



An Amphibian and Reptile Inventory of Sleeping Bear Dunes National Lakeshore

Natural Resource Technical Report NPS/GLKN/NRTR—2008/147



ON THE COVER

Erythristic eastern gartersnake (*Thamnophis sirtalis sirtalis*), Sleeping Bear Dunes National Lakeshore, April 2005
Photograph by: G.S. Casper.



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Abstract

The National Park Service, Great Lakes Network Office, commissioned a herpetological inventory of Sleeping Bear Dunes National Lakeshore, Michigan, in 2004. Sleeping Bear Dunes National Lakeshore covers approximately 71,199 acres in a 35-mile stretch of Lake Michigan's eastern coastline, and includes North and South Manitou islands. Objectives of the study were to supplement existing inventory data for amphibians and reptiles in the park, and better assess the status of species listed as "Unconfirmed" or "Probably Present" in the species lists produced in 2003 for each Great Lakes Network park. Based on the 2003 list status, and additional review of regional status, we targeted seven species for surveys. Records for 1,932 museum specimens from the park region were reviewed, as well as Sleeping Bear Dunes National Lakeshore frog and toad survey data and available published and unpublished literature. Seventy-eight new voucher specimens were collected from the park, including the first county-level documentation for nine species. We confirmed the presence of 29 species in the park, another nine species remain unconfirmed, and one species was removed from the park inventory list. Recommendations are made regarding inventory, monitoring and management of amphibians and reptiles in the park.

Acknowledgements

The authors thank Steve Yancho of the National Park Service for his kind and generous logistical support and informative discussions, and David Mauger for his irreproachable field assistance. Jon C. Bedick, Erik A. Beever, Kenneth D. Bowen, Joan Elias, James C. Gillingham, James H. Harding, J. Alan Holman, Ken Hyde, Leah Kainulainen, Kevin Kinnan, Yuman Lee, Mary C. Linton, Bill Route, Lori Sargent, Kim Struthers, Alice and Tom Van Zoeren, and Jim Wendels provided valuable insights and information. We are grateful to the following museum personnel for their kind assistance: Ned Gilmore (ANSP), Gregory Schneider (UMMZ), James H. Harding (MSUM), Kevin Kelly (CRAN), Alan Resetar (FMNH), and Kirsten E. Nicholson (CMU). Carolyn Wallingford (National Park Service) provided guidance on specimen disposition. Ted Gostomski and James Harding provided helpful critical review. Finally, we thank Bill Route and Steve Yancho (again) for their understanding and patience with factors out of our control in finalizing this report.

Introduction

This inventory was conducted to build upon prior park species lists (Hatt et al. 1948; Scharf and Jorae 1980; Case and Scharf 1985; Linton et al. 1988; Bowen and Gillingham 2004; Casper 2004), improve inventory data for amphibians and reptiles, identify additional inventory needs, and make monitoring recommendations. Based on the 2003 list status, and additional review of regional status, seven species were targeted for surveys (Table 1).

Table 1. Target species list for Sleeping Bear Dunes National Lakeshore, Michigan.

Species	Common Name	Status
Salamanders		
<i>Ambystoma tigrinum</i>	eastern tiger salamander	Probably Present
Frogs and Toads		
<i>Anaxyrus fowleri</i>	Fowler's toad	Probably Present
<i>Acris crepitans</i>	northern cricket frog	Historic
<i>Hyla chrysoscelis</i>	Cope's gray treefrog	Probably Present
Turtles		
<i>Graptemys geographica</i>	northern map turtle	Unconfirmed
<i>Terrapene carolina</i>	eastern box turtle	Unconfirmed
Snakes		
<i>Coluber constrictor foxii</i>	blue racer	Probably Present

Methods

The study area consisted of Sleeping Bear Dunes National Lakeshore in Benzie and Leelanau counties, Michigan. The park covers approximately 71,199 acres along the northeastern shore of Lake Michigan, including North and South Manitou islands (Figure 1). Natural features and ecosystems in the park are varied, but include significant sand dunes and swales, beaches, forests, lakes and ponds, rivers and streams, springs and seeps, and wetlands such as marshes and swamps.

Field Methods

Field sampling during this study was conducted throughout the park, but only one visit each was made to the islands. Sampling sites in the park and its buffer zone were selected in cooperation with park staff (Figure 2). The investigators conducted sampling over five periods: 10-13



Figure 1. Sleeping Bear Dunes National Lakeshore, Michigan.

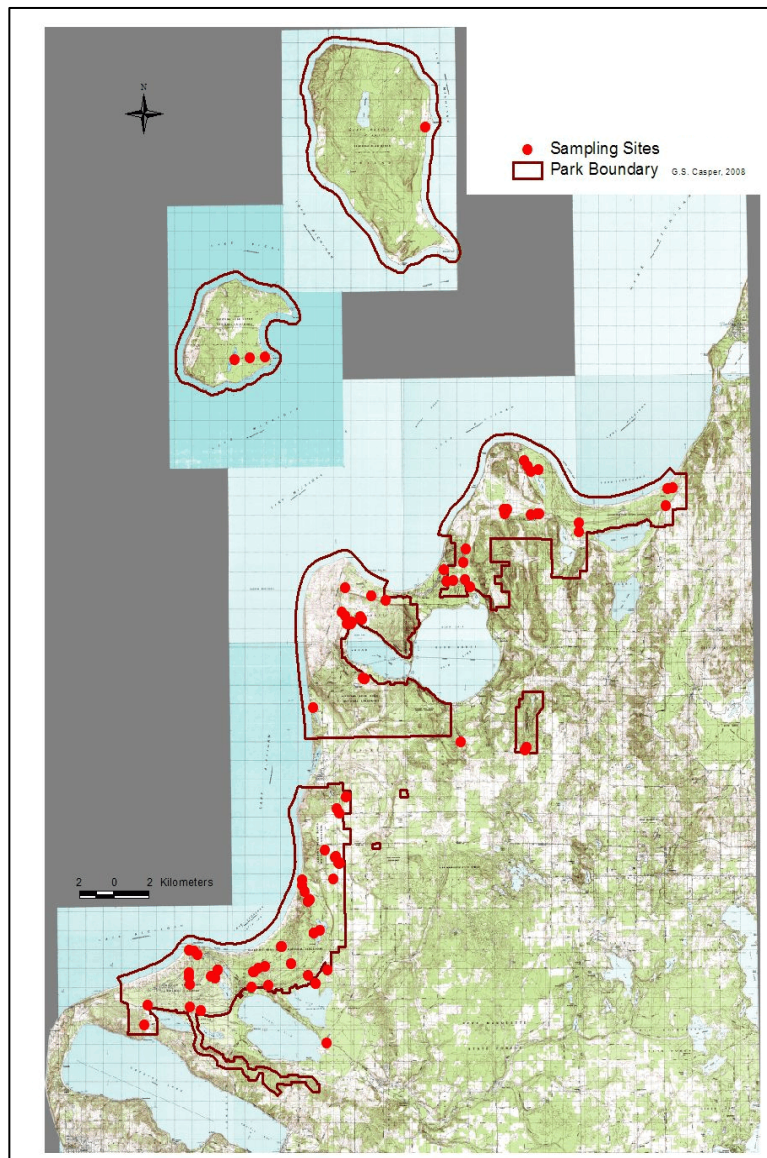


Figure 2. Locations of all sampling sites at Sleeping Bear Dunes National Lakeshore, Michigan. See Appendix B for coordinates.

October 2004 (G. Casper), 18-23 April 2005 (G. Casper), 31 May-6 June 2005 (T. Anton), 8-12 June 2006 (T. Anton, D. Mauger), and 1 October 2006 (T. Anton), with 23.5 person-field days accumulated. Visual searches of habitat areas, coupled with listening surveys to locate and identify calling frogs and toads, were used as primary sampling methods throughout the study (Table 2). Visual search methods included walking through habitat areas, searching underneath and within fallen logs and bark, searching anthropogenic trash and other debris, road cruising, and specialized searches of shoreline and hummock habitats for nesting four-toed salamanders.

Dip netting was performed occasionally for sampling amphibians. Aquatic funnel traps (minnow traps) were used to sample for amphibians in ponds at twelve sites (Figures 3 and 5). Baited hoop net traps measuring 76 cm in diameter and having 2.5-3.8 cm square nylon mesh were baited with canned sardines and used to sample for turtles at three sites (Figure 4). Black landscaping fabric measuring approximately 1 m by 0.5 m were deployed as artificial cover objects for sampling snakes and lizards in seven grassy meadow areas (Figures 3 and 5). Listening surveys to locate and identify calling frogs and toads were conducted at ten sites (Figure 5).

Collection of Vouchers

Collection and preservation of voucher specimens followed Simmons (2002). Voucher specimens were initially deposited at the Milwaukee Public Museum (MPM). However, all but two specimens (MPM 33455 and 33456) were subsequently moved to the Field Museum of Natural History (FMNH) in Chicago after collections and staffing problems arose at the MPM in May 2005. As of this writing, the remaining material remains uncataloged at the FMNH, pending the signing of a repository agreement between the FMNH and the National Park Service. However, all specimens are field tagged and properly curated, at the FMNH. Field tag numbers are therefore used for reference in this document. Tissue samples (tail, toe and scale clips) from most individuals captured were preserved in 95% ethanol for use in future DNA analyses. Field notes and specimen data are found in Appendixes A-E.



Figure 3. Aquatic funnel trap (left) were used to sample amphibians, and artificial cover objects (right) were used to sample snakes and lizards.

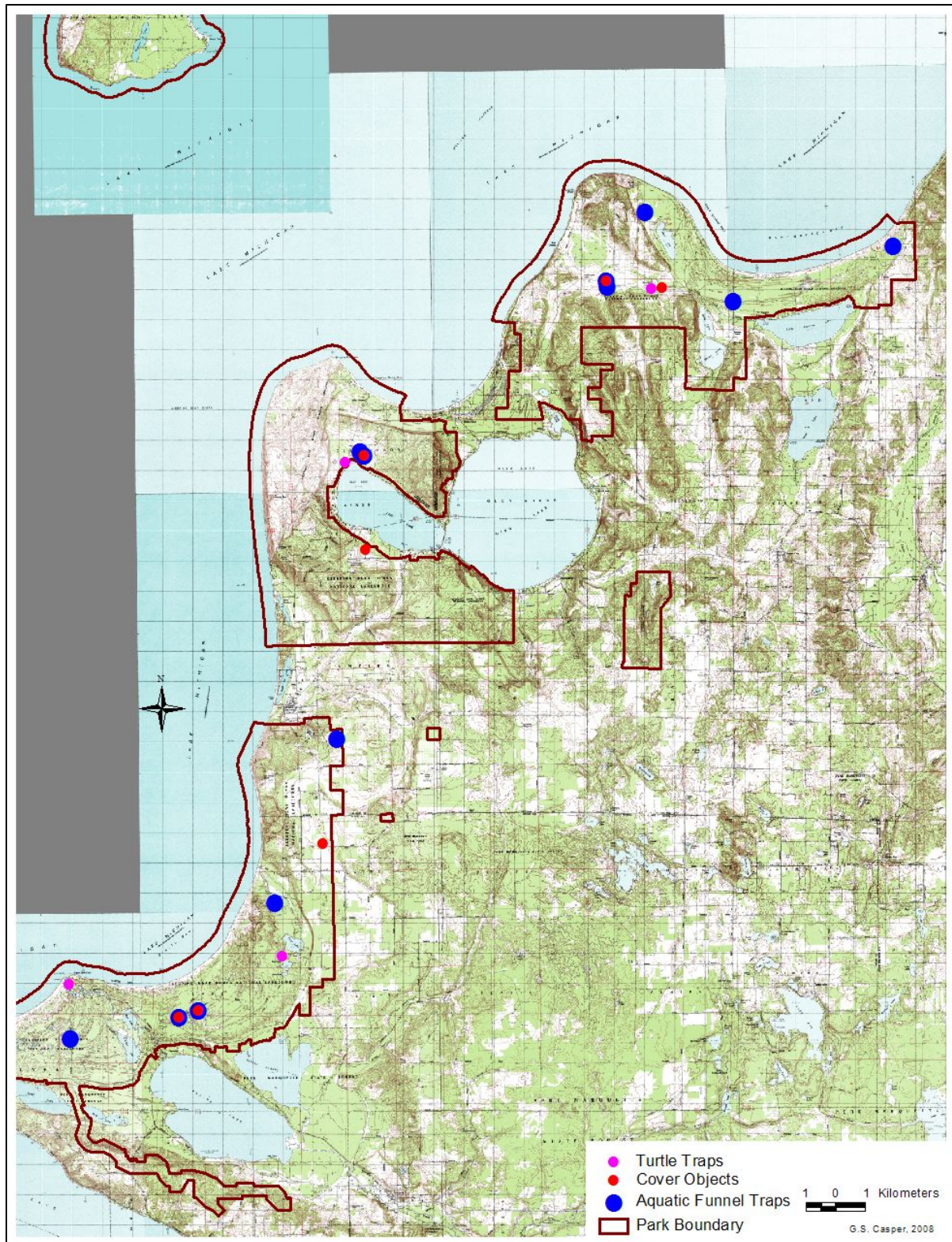


Figure 4. Trapping and cover object sites, Sleeping Bear Dunes National Lakeshore, Michigan. See Appendix B for coordinates.

Table 2. Sampling methods summary for Sleeping Bear Dunes National Lakeshore, Michigan, 2004-2006.

Site	Waypoints	Methods	N Sets	Date Set	Dates Checked	N Checks	Effort
Abandoned barns along Basch, Baker, Kelderhouse and Port Oneida Roads	none	visual recon			2005: Jun 1	1	1
Aral Hill Road S of Manning Road	TA6	visual recon			2005: Jun 2	1	1
Aral Lodge Road	WP057-58	visual recon			2005: Apr 22	1	1
Aral Road and Hwy 22 (NE corner)	WP009, WP044-45, SB15	fabric	2	4/19/05	2005: Apr 21; May 31, Jun 3	3	6
Aral Road and Hwy 22 (NE corner)	WP009, WP044-45, SB15	visual recon			2004: Oct 12. 2005: Apr 19, 21; May 31, Jun 3	5	5
Bass Lake (Benzie County)	WP001-3, TA1	turtle traps	4	5/31/05	2005: Jun 1, 2, 3, 4, 5, 6 (pulled)	6	24
Bass Lake (Benzie County)	WP001-3, TA1	visual recon			2005: May 31, Jun 1, 2, 3, 4, 5, 6. 2006: Oct 1	8	8
Beaver pond along W Lake Michigan Road trail	SB10, WP023	minnow traps	3	4/19/05	2005: Apr 20 (pulled)	1	3
Beaver pond along W Lake Michigan Road trail	SB10, WP023	visual recon			2004: Oct 11. 2005: Apr 19, 20	3	3
Boekeloo (Cooper) Road wetlands	SB1	visual recon			2004: Oct 11	1	1
Boekeloo (Cooper) Road pond	WP011	visual recon			2005: Apr 19	1	1
Boekeloo (Cooper) Road pond	WP012	minnow traps	4	4/19/05	2005: Apr 20, 22 (pulled)	2	8
Boekeloo (Cooper) Road pond	WP012	visual recon			2005: Apr 19, 20, 22	3	3
Boekeloo Road	WP013	visual recon			2005: Apr 19, Jun 4	2	2
Bog between Spencer and Lake Michigan Roads (44.710885N, -86.112969W)	Spencer Bog	visual recon			2005: Jun 4. 2006: Jun 9, 10, 12	4	4
Cass Lake	none	visual recon			2005: Apr 22	1	1
Crystal River along CR 675	WP051, WP054	visual recon			2005: Apr 21, 22; Jun 1	3	3
Crystal River along Hwy 22	TA2	visual recon			2005: Jun 1	1	1
Crystal River at Fisher Lake	SB7	visual recon			2004: Oct 11	1	1
Deadstream Swamp	SB18	visual recon			2004: Oct 12	1	1
Dune Climb area	WP047-49	visual recon			2005: Apr 21	1	1
Dune Valley Road	WP050	visual recon			2005: Apr 21	1	1
Esch Road beach	none	visual recon			2006: Aug 31	1	1

Table 2. Sampling methods summary for Sleeping Bear Dunes National Lakeshore, Michigan, 2004-2006 (continued).

Site	Waypoints	Methods	N Sets	Date Set	Dates Checked	N Checks	Effort
Farm pond W side M22 on Esch Road	SB16	visual recon			2004: Oct 12	1	1
Good Harbor Road	WP020-21	visual recon			2005: Apr 19, 20, 21, 22	4	4
Good Harbor Road pond	WP020	minnow traps	4	4/19/05	2005: Apr 20, 21, 22 (pulled)	3	12
Hwy 22 bog N of Thompson Road	WP026	visual recon			2005: Apr 22, Jun 1. 2006: Jun 9	3	3
Hwy 22 bog S of Thompson Road	WP053	visual recon			2005: Apr 22, Jun 1. 2006: Jun 9	3	3
Hwy 22 east of Boekeloo (Cooper) Road	WP010	visual recon			2005: Apr 19. 2006: Oct 1	2	2
Indian Trail	ribbons	visual recon			2006: Jun 11	1	1
Lasso Road jct	SB3	visual recon			2004: Oct 11	1	1
Lasso Road	WP016	visual recon			2005: Apr 19	1	1
Lasso Road swale pond	WP015	fabric	2	4/19/05	2005: May 31, Jun 2, 4	3	6
Lasso Road swale pond	WP015	minnow traps	8	5/31/05	2005: Jun 2, 4, 5 (pulled)	5	40
Lasso Road swale pond	WP015	visual recon			2005: Apr 19; May 31, Jun 2, 4, 5	5	5
Long Lake	none	visual recon			2004: Oct 11	1	1
Loon Lake	none	visual recon			2005: Jun 4	1	1
M-22 at park entrance	Hognose	visual recon			2006: Jun 8	1	1
M-22 near Good Harbor Drive	M22GH	visual recon			2006: Oct 1	1	1
Martin Road E from M22, wetland	SB17	visual recon			2004: Oct 12. 2006: Jun 10	2	2
Mill Pond	TA10, SB6	turtle traps	3	6/1/05	2005: Jun 2, 3, 4, 5, 6 (pulled)	5	15
Mill Pond	TA10, SB6	visual recon			2004: Oct 11. 2005: Jun 1, 2, 3, 4, 5, 6. 2006: Oct 1	8	8
N Bar Lake	N Bar Lake	visual recon			2005: Apr 22, Jun 1. 2006: Jun 10	3	3
N. Manitou Island NE dock	SB11	visual recon			2004: Oct 12	1	1

Table 2. Sampling methods summary for Sleeping Bear Dunes National Lakeshore, Michigan, 2004-2006 (continued).

Site	Waypoints	Methods	N Sets	Date Set	Dates Checked	N Checks	Effort
Narada Lake	Narada Lake	turtle traps	4	6/1/05	2005: Jun 2, 3, 4, 5 (pulled)	4	16
Narada Lake	Narada Lake	visual recon			2004: Oct 11. 2005: Jun 1, 2, 3, 4, 5. 2006: Oct 1	7	7
Narada Lake E	WP031-34	fabric	4	4/20/05	2005: Jun 1, 3	2	8
Narada Lake E	WP031-34	visual recon			2005: Apr 20, Jun 1, 3	3	3
Narada Lake W	WP035-39	fabric	4	4/20/05	2005: Jun 1, 3	2	8
Narada Lake W	WP035-39	minnow traps	3	4/20/05	2005: Apr 21 (pulled)	1	3
Narada Lake W	WP035-39	visual recon			2005: Apr 20, 21; Jun 1, 3	4	4
NE corner W Welch Road / 616 and W. Harriger Road	WP027-30	fabric	4	4/20/05	2005: Jun 1, 3	2	8
NE corner W Welch Road / 616 and W. Harriger Road	WP027-30	visual recon			2005: Apr 20, Jun 1, 3	3	3
North end of Shell Lake	WP024	visual recon			2005: Apr 19	1	1
Otter Cr area	SB4-5, WP007-8, TA5	visual recon			2004: Oct 11. 2005: Jun 2. 2006: Oct 1	3	3
Otter Lake	WP059	visual recon			2005: Apr 22	1	1
Platte Lake access	TA3	visual recon			2005: Jun 2	1	1
Platte River along Lake Michigan Road	WP042-43	visual recon			2005: Apr 21; May 31	2	2
Platte River Fish weir	WP006, WP040-41, WP069, TA9	visual recon			2004: Oct 11. 2005: Apr 21, Jun 4. 2006: Jun 8, Oct 1	5	5
Platte River mouth backwater	TA4	turtle traps	4	6/8/06	2006: Jun 9, 10, 11, 12 (pulled)	4	16
Platte River mouth backwater	TA4	visual recon			2004: Oct 11. 2005: Jun 2, 4. 2006: Jun 8, 9, 10, 11, 12; Oct 1	9	9
Pond W of Hwy 22 N of Aral Road	SB14, WP046	visual recon			2004: Oct 12. 2006: Oct 1	2	2
Round Lake	TA8	visual recon			2004: Oct 11. 2005: Jun 4	2	2
S of Esch Beach	WP008	minnow traps	2	4/18/05	2005: Apr 19 (pulled)	1	2
S of Esch Beach	WP008	visual recon			2005: Apr 18, 19	2	2

Table 2. Sampling methods summary for Sleeping Bear Dunes National Lakeshore, Michigan, 2004-2006 (continued).

Site	Waypoints	Methods	N Sets	Date Set	Dates Checked	N checks	Effort
S. Manitou I.	none	visual recon			2004: Oct 12	1	1
Sand pit pond near Shell Lake	SB12	visual recon			2004: Oct 12. 2006: Jun 9 (2x), 12	4	4
Sedge meadow along Peterson Road	WP014, SB2	fabric	2	4/19/05	2005: May 31, Jun 2, 4	3	6
Sedge meadow along Peterson Road	WP014, SB2	minnow traps	7	5/31/05	2005: Jun 2, 4, 5 (pulled)	5	35
Sedge meadow along Peterson Road	WP014, SB2	visual recon			2004: Oct 11. 2005: Apr 19; May 31, Jun 2, 4, 5	6	6
Shalda Cr at S Bohemian Road	SB8	visual recon			2004: Oct 11. 2005: Jun 3. 2006: Jun 9	3	3
Shell Lake along N. Lake Michigan Road (44.954394N, -85.903771W)	SB12	visual recon			2005: Jun 5	1	1
South side of Hwy 22 W of Narada Lake	WP025, WP052	visual recon			2005: Apr 19, 21, 22. 2006: Oct 10	4	4
South side of Hwy 22 W of Narada Lake	WP052	minnow traps	3	4/21/05	2005: Apr 22 (pulled)	1	3
Stormer Road constructed pond N side and E of Hwy 22 (44.793526N, -86.046148W)	Stormer Road pond	visual recon			2005: Jun 4	1	1
Swale on S Bohemian Road, W side road	WP022	minnow traps	3	4/19/05	2005: Apr 20, 21 (pulled)	2	6
Swale on S Bohemian Road, W side road	WP022	visual recon			2005: Apr 19, 20, 21	3	3
Swales W of Glen Arbor	WP017	visual recon			2005: Apr 19	1	1
Taylor Lake	WP005	minnow traps	6	4/18/05	2005: Apr 19 (pulled 2), 20, 21, 22 (pulled)	4	18
Taylor Lake	WP005	visual recon			2005: Apr 18, 19, 20, 21, 22	5	5
Traverse Lake area	none	visual recon			2005: Jun 3	1	1
Tucker Lake	SB13	visual recon			2004: Oct 12	1	1
W Baatz Road Bog	WP055-56	visual recon			2005: Apr 22	1	1
W Day Farm and Forest Roads	WP018-19	fabric	2	4/20/05	2005: Apr 21, Jun 1, 3	3	6
W Day Roads pond in mixed woods	WP019	minnow traps	4	4/19/05	2005: Apr 20 (1 trap disturbed), 21, 22 (pulled)	3	11

Table 2. Sampling methods summary for Sleeping Bear Dunes National Lakeshore, Michigan, 2004-2006 (continued).

Site	Waypoints	Methods	N Sets	Date Set	Dates Checked	N checks	Effort
W Day Roads pond in mixed woods	WP019	visual recon			2005: Apr 19, 20, 21, 22; Jun 1, 3	6	6
W Day Roads S constructed pond	WP018	minnow traps	2	4/19/05	2005: Apr 20, 21, 22 (pulled)	3	6
W Day Roads S constructed pond	WP018	visual recon			2005: Apr 19, 20, 21, 22; Jun 1, 3	6	6
Wetland along W Lake Michigan Road trail	SB9	visual recon			2004: Oct 11	1	1



Figure 5. Calling frog survey sites, Sleeping Bear Dunes National Lakeshore, Michigan. These surveys are conducted by park staff.

Review of Existing Data and Specimens

In addition to fieldwork, a review of available data and documentation of regional herpetofauna was conducted. Frog and toad survey data for the park were reviewed, and observational data were received from park staff (Steve Yanco and fisheries survey personnel) and local naturalists (Jon C. Bedick, Kevin Kinnan, Kim Struthers, Alice and Tom Van Zoeren, Jim Wendels). Listings of amphibian and reptile holdings from the study area were requested from 56 museums (Table 3). Common names are used throughout this report, with scientific names provided in Table 4. Scientific and common names follow the latest professional society standards (Crother 2008), but since these involve significant recent changes to long established names, Table 4 provides a comparison chart.

Table 3. Museums canvassed for Benzie County and Leelanau County material.

Acronym	Institution	N Specimens Returned
AMNH	American Museum of Natural History	
AMS	Australian Museum, Sydney	
ANSP	The Academy of Natural Sciences, Philadelphia, PA	
ASU	Arizona State University	
AUM	Auburn University Natural History Museum and Learning Center	
BLB	Borror Laboratory of Bioacoustics, Ohio State University	
BPBM	Bernice P. Bishop Museum, Honolulu, HI	
BYU	Monte L. Bean Museum, Brigham Young University, Provo, UT	
CAS	California Academy of Sciences, San Francisco, CA	
CIB	Chengdu Institute of Biology, Chinese Academy of Sciences, Chengdu, Sichuan, China	
CM	Carnegie Museum of Natural History, Pittsburgh, PA	18
CRAN	Cranbrook Institute of Science, Bloomfield Hills, MI	
CU	Cornell University Museum of Vertebrates	4
FMNH	Field Museum of Natural History, Chicago, IL	1
GMNH	Georgia Museum of Natural History, University of Georgia	
INHS	Illinois Natural History Survey, University of Illinois	
ISUA	Iowa State University Research Collection	
JFBM	Bell Museum, University of Minnesota	
KUNHM	University of Kansas Natural History Museum and Biodiversity Research Center	31
LACM	Natural History Museum of Los Angeles County	
LSU	Louisiana Museum of Natural History, Louisiana State University	
MCZ	Museum of Comparative Zoology, Harvard University	1
MHNG	Museum d'histoire naturelle de la Ville de Geneve, Switzerland	
MHP	Museum of the High Plains - Fort Hays State University, Sternberg Museum of Natural History, Fort Hays, KS	15
MPM	Milwaukee Public Museum	
MSB	Museum of Southwestern Biology, University of New Mexico	8
MSUM	Division of Vertebrate Natural History, Michigan State University Museum, East Lansing	
MVZ	Museum of Vertebrate Zoology, University of California, Berkeley	
NLU	University of Louisiana at Monroe	
OMNH	Sam Noble Oklahoma Museum, University of Oklahoma	
PSM	James R. Slater Museum, University of Puget Sound	
RM	Raffles Museum of Biodiversity Research, Singapore	
RMCA	Royal Museum of Central Africa	
RMMU	Redpath Museum, McGill University	
ROM	Royal Ontario Museum, Toronto, Ontario	
SBNHM	Santa Barbara Natural History Museum, Santa Barbara, CA	
SDNHM	San Diego Natural History Museum, San Diego, CA	
SMNS	Staatliches Museum fur Naturkunde Stuttgart, Germany	
TCWC	Texas Cooperative Wildlife Collection, Texas A & M University	
TNHC	Texas Natural History Center, University of Texas, Austin	
UA	University of Alabama Museum of Natural History	

Table 3. Museums canvassed for Benzie County and Leelanau County material (continued).

Acronym	Institution	N Specimens Returned
UAM	University of Alaska - Museum of the North	
UAMZ	University of Alberta Museum of Zoology	
UAZ	Amphibian and Reptile Collection, University of Arizona	
UCM	University of Colorado Museum	
UF	Florida Museum of Natural History, University of Florida	
UMMZ	University of Michigan Museum of Zoology, Ann Arbor	1854
UMNH	Utah Museum of Natural History	
UNAM	Instituto de Biología y Museo de Zoología, Universidad Nacional Autónoma de México	
UNR	Biological Resources Research Center, University of Nevada, Reno	
UNSM	University of Nebraska State Museum	
USNM	Smithsonian National Museum of Natural History, Washington, D.C.	
UTA	Amphibian and Reptile Diversity Research Center, University of Texas at Arlington	
UTEP	The Centennial Museum, University of Texas at El Paso	
YPM	Peabody Museum, Yale University	
ZIN	Zoological Institute, Russian Academy of Sciences, St. Petersburg, Russia	
TOTAL		1932

Table 4. Comparison of common and scientific names for species that have been reclassified (based on Crother 2008).

Old Names		New Names	
Scientific	Common	Scientific	Common
<i>Ambystoma tigrinum tigrinum</i>	Eastern Tiger Salamander	<i>Ambystoma tigrinum</i>	Eastern Tiger Salamander
<i>Acris crepitans blanchardi</i>	Blanchard's Cricket Frog	<i>Acris crepitans</i>	Northern Cricket Frog
<i>Bufo americanus americanus</i>	Eastern American Toad	<i>Anaxyrus americanus americanus</i>	Eastern American Toad
<i>Bufo fowleri</i>	Fowler's Toad	<i>Anaxyrus fowleri</i>	Fowler's Toad
<i>Pseudacris crucifer crucifer</i>	Northern Spring Peeper	<i>Pseudacris crucifer</i>	Spring Peeper
<i>Pseudacris triseriata triseriata</i>	Western Chorus Frog	<i>Pseudacris triseriata</i>	Western Chorus Frog
<i>Rana catesbeiana</i>	American Bullfrog	<i>Lithobates catesbeianus</i>	American Bullfrog
<i>Rana clamitans melanota</i>	Northern Green Frog	<i>Lithobates clamitans melanota</i>	Northern Green Frog
<i>Rana palustris</i>	Pickerel Frog	<i>Lithobates palustris</i>	Pickerel Frog
<i>Rana pipiens</i>	Northern Leopard Frog	<i>Lithobates pipiens</i>	Northern Leopard Frog
<i>Rana septentrionalis</i>	Mink Frog	<i>Lithobates septentrionalis</i>	Mink Frog
<i>Rana sylvatica</i>	Wood Frog	<i>Lithobates sylvaticus</i>	Wood Frog
<i>Eumeces fasciatus</i>	Five-lined Skink	<i>Plestiodon fasciatus</i>	Common Five-lined Skink
<i>Elaphe vulpina</i>	Western Foxsnake	<i>Pantherophis vulpinus</i>	Western Foxsnake
<i>Nerodia sipedon sipedon</i>	Northern Watersnake	<i>Nerodia sipedon sipedon</i>	Common Watersnake
<i>Regina septemvittata</i>	Queen Snake	<i>Regina septemvittata</i>	Queensnake
<i>Clemmys insculpta</i>	Wood Turtle	<i>Glyptemys insculpta</i>	Wood Turtle
<i>Graptemys geographica</i>	Common Map Turtle	<i>Graptemys geographica</i>	Northern Map Turtle

Results and Discussion

Confirmation of Species

We confirmed the presence of 29 species of amphibians and reptiles in the park (Table 5): five salamander, nine anuran, four turtle, ten snake, and one lizard species. Of these, several have limited distributions. An additional two salamander (blue-spotted, eastern tiger), two anuran (Fowler's toad, Cope's gray treefrog), three turtle (spotted, wood, Blanding's), and two snake (northern red-bellied, eastern massasauga) species remain unconfirmed, with varying probabilities of being present in the park (see species accounts). There is no support for the inclusion of the northern cricket frog in the Sleeping Bear Dunes National Lakeshore species list, and it should be removed.

First vouchers for Benzie or Leelanau counties were obtained for nine species: spotted salamander, four-toed salamander, eastern American toad, gray treefrog, eastern snapping turtle, midland painted turtle, northern map turtle, eastern hog-nosed snake, and northern ribbonsnake. Additional vouchers that significantly supplement past collections were obtained, specifically from the park, for fifteen species: common mudpuppy, eastern newt, eastern red-backed salamander, spring peeper, northern green frog, northern leopard frog, wood frog, blue racer, northern ring-necked snake, eastern milksnake, northern watersnake, smooth greensnake, DeKay's brownsnake, eastern gartersnake, and common five-lined skink.

Species with range limits in or near the park are of special interest relevant to ongoing climate change. These include the eastern tiger salamander, Fowler's toad, western chorus frog, spiny softshell, spotted turtle, northern map turtle, eastern box turtle, blue racer, and queensnake. Two of these (spiny softshell, queensnake) are currently not present in Sleeping Bear Dunes National Lakeshore but could expand their ranges into the park. Others are currently not confirmed at Sleeping Bear Dunes National Lakeshore but are suspected to occur, and their status could change (eastern tiger salamander, Fowler's toad, and spotted turtle).

Conversely, for several species Sleeping Bear Dunes National Lakeshore is well within their range limits, and the lack of confirmed records to date suggests ecological or other factors affecting occupation of Sleeping Bear Dunes National Lakeshore habitats, or simply insufficient inventory effort for difficult to detect species (blue-spotted salamander, Cope's gray treefrog, wood turtle, Blanding's turtle, northern red-bellied snake, and eastern massasauga).

Eight museums reported holdings of 1,932 total specimens from the study area (see Table 3). Relevant specimen data are included in the species accounts below and in Appendix D.

Sleeping Bear Dunes National Lakeshore provided calling frog survey data for one route in the park with ten stops, although eleven sites are named in the database, with "Kelderhouse" missing from the GIS file (see Figure 5). Annual data from 1989 through 2003 were provided. The following species were recorded: eastern American toad, spring peeper, western chorus frog, gray treefrog, American bullfrog, northern green frog, and wood frog. All of these species are now

Table 5. Sleeping Bear Dunes National Lakeshore herptile checklist.

Family	Scientific Name	Common Name	Prior Status	Current Status	References
Ambystomatidae	<i>Ambystoma laterale</i>	blue-spotted salamander	Present in Park	Unconfirmed	Harding (1997). Harding and Holman (1999). Holman (2004). Vouchers: Questionable UMMZ specimen.
Ambystomatidae	<i>Ambystoma maculatum</i>	spotted salamander	Present in Park	Confirmed*	Harding (1997). Harding and Holman (1999). Vouchers: this study, UKZM.
Ambystomatidae	<i>Ambystoma tigrinum tigrinum</i>	eastern tiger salamander	Probably Present	Unconfirmed	Harding (1997). Harding and Holman (1999). Vouchers: none.
Bufonidae	<i>Anaxyrus americanus americanus</i>	eastern American toad	Present in Park	Confirmed*	Hatt et al. (1948). Scharf and Jorae (1980). Harding (1997). Harding and Holman (1999). Bowen and Gillingham (2004). Bowen and Beever (2008). Vouchers: this study, CM, KUNHM, MPM, MSUM, UMMZ.
Bufonidae	<i>Anaxyrus fowleri</i>	Fowler's toad	Probably Present	Unconfirmed	Ruthven et al. (1928). Harding (1997). Harding and Holman (1999). Vouchers: none.
Chelydridae	<i>Chelydra serpentina serpentina</i>	eastern snapping turtle	Present in Park	Confirmed*	Hatt et al. (1948). Scharf and Jorae (1980). Case and Scharf (1985). Harding and Holman (1990). Ernst et al. (1994). Harding (1997). Bowen and Gillingham (2004). Holman (2004). Fessell (2007). Vouchers: this study, UMMZ.
Colubridae	<i>Coluber constrictor foxii</i>	blue racer	Probably Present	Confirmed	Holman et al. (1989). Harding (1997). Ernst and Ernst (2003). Holman (2004). Vouchers: this study, UMMZ.
Colubridae	<i>Diadophis punctatus edwardsii</i>	northern ring-necked snake	Present in Park	Confirmed	Hatt et al. (1948). Scharf and Jorae (1980). Holman et al. (1989). Harding (1997). Ernst and Ernst (2003). Bowen and Gillingham (2004). Holman (2004). Vouchers: this study, MSUM, UMMZ.
Colubridae	<i>Heterodon platirhinos</i>	eastern hog-nosed snake	Present in Park	Confirmed*	Holman et al. (1989). Harding (1997). Ernst and Ernst (2003). Vouchers: this study
Colubridae	<i>Lampropeltis triangulum triangulum</i>	eastern milksnake	Present in Park	Confirmed	Holman et al. (1989). Harding (1997). Ernst and Ernst (2003). Holman (2004). Vouchers: this study, KUNHM, UMMZ.

Table 5. Sleeping Bear Dunes National Lakeshore herptile checklist (continued).

Family	Scientific Name	Common Name	Prior Status	Current Status	References
Colubridae	<i>Nerodia sipedon sipedon</i>	northern watersnake	Present in Park	Confirmed	Holman et al. (1989). Holman et al. (1993). Harding (1997). Ernst and Ernst (2003). Holman (2004). Vouchers: this study, MSUM, UMMZ.
Colubridae	<i>Opheodrys vernalis</i>	smooth greensnake	Present in Park	Confirmed	Holman et al. (1989). Harding (1997). Ernst and Ernst (2003). Holman (2004). Vouchers: this study, MSUM, UMMZ.
Colubridae	<i>Pantherophis vulpinus</i>	western foxsnake	Absent	Confirmed ¹	Holman et al. (1989). Harding (1997). Ernst and Ernst (2003). Holman (2004). Bowen et al. 2007. Vouchers: ISUA (photo), MSUM (probably erroneous).
Colubridae	<i>Storeria dekayi</i>	DeKay's brownsnake	Present in Park	Confirmed	Scharf and Jorae (1980). Holman et al. (1989). Holman et al. (1993). Harding (1997). Ernst and Ernst (2003). Bowen and Gillingham (2004). Holman (2004). Vouchers: this study, MSUM, UMMZ.
Colubridae	<i>Storeria occipitomaculata occipitomaculata</i>	northern red-bellied snake	Present in Park	Unconfirmed	Holman et al. (1989). Harding (1997). Ernst and Ernst (2003). Holman (2004). Vouchers: none.
Colubridae	<i>Thamnophis sauritus septentrionalis</i>	northern ribbonsnake	Present in Park	Confirmed*	Hatt et al. (1948). Holman et al. (1989). Harding (1997). Ernst and Ernst (2003). Bowen and Gillingham (2004). Holman (2004). Vouchers: this study.
Colubridae	<i>Thamnophis sirtalis sirtalis</i>	eastern gartersnake	Present in Park	Confirmed	Hatt et al. (1948). Scharf and Jorae (1980). Holman et al. (1989). Harding (1997). Ernst and Ernst (2003). Bowen and Gillingham (2004). Holman (2004). Vouchers: this study, CM, KUNHM, UMMZ.
Emydidae	<i>Chrysemys picta marginata</i>	midland painted turtle	Present in Park	Confirmed*	Hatt et al. (1948). Case and Scharf (1985). Harding and Holman (1990). Ernst et al. (1994). Harding (1997). Bowen and Gillingham (2004). Holman (2004). Fessell (2007). Vouchers: this study, UMMZ.

Table 5. Sleeping Bear Dunes National Lakeshore herptile checklist (continued).

Family	Scientific Name	Common Name	Prior Status	Current Status	References
Emydidae	<i>Clemmys guttata</i>	spotted turtle	Probably Present	Unconfirmed	Harding and Holman (1990). Ernst et al. (1994). Harding (1997). Holman (2004). Vouchers: none.
Emydidae	<i>Glyptemys insculpta</i>	wood turtle	Present in Park	Unconfirmed	Harding and Holman (1990). Ernst et al. (1994). Harding (1997). Holman (2004). Vouchers: none.
Emydidae	<i>Emydoidea blandingii</i>	Blanding's turtle	Present in Park	Unconfirmed	Harding and Holman (1990). Ernst et al. (1994). Harding (1997). Holman (2004). Vouchers: none.
Emydidae	<i>Graptemys geographica</i>	northern map turtle	Unconfirmed	Confirmed*	Ernst et al. (1994). Harding and Holman (1990). Harding (1997). Vouchers: this study.
Emydidae	<i>Terrapene carolina</i>	eastern box turtle	Unconfirmed	Confirmed	Harding and Holman (1990). Ernst et al. (1994). Harding (1997). Holman (2004). Vouchers: this study (photo), UMMZ.
Hylidae	<i>Acris crepitans</i>	northern cricket frog	Historically Present	Absent	Harding (1997). Harding and Holman (1999). Vouchers: none.
Hylidae	<i>Hyla chrysoscelis</i>	Cope's gray treefrog	Probably Present	Unconfirmed	Bogart and Jaslow (1979). Harding (1997). Harding and Holman (1999). Holman (2004). Vouchers: none.
Hylidae	<i>Hyla versicolor</i>	gray treefrog	Present in Park	Confirmed*	Harding (1997). Harding and Holman (1999). Holman (2004). Vouchers: this study, CM, UMMZ.
Hylidae	<i>Pseudacris crucifer</i>	spring peeper	Present in Park	Confirmed	Hatt et al. (1948). Scharf and Jorae (1980). Harding (1997). Harding and Holman (1999). Bowen and Gillingham (2004). Bowen and Beever (2008). Holman (2004). Vouchers: this study, CM, KUNHM, UMMZ.
Hylidae	<i>Pseudacris triseriata</i>	western chorus frog	Present in Park	Confirmed	Harding (1997). Harding and Holman (1999). Holman (2004). Vouchers: UMMZ.
Plethodontidae	<i>Hemidactylium scutatum</i>	four-toed salamander	Present in Park	Confirmed*	Harding (1997). Harding and Holman (1999). Holman (2004). Vouchers: this study, UMMZ.

Table 5. Sleeping Bear Dunes National Lakeshore herptile checklist (continued).

Family	Scientific Name	Common Name	Prior Status	Current Status	References
Plethodontidae	<i>Plethodon cinereus</i>	eastern red-backed salamander	Present in Park	Confirmed	Hatt et al. (1948). Scharf and Jorae (1980). Harding (1997). Harding and Holman (1999). Bowen and Gillingham (2004). Bowen and Beever (2008). Vouchers: this study, KUNHM, UMMZ.
Proteidae	<i>Necturus maculosus maculosus</i>	common mudpuppy	Present in Park	Confirmed	Harding (1997). Harding and Holman (1999). Holman (2004). Vouchers: this study, MCZ, UMMZ.
Ranidae	<i>Lithobates catesbeianus</i>	American bullfrog	Present in Park	Confirmed	Hatt et al. (1948). Scharf and Jorae (1980). Harding (1997). Harding and Holman (1999). Bowen and Gillingham (2004). Bowen and Beever (2008). Vouchers: UMMZ.
Ranidae	<i>Lithobates clamitans melanota</i>	northern green frog	Present in Park	Confirmed	Hatt et al. (1948). Scharf and Jorae (1980). Harding (1997). Harding and Holman (1999). Bowen and Gillingham (2004). Bowen and Beever (2008). Vouchers: this study, UMMZ.
Ranidae	<i>Lithobates palustris</i>	pickerel frog	Present in Park	Confirmed	Harding (1997). Harding and Holman (1999). Holman (2004). Vouchers: UMMZ.
Ranidae	<i>Lithobates pipiens</i>	northern leopard frog	Present in Park	Confirmed	Hatt et al. (1948). Harding (1997). Harding and Holman (1999). Bowen and Gillingham (2004). Bowen and Beever (2008). Vouchers: this study, KUNHM, UMMZ.
Ranidae	<i>Lithobates sylvaticus</i>	wood frog	Present in Park	Confirmed	Hatt et al. (1948). Scharf and Jorae (1980). Harding (1997). Harding and Holman (1999). Bowen and Gillingham (2004). Bowen and Beever (2008). Holman (2004). Vouchers: this study, CM, KUNHM, UMMZ.
Salamandridae	<i>Notophthalmus viridescens</i>	eastern newt	Present in Park	Confirmed	Harding (1997). Harding and Holman (1999). Holman (2004). Bowen and Gillingham (2004). Bowen and Beever (2008). Vouchers: this study, CM, MSUM, UMMZ.
Scincidae	<i>Plestiodon fasciatus</i>	five-lined skink	Present in Park	Confirmed	Harding and Holman (1990). Harding (1997). Holman (2004). Vouchers: this study, UMMZ.

Table 5. Sleeping Bear Dunes National Lakeshore herptile checklist (continued).

Family	Scientific Name	Common Name	Prior Status	Current Status	References
Viperidae	<i>Sistrurus catenatus</i> <i>catenatus</i>	eastern massasauga	Present in Park	Unconfirmed	Holman et al. (1989). Harding (1997). Ernst and Ernst (2003). Holman (2004). Vouchers: none.

* - new county record, 1 - uncertain origin

confirmed with voucher specimens. Relevant species data are included in the species accounts below.

Literature was reviewed and relevant information incorporated into species accounts. It should be noted that shaded range maps (i.e., Harding 1997) tend to intentionally produce rather conservative maps, and there are often many local distribution gaps within these ranges that are not discernable. For finer scale assessments such as this study, dot maps based on actual records are more useful. In the species accounts, citations from Harding et al. are limited to the more recent publication (Harding 1997), which for purposes here is considered to include the prior Holman et al. (1989) and Harding and Holman (1990, 1999) publications.

Species Inventory Results

Below we detail our findings for each species currently on the Sleeping Bear Dunes National Lakeshore amphibian and reptile species list (taxonomy follows Crother 2008). We include waypoint numbers (e.g., WP014, SB11, TA6) for location data collected via GPS. Location coordinates corresponding to the waypoints are listed in Appendix B. All of our observations are detailed in Appendix C, while Appendix D contains information acquired from museums.

Salamanders

Blue-spotted Salamander (*Ambystoma laterale*): Blue-spotted salamanders were not detected, although some possible hatched egg jellies were noted at Taylor Lake (WP005), both wood frogs and spotted salamanders were also breeding there and these egg jellies may have been from one of these species. One Benzie County museum specimen from T27N R15W Sec. 20 was examined by the senior author and could not be confirmed (a dissected specimen which may be *A. maculatum*). This specimen could be the basis for including Benzie County in Holman (2004). Harding (1997) includes both counties within the range, but see our cautionary comments above regarding shaded range maps.

Blue-spotted salamanders appear to be rare or absent from Sleeping Bear Dunes, and deserve additional inventory work. Their abundance is expected to be positively associated with ephemeral wetlands, increasing canopy closure, increasing amount of downed woody debris, increasing thickness of duff, hardwoods, and loamy soils; and negatively associated with acid soils and dry soils. They are most reliably detected and monitored by visual and aquatic trapping surveys for eggs and adults during spring breeding at ponds (generally early April), and by aquatic trapping of larvae at ponds in June and July.

Vouchers: none.

Museum material: Benzie - UMMZ 156782 (damaged, unconfirmed).

Spotted Salamander (*Ambystoma maculatum*): Spotted salamanders were found at two Leelanau County locations - Taylor Lake (WP005) and West Baatz Road bog (WP056). They have also been reported from North Manitou Island (Linton and Kats 1987; J. Wendels, 2004 photo voucher, see Appendix E), South Manitou Island (J. C. Bedick, 2003 photo voucher, see Appendix E), and Crystal Lake (K. Kinnan, first reported Benzie County observations). Bowen

and Gillingham (2004), and Bowen and Beever (2008), reported this species from North and South Manitou islands. Linton et al. (1988) reported spotted salamanders from North (in 1987) and South (in 1984) Manitou islands, and deposited a photograph of the juvenile specimen from North Manitou Island. No prior museum material is available, and Holman (2004) had no records for Benzie or Leelanau counties. Harding (1997) includes both counties within the range.

This study confirms spotted salamanders on both islands and parts of Leelanau County. Like blue-spotted salamanders, their abundance is expected to be positively associated with ephemeral wetlands, increasing canopy closure, increasing amount of downed woody debris, increasing thickness of duff, hardwoods, and loamy soils; and negatively associated with acid soils and dry soils. They are most reliably detected and monitored by visual and aquatic trapping surveys for eggs and adults during spring breeding at ponds (generally early April), and by aquatic trapping of larvae at ponds in June and July. This species is more fossorial than the blue-spotted salamander. Our records here fill part of the distribution gap for Ecosystem Region II noted by Holman (2004), suggesting more widespread occurrence of this cryptic species. This argues for additional inventory work, especially in Benzie County.

Vouchers: Leelanau - FN 1277, FN 1303, photos (Appendix E).

Museum material: Leelanau - Univ. Kentucky Zoological Museum AP-1, 000 (photo)

Eastern Tiger Salamander (*Ambystoma tigrinum*): No eastern tiger salamanders were found, and no records were available for Benzie or Leelanau counties from museum holdings or other sources. Holman (2004) lists the species from Manistee County immediately south of Benzie County. Harding (1997) includes both counties within the range, but this may be without any specimen basis.

There is as yet no evidence that eastern tiger salamanders are present in the park, and they deserve additional inventory work. Their abundance is expected to be positively associated with ephemeral or semi-permanent wetlands, increasing thickness of duff, and loamy soils; and negatively associated with acid soils and dry soils. They are not as forest-associated as the other Ambystomids, often occupying grassland and prairie habitat where sufficient soils and moisture are present to provide for their burrowing. They are most reliably detected and monitored by visual and aquatic trapping surveys for eggs and adults during spring breeding at ponds (generally early April), and by aquatic trapping of larvae at ponds in June and July. Being at a range limit in Sleeping Bear Dunes National Lakeshore, they may be rare.

Vouchers: none.

Museum material: none.

Eastern Newt (*Notophthalmus viridescens*): Eastern newts were found along Peterson Road (WP014), at Taylor Lake (WP005), and the Good Harbor Drive pond (WP020). They have also been reported from Crystal Lake (K. Kinnan), and North Manitou Island (J. Wendels). Linton and Kats (1987), Bowen and Gillingham (2004), and Bowen and Beever (2008) reported this species from South Manitou Island. Museum holdings include a 1970 record from Platte

Township, Benzie County, and three Leelanau County records: 7.8 miles south of Leland on State Route 22 in 1978, Cedar Creek T28N R12W Sec. 5 in 1960, and a 1920 specimen without specific locality data. Holman (2004) lists the species from both counties, as does Harding (1997).

This study and previous studies confirm that eastern newts are found throughout the park and surrounding region, but additional inventory work would better document their distribution. Their presence on the islands is especially in need of confirmation (no vouchers could be found). Subspecies designation is problematic in this region, where the more eastern occurring red-spotted newt (*N. v. viridescens*) broadly intergrades with the more western occurring central newt (*N. v. louisianensis*) (Harding 1997). Eastern newts prefer permanent and semi-permanent but well-vegetated ponds and lakes, and can tolerate drier terrestrial habitats than other more terrestrial salamanders. They are tolerant of fish presence and often occupy well-vegetated lakes, where permanently aquatic individuals may reside. They are best detected and monitored by aquatic trapping of larvae and adults in May and June, which would work well for documenting presence on the islands.

Vouchers: Leelanau - FN 1301, FN 1302.

Museum material: Benzie - MSUM 11724; Leelanau - CM 68142, UMMZ 56671, UMMZ 122557.

Four-toed Salamander (*Hemidactylium scutatum*): Four-toed salamanders were found only at the Spencer Bog, for a first Benzie County record (FN 17609). One Leelanau County specimen is available, collected from between Duck and Leelanau Lakes in 1937. This specimen was examined and verified by the senior author. Holman (2004) lists the species from Leelanau County only, while Harding (1997) includes both counties within the range (but see our cautionary comments above regarding shaded range maps).

This study confirms that four-toed salamanders are present at the Spencer Bog, and a museum record from outside the park suggests more widespread occurrence. They deserve additional inventory work, including on the islands. However, they seem to be uncommon and probably have a patchy distribution, centered on appropriate breeding ponds in moist forest. Four-toed salamanders prefer moist, mature forests that include wetlands meeting their specialized breeding requirements. Eggs are laid in moss hummocks (although other moist vegetable matter is sometimes used) over shallow, stagnant waters; conditions often found in shaded vernal pools with mossy downed woody debris, and swamps or shrub wetlands with moss mounds or hummocks. Like blue-spotted salamanders, their abundance is expected to be positively associated with ephemeral wetlands, increasing canopy closure, increasing amount of downed woody debris, increasing thickness of duff, hardwoods, and loamy soils; and negatively associated with acid soils and dry soils. They are best detected and monitored by searching for nests and adults at breeding ponds in late May and early June. Appropriate habitat was noted at: WP026 ("M-22 bog"), WP047, WP048, WP049, and WP055.

Vouchers: Benzie - FN 17609.

Museum material: Leelanau - UMMZ 83006.

Eastern Red-backed Salamander (*Plethodon cinereus*): Eastern red-backed salamanders were found throughout the park (including both islands), at: Cross Farm, SB11, SB17, Spencer Bog, WP005, WP012, WP017, WP018-19, WP020, WP048, and WP026/WP053. Hatt et al. (1948), Scharf and Jorae (1980), Linton and Kats (1987), Bowen and Gillingham (2004), and Bowen and Beever (2008) reported them from both North and South Manitou islands. Museum holdings included 1,712 specimens from Benzie and Leelanau counties, with large series from North and South Manitou islands collected in the 1950s and 1960s. Holman (2004) and Harding (1997) list the species from both counties.

This species is very common in the park and surrounding region. Large voucher series are available at UMMZ from both islands, which were used for a variety of studies by A. R. and F. H. Test (i.e., Test 1955; Test and Bingham 1948). Both red- and lead-backed color morphs are present on the islands (Scharf and Jorae 1980; Linton and Kats 1987). They are wholly terrestrial, preferring moist, mature forests with abundant downed woody debris, in which they nest. They are territorial, and abundance is expected to be positively associated with increasing canopy closure, increasing amount of downed woody debris, increasing thickness of duff, hardwoods, and loamy soils; and negatively associated with acid soils and dry soils. They are best detected and monitored by time- and/or area-constrained sampling of downed woody debris in forests in May and June, or October.

Vouchers: Leelanau - FN 1280, FN 1282, FN 1296, FN 1304, FN 1305, FN 1308, FN 1309.

Museum material: Benzie - 11 UMMZ specimens (see Appendix D); Leelanau - 9 KUNHM and 1,692 UMMZ specimens (see Appendix D).

Common Mudpuppy (*Necturus maculosus maculosus*): We found one common mudpuppy guarding a nest in the Crystal River at waypoint TA2. Recent common mudpuppy observations were also reported from four Benzie County sites: Crystal Lake by Kevin Kinnan, Lower Herring and Loon lakes by Mark Tonnello (during fish surveys), and from the mouth of the Crystal River by Alice Van Zoeren. Three museum specimens from Leelanau County are available: Northport in 1970, Cedar Creek T28N R12W Sec 5 in 1960, and Crystal River in 1927. Holman (2004) lists the species from Leelanau County only, while Harding (1997) includes both counties within the range.

Common mudpuppies are documented in Leelanau County, especially the Crystal River, but are likely present throughout the park in aquatic habitats connected to Lake Michigan. Common mudpuppies prefer structured habitat, such as medium to large rock bottoms, fractured bedrock, or submerged log piles. There is concern over their sensitivity to lampricides (Matson 1990), and they are generally associated with cleaner aquatic habitat with good aquatic invertebrate populations. Excessive siltation can bury the hard structure they require for nesting, where eggs are glued to the undersurface of rocks and other structure and guarded until hatching. Additional inventory work would likely identify more populations. Visual surveys in-stream are most effective, especially during April and May when breeding takes place. The effects of the deluge

of invasive species in the Lake Michigan watershed on common mudpuppies has not been studied, but significant impacts are likely, in one direction or the other.

Vouchers: Leelanau - FN 17644 (= FMNH 267586).

Museum material: Leelanau - MCZ A-4271, UMMZ 65439, UMMZ 122556.

Frogs and Toads

Northern Cricket Frog (*Acris crepitans*): Northern cricket frogs were not found during this study. No museum material was found from Benzie or Leelanau counties, nor have they been reported to the Michigan Natural Features Inventory (Y. Lee, personal communication, 2005). The species has not been reported from the park's frog calling survey. Holman (2004) lists the species from Leelanau County without attribution, while Harding (1997) has the species range well south of Benzie County, and does not consider Sleeping Bear Dunes National Lakeshore to be within their historic or present range (personal communication, 2008). This study found no evidence that northern cricket frogs ever occupied Benzie or Leelanau counties, which area is generally considered to be out of their range limits. Early workers occasionally misidentified western chorus frogs as northern cricket frogs, perhaps accounting for the unverified northern record in Ruthven et al. (1928). We recommend removing this species from the Sleeping Bear Dunes National Lakeshore species inventory.

Vouchers: none.

Museum material: none.

Eastern American Toad (*Anaxyrus americanus americanus*): Eastern American toads are well distributed throughout the park, and were found at North Bar Lake (N Bar Lake), Crystal River (TA2), Platte River at the mouth (TA4), and North Manitou Island (SB11). Fifty-six museum specimens from Leelanau County include records from North and South Manitou islands. Scharf and Jorae (1980) reported them as common on North Manitou Island. Hatt et al. (1948), Linton and Kats (1987), Bowen and Gillingham (2004), and Bowen and Beever (2008) reported this species from North and South Manitou islands. The park's calling frog survey detected eastern American toads at nine sites (absent only from the M-22 Bog): Bow Road, Kelderhouse, Kelderhouse Road, Mill Pond, Narada Lake, Port Oneida, School Lake, Shalda Creek, and Westman Road. Harding (1997) includes both counties within the range.

This species is very common in the park and surrounding region, in virtually all habitats.

Vouchers exist from both islands. Nevertheless, we collected the first Benzie County vouchers. They are most abundant around good breeding sites such as weedy lake margins, marshes, and permanent and semi-permanent ponds. They are best detected and monitored by calling surveys, taking detection probabilities into account.

Vouchers: Benzie - FN 17631 (= FMNH 267571), FN 17634 (= FMNH 267572); Leelanau - MPM 33455, MPM 33456.

Museum material: Leelanau - 3 from CM, 2 from KUNHM, 15 from MPM, 2 from MSUM, 33 from UMMZ (see Appendix D).

Fowler's toad (*Anaxyrus fowleri*): Fowler's toads were not found during this study. Holman (2004) lists the species from Manistee County immediately south of Benzie County. No museum material was found from Benzie or Leelanau counties. The species has not been reported during the park's frog calling survey. Harding (1997) includes both counties within the range, and does not consider it unreasonable to expect the species in Sleeping Bear Dunes National Lakeshore (personal communication, 2008). Ruthven et al. (1928) did map a record for this species in Leelanau County.

Fowler's toads appear to be absent or rare in Sleeping Bear Dunes, which region represents a northern range limit for the species. Plenty of seemingly good habitats exist, especially the dune and swale habitats along the lakeshore. Additional inventory work is recommended, and expansion of calling frog survey sites into these habitat areas would be appropriate.

Vouchers: none.

Museum material: none.

Western Chorus Frog (*Pseudacris triseriata*): No western chorus frogs were seen or heard during this study. Only three Benzie County specimen records are available from 1954 with no specific locality information. The calling frog survey detected western chorus frogs at six sites: Bow Road, Kelderhouse Road, Mill Pond, Port Oneida, School Lake, and Westman Road. Holman (2004) and Harding (1997) include both Benzie and Leelanau counties in the distribution.

Western chorus frogs appear to be rare in the park. They are occasionally reported from the park's calling frog surveys, but only Benzie County vouchers are available. Where chorus frogs are present they are usually easily detected by calling surveys, and rarely have less than ten individuals calling in a chorus. Less experienced observers may mistake the trill call of the spring peeper for a chorus frog. These are generally lone calls rather than a sustained chorus, and shorter in duration. Calling frog survey participants should be trained in this subtlety, and future detections followed-up with voucher collections. This species may be sensitive to ongoing climate change.

Vouchers: none.

Museum material: Benzie - UMMZ 178864-66.

Spring Peeper (*Pseudacris crucifer*): Spring peepers are well distributed throughout the park and were detected from Taylor Lake (WP005), Boekelodge cabin (SB1), Boekeloo Road (WP012), Peterson Road wetland (SB2), Esch Beach (WP008), WP021, WP022, a beaver pond (WP023), Dune Climb area (WP048), Hwy 22 (WP025), Good Harbor Drive pond (WP020), Hwy 22 bog (WP026), North Bar Lake (N Bar Lake), W of Narada Lake (WP052), W Baatz Road bog (WP055, WP056), and W Day Farm Road and W Day Forest Road (WP018-19). Museum holdings included twelve records with one North Manitou Island specimen. Scharf and Jorae (1980) found spring peepers around both inland lakes on North Manitou Island. Hatt et al.

(1948) heard peepers on North Manitou Island, and Linton and Kats (1987) reported them from South Manitou Island. Bowen and Gillingham (2004), and Bowen and Beever (2008), reported this species from North and South Manitou islands. The park's calling frog survey detected spring peepers at all eleven sites: Bow Road, Kelderhouse, Kelderhouse Road, M-22 Bog, Mill Pond, Narada Lake, Port Oneida, School Lake, Shalda Creek, Welch Road, and Westman Road. Holman (2004) and Harding (1997) include both Benzie and Leelanau counties in the distribution.

Spring peepers are very common in the park and surrounding region, in virtually all habitats. They are most abundant in forested habitats around good breeding sites (ephemeral wetlands), and are best detected and monitored by calling surveys. Additional voucher collections are recommended on the islands.

Vouchers: Benzie - FN 1307; Leelanau - FN 1276, FN 1278-9, FN 1283-6, FN 1297, FN1299, FN 1300.
Museum material: Benzie - UMMZ 178864, UMMZ 178865-6; Leelanau - CM 68132-5, KUNHM 8115-8, UMMZ 56210, UMMZ 71003, UMMZ 83007, UMMZ 170196.

Gray Treefrog (*Hyla versicolor*): Gray treefrogs were recorded from Boekeloo Road (WP012), Peterson Road (WP014-15), Esch Road beach (SB4), a beaver pond (WP023), Shalda Creek (SB8), and near the junction of W Day Farm Road and W Day Forest Road (WP019). Three museum specimens from northern Leelanau County are available. The calling frog survey detected gray treefrogs at ten sites: Bow Road, Kelderhouse, Kelderhouse Road, M-22 Bog, Mill Pond, Narada Lake, Port Oneida, School Lake, Shalda Creek, and Westman Road. Holman (2004) and Harding (1997) lists the *Hyla versicolor/chrysoscelis* species complex from both counties.

Gray treefrogs are common in the park and surrounding region in forested habitats, but records are relatively few. They are most abundant in forested habitats around good breeding sites (ephemeral wetlands and shallow marsh), and are easily detected and monitored by calling surveys, taking detection probabilities into account.

Vouchers: Benzie - FN 17625 (= FMNH 267567); Leelanau - FN 1275, FN17608.
Museum material: Leelanau - CM 68130, CM 68140, UMMZ 133300.

Cope's Gray Treefrog (*Hyla chrysoscelis*): No Cope's gray treefrogs were detected during this study or the park's calling frog survey, and no museum records are available. Other authors have lumped this species with *H. versicolor* when displaying distribution. Bogart and Jaslow (1979) examined the distribution of the species complex in Michigan, but included no material from Benzie or Leelanau counties.

Cope's gray treefrogs appear to be either absent or rare in the park. They were not detected during this study, or reported from the park's ongoing calling frog surveys. Appropriate barrens habitat is available, and expansion of the calling frog survey sites may eventually detect them.

Calling surveys are sufficient to detect and monitor this species, taking detection probabilities into account.

Vouchers: none.

Museum material: none.

American Bullfrog (*Lithobates catesbeianus*): No American bullfrogs were detected during this study. Two specimens were collected from North Manitou Island in the 1930s. These specimens were examined and verified by the senior author. Scharf and Jorae (1980) heard >3 American bullfrogs calling from Tamarack Lake on 19 June 1973 on North Manitou Island. Hatt et al. (1948) also found American bullfrogs on North Manitou Island, describing them as “...literally swarmed in Tamarac (sic) Lake... Innumerable small individuals played in the shallow water covering the quaking bog of the lake’s border, and adults called from its center in the bright mid-morning light of July 6.” Bowen and Gillingham (2004), and Bowen and Beever (2008), reported detection on North Manitou Island. The park’s calling frog survey reports American bullfrogs at four sites from 1990 through 1997: Kelderhouse Road, M-22 Bog, Mill Pond, and Westman Road. Holman (2004) records the species from Leelanau County, perhaps based on these North Manitou Island specimens. Harding (1997) includes both counties within the range.

American bullfrogs are apparently sparsely distributed in the park, with vouchers only from North Manitou Island. We recommend that vouchers be collected from the calling frog survey sites that have recorded this species, and additional inventory work be conducted on the mainland and South Manitou Island. Calling surveys are sufficient to detect and monitor this species (while considering detection probabilities), but visual searches along shorelines and aquatic trapping of larvae are also good techniques to locate more populations. Aquatic funnel trapping for tadpoles should yield high detection probabilities, and may be well suited for monitoring this species where calling surveys are logistically difficult, such as the islands. American bullfrogs are considered an invasive species in western North America and many foreign countries, and can displace other native ranid frogs (Lannoo 2005). American bullfrogs require permanent waters for their two-year larval development cycle, but often utilize semi-permanent and ephemeral ponds and wetlands for non-breeding activities.

Vouchers: none.

Museum material: Leelanau - UMMZ 72571, UMMZ 82978.

Northern Green Frog (*Lithobates clamitans melanota*): Northern green frogs are well distributed throughout the park and were confirmed from many locations. Museum holdings included specimens from Crystal Lake, Little Platt Lake, Platte River, and North Manitou Island. Scharf and Jorae (1980) found and photographed one specimen on North Manitou Island. Hatt et al. (1948), Linton and Kats (1987), Bowen and Gillingham (2004), and Bowen and Beever (2008) reported detection on North Manitou Island. Hatt et al. (1948) found only a few northern green frogs in a beach swale at the northeastern corner of the island, and speculated that they were rare or absent from Tamarac (sic) Lake due to competitive exclusion by abundant American bullfrogs. The park’s calling frog survey reports northern green frogs at all eleven sites: Bow

Road, Kelderhouse, Kelderhouse Road, M-22 Bog, Mill Pond, Narada Lake, Port Oneida, School Lake, Shalda Creek, Welch Road, and Westman Road. Harding (1997) includes both counties within the range.

Northern green frogs are very common in the park and surrounding region along shorelines of lakes and streams, and in wetlands. The species is well represented by vouchers except for South Manitou Island, where collection of a few vouchers is recommended. Northern green frogs are most abundant in warm water habitats with abundant vegetative cover, and are best detected and monitored by calling surveys. Visual searches along shorelines are also a good method for locating more populations, and aquatic funnel traps are very successful for collecting larvae. The latter method has high detection probabilities (Casper, unpublished data), and is well suited for monitoring this species where calling surveys are logistically difficult (such as islands).

Vouchers: Benzie - FN 1306; Leelanau - FN 1295, FN 1298, FN 1310-1.

Museum material: Benzie - UMMZ 58592, UMMZ 61680, UMMZ 92330, UMMZ 224828; Leelanau - UMMZ 56213-9, UMMZ 82979, UMMZ 89500, UMMZ 156778, UMMZ 179251.

Pickerel Frog (*Lithobates palustris*): No pickerel frogs were detected during this study or reported from the park's calling frog survey. Museum records are limited to two Benzie County records: from N. Branch Platte River in 1937 (0.5 mi from Little Platte Lake), and near Platte Lake in 1923. Holman (2004) includes Benzie County but not Leelanau County within the known distribution. Harding (1997) includes both counties within the range.

Pickerel frogs appear to be rare or absent from the park, but detection is often difficult. Calling frog surveys are generally not sufficient to detect this species with confidence (false negatives are common). It has a weak call and a brief calling period. Pickerel frogs prefer streams and spring-fed ponds. Additional survey work is recommended, utilizing both calling surveys and shoreline searches.

Vouchers: none.

Museum material: Benzie - UMMZ 58569, UMMZ 92331.

Northern Leopard Frog (*Lithobates pipiens*): Northern leopard frogs were found at only two Benzie County locations: along Peterson Road (WP015) and at the Platte River mouth (TA4). One museum specimen was collected from near Platte Lake in 1923, and from the Manistee drainage in 1925. Leelanau County museum records are limited to Duck Lake and Omena. Hatt et al. (1948), Linton and Kats (1987), Bowen and Gillingham (2004), and Bowen and Beever (2008) reported detection on South Manitou Island. No northern leopard frogs were reported from the calling frog survey. Harding (1997) includes both counties within the range.

Northern leopard frog records in the park are scarce, with only Benzie County sites confirmed. Calling surveys have poor reliability in detecting this species because of its weak call and a brief calling period. Additional inventory work is recommended, combining calling surveys with visual searches of breeding habitat in May. This species has complex habitat requirements,

including permanent water for hibernating sites (often streams or deep lakes), ephemeral or semi-permanent ponds and wetlands for breeding, upland habitats (especially meadows) for summer foraging, and duff and tussocks for mid-summer estivation.

Vouchers: Benzie - FN 17632 (= FMNH 267570), FN 17633 (= FMNH 267569).

Museum material: Benzie - UMMZ 58568, UMMZ 61681; Leelanau - KUNHM 7832-34, UMMZ 56207-9, UMMZ 82961, UMMZ 89499, UMMZ 179157.

Wood Frog (*Lithobates sylvaticus*): Wood frogs are well distributed throughout the park, and were confirmed from many locations. Museum holdings included Crystal Lake, North Branch Platte River, North Manitou Island, and Omena. Hatt et al. (1948), Scharf and Jorae (1980), Linton and Kats (1987), Bowen and Gillingham (2004), and Bowen and Beever (2008) reported wood frogs from North Manitou Island. The park's calling frog survey reports wood frogs at all eleven sites: Bow Road, Kelderhouse, Kelderhouse Road, M-22 Bog, Mill Pond, Narada Lake, Port Oneida, School Lake, Shalda Creek, Welch Road, and Westman Road. Holman (2004) and Harding (1997) include both counties in the species range.

Wood frogs are common throughout the park in forested habitat. Voucher specimens are well represented, except from South Manitou Island, where additional surveys and collections are recommended to determine if the species is truly absent from the island. Their abundance is positively associated with ephemeral wetlands, increasing canopy closure, increasing thickness of duff, hardwoods, and loamy soils; and negatively associated with acid soils and dry soils. They can be detected and monitored by visual surveys for eggs and adults at breeding ponds, and by calling surveys (if appropriately timed and with detection probabilities considered). Good habitat for this species can be found throughout the park where breeding ponds are embedded within forests.

Vouchers: Leelanau - FN 1281, FN 1313-4.

Museum material: Benzie - UMMZ 70510, UMMZ 92329; Leelanau - CM 68136-9, KUNHM 9386-94, UMMZ 56211-2, UMMZ 82980, UMMZ 133699.

Turtles

Eastern Snapping Turtle (*Chelydra serpentina serpentina*): Eastern snapping turtles were observed at Narada Lake, Shell Lake (SB12), along Peterson Road (WP014), Bass Lake (Benzie County, WP001-3, TA1), Lower Platte Lake (TA3, WP014), on M22 0.2 mi N Deer Lake Road (TA12), the Platt River mouth (TA4), and at Mill Pond (TA10). Steve Yancho (personal communication) and Scharf and Jorae (1980) report them from South Manitou Island, and the latter state that Marvin Fluelling saw them in Tamarack Lake on North Manitou Island. Hatt et al. (1948) reported observing a large eastern snapping turtle digging in the beaver lodge in Tamarac (*sic*) Lake, North Manitou Island, in June 1944, and relates a South Manitou Island report given by two residents of a large individual coming ashore near the lighthouse. Case and Scharf (1985) captured a large adult eastern snapping turtle on North Manitou Island in Lake Manitou on 17 June 1981, and observed a predated nest on shore. Bowen and Gillingham (2004) reported this species from North and South Manitou islands. Fessell (2007) captured one large

individual in Tucker Lake (Leelanau County), six in North Bar Lake (Leelanau County), one in Florence Lake on South Manitou Island, and one in Lake Manitou on North Manitou Island, during 2003 and 2004 fish surveys. Museum records were limited to two records from 1921 from Leland and Traverse Lake Creek in Leelanau County. Ernst et al. (1994), Harding (1997), and Holman (2004) include both counties in the species range.

Eastern snapping turtles are reported from several lakes and ponds within the park, including both islands, and probably occupy most permanent lakes, deep ponds, and larger streams within the park. We collected the first Benzie County specimen. Not many voucher specimens are available, and more collections are encouraged, especially photo vouchers for this large animal. Fisheries staff should be encouraged to take digital photos to help document this species (and other turtles). The island records are not documented, and additional inventory work is recommended there to obtain vouchers (photo or specimen). Eastern snapping turtles can be detected and monitored by trapping with baited hoop nets. They prefer warm waters with abundant aquatic vegetation.

Vouchers: Benzie - FN 17643 (= FMNH 267577); Leelanau - FN 17641 (= FMNH 267576).

Museum material: Leelanau -UMMZ 56225-6.

Spotted Turtle (*Clemmys guttata*): Spotted turtles were not found during this study, and no museum records were found. Holman (2004) does not include either county within the known range. Ernst et al. (1994) and Harding (1997) include both counties within the range, but see our cautionary comments above regarding shaded range maps. The northern range limit for spotted turtles is Manistee County, just south of the park. Ongoing climate change may change range limits, so resource staff should be alert for this neighboring species.

Vouchers: none.

Museum material: none.

Wood Turtle (*Glyptemys insculpta*): No wood turtles were detected in the park in this study. Kevin Kinnan reported observations from the Betsie River between River Road and Hwy 115/31, and James Harding examined a specimen from there which was subsequently released (personal communication 2008). No museum specimens are available for Benzie or Leelanau counties, and Holman (2004) includes only Benzie County in the range. Ernst et al. (1994) and Harding (1997) include both counties within the range.

Wood turtles appear to be rare or absent from the park despite potentially suitable habitat along several medium- to large-sized streams and rivers, and the region being well within the species' range limits. There are observations from the Betsie River to the south of the park. Additional survey work is recommended, by periodic monitoring of potential nesting sites (sandy eroded banks with south to southwest exposure, or other stream-side or in-stream elevated sandy areas) in mid-June. Wood turtles are sensitive to poaching, and populations can be decimated by recreational uses as well (Garber and Burger 1995).

Vouchers: none.

Museum material: none.

Blanding's Turtle (*Emydoidea blandingii*): Trapping of appropriate shallow marsh and bog habitats in the park produced no Blanding's turtles during this study. Alice Van Zoeren reported an observation from near the mouth of the Platte River in October 2002. No museum specimens are available for Benzie or Leelanau counties, and Holman (2004) includes neither county in the species range, but did include adjacent counties. Ernst et al. (1994) and Harding (1997) include both counties within the range.

Blanding's turtles may be present but rare in the park. There is some potentially suitable habitat where well vegetated, still waters occur in lakes and along streams. The region is well within the species' range limits. Additional survey work is recommended, by trapping in June and July.

Vouchers: none.

Museum material: none.

Midland Painted Turtle (*Chrysemys picta marginata*): Midland painted turtles were found at many sites throughout the park, including Florence Lake on South Manitou Island. Museum specimens are available only from Leelanau County. Case and Scharf (1985) report an adult midland painted turtle on North Manitou Island from the Swenson Marsh on 2 July 1980, with numerous adults seen there on logs and in the water in June and July of 1981. Bowen and Gillingham (2004) reported this species from North and South Manitou islands. Hatt et al. (1948), and Linton and Kats (1987), give reports from South Manitou Island. Fessell (2007) captured nine midland painted turtles in Tucker Lake, 47 in Florence Lake on South Manitou Island, and five in North Bar Lake, during 2003 and 2004 fish surveys. Ernst et al. (1994), Harding (1997), and Holman (2004) include both counties in the species range.

Midland painted turtles are common throughout the park in most aquatic habitats, but surprisingly few vouchers are available (N=7). We provide the first Benzie County vouchers, and recommend more collections. Fisheries staff should be encouraged to take digital photos to help document this species (and other turtles). The island records are not documented, and additional inventory work is recommended there to obtain vouchers (photo or specimen). Midland painted turtles are easily detected and monitored by baited hoop net trapping, as well as by visual basking surveys. They prefer waters with abundant vegetation supporting the aquatic macroinvertebrates that comprise the bulk of their diet.

Vouchers: Benzie - GSC 00034, FN 17629 (= FMNH 267565).

Museum material: Leelanau - UMMZ 56227-8, UMMZ 82968-71, UMMZ 178996.

Northern Map Turtle (*Graptemys geographica*): Northern map turtles were observed regularly at the mouth of the Platte River (TA4), and Kevin Kinnan reports observations from the Betsie River. No museum specimens are available from Benzie or Leelanau counties. Holman (2004)

indicates record(s) from Benzie County, while Ernst et al. (1994) and Harding (1997) include both counties within the range but near the range limit.

We supply the first voucher specimen for Benzie County. This area represents the current northern range limit for this species. Since species at range limits may be particularly sensitive to ongoing climate change, monitoring is recommended, by visual basking surveys.

Vouchers: Benzie - FN17612.

Museum material: none.

Eastern Box Turtle (*Terrapene carolina*): We did not find any eastern box turtles during this study, but the senior author verified one specimen collected from outside the park in 1953 from Crystal Lake Township, T26N R16W Sec, 14, Benzie County. An observation on 27 July 2002, from T27N, R14W, in Leelanau County, was provided by Linda Hartman (although the reported “9 inches long” seems too large to be an eastern box turtle, and may have been a misidentified Blanding’s turtle). Jim Wendels provided digital photos (Appendix E) of an eastern box turtle captured southeast of Empire. Ernst et al. (1994), Harding (1997), and Holman (2004) include both counties in the species range, but near the range limit.

Eastern box turtle status in the park remains problematic, owing to frequent human assisted translocations (often of animals acquired through the pet trade). Nevertheless, habitats within the park are appropriate, and the region is within but near the northern range limit for the species. Observations and photos discussed above suggest that individuals are present in the park. Until breeding is confirmed, we recommend treating the status as rare resident non-breeding. Additional surveys are recommended, but are fairly time intensive, consisting of visual searches of habitat. These should focus on areas of reported observations, and are most successful in May and June, and after burns.

Vouchers: Benzie - photo (Appendix E).

Museum material: Benzie - UMMZ 108890.

Lizards

Common Five-lined Skink (*Plestiodon fasciatus*): We collected one common five-lined skink along Peterson Road (WP015) in Benzie County, and one museum specimen was collected from the Platte River in 1937. Holman (2004) records the species from Benzie but not Leelanau County, while Harding (1997) includes both counties within the range, but see our cautionary comments above regarding shaded range maps. This species’ distribution is often discontinuous and colonial. More inventory effort is recommended, by visual searching.

Vouchers: Benzie - FN 17626 (= FMNH 267566).

Museum material: Benzie - UMMZ 82101.

Snakes

Northern Ring-necked Snake (*Diadophis punctatus edwardsii*): We collected one northern ring-necked snake from near the Platte River weir (TA9), and another was observed at Spencer Bog. Museum specimens include one Benzie County record from T26N R14W Sec. 8 in 1979, and several Leelanau County records including specimens from North and South Manitou Islands. Scharf and Jorae (1980) found them on North Manitou Island in 1977 and 1978, and Linton and Kats (1987) reported observations from South Manitou Island in 1987. Hatt et al. (1948), and Bowen and Gillingham (2004), reported this species from North and South Manitou islands. Harding (1997), Ernst and Ernst (2003), and Holman (2004) include both counties in the species range.

Northern ring-necked snakes are well documented throughout the park, including both islands. They spend much of their life cycle within forests (where they prey mainly on eastern red-backed salamanders), and are most often detected by searching for gravid females in sunny, grassy fields adjacent to forests in May and June. They can be monitored by cover objects in these meadow habitats.

Vouchers: Benzie FN 17638 (= FMNH 267584).

Museum material: Benzie - UMMZ 156730; Leelanau - MSUM 13612, UMMZ 82963, UMMZ 82972-4, UMMZ 82981-3, UMMZ 83002, UMMZ 116676-7, UMMZ 156804-5, UMMZ 56806, UMMZ 174442.

Smooth Greensnake (*Opheodrys vernalis*): Smooth greensnakes were found at the Bass Lake (Benzie County) access (TA1), on Hwy 675 1.4 mile north of M72 (out of Sleeping Bear Dunes National Lakeshore), and 0.6 mi south of Empire (TA11). Additional observations are from the Beulah area (K. Kinnan), and along Bow Road south of Burdickville (A. Van Zoeren). Three museum specimens were available, including Benzie County at T26N R16W Sec. 34, and Leelanau County from South Fox Island. Harding (1997), Ernst and Ernst (2003), and Holman (2004) include both counties in the species range.

Smooth greensnakes are common throughout the park in open, sunny habitats, especially in sandy soils. They are fairly well documented with voucher specimens, except for the islands, where additional surveys are recommended to obtain voucher material. Smooth greensnakes are common in grassy meadows remaining from past farming, ranching, and homesteading. They can be detected and monitored with cover objects.

Vouchers: Benzie - FN 17639 (= FMNH 267574); Leelanau - FN 17642 (= FMNH 267573), FN 17646 (= FMNH 267575).

Museum material: Benzie - UMMZ 76186, UMMZ 156726; Leelanau - MSUM 13658.

Blue Racer (*Coluber constrictor foxii*): A blue racer was found at Aral Road and Hwy 22 (WP009, Appendix E) by a cleanup crew, and Kevin Kinnan reports observations from the Betsie River. Two museum specimens are available from Benzie County (6 mi east of Beulah), and Holman (2004) lists them from Benzie County but not Leelanau County. Harding (1997),

and Ernst and Ernst (2003), include both counties within the range, but see our cautionary comments above regarding shaded range maps.

Blue racers are resident in Benzie County; several vouchers are available. Their presence in Leelanau County is undetermined, but currently no records exist. It is possible they will expand their range with ongoing climate change. They can be monitored with cover objects and visual searches. Additional survey work is recommended.

Voucher: Benzie - FN 1289.

Museum material: Benzie - FMNH 207692, MSUM 13629.

Western Foxsnake (*Pantherophis vulpinus*): No western foxsnakes were detected during this study. One individual was photo documented from North Manitou Island in 2007 (Bowen et al. 2007), and a specimen reportedly collected from South Fox Island in 1969 was determined to be a cataloging error (personal communication J. Holman, J. Harding, 2004). Harding (1997), Ernst and Ernst (2003), and Holman (2004) record this species from the Upper Peninsula but not from the islands or Lower Peninsula. This species is generally not considered to be part of the snake fauna of this region, and the possibility of human assisted transport to North Manitou Island cannot be discounted. We consider this species accidental pending additional records.

Voucher: none.

Museum material: Leelanau - ISUA 200720 (photo), MSUM 13670 (probably erroneous).

Eastern Milksnake (*Lampropeltis triangulum triangulum*): We recorded eastern milksnakes at the Platte River weir (TA9), on Aral Hill Road S of Manning Road (TA6), the Spencer Bog, Mill Pond (TA10), and on Hwy 109 (TA7). Kevin Kinnan reports observations from the Beulah area, and Alice Van Zoeren from CTH 677 and W. Echo Valley Road. Museum records include a Benzie County record from between Crystal Lake and Lake Michigan, and a few other records outside but near Sleeping Bear Dunes National Lakeshore, including North Fox Island. Harding (1997), Ernst and Ernst (2003), and Holman (2004) include both counties in the species range.

Eastern milksnakes are widely distributed throughout the park, but with only a few voucher specimens available. There are no records for the islands. Additional survey work, especially on the islands, is recommended. They are best detected by cover object methodology.

Vouchers: Benzie - FN 17636 (= FMNH 267568); Leelanau - FN 17645 (= FMNH 267585), FN17652.

Museum material: Benzie - UMMZ 70512, UMMZ 72344; Leelanau - KUNHM 1067, UMMZ 82964, UMMZ 82985, UMMZ 89496.

Eastern Hog-nosed Snake (*Heterodon platirhinos*): Eastern hog-nosed snakes were found at two locations quite distant from each other: crossing M-22 near Peterson Road (waypoint hognose), and at the Shell Lake sand prairie (SB12). Observations were also reported from the Betsie River (K. Kinnan), along Bow Road S of Burdickville (center of Sec. 12, A. Van Zoeren), on North Manitou Island in the village area (J. Wendels), and they are frequently seen throughout the park

(S. Yancho). No museum specimens are available from Benzie or Leelanau counties, perhaps explaining their absence from both counties in Holman's (2004) maps. Harding (1997), and Ernst and Ernst (2003), include both counties within the range.

Eastern hog-nosed snakes appear to be a common park resident, though no prior voucher specimens exist. We provide the first voucher specimens for both counties. The observation from North Manitou Island is interesting because this species is not considered to be a strong swimmer, and this is the sole report from the island. We recommend additional survey work throughout the park, including the islands. Since this species is difficult to detect and does not respond to cover objects, visual surveys are required. Serendipitous encounters are often valuable records if reported, and park staff and visitors should be encouraged to take photos of encounters for documenting new locations.

Vouchers: Benzie - FN17610; Leelanau - FN17611.

Museum material: none.

Northern Ribbonsnake (*Thamnophis sauritus septentrionalis*): We found northern ribbonsnakes at four locations in Benzie County: along Peterson Road (WP014, WP015), Boekeloo Road (WP012, WP013), Platte River at mouth (TA4), and the Indian Trail (waypoint ribbons). Hatt et al. (1948) collected one specimen (apparently now either lost or re-determined), and Linton and Kats (1987) captured and examined two specimens thought to be this species, from North Manitou Island. The North Manitou Island voucher specimen could not be found for verification, and no museum specimens are available from Benzie or Leelanau counties. Holman (2004) did not include these counties in the species range. Ernst and Ernst (2003) includes both counties within the range, as does Harding (1997), who notes that their presence on Beaver Island increases the likelihood of their occupying North Manitou Island as well (personal communication, 2008). Jim Gillingham, however, who has studied northern ribbonsnakes on Beaver Island, notes that the species does not seem to be present on other islands in the archipelago (personal communication, 2008).

Northern ribbonsnakes are a common but local resident in Benzie County, and we provide the first voucher specimens here. Their presence in Leelanau County remains unconfirmed. The North Manitou Island records are unconvincing without voucher specimens, since many early Michigan *Thamnophis* collections were misidentified (four similar species are involved). We recommend more survey work in Leelanau County, including the islands. This species responds occasionally to cover objects, but visual surveys along shorelines is the survey method of choice.

Vouchers: Benzie - FN 1287, FN 17628 (= FMNH 267583).

Museum material: none.

Eastern Gartersnake (*Thamnophis sirtalis sirtalis*): Eastern gartersnakes were found throughout the park at several mainland locations, and are commonly observed (S. Yancho, K. Kinnan). Available museum holdings include specimens from both North and South Manitou islands. Scharf and Jorae (1980) considered them common on North Manitou Island. Hatt et al. (1948),

Linton and Kats (1987), and Bowen and Gillingham (2004) reported this species from North and South Manitou islands. Harding (1997), Ernst and Ernst (2003), and Holman (2004) include both counties in the species range.

Eastern gartersnakes are very common throughout the park, especially near wetlands that support ranid frogs, a favorite food. They are well documented with voucher specimens, including specimens from both islands. Eastern gartersnakes can be reliably detected and monitored with cover object surveys, and less reliably by road cruising (especially in the fall).

Vouchers: Benzie - FN 17653, FN 17661, GSC 00032; Leelanau - FN 17640 (= FMNH 267582), FN 17660, GSC 00030, GSC 00033, GSC 00035.

Museum material: Benzie - UMMZ 118651, UMMZ 156639, UMMZ 156721; Leelanau - CM 68141, CM 68143, KUNHM 2072-4, UMMZ 56220-4, UMMZ 56693, UMMZ 72570, UMMZ 82966, UMMZ 82975-6, UMMZ 82984, UMMZ 83001, UMMZ 89509, UMMZ 116672-3, MMZ 143398, UMMZ 156657, UMMZ 156722-3, UMMZ 177008.

DeKay's Brownsnake (*Storeria dekayi*): We found DeKay's brownsnakes widely dispersed throughout the park: at North Bar Lake, Stormer Road, and waypoints M22GH, SB4, TA5, WP006/WP040-41/WP069/ TA9, WP010, WP025, and WP027. Kevin Kinnan reports observations from the Beulah area, and Alice Van Zoeren from along Otter Creek Trail. Scharf and Jorae (1980) found one specimen in a rotten log near the landing field on North Manitou Island in 1978. Linton and Kats (1987), and Bowen and Gillingham (2004), reported this species from both North and South Manitou islands. Museum records include specimens from Crystal Lake, near Beulah, T26N R14W Sec. 8, and South Manitou Island at Florence Lake. Harding (1997), Ernst and Ernst (2003), and Holman (2004) include both counties in the species range.

DeKay's brownsnakes are common throughout the park. They are well documented with voucher specimens, including from South Manitou Island. We recommend surveys on North Manitou Island to obtain voucher specimens. They can be reliably detected and monitored with cover objects, and less reliably by road cruising (especially in the fall).

Vouchers: Benzie - FN 17624 , FN 17635 (= FMNH 267579), FN 17650, FN 17654, GSC 00031; Leelanau - FN 17622, FN 17630 (= FMNH 267578), FN 17651.

Museum material: Benzie - MSUM 13443, UMMZ 70509, UMMZ 88455, UMMZ 156727-9; Leelanau - CM 68124, CM 68131, UMMZ 56692, UMMZ 72569, UMMZ 89497, UMMZ 174443, UMMZ 177007.

Northern Red-bellied Snake (*Storeria occipitomaculata occipitomaculata*): Northern red-bellied snakes were not observed during this study. Kevin Kinnan reports observations from the Beulah area. No museum records could be found for Benzie or Leelanau counties, and Holman (2004) does not include these counties in the species range. Harding (1997) and Ernst and Ernst (2003) include both counties within the range.

Northern red-bellied snake records are inexplicably absent from the park, despite being solidly within the range of the species. Perhaps some ecological factor disfavors them, such as soil type.

We recommend additional survey work. Northern red-bellied snakes can be reliably detected and monitored with cover objects, and less reliably by road cruising (especially in the fall).

Vouchers: none.

Museum material: none.

Northern Watersnake (*Nerodia sipedon sipedon*): We found northern watersnakes at a half dozen locations: along Peterson Road (WP015), Platte River weir (TA9), Round Lake (TA8), Bass Lake (Benzie County, TA1), and Narada Lake. Others reported observations are from the Platte River, Crystal River, and North Bar Lake (S. Yancho, A. Van Zoeren). Museum holdings included Crystal Lake and North Fox Island. There are no records for the Manitou islands. Harding (1997), Ernst and Ernst (2003), and Holman (2004) include both counties in the species range.

Northern watersnakes are locally common in the park, in lakes and streams. Although ample voucher specimens exist, there are no records for the islands, where perhaps there is a lack of suitable hibernating sites. The islands warrant additional surveys via shoreline visual searches, as northern watersnakes do not respond well to cover objects.

Vouchers: Benzie - FN 17627 (= FMNH 267580), FN 17637 (= FMNH 267581); Leelanau - FN 17623.

Museum material: Benzie - FMNH 95315, FMNH 95316-7, UMMZ 58591; Leelanau - UMMZ 82962, UMMZ 82965, UMMZ 82986, UMMZ 89498.

Queensnake (*Regina septemvittata*): No records for queensnakes are known from Benzie or Leelanau counties, but they do occur immediately to the south in Manistee County (a northern range limit), and a relic population is present to the northeast on Bois Blanc Island (Harding 1997; Ernst and Ernst 2003). Since queensnakes are found just south of the park, ongoing climate change may result in range limit changes, and resource staff should be alert for this neighboring species.

Vouchers: none.

Museum material: none.

Eastern Massasauga (*Sistrurus catenatus catenatus*): The eastern massasauga was not found during this study. No museum records could be found for Benzie or Leelanau counties, and Holman (2004) does not include these counties in the species range. Harding (1997), and Ernst and Ernst (2003), include both counties within the range, but see our cautionary comments above regarding shaded range maps. Ruthven et al. (1928) had no records for Benzie or Leelanau counties. Kevin Kinnan related that Jerry Bloch, another Benzie Central High School teacher, has a pickled specimen from the Platte River. Marie Scott reported a massasauga over 1.5 ft long sunning on the sedge mat at Bass Lake (Benzie County) near the end of the trail west of the boat ramp on 2 May 1999. Yuman Lee (Michigan Natural Features Inventory) also has received unverified reports from the Deadstream Swamp (personal communication, 2005).

Eastern massasaugas remain unconfirmed in the park. Several other snake species are easily and often misidentified as eastern massasaugas, so observational records are not convincing. We recommend that any additional survey work focus on sites of seemingly reliable sightings, such as the Bass Lake (Benzie County) area. We also recommend that the reported pickled specimen mentioned above be examined and any locality data on it assessed for reliability.

Vouchers: none.

Museum material: none.

Other Fauna of Note

One of us (TGA) found northern black widow spiders (*Latrodectus mactans*) at the Aral Road sampling site (WP009) and the Shell Lake sand prairie (SB12) in 2005 and at the North Bar Lake boat access (in the latrine) in 2006. Care is advised when utilizing the facility.

Species Inventory Discussion

Based on our field results and review of museum material, the species list for Sleeping Bear Dunes National Lakeshore should be updated according to Table 5.

Recommendations

Conservation and Management

Generally, the existing park policy of maintaining and restoring natural plant communities is beneficial to native amphibians and reptiles. Downed woody debris and duff are especially important as moist retreats for forest amphibians, and for supporting their food base of invertebrates. Sunny openings are important to snakes for thermoregulation, for proper embryo development, as well as for the foraging and cover opportunities provided by ground vegetation, especially grasses.

Wetlands are important to many amphibians and reptiles; existing park policy for maintaining natural wetland, lake, and stream communities, and addressing pollution and invasive species problems, will benefit wetland and aquatic amphibians and reptiles. Many frogs and salamanders are dependent upon ephemeral wetlands (vernal pools, sedge meadows) and other shallow wetlands lacking fishes (freeze out ponds) for successful reproduction (Lannoo 2005). Stocking fishes in isolated ponds is detrimental to these species. Maintenance of natural, undeveloped, shoreline is beneficial to many turtles and ranid frogs, and aquatic macrophyte beds are important to these species and to eastern newts.

Impoundments, both natural (beaver ponds) and artificial, create pond communities that often provide excellent habitat for aquatic turtles (Blanding's, painted, and snapping turtles), ranid frogs (American bullfrog, northern green frog, northern leopard frog), eastern newts, and northern watersnakes. Eastern gartersnakes and northern ribbonsnakes also frequent these shorelines, preying on ranid frogs. All of these species probably fluctuate in distribution and abundance depending upon the availability of these somewhat transient (beaver ponds) communities (Stevens et al. 2006, 2007). The importance of both natural and artificial impoundments to these amphibians and reptiles should be factored into habitat management decisions.

Prairie and barrens habitats are important for species such as blue racers and eastern hog-nosed snakes. These species will benefit from existing park restoration and management policies, but special consideration should be given to the timing of burns, which can result in mortality of many reptiles (Ford et al. 2002; Durbian 2006; Wilgers and Horne 2006). Burns should be conducted when reptiles are likely to be in underground retreats (November through March). If this is not feasible, quick, cool burns are preferred, which do not unduly heat soils. Choosing cool, cloudy days, when reptiles are not likely to be active on the surface, may also reduce mortality from fire.

Inventory and Monitoring

Inventory and monitoring recommendations build on Casper (2004; see for additional details on methodology). Monitoring programs should take into account detection probabilities for the survey methods used. Detection probabilities should be locally assessed and, based on that assessment, survey methods should either, a) increase sampling to achieve 95% confidence in avoiding false negatives, or b) account for false negatives by modeling occupancy based on

detection probabilities. Anuran calling surveys are effective for detecting most species (Casper, unpublished data). Anuran calling surveys should be expanded to include the southern portion of the park and the islands. Southern sites are important for monitoring potential Fowler's toads. High detection probabilities ($DP > 0.3$) with the calling survey method can be expected for eastern American toads, western chorus frogs, spring peepers, gray treefrogs, and northern green frogs; with the remaining species having lower detection probabilities and sometimes short sampling windows (Casper, unpublished data). New automated recorders for monitoring frogs are all solid state with low power draws, and now offer software for automated scanning of digital field recordings, potentially identifying species and collecting data much more efficiently than a human listener could (Wildlife Acoustics®, <http://www.wildlifeacoustics.com/>, Song Meter™ recorder and Song Scope™ software). If this technology is successful, the system will be highly recommended for sampling in remote areas, such as islands.

Sampling via aquatic funnel trapping is recommended for additional inventory and monitoring of blue-spotted salamanders, spotted salamanders, eastern tiger salamanders, and eastern newts. This method has should return good detection probabilities for these species, but this should be locally assessed. The ambystomid salamanders can also be detected by egg surveys. Four-toed salamanders may be monitored by nest searches. Eastern red-backed salamanders may be monitored by time- or area-constrained visual searches of ground litter and downed woody debris in mature hardwood forests, which method has good detection probabilities ($DP > 0.3$; Casper unpublished data). Common mudpuppy surveys may utilize visual searches and baited aquatic trapping.

Additional inventory (and monitoring if desired) for Blanding's, midland painted, and eastern snapping turtles should utilize aquatic turtle traps. This should be an effective method on the islands, as well as in mainland habitats. Midland painted and northern map turtles can be effectively detected by visual basking surveys, whereas wood and eastern box turtles generally require time-intensive visual searches of appropriate habitats under good weather and seasonal conditions.

Cover objects are recommended for monitoring most snakes in the park (smooth greensnake, blue racer, eastern milksnake, eastern gartersnake, DeKay's brownsnake, northern red-bellied snake, and northern ring-necked snake). Wood cover objects are most successful (we recommend 3/4 inch exterior plywood) for full season attractants. Metal is useful early in the season but tends to be too hot later and does not retain heat well for attracting snakes during cool nights. The landscape fabric used here was experimental and was not very successful. Wood cover objects are a recommended method for the island surveys, since they do not require daily visits. Other snakes require visual searches, generally much more time-intensive (northern ribbonsnakes, eastern hog-nosed snake, northern watersnake, eastern massasauga).

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Appendixes

Appendix A. Field notes

Appendix B. GPS waypoints

Appendix C. Locality records

Appendix D. Museum data

Appendix E. Photo vouchers

NOTE: Appendixes are available to qualified researchers on request from the National Park Service's Great Lakes Network Office, Ashland, WI.

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