FISHES AND STREAMS RECLAIMED AFTER PHOSPHATE MINING

BY

THOMAS H. FRASER

2052 VIRGINIA AVENUE
W. DEXTER BENDER AND ASSOCIATES, INC.
FORT MYERS, FLORIDA 33901

DECEMBER, 2003

INTRODUCTION

Phosphate mining has caused the loss and/or modification of unquantified miles of streams in Hardee, Hillsborough, Polk and Manatee Counties. In recent years the Florida Department of Environmental Protection (FDEP) has examined via ecological assessments the status of a few reclaimed streams (1999 and 2000). The State's hypothesis (FDEP, 1999) was:

> '....if these created streams had adequate habitat and water quality, they would support healthy biological communities.'

The purpose of this review of four of the oldest created streams (13-15 years old at the time of the study) was:

> '....to identify the most successful stream reclamation techniques so they could be incorporated into future projects.'

The results of the first study in 1999 led to the recommendation that more created streams should be examined. In the second study (FDEP, 2000), created streams of 3-9 years old and one stream of 11-14 years old. The purpose of this review of four of the oldest created streams (13-15 years old at the time of the study) 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 state of development.'

While invertebrates were listed by FDEP with a heavy emphasis on insect larvae, fishes were not part of the sampling design to assess the streams. Florida freshwater fishes are constrained to water for all aspects of their life histories, unlike many insects which have a portion of their life cycles confined to water, but otherwise can fly. The composition of fish species, therefore, will provide valuable information about the status of a re-created stream over time.

Three aspects for assessing re-created streams were missing from the FDEP reports:

1. There were no descriptions of the original stream's physical and chemical conditions. Hydrologic metrics, stream shape metrics and gradient metrics and water quality conditions are required for any assessment of success.

2. There were no descriptions of the aquatic flora and fauna present in the original streams. Successful reclamation cannot be determined if descriptions of the pre-mining flora and fauna are not specifically compared with the post-mining reclaimed stream.

3. There was no description of how the 'planned' stream would be re-built in order to compare with the 'as built' streams.

All scientific assessment of existing reclaimed streams will suffer from the above deficiencies. One hypothesis can be tested concerning fishes or any other group which must re-invade a completely unoccupied, isolated, new habitat (re-created stream). Any initial species composition would be simplified when compared with a similar undisturbed habitat. Fish composition would become more diverse with time with reasonable access, stable and diverse aquatic habitats. Since most streams in Central and Southwest Florida are forested, appropriate riparian systems will need to be present.

The purpose of this report is to describe the species of fishes identified from five reclaimed streams sampled during the summer of 2003. Another two reclaimed streams were visited, but not sampled. The operating hypothesis is that the number of species present is an expression of habitat diversity and water quality conditions. Comparisons were made with the total number of fish species reported from the Alafia and from streams on IMC's Ona property.

METHODS

Seines, castnets and push/dip nets were used depending on conditions in the stream. All species were identified in the field. Photographs of stream habitats and fishes were taken in the field. Other photographs were taken in an aquarium from preserved material. Sampling effort was directed toward collecting as many species as possible. No quantitative effort metrics can be applied to the data. Approximately 2-3 hours were spent on each site. Figure 1 shows the locations of reclaimed sites on the Alafia River.

Figure 1.

RESULTS

Each reclaimed stream is treated individually.

Dogleg Branch a tributary of the south prong of the Alafia River, reclaimed in 1983.

The FDEP in 1999 reported this site to be the 'healthiest' site sampled, suggesting the restoration techniques used here were effective.

Four species of fish representing three families were collected in the reclaimed portion of the stream (Table 1). Another two species were collected in the downstream portion of the non-mined area.

TABLE 1.
Fishes collected on 12 August 2003

FISH SPECIES			Dogleg Preserve	Dogleg Reclaimed
Pirate perch	*Aphredoderus*	*sayanus*	1	
Eastern mosquitofish	*Gambusia*	*holbrooki*	1	1
Warmouth	*Lepomis*	*gulosus*	1	1
Bluegill	*Lepomis*	*macrochirus*	1	1
Redear	*Lepomis*	*microlophus*	1	
Sailfin molly	*Poecilia*	*latipinna*	1	1
	Native Total		6	4

Dogleg Stream Habitats

Halls Branch a tributary of the north prong of the Alafia River, restored in 1985.

Halls Branch was not considered a success by FDEP (2000), having high turbidity and high ammonia with moderate to severe silt and clay smothering

No species of fish were found at this site.

HALLS BRANCH HABITATS

Jamerson Junior a tributary of the south prong of the Alafia River.

Two species of fishes, the yellow bullhead (*Amiurus natalis*) and an exotic, the oriental weatherfish (*Misgurnus anguillicaudatus*) were collected in the reclaimed stream. Another species, the eastern mosquitofish (*Gambusia holbrooki*) was collected in the down stream, unmined portion of this site.

Lizard Branch a tributary of the south prong of the Alafia River.

Three native species of fish were collected at this reclaimed site: eastern mosquitofish (*Gambusia holbrooki*), sailfin molly (*Poecilia latipinna*), least killifish (*Heterandria formosa*). One exotic species, the brown hoplo (*Hoplosternum litterale*) was also collected

Lizard Branch Habitats

Trib-A a tributary to the south prong of the Alafia River.

Trib-A is a large semi-linear marsh system with a slow flowing, diffuse central stream area. Five species of fishes in two fish families were collected in the marsh system. At the down stream end, several ponds were present, one of which flowed into the unmined forested stream system. The pond area had eight species in four fish families. The natural stream had twelve species representing five fish families.

Table 2.

FISH SPECIES			Trib-A Reclaimed		Trib-A Unmined
			Marsh stream	Pond Outflow	
Yellow bullhead	*Ameiurus*	*natalis*			1
Pygmy sunfish	*Elassoma*	*sp*			1
Lake chubsucker	*Erimyzon*	*sucetta*		1	
Golden killifish	*Fundulus*	*chrysotus*	1		1
Seminole killifish	*Fundulus*	*seminolis*			1
Eastern mosquitofish	*Gambusia*	*holbrooki*	1	1	1
Least killifish	*Heterandria*	*formosa*	1	1	1
Flagfish	*Jordanella*	*floridae*		1	1
Bluegill	*Lepomis*	*macrochirus*		1	1
Redear	*Lepomis*	*microlophus*		1	
Spotted sunfish	*Lepomis*	*punctatus*			1
Bluefin killifish	*Lucania*	*goodei*	1		
Largemouth bass	*Micropterus*	*salmoides*			1
Golden shiner	*Notemigonus*	*crysoleucas*		1	
Coastal shiner	*Notropis*	*petersoni*			1
Sailfin molly	*Poecilia*	*latipinna*	1	1	1
	Native Total		5	8	12

Trib-A, reclaimed at top, natural stream below

Two other reclaimed stream sites were visited, but no fish samples collected. Photographs of these sites are provided.

Tadpole a tributary of the southern prong of the Alafia River.

No fish were seen in the reclaimed portion. At the downstream end, fish were present where the reclaimed stream connect to a long ditch.

Pickle a tributary of the southern prong of the Alafia River.

Sailfin mollies (*Poecilia latipinna*) and eastern mosquitofish (*Gambusia holbrooki*) were visible in the downstream portion of the stream.

Figure 2.
Locations of Pickle and Tadpole Stream Sites.

Tadpole Habitats, lower right ditched section, others on reclaimed wetlands in stream section.

Pickle Stream Habitats

DISCUSSION

None of the reclaimed streams has the number of species which might be expected for healthy natural streams. All these stream support zero to five species, which is a clearly simplified number of fish species. Trib-A is an example of the species gradient from the unmined stream into the reclaimed stream. However, some caution is needed since the recreated stream is a marsh system rather than a forested system. The Trib A complex accounted for most of the native species (Table 2). Dogleg Branch, an old site, is forested throughout the reclaimed stream with four species in the reclaimed stream and six species in the unmined stream.

The Alafia River has had a combination of 36 species of fishes reported in the literature and in museum material. Seventeen of these native species were found or presumed present cumulatively in the unmined downstream segments below reclaimed streams (Table 3). Twelve native species as a subset of the 17 species were found in reclaimed streams and flow through ponds. These species generally correspond to the species with a wide range of habitats, sometimes called generalists.

Nineteen native fishes were found living in first order streams on Ona (Table 3). The pattern of loss of species for reclaimed streams on Ona is not expected to be different than found in the Alafia watershed because all of the native fish species found in these small streams are expected to be identical or nearly so.

Carter (2003, fig 5) reported pH values for native soils were more acidic by 1-3 pH units than the reclaimed soil conditions. It may be reasonable to expect that the pH values in reclaimed streams were and are higher than in the original stream. Data in Janicki (2003) support this hypothosis. The lack of soil horizons A, B and C may affect stream water quality and certainly stream sediment conditions. Some Florida fishes have clear preferences for different pH ranges (Dunson, 2003 and papers cited therein).

The entire stream of Hall's Branch was filled with iron bacteria. Water quality data (Janicki, 2003) showed that Hall's Branch was impaired, functions of the watershed landscape characteristics. The pH of the adjacent fill material (Carter, 2003) and types of material used in reclamation may play important roles affecting water quality and stream bed habitats resulting in the exclusion all fishes from this stream.

Water quality data presented by Janicki (2003) showed that Jamerson Jr. was also impaired. This reclaimed stream had just one native species, a few juvenile yellow bullheads (*Amiurus natalis*) and a few specimens of the exotic oriental weatherfish (*Misgurnus anguillicaudatus*). One other species, the eastern mosquitofish (*Gambusia holbrooki*) was collected in the unmined downstream portion of this stream. Significant chronic effects were found for the number of young (neonates) carried per female of the water flea,*Ceriodaphnia dubia*, a crustacean, for Jamerson Jr. (Janicki, 2003).

Lizard Branch water had significant chronic effects for the number of water flea neonates. Only

three native species, all members of the live-bearing family Poeciliidae were present in the reclaimed stream. These fish do not lay eggs in water, but rather juveniles are born to fend for themselves. Poeciliids avoid most of the environmental effects of having the eggs and larvae affected by physical and chemical conditions. A few juveniles of the exotic fish, the brown hoplo (*Hoplosternum litterale*) were found.

Table 3.

Summary Comparisions for Reclaimed and Unmined Streams in the Alafia Watershed and Ona 1st order streams

Common name	Genus	species	Alafia River Watershed	Reclaimed streams	Unmined Portion*	Ona 1st order streams
white catfish	*Ameiurus*	*catus*	1	0	0	0
yellow bullhead	*Ameiurus*	*natalis*	1	1	1	1
brown bullhead	*Ameiurus*	*nebulosus*	1	0	0	0
bowfin	*Amia*	*calva*	1	0	0	1
American eel	*Anguilla*	*rostrata*	1	0	0	0
pirate perch	*Aphredoderus*	*sayanus*	1	0	1	0
pygmy sunfish	*Elassoma*	*sp.*		0	1	0
Everglades pygmy sunfish	*Elassoma*	*evergladei*	1	0	0	1
bluespotted sunfish	*Enneacanthus*	*gloriosus*	1	0	0	0
lake chubsucker	*Erimyzon*	*sucetta*	1	1	1	1
swamp darter	*Etheostoma*	*fusiforme*	1	0	0	1
golden topminnow	*Fundulus*	*chrysotus*	1	1	1	1
lined topminnow	*Fundulus*	*lineolatus*	1	0	0	0
banded topminnow	*Fundulus*	*rubrifrons*	1	0	0	0
Seminole killifish	*Fundulus*	*seminolis*	1	0	1	0
eastern mosquitofish	*Gambusia*	*holbrooki*	1	1	1	1
least killifish	*Heterandria*	*formosa*	1	1	0	1
flagfish	*Jordanella*	*floridae*	1	1	1	1
brook silverside	*Labidesthes*	*sicculus*	1	0	0	1
Florida gar	*Lepisosteus*	*platyrhincus*	1	0	0	1

Common name	Genus	species	Alafia River Watershed	Reclaimed streams	Unmined Portion*	Ona 1st order streams
redbreast sunfish	*Lepomis*	*auritus*	1	0	0	0
warmouth	*Lepomis*	*gulosus*	1	1	1	1
bluegill	*Lepomis*	*macrochirus*	1	1	1	1
dollar sunfish	*Lepomis*	*marginatus*	1	0	0	1
redear sunfish	*Lepomis*	*microlophus*	1	1	1	1
spotted sunfish	*Lepomis*	*punctatus*	1	0	1	1
bluefin killifish	*Lucania*	*goodei*	1	1	1	0
largemouth bass	*Micropterus*	*salmoides*	1	0	1	1
golden shiner	*Notemigonus*	*crysoleucas*	1	1	1	1
ironcolor shiner	*Notropis*	*chalybaeus*	1	0	0	0
redeye shiner	*Notropis*	*harperi*	1	0	0	0
coastal shiner	*Notropis*	*petersoni*	1	0	1	0
tadpole madtom	*Noturus*	*gyrinus*	1	0	0	0
sailfin molly	*Poecilia*	*latipinna*	1	1	1	1
black crappie	*Pomoxis*	*nigromaculatus*	1	0	0	0
sailfin shiner	*Pteronotropis*	*hypselopterus*	1	0	0	0
hogchoker	*Trinectes*	*maculatus*	1	0	0	0
	Native species		36	12	17	19
	Non-native species					
walking catfish	*Clarias*	*batrachus*	1	0	0	1
brown hoplo	*Hoplosternum*	*litterale*	1	1	1	1
oriental weatherfish	*Misgurnus*	*anguillicaudatus*	1	1	1	1
	Total species		39	16	19	22

* Any species found in the upstream reclaimed area must be somewhere in the unmined downstream area even if not collected.

CONCLUSIONS

1. None of the reclaimed streams were providing a stable range of habitats to allow fish species to reach the number of fish species observed in natural streams unaffected by phosphate mining.

2. There are no objective measures to judge successful reclamation of a stream for fishes set up by the Florida Department of Environmental Protection or the Florida Fish and Wildlife Conservation Commission.

3. As long as reclaimed streams are subject to the standards of past mining permits, the number of fish species in affected watersheds may decrease from 50-100%. First order and second order streams as proposed to be reclaimed after mining on Ona will suffer very significant loss of native species.

4. The reclamation standards in FAC 62C-16.0051 are not being meet with the present stream reclamation technology.

5. The Basis of Review for ERP Applications for Southwest Florida Water Management District permits was adopted by reference for the ERP Application for permits from the Florida Department of Environmental Protection. Standards for fishes, section 3.2.2, and 3.2.3 are not being meet with the present reclamation technology. Reasonable assurance is not being met.

LITERATURE

Carter, L. 2003. Comparative analysis of reclaimed IMC soils and native soils of proposed Ona mine site. Polston Engineering, Sebring Fl., 4pp. 5 figs.

Dunson. W. A. The adverse impacts of changes in water quality and hydroperiod on aquatic ecology of the Ona mine watershed. 6 pp., 3 figs.

FDEP 1999. Ecological assessment of reclaimed streams, Hillsborough, Hardee & Polk Counties. Bureau of Laboratories, Division of Administrative and Technical Services. 7pps, 3 figs. var. tabs.

FDEP 2000. Ecological assessment of reclaimed streams, Polk, Hillsborough & Hardee Counties. Bureau of Laboratories, Division of Administrative and Technical Services. 9pps, 7 figs.

Janicki, A. 2003. Water quality in streams reclaimed after mining. Janicki Environmental, Inc. 8 pp. 4 tabs.