Fish abundance and diversity in two experimental wetlands in 1999

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Introduction

Many studies have used minnow traps to sample fish communities (Tonn and Mangnuson, 1982; Tonn and Paszkowski, 1986; He and Lodge, 1990; Jackson and Harvey, 1997; Langston and Kent, 1997; Poziat and Crivelli, 1997). In situations where electrofishing and seining are not effective or not feasible minnow traps can be the best passive sampling gear for small fishes (He and Lodge, 1990). The goals of this study were to investigate the fish species diversity and abundance between two experimental riparian wetlands and compare the results to previously published fish sampling data (Gutrich et al., 1997; Hensler and Cochran, 1998).

Methods

Site Description

The Olentangy River Wetland Research Park (ORWRP) is located on The Ohio State University campus in Columbus, Ohio, USA. The park contains two one-hectare experimental riparian wetlands constructed in 1994. Wetland 1 (W1) was planted randomly with twelve macrophytes while Wetland 2 (W2) remained unplanted. Macrophytes planted in W1 included *Scirpus* sp., *Juncus* sp., and *Schoenoplectus tabernamontani* (Hensler and Cochran, 1998).

The presence of fish in the wetlands is largely a result of water that is continuously pumped in from the Olentangy River. The rate of water discharged into the wetlands is dependent on the water level of the river. At high river levels more water is pumped into the wetlands. One pump wetland managers have utilized is a Discflo ™ pump that allows for the passage of small fish and other small biota into the wetlands. A second pump, which is put to use when the Discflo TM pump is not functioning properly, is biologically unfriendly. The "biologically unfriendly" pump was used throughout most of 1999. Although the wetlands receive inputs of nutrients and small biota via the pumps, two way faunal exchange is not available. Gardner and Johnson (1996) noted two floods that occurred in 1995 that allowed fish exchange between the river and wetlands.

Basic minnow traps were used to collect fish species in both wetlands. With one exception, the traps were handmade using a wire mesh and were designed with specifications similar to standard minnow traps. One minnow trap was professionally designed. Minnow traps were 56 ± 2 cm in circumference and 48 ± 1 cm in length, with an 8 ± 2 cm wide opening (Hensler and Cochran, 1999). Eleven traps were placed in each wetland using an identical distribution scheme. In each wetland four traps were placed in the inflow basin, four in the middle basin, and three in the outflow basin (Figure 1). To avoid placement bias, traps were placed in the same location throughout the study (Langston and Kent, 1997). Sampling occurred October 11-17, 1999. The traps were checked every 24 hours. Fish were identified to species, counted, and measured to the nearest millimeter before they were released back into the wetland.

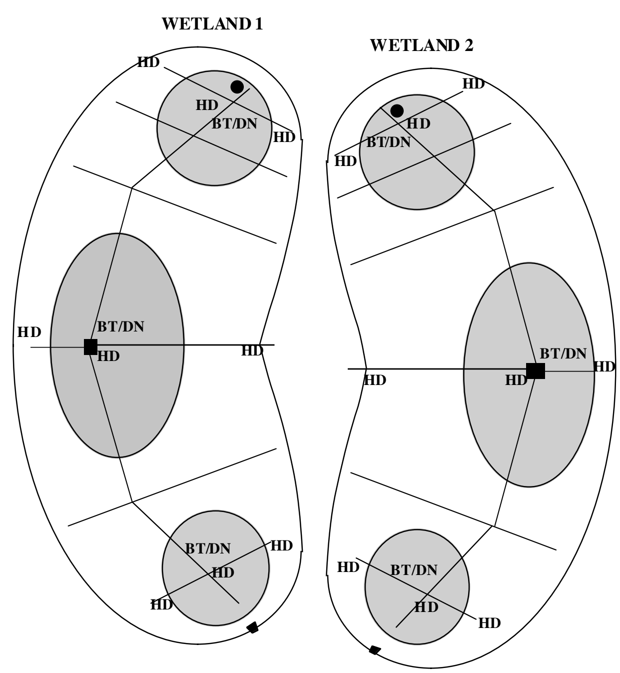

Figure 1. Sampling sites in the two wetlands at the Olentangy River Wetland Research Park (ORWRP) using the minnow traps, Hester-Dendy (HD) and emergence traps (ET).

Results and Discussion

Fish Size and Abundance

In October 1999 47 green sunfish (*Lepomis cyanellus*) were captured in W1, ranging from 34 to 90 mm in total length (Table 1). The average length for W 1 was 56.8 mm. W 2 traps captured 310 green sunfish ranging from 24 to 111 mm in length, and one fathead minnow (*Pimephales promelas*) at 50 mm (Table 1). The average length for green sunfish in W2 was 48.9 mm. There was a significant difference in fish length between W1 and W2 (two-sample t-test T=4.04, p=0.0002, d.f. = 61) (Figure 2). Eighty-five percent of green sunfish were in the 26-75 millimeter range with a large proportion coming from W2. Winter and summer mortality caused by low dissolved oxygen levels along with avian and mammalian selective predation for larger fish throughout the rest of the year explain the lack of fish greater than 100 millimeters. Lower water levels during periods of drought concentrate the fish making them more susceptible to avian and mammalian predation (Langston and Kent, 1997; Hensler and Cochran, 1999). Lack of food resources to support the ontogenetic diet shift from plankton to larger food items prohibit fish from transitioning from juvenile to adult life stages (Werner and Gilliam, 1984; Osenberg et al., 1992). According to Trautman (1981) adult green sunfish are close to 190 mm, while dwarfed individuals are usually 64 mm in length. Additionally, minnow traps do not sample large fish well. There was a significant difference in fish abundance between W 1 and W 2 (2-sample T-test=-5.91, p=0.0001, DF=10) (Table 1). The abundance of green sunfish caught in W 2 suggests that *Typha* spp. which contributes most of the aboveground productivity may provide a habitat that is advantageous to their success. *Typha* spp. is less dominant in W 1 than W 2. Mitsch and Montgomery (1998) showed that W 1 and W 2 have no significant differences in temperature, turbidity, dissolved oxygen, pH, redox potential, and nitrogen and phosphorus budgets. Comparisons from the October 1999 sampling on fish abundance between W 1 and W 2 may be brought into question. Site eighteen (W 2) caught 244 fish, while all other sites caught 114 combined. Site 18 was the only professionally designed minnow trap and was much more effective than the hand made traps used at the other sites.

Table 1. Abundance and average lengths (mm) of green sunfish found in minnow net samples in the experimental wetlands at the Olentangy Wetland Research Park from October, 12-17 1999.

Green Sunfish	W1	W2
Total Number Captured	47	310
Average Length (mm)	56.8	48.9
Range (mm)	34 - 90	24 - 111
Standard Error	1.80	0.723

Removing site 18 has a large impact on fish abundance and fish size between the two wetlands. There was no significant difference in fish abundance between W 1 and W 2 when site 18 data was omitted (2-sample T-test = -1.69, p=0.12, DF=10) (Figure 3). Sixty-six fish were caught ranging from 33 to 111 mm in length in W 2 (Table 3). The average length for wetland 2 was 54.6 millimeters. There was no significant difference for fish length between W 1 and W 2 (2-sample T-test=0.69, p= 0.49, DF=110) (Figure 3).

Species Richness

Fish species richness was greatest in the May-June 1998 sampling which consisted of green sunfish, fathead minnow, bluegill (*Lepomis macrochirus*), *Lepomis* hybrid,

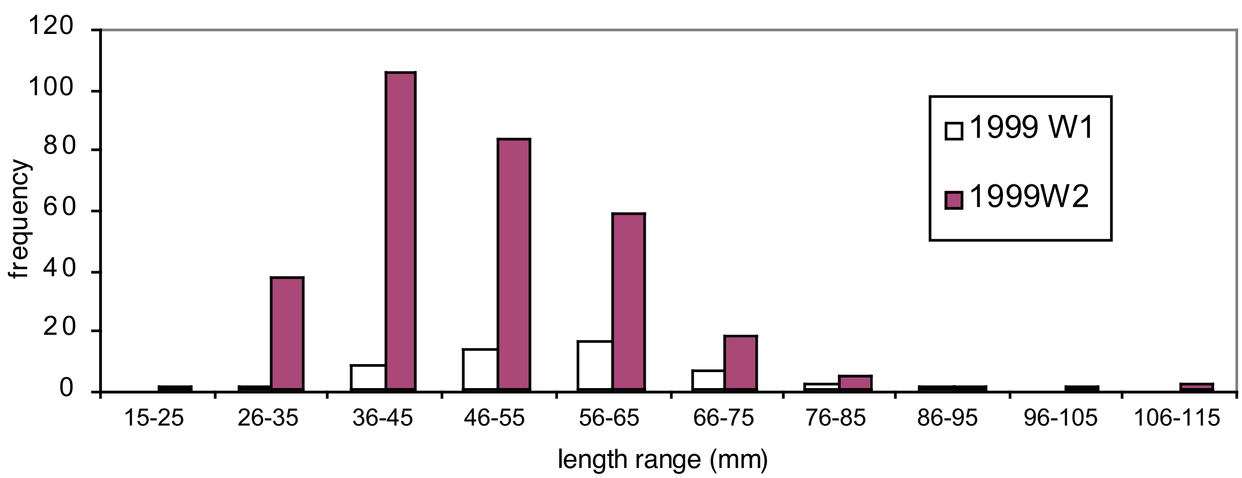

Figure 2. Length frequency of fish in W1 and W2 in 1999 found in minnow traps.

Table 2. Seasonal abundance of fish species in the two wetland basins at the ORWRP.

Sampling period	Species	W1	W2
October 1999	Green sunfish	47	310
	Fathead minnow	0	1
October 1998[a]	Green sunfish	12	52
	Fathead minnow	0	2
	Bluegill	0	1
May-June 1998[a]	Green sunfish	192	284
	Fathead minnow	179	33
	Bluegill	1	0
	Common Carp	2	0
	Pumpkinseed	2	0
	Creek chub	2	0
October 1996[b]	Green sunfish	26	30

Adapted from Hensler and Cochran, 1998
[a] (from Hensler and Cochran, 1998)
[b] (from Gutrich et al., 1997)

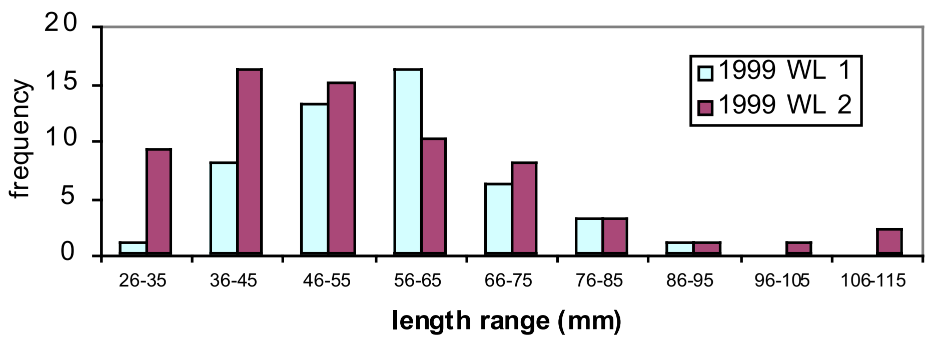

Figure 3. Length frequency of fish in W1 and W2 in 1999 (site 18 data omitted).

common carp (*Cyprinus carpio*), pumpkinseed (*Lepomis gibbosus*), and creek chub (*Semotilus atromaculatus*) (Hensler and Cochran, 1998) (Table 2). Combining this year with the 1996 and 1998 sampling resulted in only three different species from W2 (green sunfish, fathead minnow, and bluegill) (Gutrich et al., 1997 and Hensler and Cochran, 1998). This difference is likely a result of a greater habitat diversity in W1 in which four macrophytes (*S. tabernaemontani, Sparganium eurycarpum, Scirpus fluviatilis* and *Sagittaria latifolia*) contributed to 86% of the aboveground macrophytic productivity (Mitsch and Bouchard, 1998). Different habitats resulting from this vegetation may provide more niche opportunities for different species to utilize (Tonn and Magnuson, 1982). Different macrophytes provide different water chemistry and unique abundance and composition of invertebrates. Macrophytic plant forms can impact predation success on small fish and the ability of the small fish to feed on invertebrate prey (Ryer, 1988; Dionne and Folt, 1991; Lillie and Budd, 1992 as cited in Chick and McIvor, 1994). Studies on littoral zones have shown that different macrophytic patches result in different fish species present (Chick and McIvor, 1994; Conrow et al., 1990). The macrophytic homogeneity in Wetland 2, which is largely dominated by *Typha* explains the lower species richness found in W2.

Conclusion

Single gear fish surveys often underestimate the species richness of systems. Despite high levels of effort in single gear surveys as much as half of the species present may remain undetected (Jackson and Harvey, 1997). Minnow traps, like most other sampling methods, have a bias associated with size and species. Furthermore, the handmade minnow traps used in this study appear to have a low effectiveness when compared to the commercially marketed traps. The use of multiple sampling gears and/or more effective minnow traps would provide more accurate fish community data.

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