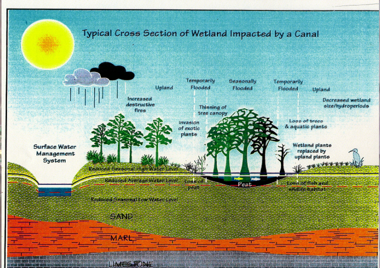
Aquatic Macroinvertebrates of Impacted and Reference Wetlands: Picayune Strand Restoration Project (PSRP)

David W. Ceilley and Edwin M. Everham, III Inland Ecology Research Group Florida Gulf Coast University

Acknowledgements

Thanks to Ian Bartoszek, Melinda Schuman and interns at the Conservancy of Southwest Florida and Connor H. Ceilley for their assistance in collecting data for the baseline assessment of aquatic fauna. Thanks also to Mike Owen and Dennis Giardina at Fakahatchee Strand State Preserve, Mike Barry at the Institute for Regional Conservation and Mike Duever (SFWMD) for their assistance in the selection of reference wetland sites and cooperation during the course of the study. Thanks to Layne Hamilton, Kim Dryden, and Daryl Thomas of the U.S solving skills, and always pleasant demeanor. Thanks to the South Florida Water Management District "ACCELER-8" program for funding this important baseline assessment and to Janet Starnes . Fish and Wildlife Service for their support and dedication to the Picayune Strand Restoration Project. Special thanks to Sonja Durrwachter (former Manager of Picayune Strand) for her dedication to land stewardship, cooperation, problem and Mike Duever for coordinating this massive restoration project and associated monitoring programs. Finally, thanks to Edwin M. Everham for his support and assistance throughout the project.

Figure 1c. Effects of Surface Water Management Systems (Ditches and Canals) on a Wetland.

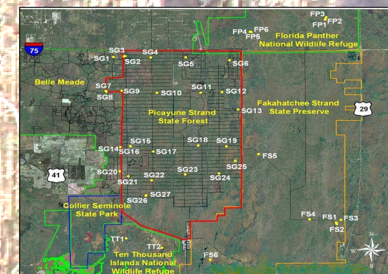


Introduction:

Prior to development in the 1960s Picayune Strand was characterized by seasonal flooding and slow-moving overland sheet flow that supported a variety of plant and animal communities in uplands and freshwater wetlands. Channelization of water flows by canals and road construction resulted in elimination of sheet-flow across Picayune Strand (formerly Southern Golden Gate Estates), a severely lowered surficial aquifer within Picayune, and an erratically fluctuating freshwater point discharge to the estuarine ecosystem via Faka-Union Canal. Upland, wetland, and estuarine plant communities have been severely degraded, the abundance of native fish, wildlife, and estuarine shellfish populations has declined, recharge of the surficial aquifer has been reduced, and invasive non-native species have greatly increased in abundance. The goals of the PSRP include reestablishment of historic flowways, overland sheetflow, wetland hydroperiods, and wet and dry season water levels within Picayune, as well as restored seasonal salinity patterns in its downstream coastal marshes and estuaries. This monitoring effort will establish a pre-construction baseline for inland aquatic fauna that will later be used to evaluate environmental changes after the PSRP has been completed. The macroinvertebrate fauna include taxa that are likely to be significantly affected by hydrologic restoration and associated changes in plant communities. They also represent a range of trophic groups inhabiting a range of Picayune Strand habitats, and can be expected to serve as practical indicators for evaluating success of the restoration.

Rationale for Using Macroinvertebrates for Assessment of Wetlands

1. Important trophic linkages & multiple functional feeding groups
2. History as stream condition & WQ indicators (Florida SCI, IBI, Bio-recon)
3. Community sensitivity to hydrology and habitat change
4. Several indicator species with known environmental tolerances
5. Cost-effective, simple and repeatable methods for long-term assessments



Methods:

Monitoring sites for aquatic fauna were established in the summer of 2005 at representative major habitat types found in the immediate vicinity of the SFWMD water-level monitoring wells. Reference sites from four major plant communities (cypress, wet prairie, hydric pine, and brackish marsh) were established on nearby, relatively undisturbed public lands to provide aquatic fauna and terrestrial invertebrate restoration targets for the Picayune sites. Reference sites are located in Florida Panther National Wildlife Refuge (FPNWR) and Fakahatchee Strand State Preserve (FSSP). Aquatic macroinvertebrate sampling was attempted at each location six times between August 2005 and February 2007. Aquatic macroinvertebrates were collected using a standard D-frame dip-net with mesh size of 500 microns (Ross 1990; FDEP 1993). Sampling was conducted in all of the major and minor micro-habitats (e.g. emergent and submergent vegetation, snags, roots, algal mats, benthos, rocks etc.) available at each site. Samples were placed in a shallow white pan and field sorted using forceps and eye-droppers until no new species were observed for a period of 10 minutes, which is believed to approximate the asymptote of species accumulation curve. Generally, this requires one hour of dip-net sampling and field sorting. All taxa collected were preserved in jars filled with 80% ethanol and labeled. Vials were used for collecting and preserving delicate specimens such as mayflies and damselflies to protect gill filaments for species-level identification. Identification to the lowest practical taxonomic level was done using stereo-microscopes (10x – 90x) and the latest taxonomic keys. Voucher specimens were archived at FGCU for future reference.

Statistical Analysis

Univariate and multivariate analyses were performed using PRIMER v6 (Clarke and Gorley 2006). Due to the small number of samples collected at each site, data were pooled for each site for all sampling events during the baseline study period. Hierarchical agglomerative cluster analysis and non-metric multidimensional scaling (MDS) ordination based on Bray-Curtis similarities were employed to search for natural groupings among samples. The groupings produced in the cluster diagrams were further evaluated for statistically significant evidence of genuine clusters using a series of similarity profile (SIMPROF) permutation tests (Clarke and Gorley 2006). Relative contributions of individual species to within-group similarities as well as between-group dissimilarities were examined using similarity percentages (SIMPER). Species contributions, in terms of relative abundance were graphically displayed as overlays on the MDS plots to illustrate relative importance to the ordination.

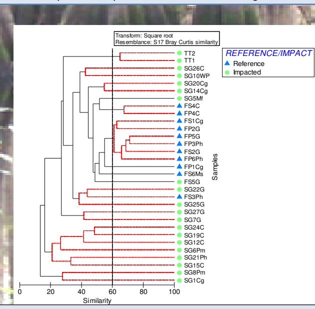


Figure 1. Hierarchical agglomerative clustering of macroinvertebrate communities from all sites where aquatic macroinvertebrates were collected and identified. Clusters are based on the Bray-Curtis similarity matrix using group average method. Black lines identify significant groupings (p<0.05) with red line clusters not significant. Slice at 60% similarity used to illustrate a grouping of six reference sites that are not significantly different from each other but as group are different from all other sites and clusters.

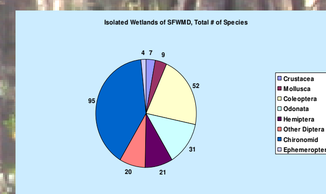


Figure 5. Wetland macroinvertebrate community structure of isolated wetlands of the SFWMD broken down by taxa group and number of species per group (Stansly et al. 1997.)

Results

Twenty (64.5%) of 31 impacted wetlands and all (100%) of the 11 reference wetlands were inundated sufficiently to produce aquatic macroinvertebrates during the baseline assessment period. A total of 7,123 individual macroinvertebrates were identified from the baseline collections delivered to FGCU. These included at least 182 species (or distinct taxa) representing 6 Classes, 20 Orders, and 57 families. Because of the limitations of identifying early instars, larval stages, and females of some groups, the total 182 taxa were reduced to125 operational taxonomic units (OTUs) considered appropriate for univariate and multivariate statistical analyses. Generally speaking, species richness and diversity metric values were higher in the reference wetlands than impacted wetlands (Table 1.)

Macroinvertebrate community structure was significantly different (p< 0.05) between impacted and reference wetlands sampled in this study (Figure 1). Most of the impacted sites in Picayune Strand with habitat designations of cypress, cypress graminoid, wet prairie, marsh, and pine were significantly different from others in that same habitat type, especially within the cypress habitat. This is further illustrated in the clustering by very low % similarity –and- in the MDS ordination as scatter or distance in 2-dimensional space (Figure 2.) This dissimilarity is attributed to the severely altered hydrology of Picayune Strand. With the exception of one pine site in Fakahatchee Strand (FS3Ph), all reference wetlands of all habitat types, shared greater than 45% similarity in community structure. Six of the ten reference sites (FS1G, FS2C, FP2G, FP5G, FP3Ph and FP6Ph) shared greater than 60% similarity and were not significantly different (P<0.05) from each other, but separated from all other groups as significantly different (Figure1). Macroinvertebrate taxa that were major contributors to the dissimilarity between reference and impacted wetlands included mayflies, *Callibaetis* (7.3%) and *Caenis* (4.4%), the damselfly, *Ischnura* (4.9%), amphipod *Hyalella* (4.0%), and snails *Hatia* (3.4%) and *Planorbella* (2.8%). Each of these taxa were much more abundant in the reference wetlands than impacted wetlands (Figure 3) and the apple snail, *Pomacea* was only collected from reference wetlands in Fakahatchee Strand and Florida Panther National Wildlife Refuge.

Macroinvertebrate Diversity Metrics for PSRP Reference sites in Blue

	location	HABITAT	Species	Total No.	Margalef d	Pielou's (J')	Shannon H'	1-Lambda'
FP1GTOTAL	FPNWR	PRAIRIE	32	218	5.76	0.86	3.0	0.93
FP1PhTOTAL	FPNWR	PINEh	36	303	6.13	0.77	2.8	0.90
FP2CTOTAL	FPNWR	CYPRESS	50	553	7.76	0.82	3.2	0.94
FP2GTOTAL	FPNWR	PRAIRIE	33	311	5.58	0.78	2.7	0.89
FP2PhTOTAL	FPNWR	PINEh	27	205	4.88	0.74	2.4	0.85
FS2CTOTAL	FSSP	CYPRESS	45	828	6.55	0.50	1.9	0.60
FS1CgTOTAL	FSSP	CYP-GR	29	266	5.01	0.80	2.7	0.91
FS1GTOTAL	FSSP	PRAIRIE	23	252	3.98	0.71	2.2	0.84
FS1Ph31Au05	FSSP	PINEh	15	89	3.12	0.65	1.8	0.69
BM1TOTAL	PSSF	BMARSH	25	450	3.93	0.68	2.2	0.82
BM2TOTAL	PSSF	BMARSH	34	580	5.19	0.73	2.6	0.86
BM3TOTAL	FSSP	BMARSH	43	367	7.11	0.80	3.0	0.93
SG1 9Au05	PSSF	CYPRESS	11	27	3.03	0.93	2.2	0.91
SG4Mfw 13Oc05	PSSF	FWMARSH	41	342	6.86	0.85	3.2	0.94
SG5 9Au05	PSSF	PINEm	8	30	2.06	0.76	1.6	0.72
SG6Pm 10Au05	PSSF	PINEM	9	54	2.01	0.62	1.4	0.61
SG6G 10Au05	PSSF	PRAIRIE	15	33	4.00	0.89	2.4	0.91
SG10CTOTAL	PSSF	CYPRESS	23	127	4.54	0.79	2.5	0.88
SG10WPTOTAL	PSSF	WILLOW	23	127	4.54	0.79	2.5	0.88
SG12Cg 10Au05	PSSF	CYP-GR	19	145	3.62	0.84	2.5	0.90
SG13C 10Au05	PSSF	CYPRESS	9	77	1.84	0.59	1.3	0.59
SG16C 19Au05	PSSF	CYPRESS	15	80	3.19	0.79	2.1	0.84
SG17TOTAL	PSSF	PRAIRIE	21	139	4.05	0.77	2.4	0.86
SG18Cg11Au05	PSSF	CYP-GR	28	416	4.48	0.80	2.7	0.90
SG19Ph 11Au05	PSSF	PINEh	25	255	4.33	0.65	2.1	0.79
SG20G 30Au05	PSSF	PRAIRIE	15	129	2.88	0.77	2.1	0.82
SG22C 30Au05	PSSF	CYPRESS	15	46	3.66	0.93	2.5	0.93
SG23G 1Se05	PSSF	PRAIRIE	17	133	3.27	0.76	2.2	0.83
SG24G 30Au05	PSSF	PRAIRIE	9	39	2.18	0.82	1.8	0.81
SG24C 30Au05	PSSF	CYPRESS	22	94	4.62	0.77	2.4	0.86

Table 2. Univariate diversity metrics for wetland macroinvertebrates collected from reference (blue) and impacted (red) wetland habitats for the baseline assessment of PSRP. Note: only 20 (above) of the total 31 impacted wetlands supported wetland fauna due to lack of inundation at 11 sites while all reference sites produced high diversity of aquatic fauna.

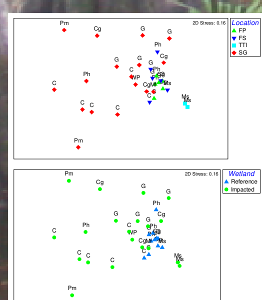


Figure 2. MDS ordination of macroinvertebrate communities similarity from impacted and reference wetlands with top figure showing location (TTI= 10,000 Islands, FP=Florida Panther Refuge, FS=Fakahatchee Strand and SG= Picayune/Southern Golden Gate) and habitat type (C=cypress, Cg=cypress graminoid, G=wet prairie, Ph=pine-hydric, Pm=pine-mesic WP=willow pond, Mf=marsh freshwater, and Ms=marsh saltwater) with bottom figure showing impacted and reference site status.

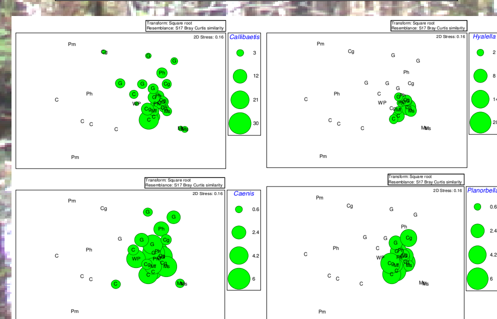


Figure 3. MDS ordination with superimposed square root abundance of wetland mayflies; *Callibaetis* (top left) and *Caenis* (bottom left), alongside amphipod crustacean, *Hyalella* (top right) and snail *Planorbella* (bottom right). Note the relative abundance in reference wetlands toward the center-right side of the plot. These taxa were important contributors for the dissimilarity between impacted and reference wetlands -and- serve as indicators of natural hydroperiods of reference wetlands and performance measures for PSRP success.

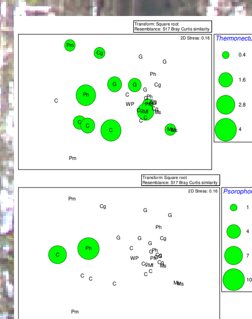


Figure 4. MDS ordination with superimposed square root abundance of a tolerant water beetle, *Thermonectes* (top) and short-hydroperiod mosquito larva, *Psorophora* (bottom) as potential indicators of disturbance due to their relative abundance in impacted (drained) wetlands of PSRP (see Figure 2). .

Conclusions

- Baseline macroinvertebrate surveys were able to detect significant differences in the faunal community structure between impacted and reference habitats of PSRP.
- Sheet flow connectivity (between habitats) and hydroperiod condition were more important than plant habitat type in determining wetland macroinvertebrate community structure, especially in impacted wetlands of Picayune Strand.
- Several taxa were identified that may serve as indicators of hydrologic recovery over time including mayflies, damselflies, dragonflies, amphipods, crayfish, freshwater shrimp, and snails.
- Trophic-level community structure of CERP wetlands may be effectively monitored using the rapid bio-assessment techniques employed in this study.

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