Fish, amphibian and aquatic macroinvertebrate diversity in the two Olentangy River wetlands - Spring 1999

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Introduction

Freshwater marshes are an important shallow water habitat for many different species of upland and aquatic animals. These systems are capable of supporting a diversity of invertebrate and fish species at specific times of the year, and are often used for spawning and rearing of young of year (YOY) fish (Mitsch and Gosselink, 1993; Eggers and Reed, 1997). In certain wetlands fish are able to immigrate and emigrate when necessary to avoid undesirable temperatures, turbidity and dissolved oxygen (DO) levels (Metzker and Mitsch, 1997). In the two wetlands (ORW 1 and 2) at the Olentangy River Wetland Research Park (ORWRP), the majority of the initial fish recruitment into the wetlands was through a pump system that originates from the Olentangy River (Gardner and Johnson, 1997). There are two styles of pumps used in the wetlands, one is a conventional pump, and the other is a secondary pump (Discflo™). The Discflo™ pump allows the passage of fish and invertebrates into the wetlands, which makes the wetlands mainly a one-way exchange with the river (Gutrich et al. 1997).

Green sunfish, *Lepomis cyanellus* and fathead minnows, *Pimephales promelas* are becoming the most abundant fish species sampled in the ORWRP wetlands (Gutrich et al., 1997; Cochran, 1998; Hensler and Cochran, 1999). Green sunfish are readily found in low-to-moderate gradient streams and are more tolerant of turbidity than other *Lepomis* spp. (Trautman, 1981). Fathead minnows have an extensive geographical range in North America (Burton, 1991; DeWitt, 1993) and are known to be an abundant fish in the Midwest's freshwater marshes (Duffy, 1998; Noraker et al., 1999). Fathead minnows also have a high fecundity rate (Gale and Buynak, 1982) and average a short life history of about one year (Duffy, 1998).

The use of mark-recapture methods are very popular for estimating fish population sizes. In this study we used the Schnabel multiple-census population estimate to calculate the green sunfish and the fathead minnow populations as described in Kohler and Hubert (1993). There are certain assumptions with each population estimate: 1) all fish (marked or unmarked) in the population are subject to capture; 2) all fish are vulnerable to capture over the length of the study; 3) there are no additions or losses in the population; and 4) fish must retain there marks for the duration of the study (Kohler and Hubert, 1993; Noraker et al., 1999).

Aquatic macroinvertebrates are an important component to understanding one of the many functions of a wetland. Commonly used as a biological water quality indicator in many systems (Wallace et al., 1996), aquatic invertebrates can indicate if a system is environmentally sound or habitat is need of improvement in water quality. Temporal, and other environmental constraints can have considerable effects on the life cycles of aquatic insects (Williams, 1996). This is the second year of sampling the aquatic insects and another sampling device was used to collect the invertebrates. Selecting a representative sampling device can be the key to obtaining an accurate sample of the aquatic invertebrate community. As summarized in Turner and Trexler (1997), the dip net and funnel trap were the best all around samplers for benthic invertebrates.

Methods

In this study the fish, amphibians and the aquatic macroinvertebrate communities were sampled in W1 and W2 from April 2, 1999 to May 6, 1999. On April 2, six Hester-Dendy (HD) multiple plate samplers were set, three in each wetland (Figure 1). On April 8, a total of 18 minnow traps were set, nine in each wetland and on April 10, six emergence traps (ET) were placed in the two wetlands (Figure 1). These sites were not chosen at random but followed the locations in studies done by Spieles (1998), Cochran (1998) and Hensler and Cochran (1999) respectively. These sites were selected to standardize this and future studies in the ORWRP wetlands.

The fish community was sampled using nine minnow traps in each wetland. The minnow traps that were used are described in Cochran (1998). The minnow traps were set for 28 days and checked three times each week on the same days to standardize the study. Each of the minnow traps were attached to the boardwalk with monofilament line and flagged for easy retrieval. Upon capture each fish was given a partial left pectoral fin clip. Fish were not measured or weighed in this study; the primary interest was estimating the populations of green sunfish and the fathead minnow in W1 and W2. Other fish species caught were recorded, but were not given a fin clip for population estimates.

Fish were sampled in an efficient manner so as not to keep them out of the water for a long period of time. A five-gallon bucket was filled with fresh water upon reaching

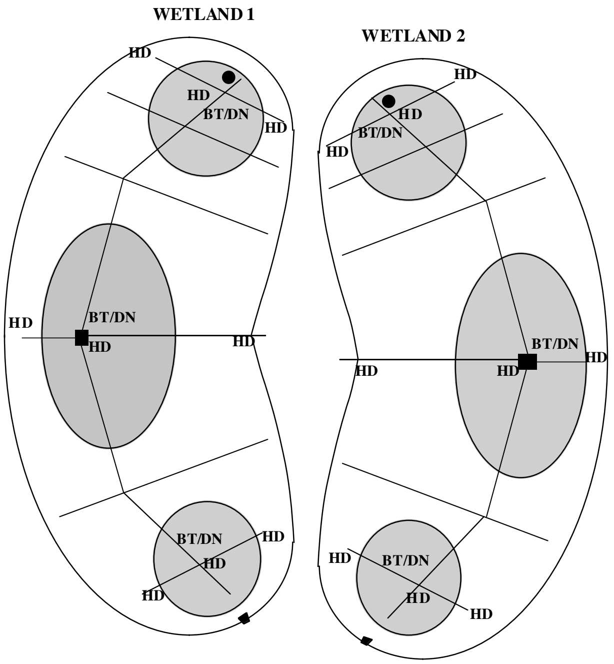

Figure 1. Sampling sites in the two wetlands at the Olentangy River Wetland Research Park (ORWRP) using the minnow traps, Hester-Dendy (HD) and emergence traps (ET).

each wetland. The fish were taken from the traps and placed in the bucket. The fish were then handled with a small minnow net and given a fin clip using scissors. Each fish was identified, examined for marks, marked if needed, recorded and then returned to the wetland. These fish were not released in close proximity to the minnow traps in order to prevent immediate recapture; however they were released in the general area of capture (i.e. fish caught in the inflow area were released near the inflow and not in the outflow area, etc.).

Bullfrog tadpoles, *Rana catesbeiana* were collected using the same minnow traps that were used for sampling the fish. The tadpoles collected were not marked for any population estimates; after sampling, they were quickly enumerated and released. No sampling effort was made to collect any adult bullfrogs during this study. Throughout the study numerous tadpoles were seen in the shallow areas.

The macroinvertebrates were sampled using Hester-Dendy colonization plates and emergence traps. Each Hester-Dendy colonization plate measured 8 x 8 x 8cm and was made from tempered hardboard (Peckarsky, 1984). These traps were tied to the boardwalk with monofilament line and flagged for a later retrieval. The Hester-Dendy plates were left submerged and undisturbed for 34 days and were retrieved using the same method as described in Custer and Johnson (1999). After the traps were retrieved they were placed in cans filled with a 70% ethyl alcohol solution for sorting and identifying at a later time in the lab.

The emergence traps were made from galvanized metal vine stakes and covered with a fine mesh screen. Inside each trap, a funnel attached to a glass jar hung freely from the top to collect the adult insects as they emerged. Each emergence trap was checked once each week for the duration of the study. These jars were filled with a 70% ethyl alcohol solution and were replaced with a new glass jar and alcohol solution after each jar was sampled. The invertebrates from both the Hester-Dendy and emergence traps were taken to the lab and identified with stereo microscopes. All of the invertebrates collected from both the Hester-Dendy and emergence traps were identified to genus when possible, using the keys in Merritt and Cummins (1996) and Emerson and Jacobson (1976), so the calculations used will be based on this taxonomic level.

In this paper, population estimates are calculated for green sunfish and flathead minnow and the amphibian and aquatic macroinvertebrate diversity are reported for the two wetlands. A *t*-test is used to determine if there were any significant differences between W1 and W2 for both the fish and the macroinvertebrate communities. A *t*-test will also be used to test for any significant differences between the Hester-Dendy catches in the previous study by Custer and Johnson (1999) and this study. Hill's diversity numbers N^1 and N^2 and the modified Hill's ratio E_5 will also be used to measure the macroinvertebrate diversity and evenness (Ludwig and Reynolds, 1988). Aill's diversity N^1 is a measure of very abundant species in a community and is the reciprical of Simpsons index ($1/\lambda$). Itills diversity N^2 is a measure of abundant species and is calculated using Shannon index (A') as an example of the natural log number ($e^{H'}$). The evenness ratio E_5 is N^2/N^1. As the number of very abundant species measures to the limit imposed by the number of abundant species, the ratio approaches its limit of 1 and represents excellent evenness. As the number of very abundant species decline relative to the number of abundant species, E declines indicating poor evenness.

Results and Discussion

In recent years fish species richness has ranged from as high as nine (Gardner and Johnson,1996) to as low as one (Gutrich et al., 1997) with experimental wetlands. The spring study performed by Cochran (1998) and this study were carried out during the same season approximately one year apart. The fish species richness in W1 decreased from six species (green sunfish, bluegill, *L. macrochirus,* pumpkinseed, *L. gibbosus,* fathead minnow, creek chub, *Semotilus atromaculatus* and common carp, *Cyprinus carpio*) in Cochran (1998), to three species in this study(the green sunfish, fathead minnow and bluntnose minnow, *P. notatus*; Table 1). In W2, the fish species richness increased from two species (green sunfish and fathead minnow) in Cochran (1998) to three species in this study (green sunfish, fathead minnow and creek chub; Table 1).

Table 1. Comparison of total number of fish species sampled using minnow traps in the two wetlands.

Sample time	Fish species	W1	W2	Reference
October-1996	Green sunfish	27	30	Gutrich et al., 1997
October-1997	Green sunfish	1294	1903	Cochron, 1998
	Fathead minnow	672	20	
	Bluntnose minnow	3	0	
	Orangespotted sunfish	1	3	
	Common carp	18	3	
May-June 1998	Green sunfish	192	281	Hensler and Cochran, 1998
	Fathead minnow	179	33	
	Common carp	2	0	
	Pumpkinseed	2	0	
	Creek chub	2	0	
October-1998	Green sunfish	12	52	Hensler and Cochran, 1999
	Fathead minnow	0	2	
	Bluegill	0	1	
April-May 1999	Green sunfish	93	13	
	Fathead minnow	69	17	
	Bluntnose minnow	3	0	
	Creek chub	0	2	

In W1, green sunfish catches were slow at the beginning of the study and not until April 24 did fish catches start to increase. Of total of 93 green sunfish caught in W1 (Table 1), only 14 were sampled before April 24. In W2, there only 13 green sunfish caught and five were caught before this date. Fathead minnow catches were higher in W1 with 69 and 17 were caught in W2 (Table 1).

In W1, the green sunfish population was estimated at 215 (95% CI 142-435). A population estimate could not be calculated for ORW 2 because no marked green sunfish were recaptured. As reported by Hensler and Cochran (1999) they estimated the population of green sunfish to be 51 in W1 and 150 in W2. The fathead minnow populations were estimated to be 12 (95% CI 10-18) and to be 15 (95% CI 8-111) in W1 and W2, respectively. No literature could be found on any other studies performed in ORWRP that have estimated populations of fathead minnows. A two-sample *t*-test indicated that there was a significant difference in the total number of fish caught between W1 and W2 ($p=0.001$). Significant differences were also found in the number of green sunfish ($p=0.01$) and fathead minnows ($p=0.006$) caught in W1 and W2.

In W1, 305 individuals were sampled and in W2, 236 individuals were sampled in April - May 1999. Cochran (1998) collected 46 tadpoles in both wetlands in May-June, and October, 1997. Hensler and Cochran (1999) found a total of 503 tadpoles in the two wetlands in 1998. In comparison with previous years bullfrog tadpole number appear to be increasing. Because no marks were made on the tadpoles there was no way of determining if the same tadpoles were being caught at each sample time. This increase may be because of the absence of predator fish in samples, such as the largemouth bass, *Micropterus salmoides* (Gutrich et al., 1997; Cochran, 1998; Hensler and Cochran, 1999).

Macroinvertebrate community decreased in total numbers caught by the Hester-Dendy plates in both wetlands from 222 in 1998 (Custer and Johnson, 1999) to 167 in this study. The total numbers of invertebrates collected were fairly equal in each wetland. A total of 84 invertebrates were collected in W1 and 83 invertebrates in W2 (Table 2). Total order richness increased in W1 from 6 in Custer and Johnson (1999) to 9 in this study (Figure 2). In W2, order richness increased from 6 in Custer and Johnson (1999) to 8 in this study (Figure 2). The middle areas in both wetlands showed the greatest order diversity and numbers of invertebrates collected which correlates with the data in Hart et al. (1997). The middle areas in this study accounted for 69% of the invertebrates in W1 and 64% in W2 (Figure 3).

The total numbers of adult insects sampled with the emergence traps differed between the two wetlands. In W1, a total of 17 taxa were represented and 70 insects were collected (Table 3). In W2, there were 12 taxa represented

Table 2. Macroinvertebrate taxa sampled with Hester-Dendy plates (HD) in W1 and W2 at the Olentangy River Wetland Research Park.

Site	Class	Order	Family	Genus	W1	W2
Inflow	Crustacea	Amphipoda				1
	Gastropoda	Basommatophora	Lymnaeidae	Lymnea		2
	Gastropoda	Basommatophora	Physidae	Physa		13
	Hirudinea				1	3
	Insecta	Collembola			1	
	Insecta	Diptera	Ceratopogonidae		1	
	Insecta	Odonata	Coenagrionidae	Amphiagron	1	
	Insecta	Odonata	Coenagrionidae	Ischnura	2	
	Insecta	Odonata	Coenagrionidae		1	
	Oligochaeta					3
	Pelecypoda				1	3
Middle	Crustacea	Amphipoda			5	
	Gastropoda	Basommatophora	Lymnaeidae	Lymnea	1	
	Gastropoda	Basommatophora	Physidae	Physa	1	4
	Gastropoda	Basommatophora	Planorbidae	Helisoma	1	
	Hirudinea				1	2
	Insecta	Diptera	Chironomidae		16	31
	Insecta	Diptera	Ceratopogonidae		2	1
	Insecta	Ephemeroptera	Caenidae	Caenis	21	10
	Insecta	Ephemeroptera	Neoephemeridae	Neoephemera	1	
	Insecta	Odonata	Coenagrionidae	Coenagrion	3	
	Insecta	Odonata	Coenagrionidae	Ischnura	3	
	Insecta	Odonata	Libelluilidae	Pachydiplax	1	1
	Oligochaeta					2
	Pelecypoda				2	2
Outflow	Gastropoda	Basommatophora	Lymnaeidae	Lymnea	1	1
	Gastropoda	Basommatophora	Physidae	Physa	1	2
	Hirudinea				2	
	Insecta	Coleoptera	Haliplidae	Peltodytes	4	
	Insecta	Diptera	Chironomidae		1	
	Insecta	Ephemeroptera	Caenidae	Caenis	2	
	Insecta	Odonata	Libellulidae	Tramea		1
	Insecta	Odonata	Libelluilidae	Pachydiplax	7	1

and 27 insects sampled (Table 3). In both wetlands, with the exception of one insect from the order Ephemeroptera in W1, Diptera and Coleoptera were the only orders collected. As reported by Williams (1996), changes in water temperature causes changes in the water density and small changes in water density can affect the life cycles of aquatic insects. Insects from the orders Odonata and Ephemeroptera may have had delayed emergent times because of temperature or other environmental constraints.

The diversity and evenness were calculated for the Hester-Dendy and emergence traps catches in W1 and W2 (Table 6). In W1, the N^2 number for HD was 5.63 and E_5 was 0.82, this suggests that no one taxon is dominating and the diversity is becoming evenly distributed (Table 4). In W2, the N^2 (1.91) and E_5 (0.55) numbers are showing that diversity is starting to approach (1.0) and evenness is low (Table 4). Diversity and evenness for the ET in W1 were 4.76 (N^2) and 0.61(E_5). A low E_5 number (0.61) for the ET in W1 was obtained, however it had the largest number of taxa represented in the sample (N0=16). Diversity and evenness could not be calculated in W2 because of unknown errors in the calculations. Diversity and evenness numbers from the HD samples from Custer and Johnson (1999) are listed for comparison of any trends. A *t*-test was run on HD catches between W1 and W2 and was found no significant difference between the wetlands (p=0.49). A *t*-test was also used to see if there were any significant differences between the HD catches last year in W1 and W2 (Custer and Johnson, 1999) and this study. There was no significance between either W1 (p=0.27), or W2 (p=0.47) in 1998 or 1999.

Conclusions

Neither the Hester-Dendy nor the emergence traps yielded the numbers or diversity in macroinvertebrate

Table 3. Macroinvertebrate taxa sampled with emergence traps (ET) in W1 and W2 at ORWRP.

Site/Day	Class	Order	Family	Genus	W1	W2
Inflow	Insecta	Coleoptera	Hydrophilidae		1	
4/17/99	Insecta	Diptera	Chironomidae	Macropelopiini	3	
Middle	Insecta	Diptera	Chironomidae	Orthocladiini		1
4/17/99	Insecta	Diptera	Chironomidae	Pentaneurini		3
	Insecta	Diptera	Chironomidae	Macropelopiini	2	3
	Insecta	Diptera	Chironomidae			2
Outflow	Insecta	Coleoptera	Haliplidae	Haliplus		1
4/17/99						
Inflow	Insecta	Coleoptera	Staphylinidae	Stenus	1	
4/24/99	Insecta	Diptera	Chironomidae	Chironomini	1	
	Insecta	Diptera	Chironomidae	Orthocladiini	1	
	Insecta	Diptera	Chironomidae	Macropelopiini	18	
Middle	Insecta	Diptera	Chironomidae		2	
4/24/99	Insecta	Diptera	Chironomidae	Macropelopiini	2	
Outflow	Insecta	Diptera	Chironomidae		1	2
4/24/99	Insecta	Coleoptera	Histeridae			1
Inflow	Insecta	Coleoptera	Noteridae	Suphisellus	2	
5/1/99	Insecta	Coleoptera	Staphylinidae	Stenus	1	
	Insecta	Diptera	Ceratopogonidae			1
	Insecta	Diptera	Chaoboridae		2	
	Insecta	Diptera	Chironomidae		4	
	Insecta	Diptera	Chironomidae	Boreochlini	2	1
	Insecta	Diptera	Chironomidae	Orthocladiini		2
	Insecta	Diptera	Dixidae			
Middle	Insecta	Coleoptera	Noteridae	Suphisellus		1
5/1/99	Insecta	Diptera	Chironomidae		2	1
	Insecta	Diptera	Chironomidae	Boreochlini	3	
	Insecta	Diptera	Chironomidae	Diamesini	4	
	Insecta	Diptera	Chironomidae	Macropelopiini	2	
	Insecta	Diptera	Ephydridae		1	
	Insecta	Ephemeroptera			1	
Outflow	Insecta	Coleoptera	Histeridae		1	2
5/1/99	Insecta	Coleoptera	Staphylinidae	Stenus		1
	Insecta	Diptera	Chironomidae			1
	Insecta	Diptera	Chironomidae	Boreochlini		1
	Insecta	Diptera	Chironomidae	Chironomini		1
	Insecta	Diptera	Chironomidae	Diamesini		1
	Insecta	Diptera	Chironomidae	Macropelopiini		
Inflow	Insecta	Diptera	Sciomyzidae		2	
5/6/99					1	
Middle	Insecta	Diptera	Chironomidae		3	
5/6/99	Insecta	Diptera	Chironomidae	Diamesini	2	
Outflow	Insecta	Coleoptera	Histeridae		1	
5/6/99	Insecta	Coleoptera	Staphylinidae		1	
	Insecta	Diptera	Chironomidae	Chironomini		
	Insecta	Diptera	Ceratopogonidae		2	1
	Insecta	Diptera	Dixidae		1	

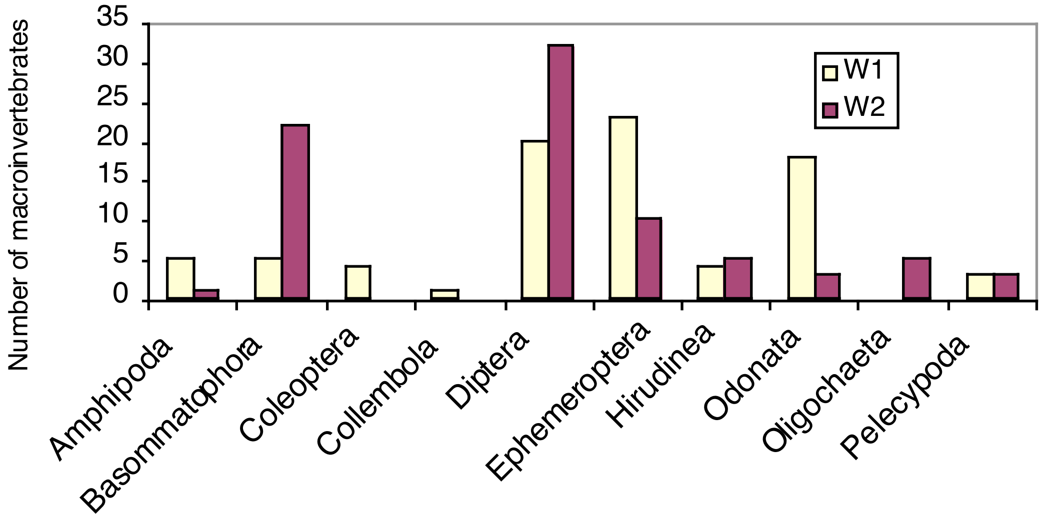

Figure 2. Numbers of invertebrates sampled from W1 and W2 using the Hester-Dendy plates.

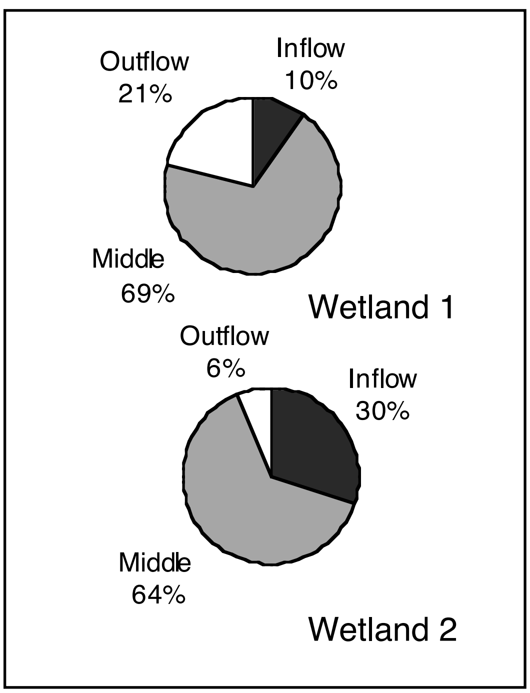

Figure 3. Percentage of invertebrates sampled in the inflow, middle and outflow areas in ORW 1 and 2 using the Hester-Dendy plates.

that has been seen in previous studies. Additional emergent traps may be needed in future studies to obtain a representative sample of the adult insect community present in the wetlands. No taxa were collected from the orders Hemiptera or Trichoptera, and future studies may need to incorporate a dip net or a funnel trap to obtain a representative sample of the benthic invertebrates in the wetlands. In future studies it might also be of interest to perform a population estimate on the bullfrog tadpoles to get an idea how large the population actually is.

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Table 4. Diversity indices and evenness for the Hester-Dendy (HD) and emergence traps (ET) in W 1 and W2.

Indices	W 1			W 2		
	HD99	HD98**	ET99	HD99	HD98**	ET99
Diversity						
Ñ	0.18	0.63	0.21	0.52	0.34	*0.08
H'	1.90	0.74	1.97	0.97	1.16	*2.32
N0	11	4	16	6	4	12
N^1	6.86	2.10	7.17	2.64	3.20	*10.03
N^2	5.63	1.59	4.76	1.91	2.91	*12.1
Evenness						
E_5	0.82	0.54	0.61	0.55	0.87	*1.23

* Calculations are invalid based on the value for Ñ which is expected to be between N0 and N^1 (Ludwig and Reynolds, 1988); and
** Data from Custer and Johnson, (1999).

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