

Biological Assessment of the

Effectiveness of Forestry Best Management Practices

Okaloosa, Gadsden, Taylor and Clay Counties
Sampled Winter of 1996 and 1997

December 1997

Bureau of Laboratories
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Comprehensive Qualiity Assurance Plan No. 870346G

Executive Summary

Silviculture is a major land use in Florida, supporting a wood products industry which produces lumber, paper, pulp, fabrics, and various organic chemicals from the harvesting and processing of trees. Tree harvesting, which typically occurs on a 20 to 30 year cycle for pulpwood and a 50 to 80 year cycle for saw timber, often involves clearcutting. Following a typical clearcut harvest, mechanical site preparation and tree planting are usually conducted to reforest the area.

As part of the development of the State's Nonpoint Source Management Program, the Florida Department of Agriculture and Consumer Services (FDACS), Division of Forestry, in cooperation with the Florida Department of Environmental Protection (FDEP), universities, and the forestry industries, developed a Silviculture Best Management Practices (BMPs) Manual in 1976. This manual, the *Silviculture BMP Manual* (FDACS 1993), was revised and expanded to address forestry activities in wetland and wildlife habitat protection in 1993. The revision resulted in over 100 specific operational practices, including the establishment of a forested buffer zone next to water bodies, erosion control, and proper use of herbicides and fertilizers.

Although good compliance with silviculture BMPs has been well documented (FDACS 1996), information about BMP effectiveness has been largely qualitative in nature. To address this issue, it was hypothesized that by following BMPs, impacts on aquatic systems associated with silviculture would be minimized or eliminated. To test this hypothesis, and to evaluate the environmental effectiveness of the revised BMPs, four north Florida stream sites (Figure 1) were chosen for an intensive study, using stream bioassessment techniques. Stream sampling parameters included benthic macroinvertebrates, habitat assessment, and standard physical/chemical measurements. Silviculture operations evaluated for BMP effectiveness included clearcut harvesting, intensive mechanical site preparation, and machine planting.

Based on the Stream Condition Index (SCI), no statistically significant changes were observed between the reference and test conditions after silviculture operations using BMPs. At three of the streams, the reference and test conditions were characterized as "excellent", both before and after the forestry operations. At the remaining stream, the reference and test conditions were characterized as "good". Results from habitat assessment showed no major adverse habitat conditions attributable to the forestry operations, and the precision or repeatability of the SCI measurements indicated high reliability of the results. Hence, the study supports the hypothesis that proper application of BMPs during silviculture operations provides adequate protection to adjacent stream systems.

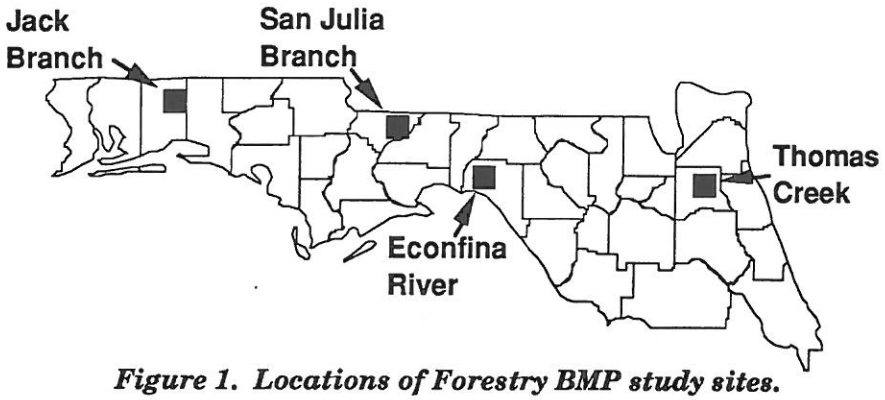


Figure 1. Locations of Forestry BMP study sites.

Introduction

Commercial forest land in Florida covers 16 million acres, which represents 47% of the state's total land area. Forestry Best Management Practices (BMPs) were originally developed in the mid-1970's to protect Florida streams and lakes from pollution associated with forestry activities (FDACS 1993). In 1992, a technical advisory committee was established to review and revise the BMPs to reflect the scientific and social changes that may have occurred since the original BMP development (Vowell 1996). The committee produced a document, *Silviculture Best Management Practices*, which contains all current BMPs for forestry operations (FDACS 1993). Compliance with BMPs has historically been very good. For example, in 1995, 96% of the 187 sites surveyed were in compliance with BMPs (FDACS 1996). Little ecological data existed, however, to determine how effective these practices actually were in protecting the water quality and biological integrity of aquatic systems. This study represents an initial effort to provide this information.

Traditional methods (water chemistry sampling of storm

ents, total suspended solids, and color were analyzed on water from the "B" stations of the reference and test sites. Methods used for all chemical analyses are on file at the Tallahassee FDEP Chemistry Laboratory.

Benthic macroinvertebrate communities were evaluated at all receiving water sites. Invertebrates were collected from multiple substrates (*e.g.*, snags, leaf packs, root mats) using 20 discrete dip net sweeps. Bacterial populations were analyzed for total and fecal coliforms and *Escherichia coli* following the methods of APHA (1989).

Explanation of Measurements of Community Health

Several different measurements of macroinvertebrate community health have been employed to determine the effects of non-point source runoff. These are briefly discussed here.

Habitat: Seven 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 (105-140 points); Suboptimal (70-104 points); Marginal (35-69 points); and Poor (0-34 points) (see example habitat assessment field sheets in Appendix).

Table 1. Total watershed area and area subject to silviculture activities for each stream sampled.

Watershed Area Information			
Site	Total Watershed Acres	Total Treatment Acres	Percent Watershed Treated
San Julia Branch	400	80	20%
Jack Branch	500	120	24%
Thomas Creek	700	80	11%
Econfina River	126,00	65	0.05%

Taxa richness: Stress tends to reduce the number of different types of organisms present in a system.

Percent Dominance: Excessive numerical dominance of a single type of organism (a high % contribution of the dominant taxon) is generally 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.

Ephemeroptera/Plecoptera/Trichoptera (EPT) 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.

Trophic composition/feeding guilds: Disturbance can shift

Table 2. Timing of silviculture activities at each site during the study period.

Silviculture Treatment - 1996						
Site	Clearcut	Roller Chop	Burned	Raked	Bedded	Planted
San Julia Branch	March/April	May	May	July	September	January '97
Jack Branch	March/June	November	None	December	December	January '97
Thomas Creek	March/April	June	July	July	September	January '97
Econfina River	April	August	September	September	None	December

el near the surface. Soil types include Carnegie, Tifton, Lakeland and Orangeburg. Slopes throughout the study area are generally steep, with grades of 6% to 14%. The channel has a site sensitivity class (SSC) of C4 (Rosgen 1996), which includes highly erodible soil and steep topography (FDACS 1993). According to the BMP Manual, this site requires a 35-foot Primary zone and a 265-foot Secondary zone, which provides a total Special Management Zone (SMZ) of 300 feet.

This first order stream appears to have undergone significant episodes of erosion in the past, based on observations of historic aerial photographs (Jeff Vowell, personal communication). There is evidence of previous rill and small gully erosion on the steep slopes, which appears to have been associated with past poor farming practices. However, no recent or active erosion or sedimentation was observed on the site, and the present watershed appears stable.

An intermittent tributary flows through the silviculture treatment area, and enters San Julia Branch just upstream of the test site. It was expected that this intermittent tributary would be the major potential contributor of sediment from the silviculture operations to San Julia Branch. Erosion from this intermittent tributary, again ap-

Table 4. Physical, chemical, and microbiological parameters.

Chemistry Summary Table	Thomas Creek				Econfina River				Jack Branch				San Julia Branch			
	1996		1997		1996		1997		1996		1997		1996		1997	
	Ref	Test	Ref	Test	Ref	Test	Ref	Test	Ref	Test	Ref	Test	Ref	Test	Ref	Test
Nutrients (mg/L)																
Ortho-phosphate			0.068	0.067			0.071	0.068			0.004 U	0.004 U			0.014	0.056 A
Total phosphorus	0.080	0.085	0.082	0.079	0.11	0.11	0.090	0.088	0.004 U	0.004 U			0.060	0.077	0.029	0.097
Ammonia	0.010 U	0.010 U	0.016 I	0.019 I	0.013	0.022 A	0.049	0.047	0.014 I	0.013 I			0.010 U	0.010 U	0.024	0.023
Nitrate+Nitrite	0.004 U	0.004 U	0.004 U	0.004 I	0.025	0.020	0.020 U	0.020 U	0.004 U	0.004 U			0.045	0.028	0.007 I	0.025 A
TKN	0.15	0.16	0.20	0.24	0.32	0.33 A	0.79	0.86	0.12	0.12			0.13	0.16	0.19	0.22
General Phys-Chem Parameters																
Habitat Assessment	121	122	113	111	145	145	129	128	125	118	136	125	127	124	121	115
D.O. (mg/L)	8.1	8.3	7.8	8.2	6.2	8.7	6.4	6.6	7.8		9.0	8.6	9.0	8.9	7.8	8.8
pH (SU)	6.0	6.1	5.7	6.1	7.5	7.6	7.2	7.2	4.8		5.7	5.5	6.2	6.0	5.7	6.0
Conductivity (µmhos/cm)	31	35	30	35	322	290	175	175	1		15	15	22	22	15	25
Temperature (°C)	19.9	18.9	18.5	17.9	20	19.7	17.7	17.4	16.9		11.7	11.0	13.6	13.1	16.3	14.6
Total Suspended Solids (mg/L)	2 U	2 U			2 U	2 U			2 U	2			2 U	2 A		
Turbidity (NTU's)	0.57	0.63	0.85 J	1.8 A	1.1	1.1 A	2.0	2.3 A	1.7	2.7	2.2	2.5	1.7	1.7	1.7	3.3 A
Color (PCU's)	40	40 A	50	70 A	120	120 A	500	500	20	20 A	30 A	30	20	30 A	30	40 A
Microbiological Communities (org/100 mL)																
Fecal coliform	430 Q	300 Q	4800 Q	2000 Q	100 Q	60 Q	20 Q	22 Q	108 Q	43 AQ	300 Q	102 Q	90 Q	154 Q	500 Q	900 Q
Total coliform	900 Q	2000 Q	28000 Q	2200 Q	1500 Q	220 Q	170 Q	140 Q	850 Q	510 AQ	2000 Q	880 Q	1000 Q	2200 Q	1600 Q	5200 Q
Escherichia coli	400 Q	270 Q	5600 Q	3000 Q	80 Q	32 Q	14 Q	18 Q	80 Q	45 AQ	320 Q	100 Q	96 Q	132 Q	630 Q	2000 Q

A - Value reported is the mean of two or more determinations
I - Value reported is less than the minimum quantitation limit, and greater than or equal to the minimum detection limit
J - Estimated value
Q - Sample held beyond normal holding time
U - Material analyzed for but not detected; value reported is the minimum detection limit

of Ates Creek, is a stable, second order stream originating on this tract, and has a SSC of C6.

Prior to Gilman acquiring the land in the early 1950's, the land was owned by the J. C. Penny Foundation and the Reinhold Corporation. Both owners used the land for cattle grazing and timber production. In 1962, three hundred and sixty acres of previously cut timberland were mechanically prepared and planted with slash pine. In the spring of 1996, 80 acres of the pine plantation adjacent to Thomas Creek were clear-cut by Gilman. During the summer of 1996, the site was chopped, spot-raked into windrows, burned, and bedded. The clear-cut acreage was planted with slash pine in January 1997. In addition to timber production, the tract is being used for apiary, cattle, and hunting activities.

Econfina River

This site consists of 65 acres of planted pine in the Cabbage Grove area of Taylor County. It is located east of the Econfina River in the Southeastern quarter of Section 5, Township 4 S, Range 5 E. The treatment area was formerly owned

Table 5. Individual scores for habitat components visually assessed at each station.

Habitat Assessment Components	1996						1997					
	Reference Site			Test Site			Reference Site			Test Site		
	A	B	C	A	B	C	A	B	C	A	B	C
San Julia												
Bottom Substrate/ Available Cover	11	12	13	9	10	9	11	12	13	12	11	12
Water Velocity	20	20	20	20	20	20	15	15	15	20	20	20
Artificial Channelization	20	20	20	20	20	20	20	20	20	20	20	20
Habitat Smothering	17	17	17	16	16	17	17	16	17	16	16	16
Bank Stability	18	18	18	16	18	18	18	18	18	18	18	18
Riparian Zone Buffer Width	20	20	20	20	20	20	20	20	20	10	10	10
Riparian Zone Vegetation Quality	20	20	20	20	20	20	20	20	20	20	20	20
Jack Branch												
Bottom Substrate/ Available Cover	14	13	14	14	12	14	14	13	14	17	13	14
Water Velocity	20	20	20	20	20	20	20	20	20	20	20	20
Artificial Channelization	20	20	20	20	20	20	20	20	20	20	20	20
Habitat Smothering	17	18	17	17	13	17	17	18	17	17	18	17
Bank Stability	20	20	20	19	20	20	20	20	20	20	20	20
Riparian Zone Buffer Width	20	14	20	13	13	13	20	20	20	9	9	9
Riparian Zone Vegetation Quality	20	20	20	20	20	20	20	20	20	20	20	20
Thomas Creek												
Bottom Substrate/ Available Cover	9	10	10	10	10	10	13	13	13	12	12	11
Water Velocity	20	20	20	20	20	20	14	14	14	14	14	14
Artificial Channelization	20	20	20	20	20	20	20	20	20	20	20	20
Habitat Smothering	18	16	16	16	17	17	18	18	18	18	18	18
Bank Stability	15	15	15	15	15	15	18	18	18	18	18	18
Riparian Zone Buffer Width	20	20	20	20	20	20	20	20	20	9	9	9
Riparian Zone Vegetation Quality	20	20	20	20	20	20	20	20	20	20	20	20
Econfina River												
Bottom Substrate/ Available Cover	20	20	20	20	20	20	14	8	13	20	9	20
Water Velocity	20	20	20	20	20	20	14	16	14	13	14	12
Artificial Channelization	20	20	20	20	20	20	20	20	20	20	20	20
Habitat Smothering	20	20	20	20	20	20	20	20	20	20	20	20
Bank Stability	20	20	20	20	20	20	20	20	20	20	20	20
Riparian Zone Buffer Width	20	20	20	20	20	20	20	20	20	20	20	20
Riparian Zone Vegetation Quality	20	20	20	20	20	20	20	20	20	20	20	20

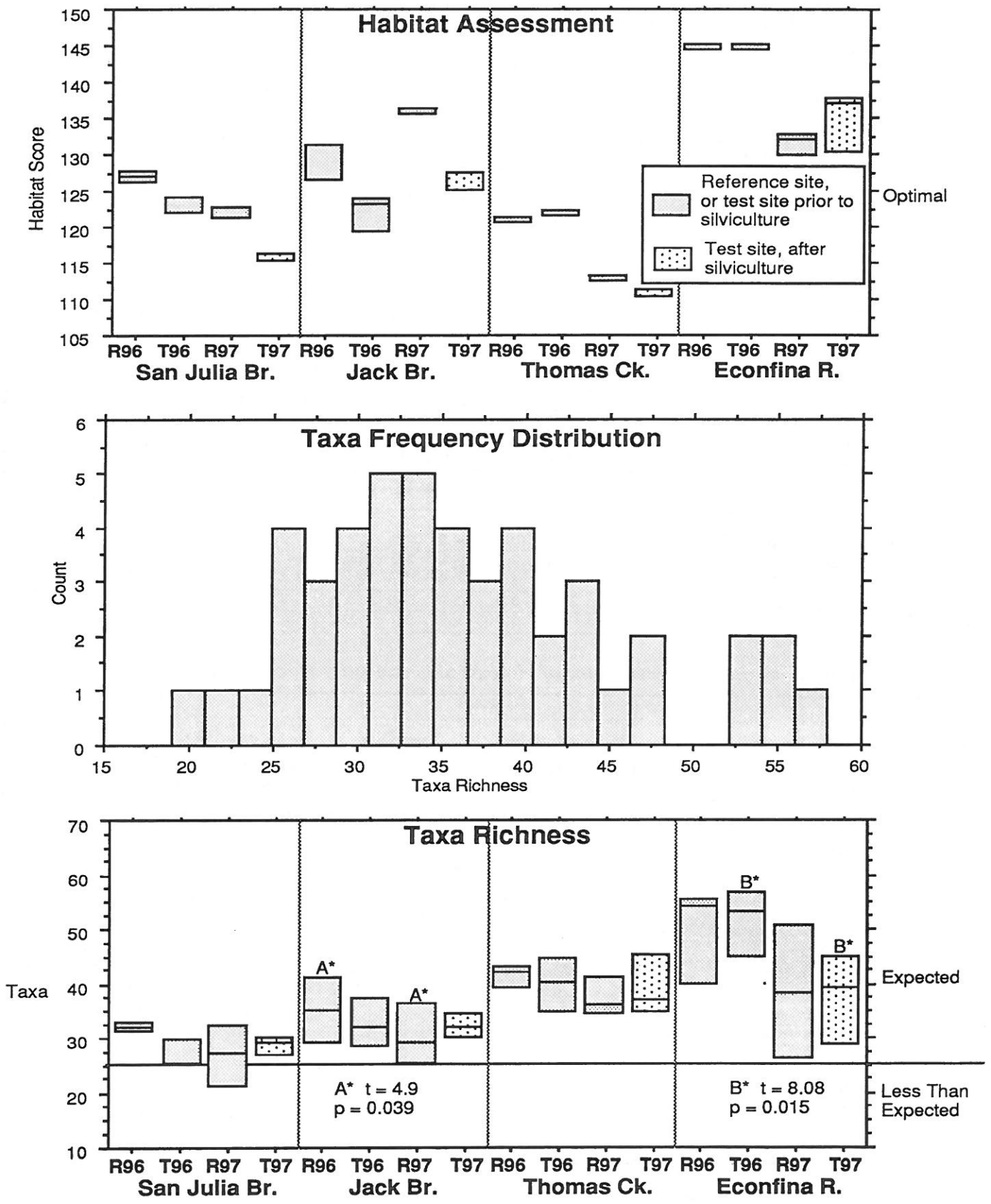


Figure 3. Box plot of habitat and taxa richness scores and frequency distribution plot of taxa richness values.

Table 8. Major characteristics of biological community stucture at Thomas Creek.

Thomas Creek	1996						1997					
	Reference Site			Test Site			Reference Site			Test Site		
	A	B	C	A	B	C	A	B	C	A	B	C
Macroinvertebrate Qualitative												
Number of Taxa	42	43	38	46	40	33	36	34	43	48	34	37
Florida Index	23	23	29	23	21	23	19	22	26	35	20	30
SCI	33	33	33	33	31	31	33	33	33	33	33	33
EPT Index	10	10	10	10	12	8	7	11	8	14	10	13
# Chironomid Taxa	17	14	16	21	15	16	15	10	16	17	12	13
% Contribution of Dominant Taxon	12.4	10.8	12.8	7.1	8.4	12.2	11.9	19.5	10.5	9.9	11.5	12.3
% Oligochaeta	6.6	3.9	1.8	7.1	5.8	0	1.8	3.1	6.1	1.2	2.9	0
% Diptera	57.8	51.2	57.8	51.3	53.2	67.3	53.2	42.8	49.1	48.1	51.0	43.0
% Ephemeroptera	11.6	11.6	14.7	8.0	15.8	6.8	5.5	11.3	14.0	14.2	13.5	15.8
% Trichoptera	2.5	10.8	10.1	15.9	10.5	15.0	20.2	23.9	7.9	13.0	5.8	12.3
% Plecoptera	9.1	8.5	2.7	0	2.6	1.4	2.7	5.7	4.4	8.0	14.4	8.8
% Acarina	0	2.3	0	3.5	0.5	1.4	0	0	3.5	0.6	1.9	0
% Gastropoda	3.3	1.6	0	2.6	4.2	2.0	0	0	0.9	1.2	3.8	1.7
% Amphipoda	2.5	2.3	3.7	0.9	0	0.7	0.9	0.6	1.7	3.7	0	0.9
% Odonata	0.8	2.3	1.8	3.5	4.2	0.7	4.6	1.3	0.9	0.6	3.8	4.4
% Coleoptera	5.0	3.9	7.3	6.2	2.6	4.8	9.2	10.7	7.9	6.2	2.9	11.4
% Other	0.8	1.6	0	0.9	0.5	0	1.8	0.6	3.5	3.2	0	1.7
% Predators	13.2	16.7	16.5	23.0	21.8	18.7	21.6	16.7	19.7	19.7	23.6	22.8
% Above Surface Deposit Feeders	35.1	29.5	35.8	32.3	37.4	34.7	29.4	19.8	29.8	35.2	35.6	32.0
% Below Surface Deposit Feeders	6.6	3.9	1.8	7.1	5.8	0	1.8	3.1	5.3	1.2	2.9	0
% Suspension Feeders	15.3	24.4	22.0	14.2	12.4	34.0	18.3	29.2	19.7	17.0	13.5	18.4
% Scrapers	11.2	8.9	7.8	8.4	8.9	6.5	6.0	11.0	13.2	12.0	11.5	14.9
% Shredders	12.8	14.3	13.3	13.3	11.0	5.4	17.4	5.0	7.5	12.3	12.0	9.2

Table 9. Major characteristics of biological community stucture at Econfina River.

Econfina River	1996						1997					
	Reference Site			Test Site			Reference Site			Test Site		
	A	B	C	A	B	C	A	B	C	A	B	C
Macroinvertebrate Qualitative												
Number of Taxa	56	54	35	58	42	53	38	22	55	47	45	39
Florida Index	27	26	17	34	20	26	20	21	29	28	22	28
SCI	33	33	33	33	33	33	33	29	33	33	29	31
EPT Index	7	7	6	10	7	8	8	7	11	11	8	10
# Chironomid Taxa	24	21	15	21	18	23	10	7	21	13	12	13
% Contribution of Dominant Taxon	7.0	9.6	13.1	6.8	10.9	8.6	17.1	16.8	13.9	8.4	27.4	15.4
% Oligochaeta	12.1	6.3	3.7	4.8	9.4	4.9	6.3	0	3.8	4.5	3.4	0.5
% Diptera	53.6	51.3	52.3	46.4	42.0	51.3	32.7	51.4	33.4	43.2	44.2	61.0
% Ephemeroptera	7.3	7.0	14.0	5.7	8.0	9.8	7.8	12.3	7.7	8.7	4.2	9.2
% Trichoptera	2.2	5.5	8.4	4.5	3.6	3.2	7.8	27.4	8.6	9.9	2.9	8.2
% Plecoptera	0	0	0	0.2	0	0	0.5	0.6	0.6	1.2	0.3	0.5
% Gastropoda	1.3	4.4	6.5	5.7	1.4	1.5	2.4	0	4.4	3.0	3.4	0.5
% Pelecypoda	7.0	9.6	0.9	5.7	5.8	5.4	12.7	1.7	11.5	6.6	6.0	0
% Amphipoda	0.9	1.5	2.8	0.7	0.7	0.7	0	0	2.4	0	2.1	0.5
% Isopoda	4.8	2.2	2.8	8.2	19.6	11.5	17.1	0.6	13.9	6.6	19.7	4.1
% Odonata	0.9	0.4	0	0.7	0.7	0.2	0.5	0.6	0.6	1.2	0.3	1.0
% Coleoptera	8.2	9.2	6.5	16.6	8.0	9.8	11.7	5.6	10.6	14.4	12.1	13.8
% Other	1.7	2.6	1.9	0.7	0.7	1.7	0.5	0	2.4	0.7	1.3	0.5
% Predators	14.3	16.8	17.3	15.9	11.2	13.1	3.4	2.2	7.5	6.8	6.4	6.1
% Above Surface Deposit Feeders	28.2	29.0	31.3	32.9	26.4	24.0	19.0	20.4	21.7	25.8	29.2	26.7
% Below Surface Deposit Feeders	11.4	5.5	3.7	4.8	9.4	4.9	4.9	0	3.2	4.5	2.9	0.5
% Suspension Feeders	26.0	27.1	22.4	13.9	18.8	26.0	32.4	51.4	32.7	26.6	11.6	32.0
% Scrapers	6.2	10.1	15.4	14.3	7.2	9.0	11.9	8.9	11.1	12.0	10.3	9.0
% Shredders	4.4	2.0	4.2	7.3	6.2	3.8	7.3	10.3	7.1	11.7	17.8	12.3

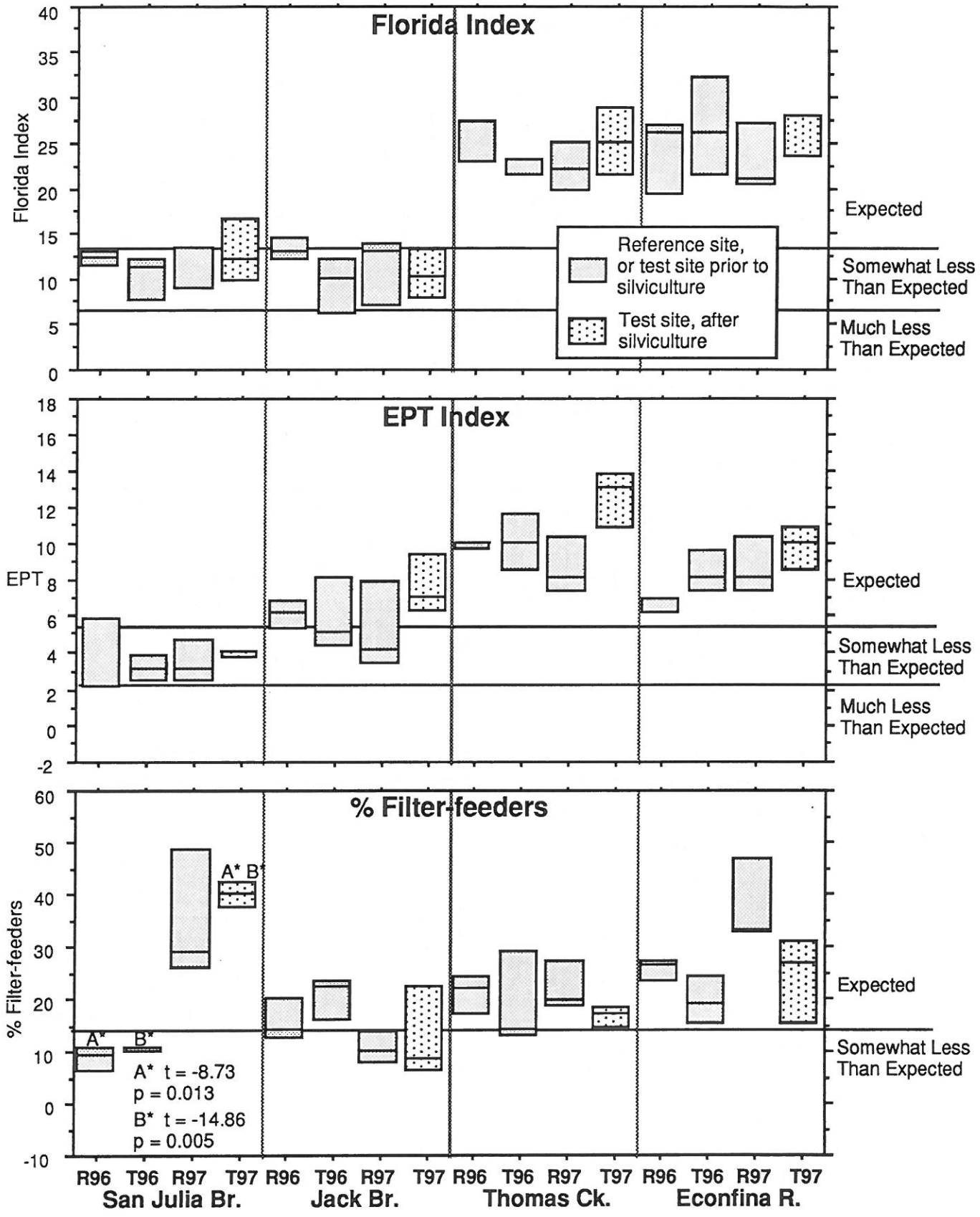


Figure 4. Box plots of Florida Index, EPT Index, and % filter feeders.

ed at San Julia, mostly within range at Jack Branch, and entirely above expectations at the remaining sites (Figure 4). Again, there were no significant within-site differences in the EPT Index. San Julia Branch was the smallest stream in the study and Jack Branch the second smallest. It is possible that reduced macroinvertebrate recruitment potential from upstream areas would be a limiting factor.

The % filter-feeders exceeded expectations at all sites except for San Julia in 1996 (both reference and test sites) and Jack Branch in 1997 (both reference and test sites). The only significant difference was at San Julia, where the test site had more filter-feeders in 1997 than did either the test or reference site in 1996. All sites generally had an adequate number of chironomid taxa (Figure 5). There were two significant between-year differences: the Jack Branch reference site was lower in the mean number of chironomid taxa in 1997 than it was in 1996, and the Thomas Creek test site was lower in the mean number of chironomid taxa in 1997 than it was in 1996. Note, however, that the chironomid taxa at the Thomas Creek test site in 1997 was very similar to the reference site value for the same year, suggesting no longitudinal differences caused by silviculture.

The % contribution of the dominant taxon was generally less than 26%, the value anticipated based upon the SCI (Figure 5). Again, there were exceptions at San Julia and Jack Branch. The two significant differences in this parameter did not involve any post-disturbance test site. There was a higher % Diptera than one would have predicted at San Julia (both test and reference sites) in 1997 and at Jack Branch (test and reference) in 1996. Although the San Julia test site in 1997 had a significantly higher % Diptera than did the 1996 reference or test site, the reference site in 1997 also was significantly higher than the reference site in 1996. This was due to a stream-wide increase in *Simulium* sp. during 1997. *Simulium* sp., considered pollution senstive in Florida, is an organism which tends to "pulse" in abundance.

The Stream Condition Index (SCI) is a composite of the seven different measures of macroinvertebrate community structure and function mentioned above. Streams with SCI scores of 27 or above are ranked as "excellent", while those with scores between 21 and 26 are in the "good" category. Scores less than 21 are ranked either "poor" or "very degraded", depending on how low the score is. In the 1996 sampling, the mean SCI at San Julia was 26.3 at the reference site and 23 at the test site, a significant difference ($p=0.038$) (Figure 6). This indicates that even before silviculture operations commenced, there were signs of stress at the test site, probably related to historical (intensive agriculture) land use practices. In the 1997 (post-disturbance) sampling, the mean SCI at the reference site was 25.7, while the test site mean improved to 25.0, a minor difference that was no longer significant. This suggests that despite ongoing stress at the San Julia test site, forestry operations did not exacerbate the problem. The biological community at the test site actually scored marginally better in 1997.

In 1996, the mean SCI at Jack Branch was 29.7 at the reference site and 28.3 at the test site, both scores in the excellent category. In 1997, the mean scores decreased slightly to 27.0 at the reference site and 27.7 at the test site, both remaining in the excellent category. There were no significant differences. The slightly lower scores in 1997 (at both the reference and test sites) probably reflect somewhat less efficient sampling effort due to the high water conditions that were prevalent at that time.

Thomas Creek's mean SCI scores ranged from 39.7 to 41.0 in 1996 and from 37.7 to 39.7 in 1997. Again, there were no significant differences, with all sites consistently in the upper range of the excellent category.

In 1996, Econfina River's mean SCI scores were 33 at the reference and test sites alike. In the post-disturbance sampling the mean SCI was 31.7 at the reference and 31 at the test site. There were no significant differences in either year, and all sites were consistently in the upper range of the excellent category, despite sampling difficulties (high water) in 1997.

Due to the triplicate replication at all sites during this study, an evaluation of the degree of variability in the SCI sampling and analysis methodology is possible. The coefficient of variation was calculated for each set of three SCI measurements taken at a given site, with 16 data sets possible, shown in Figure 6. In 12 out of 16 such triplicate measures (75% of the total), the coefficient of variation was 10% or less. In the remaining four data sets (25% of the total), the coefficient of variation ranged from 15% to 22%. The Jack Branch reference site in 1997 had the highest variability in the SCI measurements (22%). As stated earlier, this stream was flooded at the time, and sampling took place in a driving rain, conditions which may be expected to contribute to increased sampling variability.

Conclusions

Habitat quality was in the "optimal" category at all sites, both before and after silviculture activities. The BMPs appeared successful in controlling erosion, since no additional habitat smothering or stream bank instability was noted after silviculture operations took place. The decreases in riparian buffer zone width that were noted at three of the four sites were allowed by the BMPs, and did not shift the overall habitat category at any site.

There appeared to be no major changes in physical-chemical measurements due to silviculture activities. Turbidity was low at all sites. During an intense rain in February, 1997, direct observation at Jack Branch indicated that no turbid water from the clear-cut site was reaching the stream. Nutrients were relatively low at all sites, both before and after the forestry operations.

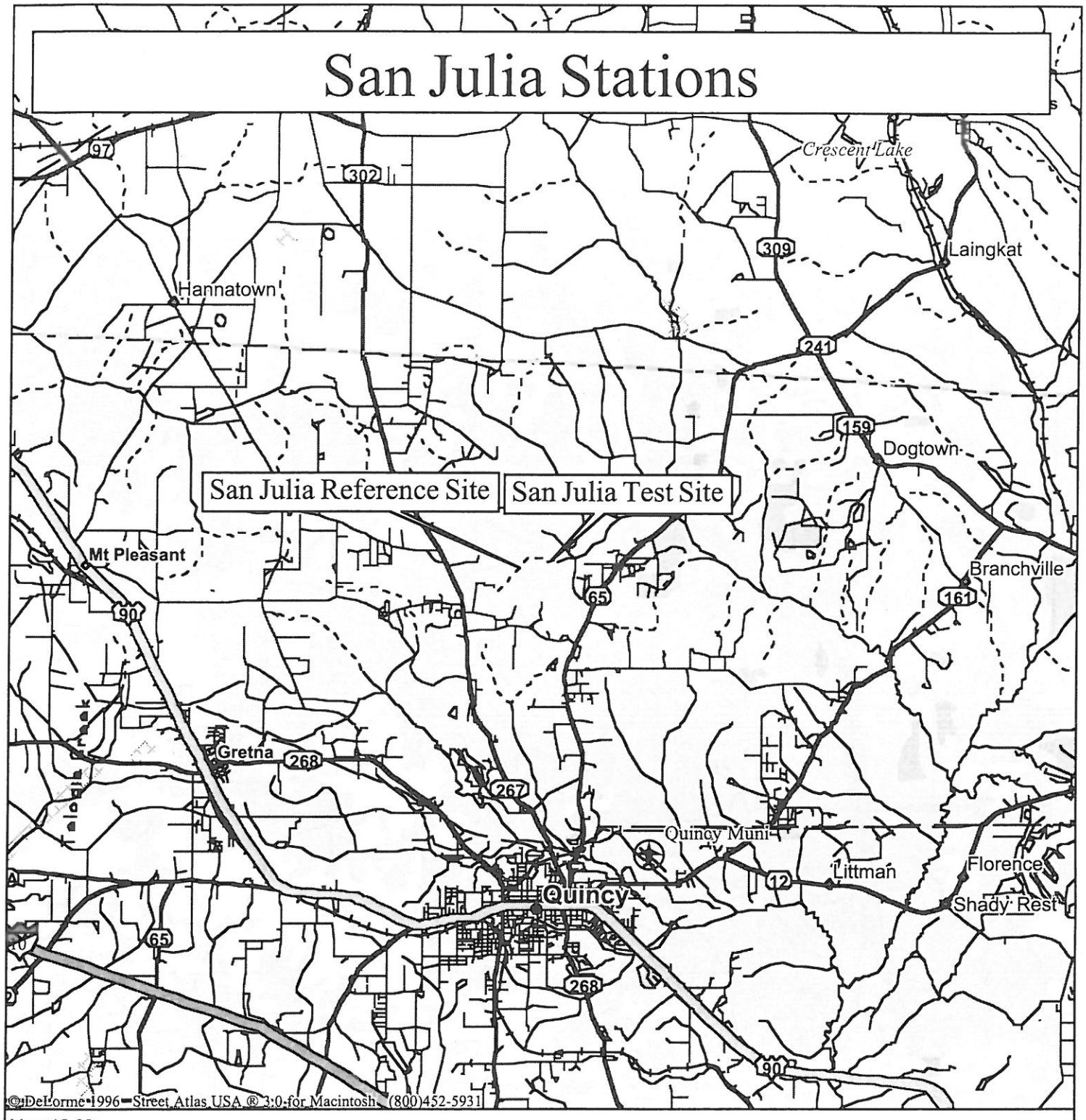
Fecal coliforms exceeded the Class III water quality standard of 800 organisms/100 mL (maximum) at three sites, including Thomas Creek in 1997 (at the reference and test sites alike) and at the San Julia Branch test site in 1997. Also in 1997, total coliform bacteria exceeded the Class III water quality standard (maximum of 2,400 organisms/100 mL) at the Thomas Creek reference site and at the San Julia Branch test site. The presence of the bacteria was attributed to cattle grazing in the Thomas Creek watershed and extensive wildlife activity (beavers, deer) at San Julia Branch.

Biological health, reflected by the Stream Condition Index (SCI), was not adversely affected by silviculture activities when BMPs were followed. After forestry operations had occurred, the mean SCI scores were in the upper range of the "good" category at the San Julia Branch test and reference sites alike, and in the "excellent" category at both the reference and test sites of Jack Branch, Thomas Creek, and the Econfina River. There were no statistically significant differences in the mean SCI scores (between the reference and test sites) of any stream after logging, site preparation, and replanting had occurred. Additionally, there were no significant differences between any pre- and post-disturbance test site SCI scores. These data suggest the streams were adequately protected by the BMPs.

The SCI coefficient of variation was 10% or less in 12 out of 16 triplicate measures (75% of the total). In the remaining four data sets (25% of the total), the coefficient of variation ranged from 15% to 22%. These results indicate the reproducibility of the SCI methods in arriving at a consistent, repeatable assessment at a given site.

Appendix

San Julia Stations

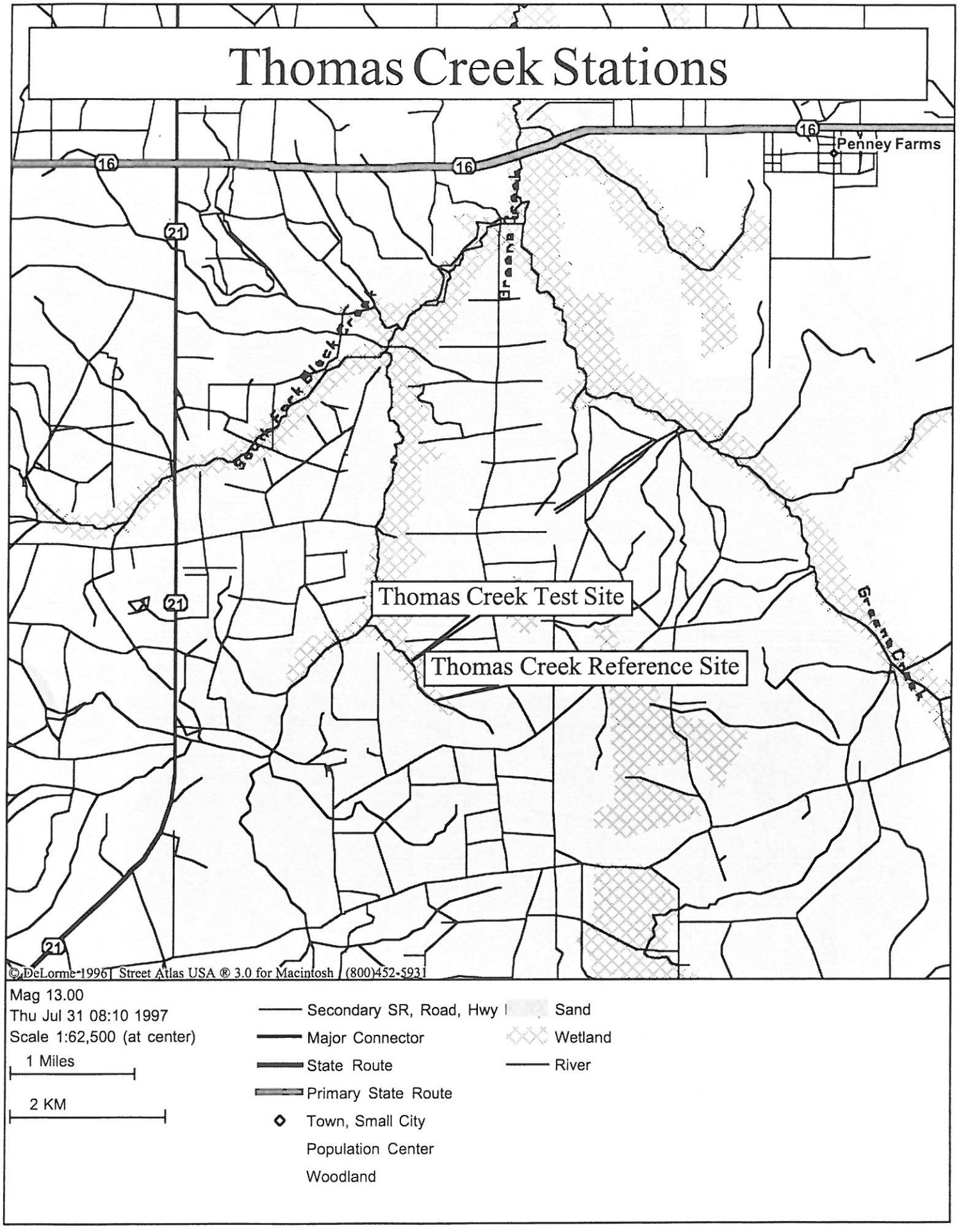


Mag 12.00
Thu Jul 31 07:59 1997
Scale 1:125,000 (at center)

2 Miles

2 KM

- Secondary SR, Road, Hwy Ramp
- Major Connector
- State Route
- Trail
- Interstate/Limited Access
- US Highway
- Utility
- Railroad
- County Seat
- Town, Small City
- Airfield
- Locale
- Public Airport
- State Boundary


Thomas Creek Stations
16
16
16
21
21
21
Penney Farms
Green Creek
South Fork Black Creek
Thomas Creek Test Site
Thomas Creek Reference Site
Green Creek
©DeLorme 1996 | Street Atlas USA ® 3.0 for Macintosh | (800)452-5931
Mag 13.00
Thu Jul 31 08:10 1997
Scale 1:62,500 (at center)
1 Miles
2 KM
Secondary SR, Road, Hwy
Major Connector
State Route
Primary State Route
Town, Small City
Population Center
Woodland
Sand
Wetland
River

Typical Values for Selected Parameters in Florida Waters

Adapted from Joe Hand, FDER, personal communication, 1991
(data was collected between 1980 and 1989)

Percentile Distribution

Parameter	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%
STREAMS (1617 stations)											
Phytoplankton Chlorophyll *a*	0.22	0.52	0.94	1.60	3.02	4.63	6.72	9.87	14.68	27.35	48.70
Periphyton Chlorophyll *a*	0.31	0.43	0.77	1.04	2.16	2.94	6.45	10.51	17.00	39.51	60.85
H-D Diversity	0.84	2.12	2.48	2.74	2.88	3.09	3.25	3.40	3.52	3.76	3.90
Qualitative Taxa Richness	9.00	12.00	17.00	20.00	22.00	24.50	26.00	28.00	31.00	37.00	53.00
H-D Taxa Richness	6.00	6.50	9.00	11.50	13.00	15.00	17.00	21.50	26.00	29.00	32.00
TKN	0.30	0.39	0.56	0.73	0.87	1.00	1.11	1.26	1.49	1.93	2.80
Ammonia	0.02	0.02	0.04	0.05	0.06	0.08	0.11	0.14	0.20	0.34	0.60
NO2-NO3	0.01	0.01	0.03	0.05	0.07	0.10	0.14	0.20	0.32	0.64	1.05
Total Phosphorus	0.02	0.03	0.05	0.06	0.10	0.13	0.18	0.25	0.39	0.74	1.51
Ortho Phosphate	0.01	0.01	0.03	0.04	0.05	0.08	0.11	0.17	0.27	0.59	1.37
Turbidity	0.60	0.90	1.20	1.45	2.10	2.80	3.60	4.50	6.65	10.45	16.30
LAKES (477 stations)											
Phytoplankton Chlorophyll *a*	0.80	1.71	2.88	4.28	10.06	13.40	20.00	30.10	47.20	65.44	113.90
Dredge Diversity	0.71	0.97	1.43	1.74	1.98	2.12	2.21	2.59	2.85	3.15	3.17
Dredge Taxa Richness	3.00	5.00	6.50	7.00	9.00	10.00	11.00	13.00	15.00	17.00	21.00
TKN	0.36	0.49	0.67	0.83	1.08	1.26	1.40	1.51	1.68	2.11	3.46
NH3+NH4	0.01	0.02	0.02	0.03	0.04	0.06	0.08	0.12	0.15	0.21	0.28
NO2-NO3	0.00	0.00	0.01	0.01	0.01	0.02	0.04	0.05	0.10	0.14	0.23
Total Phosphorus	0.01	0.02	0.02	0.03	0.05	0.07	0.09	0.11	0.14	0.23	0.42
Ortho-Phosphate	0.00	0.01	0.01	0.02	0.03	0.04	0.05	0.06	0.08	0.21	0.32
Turbidity	1.00	1.25	1.55	2.05	2.75	4.50	6.45	9.60	14.10	26.00	40.00
ESTUARIES (690 stations)											
Phytoplankton Chlorophyll *a*	2.14	3.28	4.49	5.13	6.00	6.93	7.94	9.60	12.40	17.60	22.20
Dredge Diversity	1.34	1.53	1.91	2.28	2.56	2.90	3.15	3.59	4.01	4.53	4.98
Dredge Taxa Richness	4.00	6.00	9.00	11.00	15.00	18.50	25.00	35.00	41.00	62.00	90.00
TKN	0.26	0.34	0.42	0.50	0.59	0.69	0.76	0.82	0.95	1.30	1.49
NH3+NH4	0.01	0.02	0.03	0.04	0.05	0.06	0.08	0.09	0.13	0.22	0.28
NO2-NO3	0.00	0.00	0.01	0.01	0.01	0.02	0.03	0.05	0.08	0.17	0.23
Total Phosphorus	0.01	0.02	0.06	0.07	0.10	0.11	0.14	0.17	0.23	0.43	0.59
Ortho-Phosphate	0.01	0.02	0.03	0.04	0.04	0.05	0.07	0.09	0.12	0.21	0.44
Turbidity	3.50	4.00	4.50	5.05	5.40	5.60	6.30	6.80	8.00	11.40	11.75

Units:
Phytoplankton Chlorophyll *a* (ug/L), Periphyton Chlorophyll *a* (mg/m^2), Nutrients (mg/L), Turbidity (NTU), Taxa richness and diversity values are for macroinvertebrates

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
FRESHWATER BENTHIC HABITAT ASSESSMENT FIELD DATA SHEET (4-22-96)

SUBMITTING AGENCY CODE: / SUBMITTING AGENCY NAME:	STORET STATION NUMBER:	DATE (M/D/Y):	RECEIVING BODY OF WATER:
		2/25/97	

REMARKS:	COUNTY:	LOCATION:	FIELD ID/NAME:
	Okaloosa	Jack's Branch	Ref B

Habitat Parameter	Optimal	Suboptimal	Marginal	Poor
Substrate Types & Availability	Greater than 30% snags, logs, tree roots, aquatic vegetation, leaf packs (partially decayed), undercut banks, rock, or other stable habitat.	16% to 30% snags, logs, tree roots, aquatic vegetation, leaf packs, etc. Adequate habitat. Some substrates may be new fall (fresh leaves or snags).	5% to 15% snags, logs, tree roots, aquatic vegetation, leaf packs, etc. Less than desirable habitat, frequently disturbed or removed.	Less than 5% snags, logs, tree roots, aquatic vegetation, leaf packs, etc. Lack of habitat is obvious, substrates unstable or smothered.
13 / 13	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Water Velocity	Max. observed at typical transect: >0.25 m/sec. but < 1 m/sec	Max. observed at typical transect: 0.1 to 0.25 m/sec	Max. observed at typical transect: 0.05 to 0.1 m/sec	Max. observed at typical transect <0.05 m/sec, or spate occurring; > 1 m/sec
20 / 20	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Artificial Channelization	No artificial channelization or dredging. Stream with normal, sinuous pattern	May have been channelized in the past (>20 yrs), but mostly recovered, fairly good sinuous pattern	Channelized, somewhat recovered, but > 80% of area affected	Artificially channelized, box-cut banks, straight, instream habitat highly altered
20 / 20	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Habitat Smothering	Less than 20% of habitats affected by sand or silt accumulation	20%-50% of habitats affected by sand or silt accumulation	Smothering of 50%-80% of habitats with sand or silt, pools shallow, frequent sediment movement	Smothering of >80% of habitats with sand or silt, a severe problem, pools absent
18 / 18	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Bank Stability	Stable. No evidence of erosion or bank failure. Little potential for future problems.	Moderately stable. Infrequent or small areas of erosion, mostly healed over.	Moderately unstable. Moderate areas of erosion, high erosion potential during floods.	Unstable. Many (60%-80%) raw, eroded areas. Obvious bank sloughing.
20 / 20	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Riparian Buffer Zone Width	Width of native vegetation (least buffered side) greater than 18 m	Width of native vegetation (least buffered side) 12 m to 18 m	Width of native vegetation 6 to 12 m, human activities still close to system	Less than 6 m of native buffer zone due to intensive human activities
20 / 19	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Riparian Zone Vegetation Quality	Over 80% of riparian surfaces consist of native plants, including trees, understory shrubs, or non-woody macrophytes. Normal, expected plant community for given sunlight & habitat conditions.	50% to 80% of riparian zone is vegetated, and/or one class of plants normally expected for the sunlight & habitat conditions is not represented. Some disruption in community evident.	25% to 50% of riparian zone is vegetated, and/or one or two expected classes of plants are not represented. Patches of bare soil or closely cropped vegetation, disruption obvious.	Less than 25% of streambank surfaces are vegetated and/or poor plant community (*e.g.* grass monoculture or exotics) present. Vegetation removed to stubble height of 2 inches or less.
20 / 20	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

5 — Add 5 points if cross-sectional area of flow is estimated to be > one square meter during periods of normal flow.

136 **TOTAL SCORE**

Comments

ANALYSIS DATE:	ANALYST:	SIGNATURE:
2/25/97	RBF	Russell Frydenborg

EPT Index

Descriptive Statistics

	Mean	Std. D...	Std. Err...	Minim...	Maxim...	Coef. V...
SJ R96 EPT	3.667	2.887	1.667	2.000	7.000	.787
SJ T96 EPT	3.000	1.000	.577	2.000	4.000	.333
SJ R97 EPT	3.333	1.528	.882	2.000	5.000	.458
SJ T97 EPT	4.000	0.000	0.000	4.000	4.000	0.000
Jk R96 EPT	6.000	1.000	.577	5.000	7.000	.167
Jk T96 EPT	6.000	2.646	1.528	4.000	9.000	.441
Jk R97 EPT	5.333	3.215	1.856	3.000	9.000	.603
Jk T97 EPT	7.667	2.082	1.202	6.000	10.000	.272
Tm R96 E...	10.000	0.000	0.000	10.000	10.000	0.000
Tm T96 E...	10.000	2.000	1.155	8.000	12.000	.200
Tm R97 E...	8.667	2.082	1.202	7.000	11.000	.240
Tm T97 E...	12.333	2.082	1.202	10.000	14.000	.169
Ec R96 EPT	6.667	.577	.333	6.000	7.000	.087
Ec T96 EPT	8.333	1.528	.882	7.000	10.000	.183
Ec R97 EPT	8.667	2.082	1.202	7.000	11.000	.240
Ec T97 EPT	9.667	1.528	.882	8.000	11.000	.158

Florida Index

Descriptive Statistics

	Mean	Std. Dev.	Std. Err...	Minim...	Maxim...	Coef. V...
SJ R96...	12.000	1.000	.577	11.000	13.000	.083
SJ T96...	9.667	3.215	1.856	6.000	12.000	.333
SJ R97...	11.000	3.464	2.000	7.000	13.000	.315
SJ T97...	13.000	4.583	2.646	9.000	18.000	.353
Jk R96...	13.333	1.528	.882	12.000	15.000	.115
Jk T96...	9.333	4.041	2.333	5.000	13.000	.433
Jk R97...	10.667	4.933	2.848	5.000	14.000	.462
Jk T97...	10.333	3.512	2.028	7.000	14.000	.340
Th R96...	25.000	3.464	2.000	23.000	29.000	.139
Th T96...	22.333	1.155	.667	21.000	23.000	.052
Th R97...	22.333	3.512	2.028	19.000	26.000	.157
Th T97...	25.000	5.000	2.887	20.000	30.000	.200
Ec R96 Fl	23.333	5.508	3.180	17.000	27.000	.236
Ec T96 Fl	26.667	7.024	4.055	20.000	34.000	.263
Ec R97 Fl	23.333	4.933	2.848	20.000	29.000	.211
Ec T97 Fl	26.000	3.464	2.000	22.000	28.000	.133

% Diptera

Descriptive Statistics

	Mean	Std. Dev.	Std. Error	Minimum	Maximum	Coef. Var.
SJ R96 Dip	48.300	8.871	5.122	39.800	57.500	.184
SJ T96 Dip	46.633	.321	.186	46.400	47.000	.007
SJ R97 Dip	69.067	13.406	7.740	55.900	82.700	.194
SJ T97 Dip	74.133	4.574	2.641	70.600	79.300	.062
Jk R96 Dip	66.600	11.651	6.727	57.100	79.600	.175
Jk T96 Dip	57.867	9.355	5.401	48.700	67.400	.162
Jk R97 Dip	50.733	13.995	8.080	35.300	62.600	.276
Jk T97 Dip	53.767	10.852	6.265	45.300	66.000	.202
Th R96 Dip	55.633	3.840	2.217	51.200	57.900	.069
Th TR96 Dip	57.300	8.798	5.080	51.300	67.400	.154
Th R97 Dip	48.367	5.239	3.025	42.800	53.200	.108
Th T97 Dip	47.400	4.060	2.344	43.000	51.000	.086
Ec R96 Dip	52.400	1.153	.666	51.300	53.600	.022
Ec T96 Dip	46.600	4.703	2.715	42.000	51.400	.101
Ec R97 Dip	39.167	10.600	6.120	32.700	51.400	.271
Ec T97 Dip	49.467	10.001	5.774	43.200	61.000	.202

% Filter-feeders

Descriptive Statistics

	Mean	Std. Dev.	Std. Error	Minimum	Maximum	Coef. Var.
SJ R96 Fil	8.600	3.012	1.739	5.300	11.200	.350
SJ T96 Fil	10.433	.404	.233	10.000	10.800	.039
SJ R97 Fil	36.300	16.496	9.524	24.800	55.200	.454
SJ T97 Fil	39.933	3.253	1.878	36.600	43.100	.081
Jk R96 Fil	16.067	5.387	3.110	12.100	22.200	.335
Jk T96 Fil	19.867	5.300	3.060	13.800	23.600	.267
Jk R97 Fil	10.700	3.996	2.307	7.100	15.000	.373
Jk T97 Fil	13.733	11.471	6.623	5.900	26.900	.835
Th R96 Fil	20.567	4.716	2.723	15.300	24.400	.229
Th T96 Fil	20.167	12.010	6.934	12.400	34.000	.596
Th R97 Fil	22.467	5.953	3.437	18.400	29.300	.265
Th T97 Fil	16.300	2.524	1.457	13.500	18.400	.155
Ec R96 Fil	25.167	2.458	1.419	22.400	27.100	.098
Ec T96 Fil	19.567	6.086	3.514	13.900	26.000	.311
Ec R97 Fil	38.833	10.884	6.284	32.400	51.400	.280
Ec T97 Fil	23.433	10.611	6.126	11.600	32.100	.453

Stream Condition Index

Paired t-test
Hypothesized Difference = 0

	Mean Diff.	DF	t-Value	P-Value
SJ R96 SCI, SJ T96 SCI	3.333	2	5.000	.0377
SJ R96 SCI, SJ R97 SCI	.667	2	.277	.8075
SJ R96 SCI, SJ T97 SCI	1.333	2	.555	.6349
SJ T96 SCI, SJ R97 SCI	-2.667	2	-1.000	.4226
SJ T96 SCI, SJ T97 SCI	-2.000	2	-.866	.4778
SJ R97 SCI, SJ T97 SCI	.667	2	.500	.6667

Paired t-test
Hypothesized Difference = 0

	Mean Diff.	DF	t-Value	P-Value
Jk R96 SCI, Jk T96 SCI	1.333	2	1.000	.4226
Jk R96 SCI, Jk R97 SCI	2.667	2	.658	.5784
Jk R96 SCI, Jk T97 SCI	2.000	2	1.732	.2254
Jk T96 SCI, Jk R97 SCI	1.333	2	.305	.7892
Jk T96 SCI, Jk T97 SCI	.667	2	.378	.7418
Jk R97 SCI, Jk T97 SCI	-.667	2	-.229	.8399

Paired t-test
Hypothesized Difference = 0

	Mean Diff.	DF	t-Value	P-Value
Tm R96 SCI, Tm T96 SCI	1.333	2	1.000	.4226
Tm R96 SCI, Tm R97 SCI	-.667	2	-1.000	.4226
Tm R96 SCI, Tm T97 SCI	-.667	2	-.500	.6667
Tm T96 SCI, Tm R97 SCI	-2.000	2	-1.732	.2254
Tm T96 SCI, Tm T97 SCI	-2.000	2	•	•
Tm R97 SCI, Tm T97 SCI	0.000	2	0.000	•

Paired t-test
Hypothesized Difference = 0

	Mean Diff.	DF	t-Value	P-Value
Ec R96 SCI, Ec T96 SCI	0.000	2	•	•
Ec R96 SCI, Ec R97 SCI	1.333	2	1.000	.4226
Ec R96 SCI, Ec T97 SCI	2.000	2	1.732	.2254
Ec T96 SCI, Ec R97 SCI	1.333	2	1.000	.4226
Ec T96 SCI, Ec T97 SCI	2.000	2	1.732	.2254
Ec R97 SCI, Ec T97 SCI	.667	2	1.000	.4226

EPT Index

Paired t-test
Hypothesized Difference = 0

	Mean Diff.	DF	t-Value	P-Value
SJ R96 EPT, SJ T96 EPT	.667	2	.378	.7418
SJ R96 EPT, SJ R97 EPT	.333	2	.139	.9024
SJ R96 EPT, SJ T97 EPT	-.333	2	-.200	.8600
SJ T96 EPT, SJ R97 EPT	-.333	2	-.500	.6667
SJ T96 EPT, SJ T97 EPT	-1.000	2	-1.732	.2254
SJ R97 EPT, SJ T97 EPT	-.667	2	-.756	.5286

Paired t-test
Hypothesized Difference = 0

	Mean Diff.	DF	t-Value	P-Value
Jk R96 EPT, Jk T96 EPT	0.000	2	0.000	•
Jk R96 EPT, Jk R97 EPT	.667	2	.329	.7735
Jk R96 EPT, Jk T97 EPT	-1.667	2	-1.147	.3701
Jk T96 EPT, Jk R97 EPT	.667	2	.210	.8534
Jk T96 EPT, Jk T97 EPT	-1.667	2	-.640	.5876
Jk R97 EPT, Jk T97 EPT	-2.333	2	-3.500	.0728

Paired t-test
Hypothesized Difference = 0

	Mean Diff.	DF	t-Value	P-Value
Tm R96 EPT, Tm T96 EPT	0.000	2	0.000	•
Tm R96 EPT, Tm R97 EPT	1.333	2	1.109	.3828
Tm R96 EPT, Tm T97 EPT	-2.333	2	-1.941	.1917
Tm T96 EPT, Tm R97 EPT	1.333	2	1.512	.2697
Tm T96 EPT, Tm T97 EPT	-2.333	2	-1.067	.3975
Tm R97 EPT, Tm T97 EPT	-3.667	2	-1.525	.2667

Paired t-test
Hypothesized Difference = 0

	Mean Diff.	DF	t-Value	P-Value
Ec R96 EPT, Ec T96 EPT	-1.667	2	-1.890	.1994
Ec R96 EPT, Ec R97 EPT	-2.000	2	-1.309	.3206
Ec R96 EPT, Ec T97 EPT	-3.000	2	-3.000	.0955
Ec T96 EPT, Ec R97 EPT	-.333	2	-.229	.8399
Ec T96 EPT, Ec T97 EPT	-1.333	2	-4.000	.0572
Ec R97 EPT, Ec T97 EPT	-1.000	2	-.866	.4778

Chironomidae

Paired t-test
Hypothesized Difference = 0

	Mean Diff.	DF	t-Value	P-Value
SJ R96 Chi, SJ T96 Chi	.333	2	.277	.8075
SJ R96 Chi, SJ R97 Chi	0.000	2	0.000	•
SJ R96 Chi, SJ T97 Chi	-2.667	2	-3.024	.0942
SJ T96 Chi, SJ R97 Chi	-.333	2	-.128	.9098
SJ T96 Chi, SJ T97 Chi	-3.000	2	-3.000	.0955
SJ R97 Chi, SJ T97 Chi	-2.667	2	-1.512	.2697

Paired t-test
Hypothesized Difference = 0

	Mean Diff.	DF	t-Value	P-Value
Jk R96 Chi, Jk T96 Chi	2.667	2	.651	.5818
Jk R96 Chi, Jk R97 Chi	5.000	2	4.330	.0494
Jk R96 Chi, Jk T97 Chi	7.667	2	3.190	.0858
Jk T96 Chi, Jk R97 Chi	2.333	2	.788	.5135
Jk T96 Chi, Jk T97 Chi	5.000	2	2.887	.1020
Jk R97 Chi, Jk T97 Chi	2.667	2	2.000	.1835

Paired t-test
Hypothesized Difference = 0

	Mean Diff.	DF	t-Value	P-Value
Th R96 Chi, Th T96 Chi	-1.667	2	-1.387	.2999
Th R96 Chi, Th R97 Chi	2.000	2	1.732	.2254
Th R96 Chi, Th T97 Chi	1.667	2	1.890	.1994
Th T96 Chi, Th R97 Chi	3.667	2	1.976	.1869
Th T96 Chi, Th T97 Chi	3.333	2	10.000	.0099
Th R97 Chi, Th T97 Chi	-.333	2	-.200	.8600

Paired t-test
Hypothesized Difference = 0

	Mean Diff.	DF	t-Value	P-Value
Ec R96 Chi, Ec T96 Chi	-.667	2	-.182	.8725
Ec R96 Chi, Ec R97 Chi	7.333	2	1.100	.3860
Ec R96 Chi, Ec T97 Chi	7.333	2	2.688	.1150
Ec T96 Chi, Ec R97 Chi	8.000	2	2.667	.1165
Ec T96 Chi, Ec T97 Chi	8.000	2	6.928	.0202
Ec R97 Chi, Ec T97 Chi	0.000	2	0.000	•

% Filter-feeders

Paired t-test
Hypothesized Difference = 0

	Mean Diff.	DF	t-Value	P-Value
SJ R96 Fil, SJ T96 Fil	-1.833	2	-1.070	.3966
SJ R96 Fil, SJ R97 Fil	-27.700	2	-2.491	.1303
SJ R96 Fil, SJ T97 Fil	-31.333	2	-8.729	.0129
SJ T96 Fil, SJ R97 Fil	-25.867	2	-2.733	.1119
SJ T96 Fil, SJ T97 Fil	-29.500	2	-14.856	.0045
SJ R97 Fil, SJ T97 Fil	-3.633	2	-.445	.6999

Paired t-test
Hypothesized Difference = 0

	Mean Diff.	DF	t-Value	P-Value
Jk R96 Fil, Jk T96 Fil	-3.800	2	-1.688	.2335
Jk R96 Fil, Jk R97 Fil	5.367	2	1.023	.4140
Jk R96 Fil, Jk T97 Fil	2.333	2	.267	.8143
Jk T96 Fil, Jk R97 Fil	9.167	2	1.720	.2276
Jk T96 Fil, Jk T97 Fil	6.133	2	.637	.5891
Jk R97 Fil, Jk T97 Fil	-3.033	2	-.645	.5848

Paired t-test
Hypothesized Difference = 0

	Mean Diff.	DF	t-Value	P-Value
Th R96 Fil, Th T96 Fil	.400	2	.058	.9593
Th R96 Fil, Th R97 Fil	-1.900	2	-.878	.4724
Th R96 Fil, Th T97 Fil	4.267	2	1.168	.3632
Th T96 Fil, Th R97 Fil	-2.300	2	-.254	.8234
Th T96 Fil, Th T97 Fil	3.867	2	.657	.5789
Th R97 Fil, Th T97 Fil	6.167	2	1.280	.3289

Paired t-test
Hypothesized Difference = 0

	Mean Diff.	DF	t-Value	P-Value
Ec R96 Fil, Ec T96 Fil	5.600	2	1.184	.3580
Ec R96 Fil, Ec R97 Fil	-13.667	2	-2.515	.1284
Ec R96 Fil, Ec T97 Fil	1.733	2	.235	.8359
Ec T96 Fil, Ec R97 Fil	-19.267	2	-2.574	.1236
Ec T96 Fil, Ec T97 Fil	-3.867	2	-.661	.5767
Ec R97 Fil, Ec T97 Fil	15.400	2	1.253	.3369

Taxa list for Forestry BMP Study, collected during the winter of 1996 and again in the winter of 1998. Abundance values represent the number of individuals found in 20 dipnet sweeps of the most productive habitats.

	Econfina Reference	Econfina Test	Jack Reference	Jack Test	Thomas Reference	Thomas Test	San Julia Reference	San Julia Test
Turbellaria	–	–	–	–	–	9	–	–
Planariidae	–	36	–	–	–	–	–	–
Dugesia sp.	143	–	–	–	–	–	–	–
Dugesia tigrina	30	179	–	–	–	–	–	–
Rhynchocoela								
Prostoma rubrum	93	143	–	–	–	–	–	–
Oligochaeta	–	–	6	–	–	–	–	–
Lumbriculidae	–	36	–	–	–	–	5	–
Eclipidrilus sp.	432	500	172	95	149	24	641	296
Eclipidrilus palustris	65	–	18	–	–	9	39	57
Enchytraeidae	33	36	1293	1317	96	45	67	87
Tubificidae	–	36	–	–	–	–	–	–
Spirosperma ferox	–	–	–	–	–	–	36	–
Limnodrilus hoffmeisteri	548	681	50	139	45	198	28	–
Ilyodrilus templetoni	–	36	–	8	–	–	–	–
Aulodrilus pigueti	–	–	–	12	18	–	–	–
Haber speciosus	181	36	–	6	7	–	–	–
Psammoryctides convolutus	18	–	41	–	–	–	–	22
Rhyacodrilus sodalis	–	–	–	9	–	–	–	–
Slavina appendiculata	422	826	18	8	–	–	12	18
Stylaria lacustris	–	396	–	–	–	–	–	–
Pristina sp.	–	–	–	–	–	–	–	5
Pristina aequiseta	–	–	18	12	–	–	–	–
Pristina leidyi	–	108	6	24	–	–	–	–
Pristina synclites	–	–	–	–	–	6	–	–
Dero sp.	–	–	–	–	–	–	9	7
Dero trifida	–	–	–	–	18	–	–	6
Dero digitata	–	–	12	–	–	–	–	–
Dero pectinata	15	–	–	–	–	–	–	–
Dero lodeni	–	–	–	–	–	–	5	–
Nais communis	66	287	–	–	43	–	164	28

	Econfina Reference	Econfina Test	Jack Reference	Jack Test	Thomas Reference	Thomas Test	San Julia Reference	San Julia Test
Asellidae	–	144	–	–	–	–	–	–
Lirceus sp.	–	2937	–	–	7	–	–	–
Caecidotea sp.	2704	4446	–	–	25	–	21	–
Amphipoda	66	72	1	–	–	36	–	–
Gammaridae	–	108	–	–	–	–	–	–
Gammarus sp.	–	71	–	–	–	–	–	–
Hyalella azteca	190	36	18	57	108	6	–	–
Crangonyx sp.	156	286	–	–	69	71	–	–
Decapoda								
Palaemonetes sp.	15	–	–	–	–	–	–	–
Palaemonetes paludosus	–	36	–	–	–	–	–	–
Cambaridae	–	–	–	8	–	–	14	5
Procambarus sp.	–	–	18	21	15	–	–	7
Procambarus pictus	–	–	–	–	7	–	–	–
Collembola	–	–	–	30	18	9	6	–
Isotomurus sp.	–	–	–	–	–	–	–	14
Isotomurus tricolor	–	–	–	–	–	–	33	–
Sminthuridae	–	–	–	–	–	–	18	–
Sminthurinus sp.	–	–	–	–	7	–	–	–
Dicyrtoma sp.	–	–	–	–	–	–	–	18
Ephemeroptera	15	288	29	8	–	26	–	21
Heptageniidae	184	108	–	12	36	54	–	–
Stenonema sp.	–	214	–	63	36	102	–	–
Stenonema exiguum	1100	822	107	–	90	–	–	–
Stenonema smithae	–	–	30	9	511	613	–	–
Stenacron sp.	15	144	27	48	–	–	–	–
Stenacron floridense	–	–	18	–	–	–	–	–
Baetidae	33	–	6	12	–	15	–	–
Baetis sp.	–	–	6	–	–	–	–	–
Labiobaetis sp.	66	251	9	29	32	–	–	–
Labiobaetis propinquus	48	–	–	–	–	–	–	–
Baetis propinquus	–	72	–	–	–	18	–	–
Acerpenna pygmaeus	997	2008	–	–	–	6	–	–
Leptophlebiidae	88	–	105	120	147	206	505	736
Habrophlebiodes brunneipennis	–	–	–	–	–	–	256	255
Leptophlebia sp.	–	–	–	–	36	–	–	–

	Econfina Reference	Econfina Test	Jack Reference	Jack Test	Thomas Reference	Thomas Test	San Julia Reference	San Julia Test
Isoperla sp.	–	–	–	–	–	–	6	–
Perlesta placida	83	107	–	18	74	215	6	52
Hemiptera	–	–	–	–	29	–	–	–
Ranatra sp.	36	36	–	–	–	–	–	–
Microvelia sp.	–	–	–	–	–	38	–	–
Coleoptera								
Peltodytes sp.	54	216	–	–	–	–	–	–
Dytiscidae	–	–	18	6	–	–	18	–
Celina sp.	–	–	–	–	18	–	–	–
Hygrotus sp.	–	–	1	–	–	–	–	–
Hydrovatus sp.	–	–	18	–	–	–	–	–
Laccornis sp.	–	–	6	–	–	–	–	–
Hydroporus sp.	18	–	13	36	–	18	–	5
Neoporus mellitus	90	–	–	–	–	–	–	–
Hydroporus oblitus	–	–	18	–	–	–	–	–
Lioporeus sp.	–	179	–	–	–	–	–	–
Neoporus sp.	–	108	–	–	–	18	–	–
Suphisellus sp.	–	36	–	–	–	–	–	–
Gyrinidae	–	36	–	–	–	–	–	–
Gyrinus sp.	15	72	–	–	–	–	–	–
Dineutus sp.	48	72	–	–	–	–	–	–
Hydraena sp.	–	–	18	–	–	–	–	–
Sperchopsis tessellatus	–	–	–	–	–	108	–	–
Helodidae	33	–	–	–	–	–	–	–
Prionocyphon sp.	36	36	–	–	–	–	–	–
Cyphon sp.	–	–	–	–	7	–	–	–
Dryopidae	–	36	–	–	–	–	–	–
Pelonomus sp.	–	36	–	–	–	–	–	–
Helichus sp.	71	–	–	–	–	–	–	–
Helichus lithophilus	–	71	–	–	–	–	–	–
Helichus fastigiatus	–	–	–	–	–	–	–	12
Elmidae	317	251	–	–	–	179	36	22
Stenelmis sp.	627	2259	–	–	258	200	78	39
Stenelmis hungerfordi	–	–	–	–	–	6	–	–
Stenelmis sinuata	–	–	–	–	–	–	–	12
Dubiraphia sp.	382	934	26	15	–	–	6	–

	Econfina Reference	Econfina Test	Jack Reference	Jack Test	Thomas Reference	Thomas Test	San Julia Reference	San Julia Test
Oecetis sp.	104	214	36	37	56	209	–	18
Oecetis cinerascens	–	72	–	–	–	–	–	–
Oecetis georgia	–	72	–	–	53	21	–	–
Oecetis sp. f Floyd	–	–	–	18	–	–	–	–
Nectopsyche sp.	–	–	12	–	18	18	–	–
Lepidostoma sp.	–	–	18	42	–	–	36	–
Micrasema sp.	–	–	–	–	–	9	–	–
Agarodes sp.	–	–	–	–	–	24	–	–
Polycentropodidae	18	71	–	–	–	59	–	–
Polycentropus sp.	–	143	9	–	27	9	–	–
Cyrnellus fraternus	–	–	–	9	–	–	–	–
Neureclipsis sp.	–	–	–	9	18	–	–	–
Nyctiophylax sp.	–	–	1	9	–	–	–	–
Paranyctiophylax sp.	71	108	36	12	–	–	–	–
Lepidoptera	–	–	–	–	–	–	–	7
Pyralidae	–	–	–	21	–	–	–	–
Diptera	–	–	18	–	–	–	–	–
Tipulidae	–	–	–	–	18	–	25	35
Leptotarsus sp.	–	–	–	–	–	–	5	–
Tipula sp.	–	71	18	9	25	18	3	30
Hexatoma sp.	–	–	–	9	7	–	–	12
Pilaria sp.	–	–	–	–	15	–	–	36
Pseudolimnophila sp.	–	–	–	–	–	–	112	–
Cryptolabis sp.	–	–	–	–	–	–	12	–
Corethrella sp.	–	–	–	–	12	–	12	–
Simulium sp.	538	572	279	378	587	692	2139	1802
Atrichopogon sp.	–	36	–	–	–	–	–	7
Palpomyia/Bezzia grp.	780	2048	184	153	240	119	291	267
Chironomidae	514	1471	193	209	104	155	131	47
Clinotanypus sp.	–	–	54	–	27	–	–	–
Coelotanypus	–	–	–	–	–	6	–	–
Apsectrotanyp sp.*us johnsoni*	–	–	–	–	27	84	–	–
Ablabesmyia sp.	–	–	21	–	–	–	–	–
Ablabesmyia hauberi	–	–	–	9	–	–	–	–
Ablabesmyia mallochi	390	576	158	48	36	90	10	107
Ablabesmyia rhamphe grp.	577	431	1	–	–	12	12	–

	Econfina Reference	Econfina Test	Jack Reference	Jack Test	Thomas Reference	Thomas Test	San Julia Reference	San Julia Test
Parakiefferiella sp. c Epler	–	–	–	6	–	–	–	–
Parametriocnemus	–	–	287	336	980	1140	445	404
Parametriocnemus sp. f Epler	–	–	–	–	24	–	36	–
Pseudorthocladius sp.	–	–	18	–	–	–	–	–
Rheocricotopus sp.	–	–	–	9	–	–	–	–
Rheocricotopus robacki	362	788	–	9	–	18	–	12
Rheocricotopus tuberculatus	–	–	63	20	29	–	–	–
Thienemanniella sp.	–	612	–	–	9	–	18	–
Thienemanniella xena	–	180	–	6	7	72	–	–
Thienemanniella sp. a Epler	113	288	–	–	–	–	54	–
Tvetenia discoloripes grp.	574	1429	–	–	–	–	–	–
Unniella multivirga	–	–	54	48	9	36	–	–
Xylotopus par	–	–	–	–	–	9	12	12
Cladopelma sp.	–	–	–	–	–	18	–	–
Cryptochironomus	18	–	–	6	–	–	–	22
Cryptotendipes	45	–	–	–	–	–	–	–
Dicrotendipes modestus	15	72	–	–	–	–	–	–
Microtendipes sp.	–	–	36	17	–	–	–	–
Microtendipes pedellus	–	–	7	–	108	–	–	–
Microtendipes pedellusI.	–	–	319	171	71	65	–	–
Nilothauma sp.	–	–	–	8	7	9	–	–
Pagastiella sp.	30	–	–	–	–	–	–	–
Paracladopelma sp.	–	–	–	–	–	–	12	–
Paralauterborniella nigrohalterale	–	–	1	–	–	–	–	–
Paratendipes subaequalis	–	–	18	16	–	18	18	–
Phaenopsectra punctipes grp.	–	–	–	–	–	9	6	–
Phaenopsectra obediens grp.	–	–	12	–	–	–	–	–
Polypedilum sp.	24	71	1	–	–	6	18	24
Polypedilum aviceps	–	–	206	204	173	209	–	34
Polypedilum convictum	–	–	–	–	–	36	–	–
Polypedilum fallax	54	–	6	–	23	47	–	18
Polypedilum illinoense	54	–	42	8	18	197	16	–
Polypedilum scalaenum	54	36	15	–	–	–	–	–
Polypedilum tritum	–	–	12	24	–	–	–	–
Polypedilum scalaenum grp.	72	108	12	42	79	24	–	12
Polypedilum illinoense grp.	1068	5930	18	12	22	27	524	316

	Econfina Reference	Econfina Test	Jack Reference	Jack Test	Thomas Reference	Thomas Test	San Julia Reference	San Julia Test
Clinocera sp.	–	–	–	–	–	–	–	18
Hemerodromia sp.	60	143	12	6	372	1006	5	–
Dolichopodidae	–	–	18	–	–	–	–	–