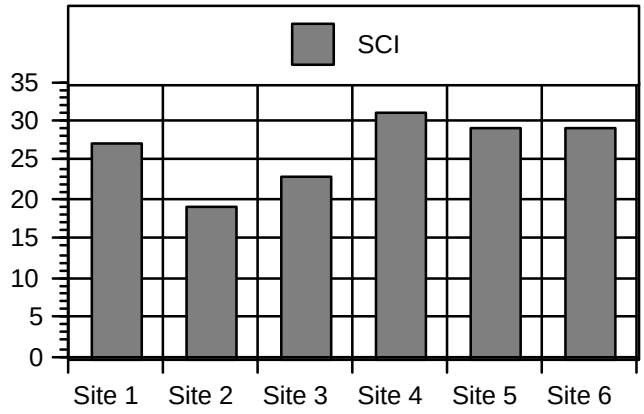
Community structure: Substantial shifts in the proportions of major groups of organisms, compared to reference conditions, may indicate degradation. In marine systems, an increase in the % tubificid oligochaetes, a decrease in the % pelecypods, and a decrease in the number of polychaete taxa are all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

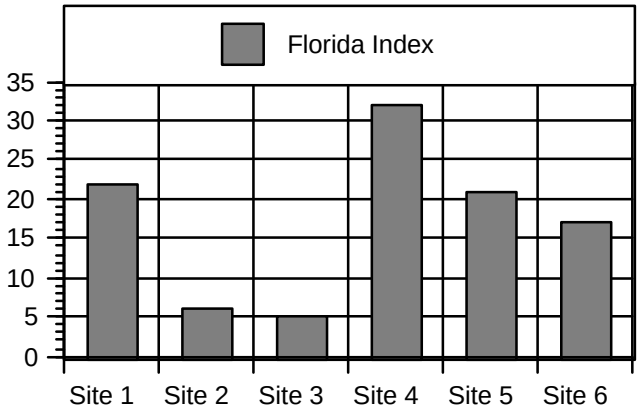
Trophic composition/feeding guilds: Disturbances can shift the feeding strategies of invertebrates. In Flor-

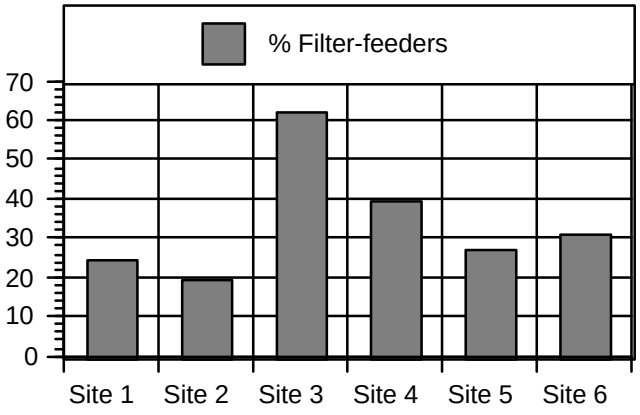
Figure 3. Biological community measurements at study sites.

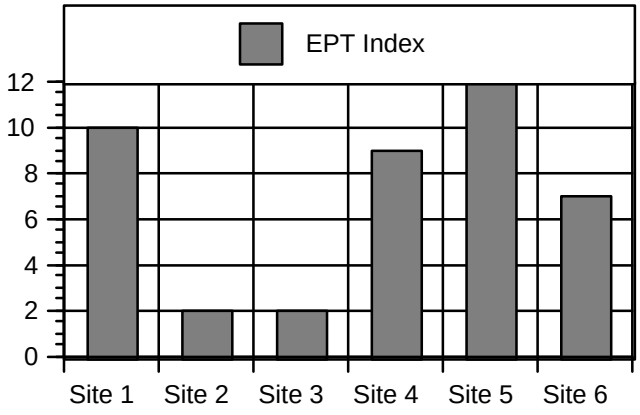












ida, for example, pollution may be responsible for reducing the numbers of filter-feeders (FDEP 1994) and shredders (EA Engineering 1994).

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.

Sampling for this investigation was performed by Tim McKelvey and Pat O'Conner from the FDEP Northeast District. The FDEP Central Laboratory performed the biological and chemical analysis and report writing.

Results and Discussion

Habitat/Phys-Chem Parameters

Habitat quality was in the "optimal" category at all sites, ranging from a low of 112 points at Mill Log Creek at CR 209 and Peters Creek below the "dam" (sites 3 and 4, respectively) to a high of 153 at Peters Creek at SR 16 (Site 6). Most sites, except for Peters Creek at SR 16, lost points in the category of habitat smothering (see Habitat Assessment sheets in Appendix). Additionally, the riparian buffer zone at Mill Log Creek at CR 209 was less than 10 m wide. This site, and Peters Creek below the "dam" showed small areas of erosion or the potential for erosion during rain events.

Dissolved oxygen concentrations, ranging between 7.4 mg/L at Mill Log Creek at CR 739B and 9.7 mg/L at Mill Log Creek at CR 209, were adequate to support aquatic life at all sites (Class III standard = 5.0 mg/L). Specific conductance was below 100 µmhos/cm at most sites, except for Mill Log Creek at CR 739B (235 µmhos/cm) and Mill Log Creek at CR 209 (160 µmhos/cm). The higher conductivity in Mill Log Creek is potentially related to either calcareous inputs or agricultural runoff. The pH ranged from a high of 6.3 SU at Mill Log Creek at CR 209 to a low of 5.3 SU at Bradley Creek.

Water Chemistry

Surface water samples were collected at all sites and analyzed for ammonia, nitrite-nitrate, total Kjeldahl nitrogen, ortho-phosphate, total phosphorus, algal growth potential, chlorophyll *a* and phaeophyton. Sites 4 (Peters Creek at the dam) and 5 (Peters Creek at Rosemary Hill) were also sampled for metals and extractable organic pollutants.

Algal Growth Potential at Peters Creek at SR 16 (site 6 = 2.0 mg dry wt/L) and Peters Creek at Rosemary Hill (site 5 = 1.2 mg dry wt/L) was below the "problem threshold" of 5 mg dry wt/L (Raschke and Schultz 1987). The farthest downstream Peters Creek site (station 4, below the dam) had an AGP value of 19.8 mg dry wt/L, about ten times the upstream values. Anthropogenic sources of nutrients between stations 4 and 5 include a landfill, three dairy farms, and a beef cattle farm. Similarly, dairy farms and new residential development drain into Bradley Creek, where the AGP was 23.31 mg dry wt/L, almost 5 times the "problem threshold". AGP at Mill Log Creek at CR 739B (station 2) was exceptionally high, 42.79 mg dry wt/L. AGP at the Mill Log Creek at CR 209 (11.51 mg dry wt/L) was lower, probably due to dilution from feeder tributaries, but this value was still twice the "problem threshold".

Neither chlorophyll *a* nor phaeophyton were detected at any of the six sites. Apparently, factors such as water velocity, light penetration (color, canopy cover) precluded phytoplankton blooms from occurring in these streams, although such effects may occur farther downstream in the St. Johns River.

Elevated nutrient levels were associated with the high AGP values. For example, in Mill Log Creek at CR 739B (the highest AGP value), ortho-phosphate (2 mg/L) was extremely high, above the 95% of other Florida streams (see appendix for Typical Values for Selected Parameters in Florida Waters). Conversely, Peters Creek at SR 16

was below the 20th percentile for all measured parameters and had a correspondingly low AGP result.

Ammonia enrichment was observed at Mill Log Creek at CR 739B (0.33 mg/L) where the value was higher than 80% of other Florida streams. Similarly, total Kjeldahl nitrogen at this site (1.9 mg/L of TKN) was near the 90th percentile of streams in the state.

The nitrite-nitrate concentration at Bradley Creek at CR 739B (site 1) was 1.7 mg/L, which exceeds the values found in 95% other Florida streams. Elevated nitrite-nitrate was also found at Mill Log Creek at CR 739B (0.82 mg/L), and at Peters Creek at the dam (0.45 mg/L), where the levels were higher than those found in 90% and 85%, respectively, of other Florida streams.

Substantial phosphorus enrichment was observed at station 2 (1.7 mg/L) and station 3 (1.1 mg/L), both on Mill Log Creek, where the levels exceeded those found in 95% of Florida streams.

Peters Creek at Rosemary Hill and Peters Creek at the dam were sampled for metals and extractable organics (see appendix). No organic constituents were detected at either site, and metals were found at non-problem levels.

Macroinvertebrate Parameters

Macroinvertebrate sampling using the 20 dip net sweep method was performed at all 6 sampling locations. Taxa richness ranged from a high of 46 at Bradley Creek (site 1) to a low of 23 at Mill Log Creek at CR 209 (site 3), all exceeding the minimum of 22 taxa expected for northeast Florida. Florida Index scores at Mill Log Creek at CR 209 (5 Florida Index points) and Mill Log Creek at CR 739B (6 Florida Index points) were lower than the expected SCI threshold of 8 points. At the remaining five sites, the Florida Index scores exceeded this threshold with a high of 32 at site 4 (Peters Creek at dam). Only 2 EPT taxa were found at both sites on Mill Log Creek. At the remaining sites, the EPT Index was greater than the threshold (3 EPTs) expected at an unimpaired stream in northeast Florida.

The Stream Condition Index is a composite of seven different measures of macroinvertebrate community structure and function. This index includes taxa richness, number of EPT taxa and the Florida Index, as well as percent dominance, percent filter-feeders, percent Diptera, and the number of chironomid taxa. Four sites (Bradley Creek and all the three stations on Peters Creek) scored in the "excellent" category. Mill Log Creek at CR 209 had an SCI score of 23, falling within the "good" range. The only "poor" site was Mill Log Creek at CR 739B with an SCI score of 19. Apparently, human activities in that area (runoff from dairy and cattle operations) were sufficiently intense to have negative effects on Mill Log Creek.

Conclusions

All six sites in the study scored in the "optimal" category for habitat assessment. Of the parameters measured during this study, habitat smothering (with sand) was the factor which potentially could exert negative influences on aquatic fauna. Erosion from unpaved roads was one observed sediment source.

Dissolved oxygen concentrations complied with Class III standards for all sites. Specific conductance moderately elevated in Mill Log Creek.

Algal growth potential exceeded the 5 mg dry wt/L "problem threshold" at many sites in the watershed. Stations with the most elevated AGP values included both Mill Log Creek sites (42.79 mg dry wt/L at CR 739B and 11.51 mg dry wt/L at CR 209), Bradley Creek (23.31 mg dry wt/L), and Peters Creek at the "dam" (19.80 mg dry wt/L). Phytoplankton chlorophyll *a* was undetected. Apparently factors such as water velocity, light penetration (color,

canopy cover) precluded phytoplankton blooms from occurring in these streams, although such effects may occur farther downstream in the St. Johns River.

Nutrient enrichment was observed in the watershed, appearing to originate from land used for dairy farming and cattle operations. Ammonia was higher than approximately 90% of other Florida streams at Mill Log Creek at CR 739B (0.33 mg/L). Nitrate-nitrite at Bradley Creek (1.7 mg/L) and Mill Log Creek at CR 739B (0.82 mg/L) was higher than the levels found in 95% and 90%, respectively, of Florida streams. Phosphorus enrichment was also observed at Mill Log Creek at CR 739B and Mill Log Creek at CR 209, where concentrations were higher than the levels found in 95% and 90%, respectively, of Florida streams.

No organic compounds or metal analytes were detected at levels which exceeded Class III water quality standards.

Bradley Creek, and all three Peters Creek stations received an "excellent" Stream Condition Index rating for macroinvertebrate health. Mill Log Creek received a "poor" rating at CR 739B (closest to the dairy and cattle lands) improving to the "good" category at CR 209. It appears that this improvement in water quality was due to dilution with water from other small tributaries between the two locations.

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