



An Amphibian and Reptile Inventory of Isle Royale National Park

Natural Resource Technical Report NPS/GLKN/NRTR—2008/146



ON THE COVER

Eastern American toads, Daisy Farm Campground, Isle Royale, 2005.

Photo by G.S. Casper



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Natural Resource Technical Report NPS/GLKN/NRTR—2008/146

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December 2008

U.S. Department of the Interior
National Park Service
Natural Resource Program Center
Fort Collins, Colorado

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Please cite this publication as:

Casper, G. S. 2008. An amphibian and reptile inventory of Isle Royale National Park. Natural Resource Technical Report NPS/GLKN/NRTR—2008/146. National Park Service, Fort Collins, Colorado.

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Abstract

The National Park Service, Great Lakes Network Office, commissioned a herpetological inventory of Isle Royale National Park, Michigan, in 2004. Isle Royale National Park is actually a collection of over 400 islands (one large island surrounded by many smaller islands), covering approximately 54,228 ha (134,000 acres) in western Lake Superior. The park was federally designated a wilderness area on October 20, 1976, and an International Biosphere Reserve in 1980. The protected area includes submerged land extending 7.2 km (4.5 miles) into Lake Superior, the largest freshwater lake in the world. Objectives of this study were to: 1) supplement existing inventory data for amphibians and reptiles in the park, and 2) better assess the status of species listed as “Unconfirmed” or “Probably Present” in the park’s species list, which was produced in 2003. Based on the 2003 list status and additional review of regional status, we targeted six species for surveys. We reviewed records for 232 museum specimens from the park, frog and toad survey data provided by the park, and all available literature and observations, both published and unpublished. Sampling was performed over three periods in 2004 and 2005, utilizing visual searches, calling frog surveys, aquatic funnel traps, and artificial cover objects. Thirty-five new voucher specimens were collected from the park. No new species were documented, but nine amphibian and three reptile species were confirmed in the park, with one more remaining unconfirmed. Recommendations are made regarding inventory, monitoring, and management of amphibians and reptiles in the park.

Acknowledgments

I thank Jean Battle and Mark Romanski of the National Park Service for their kind and generous logistical support and informative discussions. Joan Elias, Stephen J. Hecnar, Wendel Johnson, Yuman Lee, Bill Route, David C. Smith, and Lori Sargent provided valuable insights and information. David Mauger and Lacey Klucas were indispensable field assistants. Jill Burkland of the Isle Royale and Keweenaw Parks Association assisted with collecting observational data. I am grateful to the following museum personnel for their kind assistance: Kevin de Queiroz and Addison Wynn (USNM), Gregory Schneider (UMMZ), James H. Harding (MSUM), Kevin Kelly (CRAN), Alan Resetar and Thomas Anton (FMNH), and Kirsten E. Nicholson (CMU). Carolyn Wallingford (National Park Service) provided guidance on specimen disposition. Finally, I thank Bill Route and Jean Battle (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 (Adams 1909; Johnsson et al. 1982; Casper 2002, 2004) and improve inventory data for amphibians and reptiles. The study area consisted of Isle Royale National Park (Figure 1), which is a collection of over 400 islands (one large island surrounded by many smaller islands), covering approximately 54,228 ha (134,000 acres) in western Lake Superior (approximately 89 degrees west longitude and 48 degrees north latitude). The islands were formed after the last glacial retreat, ca. 10,000 years ago, and consist of mostly forested bedrock with thin soils. The islands have been isolated from the mainland since formation by the deep cold waters of Lake Superior, which has had ecological consequences, limiting the number of species that have arrived and established populations. The islands are approximately 21.9 km (13.6 miles) distant from the nearest mainland (Thunder Bay, Ontario), and 19.8 km (12 miles) distant from the closest offshore island, with prevailing currents flowing southwest through the channel between the mainland and the islands. The geology, characterized by a series of ridges and valleys oriented southwest to northeast, is reviewed in detail in Huber (1983). Climate is characterized by late springs, cool summers, early frosts in fall, and bitterly cold winters with heavy insulating snow cover. The islands are densely forested with coniferous boreal forest and, at higher interior elevations, sugar maple-yellow birch associations. Many bogs, lakes and streams are present, along with vernal pools. The vegetation is reviewed in Slavick and Janke (1993).

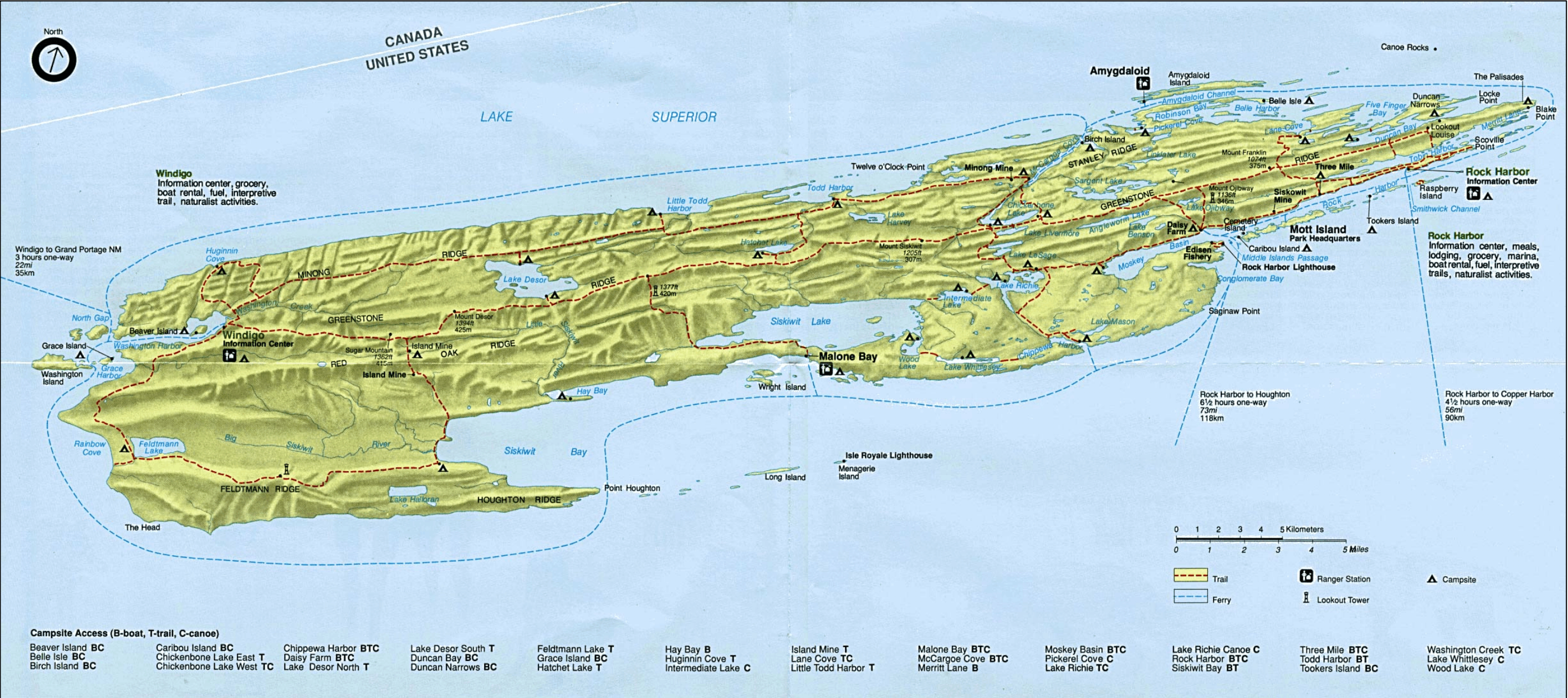


Figure 1. Study area, Isle Royale National Park.

Methods

Field Methods

Sampling sites in the park were selected in cooperation with park staff and were limited to the Windigo area, Daisy Farm/Mount Ojibway trails area, and the Mott Island park headquarters area. Sampling was performed over three periods: 28-30 September 2004 (G. Casper), 11-17 May 2005 (G. Casper, D. Mauger), 9-14 September 2005 (G. Casper, L. Klucas), totaling approximately 31 person-field days.

Visual searches of habitat areas (including listening for calling frogs) were used as the primary sampling method throughout the study. This included walking through habitat areas, searching underneath and within fallen logs, and searching anthropogenic trash and other debris. Aquatic funnel traps (minnow traps) were used to sample for amphibians in ponds at eleven sites (Table 1). Artificial cover objects (approximately 1 m by 0.5 m pieces of black landscaping fabric) were deployed for sampling snakes in four grassy meadow areas, but only two sets of these were sampled by us due to logistic constraints (Table 1).

Collection of Vouchers

Collection and preservation of voucher specimens followed Simmons (2002). Voucher specimens were initially deposited at the Milwaukee Public Museum (MPM), then all but four specimens (MPM 33451-54) 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 were field tagged and are properly curated at the FMNH. Field tag numbers are 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 B-F.

Review of Existing Data and Specimens

In addition to fieldwork, a review of the available data and documentation for regional amphibians and reptiles was conducted. Frog and toad survey data for the park were reviewed, and observational data were received from park staff (J. Battle, M. Romanski, and fisheries survey personnel), park visitors, and other researchers. Listings of amphibian and reptile holdings from the study area were requested from 56 museums (Table 2). Common names are used throughout this report, with scientific names provided in Appendix A. Scientific and common names follow the latest professional society standards (Crother 2008), but these involve significant recent changes to long established names. A comparison of new and old names is provided in Table 3.

Table 1. Sampling methods, Isle Royale National Park, 2004-2005.

Site	Waypoints	Methods	N Set	Date Set	Dates Checked	N checks	Effort ¹
clearing along stream at start of Greenstone Trail	WP216	fabric cover	3	5/16/05	park personnel may have checked these		
Daisy Farm Campground	IR1	fabric cover	3	6/15/05	2005: Sept 10,11,12,13	4	12 CO-days
meadow near Windigo housing	WP215	fabric cover	3	5/16/05	park personnel may have checked these		
Ojibway Tower Trail	WP434, WP435	fabric cover	3	6/15/05	2005: Sept 10,11,12,13	4	12 CO-days
along Feldtmann Lake Trail near Windigo Harbor	WP203	minnow traps	2	5/13/05	2005: May 14 (picked up)	1	2 trap-days
Benson Cr Daisy Farm Trail	WP448, WP450-51	minnow traps	2	9/11/05	2005: Sept 12,13 (picked up)	2	4 trap-days
Benson Cr Mt Ojibway Trail	IR2, WP436, WP437	minnow traps	2	9/11/05	2005: Sept 12,13 (picked up)	2	4 trap-days
Daisy Farm Campground pier	WP433	minnow traps	3	9/9/05	2005: Sept 10 (1 trap missing), 11 (picked up)	2	6 trap-days
Daisy Farm Campground stream	WP432	minnow traps	3	9/9/05	2005: Sept 10,11 (picked up)	2	6 trap-days
Grace Cr meadows	WP199	minnow traps	2	5/12/05	2005: May 13,14,15 (picked up)	3	6 trap-days
Greenstone Ridge Trail vernal pool	WP207	minnow traps	4	5/14/05	2005: 15,16 (picked up)	2	8 trap-days
Huginnin Cove Trail pond Site #2	DM WP12-15	minnow traps	4	5/12/05	2005: May 13,14,15,16 (picked up)	4	16 trap-days
Huginnin Cove Trail Site #1	DM WP20-21	minnow traps	2	5/12/05	2005: May 13,14,15 (picked up)	3	6 trap-days
Huginnin Cove Trail Site #3	DM WP16-19, 27, 28	minnow traps	2-4	5/12/05	2005: May 13,14,15 (added 2 traps),16 (picked up)	4	10 trap-days
Old Windigo sewage pond	WP204	minnow traps	2	5/14/05	2005: 15,16 (picked up)	2	4 trap-days
Daisy Farm campground, inc. Daisy Farm and Lake Ojibway trails	IR1-6, WP431-61	visual recon			2004: Sept 29. 2005: Sept 9,10,11,12,13	6	11 person-days
Forbes Lake	WP455	visual recon			2005: Sept 11	1	1 person-days
Mott Island	WP430	visual recon			2004: Sept 29. 2005: Sept 9,14	3	5 person-days
Windigo area	WP009, WP191-213	visual recon			2005: May 11,12,13,14,15,16	6	12 person-days

¹ CO-days = number of days fabric covers were left out

Table 2. Museums canvassed for Isle Royale material (either individually or through HerpNet).

Acronym	Institution	N specimens returned
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	1
CMU	Central Michigan University, Mt. Pleasant, MI	
CRAN	Cranbrook Institute of Science, Bloomfield Hills, MI	
CU	Cornell University Museum of Vertebrates	
FMNH	Field Museum of Natural History, Chicago, IL	
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	
LACM	Natural History Museum of Los Angeles County	
LSU	Louisiana Museum of Natural History, Louisiana State University	
MCZ	Museum of Comparative Zoology, Harvard University	
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	
MPM	Milwaukee Public Museum	
MSB	Museum of Southwestern Biology, University of New Mexico	
MSUM	Division of Vertebrate Natural History, Michigan State University Museum, East Lansing	77
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 für 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	
UAM	University of Alaska - Museum of the North	
UAMZ	University of Alberta Museum of Zoology	
UAZ	Amphibian and Reptile Collection, University of Arizona	

Table 2. Museums canvassed for Isle Royale material (either individually or through HerpNet) (continued).

UCM	University of Colorado Museum	
UF	Florida Museum of Natural History, University of Florida	
UMMZ	University of Michigan Museum of Zoology, Ann Arbor	144
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.	10
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		232

Table 3. 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>Bufo americanus americanus</i>	Eastern American Toad	<i>Anaxyrus americanus americanus</i>	Eastern American Toad
<i>Pseudacris crucifer crucifer</i>	Northern Spring Peeper	<i>Pseudacris crucifer</i>	Spring Peeper
<i>Pseudacris triseriata maculata</i>	Boreal Chorus Frog	<i>Pseudacris maculata</i>	Boreal Chorus Frog
<i>Rana clamitans melanota</i>	Northern Green Frog	<i>Lithobates clamitans melanota</i>	Northern Green 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

Results and Discussion

Confirmation of Species

We confirmed the presence of twelve species of amphibians and reptiles in the park (three salamanders, six anurans, one turtle, and two snakes), with one other anuran remaining unconfirmed (Table 4). With the exception of the boreal chorus frog and the common mudpuppy, resident species probably have park-wide distributions in appropriate habitats. There is no support for the inclusion of the gray ratsnake (formerly black ratsnake) or the northern ribbonsnake in the Isle Royale National Park species list, and they should be removed (see species accounts). Several other species found on the nearby mainland and currently considered absent from the park are likely candidates for future colonization: eastern red-backed salamander, spotted salamander, northern leopard frog, and eastern snapping turtle. Four museums reported holdings of 232 specimens from the park. Relevant specimen data are included in the species accounts below and detailed records are in Appendix E. Additional voucher specimens, which significantly supplement past collections, were obtained from the park for these species: blue-spotted salamander, central newt, eastern American toad, spring peeper, northern green frog, wood frog, northern red-bellied snake, common gartersnake, and western painted turtle. Literature and observation records were also reviewed, and relevant information is incorporated into species accounts and the literature cited section of this report.

Species at or near their range limits are of special interest relative to ongoing climate change because their dispersal and occupation of habitats may be constrained by climatic factors. For Isle Royale, these include the common mudpuppy, gray treefrog, and northern red-bellied snake. Species with range limits near Isle Royale but currently not present in the park could potentially expand their ranges into the park. These are the eastern red-backed salamander, spotted salamander, and eastern snapping turtle. Conversely, Isle Royale is well within the range limits for the northern leopard frog, and there is no lack of suitable habitat. Its absence suggests stochastic, ecological, or dispersal factors which have so far prevented colonization of the park.

Isle Royale National Park provided annual calling frog survey data from 1996 through 2005 for three routes in the park (Daisy Farm - Mt. Ojibway loop, Three Mile - Lane Cove, Moskey Basin - Lake LeSage, and the Huginnin Loop), each with 10 stops. The following species were recorded: boreal chorus frog, spring peeper, gray treefrog, eastern American toad, mink frog, northern green frog, and wood frog. All of these species, except the gray treefrog, are confirmed with voucher specimens, although some species are represented by only one or a few specimens in collections (Appendix E). Relevant species data are included in the species accounts below.

Table 4. Isle Royale National Park amphibian and reptile checklist.

Family	Scientific Name	Common Name	Prior Status	Current Status	References
Ambystomatidae	<i>Ambystoma laterale</i>	blue-spotted salamander	Present in Park	Confirmed	Johnson (1965), Shelton (1975), Johnsson et al. (1982), Van Buskirk and Smith (1991), Smith and Van Buskirk (1995), Harding (1997), Harding and Holman (1999), Casper (2002). Vouchers: this study, CM, UMMZ
Ambystomatidae	<i>Ambystoma maculatum</i>	spotted salamander	Unconfirmed	Absent*	Ruthven et al. (1928), Shelton (1975), Harding (1997), Shelton (1997), Harding and Holman (1999), Casper (2002). Vouchers: none
Bufonidae	<i>Anaxyrus americanus</i>	eastern American toad	Present in Park	Confirmed	Adams (1906, 1909), Ruthven et al. (1928), Johnson (1965), Shelton (1975), Johnsson et al. (1982), Smith (1983a), Beeman and Oelfke (1997a, 1997b), Harding (1997), Niemela et al. (1998), Harding and Holman (1999), Peterson et al. (1999), Milanowski et al. (2000), Goodwin and Egan (2001), Schuster (2001), Casper (2002), Wagner and Egan (2002), Thompson and Egan (2003), Egan (2004, 2005). Vouchers: this study, MSUM, UMMZ.
Chelydridae	<i>Chelydra serpentina serpentina</i>	eastern snapping turtle	Unconfirmed	Absent*	Ruthven et al. (1928), Shelton (1975), Harding and Holman (1990), Ernst et al. (1994), Harding (1997), Shelton (1997), Casper (2002). Vouchers: none
Colubridae	<i>Pantherophis spiloides</i>	gray ratsnake	False Report	Absent	Ernst and Ernst (2003). Vouchers: none
Colubridae	<i>Storeria occipitomaculata occipitomaculata</i>	northern red-bellied snake	Present in Park	Confirmed	Adams (1906), Ruthven et al. (1928), Johnson (1965), Shelton (1975), Johnsson et al. (1982), Harding (1997), Casper (2002), Holman and Harding (2006). Vouchers: this study, MSUM, UMMZ
Colubridae	<i>Thamnophis sauritus septentrionalis</i>	northern ribbonsnake		Absent	Ruthven et al. (1928), Casper (2002), Ernst and Ernst (2003), Holman and Harding (2006). Vouchers: UMMZ (lost)

Table 4. Isle Royale National Park amphibian and reptile checklist (continued).

Family	Scientific Name	Common Name	Prior Status	Current Status	References
Colubridae	<i>Thamnophis sirtalis</i>	common gartersnake	Present in Park	Confirmed	Adams (1906, 1909), Ruthven et al. (1928), Johnson (1965), Shelton (1975), Johnsson et al. (1982), Smith (1983a), Harding (1997), Casper (2002), Ernst and Ernst (2003), Holman and Harding (2006). Vouchers: this study, MSUM, UMMZ
Emydidae	<i>Chrysemys picta bellii</i>	western painted turtle	Present in Park	Confirmed	Ruthven et al. (1928), Johnson (1965), Moll (1974), Shelton (1975), Johnsson et al. (1982), Harding and Holman (1990), Harding (1997), Casper (2002), Ernst et al. (1995). Vouchers: this study, MSUM, UMMZ (lost)
Hylidae	<i>Hyla versicolor</i>	gray treefrog	Unconfirmed	Unconfirmed	Adams (1909), Thompson and Egan (2003), Egan (2004). Vouchers: UMMZ (lost)
Hylidae	<i>Pseudacris crucifer</i>	spring peeper	Present in Park	Confirmed	Adams (1905, 1909), Ruthven et al. (1928), Johnson (1965), Shelton (1975), Johnsson et al. (1982), Smith and Van Buskirk (1995), Beeman and Oelfke (1997a, 1997b), Harding (1997), Niemela et al. (1998), Harding and Holman (1999), Peterson et al. (1999), Milanowski et al. (2000), Goodwin and Egan (2001), Casper (2002), Wagner and Egan (2002), Thompson and Egan (2003), Egan (2004, 2005). Vouchers: this study, MSUM, UMMZ
Hylidae	<i>Pseudacris maculata</i>	boreal chorus frog	Present in Park	Confirmed	Johnson (1965), Shelton (1975), Johnsson et al. (1982), Smith (1983a, 1983b, 1987, 1990), Van Buskirk and Smith (1993), Smith and Van Buskirk (1995), Beeman and Oelfke (1997a, 1997b), Niemela et al. (1998), Harding and Holman (1999), Peterson et al. (1999), Milanowski et al. (2000), Goodwin and Egan (2001), Casper (2002), Wagner and Egan (2002), Thompson and Egan (2003), Egan (2004, 2005). Vouchers: UMMZ

Table 4: Isle Royale National Park amphibian and reptile checklist (continued)

Family	Scientific Name	Common Name	Prior Status	Current Status	References
Plethodontidae	<i>Plethodon cinereus</i>	eastern red-backed salamander	Unconfirmed	Absent*	Ruthven et al. (1928), Shelton (1975), Harding (1997), Shelton (1997), Romanski (1998), Harding and Holman (1999), Casper (2002). Vouchers: none
Proteidae	<i>Necturus maculosus maculosus</i>	common mudpuppy	Historic	Confirmed	Yarrow (1883), Adams (1905), Ruthven et al. (1928), Shelton (1975), Johnsson et al. (1982), Harding and Holman (1999), Casper (2002). Vouchers: UMMZ (specimens damaged and cannot be confirmed), USNM
Ranidae	<i>Lithobates clamitans melanota</i>	northern green frog	Present in Park	Confirmed	Adams (1909), Ruthven et al. (1928), Johnson (1965), Shelton (1975), Johnsson et al. (1982), Smith (1983a), Beeman and Oelfke (1997a, 1997b), Niemela et al. (1998), Peterson et al. (1999), Milanowski et al. (2000), Goodwin and Egan (2001), Schuster (2001), Harding and Holman (1999), Casper (2002), Wagner and Egan (2002), Thompson and Egan (2003), Egan (2004, 2005). Vouchers: this study, MSUM, UMMZ, USNM
Ranidae	<i>Lithobates pipiens</i>	northern leopard frog	Unconfirmed	Absent*	Ruthven et al. (1928), Shelton (1975), Harding (1997), Shelton (1997), Harding and Holman (1999), Casper (2002). Vouchers: none
Ranidae	<i>Lithobates septentrionalis</i>	mink frog	Present in Park	Confirmed	Ruthven et al. (1928), Johnson (1965), Shelton (1975), Johnsson et al. (1982), Smith (1983a), Beeman and Oelfke (1997a, 1997b), Harding (1997), Niemela et al. (1998), Harding and Holman (1999), Peterson et al. (1999), Milanowski et al. (2000), Goodwin and Egan (2001), Schuster (2001), Casper (2002), Wagner and Egan (2002), Thompson and Egan (2003), Egan (2004, 2005). Vouchers: MSUM, UMMZ

Table 4: Isle Royale National Park amphibian and reptile checklist (continued)

Family	Scientific Name	Common Name	Prior Status	Current Status	References
Ranidae	<i>Lithobates sylvaticus</i>	wood frog	Present in Park	Confirmed	Adams (1906, 1909), Ruthven et al. (1928), Johnson (1965), Shelton (1975), Johnsson et al. (1982), Beeman and Oelfke (1997), Beeman and Oelfke (1997a, 1997b), Harding (1997), Niemela et al. (1998), Harding and Holman (1999), Peterson et al. (1999), Milanowski et al. (2000), Goodwin and Egan (2001), Schuster (2001), Casper (2002), Wagner and Egan (2002), Thompson and Egan (2003), Egan (2004, 2005). Vouchers: this study, MSUM, UMMZ, USNM
Salamandridae	<i>Notophthalmus viridescens louisianensis</i>	central newt	Present in Park	Confirmed	Dustin (1946), Johnson (1965), Shelton (1975), Johnsson et al. (1982), Smith (1983a), Parratt and Welker (1999), Harding (1997), Harding and Holman (1999), Casper (2002). Vouchers: this study, MSUM, UMMZ

*These species could potentially colonize Isle Royale in the future, but they are considered to be absent at present.

Species Inventory Results

Taxonomy used in the following species accounts follows Crother (2008). Complete observational and literature records are provided in Appendix D. Voucher numbers are from specimens collected during this study. Museum material details are provided in Appendix E.

Salamanders

Blue-spotted Salamander (*Ambystoma laterale*): Blue-spotted salamanders (Figure 2) were found at both the Windigo and Daisy Farm sampling areas. It is a common salamander distributed park-wide in appropriate habitats. Other observers have reported them from Mott Island and North Government Island (Smith 1983a; Smith and Van Buskirk 1995). Van Buskirk and Smith (1991) found them breeding in rock pools on the exposed bedrock shores of Edwards and North Government islands, and D. C. Smith reports them from most of his study sites on the northeastern outer islands (personal communication, November 2, 2008). A cover object survey for salamanders in 1999 and 2000 resulted in only one blue-spotted salamander found in the Moskey sampling site and none at the Windigo site, suggesting that this species does not respond well to this sampling method (Romanski 1998 and unpublished data). Johnsson et al. (1982) reported them to be common and widespread, but earlier workers often overlooked them or considered their occurrence questionable (Ruthven et al. 1928; Shelton 1975). Johnson (1965) collected specimens from Isle Royale for his thesis. Harding (1997) and Harding and Holman (1999) include the park within the range, and this species is found throughout the Lake Superior Basin (Casper 2002). Museum material is limited to two specimens from the Daisy Farm/Moskey Basin trail in 1968 and one specimen without locality data from 1944.



Figure 2. Blue-spotted salamander, Isle Royale, 2005.
Photo by G.S. Casper.

Blue-spotted salamander abundance is expected to be positively associated with ephemeral wetlands, semi-permanent and permanent water bodies which lack game fish, increasing canopy closure, increasing amount of downed woody debris, increasing thickness of duff, hardwoods, and loamy soils; it is negatively associated with acid soils and dry soils. They can usually be reliably detected and monitored by visual and aquatic trapping surveys for eggs and adults

during spring breeding at ponds (generally May) (Figure 3), and by aquatic trapping of larvae at ponds in June and July. Monitoring programs should determine and then take into account local detection probabilities for the survey methods used. Casper and Hecnar (unpublished data) had poor detection results in Thunder Bay and other Lake Superior basin locations by aquatic funnel trapping and visual searches, but conditions on Isle Royale may be more favorable for these methods, as suggested by survey success during this study in May 2005. Blue-spotted salamanders are secretive and fossorial, and they are only occasionally encountered during the non-breeding season, usually under cover or after rains.

Vouchers: FN 2086, MPM 33453.

Museum material: CM 130416; UMMZ 94150.



Figure 3. Blue-spotted salamander eggs, Isle Royale, 2005. Photo by G.S. Casper.

Spotted Salamander (*Ambystoma maculatum*): Spotted salamanders were not found during this study, and no other observational, literature, or museum records could be found for the park. Ruthven et al. (1928) did not record spotted salamanders from the park. Harding (1997), Harding and Holman (1999), and Casper (2002) note that this species is found throughout the Lake Superior basin except along the Minnesota shoreline and on Isle Royale. Shelton (1975, 1997: p. 28) explicitly mentions that spotted salamanders are absent from the park. They are becoming rare in the Thunder Bay area (S. Hecnar, personal communication, 2007). It appears to be a likely candidate for colonization of the islands, but apparently has not yet arrived. It is considered absent at this time.

Spotted salamander habitat is very similar to that preferred by blue-spotted salamanders. Spotted salamanders can be detected and monitored by visual and aquatic trapping surveys for eggs and adults during spring breeding at ponds (generally May), and by aquatic trapping of larvae at ponds in June and July. Casper and Hecnar obtained good detection results ($DP > 0.3$) in south and east shore Lake Superior basin locations by aquatic funnel trapping and visual searches (unpublished data). Personnel studying or monitoring blue-spotted salamanders should remain alert for this species.

Vouchers: none.

Museum material: none.

Central Newt (*Notophthalmus viridescens louisianensis*): Central newts (Figures 4-6) were found at both the Windigo and Daisy Farm sampling areas. They are considered a common salamander, distributed park-wide in appropriate habitats (Johnsson et al. 1982). Smith (1983a) reported them from near Edwards and North Government islands, and generally at most of his northeastern outer islands study sites (personal communication, November 2, 2008). Newt Lake (3.5 km/2.2 miles) south-southwest of the Daisy Farm Campground) was named by researcher Walter Koelz for the great number of newts observed there sometime before 1946 (Parratt and Welker 1999, referenced to Dustin 1946). Like the blue-spotted salamander, some earlier accounts overlooked this species, which was not recorded by Ruthven et al. (1928) and considered of questionable occurrence by Shelton (1975). Johnson (1965) collected specimens from Isle Royale for his thesis. Harding (1997), Harding and Holman (1999), and Casper (2002) include the park within the species's range, and it is found throughout the Lake Superior basin, with some possible gaps on the northeastern and far western shores (these may be artifacts of insufficient collecting effort, or a gap between subspecies distributions). Museum material from 1926-1963 includes locations near Lake Ojibway, Duncan Bay, Benson Creek at Daisy Farm, Lily Lake, Newt Lake, Sholts Lake, and Wallace Lake.

This and previous studies confirm that newts occur throughout the park and the Lake Superior basin. Subspecies designation is problematic in this region, where the more eastern occurring red-spotted newt (*Notophthalmus viridescens viridescens*) may intergrade with the more western occurring central newt (*Notophthalmus viridescens louisianensis*) across a possible post-Pleistocene secondary contact zone (Zamudio and Savage 2003). Harding and Holman (1999) and Casper (2002) consider the Isle Royale population to be the central newt, and specimens examined during this study also tended towards the central newt phenotype. Future molecular analysis of newts basin-wide may reveal a more accurate picture of subspecies distribution and population evolutionary history.

Central newts prefer permanent and semi-permanent, but well vegetated, ponds and lakes and can tolerate drier terrestrial habitats better than other more terrestrial salamanders (Lannoo 2005). Compared to many amphibians, newts are more tolerant of fish, owing to their noxious skin secretions, and often occupy well vegetated lakes where permanently aquatic individuals may reside (Harding 1997). They are best detected and monitored by aquatic trapping of larvae and adults throughout the active season. Casper and Hecnar (unpublished data) obtained good detection results ($DP > 0.3$) in south and east shore Lake Superior basin locations by aquatic funnel trapping, but less so in Thunder Bay. Survey results for 2005 suggest that conditions on Isle Royale are favorable for good detection probabilities by aquatic funnel trapping in May.

Vouchers: FN 2078-79, 2087, 2089; MPM 33451-52.

Museum material: MSUM 7903-06; UMMZ 67872, 69644-45, 83867, 116692.



Figure 4. Terrestrial adult newt, Isle Royale, 2005. Photo by G.S. Casper.

Figure 5. Aquatic adult newt, Isle Royale, 2005. Photo



by G.S. Casper.

Figure 6. Newt eft, Isle Royale, 2005. Photo by G.S. Casper.



Eastern Red-backed Salamander (*Plethodon cinereus*): Eastern red-backed salamanders were not found during this study, and no observational, literature, or museum records could be found for the park. Ruthven et al. (1928) did not record them from the park. Harding (1997), Harding and Holman (1999), and Casper (2002) note that this species is found throughout the Lake Superior basin, but is apparently absent from Isle Royale. Shelton (1997: p. 28) explicitly mentions that eastern red-backed salamanders are absent from the park. A cover object survey for salamanders in 1999 and 2000 found no eastern red-backed salamanders in the Moskey or Windigo sampling sites, lending further support to their absence (Romanski 1998 and unpublished data). Eastern red-backed salamanders appear to reach a northern range limit along the north shore of Lake Superior and could be a candidate for colonization of the islands, but apparently have not yet arrived. They are considered absent at this time.

Eastern red-backed salamanders are wholly terrestrial, preferring moist, deciduous or mixed 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; it is negatively associated with acid soils and dry soils (Lannoo 2005). They are best detected and monitored by searching for adults by time- and/or area- constrained sampling during the active season. Casper and Hecnar (unpublished data) obtained good detection probabilities ($DP > 0.3$) throughout the Lake Superior basin by terrestrial searches. Park personnel should remain alert for this species and consider periodic terrestrial searches to detect potential colonization by this species.

Vouchers: none.

Museum material: none.

Common Mudpuppy (*Necturus maculosus maculosus*): No common mudpuppies were found during this study, but little dedicated effort was targeted towards this species. Common mudpuppy observations were reported in Adams (1906) from “Benson Brook” near the Daisy Farm Campground, at Sumner Lake by Johnsson et al. (1982), and are listed from Isle Royale in Yarrow (1883). Ruthven et al. (1928) reported a record from the park (presumably based on the Adams expeditions). Harding (1997) does not display Isle Royale within the range, but this was an error in map production (personal communication, 2005). Harding and Holman (1999) subsequently mapped Isle Royale as occupied. Casper (2002) also included a record from the park. While likely found throughout the Lake Superior basin, the only north shore records for common mudpuppies are from Thunder Bay (Casper 2002). Museum material from the park is limited to two larval specimens from Sumner Lake in 1905 (which are currently dried, shriveled, and unidentifiable; G. Schneider, UMMZ, personal communication, 2008) and two juvenile specimens (ca. 16 cm total length) at USNM that are attributed to Isle Royale but have no other accompanying data (verified 4 November 2008 by Wynn Addison, USNM). The Sumner Lake record, collected by C. C. Adams in 1905, is problematic, as the now damaged specimens cannot be distinguished from blue-spotted salamander larvae, and the presence of common mudpuppies in a relatively small land-locked lake would be unusual, but not impossible. It is also possible that the locality data “Sumner Lake” are in error, as the 1905 Adams expedition collecting stations were all at the western end of the park around Washington Harbor, with the nearest

collecting station to Sumner Lake being along the northwestern shore of Siskiwit Bay (Adams 1906, 1909). Ruthven, in Adams (1909), mentions only the Benson Brook specimens, and an earlier report by Yarrow (1883). I have been unable to obtain the Yarrow reference to examine any other details contained therein, but Ruthven states that Stejneger examined the Benson Brook specimens, implying that these specimens were deposited at USNM. However, the catalog for the USNM specimens gives “Whittlesay” as the collector, with no specific locality, and this name is not listed in the Adams expedition. Shelton (1975) considered their occurrence questionable. All of the literature mapping this species on Isle Royale appears to be relying on the 1883 and 1905 records, which, as shown here, leaves room for doubt.

The status of the common mudpuppy in the park remains uncertain and warrants further investigation. Most likely they are present, but their distribution and status is unknown. Common mudpuppies prefer structured aquatic habitat, such as lake and river bottoms with medium-to-large rocks, fractured bedrock, or submerged log piles. There is concern over their sensitivity to lampricides (Matson 1990), and they are generally associated with cleaner aquatic habitats with abundant 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 structures and guarded until hatching. Additional inventory work may identify extant populations. Visual in-stream surveys are most effective, especially during May when breeding takes place. Baited aquatic funnel trapping may be effective but requires testing. Common mudpuppies can be detected by dip net surveys which disturb stream bottoms (Pearse 1921; Gibbons and Nelson 1968; Sajdak 1982), a technique often used for surveying aquatic invertebrates. They are sometimes detected by electro-shocking crews, although shocked specimens often do not float up, being hidden beneath rocks and logs (Fitch 1959). It may be productive to ask aquatic invertebrate and fish survey crews to document common mudpuppy observations. Placement of artificial aquatic stream bottom cover objects (such as patio pavers or other flat stones) may also detect common mudpuppies, but is a technique needing verification. Surveys in near-shore Lake Superior will be problematic owing to logistical and safety issues, but it would be worthwhile to ask diving outfitters to watch for and report mudpuppy sightings, as mudpuppies are suspected to frequent ship wrecks in Lake Michigan (T. Anton, personal communication, 2005). The impacts of the many invasive species in the Lake Superior watershed on common mudpuppies has not been studied, but these may be significant, in one direction or another.

Vouchers: none.

Museum material: UMMZ 33512; USNM 7006, 277336.

Frogs and Toads

Eastern American Toad (*Anaxyrus americanus americanus*): Eastern American toads (Figure 7) are well distributed throughout the park and were found during this study at the Daisy Farm Campground area, the Greenstone Ridge, and Mott Island. They have also been reported, beginning in 1904, from Washington River, along rocky shorelines near North Government and Edwards islands, the base of the north slope of the Jack Pine Ridge (T66N, R34W, Sec. 26), the Desor Trail, the western end of Siskiwit Bay, near the Siskiwit Falls at Malone Bay, the Greenstone Ridge near Mt. Franklin, Lane Cove, Chippewa Harbor, and Lake Richie (Adams 1906, 1909; Johnson 1965; Smith 1983a). Shelton (1975) rated the eastern American toad as

common, and Johnsson et al. (1982) described them as the most commonly encountered amphibian on Isle Royale. The park regularly records them from calling frog survey routes (Beeman and Oelfke 1997a, 1997b; Niemela et al. 1998; Peterson et al. 1999; Milanowski et al. 2000; Goodwin and Egan 2001; Wagner and Egan 2002; Thompson and Egan 2003; Egan 2004, 2005). Schuster (2001) found them along the Indian Portage Trail. D. C. Smith reported them generally occurring at most of his northeastern outer islands study sites (personal communication, November 2, 2008). Thirty museum specimens are available. These were collected between 1904 and 1977 from the Mount Franklin Trail, Daisy Farm area, Scoville Point, a stream south of Moskey Basin, Tobin Creek, the trail between Lake Richie and Moskey Basin, Chickenbone Lake, Lake Desor, and Anglemorm Lake. Ruthven et al. (1928) mapped this species in the park. Harding (1997), Harding and Holman (1999), and Casper (2002) include the entire Lake Superior basin and Isle Royale in their range.

Figure 7. Toad hunting at night on Daisy Farm Trail, Isle Royale, 2005. Photo by G.S. Casper.



This species is very common in virtually all habitats on Isle Royale and in the surrounding region. They breed along weedy lake margins and in temporary, semi-permanent and permanent ponds. They are best detected and monitored by calling surveys or nighttime visual surveys immediately after or during rains, which should achieve sufficient detection probabilities. We found toads routinely hunting along trails after dark in early September, especially after and during rains, and this appears to be an effective survey method, albeit as yet untested. Casper and Hecnar (unpublished data) obtained good detection probabilities ($DP > 0.3$) at most Lake Superior basin sites by calling surveys.

Vouchers: FN 1290, 1681-85.

Museum material: MSUM 8215-16, 8225-33, 13956-558; UMMZ 7455, 32318-19, 32876-78, 33422, 33427-28, 33515, 69303, 69647, 106580, 113508-09, 206544.

Boreal Chorus Frog (*Pseudacris maculata*): No boreal chorus frogs were seen or heard during this study. The park records boreal chorus frogs on some of their calling frog survey routes, but with few or no detections since 2000, and they are believed to be absent from inland habitats on Isle Royale (Beeman and Oelfke 1997a, 1997b; Niemela et al. 1998; Peterson et al. 1999; Milanowski et al. 2000; Goodwin and Egan 2001; Wagner and Egan 2002; Thompson and Egan 2003; Egan 2004, 2005). The reasons for this are unclear. These frogs appear to have a limited distribution in the park, breeding in splash pools along south-facing shorelines at the extreme northeastern end of the park, where they have been studied extensively (Smith 1983a, 1983b, 1987, 1990; Van Buskirk and Smith 1991; Smith and Van Buskirk 1995). Only one voucher specimen could be found (from Scoville Point, 1964; verified October 2008 by G. Schneider, UMMZ). Ruthven et al. (1928) had no records for this species from the park. Johnson (1965) reported them from unspecified locations, while Shelton (1975) considered them common in rock pools. Johnsson et al. (1982) noted they have only been recorded from Isle Royale within the last 25 years (presumably meaning since the late 1950s), but suspected they may have been overlooked previously. Boreal chorus frogs have been specifically reported from Scoville Point, Blakes Point, and the northeastern outer islands, including: Edwards, Elizabeth, Flag, Greens, Long, North Government, Passage, Raspberry, Smith, South Government, Split, the island just off the southwest end of Porters Island, and a small island off the point to the north of Duncan's Island. Until recently the boreal chorus frog was considered a subspecies of the western chorus frog (*Pseudacris triseriata*), and most range maps did not differentiate the two. The latest published range map considers Isle Royale and the north shore of Lake Superior region to be occupied by the boreal chorus frog (Lemmon et al. 2007). Harding and Holman (1999) and Casper (2002) include all but the south shore of the Lake Superior basin within the species complex's range, with Isle Royale occupied. Harding (1997) did not include Isle Royale within the range but this was an error in map production (personal communication, 2005).

Boreal chorus frogs should be reliably detectable by calling surveys, but detection probabilities need to be determined in the Isle Royale environment. They prefer (but are not limited to) more open habitats such as wet meadows and open bogs, and Isle Royale colonies appear to depend upon, or at least are currently limited to, shoreline splash pools for successful breeding. Given the limited distribution and the probable short life span of this species (estimated 1-3 years for the related *P. nigrita*; Lannoo 2005), a voucher series, complete with DNA, should be obtained.

Vouchers: none.

Museum material: UMMZ 126073.

Spring Peeper (*Pseudacris crucifer*): Spring peepers are widely distributed throughout the park (Johnsson et al. 1982) and were detected during this study along the East Huginnin Cove Trail, Feldtmann Lake Trail, Mount Ojibway Trail, Windigo area, and the Daisy Farm campground. Adams (1909) first reported spring peepers in 1905 at Station V.5 (T65N, R35W, Sec. 31 or 32), and subsequent reports through 2008 include Mason Lake and North Government and nearby islands. Shelton (1975) considered them common, and Johnson (1965) collected specimens from Isle Royale for his thesis. The park regularly records spring peepers on calling frog survey routes and considers them the most common and most abundant species of anuran on Isle Royale

(Beeman and Oelfke 1997a, 1997b; Niemela et al. 1998; Peterson et al. 1999; Milanowski et al. 2000; Goodwin and Egan 2001; Wagner and Egan 2002; Thompson and Egan 2003; Egan 2004, 2005). Museum holdings are limited to twelve specimens collected from 1905 through 1977, with Lake Benson, Lily Pond, Daisy Farm Trail, trail from Greenstone Ridge to Lake Richie, north of the trail between Three Mile and Daisy Farm campgrounds, and between Lookout Louise and Mount Franklin, mentioned as specific localities. Ruthven et al. (1928) mapped this species in the park. Harding (1997), Harding and Holman (1999), and Casper (2002) include the entire Lake Superior basin and Isle Royale in their range.

Spring peepers are very common in the park in virtually all habitats. They are most abundant in forested habitats around good breeding sites (ephemeral and semi-permanent wetlands), and are best detected and monitored by calling surveys. Casper and Hecnar (unpublished data) obtained good detection probabilities ($DP > 0.3$) at all Lake Superior basin sites by calling surveys.

Vouchers: FN 2084-85, 1674.

Museum material: MSUM 8266-69, 13965-66; UMMZ 33442, 33456-57, 33459, 113515, 83868.

Gray Treefrog (*Hyla versicolor*): Gray treefrogs were not found during this study, nor could D. C. Smith recall ever seeing or hearing one in his several decades of work in the northeastern portion of the park (personal communication). Adams (1909) mentions finding one in the summer of 1905, but the specimen has been lost and cannot be verified (G. Schneider, UMMZ, personal communication, 2008). No other specimen records could be found. Ruthven et al. (1928) had no records for this species from the park. The park calling frog surveys report that since 1998 there have been two incidental reports of the gray treefrog at the western end of Isle Royale (near Island Mine campground in mid-July 1998, and on the Huginn Loop trail in 2002), but that they are previously unknown to the island, and no documentation exists (Thompson and Egan 2003; Egan 2004). Harding (1997) does not include Isle Royale as occupied, mapping a northern and eastern range limit near Thunder Bay, Ontario. Harding and Holman (1999) also consider Isle Royale as unoccupied. Casper (2002) places the northern and eastern range limit near Lake Nipigon and had no records for Isle Royale. The range may extend farther east in Ontario, but survey effort has been very limited. They are locally common in the Thunder Bay area (S. Hecnar, personal communication, 2005).

Gray treefrogs are apparently quite rare or transient in the park, and their presence needs verification. Possibly the species is accidental, with a limited colonization that has not dispersed from the Windigo area and may not persist. I have known them to inadvertently hitch rides on automobiles and in shoes and other items, resulting in accidental translocations. This species is most abundant in forested habitats around good breeding sites (ephemeral wetlands, semi-permanent ponds, bog moats, and shallow marshes), and they are readily detected and monitored by calling surveys. Casper and Hecnar (unpublished data) obtained good detection probabilities ($DP > 0.3$) at most Lake Superior basin sites by calling surveys. Aquatic funnel traps for larvae are also productive for detecting this species, as the tadpoles are distinctive and relatively easy to identify. Isle Royale is near a range limit for gray treefrogs, which could change in response to

ongoing climate change. This species is considered unconfirmed at this time, pending future occurrence documentation.

Vouchers: none.

Museum material: UMMZ 7457 (lost).

Northern Green Frog (*Lithobates clamitans melanota*): Northern green frogs are well distributed throughout the park and were confirmed from along the Minong Ridge Trail, the Daisy Farm campground and trail, and the Mount Ojibway Trail. They have also been reported from near North Government and Edwards islands, a beaver pond near Lane Cove, Siskiwit Bay, tamarack swamps (T65N, R35W, Secs. 31 and 32), and most inland lakes (Adams 1909; Johnson 1965; Smith 1983a). D. C. Smith found a few at some of his northeastern outer islands study sites in the 1980s but has not seen any since (personal communication, November 2, 2008). The park regularly records northern green frogs on calling frog survey routes and considers them the most common species heard on the July samples (Beeman and Oelfke 1997a, 1997b; Niemela et al. 1998; Peterson et al. 1999; Milanowski et al. 2000; Goodwin and Egan 2001; Wagner and Egan 2002; Thompson and Egan 2003; Egan 2004, 2005). Schuster (2001) found them along the Indian Portage Trail, the Daisy Farm-Mt. Ojibway loop trail, and the Three Mile to Lane Cove trail. Sixty museum specimens have been collected from 1905 through 1977. Collecting locations include the Daisy Farm area, Hidden Lake, Benson Creek, Lake Ojibway, McCargoe Cove, Moskey Basin, Chickenbone Lake, Lighthouse Peninsula, Siskiwit Lake, Rock Beach, Rock Harbor, Siskiwit Bay, Sumner Lake, and Lake Benson. Ruthven et al. (1928) mapped this species in the park. Shelton (1975) rated northern green frogs as the islands' most common amphibian. Harding (1997) does not show Isle Royale as occupied, but this was an error in map production (personal communication, 2005). Harding and Holman (1999) and Casper (2002) include the entire Lake Superior basin and Isle Royale in their range maps. Johnsson et al. (1982) considered northern green frogs to be the most common frog in the park, found in all aquatic habitats except the open shores of Lake Superior.

Northern green frogs are very common in the park along shorelines of lakes and streams, and in wetlands. Unlike most Isle Royale amphibians, this species is well represented by voucher specimens. Northern green frogs are most abundant in warm water habitats with abundant vegetative cover, and they are best detected and monitored by calling surveys. Visual searches along shorelines are also successful for locating more populations, and aquatic funnel traps are successful for collecting larvae. The latter method has high detection probabilities and is well suited for monitoring this species where calling surveys are logistically difficult. Casper and Hecnar (unpublished data) obtained good detection probabilities ($DP > 0.3$) at all Lake Superior basin sites by calling surveys, aquatic funnel traps (for tadpoles), and shoreline visual searches.

Vouchers: FN 1291, 1675-76, 2080.

Museum material: MSUM 8288-8289, 8354- 73, 14018-22; UMMZ 7456, 33423-25, 33429- 41, 33443-51, 33460, 113511-12, 206530-31; USNM 57929, 57933.

Mink Frog (*Lithobates septentrionalis*): Mink frogs were not found during this study. Schuster (2001) found them along the Indian Portage Trail, Daisy Farm-Mt. Ojibway Loop Trail, and the

Three Mile to Lane Cove Trail. David C. Smith observed one at Hidden Lake in the late 1970s (Smith 1983a, personal communication 2008), and the park occasionally records mink frogs on their calling frog survey routes (Beeman and Oelfke 1997a, 1997b; Niemela et al. 1998; Peterson et al. 1999; Milanowski et al. 2000; Goodwin and Egan 2001; Wagner and Egan 2002; Thompson and Egan 2003; Egan 2004, 2005). Four museum specimens collected between 1905 and 1977 were found; two from unspecified locations and one each from Hidden Lake and Benson Creek (T66N R34W). Ruthven originally confirmed the 1905 specimen, and this and the remaining specimens were reconfirmed in 2008 (personal communications: G. Schneider, UMMZ; J. Harding, MSUM). Ruthven et al. (1928) mapped this species in the park, presumably based on the 1905 museum specimens. Shelton (1975) listed their occurrence as questionable. Harding (1997), Harding and Holman (1999), and Casper (2002) include the entire Lake Superior basin and Isle Royale in their range maps. Johnson (1965) reported mink frogs from surveys for his thesis work, while Johnsson et al. (1982) considered it to be the least known frog in the park.

Mink frogs appear to be uncommon in the park. They typically prefer warm water habitats with abundant vegetative cover, especially water lilies (Lannoo 2005). They can be detected and monitored by calling surveys and aquatic funnel traps for tadpoles with adequate detection probabilities (Casper and Hecnar, unpublished data). Calling surveys can be compromised by unusual calling times, with mink frogs often calling between midnight and 0300 hrs, or at mid-day (personal observations, Alger and Keweenaw counties, Michigan). Such call timing may enhance reproductive isolation from the sympatric northern green frog, which typically calls for a few hours before and after sunset and is suspected to hybridize with mink frogs (Lannoo 2005). Visual searches along shorelines are another successful technique for locating populations.

Vouchers: none.

Museum material: MSUM 8573, 13964; UMMZ 33426, 113510.

Northern Leopard Frog (*Lithobates pipiens*): Northern leopard frogs were not found during this study and no observational or museum records could be found for the park. Ruthven et al. (1928) had no records for this species in the park. Harding (1997), Harding and Holman (1999), and Casper (2002) include the entire Lake Superior basin within their range, including the Thunder Bay area where they are locally common, but there are no records for Isle Royale. Shelton (1997: p. 28) explicitly mentions that northern leopard frogs are absent from the park. They apparently have not colonized the islands, and park personnel should remain alert for this species, as Isle Royale habitats and climate appear to be suitable for northern leopard frogs (Lannoo 2005).

Northern leopard frogs can be detected by calling frog surveys but with poor reliability due to a weak call and brief calling period (Casper and Hecnar, unpublished data). Surveys should combine calling surveys with visual searches of breeding habitat in mid- to late summer for better detection. This species has complex habitat requirements, utilizing permanent water hibernating sites (often streams or deep lakes) and ephemeral or semi-permanent ponds and wetlands for breeding, while summer foraging takes place in upland habitats and open bogs, with meadows being especially favored (Pope et al. 2000). Mid-summer estivation in duff and tussocks is not uncommon (Lannoo 2005).

Vouchers: none.

Museum material: none.

Wood Frog (*Lithobates sylvaticus*): Wood frogs are well distributed throughout the park and were confirmed from many locations during this study, including along the West Huginn Cove Trail, Feldtmann Lake Trail near Middle Point, Windigo area, Greenstone Ridge Trail, Grace Creek north of the Feldtmann Lake Trail, Daisy Farm campground and trails, and the Mount Ojibway Trail. They were also reported from along the edge of Mason Lake (near Chippewa Harbor) in 2008, and by Adams (1906, 1909) from Lake Desor, an island offshore of Neutson's Resort, and at tamarack swamp Station V.5 (T65N, R35W, Secs. 31 and 32). Schuster (2001) found them along the Indian Portage Trail. The park regularly records wood frogs on their calling frog survey routes, and considers them stable and present island-wide (Beeman and Oelfke 1997a, 1997b; Niemela et al. 1998; Peterson et al. 1999; Milanowski et al. 2000; Goodwin and Egan 2001; Wagner and Egan 2002; Thompson and Egan 2003; Egan 2004, 2005). Museum holdings include 38 specimens collected between 1904 and 1977 from the Daisy Farm area, the Mt. Franklin Trail, Lake Desor, Forbes Lake, Tobin Harbor, Chickenbone Lake, T66N R34W, and Lane Cove. Ruthven et al. (1928) mapped this species in the park. Johnson (1965) recorded them from the park, and Shelton (1975) considered them common. Harding (1997), Harding and Holman (1999), and Casper (2002) include the entire Lake Superior basin and Isle Royale in their range maps. Johnsson et al. (1982) include it as a park resident but suggested it is not abundant.

Wood frogs are common throughout the park in forested habitat and are well represented by voucher specimens. Their abundance is positively associated with ephemeral wetlands, increasing canopy closure, increasing thickness of duff, hardwoods, and loamy soils; it is 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 (early) calling surveys. Casper and Hecnar (unpublished data) obtained good detection probabilities ($DP > 0.3$) at most Lake Superior basin sites by calling surveys and visual searches. Good habitat for this species can be found throughout the park where breeding ponds are embedded within forests.

Vouchers: FN 1292, 1673.

Museum material: MSUM 8610, 8615-18, 13959-63; UMMZ 32313, 33458, 33495-509, 69646, 106582, 113513- 14, 116691; USNM 57930-36.

Turtles

Eastern Snapping Turtle (*Chelydra serpentina serpentina*): Eastern snapping turtles were not found during this study and no observational or museum records could be found for the park. Ruthven et al. (1928) had no records for this species in the park. Both Harding (1997) and Casper (2002) note that snapping turtles are found throughout the Lake Superior basin, albeit with extremely few records for the north shore, which may represent a range limit (additional northern Ontario records are under review; S. Hecnar, personal communication, 2008). Harding and Holman (1990) do not include Isle Royale within the range. Ernst et al. (1994) does not include the north shore of Lake Superior within the range, but they may have been unaware of the few north shore records. Shelton (1997: p. 28) explicitly mentions that snapping turtles are absent from the park. This species is a possible candidate for colonization of the islands, but apparently has not yet arrived and is considered absent at this time.

Eastern snapping turtles can be detected and monitored by baited hoop net trapping, but detection probabilities are low, requiring greater effort for confidence (Casper and Hecnar, unpublished data). They are highly aquatic and do not bask as often as western painted turtles. They prefer warm waters with abundant aquatic vegetation, and where established are often observed during the June nesting season digging in sand and gravel soils. Park staff, visitors, and fisheries personnel should remain alert for this species and document any observations with photographs.

Vouchers: none.

Museum material: none.

Western Painted Turtle (*Chrysemys picta bellii*): Western painted turtles (Figure 8) are common throughout the park in most aquatic habitats, but surprisingly few vouchers are available. We found them in the Daisy Farm area, but not at Windigo, where we probably were surveying too early in the season for this species to be very active. They have been observed by others at Chickenbone Lake, Lake Richie, Lake Harvey, the Moskey Basin dock, and at Duncan Bay, and they are reported present in most inland lakes. Museum material is limited to a 1963 specimen with no specific locality data, and a 1929 specimen from Lake Eva which is now lost. Ruthven et al. (1928) mapped this species in the park. Johnson (1965) collected this species from Isle Royale for his thesis and Shelton (1975) considered them common. Moll (1974) hand-captured several painted turtles while wading on Isle Royale, and he postulates that the unusual tameness he observed may be an adaptive behavioral response to a lack of predators. Harding and Holman (1990), Harding (1997), and Casper (2002) include the park within the species's range, and it is found throughout the Lake Superior basin (Ernst et al. 1994). Johnsson et al. (1982) considered them common in large beaver ponds and small or shallow lakes with muddy bottoms.



Figure 8. Basking painted turtle, Benson Creek, Isle Royale, 2005. Photo by G.S. Casper.

Western painted turtles are easily detected and monitored by trapping, as well as by visual basking surveys. Casper and Hecnar (unpublished data) obtained good detection probabilities ($DP > 0.3$) at most Lake Superior basin sites by these methods. They prefer waters with abundant vegetation supporting the aquatic macroinvertebrates which comprise the bulk of their diet. Fisheries staff and park visitors should be encouraged to take digital photos to help document the distribution of this species in the park. Additional inventory work is recommended to obtain a useful voucher series (photo or specimen).

Vouchers: GSC 00002.

Museum material: MSUM 8688; UMMZ 68757 (lost).

Snakes

Northern Red-bellied Snake (*Storeria occipitomaculata occipitomaculata*): Northern red-bellied snakes were found at Windigo, Daisy Farm, and Mott Island during this study. Additional observations dating back to 1904 are available from the Greenstone Range, Windigo sump, Intermediate campsite, Moskey Basin campsite, and Rock Harbor (Adams 1906). Museum material spanning the period from 1904 through 1977 is available from the Mt. Franklin Trail, Rock Harbor Lighthouse, Siskiwit Lake, Rock Harbor, Neutson's Resort, McCargoe Cove, Chickenbone Lake, and Washington Harbor. They are considered to be a common but secretive resident throughout the park. Ruthven et al. (1928) mapped this species in the park, and Shelton (1975) portrayed them as uncommon. Johnsson et al. (1982) note that it occurs widely over the island and suggested it was associated with thick leaf or plant cover close to the ground. Johnson (1965) collected specimens from Isle Royale for his thesis. Harding (1997) and Holman and Harding (2006) map Isle Royale occupancy. Casper (2002) does as well, but he shows that most of Lake Superior's north shore is either unoccupied or not surveyed, so Isle Royale may represent a range limit for this species, or perhaps an accidental human-assisted colonization. Ernst and Ernst (2003) also show absence along the north shore of Lake Superior east of

Thunder Bay, and they may be absent from the Thunder Bay area (S. Hecnar, personal communication, 2008).

Regardless of their origin, northern red-bellied snakes have long been established on Isle Royale, and they may be detected and monitored with cover object surveys (both natural and artificial) and are occasionally encountered on trails and roadways throughout the active season. Casper and Hecnar (unpublished data) obtained variable detection probabilities using wooden cover object surveys, with good detection ($DP > 0.3$) at south shore Lake Superior sites, and poor detection at north shore sites. Additional research is needed regarding the efficacy of cover object surveys for snakes in the north part of the Lake Superior basin, including Isle Royale.

Vouchers: FN 17659.

Museum material: MSUM 8693, 13970; UMMZ 33408-17, 33475-78, 33493-94, 68838, 83875, 172049.

Common Gartersnake (*Thamnophis sirtalis*): Common gartersnakes were found throughout the park and are commonly observed. This study recorded them at Daisy Farm, Windigo, the Greenstone Ridge, and Mott Island. Other reports dating back to 1904 are available from Tobin Harbor, Lake Richie, Chickenbone Lake, Washington Creek, the Greenstone Ridge, North Government and Edwards islands, Ransom Clearing and Benson Brook, near Sargent Lake, at the western end of Siskiwit Bay, Mott Island, Richie/Moskey Trail, Woodlake Camp, Grace Island, Windigo, and Huginnin Cove (Adams 1906, 1909; Johnson 1965; Smith 1983a). Available museum holdings dating from 1904 to 1977 include specimens from Mt. Franklin, Lookout Louise, Moskey Trail, Chickenbone Lake, Greenstone Ridge, Lake Ojibway, Minong Mine, Ransom Clearing, Rock Harbor, Rock Harbor Lighthouse, Siskiwit Bay, Siskiwit Lake, and Sumner Lake. Ruthven et al. (1928) mapped this species in the park, and Shelton (1975) considered them common. Harding (1997), Casper (2002), Ernst and Ernst (2003), and Holman and Harding (2006) include Isle Royale and the entire Lake Superior basin within the species's range. Johnsson et al. (1982) considered them common in many habitats, especially moist, grassy, or brushy sites.

Color and pattern are extremely variable in gartersnakes from Isle Royale. Ruthven (in Adams 1909) described color variation in detail, which merits quoting here:

The specimens of this snake obtained vary greatly in color. A number, like the few obtained in 1904, would be referred unhesitatingly to [the] variety [T. s.] parietalis, were it not for the fact that there are other specimens in the collection which have a smaller amount of red on the sides, as well as some in which it is entirely wanting. When the series is examined as a whole it is quite evident that the specimens are intermediate between the typical form and variety parietalis, which is not surprising...

This, however, in no way vitiates the statement made in 1904 that the presence of this snake on the island is an evidence of a western

affinity in the fauna; for the frequent presence of a considerable amount of red pigment on the sides and the tendency toward the fusion of upper row of spots, indicate that the Isle Royale specimens are more closely related to the western parietalis than to the garter-snake of eastern Canada and Northern Michigan, which belongs to the typical form, in that it never has the interspaces of the first row of spots entirely suffused with red, not the upper row of spots usually fused.

A number of specimens from Rock Harbor, differ so much from the usual color of Isle Royale specimens as to merit special mention. The ground color in these individuals is black or blackish. The stripes are dark greenish, the dorsal being indistinct. The spots of the first row are distinct, the interspaces being of a light bluish color; the upper row of spots is usually fused except for short bars or spots of bluish. Belly dark blue with a black band on the outer margin of each scute. Supralabials dark blue, bases of the second to the fifth, white. Iris black. These specimens are identical with those from New Hampshire...

Johnsson et al. (1982) also noted that color varies widely, from light brown and yellow to deep blue-black. In this study, we made color notes as well, only later to discover that we had re-described color variation very similar to that which Ruthven had detailed exactly 100 years ago. In our sample from the Daisy Farm area (N=20), 60% of specimens observed were normal, 30% had some stage of prominent red pigment, and 10% were melanistic (unpublished data; Figure 9). This stable color polymorphism is interesting, and possibly related to small population size and/or founder effects increasing the expression of recessive alleles. Similar color variation has been noted in other island and isolated populations in the Lake Superior and Lake Winnipeg basins (Mooi et al., *in prep*). R. Rutherford and J. Anderson also provided photo documentation of melanistic common gartersnakes observed at Tobin Harbor and Lake Richie in 2008 (personal communication).

The subspecies normally assigned to this region is the eastern gartersnake, *Thamnophis sirtalis sirtalis*, but individuals closely resembling the red-sided gartersnake, *T. s. parietalis*, are commonly encountered on Isle Royale, as noted by Ruthven above. The subspecies of *T. sirtalis* described from morphology appear to be nonconforming to molecular clades and are likely to be revised in the future (Janzen et al. 2002). Subspecies designations are therefore not used in this report.

A melanistic individual (see Figure 8e) could have been responsible for the erroneous report of a black ratsnake (formerly *Elaphe obsoleta*, now considered to be the gray ratsnake, *Pantherophis spiloides*; Burbrink et al. 2000; Burbrink 2001) on Isle Royale. Johnsson et al. (1982) reported a black ratsnake captured at Chickenbone Lake in July 1987, which was photographed and released, but the photograph was inconclusive and the species presence on Isle Royale was considered questionable. Isle Royale is approximately 500 km beyond the known range limits for

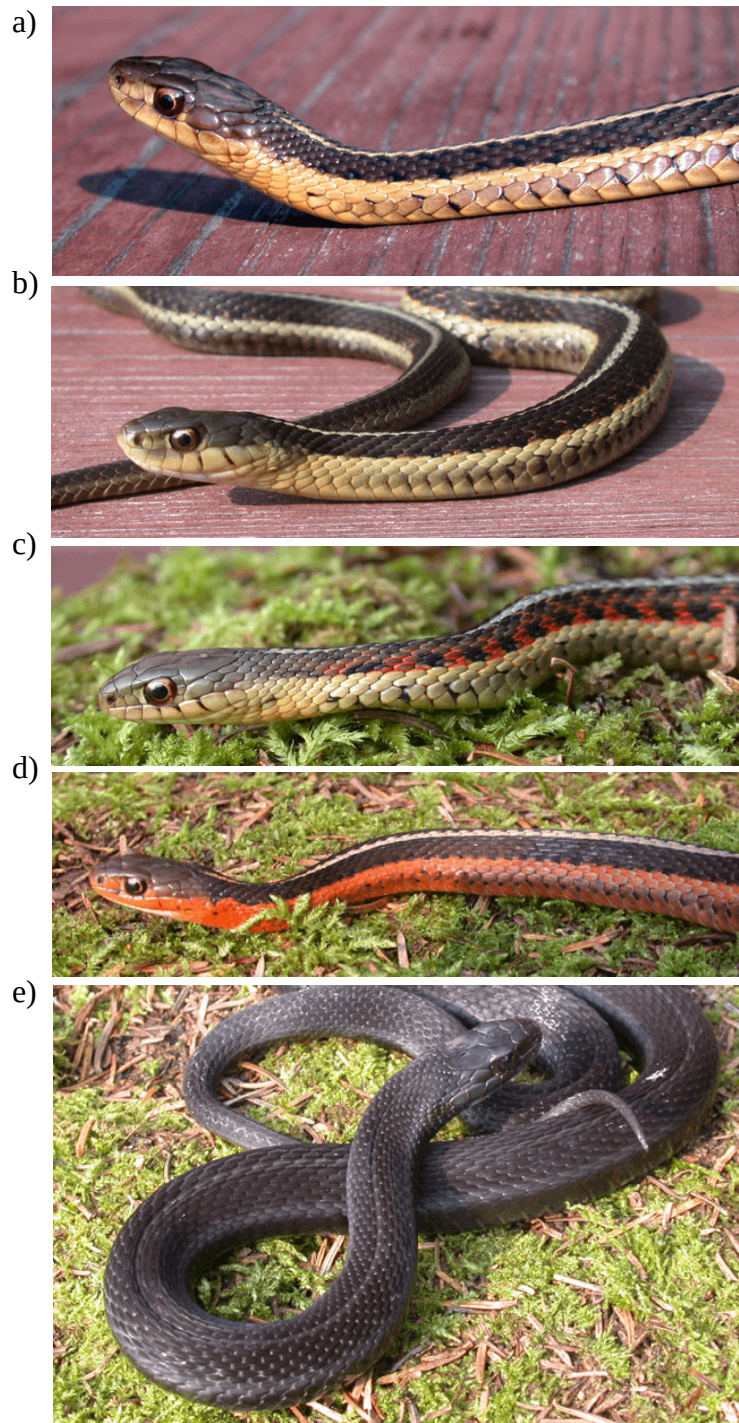


Figure 9. Color variation in Isle Royale gartersnakes (Daisy Farm Campground, 2005). Photos by G.S. Casper.

ratsnakes (Ernst and Ernst 2003). Another possible explanation is that a visitor brought a black ratsnake to Isle Royale (J. Elias, personal communication, 2008).

Common gartersnakes are very common throughout the park, especially near wetlands that support ranid frogs, a favorite food. They can be found in nearly all habitats, including the top of the Greenstone Ridge. They are well documented with voucher specimens. These gartersnakes can be reliably detected and monitored with cover object surveys. Casper and Hecnar (unpublished data) obtained variable detection probabilities using wooden cover object surveys; good detection ($DP > 0.3$) was achieved at south shore Lake Superior sites, and poor detection at north shore sites. Additional research is needed regarding the efficacy of cover object surveys for snakes in the north part of the Lake Superior basin, including Isle Royale.

Vouchers: FN 1664, 1672, 1714, 2081-83; GSC 9-10, 12; MPM 33454.

Museum material: MSUM 8744-52, 14023-24; UMMZ 7454, 33418-21, 206532, 33461-64, 33467-68, 33470-74, 33479-83, 33485-92, 43931, 33469, 33484, 33465-66, 33477, 33538-39.

Northern Ribbonsnake (*Thamnophis sauritus septentrionalis*): The northern ribbonsnake is erroneously reported from Isle Royale. The specimen collected by A. E. Foote, probably acquired during the expeditions to Isle Royale in the early 1900s, has been lost and cannot be verified (G. Schneider, UMMZ, personal communication, 2008). This species can be confused with the common gartersnake, which is the most likely candidate for this specimen. Isle Royale is over 300 km beyond the recorded range limits of this species (Ruthven et al. 1928; Casper 2002; Ernst and Ernst 2003; Holman and Harding 2006).

Vouchers: none.

Museum material: UMMZ 1752 (lost).

Species Inventory Discussion

Based on our field results and review of museum material, the species list for Isle Royale National Park should be updated according to Table 4.

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 is especially important to forest amphibians. Sunny openings are important to snakes for thermoregulation, for proper embryo development, and 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. Stocking fishes in isolated ponds, or lakes that previously lacked game fish, is detrimental to these species. Maintenance of natural, undeveloped shoreline is beneficial to many turtles and ranid frogs, and healthy native aquatic macrophyte beds are important to these species, as well as newts.

Beaver (*Castor canadensis*) ponds provide important and potentially limiting habitat for painted turtles, frogs (northern green frog, mink frog, and wood frog), blue-spotted salamanders, central newts, and common gartersnakes (Shelton 1975; Dalbeck et al. 2007; Stevens et al. 2007). These species probably fluctuate in distribution and abundance depending upon the availability of these somewhat transient communities (beaver ponds), which on Isle Royale may be linked to cyclic fluctuations in beaver predator populations (chiefly wolves, *Canis lupus*). The importance of both natural and artificial impoundments to these amphibians and reptiles should be factored into any management decisions. Some snakes and turtles also utilize beaver lodges as winter denning sites.

Inventory and Monitoring

The following inventory and monitoring recommendations build on Casper (2004; see also for additional details on methodology). Anuran calling surveys are effective for detecting most species (Casper and Hecnar, unpublished data). However, 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 (MacKenzie et al. 2006). At Isle Royale National Park, habitats are fairly uniform in their distribution, such that it is unlikely that species composition at remote sites will significantly differ from more easily accessible sites. Therefore, a trail and access point-based monitoring program should be representative of the entire park. Nonetheless, details of incidental observations of amphibians and reptiles from all areas, made during any activities, should be recorded to continue building a distribution atlas. Detection probabilities for Isle Royale species are becoming available for several sampling methods, which will make survey data more useful and will assist program managers in choosing appropriate species to monitor. Preliminary results, for example, suggest that calling surveys are adequate for detecting most anurans, but the frequency of calling surveys should be increased to two-to-four surveys per calling period in order to obtain better confidence in data for more

species (Casper and Hecnar, unpublished data). New low power solid state remote recorders for monitoring frogs have long battery life and 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.

Sampling via aquatic funnel trapping is recommended for additional inventory and monitoring of blue-spotted salamanders and central newts; it would also detect potential future colonization by spotted salamanders. This method has generally good detection probabilities for these species (Casper and Hecnar, unpublished data), but should be locally calibrated.

Salamanders may be more reliable indicators of ecological change than anurans because their poorer mobility makes them less able to respond to changing conditions through immigration and expansion of activity areas (e.g., to find new breeding sites in drier years). Blue-spotted and spotted salamanders can also be reliably detected by visual egg surveys. Eastern red-backed salamanders may be monitored by time- or area-constrained visual searches of ground litter and downed woody debris with high confidence by only three searches per season (Casper and Hecnar, unpublished data). While not yet known to occur on Isle Royale, this relatively easy monitoring technique could be considered for a periodic effort to detect colonization by this species. Common mudpuppy surveys may utilize visual searches and baited aquatic trapping, but more research is needed relative to the efficacy of these techniques at reference sites. A citizen science program that enlists the aid of divers may prove fruitful as well.

Additional turtle inventory (and monitoring if desired) should use visual basking surveys for painted turtles and baited hoop net traps for detecting potential future colonization by eastern snapping turtles. Baited hoop net traps can also be used for collecting demographic data on painted turtles, including easy mark-recapture studies by shell notching. A program of periodic trapping could yield population monitoring of painted turtles and simultaneously allow for the detection of snapping turtles should they arrive.

Cover object surveys may be effective for monitoring eastern gartersnake and northern red-bellied snakes in the park, but more research is needed relative to the efficacy of this method in the park environment. Wood cover objects are generally recommended (¾-inch exterior plywood is best), which attract snakes later into the season than do metal cover objects (which tend to become too hot later and do not retain heat well for attracting snakes during cool nights), but other materials should not be ruled out until more testing has been performed. The landscape fabric used during this study was experimental and was not very successful. However, placement was not optimal, nor was sufficient sampling effort or timing achieved. An advantage of cover objects over other methods is that they do not require daily visits or special skills.

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Appendixes

Appendix A. Common and scientific names for species mentioned in this report.

Appendix B. Field notes

Appendix C. GPS waypoints

Appendix D. Locality records

Appendix E. Museum data

Appendix F. Photo vouchers

NOTE: Appendixes B through F are available to qualified researchers on request from the National Park Service, Great Lakes Network Office in Ashland, Wisconsin.

Appendix A. Common and scientific names for species mentioned in this report.

List is organized in alpha order by common name. Taxonomy is based on Crother (2008).

Scientific	Common
<i>Ambystoma laterale</i>	Blue-spotted Salamander
<i>Pseudacris maculata</i>	Boreal Chorus Frog
<i>Notophthalmus viridescens louisianensis</i>	Central Newt
<i>Thamnophis sirtalis</i>	Common Gartersnake
<i>Necturus maculosus maculosus</i>	Common Mudpuppy
<i>Anaxyrus americanus americanus</i>	Eastern American Toad
<i>Plethodon cinereus</i>	Eastern Red-backed Salamander
<i>Chelydra serpentina serpentina</i>	Eastern Snapping Turtle
<i>Hyla versicolor</i>	Gray Treefrog
<i>Lithobates septentrionalis</i>	Mink Frog
<i>Lithobates clamitans melanota</i>	Northern Green Frog
<i>Lithobates pipiens</i>	Northern Leopard Frog
<i>Storeria occipitomaculata occipitomaculata</i>	Northern Red-bellied Snake
<i>Thamnophis sauritus septentrionalis</i>	Northern Ribbonsnake
<i>Ambystoma maculatum</i>	Spotted Salamander
<i>Pseudacris crucifer</i>	Spring Peeper
<i>Chrysemys picta bellii</i>	Western Painted Turtle
<i>Lithobates sylvaticus</i>	Wood Frog

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NPS D-123, December 2008

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