Fish and amphibian abundance in created riparian marshes with pulsing hydrology

Daniel F. Fink and William J. Mitsch

Olentangy River Wetland Research Park, Environmental Science Graduate Program and School of Natural Resources, The Ohio State University

Introduction

Wetlands provide a variety of functions that are important to both upland and aquatic ecosystems. The shallow water conditions allow for emergent macrophyte communities (Mitsch and Gosselink, 2000) that provide habitat for various species of fish and amphibians. Hydrologic pulses that feed water to the wetland also bring in a supply of nutrients and immigrant species, and food that can further enrich the habitat. Annual and seasonal fluctuations in the water level of a wetland can have a significant impact on the animal species living within the wetland. For example, species that have immigrated into the wetland during a flood event may find themselves cut off from the river system when flooded water levels recede. This can rapidly change the species composition of a wetland as this influx of new species or new individuals may cause an extirpation of previous populations and thereby create a new foundation for the wetland population.

The Olentangy River Wetland Research Park (ORWRP) contains two 1-ha created riparian wetlands built to imitate freshwater riparian marshes in 1993. The two wetlands have the same basin morphology, the same water source, and the same hydrology. The difference between the two wetlands is that Wetland 1 was planted in 1994 while Wetland 2 was left to colonize naturally. This difference in initial conditions has led to developmental differences between the two created marshes.

Goals and Objectives

This study was designed to measure the abundance and species richness of fish and amphibian species in these two wetlands. The goals were to determine population estimates for each wetland, determine what fish species and amphibian species are present in each wetland and to determine if there are any differences between presence in the inflow, middle, and outflow basins of each wetland.

Methods

Fish taxa were collected using minnow traps placed in each of the three deepwater basins in the two wetlands (Figure 1). The traps were 56 ± 2 cm in circumference and 48 ± 1 cm in length with a 8 ± 2 cm diameter opening in each end. Sampling occurred on four different dates between 26 July and 6 August, 2004. Traps were placed underwater and left to collect fish for 24 hours. Harvested fish were identified, measured for length, and marked with a fin clip. The fins were clipped according to where they were first captured (Table 1). Populations were estimated using Bailey's Modification of the Lincon-Peterson Index Method. The Bailey modification reduces the bias associated with sampling efforts with zero recaptures (Bailey, 1952). The assumptions for this method are: 1) all individuals have an equal chance of being captured; 2) the population is closed – i.e. there is no recruitment during the period of study; 3) marked animals redistribute themselves homogenously throughout the wetland; 4) marks do not hinder the survivability of the fish (Brower et al. 1998).

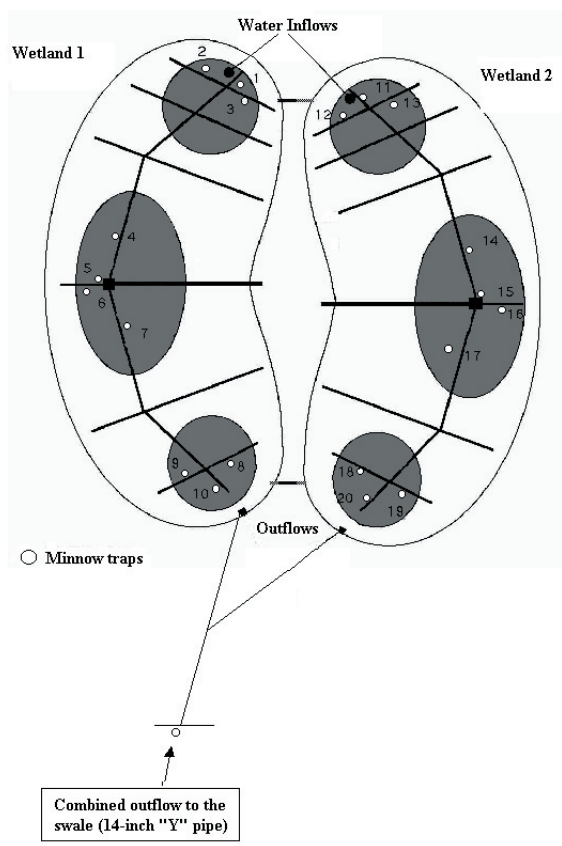

Figure 1. Location of minnow traps In the experimental wetlands

Table 1. Locations of fin clips for identification within the experimental wetlands, July-August 2004.

	Wetland 1		Wetland 2	
	Clip	Trap #	Clip	Trap #
Inflow	Right pectoral	1-3	Left pectoral	11-13
Middle	Top caudal	4-7	Bottom caudal	14-17
Outflow	Right pelvic	8-10	Left pelvic	18-20

Table 2. Number of tadpoles caught in the experimental wetlands, July-August 2004.

	Bullfrog		Leopard Frog	
	Number	Length cm	Number	Length cm
Wetland 1	7	8.73	0	
Wetland 2	15	9.92	73	4.29
Combined	22	9.54	73	4.29

$$N = \frac{M(C+1)}{R+1}$$

N = population size

M = total number of marked individuals from previous sampling efforts

C = number of captured individuals in current sampling efforts

R = number of recaptures in the current sampling effort

Results

Amphibians were not marked for recapture, so population estimates are not possible. In 1920 trap hours, 22 bullfrogs (*Rana catesbeiana*) and 73 leopard frogs (*Rana pipiens*) were captured (Table 2). There was a significant difference ($p < 0.05$) between the two wetlands for the number of tadpoles captured, with more than twice as many captured in Wetland 2. There was no significant difference in mean tadpole length between the wetlands (Table 2).

There were enough recaptures to estimate the population of common carp (*Cyprinus carpio*), bluegill (*Lepomis macrochirus*), and green sunfish (*Lepomis cyanellus*). The low number of captured and recaptured golden shiner minnows (*Notemigonus* sp.) and large mouth bass (*Micropterous salmoides*) make the population estimates for these two species unreliable. In July and August 2004, Wetland 1 had 972 ± 11 common carp, 15 ± 4 and 30 ± 9 green sunfish. Wetland 2 had 245 ± 24 common carp, 8 ± 2 bluegill and 118 ± 6 green sunfish (Figure 2). Many of the captured sunfish appeared to be hybrids between green sunfish and bluegill. To account for this, a general population estimate of *Lepomis spp*. is given as 48 ± 13 in Wetland 1 and 140 ± 9 in Wetland 2. In both Wetland 1 and Wetland 2 there were significantly more carp and sunfish captured in the central basin than in any other basin (Figure 3). Both carp and sunfish were observed to migrate between basins and between wetlands (presumably though the common outflow pipe that connects the two experimental wetlands).

Discussion

According to the Ohio EPA (as reported in Smith and Mitsch, 2004), the most abundant species of fish at river mile 3.6 of the Olentangy River were bluegill (13.72%), largemouth bass (7.35%), golden shiners (6.37%), and common carp (3.77%). Green sunfish were the sixth most abundant species found in this portion of the river. Over the past ten years green sunfish and common carp have been the most prevalent species in the wetlands (Table 3). The species composition of the river and the wetlands are different, suggesting that certain features of the wetlands select for a different species composition than the river.

This is the first year of sampling at the ORWRP in which the common carp population was greater than the green sunfish population (Table 3). This is very likely due to the pulsing hydrologic conditions present in 2004. Adult common carp, particularly in spring and early summer, tend to swim counter-current, seeking appropriate habitat for spawning. During the first week of the first six months of the year the wetlands received large pulses of river water. This led to outflow conditions that were conducive to adult carp swimming up the outflow swale into the two wetlands.

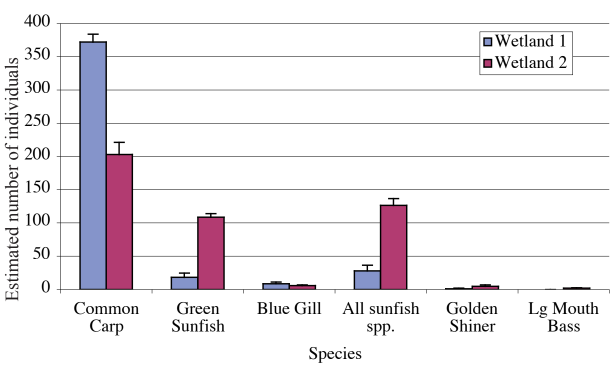

Figure 2. Estimated population of each fish species captured in the experimental wetlands during July and August, 2004. Bars represent standard errors.

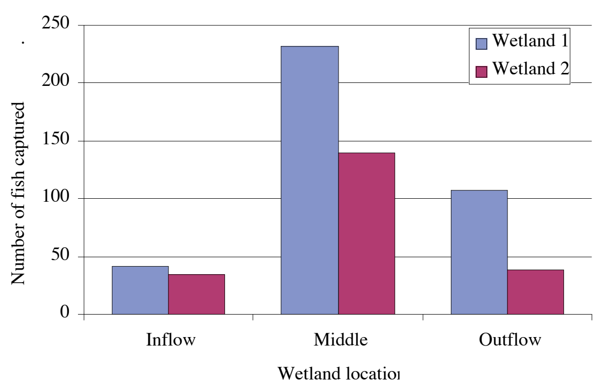

Figure 3. Total number of fish caught in the experimental wetlands, July-August 2004. Numbers given are total captures minus recaptures.

Table 3. Species and number of fish caught in previous studies conducted in the ORWRP experimental wetlands, using minnow traps.

Sample Date	Fish Species	Fish Caught W 1	W2	Reference
1996 October	*Lepomis cyanellus*	27	30	Gutrich *et al.*, 1997
1997 October	*Lepomis cyanellus*	1294	1903	Cochran, 1998
	Pimephales promelas	672	20	
	Pimephales notatus	3	0	
	Lepomis humilis	1	3	
	Cyprinus carpio	18	3	
1998 May-June	*Lepomis cyanellus*	192	281	Hensler and Cochran, 1999
	Pimephales promelas	179	33	
	Lepomis macrochirus	1	0	
	Cyprinus carpio	2	0	
	Lepomis gibbous	2	0	
	Semotilis atromaculatus	2	0	
1998 October	*Lepomis cyanellus*	12	52	Hensler and Cochran, 1999
	Pimephales promelas	0	2	
	Lepomis macrochirus	0	1	
1999 April-May	*Lepomis cyanellus*	93	13	Custer, Johnson, and
	Pimephales promelas	69	17	Mitsch, 2000
	Pimephales notatus	3	0	
	Semotilis atromaculatus	0	2	
1999 October	*Lepomis cyanellus*	47	310	Ellrott and Mitsch, 2000
	Pimephales promelas	0	1	
2000 October-November	*Lepomis cyanellus*	874	154	Kleber, Gifford, Johnson, and Mitsch, 2001
2003 October	*Lepomis cyanellus*	111	100	Smith and Mitsch, 2004
2004 July-August	*Cyprinus carpio*	298	98	This study
	Lepomis cyanellus	24	44	
	Lepomis macrochirus	16	8	
	Pimephales	3	7	
	Micropterous salmoides	0	3	

The carp captured in mid-to-late summer of 2004 are likely the spawn of adult carp that moved into the wetlands earlier in the spring.

Immediately following the last sampling date (5 August, 2004) the wetlands were partially drained to facilitate biomass harvesting. A study of fish populations conducted in Fall 2004, subsequent to this drainage, indicated that the wetlands once again were dominated by sunfish and no longer by common carp. This suggests that a) draining the wetlands caused significant carp mortality and allowed sunfish to regain dominance; or that b) sunfish populations develop later in the year than common carp, and are able to out-compete and displace carp as their populations grow. The first explanation is more likely as green sunfish can reach maturity and begin reproducing in stressful environments at a very early age and at very small sizes. They are especially tolerant of the types of stresses associated with wetland environments, particularly low oxygen levels.

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