Daytime Amphibian Surveys in Three Protected Areas in the Western Great Lakes

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We performed pilot monitoring of amphibian populations at Apostle Islands National Lakeshore (APIS) in 2006, Pictured Rocks National Lakeshore (PIRO) in 2007, and Sleeping Bear Dunes National Lakeshore (SLBE) in both 2006 and 2007. We performed daytime surveys (using multiple methods) at numerous sites in each of the three parks. We detected 10 amphibian and two reptilian species at APIS, nine amphibian and four reptilian species at SLBE, and nine amphibian and one reptilian species at PIRO. No one daytime survey technique appeared to be superior to any other. Our work resulted in two new species records (Gray Treefrog and Green Frog) for Basswood Island at APIS.

The Great Lakes Inventory and Monitoring Network (hereafter GLKN or the Network) was formed by the U.S. National Park Service (NPS) in 1999 and is one of 32 networks of parks that share common geography and management priorities. The purpose of GLKN is to inventory and monitor natural resources within nine national park units in the northern Great Lakes ecoregion, including Indiana, Michigan, Minnesota, and Wisconsin (Route and Elias 2007). In 2000, GLKN began a biological inventory in Network parks (Route 2000), and, in 2002, the Network began planning a "Vital Signs" monitoring program. Vital Signs are defined as a select group of attributes that are particularly rich in information needed for understanding and managing NPS areas (Route 2004). Vital Signs were chosen in part based on how they reflect the health of park ecosystems and how they respond (or are hypothesized to respond) to natural or anthropogenic stressors. A prioritized list of Vital Signs was finalized in 2004 and amphibian populations were one of the Vital Signs chosen for early protocol development (Route and Elias 2007).

Amphibian populations were chosen as a GLKN Vital Sign for several reasons. Many species of amphibians need both aquatic and terrestrial habitats for life cycle completion, and therefore provide a biological link between land and water and the stressors of each (Stebbins and Cohen 1995, Semlitsch 2000). Concordantly, amphibians are important components of both forest and wetland ecosystems. Amphibians often occur at high density and therefore occupy an important position in food webs while potentially dominating energy transfer between terrestrial and aquatic habitats (Stebbins and Cohen 1995, Welsh and Droege 2001, Gibbons et al. 2006). Finally, amphibians are sensitive to a wide variety of natural and anthropogenic stressors (Alford and Richards 1999, Boone et al. 2007, Davidson and Knapp 2007), and the worldwide decline of amphibian species diversity and abundance is well-documented (Wake 1991, Green 1997, Lannoo 2005).

In 2006 and 2007, the GLKN performed pilot work surveying for amphibians within network management units. The portion of the pilot work reported on here had two primary objectives: (1) To gather information on species distribution and abundance for park inventories and as a baseline for future work, and (2) to test the efficiency and effectiveness of daytime survey and research methods.

Methods

Study Areas.—We performed pilot work at Apostle Islands National Lakeshore (APIS) in 2006, Pictured Rocks National Lakeshore (PIRO) in 2007, and Sleeping Bear Dunes National Lakeshore (SLBE) in both 2006 and 2007. Apostle Islands National Lakeshore is located near Bayfield, Wisconsin and consists of an archipelago of 21 islands and a narrow 12-mile segment along the mainland shore of Lake Superior. The park is primarily hemlock-hardwood forest (but contains elements of southern boreal forest), and has a wide diversity of coastal features. About 190,000 people visit the park annually. Pictured Rocks National Lakeshore is headquartered in Munising, Michigan and is located along the south-central shore of Lake Superior within a transition zone between the boreal and eastern deciduous forest. Wetlands are common throughout the park. About 450,000 people visit annually. Sleeping Bear Dunes National Lakeshore is headquartered

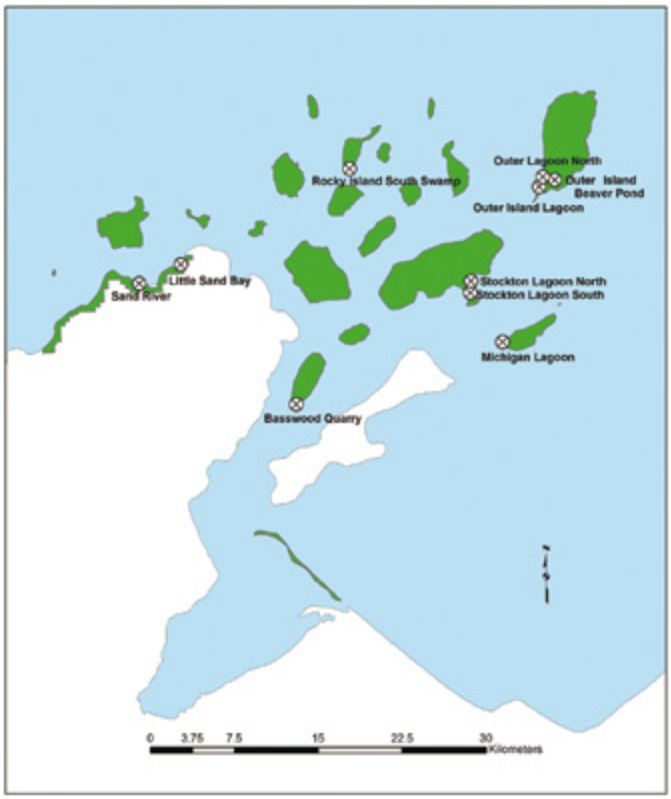

Fig. 1. Daytime survey points for 2006 at Apostle Islands National Lakeshore, Wisconsin. Green indicates parkland.

in Empire, Michigan along the northeastern shore of Lake Michigan. The Park includes two large islands in Lake Michigan as well as 65 miles of Lake Michigan shoreline, 26 inland lakes, and four streams. About 1.2 million people visit the park annually (Route and Elias 2007).

Site Selection.—Daytime survey sites were chosen by several methods, depending on the logistical difficulties present. At APIS, sampling of wetlands was constrained by numerous logistical factors. These included lake conditions and the availability of watercraft and qualified pilots. The resource-management staff at APIS communicated that only a limited number of permanent wetlands were present on the island group, and we sampled all of the sites that were identified (10 sites; Fig. 1).

Sampling of wetlands at SLBE was limited by several factors. The largest source of littoral habitats was Lake Michigan. However, much of this was unprotected, and thus exposed to too much wave action to be suitable as amphibian habitat. That action also created sandy bottoms without submerged or emergent vegetation along much of the coastline. Additionally, many bodies of water had private in-holdings within the Lakeshore boundaries, and thus were not available for sampling. Water bodies known to the resource managers that were not affected by the above constraints were selected for sampling (seven sites; Fig. 2).

Fig. 2. Daytime survey points for 2006 and 2007 at Sleeping Bear Dunes National Lakeshore, Michigan. Green indicates parkland.

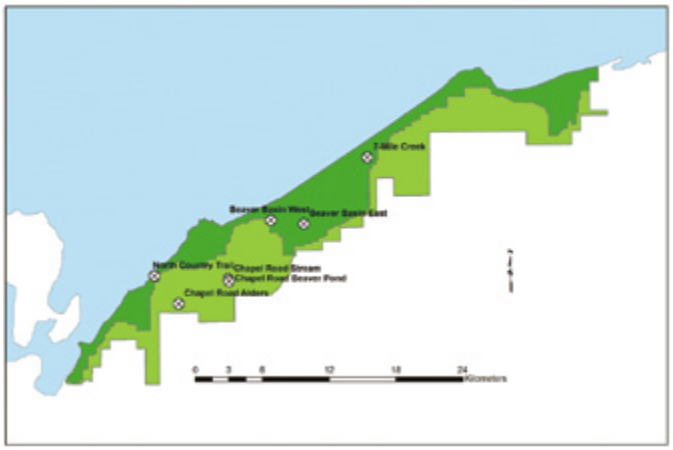

Fig. 3. Daytime survey points for 2007 at Pictured Rocks National Lakeshore, Michigan. Dark Green indicates parkland; light green indicates the non-federal Inland Buffer Zone.

Site selection at PIRO was more probabilistic. All wetlands from the NHD (National Hydrography Dataset) database with areas of 0.02–2.0 ha were assigned random numbers, which we used to select the top 20 of 108 sites. The natural-resources staff at PIRO indicated which of these 20 sites they considered reasonable for sampling (i.e., relative accessibility of habitats within one day's time; Fig. 3).

Field Methods.—Methods for daytime surveys consisted of five components at each site: call survey, sampling of physical and chemical attributes of the wetland, visual encounter survey (Heyer et al. 1994) and dip-net sweep (Thoms et al. 1997), and perimeter search. We performed the surveys in that order if we arrived at the site in the morning; but to increase detectability in the call surveys, we performed those last if we arrived in the afternoon. Two observers performed one subsample of each type of survey at each site, or one observer performed two of each type of survey at each site if two observers were unavailable. Where possible, daytime survey sites were sampled once each during each of three seasons (Weir and Mossman 2005). The "early spring" season roughly corresponded to the period from early April–early May, the "late spring" season to mid-May–early June, and the "summer" season to mid-June–early July.

Call surveys consisted of standing in an open location on the periphery of the site and listening for calling anurans for a ten-minute period. General methodology for call surveys followed Weir and Mossman (2005). We recorded the species calling, the maximum calling index value for each species (Weir and Mossman 2005), and the time to first detection (TTFD) for each species.

For visual encounter and dip-net surveys, the observer walked a transect through the wetland. Transects were located arbitrarily (but far enough apart so that observers did not disturb each other) along the edge of open water and consisted of ten nodes, with each node being two minutes in duration. At the end of each two-minute node, the observer performed a dip-net sweep (~1 m in length). We recorded the species observed, the approximate number of individuals of each species, and the TTFD of each species during each two-minute node. We also recorded the species observed and the approximate number of each species for each dip-net sweep. Any ensnared animals were immediately released at the point of capture.

Perimeter surveys consisted of the observer walking along the land-water interface of the site or, alternatively, along the edge of the wetland basin if it was clearly defined. Starting points were located arbitrarily, but were far enough apart so that observers did not disturb each other while searching. Perimeter surveys were terminated after 20 minutes or (rarely) when the site had been thoroughly circumnavigated, whichever came first. We scrutinized the land/water interface for adult amphibians, larvae, and egg masses, and also looked under logs and other potential cover objects adjacent to the wetland. We recorded the species observed, the approximate number of individuals of each species, and the TTFD for each species.

Analytical Methods.—To analyze daytime survey data, we first organized species detections by year, park, site, method, and season. We combined visual encounter and dip-net survey results for the analysis. Detections were defined as an observation of a species at a given site, on a given day, using a given method. For example, if 20 Green Frogs (*Lithobates clamitans*) were detected by a dip-net survey at a given site on a given day, it was considered to be one detection of that species. If Green Frogs were also detected during the call survey at the same site on the same day, it was considered to be a separate detection. This approach allowed us to determine the species composition at each park and site, and to determine which species were most common (and most commonly detected) among sites without biasing our results toward species that are locally abundant or toward a particular survey technique. We calculated the percentage of survey sites at which each detected species was found (naïve occupancy; Mackenzie et al. 2002).

Occasionally, we observed species at sites outside of the proscribed survey periods; these species do not appear in the above analyses. We therefore

Table 1. Amphibian species detections by site, method, and season at Apostle Islands National Lakeshore (Wisconsin) in 2006. ES = early spring, LS = late spring, S = summer.

Species	Site	Method	Season
Anaxyrus americanus	Rocky Island South Swamp	Dip Net Survey	LS
	Michigan Lagoon	Dip Net Survey	S
	Outer Island Lagoon	Perimeter Survey	LS
Hyla versicolor	Little Sand Bay	Dip Net Survey	LS
Pseudacris crucifer	Little Sand Bay	Call Survey	ES
	Basswood Quarry	Call Survey	ES, LS
		Dip Net Survey	ES, S
	Stockton Lagoon South	Call Survey	ES, LS
		Dip Net Survey	LS
	Stockton Lagoon North	Call Survey	LS
	Rocky Island South Swamp	Call Survey	LS
	Sand River	Call Survey	LS
		Perimeter Survey	LS
	Michigan Lagoon	Call Survey	LS
		Dip Net Survey	LS, S
	Outer Island Lagoon	Perimeter Survey	LS
	Outer Island Beaver Pond	Call Survey	LS
		Dip Net	LS
		Perimeter Survey	LS
Lithobates clamitans	Little Sand Bay	Call Survey	S
		Dip Net Survey	LS, S
		Perimeter Survey	S
	Basswood Quarry	Call Survey	S
		Dip Net Survey	LS, S
		Perimeter Survey	S
	Stockton Lagoon North	Dip Net Survey	S
	Sand River	Dip Net Survey	LS, S
		Perimeter Survey	LS, S
	Michigan Lagoon	Dip Net Survey	LS, S
		Perimeter Survey	S
	Outer Island Beaver Pond	Dip Net Survey	LS
		Perimeter Survey	LS
	Outer Lagoon North	Dip Net Survey	S
		Perimeter Survey	S
Lithobates septentrionalis	Sand River	Dip Net Survey	LS
Lithobates sylvatica	Basswood Quarry	Dip Net Survey	LS, S
		Perimeter Survey	LS
	Rocky Island South Swamp	Dip Net Survey	LS
		Perimeter Survey	ES, LS
	Michigan Lagoon	Perimeter Survey	LS
Ambystoma maculatum	Basswood Quarry	Dip Net Survey	ES, LS
	Rocky Island South Swamp	Dip Net Survey	ES, LS
	Michigan Lagoon	Dip Net Survey	LS, S
	Stockton Lagoon South	Dip Net Survey	S
		Perimeter Survey	S
	Sand River	Dip Net Survey	S
	Outer Island Beaver Pond	Dip Net Survey	LS
		Perimeter Survey	LS
	Outer Lagoon North	Perimeter Survey	S
Notophthalmus viridescens	Michigan Lagoon	Dip Net Survey	LS
	Outer Island Beaver Pond	Dip Net Survey	LS
Ambystoma laterale	Rocky Island South Swamp	Perimeter Survey	LS
Hemidactylium scutatum	Rocky Island South Swamp	Perimeter Survey	LS


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Fig. 4. A Northern Leopard Frog (*Lithobates pipiens*) at Long Island, Apostle Islands National Lakeshore, Wisconsin.


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Fig. 5. Stockton Island Lagoon South, one of the sampling sites at Apostle Islands National Lakeshore, Wisconsin.

compiled a separate list of species found outside of the survey periods at each site in each park in order to provide a more complete accounting of the species present. We included any observed reptilian species in this list. For all analyses, common and scientific names of species follow Crother (2008).

Results

We were unable to determine the number of detections or the most-common species with regard to season because not all sites were visited in all three seasons, and some sites were visited multiple times in one season. Furthermore, we were unable to quantitatively determine the utility of various methods based on detections because we were unable to perform all surveys during every visit at all sites. For these same reasons, naïve occupancy estimates and species and detections per site should be viewed with caution. However, quantity or diversity of detections differed little among methods or seasons, with the possible exception of summer season surveys resulting in lower species diversity.

We detected a total of 10 amphibian species at APIS (Figs. 4 & 5). Outer Island and Michigan Island appeared to have the most diverse herpetofaunas, with five amphibian and two reptilian species and six amphibian and one reptilian species, respectively. With regard to individual sampling sites, Michigan Lagoon and Rocky Island South Swamp had the most amphibian species detections (six each). Basswood Quarry produced the largest number of amphibian detections (13), followed by Michigan Lagoon (11; Table 1). Naïve occupancy ranged from 90% of sites for the Spring Peeper (*Pseudacris crucifer*) to only one of ten sites for Gray Treefrogs (*Hyla versicolor*), Mink Frogs (*Lithobates septentrionalis*), Blue-spotted Salamanders (*Ambystoma laterale*), and Four-toed Salamanders (*Hemidactylium scutatum*; Table 2). We found Painted Turtles (*Chrysemys picta*) on Outer Island and Stockton Island, and Eastern Gartersnakes (*Thamnophis sirtalis*) on Outer Island and Michigan Island.

We detected a total of nine amphibian species and four reptilian species at SLBE over two years (Tables 3 & 4; Figs. 6–8). In 2006, Aral Lodge and Indian Trail West had the most amphibian species detections (five each). Aral Lodge produced the largest number of amphibian detections (seven), followed by Indian Trail West (six; Table 3). Naïve occupancy ranged from 85.7% of sites for the Green Frog to only one of seven sites for Gray Treefrogs and Central Newts (*Notophthalmus viridescens*; Table 2). Outside of the survey periods, we observed Green Frogs at Aral Lodge and Northern Leopard Frogs (*Lithobates pipiens*) at Indian Trail West. If combined with survey data, this results in a naive occupancy of 100% at daytime sites for Green Frogs in 2006. The only reptilian species that we observed in 2006 were the Eastern Gartersnake at Otter Creek and the Northern Ribbonsnake (*Thamnophis sauritus*) at Aral Lodge and Indian Trail East.

Table 2. Number of daytime sampling sites (in parentheses) at which amphibian species were detected and percent of sites occupied by amphibian species (naïve occupancy) for Apostle Islands National Lakeshore in 2006 (APIS, Wisconsin), Pictured Rocks National Lakeshore in 2007 (PIRO, Michigan), and Sleeping Bear Dunes National Lakeshore in 2006 and 2007 (SLBE, Michigan).

	Anaxyrus americanus	*Hyla versicolor*	*Pseudacris crucifer*	*Lithobates clamitans*	*Lithobates pipiens*	*Lithobates septentrionalis*
APIS 2006	(3) 30.0	(1) 10.0	(9) 90.0	(7) 70.0		(1) 10.0
SLBE 2006	(2) 28.6	(1) 14.3	(5) 71.4	(6) 85.7		
SLBE 2007	(1) 14.3	(5) 71.4	(5) 71.4	(6) 85.7	(2) 28.6	
PIRO 2007	(3) 42.9	(2) 28.6	(5) 71.4	(7) 100.0	(1) 14.3	(1) 14.3

	Lithobates sylvatica	*Notophthalmus viridescens*	*Plethodon cinereus*	*Hemidactylium scutatum*	*Ambystoma laterale*	*Ambystoma maculatum*
APIS 2006	(3) 30.0	(2) 20.0		(1) 10.0	(1) 10.0	(7) 70.0
SLBE 2006	(2) 28.6	(1) 14.3	(2) 28.6			
SLBE 2007	(2) 28.6	(1) 14.3	(3) 42.9			(1) 14.3
PIRO 2007	(2) 28.6	(1) 14.3	(1) 14.3			


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Fig. 6. Indian Trail East, one of the sampling sites at Sleeping Bear Dunes National Lakeshore, Michigan.

In 2007, Indian Trail West had the most amphibian species detections (five), followed by Platte River, Kelderhouse, and Indian Trail East (four each). Martin Road produced the largest number of amphibian detections (14), followed by Indian Trail West and Platte River (12 each; Table 4). However, detections at Martin Road were dominated by Green Frogs and Spring Peepers. Naïve occupancy ranged from 85.7% of sites for the Green Frog to only one of seven sites for American Toads (*Anaxyrus americanus*), Spotted Salamanders (*Ambystoma maculatum*), and Central Newts


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Fig. 7. An American Toad (*Anaxyrus americanus*) at Sleeping Bear Dunes National Lakeshore, Michigan.

Table 3. Amphibian species detections by site, method, and season at Sleeping Bear Dunes National Lakeshore (Michigan) in 2006. LS = late spring, S = summer.

Species	Site	Method	Season
Anaxyrus americanus	Aral Lodge	Call Survey	LS
		Dip Net Survey	S
	Indian Trail West	Dip Net Survey	S
Hyla versicolor	Aral Lodge	Call Survey	LS
		Dip Net Survey	LS
Pseudacris crucifer	Platte River	Call Survey	LS
	Aral Lodge	Dip Net Survey	S
	Indian Trail West	Dip Net Survey	S
	Indian Trail East	Dip Net Survey	S
	Kelderhouse	Dip Net Survey	S
Lithobates clamitans	Otter Creek	Call Survey	S
		Dip Net Survey	LS, S
		Perimeter Survey	LS, S
	Platte River	Dip Net Survey	LS, S
		Perimeter Survey	LS, S
	Indian Trail West	Call Survey	S
		Perimeter Survey	S
	Indian Trail East	Call Survey	S
		Perimeter Survey	S
	Kelderhouse	Call Survey	S
		Dip Net Survey	S
		Perimeter Survey	S
	Martin Road	Call Survey	S
		Perimeter Survey	S
Lithobates sylvatica	Aral Lodge	Dip Net Survey	S
	Indian Trail East	Dip Net Survey	S
Notophthalmus viridescens	Indian Trail West	Dip Net Survey	S
Plethodon cinereus	Aral Lodge	Perimeter Survey	LS
	Indian Trail West	Perimeter Survey	S

(Table 2). We observed Eastern Gartersnakes at Platte River, Indian Trail East, and Indian Trail West and Northern Ribbonsnakes at Aral Lodge, Indian Trail East, and Indian Trail West. We also observed Painted Turtles


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Fig. 8. An abnormally pigmented Green Frog (*Lithobates clamitans*) larva found at Kelderhouse, Sleeping Bear Dunes National Lakeshore, Michigan.

Table 4. Amphibian species detections by site, method, and season at Sleeping Bear Dunes National Lakeshore (Michigan) in 2007. ES = early spring, LS = late spring, S = summer.

Species	Site	Method	Season
Anaxyrus americanus	Kelderhouse	Call Survey	LS
Hyla versicolor	Platte River	Call Survey	LS
		Perimeter Survey	LS
	Aral Lodge	Perimeter Survey	LS
	Indian Trail West	Call Survey	LS
		Dip Net Survey	LS
		Perimeter Survey	LS
	Indian Trail East	Call Survey	ES, LS
		Dip Net Survey	LS
		Perimeter Survey	LS
	Martin Road	Call Survey	LS
		Dip Net Survey	ES
		Perimeter Survey	LS
Pseudacris crucifer	Otter Creek	Call Survey	ES
	Aral Lodge	Call Survey	LS
		Dip Net Survey	LS
	Indian Trail West	Dip Net Survey	LS
	Kelderhouse	Call Survey	ES, LS
	Martin Road	Call Survey	ES, LS
		Dip Net Survey	LS
		Perimeter Survey	LS
Lithobates clamitans	Otter Creek	Dip Net Survey	ES, LS, S
		Perimeter Survey	ES, LS, S
	Platte River	Call Survey	S
		Dip Net Survey	ES, LS, S
		Perimeter Survey	ES, LS, S
	Indian Trail West	Call Survey	S
		Dip Net Survey	LS, S
		Perimeter Survey	LS, S
	Indian Trail East	Call Survey	LS, S
		Dip Net Survey	LS, S
	Kelderhouse	Call Survey	S
		Dip Net Survey	ES, LS, S
		Perimeter Survey	LS, S
	Martin Road	Call Survey	LS, S
		Dip Net Survey	ES, LS, S
		Perimeter Survey	LS
Lithobates pipiens	Platte River	Perimeter Survey	LS, S
	Indian Trail East	Call Survey	ES
Lithobates sylvatica	Platte River	Perimeter Survey	LS
	Kelderhouse	Perimeter Survey	ES
Ambystoma maculatum	Martin Road	Perimeter Survey	LS
Notophthalmus viridescens	Indian Trail West	Dip Net Survey	LS
Plethodon cinereus	Aral Lodge	Perimeter Survey	LS
	Indian Trail West	Perimeter Survey	ES, LS
	Indian Trail East	Perimeter Survey	LS

at Indian Trail East and Martin Road and Snapping Turtles (*Chelydra serpentina*) at Platte River, Indian Trail West, and Martin Road.

We detected a total of nine amphibian species and one reptilian species at PIRO (Table 5; Figs. 9–11). North Country Trail had the most

Table 5. Amphibian species detections by site, method, and season at Pictured Rocks National Lakeshore (Michigan) in 2007. ES = early spring, LS = late spring, S = summer.

Species	Site	Method	Season
Anaxyrus americanus	Chapel Road Stream	Perimeter Survey	LS
	Chapel Road Beaver Pond	Call Survey	ES
	North Country Trail	Call Survey	ES
		Dip Net Survey	ES
Hyla versicolor	North Country Trail	Call Survey	ES
		Dip Net Survey	LS
	Chapel Road Alders	Call Survey	ES
Pseudacris crucifer	7-Mile Creek	Call Survey	ES
	Chapel Road Stream	Call Survey	ES
	Chapel Road Beaver Pond	Call Survey	ES
	North Country Trail	Call Survey	ES
	Chapel Road Alders	Call Survey	ES
		Dip Net Survey	LS
		Perimeter Survey	ES
Lithobates clamitans	7-Mile Creek	Perimeter Survey	S
	Beaver Basin West	Call Survey	S
		Perimeter Survey	S
	Beaver Basin East	Dip Net Survey	S
		Perimeter Survey	S
	Chapel Road Stream	Call Survey	S
		Perimeter Survey	ES, LS
	Chapel Road Beaver Pond	Call Survey	LS
		Dip Net Survey	ES, LS
		Perimeter Survey	LS, S
	North Country Trail	Dip Net Survey	LS, S
		Perimeter Survey	LS
	Chapel Road Alders	Dip Net Survey	LS, S
Lithobates pipiens	North Country Trail	Dip Net Survey	LS
Lithobates septentrionalis	Chapel Road Beaver Pond	Call Survey	S
Lithobates sylvatica	North Country Trail	Dip Net Survey	ES
		Perimeter Survey	LS
	Chapel Road Alders	Call Survey	ES
Notophthalmus viridescens	Beaver Basin West	Perimeter Survey	S
Plethodon cinereus	Beaver Basin West	Perimeter Survey	S

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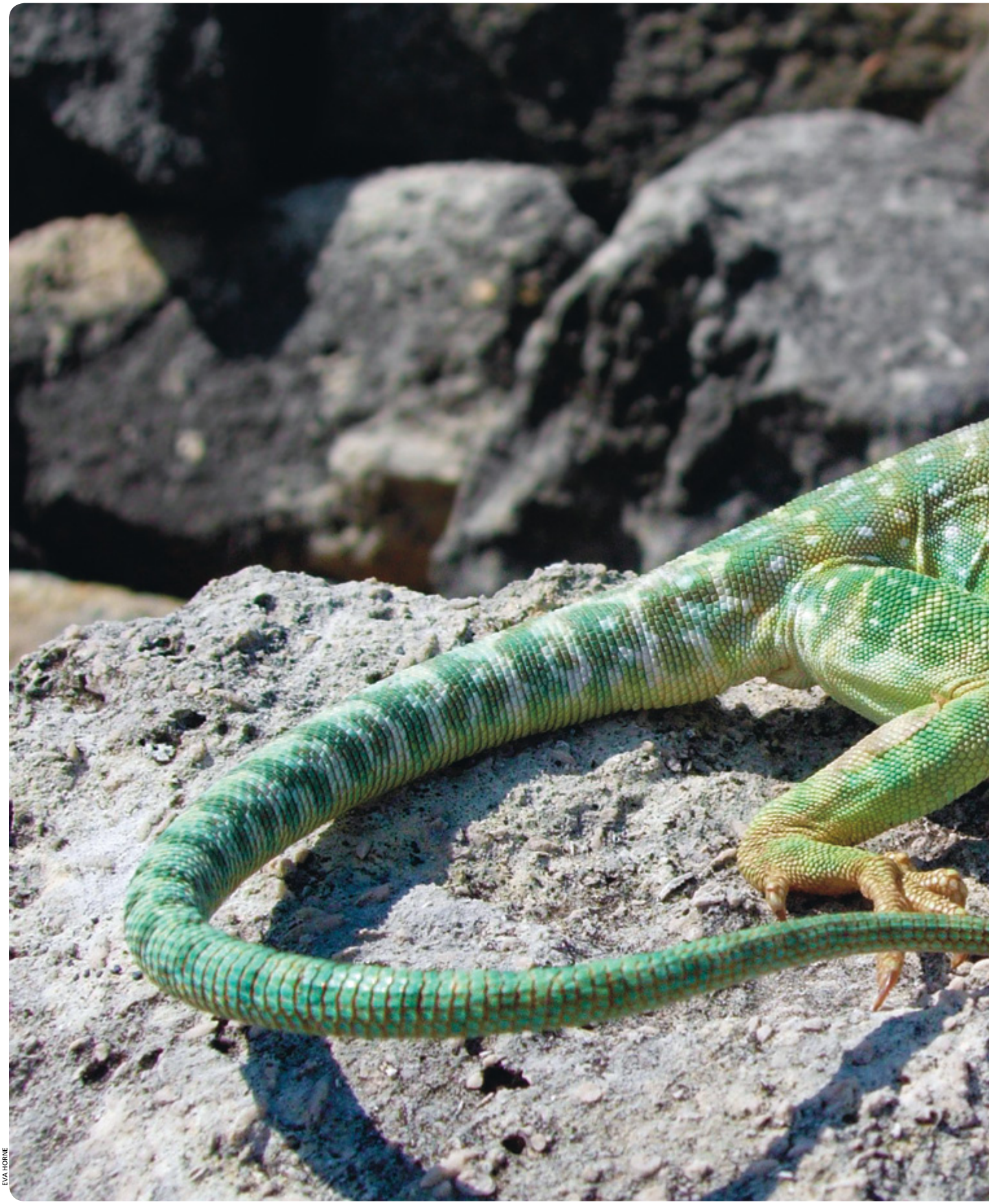
Fig. 9. An Eastern Gartersnake (*Thamnophis sirtalis*) at Pictured Rocks National Lakeshore, Michigan.



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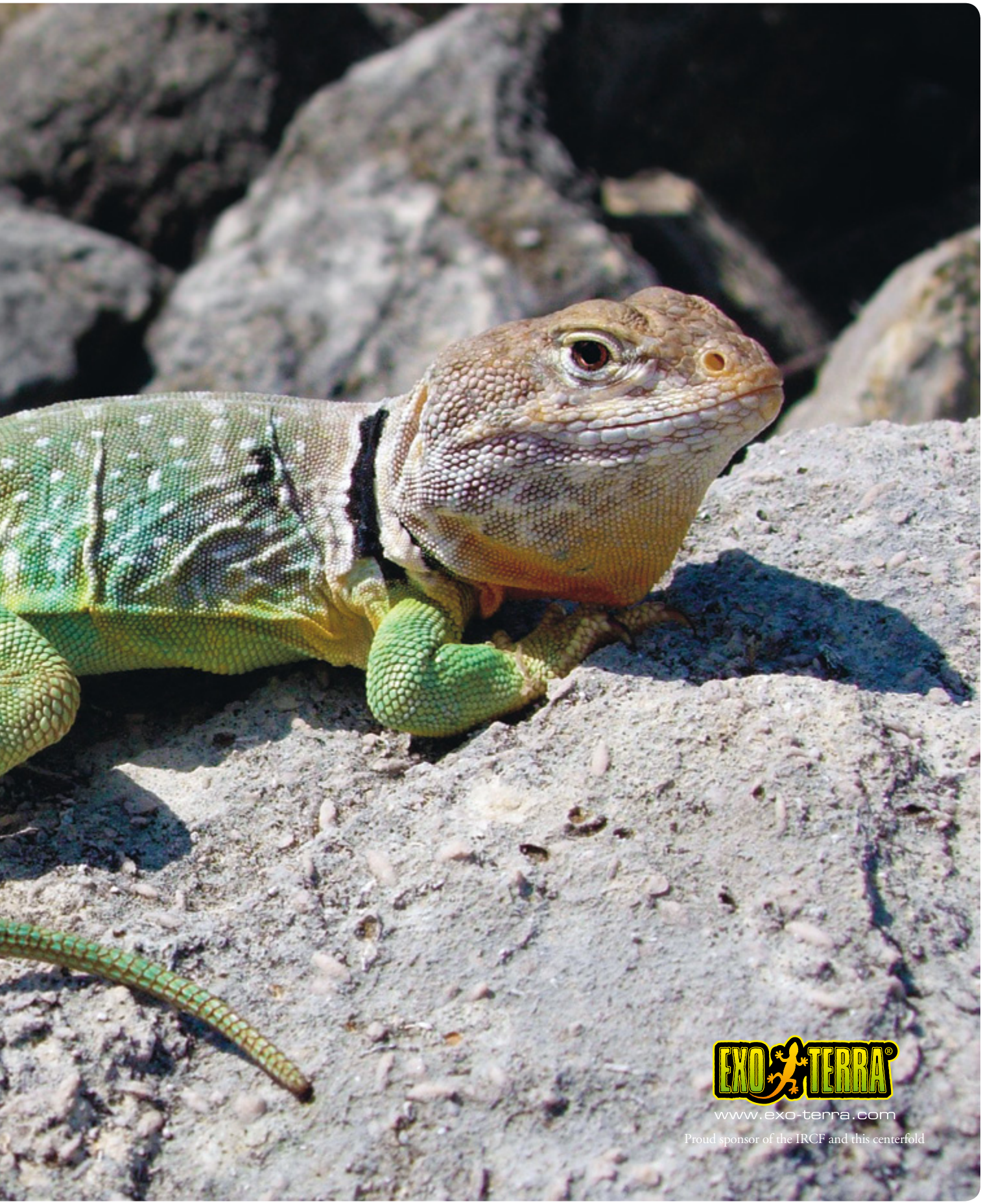
The Eastern Collared Lizard (*Crotaphytus collaris*) was the subject of one of Dr. Fitch's many contributions to better understanding the natural history of the Kansas herpet



ofauna (Fitch, H.S. 1956. An ecological study of the Collared Lizard (*Crotaphytus collaris*). *University of Kansas Publications of the Museum of Natural History* (8):213–274).

amphibian species detections (six), followed by Chapel Road Alders and Chapel Road Beaver Pond (four each). North Country Trail produced the largest number of amphibian detections (11), followed by Chapel Road Beaver Pond (eight; Table 5). Naïve occupancy ranged from 100% of sites for the Green Frog to only one of seven sites for Northern Leopard Frogs, Mink Frogs, Central Newts, and Eastern Red-backed Salamanders (*Plethodon cinereus*; Table 2). Outside of the survey periods, we observed American Toads at Beaver Basin West and Chapel Road Alders. The only reptilian species that we observed at PIRO was the Eastern Gartersnake at North Country Trail.

Discussion

With regard to overall number of species detected, daytime surveys were an effective way to monitor amphibians. More species were detected using the different daytime survey methods than by using nighttime call surveys (data not shown). In particular, daytime surveys resulted in detections of species that do not call, such as salamanders. Daytime surveys also allowed us to determine if reproduction was actually occurring via detections of egg masses and larvae, whereas calling males do not necessarily equate with successful reproduction (Heyer et al. 1994). At this time, we cannot recommend one of the four daytime sampling methods over the others. Dip-net surveys tended to produce more detections, but call surveys and perimeter surveys allowed us to detect species that would not have been noted using dip-net surveys alone. Our data suggest that changing seasons does not change the effectiveness of visual encounter and dip-net surveys for detecting Green Frogs (the only species with enough detections for a comparison).

SLBE was the most diverse park in terms of reptilian and amphibian species detected, followed by APIS and PIRO. This is sensible given the fact that SLBE is the southernmost park that we sampled. However, more amphibian species were detected at APIS than at either of the other parks. A number of species at all three parks should have been present but were not detected, such as Fowler's Toads (*Anaxyrus fowleri*) at SLBE, Four-toed Salamanders at PIRO, and Eastern Red-backed Salamanders at APIS (Harding 1997; Casper 2001, 2005; Casper and Anton 2008). In some cases, we know that these species are present based on past surveys. Regardless, we cannot state with confidence that any species is absent without more surveying effort (Kéry 2002, Mackenzie 2005). Notable species detections included two new records for Basswood Island at APIS (Gray Treefrogs and Green Frogs; Casper 2001).

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Fig. 10. A Green Frog (*Lithobates clamitans*) at Pictured Rocks National Lakeshore, Michigan.

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Fig. 11. Chapel Road Stream, one of the sampling sites at Pictured Rocks National Lakeshore, Michigan.

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Male Calling Sites in Two Species of Australian Toadlets (Anura: Myobatrachidae: *Uperoleia*) at Two Ponds in New South Wales

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Introduction

"Toadlets" of the myobatrachid genus *Uperoleia* are commonly encountered calling around ponds located in southeastern Australia. Usually one species only is present at any given pond, but two species occasionally can be calling around the same site. The Smooth Toadlet (*Uperoleia laevigata*) and the Dusky Toadlet (*U. fusca*) call at the same time on the same nights around two ponds on the central coast of New South Wales, Australia, and observations suggest that the males call in relatively discrete groups that differ to at least some degree in location. The two species are closely related (Tyler et al. 1981), the advertisement calls of the two species are similar (Barker et al. 1995, Cogger 2000), and they possess similar calling seasons and preferred breeding sites (Barker et al. 1995, Cogger 2000, Anstis 2002). Under such circumstances the two species may be expected to show differences in their call site selection (Littlejohn and Martin 1969) that will assist in distinguishing the males of the two species by females moving to the pond to breed.

A calling male *Uperoleia fusca*.

We collected data on the calling positions of the males of each species to determine if the males were selecting different calling areas or types of calling sites. We compared locations of calling males relative to the ponds and also microhabitat information associated with the calling positions to determine what features the males of each species might be selecting for a calling site and how much they differ — if at all.

Methods

The study site consists of two adjacent ponds (within 5 m) that are located approximately 15 km northwest of Kulnura on the central coast of NSW, around 120 km north of Sydney (33° 07' 58.9" S, 151° 12' 22.6" E). Both ponds have been present since at least the late 1970s and are roughly circular in shape. The smaller pond is approximately 10 m in diameter and 0.3 m deep, and the larger 14 m in diameter and 0.9 m deep (depths vary with rainfall).