
INFLUENCE OF HABITAT RESTORATION ON AMPHIBIANS AT COWLES BOG, INDIANA DUNES NATIONAL LAKESHORE

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Abstract.—*The purpose of this research is to assess and interpret the direct impacts of habitat restoration at Cowles Bog on amphibian diversity, abundance, and reproductive success. The data presented here includes baseline, during restoration and post-restoration. The habitat restoration increased habitat heterogeneity by adding open canopy wet prairie and shallow marsh habitat dominated by native plants to an area that was mostly fen surrounded by closed canopy forest and wetland swamp habitat. The result is an increased diversity and species richness of amphibians by adding species that prefer open and early succession habitat.*

Key Words.—Amphibians, habitat restoration, diversity, Cowles Bog INDU

INTRODUCTION

Removal of invasive plants and canopy cover, and the reintroduction of fire are important manipulations used to restore wet prairie habitat. Amphibians are bioindicators of wet prairie and marsh habitat quality. Reseeding wet prairies can be beneficial to amphibians (Brodman et al. 2006; Lannoo et al., 2009; Balas et al., 2012). However removal of canopy even if coarse debris is left in place has had mixed results with trade-offs between benefits and harm to amphibians (Patrick et al., 2006; Owens et al., 2008; Rittenhouse et al., 2008; Semlitsch et al., 2009; Todd et al., 2009; Wagner et al., 2009; Popescu et al., 2012). To assess the responses of amphibians to habitat restoration from a wood lot with invasive species to native wet prairie, we collected baseline data in 2014 that will be compared to post-management data that we collected in 2015.

METHODOLOGY

Sampling plots were established within wetlands and surrounding upland on the south side of Cowles Bog that were actively managed for habitat restoration in 2014-2017, and within wetlands and surrounding upland forest on the north side of Cowles Bog that has not been recently managed (Fig. 1). Amphibians have been surveyed site annually since 2009.

Forest surveys primarily included time-constrained cover object surveys for terrestrial salamander adults and juveniles. Amphibian breeding activity was assessed by frog call surveys, and aquatic surveys of amphibian eggs and larvae in wetlands. A song meter was set at Cowles Bog in the second week of March each year from 2010-2016 to record frog calls every night until the two 16GB sound cards filled in June. Wetlands were sampled by time-constrained visual searches for egg masses, and larvae were sampled by minnow traps, dip-nets and seine. Visual and aquatic surveys were seven times each year from April to July. In addition 48 minnow traps were deployed on June 9 and checked daily from June 10-13 in 2014, 64 minnow traps were deployed on June 8 and checked daily from June 9-12 in 2015, and 94 minnow traps were deployed June 6 and checked daily from June 7-10 in 2016. The reason why we added traps was to sample new wetlands created in the restoration area. From 2009-2013 we made a total of 12 visits to conduct visual and aquatic surveys. I pooled those data since it represents the same effort that we made annually from 2014-2016. Together, these data from 2009-2013 represent base-lines of the amphibian community and the data from 2014-2015 during the restoration and 2016-2017 post-restoration are used to assess community responses to habitat restoration.

Unisexual (all female) populations of salamanders are cryptic with respect to Blue-spotted Salamanders and Jefferson Salamanders. However unisexual salamanders have hybrid genomes, so tail tips (2 mm) were taken in the field from salamanders that looked like Blue-spotted Salamanders or Jefferson Salamanders for genetic work using microsatellite analysis. These salamanders and all other amphibians collected were photographed and identified in the field and then

immediately returned to their site of collection. Preliminary analysis of DNA samples collected 2009-2012 indicates that 59% are Blue-spotted Salamanders and 41% are unisexual. Analysis DNA samples collected 2013-2017 is on-going.

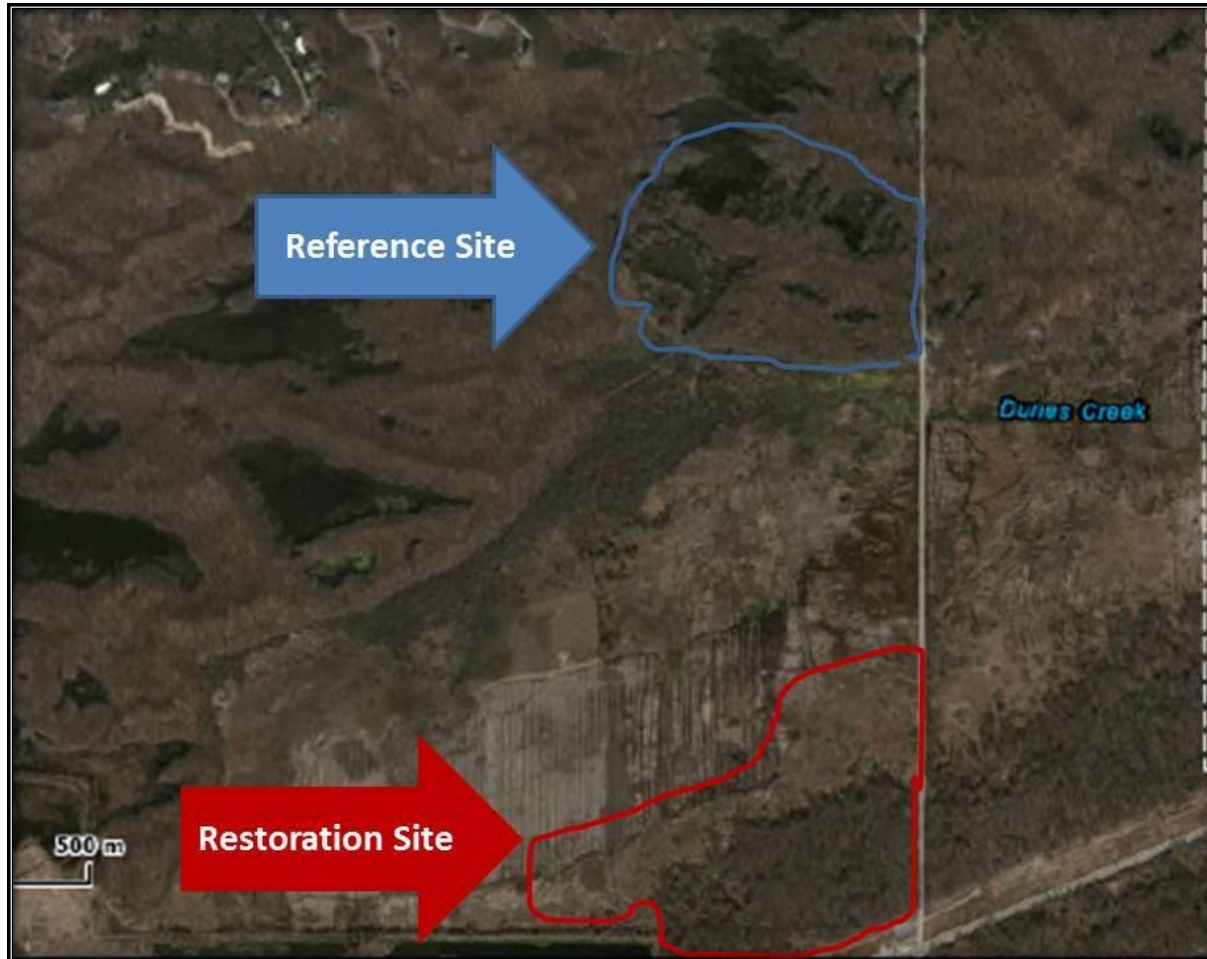


FIGURE 1. Map of study area within Cowles Bog. The reference area is indicated in blue and the restoration site is indicated in red.

RESULTS

A total of 7452 amphibians were found during the four field seasons. Of these 3413 were captured in aquatic surveys and 4039 from terrestrial searches. An additional 911 amphibians were encountered from 2009-2013. Abundance, diversity, and number of species of amphibians increased from the baseline (2009-2014) to post restoration 2015-2017 (table 1). The most abundant salamander species were Blue-Spotted Salamanders and Red-backed Salamanders and the most abundant frog species were American Toads, Spring Peepers, and Wood Frogs. Many of the Blue-spotted Salamanders, Spring Peepers, American Toads, and Wood Frogs were young of the year metamorphs observed in July each year indicating successful breeding and recruitment. The open canopy and shallow wetlands created in the restoration site had large numbers of toad tadpoles that survived to metamorphosis and attracted three new species, Fowler's Toads, Northern Leopard Frogs, and Bullfrogs which hadn't been detected at Cowles Bog prior to 2015-2016. Regression models indicate that American Toads, Fowler's Toads, Green frogs, Northern Leopard Frogs, and species richness all increased significantly from baseline to post-restoration ($p < 0.05$).

Table 1. Abundance of amphibians in the reference and restoration sites. Values are total number of each species in each year, total from 2013–2017, Shannon-Wiener diversity index (H') and species richness (R).

Species	2013	2014	2015	2016	2017		total
Blue-spotted Salamander (<i>Ambystoma laterale</i>)	79	158	176	132	129	✓	595
Tiger Salamander (<i>Ambystoma tigrinum</i>)	2	10	1	1	6	✓	18
Eastern Newt (<i>Notophthalmus viridescens</i>)	0	2	1	2	1	✓	6
Red-backed Salamander (<i>Plethodon cinereus</i>)	148	100	76	123	133	✓	432
Four-toed Salamander (<i>Hemidactylium scutatum</i>)	3	3	2	1	1	✓	7
Spring Peeper (<i>Psuedacris crucifer</i>)	381	582	239	410	121	✓	1352
Western Chorus Frog (<i>Psuedacris triseriata</i>)	31	135	15	20	9	✓	179
Eastern Gray Treefrog (<i>Hyla versicolor</i>)	53	7	85	17	7	✓	116
American Toad (<i>Anaxyrus americanus</i>)	3	85	973	643	509	✓	2210
Fowler's Toad (<i>Anaxyrus fowleri</i>)	0	0	16	11	4	✓	31
Green Frog (<i>Lithobates clamitans</i>)	15	9	88	137	115	✓	349
Bullfrog (<i>Lithobates catesbeianus</i>)	0	0	0	1	5	✓	6
Northern Leopard Frog (<i>Lithobates pipiens</i>)	0	0	13	11	3	✓	27
Wood Frog (<i>Lithobates sylvaticus</i>)	196	454	449	298	873	✓	2074
total	911	1545	2134	1807	1916		7402
H'	1.60	1.62	1.63	1.75	1.53		1.77
R	10	11	12	14	14		14



Blue-spotted Salamander, Four-toed Salamander, Eastern Newt, and Spring Peeper.

DISCUSSION

We established baseline data prior and during restoration activity in 2014 that included removal of canopy and invasive plants. In 2015 the restoration site was re-vegetated and a series of shallow wetlands had been created. The diversity, species richness, and total number of amphibians, especially Green Frogs, American Toads, Fowler's Toads, and Northern Leopard Frogs, increased from 2014 to 2017. These species are known to have a preference for wet prairie, open canopy wetlands, and early succession communities (Minton 2001; Brodman et al. 2006). However the diversity in the new wetlands and prairie was low. The open canopy in the restoration area is no longer good habitat for the forest species. Blue-spotted Salamanders and Red-backed Salamanders are doing well in the reference sites but were not found in the restoration site after 2014. the Slimy Salamanders, Four-toad Salamanders, and Wood Frogs have declined overall. Other species, especially salamanders may need more time to respond to the restoration and establishment of important habitat elements.

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NPS Rangers and students gaining valuable field experience working with amphibians.