Grant Agreement #12-022W

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Project objective: To evaluate the quality of created wetlands by sampling metamorphic amphibians.

Introduction

Wetlands in the United States have been anthropologically destroyed or altered since the settlement of Europeans. Recently, Dahl (2006) concluded that this trend has been reversed and overall acreage of wetlands in the U.S. increased from 1998 to 2004. However, this net gain in acreage of wetlands does not account for the replacement of function in created wetlands. A significant percentage of the gains in wetlands are in the form of freshwater ponds, which offset the loss of freshwater vegetated wetlands (Dahl 2006). Constructed wetlands usually fail to replicate hydrology and vegetation of the natural wetlands being replaced (Zedler and Callaway 1999; NRC 2001). Created wetlands with abnormal hydrological cycles and vegetation often fail to provide adequate habitat for wetland-dependent wildlife (Pechmann et al. 2001; Vasconcelos and Calhoun 2006) and can have a negative effect on overall wildlife diversity within a region (Porej and Hetherington 2005). Thus, the net gains in acreage may not translate into net gains in ecological function.

Seasonal wetlands (also known as vernal pools) are shallow, depressional wetlands that occur throughout the Midwestern and Eastern United States. Distribution and abundance of seasonal wetlands are regarded as an indicator of overall ecosystem health and are especially important to numerous species of plants and amphibians. In addition to their biological importance, these seasonal wetlands play critical roles in hydrology (surface water storage and groundwater exchange), biogeochemical cycling, and energy exchange (via amphibian production and dispersal) to adjacent terrestrial habitat. Despite their ecological significance within the landscape, seasonal wetlands typically receive minimal regulatory protection at both the federal and state levels because they are often small (less than 0.5 hectares) and hydrologically isolated (Lichko and Calhoun 2003).

Amphibian assemblages make up an important ecological component of many ecosystems. They play a large role in food webs as both predators of invertebrates and prey of larger vertebrates (Davic and Welsh 2004), and they often exceed the combined biomass of other terrestrial vertebrates within the system (Peterman et al. 2008). Due to their unique life history cycle, amphibians can potentially supply a large proportion of the energy transfer between aquatic and terrestrial habitats (Gibbons et al. 2006). Additionally, amphibians can serve as useful bioindicators of environmental change because they are sensitive to various forms of habitat alteration (Cushman 2006). Due to their importance in wetland ecosystems and their status as an indicator taxon, amphibians can serve as a model for understanding the roles that seasonal wetlands play in ecosystem function.

The design of created wetlands, including steep slopes with a narrow fringe of vegetation, meets criteria for mitigation but does not create conditions that favor amphibian richness (Porej and Hetherington 2005, Shulse 2010). Placement of created wetlands should consider proximity to source populations to increase the re-colonization probability by amphibians (Vasconcelos and Calhoun 2006) and avoid disturbed landscapes that are vulnerable to fish colonization (Shulse

2010). Focusing only on wetland size will not increase amphibian richness because species found in small vernal wetlands are not a subset of species found in larger wetlands, which means that wetland size is generally a poor predictor for amphibian species richness (Cushman 2006, Snodgrass et al 2000). Likewise, a large replacement wetland that is created to replace many smaller wetlands will yield low quality amphibian habitat and negatively affect amphibian species richness (Porej and Hetherington 2005). Created wetlands should have a diversity of hydro-periods and be connected to other wetlands to maximize the persistence of amphibians (Porej and Hetherington 2005, Snodgrass et al 2000).

Several methods have been developed and utilized to assess the quality of created wetlands. Re-colonization by amphibians over different time periods has given some insight on the effectiveness of attempting to replace ecological function. However, re-establishing an identical assemblage of amphibians in the short term has proven difficult. Pechmann et al (2001) found that overall richness was lowered and abundance of species detected was significantly different in a pool of mitigated wetlands meant to replace a Carolina Bay. Similarly, Lehtinen and Galatowitsch (2001) monitored constructed wetlands and detected only 8 out of 12 species found in reference wetlands. Zedler and Callaway (1999) tested the trajectory of a restored saltwater marsh and the succession of this restoration was predicted to follow a path that would lead to vegetative levels that could support an endangered bird compared to the levels in reference marsh. The data from this 10 year study of the 12 year old site showed that while restoration efforts had progressed towards the levels of the reference site, the trajectory seemed to level off at approximately 80% of the reference level. This unsuccessful mitigation adds to the literature that supports the need for long-term monitoring of restored wetlands.

Along with the re-colonization of breeding adults in restored wetlands, amphibian juvenile recruitment has been used to assess the quality of sites (Vasconcelos and Calhoun 2006, Pechmann et al 2001). Recruitment for pond-breeding amphibians refers to the shift from an aquatic larval stage to a terrestrial adult stage. Juvenile dispersal from breeding ponds is important for the conservation of pond-breeding amphibians because the number and quality of individuals metamorphosing and moving into the adult population will determine success at the population level (Cushman 2006). Juveniles represent the primary dispersal stage and the successful metamorphosis rate must be high enough to maintain local populations, re-establish locally extinct populations, and establish new populations. Survival of juveniles in the terrestrial environment is increased with larger size at metamorphosis. Also, larger size at metamorphosis facilitates an earlier age of first reproduction and increases the likelihood of success of the first reproduction (Semlitsch 2002). Although an assemblage of breeding adults may be present in a restored wetland, larval amphibians may not reach metamorphosis and successfully enter the terrestrial part of their life cycle (Pechmann et al 2001). Inappropriate hydro-periods of created wetlands may result in a population sink because of high or complete larval mortality. Also, factors such as predation and competition can limit the number of juveniles dispersing from a pond. For instance, predation by green frog tadpoles on wood frog eggs has been found to limit the number of wood frogs reaching metamorphosis (Vasconcelos and Calhoun 2006).

Within Illinois, wetland conversion and drainage has been especially extensive where an estimated 90% of original wetland area has been lost (Suloway and Hubbell 1994). Therefore, protection of remaining wetlands and creation of functional replacement wetlands to mitigate unavoidable losses is a high priority within the state. Although the National Research Council (2001) report on compensating for wetland losses identified seasonal wetlands as one of the most difficult wetland types to create, wetland creation is listed as a Priority Action Campaign within the Illinois Wildlife Action Plan (IDNR 2005). In southeastern Illinois (Natural Heritage Districts 14, 21, and 22) more than 250 seasonal wetlands have been created at 14 different Illinois Department of Natural Resources (IDNR) managed properties over the last 7 years (T. Esker and R. Jansen, IDNR District Heritage Biologists, pers. comm.). However, follow up sampling to document the success or failure of these created wetlands is lacking (T. Esker and R. Jansen pers. comm.). Habitat alteration in the United States has led to the destruction of many wetlands through draining or filling. In recognition of the loss of wetlands, the United States government has implemented policies that require any lost wetlands be replaced with created or restored wetlands.

Methods

Three state conservation areas in east-central Illinois were sampled (each containing at least one natural wetland along with created wetlands of varying ages). Crawford County Conservation Area (CCCA) was sampled in 2011 and contained a control wetland and three wetlands that were created in 2006. Lincoln Trail State Recreation Area (LTSRA) was sampled in 2012 and contained a control wetland and three wetlands that were created in 2007. Hurricane Creek Habitat Area (HCHA) was sampled in 2012 and contained two control wetlands and three wetlands created in 2010.

Wetlands were completely enclosed using black silt fence. Paired pitfall traps were installed along the inside and outside of the fence using 5 gallon buckets. Bucket lids were modified by cutting a circular hole in the lid to prevent amphibians from escaping and by attaching a tabletop constructed with lumber to prevent intrusions by raccoons (Figure 1).

Amphibian pitfall traps were sampled once every 1-3 days. Total number of each species was recorded at each trap. Additionally, the snout-vent length (SVL) and weight of the first ten metamorphic amphibians of each species collected from the inside buckets at each pond on each trapping day was recorded. Differences in total numbers, SVLs and weights were analyzed using Student's t-tests and Analysis of Variance (ANOVA) using program SPSS (version 19).

Results

The control wetlands generally produced more metamorphic amphibians than the created wetlands (Table 1). However, depending on species and site, this was not always true. At LTSRA, the natural wetland produced more metamorphic green frogs and jefferson's salamanders than any individual created wetland. The natural wetland produced nearly 5 times as many green frogs as the created wetlands combined. On the other hand, the created wetlands combined produced more metamorphic jefferson's salamanders than the natural. Further, the created wetlands produced metamorphic southern leopard frogs, chorus frogs, and spring peepers while the natural wetland didn't produce any.

At HCHA, the natural wetlands produced more metamorphic amphibians than the control wetland across all species except southern leopard frogs. A natural wetland was the only wetland to produce metamorphic bull frogs. Only one control wetland and one created wetland produced metamorphic wood frogs. The control wetland produced more wood frogs than the created wetland, but the created wetland produced more metamorphic wood frogs per square meter. The created wetlands produced a small amount of metamorphic small mouth salamanders and spring peepers compared to the control wetlands.

At LTSRA, sample sizes for green frogs and jefferson's salamanders were large enough for statistical analysis. Analysis of variance was used to compare the mean size and weight among the wetlands. The SVLs of green frogs at LTNS (a created wetland) were significantly larger ($p = 0.004$) than LT82 (a natural wetland). All other pairwise comparisons of SVL and weight lacked significance (Figures 2 and 3). Jefferson's salamanders from LT60 had significantly larger SVLs ($p < 0.0001$) and weights ($p < 0.0001$) than the natural wetland (Figures 4 and 5).

At HCHA, wood frogs were only captured at one created wetland and one natural wetland. A Student's t test showed that the created wetland produced significantly heavier ($p = 0.036$) wood frogs than the natural wetland (Figures 6 and 7). Because of small capture numbers, metamorphic small mouth salamanders were pooled from the 2 natural wetlands and the 3 created wetlands. The Student's t tests showed the natural wetlands produced significantly heavier ($p = 0.019$) small mouth salamanders than the created wetlands. The pooling of data and the low capture numbers at created wetlands ($n = 7$) should be considered when interpreting this difference (Figures 8 and 9).

In response to drought conditions in 2012, more non-breeding adult amphibians returned to the created wetlands than the control wetlands (Figure 10). Further, metamorphic green frogs were more likely to enter created wetlands in 2012 than the control wetlands or the created wetlands at CCCA in 2011 (Figure 11).

Discussion

Ambystoma spp. salamander recruitment appears to be increasing as the wetlands move through succession. Low capture numbers were seen at the newest wetlands, which can be explained because adult salamanders are highly philopatric to natal wetlands (Rothermel and Semlitsch 2002). The newer wetlands will likely be colonized primarily by dispersing juvenile salamanders. Most *Ambystoma* spp. reach sexual maturity at approximately 3 years of age. Thus, an increase in salamander recruitment at the created wetlands at HCHA should occur within the next two years. Further, one of the created wetlands at LTSRA (LT60; age 5) produced more salamanders per square meter than the control wetland (0.334 vs. 0.19 salamanders/m^2).

Created wetlands served as refuge for adult amphibians at both LTSRA and HCHA during drought conditions in 2012 (Figure 5). These results were unexpected considering the control wetlands were larger and with the exception of HC52 held water throughout sampling. Although recruitment was lower, the created wetlands served as a refuge in the landscape.

In 2011 at CCCA, a low percentage of metamorphic green frogs were captured entering the created wetlands. However, in 2012 at LTSRA, 2 out the 3 created wetlands had more metamorphic green frogs entering the pond than leaving the pond. Since green frog dispersal is assumed to occur in distinct stages of movement, the created wetlands appeared to serve as stepping stones as the metamorphs moved away from natal ponds.

Although created wetlands have not matched the control wetlands in amphibian recruitment, they are functioning as alternate breeding locations after fish colonization of natural wetlands, as refuges from drought conditions, and as stepping stones for dispersal. Ultimately, a diversity of properly constructed and placed wetlands will aid in amphibian persistence across the landscape.

Acknowledgements

T. Esker (IL-DNR) & R. Jansen (IL-DNR) for providing resources and information about potential sites. B. Hileman, M. Blackowitz, E. Kessler, and L. Jacques for help with drift fence installation. C. Phillips for helpful discussions and advice. Funding for the project was provided by a Wildlife Preservation Fund Grant from the Illinois Department of Natural Resources (EMW) and an EPA Region 5 Wetlands Protection Development Grant (JAC & ARK).

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Wetland ID	Wetland Age (yrs)	Pond Area (m^2)	*Rana clamitans*	*Rana catesbeiana*	*Rana sphenocephala*	*Rana sylvatica*	*Psuedacris triseriata*	*Psuedacris crucifer*	*Ambystoma texanum*	*Ambystoma jeffersonianum*
HC48	control	531	-	5		344	0	11	19	-
HC52	control	683	-	593	5	0	0	5	20	-
LT82	control	415	505	0	1	-	0	0	-	96
HCCB	2	143	-	0	23	0	0	1	3	-
HC50	2	177	-	0	1	225	0	0	0	-
HC51	2	64	-	0	1	0	0	1	4	-
LT60	5	212	21	0	2	-	7	9	-	71
LT59	5	123	8	0	0	-	4	2	-	2
LTNS	5	115.5	82	0	8	-	0	3	-	19

Table 1: The number of metamorphic amphibians caught from each wetland in 2012.

Wetland ID	N	Mean	95% Confidence Interval	
			Lower Bound	Upper Bound
LTNS	53	34.5228	33.9182	35.1274
LT59	6	33.63	31.4302	35.8298
LT60	21	32.7176	31.7849	33.6504
LT82*	71	33.2135	32.7421	33.6849

Table 2: Snout vent length (mm) of metamorphic *Rana clamitans*from Lincoln Trail State Park. Analysis of Variance showed a significant difference between LT82 and LTNS (p=0.004). No significant difference was found between LT82 and LT60 or LT59. *Control wetland

Wetland ID	N	Mean	95% Confidence Interval	
			Lower Bound	Upper Bound
LTNS	56	3.42882	3.25991	3.59773
LT59	6	3.09783	2.44334	3.75233
LT60	22	3.81668	1.99606	5.6373
LT82*	81	2.89568	2.78137	3.00999

Table 3: Weight (g) of metamorphic *Rana clamitans*from Lincoln Trail State Park. Analysis of Variance showed no significant difference between LT82 and any of the created wetlands. *Control wetland

Pond	N	Mean	95% Confidence Interval	
			Lower Bound	Upper Bound
LTNS	20	36.7565	36.1844	37.3286
LT60	61	38.4964	38.0224	38.9704
LT82*	76	36.7126	36.0382	37.387

Table 4: Snout vent length (mm) of metamorphic *Ambystoma jeffersonium*from Lincoln Trail State Park. Analysis of Variance showed a significant difference between LT82 and LT60 (p>.001) and between LTNS and LT60 (p=0.015). No significant difference was found between LTNS and LT60. LT59 was excluded from analysis because of low capture numbers. *Control wetland

Pond	N	Mean	95% Confidence Interval	
			Lower Bound	Upper Bound
LTNS	23	1.28591	1.19949	1.37233
LT60	61	1.60487	1.48871	1.72103
LT82	80	1.29597	1.2343	1.35765

Table 5: Weights (g) of metamorphic *Ambystoma jeffersonium*from Lincoln Trail State Park. Analysis of Variance showed a significant difference between LT82 and LT60 (p>.001) and between LTNS and LT60 (p=0.001). No significant difference was found between LTNS and LT82. LT59 was excluded from analysis because of low capture numbers. *Control wetland

Wetland ID	N	Mean	95% Confidence Interval	
			Lower Bound	Upper Bound
HC48*	35	18.985	18.616	19.354
HC50	54	19.094	18.811	19.377

Table 6: Snout vent length (mm) of metamorphic *Rana sylvatica*from Hurricane Creek Habitat Area. Student's t test showed no significant difference between the created and natural wetlands (p=0.585). *Control wetland

Wetland ID	N	Mean	95% Confidence Interval	
			Lower Bound	Upper Bound
HC48*	36	0.503	0.47844787	0.526996575
HC50	54	0.473	0.456998576	0.488519942

Table 7: Weight (g) of metamorphic *Rana sylvatica*from Hurricane Creek Habitat Area. Student's t test showed no significant difference between the created and natural wetlands (p=0.347). *Control wetland

Wetland Type	N	Mean	95% Confidence Interval	
			Lower Bound	Upper Bound
Control	25	28.814	27.730	29.898
Created	6	26.855	23.820	29.890

Table 8: Snout vent length (mm) of metamorphic *Ambystoma texanum*from Hurricane Creek Habitat Area. Because of low capture numbers, 2 control wetlands and 3 created wetlands were grouped together for analysis. Student's t test showed no significant difference (p=0.247).

Wetland Type	N	Mean	95% Confidence Interval	
			Lower Bound	Upper Bound
Control	29	0.659	0.594	0.724
Created	7	0.479	0.375	0.582

Table 9: Weight (g) of metamorphic *Ambystoma texanum*from Hurricane Creek Habitat Area. Because of low capture numbers, 2 control wetlands and 3 created wetlands were grouped together for analysis. Student's t test showed no significant difference (p=0.240).

Pond	*Bufo americanus/fowleri*	*Psuedacris triseriata*	*Psuedacris crucifer*	*Hyla versicolor*
HC48*	15	0	0	0
HC52*	9	1	0	0
LT82*	11	0	1	0
HC50	4	0	0	0
HC51	22	1	1	6
LT60	13	8	1	7
LT59	11	6	2	4
LTNS	6	13	0	1

Table 10: Adult animals captured entering the pond during drought conditions in June and July.

Pond	# leaving pond	# entering pond	Percent returning
CCCA1* 2011	41	12	29.27
CCCA4 2011	79	8	10.13
CCCA5 2011	189	14	7.41
LT82* 2012	505	139	27.52
LT60 2012	42	111	264.29
LT59 2012	8	26	325.00
LTNS 2012	82	75	91.46

Table 11: Capture data of metamorphic *Rana clamitans* at Lincoln Trail State Park in 2011 compared to capture data at Crawford County Conservation Area in 2012. *Control Pond

Figure 1: Drift fence constructed of black silt fencing and pitfall trap with modified bucket lid.

Figure 2: Metamorphic green frog.

Figure 3: Metamorphic jefferson's salamander.

Figure 4: Metamorphic wood frog.

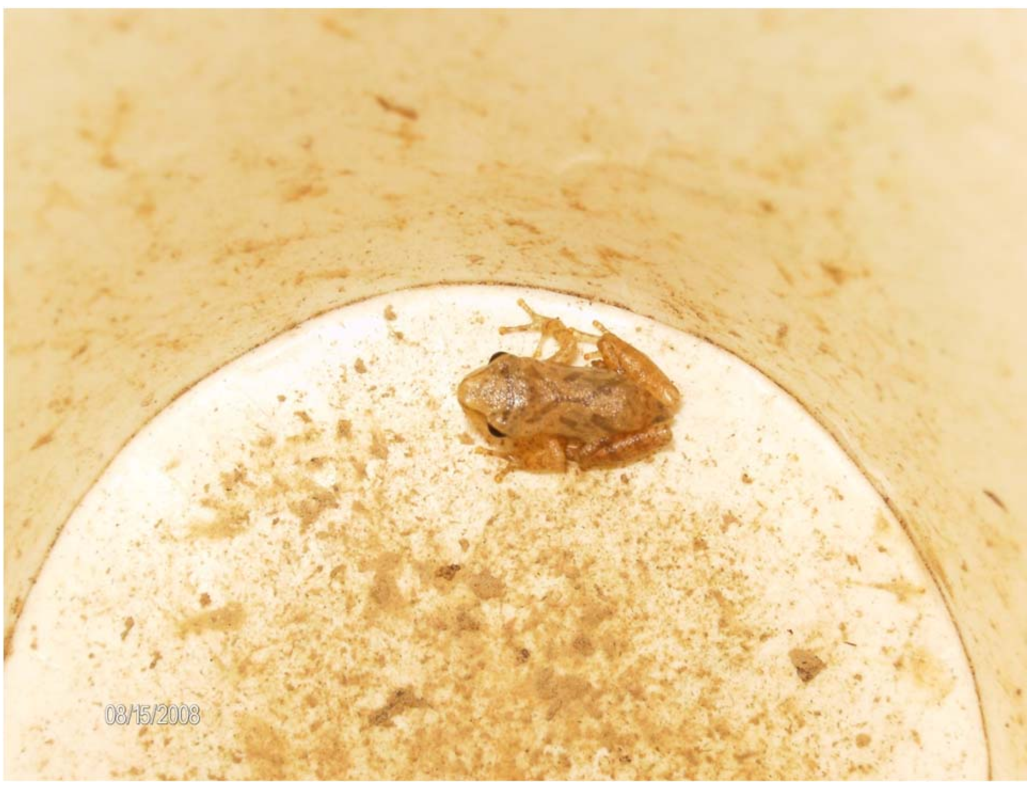

Figure 5: Metamorphic spring peeper.

List of affected wildlife:

Small mouth salamanders (*Ambystoma texanum*)

Jefferson's salamanders (*Ambystoma jeffersonianum*)

Spotted salamanders (*Ambystoma maculat*um)

Green frogs (*Rana clamitans*)

American bullfrogs (*Rana catesbiana*)

Southern leopard frogs (*Rana sphenocephala*)

Western chorus frog (*Pseudacris triseriata*)

Spring peepers (*Pseudacris crucifer*)

This project evaluated the quality and functions of created wetlands used by the above species for breeding. Significant differences were found between natural and created wetlands. However, a diversity of wetlands across the landscape will benefit amphibians.

Project Expenditures

Vendor Name	Vendor address	Date of purchase	Item description	quantity purchased	Total price of purchases
Menards	1100 Avenue Effingham IL 62401	4/25/2012	rope	3	
Menards	1101 Avenue Effingham IL 62401	4/25/2012	garden stakes	3	
Menards	1102 Avenue Effingham IL 62401	4/25/2012	duct tape	1	20.86
The Home Depot	2500 Troy Road Edwardsville, IL 62025	4/25/2012	Silt fence with stakes	20	596.22
The Home Depot	1049 Collinsville Crossing Collinsville IL 62234	5/7/2012	bucket lids	10	
The Home Depot	1050 Collinsville Crossing Collinsville IL 62234	5/7/2012	5 gal bucket	62	
The Home Depot	1051 Collinsville Crossing Collinsville IL 62234	5/7/2012	Silt fence with stakes	5	310.16
The Home Depot	2500 Troy Road Edwardsville, IL 62025	5/8/2012	staples	1	
The Home Depot	2501 Troy Road Edwardsville, IL 62025	5/8/2012	Spade	1	
The Home Depot	2502 Troy Road Edwardsville, IL 62025	5/8/2012	bucket lids	52	100.75
The Home Depot	1050 Collinsville Crossing Collinsville IL 62234	5/13/2012	5 gal bucket	1	

The Home Depot	1051 Collinsville Crossing Collinsville IL 62234	5/13/2012	bucket lids	1	
The Home Depot	1052 Collinsville Crossing Collinsville IL 62234	5/13/2012	deck screws	1	
The Home Depot	1053 Collinsville Crossing Collinsville IL 62234	5/13/2012	2x4 8ft	3	
The Home Depot	1054 Collinsville Crossing Collinsville IL 62234	5/13/2012	4x8 plywood	2	99.71
The Home Depot	1055 Collinsville Crossing Collinsville IL 62234	5/20/2012	2x4 8ft	1	
The Home Depot	1056 Collinsville Crossing Collinsville IL 62234	5/20/2012	Sponges	8	
The Home Depot	1057 Collinsville Crossing Collinsville IL 62234	5/20/2012	AAA Batteries		100.25
Unbeatablesales.com	195 Leigh Avenue STE 5 Lakewood, NJ 08701	5/10/2012	digital scale	1	172.76
				Total cost	1400.71

WETLAND

Granite City man doing study of amphibian habitat

JULY 18, 2012 5:00 AM • BY JIM MERKEL

Once, wet areas covered the land, more than enough for hopping frogs and slimy salamanders. But then came civilization, and too many of those pools disappeared. In state parks and conservation areas, it's easy for workers to create more pools with a small bulldozer — Eric Wright, 30, of Granite will study the impact of those man-made wetlands.

Wright, who just received his undergraduate biology degree from Lindenwood University, has won a $2,000 grant from the Illinois Wildlife Preservation Fund to study artificial wetlands. He is doing research on how well artificial wetlands are helping the reproduction and larval growth of declining amphibian populations.

"We have to make sure that we're helping those amphibians and not hurting them," said Wright, who will start studying for a master's degree at the University of Illinois in the fall.

Wright, a member of Granite City High School class of 2000, is doing his research in eastern Illinois at areas south of Charleston and Marshall. That's where his advisor at Lindenwood, John Crawford, was doing research and where many man-made wetlands are located. He goes to the area to check his traps every three days.

In his research, Wright is capturing, measuring and weighing amphibians from the new wetlands to determine whether they're smaller or bigger than those in the naturally produced ones.

Wright has started his research but hasn't finished it yet. He hasn't collected enough information to draw any conclusions. But, in this year's drought, he has learned something.

"A lot of adult amphibians are coming back to the pond to get a drink of water," Wright said. In normal weather, adult amphibians wouldn't return to ponds; the animals' behavior during the dry weather is showing how important the man-made ponds are, Wright said.

Wright's work will help district heritage biologists for the Illinois Department of Natural Resources. These biologists are responsible for creating and managing wetlands so that amphibians and endangered species have habitats.

"It will allow us to better understand where we put those (ponds) in the landscape," said Roger Jansen, a district heritage biologist for east-central Illinois. "There really is minimal research done on this particular type of habitat."

If new wetland areas aren't created correctly, Wright said, they could draw animals away from better wetlands.

Wright hopes the research will bring him closer to realizing his dream of being a wildlife biologist. His father was the superintendent of the Horseshoe Lake State Park.

"I just grew up outside," he said. "I just wanted to find a way to be outside."

Contact reporter Jim Merkel at 618-344-0264, ext. 138

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