Recovery of a Midwest Stream Following an Ammonia Spill

Benjamin Batten
Department of Natural Resources and Environmental Sciences
University of Illinois Urbana-Champaign
16 May 2004

INTRODUCTION

Ecological disturbances have a great affect on fish community assemblages. One example of such a disturbance is an ammonia spill occurred recently in Champaign

County, Illinois. On July 11th, 2002, there was a large release of ammonia into the Saline Branch Drainage Ditch (Bloomer 2002). The ammonia originally came from cleaning materials used at the Abbott power plant located on the campus of the University of Illinois at Urbana-Champaign. The ammonia then came through the system and ended up at the sanitary district's wastewater plant. The plant was not prepared to handle this large dose of ammonia entering at such a rapid rate, and consequently it entered the Saline Branch. The ammonia affected a 10-mile stretch of waterway, including the Saline Branch as well as the Salt Fork River, and was at a dosage 10 times larger than what the sanitary district was prepared to handle.

Because the fish community was widely affected, employees of the Illinois Department of Natural Resources (IDNR) assessed the damage done to the fish community. In order to assess this damage, the IDNR group sampled several sites on the Saline and Salt Fork, and used these results to estimate the extent of the fish kill. The total number of dead fish was estimated to be 80,000. Of these fish, 40,000 were cyprinids (minnows), 17,000 were catostomids (suckers), 16,000 were perciformes (darters), 4,500 were centrarchids (sunfish) excluding *Micropterus dolomieu*, 2,500 were *Micropterus dolomieu* (smallmouth bass) and the remainder were various unidentified species (Bloomer 2002). Before this, the Saline Branch had been considered a valuable smallmouth stream (Larimore 2002).

When a stream is disturbed, and the community structure is damaged, the fish must eventually recolonize in order to attain the original community. While this is a widely studied topic, very little is actually known about the process (Reise et al. 1990). According to Olmsted (1974), "Without an understanding of the processes involved in

repopulation, the significance of a fish kill is difficult to ascertain." The rate at which recolonization occurs depends on many factors, such as geography, changes in water quality, etc. In addition to this, different species come back at different rates. Species with a larger tolerance range for degraded habitat and water quality should re-populate the steam more quickly than those which require more pristine habitats. More mobile fish are also more likely to reappear sooner than less mobile fish (Gunning and Berra 1968). Extensive data must be collected on population density, previous community structure, and recolonization rates before a plan for rehabilitation of the stream is formed (Ensign and Leftwich, 01997). The goal of this research is to assess the damage to and repopulation of the Saline Branch following this ammonia spill.

METHODS

Study Sites

The Saline Branch drainage ditch is a tributary of the Salt Fork River (Wabash River Drainage) and is located in Champaign County, Illinois. This 9-mile stretch of stream is a third order stream which is part of the Vermilion/Wabash Drainage. It runs through Urbana, and then east where it drains into the Salt Fork of the Vermilion River. It is rated as a class "B" stream (Highly Valued Aquatic Resource) (Page et al. 1992). No Threatened and Endangered species are located in the stream, however, there are state endangered bluebreast darters (*Etheostoma camurum*) and bigeye chub (*Hybopsis amblops*) found within the drainage in the Vermilion river system as well as state threatened river redhorse (*Moxostoma carinatum)* and eastern sand darters (*Ammocrypta*

pellucidum). Three sample sites were chosen in relation to the fish kill and a survey by R. W. Larimore in 1999.

All three sites are relatively similar in that they are found at bridges and contain similar bed material and riffle/pool structure. Site 1 is located 1.5 miles north of Mayview at the 1900 N bridge. Site 2 is found three miles northeast of Urbana at the bridge on High Cross Road. Site 3 is a bridge found two miles north-east of Urbana on Perkins Road. Sites 1 and 2 directly correspond to Larimore's 1999 survey, and site 3 is a separate site located about 2 miles east of Dr. Larimore's 3rd site.

Landuse at the sites is mainly agricultural, but upstream the landuse is urban. Problems in the drainage which all apply to the specific sites are domestic sewage, siltation, and dredging (Page et al. 1992).

Collections

All collections were made using some combination of a 0.5 cm mesh minnow seine and a backpack shocker. Table one summarizes dates of sampling as well as techniques employed.

Table 1: Date and Collection Methods for Three Sites on the Saline Branch Drainage Ditch

Site Number	Date sampled	Collection methods
1	27-Oct-02	Minnow seine
2	31-Oct-02	Minnow seine
3	31-Oct-02	Minnow seine
1	15-May-03	Backpack shocker and minnow seine
2	15-May-03	Backpack shocker and minnow seine
3	15-May-03	Backpack shocker and minnow seine
1	16-Aug-03	Backpack shocker and minnow seine
2	16-Aug-03	Backpack shocker and minnow seine
3	16-Aug-03	Backpack shocker and minnow seine
1	28-Feb-04	Backpack shocker and minnow seine
2	28-Feb-04	Backpack shocker and minnow seine
3	28-Feb-04	Backpack shocker and minnow seine

At each site, an effort was made to sample each microhabitat type (run, riffle, and pool). Collection times were between 30 and fifty minutes devoted to each sampling type at each site. The sample area included the areas found up to 150m above and below each of the three bridges for a total of 300m of survey area at each site. The aim of the sampling was to catch one specimen of each species present at each site. To do species were collected. The study was designed to consider presence/absence of species and not their abundance.

Data tables were created based on species present at the sites by date. These fish were identified using Smith (1979) and Page and Burr (1991). Preserved vouchers were returned to the INHS fish collection for identification and eventual deposit into the collection. Larger specimens or visual vouchers were documented in the field.

Data

Total species numbers are compared for collections made by the author, Dr. R. W. Larimore, and the IDNR. Dr. Larimore's information comes from the INHS fish collection database. The raw collection data for the IDNR was given to the author by IDNR aquatic ecologist Gary Lutterbie.

RESULTS

A total of 29, 32, and 29 species were collected by the surveys of Dr. Larimore, IDNR, and Batten (Table 2). The expanded data series including individual catch at each site for both the author and Dr. Larimore can be found in Appendices 1 and 2.

Table 2: Total species counts for 3 surveys made on the Saline Branch Drainage Ditch

Collector	Dates collected	Total Species number
R. W. Larimore	Jul-99	29
IDNR	Aug-02	32
Batten	October 2002 - February 2004	29

According to results of the survey (Appendix 2) species richness increased with time. This can be seen by the composition of the community throughout the sampling period. Fishes considered less tolerant to pollution became more abundant as the surveys continued. My results from three months after the spill found 12 species, and my second collection taken 10 months after the spill found 21 species, the highest abundance of any of my samples.

Overall, the five most common species were rosyface shiner (*Notropis rubellus*), white sucker (*Catostomus commersoni*), northern hogsucker (*Hypentelium nigricans*), striped shiner (*Luxilus chrysocephalus*), and longear sunfish (*Lepomis megalotis*). Of these species, all of them are considered relatively intolerant species except for the rosyface shiner (Retzer, Personal Communication). The rosyface shiner was the most common of all the species found at the sign, and was caught at every site for each sample date.

Darters were found at all three sites after one year, including the greensided darter (*Etheostoma blennioides*) and rainbow darter (*Etheostoma caeruleum*). Rainbow darters are considered indicators of good water quality due to their low tolerance to pollution

(Paulson and Hatch, 2002). Rainbow darters occurred at all three study sites after 18 months.

DISCUSSION

As one can see from the results section, the data for the three different samples was very similar and seemed to show that the stream was very able to bounce back to its original composition. This included both tolerant species such as the white sucker and different centrarchids as well as rather intolerant species such as the darters and the rosyface shiner (Retzer, Personal Communication, 2004). Our total species numbers were relatively similar, with IDNR having slightly more species than Dr. Larimore and the author. Historically, there have been 46 different total species collected on the Saline Branch Drainage Ditch, which can be viewed in Appendix 3.

Species richness seemed to increase with time, as shown by the community composition throughout the sampling period. Throughout the survey, the Cyprinid community seemed to stay relatively consistent, as did the Catostomid community. The Ictalurid, Centrarchid, and Percid communities showed increases in diversity over time.

Ictalurids were completely absent from the original sampling period three months after the contamination incident. Starting from the 10 month period on, yellow bullhead (*Ameiurus natalis*) became common. Tadpole madtom (*Noturus gyrinus*) was recorded on this same date, but was not collected again. One reason for this increase in abundance of Ictalurids could be the addition of the backpack shocker as a collection method. Many of the *Ameiurus* specimens were collected as a result of electrofishing.

The Centrarchids tell a better story of species richness increase. Longear sunfish (*Lepomis megalotis*) were common in the stream throughout the entire study period. As time went on, more Centrarchid species were found including rock bass (*Amboplites rupestris*), green sunfish (*Lepomis cyanellus*), bluegill (*Lepomis macrochirus*), and all three of the temperate black bass species, largemouth (*Micropterus salmoides*), smallmouth (*Micropterus dolomieu*), and spotted (*Micropterus punctulatus*). This increase of diversity is an indicator that species richness has increased.

The Percids also display an increase. No darters were found for the first year, but after this point, both the greenside darter (*Etheostoma blennioides*) and rainbow darter (*Etheostoma caeruleum*). As was mentioned, the darters are often seen as an indicator of high quality habitat, and good water quality, so the increase in darter presence is a positive sign.

There are many factors governing recovery time of a community from a disturbance such as a pollution event. In this case, two main factors which played an important role are the surrounding tributary system within the drainage, and the extent of the pollution event. The number and closeness of tributaries must play a large role in the recovery of a fish population. The saline branch has a total of 10 first-order streams and 3 second-order streams located upstream of the site of the spill. Downstream of the spill there are numerous streams of varying order associated with the Salt Fork Vermilion River system. Because of this vast network of streams, there are many opportunities for species to reappear following a disturbance.

The next factor is the extent of the spill. In this case, it is thought that most likely the majority of the ammonia present traveled along the main course of the Saline, and

down into the Salt Fork. As the ammonia moved downstream, it stayed in the middle, mostly affecting large fish which could not reach shallower water, as well as smaller fish who were not able to get near the mostly unaffected shallower reaches (Retzer, Personal Communication, 2004). All the while that it is moving downstream, it is also dissipating, until after a certain amount of distance, it has no effect.

ACKNOWLEDGEMENTS

I would like to acknowledge the following people and groups for supporting my work on this project. Dr. Michael Retzer, INHS Ichthyologist, for guidance, support, and editing. The R. Weldon Larimore memorial grant for funding the research. The INHS for allowing me to use equipment and a vehicle associated with the project. IDNR aquatic ecologist Gary Lutterbie for cooperation with data and guidance. John Warner, Doug Zobrist, Clint Kohlmeier, and Patrick Hodina for sampling assistance.

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Appendix 1: Results for Dr. Larimore's survey July 13th, 1999

Family/Species	Site 1	Site 2	Site 3	Total
Cyprinidae				
Campostoma anomalum	4	9		13
Cyprinella spiloptera	12	26	3	41
Ericymba buccata	10	2	2	14
Luxilus chrysocephalus	9	10		19
Nocomis biguttatus	5	11		16
Notemigonus crysoleucas	1		1	2
Notropis ludibundus	10	40	2	52
Notropis rubellus	5	51	7	63
Pimephales notatus	10	12	3	25
Pimephales promelas			1	1
Semotilus atromaculatus	1		3	4
Catostomidae				
Catostomus commersoni		1	3	4
Hypentelium nigricans	1	2	10	13
Minytrema melanops		2		2
Ictaluridae				
Ameiurus natalis			1	1
Noturus flavus	2		3	5
Noturus gyrinus	4	2		6
Noturus miurus	1			1

Fundulidae				
Fundulus notatus	2			2
Centrarchidae				
Ambloplites rupestris			1	1
Lepomis cyanellus	1	1		2
Lepomis macrochirus	3	1		4
Lepomis megalotis	2	4	2	8
Micropterus dolomieu			1	1
Micropterus salmoides			5	5
Percidae				
Etheostoma blennioides	5	2	9	16
Etheostoma nigrum			16	16
Percina caprodes	1			1
Percina phoxocephala	4	5		9
Total number of species	21	17	17	29

Appendix 2: Collection Results from Saline Branch Survey October 2002 – February 2004

Family/Species	Site 1	Site 2	Site 3	10/27/02	Site 1	Site 2	Site 3	5/15/03
Cyprinidae								
Campostoma anomalum	1			**1**	1		1	**2**
Cyprinella spiloptera	1	1	1	**3**		1		**1**
Cyprinella whipplei							1	**1**
Ericymba buccata	1		1	**2**			1	**1**
Luxilus chrysocephalus	1	2	1	**4**	1	1	1	**3**
Lythrurus umbratilis	1			**1**				
Nocomis biguttatus		1		**1**			1	**1**
Notropis ludibundus	1			**1**	2			**2**
Notropis rubellus	1	1	1	**3**	1		7	**8**
Pimephales notatus	1		1	**2**	1	1		**2**
Semotilus atromaculatus					1			**1**
Catostomidae								
Catostomus commersoni	1	1	1	**3**	1	1	1	**3**
Erimyzon oblongus					1			**1**
Hypentelium nigricans	1	1	1	**3**	1	1	1	**3**
Minytrema melanops						1		**1**
Moxostoma erythrurum								
Ictaluridae								
Ameiurus natalis							1	**1**

Noturus gyrinus					1			**1**
Fundulidae								
Fundulus notatus					1			**1**
Centrarchidae								
Ambloplites rupestris							1	**1**
Lepomis cyanellus							1	**1**
Lepomis macrochirus								
Lepomis megalotis			1	**1**	1	2		**3**
Micropterus dolomieu					1			**1**
Micropterus punculatus								
Micropterus salmoides								
Percidae								
Etheostoma blennioides								
Etheostoma caeruleum								
Total number of species	10	6	8	**12**	13	7	11	**21**

Appendix 2: Collection Results from Saline Branch Survey October 2002 – February 2004 Continued

Site 1	Site 2	Site 3	8/16/03	Site 1	Site 2	Site 3	2/28/04	Overall
				2			**2**	**5**
1	1	1	**3**	1			**1**	**8**
								1
1			**1**	1	1		**2**	**6**
1	1		**2**	1		1	**2**	**11**
						1	**1**	**2**
				1			**1**	**3**
1			**1**	1			**1**	**5**
1	1		**2**	1	1		**2**	**15**
				1			**1**	**5**
1								**1**
			1					**1**
1	1	1	**3**	1	1	1	**3**	**12**
								1
1	1	1	**3**	1	1	1	**3**	**12**
								1
					1		**1**	**1**
2	1	1	**4**	1		1	**2**	**7**

								1
								1
								1
1			**1**					**2**
1	1		**2**		1		**1**	**2**
	2	1	**3**	1	1	1	**3**	**10**
								1
				1			**1**	**1**
1			**1**					**1**
1		1	**2**	1	1	1	**3**	**5**
				1	1	1	**3**	**3**
13	8	6	**14**	15	9	8	**18**	**29**

Appendix 3: Species List for Saline Branch Drainage Ditch – Based on Vouchered Specimens in the INHS Fish Collection

INHS Fish Collection Species List

This printout is provided with the understanding that the Illinois Natural History Survey (INHS) is acknowledged in any publications, reports, etc. resulting from the use of the data.

Clupeidae

- *Dorosoma cepedianum* - gizzard sha

Cyprinidae

- *Campostoma anomalum* - central stonerolle
- *Campostoma oligolepis* -
- *Cyprinella spiloptera* - spotfin shine
- *Cyprinella whipplei* - steelcolored shine
- *Cyprinus carpio* - common carp II
- *Ericymba buccata* - silverjaw minnow
- *Luxilus chrysocephalus* - striped shine
- *Lythrurus umbratilis* - redfin shine
- *Nocomis biguttatus* - hornyhead chu
- *Notemigonus crysoleucas* - golden shine
- *Notropis ludibundus* - sand shine
- *Notropis rubellus* - rosyface shine
- *Phenacobius mirabilis* - suckermouth minnow
- *Pimephales notatus* - bluntnose minnow
- *Pimephales promelas* - fathead minnow
- *Semotilus atromaculatus* - creek chub

Catostomidae

- *Carpiodes cyprinus* - quillback
- *Catostomus commersoni* - white sucker
- *Erimyzon oblongus* - creek chubsucke
- *Hypentelium nigricans* - northern hog sucke
- *Minytrema melanops* - spotted sucke
- *Moxostoma erythrurum* - golden redhors
- *Moxostoma macrolepidotum* - shorthead redhor

Ictaluridae

- *Ameiurus melas* - black bullhead
- *Ameiurus natalis* - yellow bullhead
- *Noturus flavus* - stoneca
- *Noturus gyrinus* - tadpole madtom
- *Noturus miurus* - brindled madtom

Esocidae

- *Esox americanus* - grass pickere

Atherinidae

- *Labidesthes sicculus* - brook silversid

Fundulidae

- *Fundulus notatus* - blackstripe topminnow

Poeciliidae

- *Poecilia reticulata* - guppy I

Centrarchidae

- *Ambloplites rupestris* - rock bass
- *Lepomis cyanellus* - green sunfish
- *Lepomis macrochirus* - bluegill
- *Lepomis megalotis* - longear sunfish
- *Micropterus dolomieu* - smallmouth bass
- *Micropterus punctulatus* - spotted bas
- *Micropterus salmoides* - largemouth bass

Percidae

- *Etheostoma blennioides* - greenside dart
- *Etheostoma caeruleum* - rainbow darte
- *Etheostoma nigrum* - johnny darte
- *Etheostoma spectabile* - orangethroat dart
- *Percina caprodes* - logperch
- *Percina maculata* - blackside darte
- *Percina phoxocephala* - slenderhead dart

14 May 2004