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THE AMPHIBIANS OF THE MERRY LEA ENVIRONMENTAL LEARNING CENTER OF GOSHEN COLLEGE, NOBLE COUNTY, INDIANA

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ABSTRACT. We report the results of a survey of amphibians near Wolf Lake, Noble County, Indiana. From 1995 to 2001 we conducted terrestrial surveys of adult amphibians, anuran calls, and aquatic surveys of spring breeding amphibians and fall amphibians beginning to hibernate in wetland sediments of temporary, semi-permanent and permanent wetlands. We collected 20 of the 22 amphibians whose published ranges include Noble County. In our survey we established the presence of *Ambystoma jeffersonianum*, *A. laterale*, *A. maculatum*, *A. texanum*, unisexual *Ambystoma* hybrids, *Bufo americanus*, *B. fowleri*, *Acris crepitans blanchardi*, *Hyla chrysoscelis*, *H. versicolor*, *Rana catesbeiana*, and *R. palustris*. We also collected *Ambystoma tigrinum tigrinum*, *Plethodon cinereus*, *Notophthalmus viridescens viridescens*, *Pseudacris crucifer*, *P. triseriata triseriata*, *Rana clamitans melonata*, *R. pipiens*, and *R. sylvatica*. Amphibians, including *A. crepitans blanchardi*, have readily established in restored wetlands.

Keywords: Amphibians, species diversity, Merry Lea Environmental Learning Center of Goshen College, Noble County, conservation

Studies of global amphibian decline point to complex causes, including habitat loss, pesticide poisoning, introduction of new predators, changing hydroperiod, parasites, UV radiation, and warming climate (for examples, see Wake 1991; Blaustein & Kiesecker 2002; Hayes et al. 2002; Garcia et al. 2004; Mills & Semlitsch 2004; Rohr et al. 2004). The science of amphibian decline has matured such that it can clarify the effect of the interactions and synergisms of a combination of stressors on species and populations (see above studies). Conservation of amphibian species under such assault will require the preservation of habitat that minimizes or mediates the causes of decline, and the perceived urgency of conservation efforts in local areas will undoubtedly be linked to an understanding of the rate of decline. Not all areas in Indiana have been adequately surveyed for populations of amphibian species known to have historically existed or invaded, so good habitat and decline rates are not completely identified.

Prior to current agricultural development, Noble County, Indiana, consisted of extensive wetlands and uplands of glacial origins. If the original wetlands were as diverse as the remnant wetlands, Noble County in pre-settlement times supported many amphibian species. In addition to diverse wetland habitat, amphibians need well-drained but moist uplands to support adult amphibians and those amphibians that do not use wetlands for breeding. The current uplands in Noble County support mesic maple and oak-hickory forests that are suitable habitat for amphibians. Current wetland land cover is a small fraction of pre-settlement wetlands, and the wetland and upland habitats have been fragmented by development. Multiple studies suggest that this sort of fragmentation and habitat loss is a contributing factor in amphibian decline (Semlitsch 2000; Pellet et al. 2003).

Semlitsch & Bodie (2003) proposed a system of buffers and preserved upland adult habitat around breeding wetlands to protect amphibian populations. The buffers protect the wetlands from chemical contamination and adult habitat from disturbance. The proposed system of protected land would form a ring 222–399 m wide around each wetland. Since a large percentage of the land of Noble

County is used for agriculture, only a few areas have enough appropriate upland around breeding wetlands to protect the amphibian habitat as Semlitsch & Bodie (2003) suggest.

The Merry Lea Environmental Learning Center of Goshen College, located in Noble County, is a rich environment for amphibians. It contains many wetland complexes connected by forest and grassland uplands. It therefore approximates the habitat in Noble County prior to extensive agricultural development. Although much of the Learning Center environment has had significant human impact such as farming, draining, or timber harvest, current management is actively restoring historic ecosystems and other ecosystems have begun to recover on their own. Because of the Center's large contiguous area (470 ha) and management history, amphibian habitat is less fragmented than in surrounding areas. Wetland complexes at Merry Lea are connected by uplands suitable for buffering and adult habitat. The restoration and creation of permanent ponds and marshes added further critical amphibian habitat for many anurans.

We report results from studies of amphibian populations conducted for seven years at our study property. The studies were diverse and included fall and spring terrestrial surveys, fall and spring trapping of amphibians in wetlands, and anuran call surveys. Amphibian species observed were compared with those expected (Petranka 1998; Minton 2001) and documented for Noble County (Minton 2001).

METHODS

Study area.—The Merry Lea Environmental Learning Center is a 470 ha natural area that is a diverse assemblage of ecosystems including a wide variety of wetlands, upland forests, prairies, meadows and restored oak savanna. The study site is located in central Noble County, Indiana (45 km NW of Fort Wayne, Indiana, and 10 km SW of Albion, Indiana). Much of the property is bordered by three small lakes (Bear Lake, Cub Lake, and High Lake) that are the survivors of the draining of a larger lake/wetland complex for agricultural purposes around 1900.

Within the study area, wetlands with different hydroperiods and forest cover support diverse amphibian communities. Most of the permanent open wetlands are restored wetlands and are within the shorelines of the original lake. There are also several permanent swamps and shrub-carrs (swamps dominated by tall shrubs and included with swamps in Tables 2 and 3). The distinguishing feature of the Learning Center is an abundance of true temporary wetlands. Many forested temporary ponds exist in the oak-hickory woodlands that bordered the original lake, and several temporary silver maple swamps thrive in the old lakebed. Some of the forested wetlands exhibit semi-permanent hydrology in wet years. In addition, several open temporary ponds have been excavated to facilitate drainage along trails.

All permanent wetlands contain plant communities typical of the Northern Lakes Natural Region of Indiana (Homoya et al. 1985). The edges support *Typha latifolia*, *T. augustifolia*, *Scirpus cyperinus*, *Schoenoplectus validus*, *Schoenoplectus acutus*, various *Carex* and *Juncus* species, *Bidens cernua*, *Altissima plantago-aquatica*, *Leersia oryzoides* and *Phalaris arundinacea*. The shallow waters support *Potamogeton* sp., *Eleocharis* sp., *Polygonum* sp., *Utricularia vulgaris*, *Ceratophyllum demersum* and *Chara* species. Some permanent wetlands have deep waters that contain no vegetation. One permanent wetland and two temporary wetlands are dominated by buttonbush (*Cephalanthus occidentalis*). The shrub-carr contains the woody plants *Cornus stolonifera*, *C. sericea*, *Acer saccharinum*, *Salix exigua*, and *Ilex verticillata*. The small open temporary ponds support a subset of the species found in the open permanent ponds. The forested temporary ponds are generally devoid of vegetation in the wetland basin.

Survey techniques.—Amphibians were surveyed in the spring (1997–2001) and fall (1995–2001). Because the semi-permanent wetlands only exhibited a permanent hydroperiod in one wet year during our study and in all other years of the study dried in fall, results from those wetlands were combined with those of temporary wetlands. In the springs of 1998 to 2001, anurans were monitored using standard call survey techniques (Scott & Woodward 1994), with three call surveys done each season. Amphibian species were identified by their calls and abundance was estimated using a three point scale: 1 = individuals can be counted, 2 = calls of individuals can be distinguished but there are some overlapping of calls, and 3 = full chorus

and calls are constant, continuous and overlapping. Salamanders and some anurans were surveyed using minnow traps set in a subset of the wetlands (Adams et al. 1997). These were not baited and were checked daily for the duration of the *Ambystoma* mating season (usually mid-February through mid-April). Each wetland was sampled with the same intensity (1 trap per 7 m of perimeter). For most years, wetlands with a range of hydroperiods in one 25 ha area were trapped. In the spring of 2001, eight new temporary wetlands (all wooded wetlands), one new temporary swamp, and one new permanent wetland were trapped in five other areas of Merry Lea. Finally, some terrestrial surveys were conducted in spring by turning over logs and woody debris from mid-February to early June. Most spring terrestrial surveys were not systematic, but in three years (1998, 2000, and 2002) college classes turned over all woody debris in two 4 ha oak-hickory woods, and in two years (2000 and 2002) in one 2 ha oak-hickory woods (Crump & Scott 1994). Identification and number of salamanders were recorded. Only *Plethodon cinereus* density data will be reported since other salamander species found are primarily fossorial species; consequently our collection could not accurately reflect their densities.

Many wetlands and terrestrial areas were sampled again in the fall using minnow trapping and terrestrial surveys. Since temporary wetlands dried by August, only permanent wetlands were trapped in the fall. More terrestrial surveys were conducted between September and November of 1998 and 1999. Woody debris in appropriate uplands was overturned and the presence of amphibian species was recorded. During the rest of the year, all amphibians encountered were noted. Voucher specimens or photographs are stored in the collections of the Learning Center.

RESULTS

Eight salamander species and 12 anuran species were encountered during the study period for a total amphibian species richness of 20 species (Table 1). Seven salamander species (*Ambystoma jeffersonianum*, *Ambystoma laterale*, *Ambystoma maculatum*, *Ambystoma texanum*, *Ambystoma tigrinum tigrinum*, *Ambystoma* unisexual hybrids, and *Notophthalmus viridescens viridescens*) and five anuran species (*Bufo americanus*, *Pseudacris crucifer*, *Pseudacris triseriata triseriata*, *Rana pipiens* and *Rana sylvatica*) were captured during spring trapping. All *Ambystoma*, *Plethodon cinereus*, *N. viridescenes viridescens*, and *R. sylvatica* were collected during terrestrial surveys of the uplands around surveyed wetlands. All anurans were heard during the call surveys and encountered during spring and summer months near the wetlands.

Caudata.—Of the nine salamander species (and *Ambystoma* hybrids) whose ranges include Merry Lea, seven were encountered during our surveys (Table 1). All expected *Ambystoma* species were collected in spring trapping of breeding ponds, including members of the *A. jeffersonianum* complex of unisexual hybrids. In addition to those *Ambystoma* expected, *A. jeffersonianum* (Jefferson's salamander) was collected. Of the diploid species, *A. texanum* (smallmouth salamander) was by far the most abundant (Table 2), being found in large numbers in wooded temporary ponds on the east side of the Learning Center property and rarely on the west side. The next most abundant species was *A. laterale*, but this field designation includes unisexual hybrids, so it is unclear how many diploid bisexual *A. laterale* were actually collected. *Ambystoma tigrinum tigrinum* (eastern tiger salamander), *A. jeffersonianum*, and *A. maculatum* (spotted salamander) were rarer.

Plethodon cinereus (red-backed salamander) was common in spring and fall terrestrial surveys of upland oak-hickory forests. A total of 224 red-backed salamanders was captured with 63.8% red-backed and 36.2% lead-backed morphs. The average density of *P. cinereus* in eight surveys conducted in three years was 2.7 ± 0.02 (mean ± standard error) salamanders/ha.

Notophthalmus viridescens viridescens (eastern newt) was less abundant than the other salamanders collected. Eight eastern newts were collected in minnow traps in spring and fall in a permanent and a semipermanant wetland dominated by buttonbush. In addition, eastern newt adults were collected in spring and fall terrestrial surveys of the uplands surrounding those wetlands.

Of the salamanders whose ranges include the study site, *Hemidactylium scutatum* (four-toed salamander) and *Necturus maculosus* (mudpuppy) were not collected. In an exten-

Table 1.—Amphibian species of Merry Lea Environmental Learning Center of Goshen College. F = found during this study, R = included in range maps of Minton (2001) or Petranka (1998), M = Minton county record, and N = new county record.

Species expected	Common name	F	R	M	N
Caudata					
Ambystomatidae					
Ambystoma jeffersonianum	Jefferson's salamander	X			X
A. laterale	Blue-spotted salamander	X	X		X
A. maculatum	Spotted salamander	X	X		X
A. texanum	Smallmouth salamander	X	X		X
A. tigrinum tigrinum	Eastern tiger salamander	X	X	X	
Unisexual *Ambystoma*		X	X		X
Plethodontidae					
Hemidactylium scutatum	Four-toed salamander	X	X		
Plethodon cinereus	Red-backed salamander	X	X	X	
Proteidae					
Necturus maculosus	Mudpuppy		X		
Salamandridae					
Notophthalmus viridescens viridescens	Eastern newt	X	X	X	
Anura					
Bufonidae					
Bufo americanus	American toad	X	X		X
B. fowleri	Fowler's toad	X	X		X
Hylidae					
Acris crepitans blanchardi	Blanchard's cricket frog	X	X		X
Hyla chrysoscelis	Cope's gray treefrog	X	X		X
H. versicolor	Eastern gray treefrog	X	X		X
Pseudacris crucifer	Spring peeper	X	X	X	
P. triseriata triseriata	Western chorus frog	X	X	X	
Ranidae					
Rana catesbeiana	Bullfrog	X	X		X
R. clamitans melonata	Green frog	X	X	X	
R. palustris	Pickerel frog	X	X		
R. pipiens	Northern leopard frog	X	X	X	
R. sylvatica	Wood frog	X	X	X	

sive survey of Merry Lea's bogs and remnant bogs, the four-toed salamander was not seen (A. Swinehart pers. commun.). Later surveys by one of the authors (MCL) also did not find any specimen. The study site does contain some typical *N. maculosus* habitat, but mudpuppies were not encountered in pond or ditch surveys. There exist accounts of mudpuppies caught by fishermen in High Lake and Bear Lake, but these accounts cannot be verified.

Throughout the study period, ambystomatid salamanders exhibited a strong preference for breeding in temporary ponds and in most years were trapped only in wetlands of this type (Table 2). In the spring of 2000 we observed a shift in *Ambystoma* breeding to temporary swamps and a permanent swamp (Table 2) which coincided with a drought that kept the temporary ponds we surveyed from filling in the fall of 1999 or spring of 2000. The permanent shrub-carr where most of the spring 2000 breeding occurred had dried to isolated deeper pools. This permanent shrub-carr had been surveyed in the previous spring seasons, but no breeding salamanders had been captured.

Anura.—All anuran species expected to be found at the Learning Center were encountered (Table 1). Call surveys showed *H. chrysoscelis* (Cope's gray treefrog), *H. versicolor* (eastern gray treefrog), *P. crucifer* (spring peeper) and *P. triseriata triseriata* (western chorus frog) to be consistently most abundant (Table 3). *Bufo americanus* (American toad), *B. fowleri* (Fowler's toad), *R. catesbeiana* (bullfrog), *R. clamitans melanota* (green frog),

Table 2.—Total minnow trap captures of *Ambystoma* salamanders in four wetland types. Unisexual hybrids are included with *Ambystoma laterale.* Numbers of wetlands of each type that were sampled are in parentheses after the wetland type. In 2000 the previously sampled wooded temporary ponds were dry due to drought so two open ponds that were in the vicinity (within 150 meters of the wooded ponds) were sampled. The wooded temporary ponds in the original study site filled in 2001, so were revisited. In addition, five new study sites with eight wooded temporary wetlands, one temporary swamp and one permanent swamp were sampled. In 2002, the original study site was sampled, and also two of the wooded temporary ponds sampled in 2001 were included. Aj = *Ambystoma jeffersonianum,* Al = *Ambystoma laterale,* Am = *Ambystoma maculatum,* At = *Ambystoma texanum,* and Ati = *Ambystoma tigrinum tigrinum.*

Year/Wetland type	Trap nights	Aj	Al	Am	At	Ati
1997						
Temporary pond (3)	1223	15	159	0	307	0
Temporary swamp (1)	180	0	0	0	0	0
Permanent pond (1)	516	0	0	0	0	0
Permanent swamp (1)	450	0	0	0	0	0
1998						
Temporary pond (3)	573	15	8	0	196	0
Temporary swamp (1)	84	0	0	0	0	0
Permanent pond (1)	84	0	0	0	0	0
Permanent swamp (1)	210	0	0	0	0	0
1999						
Temporary pond (3)	837	25	182	0	449	4
Temporary swamp (1)	124	0	0	0	0	0
Permanent pond (1)	124	0	0	0	0	0
Permanent swamp (1)	310	0	0	0	0	0
2000						
Temporary pond (2)	144	0	5	0	20	2
Temporary swamp (1)	180	1	9	0	12	0
Permanent pond (1)	216	0	0	0	0	0
Permanent swamp (1)	216	3	27	0	192	0
2001						
Temporary pond (11)	3748	42	811	11	1135	21
Temporary swamp (2)	519	3	24	0	35	0
Permanent pond (1)	172	0	0	0	0	0
Permanent swamp (2)	641	0	4	0	42	0
2002						
Temporary pond (5)	1998	30	497	0	517	39
Temporary swamp (1)	210	0	0	0	0	0
Permanent pond (1)	432	0	0	0	0	0
Permanent swamp (1)	378	0	0	0	0	0

R. sylvatica (wood frog), and *R. pipiens* (northern leopard frog) were found at intermediate abundance. The least common frogs of Merry Lea were *R. palustris* (pickerel frog) and *A. crepitans blanchardi* (Blanchard's cricket frog). In fact, Blanchard's cricket frog was heard in only one permanent swamp and only in 2001. This was a restored swamp and 2001 was the first year it held water. The swamp was then sampled with dip nets and several *A. crepitans blanchardi* individuals were collected.

DISCUSSION

Of the 22 amphibian species whose ranges include Noble County, 20 were encountered in our studies at Merry Lea. Species that were collected in this survey that are not included in Minton (2001) belong to the Ambystomatidae: *A. jeffersonianum, A. laterale, A. ma-*

Table 3.—Mean maximum call indices for anurans. The call indices are averaged for four wetland types. Two restored wetlands were added in 2001. Ba = *Bufo americanus,* Bf = *Bufo fowler,* Acb = *Acris crepitans blanchardi,* Hch = *Hyla chrysoscelis,* Hv = *H. versicolor,* Pc = *Pseudacris crucifer,* Ptt = *P. triseriata triseriata,* Rca = *Rana catesbeiana,* Rcm = *R. clamitans melonata,* Rpa = *R. palustris,* Rpi = *Rana pipiens,* and Rs = *R. sylvatica.* Number of wetlands of each type is indicated in parentheses. Call index numbers are 1 = individuals can be counted, there is space between calls; 2 = calls if individuals can be distinguished but there is some overlapping of calls; and 3 = full chorus, calls constant and overlapping.

Year/Wetland type	Ba	Bf	Acb	Hch	Hv	Pc	Ptt	Rca	Rcm	Rpa	Rpi	Rs
1998												
Temporary pond (3)	0	0	0	0	0	0	0	0	0.7	0	0	0
Temporary swamp (1)	0	0	0	2	2	3	3	0	2	0	0	2
Permanent pond (1)	1	0	0	2	2	3	3	2	2	1	3	0
Permanent swamp (2)	1	0	0	3	3	3	1	0.5	1.5	3	3	0
1999												
Temporary pond (3)	0	0	0	0	0	0	0	0	0	0	0	0
Temporary swamp (1)	0	0	0	2	2	2	2	0	0	0	0	2
Permanent pond (1)	2	2	0	2	2	2	2	1	1	1	1	0
Permanent swamp (2)	0	0.7	0	3	2.7	3	2.7	0.7	2	1	1.3	0
2000												
Temporary pond (3)	0	0	0	0	0	0	0	0	0.7	0	0	0
Temporary swamp (1)	0	0	0	2	2	3	3	0	2	0	0	2
Permanent pond (1)	1	0	0	2	2	3	0	2	2	1	3	0
Permanent swamp (2)	1	0	0	3	3	3	1	0.5	1.5	0	1	0
2001												
Temporary pond (3)	0	0	0	0	0	0.7	2	0	0	0	0	1.7
Temporary swamp (2)	0	1	0	3	1	2	2	0	1	0	1	3
Permanent pond (1)	0.5	2	0	2	2	2	3	0.5	2	1	2	0
Permanent swamp (3)	0	0.7	0.7	3	2.7	3	2.7	0.7	2	1	1.3	0

culatum, and *A. texanum*; Bufonidae: *B. americanus* and *B. fowleri*; Hylidae: *A. crepitans blanchardi*, *H. chrysoscelis*, and *H. versicolor*; and Ranidae: *R. catesbeiana* and *R. palustris*. Of these, only *A. crepitans blanchardi* and *R. palustris* are possibly rare at Merry Lea. The absence of these new county record species from Minton's list for Noble County is probably the result of a lack of study time in the area. The species common at Merry Lea—*A. texanum, B. americanus*, *H. versicolor*, *P. crucifer*, *P. triseriata triseriata*, and *R. clamitans melanota*—are common in counties surrounding Noble County. The anurans we found seemed common throughout Noble County, with the possible exceptions of *R. palustris* and *A. crepitans blanchardi* listed above. All of the Caudata collected would be found where temporary breeding ponds are surrounded by appropriate forested adult habitat. With increased development in Noble County, these two critical habitat elements are becoming more rare and unlinked.

The collection of *A. jeffersonianum* extends the species range. Brodman (2001) collected *A. jeffersonianum* in Wells County just south of Noble County, so its discovery in our study is not surprising. Several *Ambystoma* salamanders (*A. jeffersonianum*, *A. laterale*, *A. texanum*, and *A. tigrinum*) can form female triploid hybrids that reproduce via gynogenesis (Bogart & Licht 1986). The hybrid members of this complex cannot be identified, nor separated from the diploid species, in the field. Since the exact identity must be determined by analysis of the genome, we cannot be certain that all of the 134 salamanders we identified as *A. jeffersonianum* were the diploid bisexual species. We did collect male *A. jeffersonianum*, which proves that the bisexual species is present at Merry Lea. On average, only 36.2% of the *A. jeffersonianum* we col-

lected were male, therefore there were probably many unisexual female *A. jeffersonianum/A. laterale* hybrids previously known as *Ambystoma platineum* (formed from the fusion of a diploid egg and a haploid sperm, resulting in a nuclear condition of two sets of *A. jeffersonianum* chromosomes and one set of *A. laterale* chromosomes, or JJL), or *Ambystoma tremblayi* (JLL).

We also made no genetic analysis of the unisexual *Ambystoma* hybrids that were included with *A. laterale* in Table 2. Again, we collected *A. laterale* males, so we did encounter the diploid bisexual *A. laterale*. Without the genetic analysis, we cannot definitely determine which *Ambystoma* species were involved in the hybridizations. In Adams, Wells and Jay counties of Indiana, Brodman (2001) collected salamanders which genetic analysis identified as *A. laterale* (the bisexual diploid species) and *A. jeffersonianum/A. laterale* (JLL) triploid hybrids. The range of *A. jeffersonianum/A. laterale* unisexual triploids includes Noble County (Petranka 1998), hence an identification of the hybrids we collected as *A. jeffersonianum/A. laterale* (JLL) unisexuals is plausible. The appearance of many of the hybrids we collected was intermediate between *A. laterale* and *A. texanum*. The range of *A. texanum*/A. laterale unisexuals stops abruptly at the northwest Ohio-Indiana state line and extends into southern Michigan (Petranka 1998; Kraus 1985; Bogart et al. 1985). Given that Merry Lea is about 64 km from the state line and the *A. texanum/A. laterale* unisexual range, it is entirely possible that some of the hybrids we collected are *A. texanum/A. laterale* hybrids.

Good habitat for the two species not encountered, *H. scutatum* and *N. maculosus*, was not common in our study area. *Hyla scutatum* prefers to nest on moss mats that allow the larvae to wiggle through to open water. Most of the bog habitat in our study area was degraded when the lake levels were lowered to promote agriculture, making breeding habitat for *H. scutatum* rare. Still, more systematic surveys are justified in the higher quality bog remnants. *Necturus maculosus* was not encountered in surveys of ditches on site, nor has it been captured in Cub Lake, the smallest lake in the survey area, or in permanent ponds. The mudpuppy has declined in Indiana, possibly due to increased siltation and chemical pollution (Minton 2001). Since the Learning Center is surrounded by agriculture and has experienced much siltation, mudpuppies may have been extirpated.

The high richness and abundance of amphibians we found can be attributed to physical characteristics of the study property. The landscape contains healthy temporary, semi-permanent, and permanent wetlands for amphibian breeding and adult use. The temporary wetlands protect *R. sylvatica* tadpoles and *Ambystoma* larvae from vertebrate predators that are voracious consumers of eggs and larvae. The permanent wetlands, many of which are restored, provide ample tadpole habitat for other anurans. These wetlands are still directly linked with upland habitat that is suitable for metamorphs emerging in summer and fall, and for adults. The metamorph stage can be particularly sensitive to inappropriate habitat since they may not be able to direct their movements toward suitable habitat (Rothermel 2004; but see also Marsh et al. 2004; Rothermel & Semlitsch 2002) and are more susceptible to desiccation (Spight 1968).

In a wide survey of northwest Indiana landscape variables, Brodman et al. (2003) correlated the presence of ditches and agriculture within 200 m with lower amphibian species richness and abundance. Amphibian richness and abundance were positively correlated with the number of wetlands within 400 m, wetland area, and the presence of semi-permanent hydrology. As a relatively large preserve, Merry Lea can maintain wetland complexes with temporary to permanent hydrology in places removed from agricultural development. This protection of wetlands not only buffers them from sources of chemical contamination, but also protects the essential upland habitat suitable for metamorphs and adults. Increased fragmentation of landscapes that separates larval habitat from adult habitat, and wetlands from each other, puts amphibian populations in northeastern Indiana at risk.

Long-term data are critical to ensure accurate assessment of amphibian species richness. In our study, we were not always able to detect the presence of less common species, such as *B. fowleri*. Because the property was surveyed for several years, we are confident that the Fowler's toad population is stable. Long-term data overlap years when environmental conditions such as drought or flood

prevent breeding by particular amphibians, or when the landscape changes through fragmentation or restoration. In the last year of this survey, we were able to document *A. crepitans blanchardi* breeding in a newly-restored wetland. This sort of monitoring is being done accurately by trained citizens who survey anuran calls and salamanders locally (Nelson & Graves 2004; Lepage et al. 1997). These data have great potential to enhance our ability to appropriately identify and protect amphibian populations in the midwestern USA.

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