

Ecological Assessment of

Reclaimed Streams

Polk, Hillsborough & Hardee Counties

Sampled August 1999

July 2000

Bureau of Laboratories

Division of Resource Assessment and Management

Comprehensive Quality Assurance Plan No's:

Laboratories- 870346G & 870688G

Field- 980028

Executive Summary

This study was a continuation of the 1998 cooperative study between FDEP's Bureau of Mine Reclamation and Bureau of Laboratories (FDEP, 1999) to determine the biological success of stream reclamation or creation efforts in phosphate mining areas. In the earlier study, some of the oldest streams were evaluated. The purpose of this second phase was to evaluate some of the more recently reclaimed streams to determine if adequate habitat and water quality were present to support healthy biological communities at an earlier stage of development. Most of the streams sampled were reclaimed between 3 and

9 years ago. One older stream (11 – 14 years) not sampled during the initial sampling event was included. Two unmined stream segments were also included: an unmined portion of stream downstream from a mined and reclaimed headwater marsh was sampled to determine the health of the receiving water biota, and the upper portion of Horse Creek was sampled for use as a potential reference site. Standard habitat assessment and physical/chemical data were collected and rapid surveys of aquatic biological communities (Bio-Recon) were performed at each site.

All sites in this study showed some type of impairment. Horse Creek was the only site to demonstrate biological integrity by passing the Bio-Recon (30 total taxa, 13 Florida Index

points and 9 EPT). However, Horse Creek was in violation of the Class III Water Quality Standard for fecal (1500 col/100 mL) and total coliforms (9500 col/100 mL). Furthermore, every site except for JP Creek had a water quality violation for either fecal or total coliforms. Nutrient concentrations at the study sites were generally low. Phosphorus levels were elevated compared to the rest of the state at all the sites, but that is expected in this phosphate rich area. Additionally, all sites failed to meet the Class III standard of 5.0 mg/L for dissolved oxygen.

Total habitat assessment scores suggested that, overall, restoration activities had not provided for full habitat recovery. Half the test sites (Mill Branch, JP Creek and Big Marsh) had only one type of in-stream

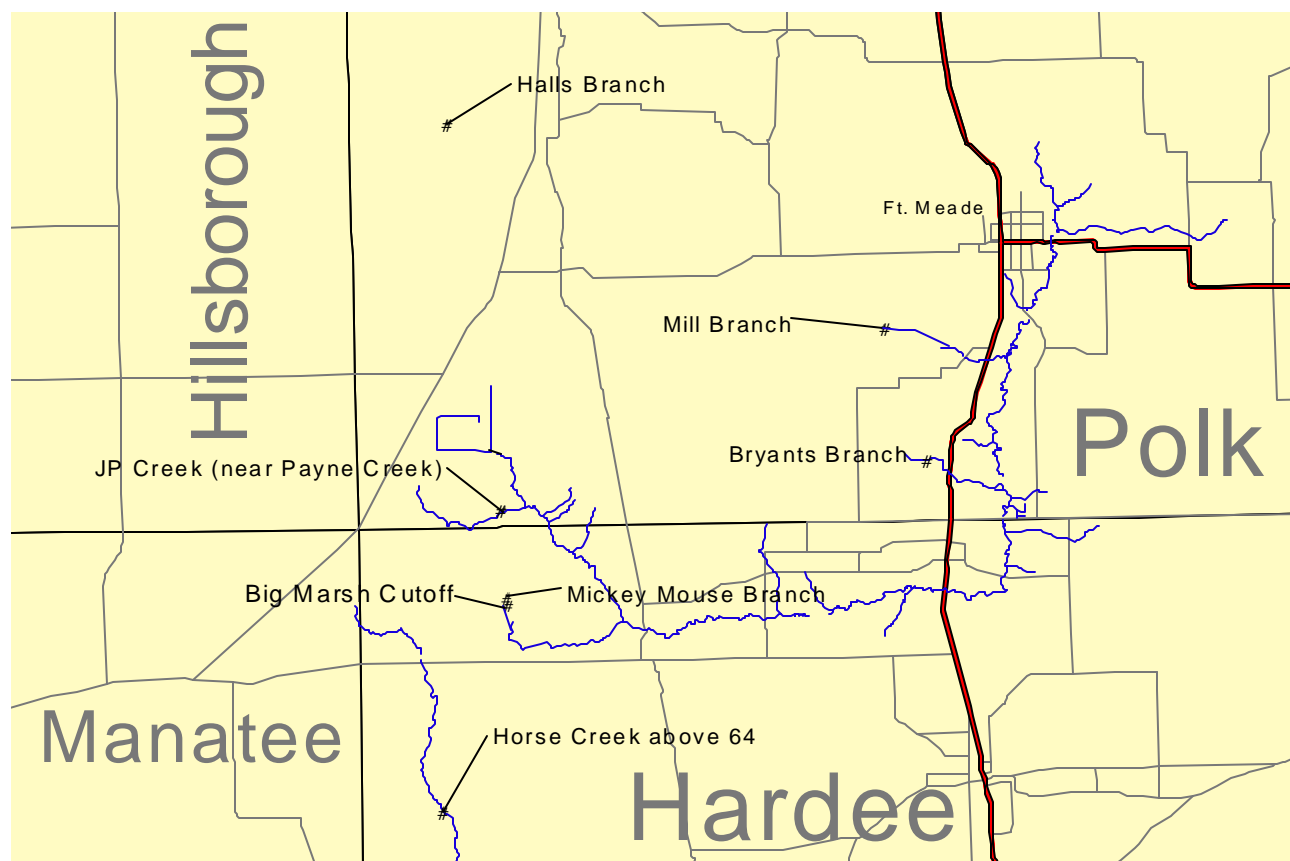


Figure 1: Overview Map

habitat (aquatic vegetation) and little to no riparian buffer zone. Moderate to severe smothering existed at every site except for Horse Creek, the reference site. Smothering, combined with a lack of substrate diversity, greatly limited the habitat available to organisms.

Introduction

This study was a continuation of the 1998 cooperative study between FDEP's Bureau of Mine Reclamation and Bureau of Laboratories (FDEP, 1999) to determine the biological success of stream reclamation or creation efforts in phosphate mining areas. Seven sites: Bryants Branch, Horse Creek, Mill Branch, Halls Branch, JP Creek, Mickey Mouse Branch and Big Marsh outfall were sampled from August 17 – 19, 1999, for water quality, habitat and biological parameters

Methods

Benthic macroinvertebrate communities were evaluated using the FDEP Bio-Recon technique. Invertebrates were collected from multiple substrates (e.g., roots, snags, leaf packs, vegetation) using 4 discrete dip net sweeps (FDEP, 2000a), field picked, and finally brought back to the laboratory for identification under the dissecting microscope. Bio-Recon results were then compared to existing

criteria for three categories (minimum expected values for peninsular streams are in parentheses): total taxa richness (18), total Florida Index (10), and total EPT (Ephemeroptera/Plecoptera/Trichoptera) Index (4). These threshold values determine the impairment rating assigned to the sample site. If two or more of the metrics are greater than or equal to the target values, the site is considered "healthy". If less than two of the metrics are within target range, the site is "suspected to be impaired", and more rigorous, follow up sampling (using the Stream Condition Index) is necessary to confirm the evaluation and determine the degree of impairment.

Habitat quality was determined for each station during an *in situ* assessment (FDEP, 2000b). Eight attributes (substrate diversity, substrate availability, water velocity, artificial channelization, bank stability, habitat smothering, riparian zone buffer width, and riparian zone vegetation quality; see habitat assessment sheets in Appendix) known to have potential effects on the stream biota were evaluated and scored, with 20 points possible for each factor. Of these, providing adequate substrate diversity (and availability) and water velocity are probably the most difficult challenges when creating or restoring a stream. Based on the sum of these individual scores, overall habitat quality is assigned to one of four categories: Optimal (121-160 points); Suboptimal (81-120 points); Marginal (41-80 points); and Poor (0-40 points).

A physical/chemical characterization (FDEP, 2000c) was also performed at all study sites. Water samples from all sites were analyzed for nutrients, turbidity, fecal and total

coliforms, total suspended solids (TSS), and total organic carbon (TOC).

Explanation of Measurements of Community Health

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

Taxa richness: This measurement is based on the total number of taxa found at a site. Stress tends to reduce the number of different types of organisms present in a system.

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 (EPT) Index: This index is the sum of the number of larval EPT taxa present. Higher EPT values are associated with healthier systems.

Sampling for this investigation was performed by FDEP Central Laboratories and Bureau of Mine Reclamation staff. FDEP Central Laboratories performed the biological and chemical analyses.

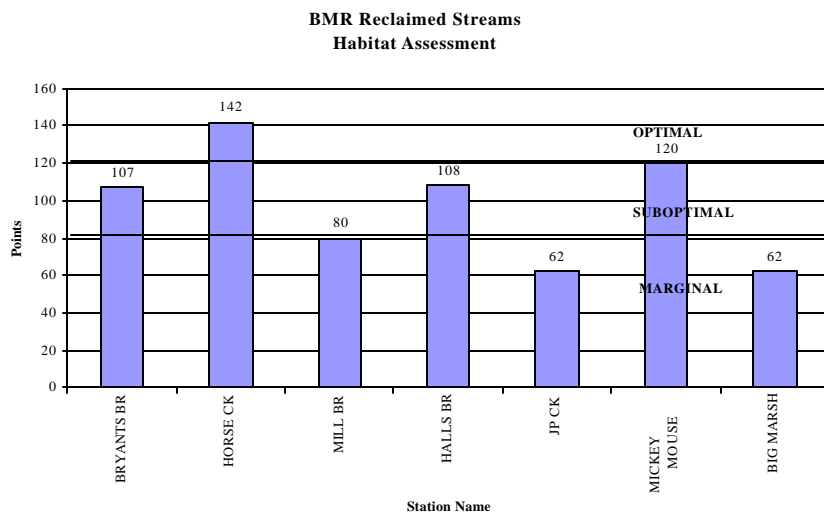


Figure 2: Habitat Assessment Score

Site Description

The sites in this study are all located in the Southwestern Florida Flatwoods Subcoregion of the Southern Coastal Plain Ecoregion (see Figure 1). This subregion is characterized by forest, pasture and rangeland, spreading urbanization, lands disturbed by phosphate mining, and citrus groves (EPA Florida Regionalization Project, unpublished report). Bryants Branch, Mill Branch and JP Creek are in Polk County, and Halls Branch is in Hillsborough County. Big Marsh outfall, Mickey Mouse Branch and the sampled portion of Horse Creek are in Hardee County.

Bryants Branch (Figure 3) is a minor tributary to the Peace River. This 25-acre, 200-foot wide stream project was completed in 1990. The area was created on sand tailings capped with overburden and 6 inches of wetland topsoil. The adjacent land use is primarily pasture. Two lakes contribute

drainage to the tributary, however a significant portion of the remaining watershed remains temporarily isolated from the stream in areas that are currently occupied by active clay settling areas.

Mill Branch is a tributary to Whidden Creek, which flows into McCullough Creek and then the Peace River. The reclaimed portion of the creek is part of a 25-acre wetland hardwood forest that was reclaimed in 1996 on sand tailings capped with overburden.



Figure 3: Bryant's Branch

Flow was restored to the wetland and the stream was allowed to form its own channel and connect with the unmined portion of the creek in early 1997. This project has a unique design consisting of a series of low berms extending across the wetland toward the channel, forming a series of backwater pools. The surrounding land use includes mostly pasture with some upland forest, a clay settling area in the process of being reclaimed, and an active phosphogypsum stack that is isolated from the watershed. Upstream portions of the creek are mainly confined to a series of ditches in land mined prior to any requirements for reclamation.

Halls Branch is a tributary to the North Prong of the Alafia River. The 3.8-acre headwater section of the stream was mined and restored in 1985 on sand tailings and overburden. An additional 17.2 acres of wetland forest surrounding the central portion were added in 1988. Two shallow depressions along the future stream channel were excavated and spread with 3 to 6 inches of wetland topsoil. The stream was allowed to cut its own channel between the depressions and between the lower depression and the unmined portion of the creek downstream. The sur-



Figure 4: JP Creek



Figure 5: Horse Creek

rounding land use includes mostly reclaimed sand pine scrub and pasture.

JP Creek (Figure 4) is a 126-acre tributary to Payne Creek that was reclaimed in four phases. The most recent phase was reclaimed on sand tailings capped with overburden in 1999. Most of the wetland received several inches of muck from adjacent marshes. Sampling was performed on the section completed in 1995, just upstream from the unmined portion of the creek. Most of the watershed has been reclaimed and consists primarily of pasture with some upland shrub and brush land and additional wetlands.

The Mickey Mouse Wetland is an unmined, forested wetland that receives water from a mined and restored headwater area, called Big Marsh that was reclaimed in 1993. These wetlands drain through several unmined wetlands into a minor tributary to Gum Swamp Branch and eventually Payne Creek. The surrounding land use is primarily improved pasture. Portions of the watershed remain isolated since they are currently in use as active clay setting areas.

Horse Creek (Figure 5) is a major tributary to the Peace River and was included as a potential reference site. This unmined stream was sampled several miles downstream from current mining activities. The adjacent land use near the area sampled includes upland forest, pine flatwoods and oak-scrub that is subject to light cattle grazing. Other land uses in the watershed include pasture land and agriculture.

Results and Discussion

Habitat Parameters

Total habitat assessment scores were in the “optimal” range at only two sites, Mickey Mouse Branch (120), an unmined stream segment, and Horse Creek (142), a minimally impacted reference site. Bryants Branch (107), Halls Branch (108) and Mill Branch (80) scored in the “suboptimal” range. The remaining two stations, JP Creek and Big Marsh scored 62 points, falling into the mid “marginal” range. These scores suggest that, overall, restoration activities at the study streams have not provided for full habitat recovery.

All sites sampled contained greater than 17% aerial coverage of habitat, indicating adequate amounts were present to support invertebrate life. However, aquatic vegetation represented the only type of habitat present in Mill Branch, Big Marsh and JP Creek (>40% coverage). Multiple habitat types are needed to support a diversity of organisms. Horse Creek, Bryants Branch, Mickey Mouse and Halls Branch each had 3 or more different substrate types for habitat.

Habitat smothering decreases the surface area for invertebrates to use as refugia. Moderate to severe silt and clay smothering existed at all the sites except for Horse Creek. Bryants Branch, Halls Branch, and JP Creek’s habitat were severely (greater than 50%) smothered.

Water velocity was ranked as “optimal” at only one station, Horse Creek (0.25 m/s). Mill Branch, Halls Branch, and Bryants Branch had lower water velocities, falling in the “suboptimal” range (0.23 m/s, 0.2 m/s, and 0.15 m/s, respectively), while Mickey Mouse Branch (0.02 m/s), JP Creek (0.01 m/s), and Big Marsh (0.00 m/s) all fell into the “poor” category. Because the amount of dissolved oxygen and the movement of materials and food particles in a system is directly correlated to the velocity of water flowing through it, systems with water velocities lower than 0.1 m/sec will support fewer taxa.

Big Marsh, JP Creek, and Mill Branch had either no riparian buffer zone, or a recently planted one lining the system. Consequently, each of these sites had only 1 source of habitat, aquatic vegetation. Riparian zone vegetation not only provides leaf litter, roots, and snags (sources of food energy, bank stabilization, and habitat) to a system, but also shades the stream corridor for summer time temperature stabilization. Riparian vegetation also serves as a buffer to mitigate pollutants entering a stream from runoff. Narrow riparian zones suggest increased potential for contaminated stormwater and sediment to enter the system.

Water Chemistry Parameters

Dissolved oxygen concentrations were below the Class III Water Quality Standard of 5.0 mg/L at all sites (see Figure 3). Dissolved oxygen concentrations at these low levels can limit the diversity of organisms able to survive in a stream, particularly macroinverte-

brates. DO levels were exceptionally low in JP Creek and Big Marsh Cut-off.

The turbidity level at Halls Branch (36 NTU) may have been above the Class III Water Quality Standard limit of 29 NTU above background (Typical background levels for turbidity are below 3 NTU). Turbidity at the other sites ranged from a low of 1.3 NTU at Big Marsh to 18 NTU at Mills Branch.

Nitrate-nitrite (NO_x) values were low at all sites (less than 0.035 mg/L), well below those levels found in 80% of Florida streams. Ammonia (NH₃) concentration was elevated above background (0.07 mg/L) only at Halls Branch, 0.26 mg/L. This is a higher concentration than is found in 90% of Florida streams. Total Kjeldahl nitrogen (TKN) concentrations greater than those found in 60% of Florida streams were found at Horse Creek and Halls Branch. Mickey Mouse Branch (0.97 mg/L), and Big Marsh Cut-off (1.0 mg/L) had moderately elevated levels of Kjeldahl nitrogen. TKN values were low at the remaining study sites. Phosphorus enrichment compared to the rest of Florida was found at all sites, common in this area of the state. Total phosphorus (TP) concentrations were greater than those found in 90% of Florida streams (0.74 mg/L) in Bryants Branch, Horse Creek and JP Creek; TP concentrations were greater than those found in 95% of Florida streams (1.51 mg/L) at the remaining sites.

Bryants Branch, Horse Creek, and Halls Branch, were all in violation of the Class III Water Quality Standard for fecal coliform concentrations; these three sites had fecal coliform levels well above the 800 col/100ml standard as

Station	BRYANTS BR	HORSE CK	MILL BR	HALLS BR	JP CK	MICKEY MOUSE	BIG MARSH
Date	08/19/99	08/18/99	08/19/99	08/17/99	08/17/99	08/17/99	08/17/99
Habitat Assessment	107	142	80	108	62	120	62
# Taxa	18	30	15	15	30	23	28
Florida Index	0	13	4	0	5	5	3
EPT	1	9	3	0	3	2	3
Conductivity	290	80	395	375	345	300	135
Dissolved Oxygen (mg/L)	4.7	4.9	No Data	4.5	0.9	3.6	1.1
pH (SU)	6.19	6	6.44	7.17	7.02	7.2	6.7
Temperature (C)	25.6	27.6	31.3	25.4	28	29.1	29.2
Turbidity (NTU)	6.3	2.5	18	36	1.7	3.7	1.3
Ammonia (mg/L)	0.065	0.021	0.017	0.26	0.017	0.027	0.021
Nitrate-nitrite (mg/L)	0 BDL	0.01	0.01	0.03	0.01	0 BDL	0 BDL
TKN (mg/L)	0.62	1.5	0.66	1.5	0.74	0.97	1
Total Phosphorus (mg/L)	0.23	0.31	5.9	0.64	0.35	0.7	1.4
Biological Oxygen Demand	1	1.6	1.1	2.8	1	1.5	1.4
Fecal Coliforms (col/100ml)	7000	1500	460	1500	4	330	60
Total Coliforms (col/100ml)	7100	9500	3200	16000	330	4100	3700
Total Organic Carbon (mg/L)	16	16	14	35	19	49	23
Total Suspended Solids (mg/L)	10	4	38	17	4	6	4
Color (PCU)	100	500	100	300	80	150	200

Figure 6: Summary of Data

well. Bryants Branch, Horse Creek, Mill Branch, Halls Branch, Mickey Mouse Branch and Big Marsh Cut-off were all in violation of the Class III water quality-standard (2400 col/100ml) for total coliform levels. See Figure 6 for a summary of the water chemistry parameters

Macroinvertebrate Parameters

The Bio-Recon thresholds a site must meet or exceed to be considered healthy for peninsular Florida are: a total taxa value of 18, a Florida Index value of 10, and a EPT Index value of 4. A site must pass 2 of the 3 metrics to be considered healthy. Sites failing the Bio-Recon are only suspected to be impaired until further, more definitive sampling can be done (e.g. Stream Condition Index). Horse Creek was the only site to meet or exceed the Florida and EPT Index thresholds with a value of 13 and 9 respectively. All other study sites

sampled for these parameters failed to meet the minimum values (Figures 7). Mill Branch and Halls Branch were the only two sites not to pass the threshold for total number of taxa (Figures 7). Thus, Horse Creek was the only site to pass the Bio-Recon in this study (Also see Table 1 for a summary of macroinvertebrate parameters).

Low flow conditions seemed to limit macroinvertebrate communities. Horse Creek was the only site to have flow in the “optimal” category and the only site to pass the Bio-Recon. However, flow was not the only factor limiting biological health. Moderate to severe smothering existed at every site except for Horse Creek. Smothering, combined with a lack of substrate diversity, greatly limited the habitat available to organisms.

Conclusions

All sites in this study showed some type of impairment. Horse Creek was the only site to demonstrate biological integrity by passing the Bio-Recon (30 total taxa, 13 Florida Index points and 9 EPT). However, Horse Creek was in violation of the Class III Water Quality Standard for fecal (1500 col/100 mL) and total coliforms (9500 col/100 mL). Furthermore, every site except for JP Creek had a water quality violation for either fecal or total coliforms. Nutrient concentrations at the study sites were low, with the exception of the ammonia concentration at Halls Branch (0.26 mg/L). Phosphorus was elevated compared to the rest of the state at all the sites. Additionally, all sites failed to meet the Class III standard of 5.0 mg/L for dissolved oxygen.

Total habitat assessment scores suggested that, overall, restoration activities had not provided for full habitat recovery. Half the test sites (Mill Branch, JP Creek and Big Marsh) had only 1 in-stream habitat (aquatic vegetation) and little to no riparian buffer zone. The two older sites (Bryants Branch and Halls Branch) had a greater diversity of habitats which was reflected in the higher habitat assessment scores, although these too were still less than optimal. Moderate to severe smothering existed at every site except for Horse Creek, the reference site. Smothering and low water velocities, combined with a lack of substrate diversity, greatly limited the habitat available to organisms. It is hoped that the current state of several of these sites is due to their young age and that as the adjacent canopy matures, additional habitats will be created. Low flow conditions in a site like Bryants Branch should improve over time as more of the watershed is reclaimed. A site like Halls Branch may never pass the BioRecon because it functions more as a seepage driven, forested headwater wetland. A similar situation may exist in the lower portion of Big Marsh which functions more like a broad wetland slough than a stream.

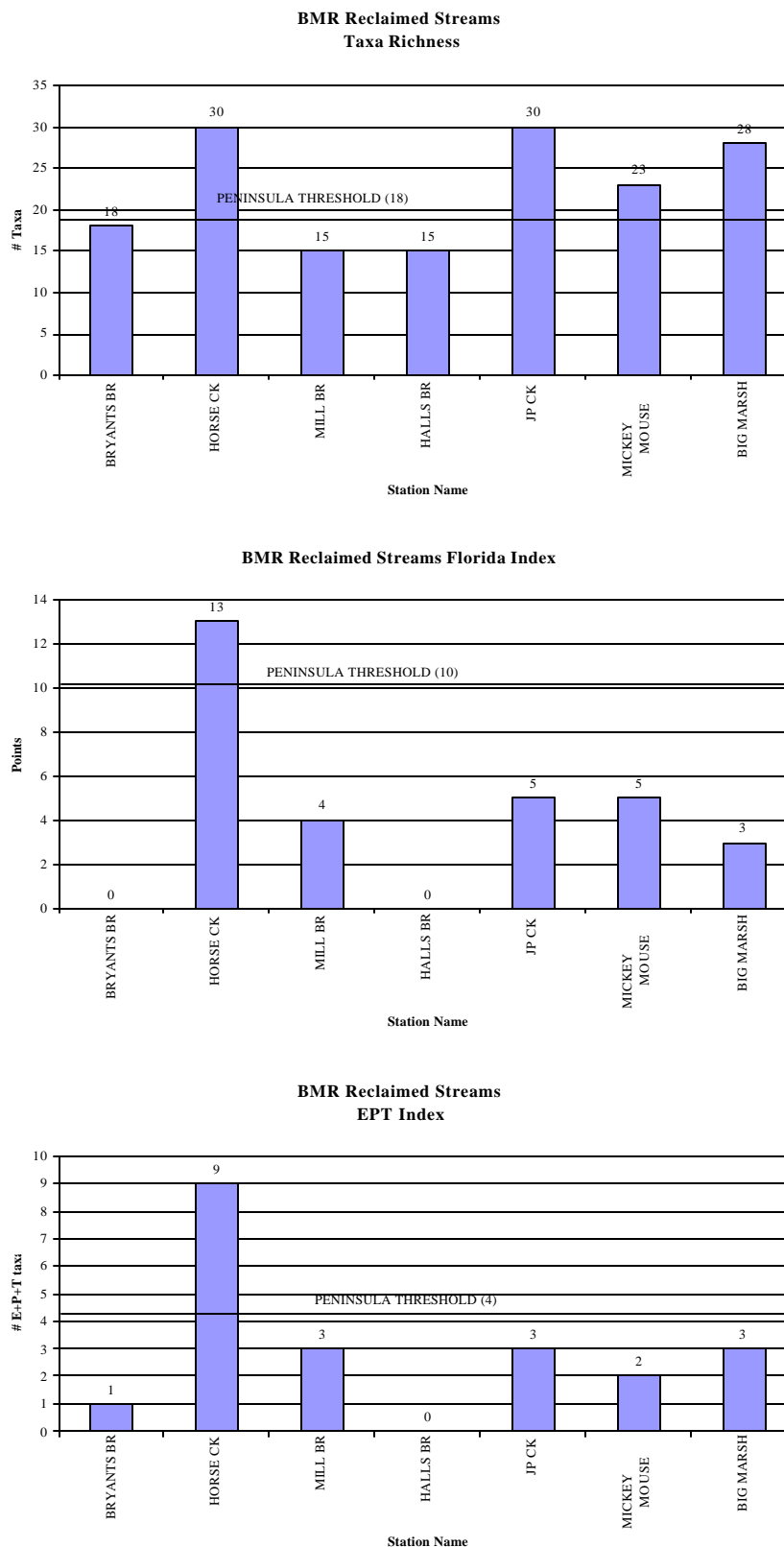


Figure 7: BioRecon Metrix Scores

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