Amphibian and Reptile Monitoring in the Great Lakes Network National Parks: Review and Recommendations

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Smooth Greensnake, *Opheodrys vernalis*, Pictured Rocks National Lakeshore.

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Gray Treefrog, *Hyla versicolor*, Pictured Rocks National Lakeshore.

1. INTRODUCTION

The Great Lakes Inventory and Monitoring Network (GLKN) consists of nine national parks, lakeshores, and monuments in the western Great Lakes region (Table 1). The GLKN office is preparing its monitoring plan, and because herptiles are among the indicators likely to be monitored, the GLKN requested a review of existing monitoring programs, and recommendations for improved methods and consistency. Currently eight of the nine parks are engaged in separate amphibian surveys, and only one park is conducting reptile monitoring (*fide* GLKN office August 2003, Table 2). Amphibian and reptile inventories for these parks are in various stages of completion (personal communications with parks and GLKN office). Some parks still have significant inventory needs. This report reviews the existing programs, makes recommendations for expanding monitoring programs, and recommends measures to attain consistency among parks.

2. EXISTING PROGRAMS AND INVENTORY STATUS

Existing inventory efforts have identified 61 species as confirmed or possible within the nine GLKN parks (Table 3). These represent 11 salamander, 15 frog and toad, 13 turtle, four lizard, and 18 snake species.

2.1 Apostle Islands National Lakeshore (APIS, *fide* Julie Van Stappen, June 2004):

Currently anuran calling surveys following the Wisconsin Frog and Toad Survey (Mossman et al. 1998) protocol are conducted on the mainland only. Island anuran calling surveys have been conducted in the past utilizing frog loggers, but adequate coverage has been difficult to achieve due to logistical issues. An amphibian malformation survey was completed in 2001 (Casper 2001a), using fluctuating asymmetry as a measure (Palmer and Strobeck 1986). Follow up surveys would be required for analyses.

The status of herptile inventory in the APIS is good (GLKN office inventory lists). Matrices of herptile species occurrence by island have been developed (Casper 2001a-b), and are being actively maintained through ongoing research (Casper programs). A review of voucher specimens representing a permanent verifiable record has been produced (Casper 2001a-b), and a reference specimen collection has been deposited at park headquarters in Bayfield. Recent voucher specimens have been deposited at the Milwaukee Public Museum.

2.2 Grand Portage National Monument (GRPO, *fide* Suzanne Gucciardo, June 2004):

Currently only anuran calling surveys are contributing to monitoring, with one point on one route on park property started in 2004, in cooperation with the Minnesota Frog & Toad Calling Survey (Moriarty 1997).

The status of herptile inventory in the GRPO is fair (GLKN office inventory lists). Some species are likely present but have not yet been confirmed (Common Mudpuppy, Eastern Newt, Eastern Snapping Turtle, Painted Turtle, Northern Red-bellied Snake), and a listing of voucher specimens representing a permanent verifiable record is not available, but several electronic databases exist (i.e., GLKN, Minnesota County Biological Survey, Minnesota Frog and Toad Calling Surveys, various museums). Given the narrow corridor represented by the park, and limited habitat diversity (especially wetlands), many herptile species may be transient, or conduct only part of their life cycle, within park boundaries. The existing beaver pond may be a critical habitat for amphibians and turtles, allowing some species to carry out their full life cycle within the park.

2.3 Indiana Dunes National Lakeshore (INDU, *fide* Ralph Grundel, June 2004):

Currently only anuran calling surveys are contributing to monitoring, in cooperation with the Michigan Frog and Toad Survey (Genet and Sargent 2003), and the Marsh Monitoring Program (Weeber and Vallianatos 2000), with six to seven points in the park during peak coverage, and presently three to four still running. Some recent inventory projects have established cover object and drift fence arrays which may be available to utilize for monitoring.

The status of herptile inventory in the INDU is good (GLKN office inventory lists), and is being actively updated through ongoing research (GLKN; A. Resetar, Field Museum of Natural History). A listing of voucher specimens representing a permanent verifiable record is available (Resetar, Field Museum of Natural History). Several recent inventory projects have been completed (a three year drift fence study concluded in 2002), or are ongoing (Eastern Massasauga surveys since 2002 utilizing cover objects, drift fences, and visual searches; A. Resetar's ongoing monograph on INDU herptiles). Spencer Cortwright (Indiana University Northwest, Gary, IN) studied pond breeding amphibians for several years, and may have data that could be incorporated into a monitoring program (personal communications R. Grundel and A. Resetar, June 2004).

2.4 Isle Royale National Park (ISRO, *fide* Jean Battle, June 2004):

Currently only anuran calling surveys are ongoing. These were established in 1996 in cooperation with the Michigan Frog and Toad Calling Survey (Goodwin and Egan 2001). Two transects with 10 points each were established in 1996, with third and fourth transects added in 1997 and 1999. As of 2001, three transects were in the east and one in the west, following park trails. Michigan Frog and Toad Calling Survey protocols (Genet and Sargent 2003) are followed. Research on the Boreal Chorus Frog has been ongoing for 20 years (David Smith, Williams College, MA), and these data may contribute to monitoring. A proposal for salamander monitoring was prepared (Romanski 1998), following the Terrestrial Salamander Monitoring Program protocol (Droege et al. 1998), but it is unclear if the proposal was implemented. An amphibian malformation study was performed in 1996, with the intent of continuing periodic sampling to monitor for amphibian malformations (Schuster and Romanski no date). This study consisted of sampling 50-100 frogs from five sites, and gross examination of amphibians for visible malformations and symmetry, after methods put forth by the North American Reporting Center for Amphibian Malformations (NARCAM, http://frogweb.nbii.gov/narcam/). Data collected were shared with NARCAM.

The status of herptile inventory in ISRO is fair, with several herptile species of unknown status (GLKN office inventory lists). Plans for conducting herptile inventories in 2004-05 should elevate inventory status to good, and provide a listing of voucher specimens representing a permanent verifiable record.

2.5 Mississippi National River and Recreation Area (MISS, *fide* Nancy Duncan and John Moriarty, June 2004):

Currently only anuran calling surveys are contributing to monitoring, in cooperation with the Minnesota Frog and Toad Calling Survey (Moriarty 1997). The narrow park corridor does not encompass any entire route, but contains a few points along several routes.

The status of herptile inventory in the MISS is fair, with many species presumed present from general range limits (GLKN office inventory lists). A listing of voucher specimens representing a permanent verifiable record is not available, but several electronic databases exist (i.e., Wisconsin Herp Atlas, GLKN, Minnesota County Biological Survey, Minnesota and Wisconsin frog and toad calling surveys, various museums).

2.6 Pictured Rocks National Lakeshore (PIRO, *fide* Jerry Belant and Lora Loope, May 2004):

Currently only anuran calling surveys are contributing to monitoring, in cooperation with the Michigan Frog and Toad Survey (Genet and Sargent 2003). Existing routes only cover the extreme east and west ends of the park property, and most points are not within park boundaries.

The status of herptile inventory in the PIRO is fair (GLKN office inventory lists), but ongoing 2004 inventory should elevate inventory status to good, and provide a listing of voucher specimens representing a permanent verifiable record. Data from a 1990 inventory by Jeff Davis will be incorporated into 2004 reports.

2.7 Saint Croix National Scenic Riverway (SACN, *fide* Robin Maercklein, June 2004; Maercklein 2003):

Anuran calling surveys are contributing to monitoring, in cooperation with the Minnesota and Wisconsin frog and toad calling surveys (Moriarty 1997, Mossman et al. 1998, respectively). Currently about 3.5 routes are within the park (one with only five points), and follow the Wisconsin protocol. Four cover object arrays were also established 1998, targeting salamanders and following Fellers and Dorst (in Heyer et al. 1994) protocols, and were checked for several years but currently are not active. In addition, fairly informal basking turtle surveys have been conducted regularly by park staff incidental to other river work, since 1999. Walt Sadinski (USGS, Upper Midwest

Environmental Sciences Center, La Crosse, Amphibian Research and Monitoring Initiative program) is conducting a three year study in SACN with the intent of setting up a cooperative monitoring program between the GLKN and the USGS Amphibian Research and Monitoring Initiative (ARMI) program. Sadinski's studies, which began in 2002, included surveys of 25-ha blocks for potential breeding sites for amphibians. Sites were visited up to three times over the course of three two-week periods, each a month apart beginning in early May, and measures of relative abundance, reproductive success, frequencies and types of deformities, and habitat conditions were taken. Methods included, but may not have been limited to, visual searches for basking turtles, cover objects, dip netting larval amphibians, and calling anuran surveys (personal communication, Robin Maercklein, June 2004; NPS Investigator Annual Reports). These sites were also surveyed for the presence/absence of turtles and snakes.

The status of herptile inventory in the SACN is good, although some species are presumed present from general range limits (GLKN office inventory lists). A listing of voucher specimens representing a permanent verifiable record is not available, but several electronic databases exist (i.e., Wisconsin Herp Atlas, GLKN, Minnesota County Biological Survey, Minnesota and Wisconsin frog and toad calling surveys, St. Croix Watershed Research Station, Sadinski's data, various museums). Ongoing inventory work by Sadinski should improve inventory status with park-specific data. Several recent inventory projects have been completed (Robin Maercklein cover object surveys), or are ongoing (Sadinski).

2.8 Sleeping Bear Dunes National Lakeshore (SLBE, *fide* Steve Yancho, June 2004):

Currently only anuran calling surveys are contributing to monitoring, in cooperation with the Michigan Frog and Toad Survey (Genet and Sargent 2003). These surveys cover only the north end of the park, and exclude the islands.

The status of herptile inventory in the SLBE is fair, with several herptile species of unknown status (GLKN office inventory lists). Plans for conducting herptile inventories in 2004-05 should elevate inventory status to good, and provide a listing of voucher specimens representing a permanent verifiable record.

2.9 Voyageurs National Park (VOYA, *fide* Steve Windels, June 2004):

Currently no monitoring programs are in place. However, Walt Sadinski (USGS) is conducting a three year study in VOYA with the intent of setting up a cooperative monitoring program. Sadinski's studies, which began in 2002, included surveys of 25-ha blocks for potential breeding sites for amphibians. Sites were visited up to three times over the course of three two-week periods, each a month apart beginning in early May, and measures of relative abundance, reproductive success, frequencies and types of deformities, and habitat conditions were taken. Methods included, but may not have been limited to, visual searches, dip netting larval amphibians, and calling anuran surveys (personal communication, Steve Windels, June 2004; NPS Investigator

Annual Reports). These sites were also surveyed for the presence/absence of turtles and snakes.

The status of herptile inventory in the VOYA is poor, with many species presumed present from general range limits (GLKN office inventory lists). However, ongoing inventory work by Sadinski should elevate inventory status to good. A listing of voucher specimens representing a permanent verifiable record is not available, but several electronic databases exist (i.e., Ontario Herp Atlas, GLKN, Minnesota County Biological Survey, Minnesota and Wisconsin Frog and Toad Calling Survey, Sadinski's data, various museums).

3. EXISTING METHOD REVIEW

A variety of methods have been used in the parks for inventory purposes, including drift fences, funnel traps, visual searches, turtle trapping, cover objects, and aquatic funnel trapping. These were generally one to three year limited studies, intended as one-time sampling events. Only those methods which are considered for use as potential long term monitoring programs are reviewed in this section.

3.1 Anuran Calling Surveys

The only monitoring method that is currently widely used among the nine parks is anuran calling surveys. This method has a long history, and was first established by the Wisconsin Department of Natural Resources (Mossman et al. 1998). The same protocols are followed by other state anuran calling surveys. This method is well established, relatively inexpensive, and well suited to GLKN goals. Data analysis is well served by statisticians at the USGS Patuxent Wildlife Research Center, where a variety of techniques can be applied at various scales. Coverage in the nine GLKN parks varies among parks, and should be expanded where warranted. See Section 4 for additional comments on coverage and data analyses for this method.

3.2 Basking Turtle Surveys

Currently only SACN has engaged this method. Maercklein (2003) addresses inherent biases and problems, which identify room for improvements. Recommended improvements include; a) encourage surveyors to submit negative data sheets (i.e., when no turtles are observed - this differs from no survey being conducted and requires the recording of weather, location, and time of day data); b) have a column for "unidentified turtles observed" on data forms (this may already be included but no data forms were available for review); and 3) attempt to obtain more equal coverage among river sections, perhaps by utilizing volunteers. See Section 4 for additional recommendations on this method.

3.3 Terrestrial Cover Object Surveys

Terrestrial cover object (CO) surveys come in a number of variations, depending on the target species, generally snakes and salamanders. SACN has engaged this method as a potential monitoring technique (Maercklein 2003), and followed protocol more suitable for salamanders than snakes. Cover boards (183 X 5 30 cm), overlaid by 5 X 15 cm boards with 0.6 cm lathe separators, were used. These provide long, narrow cover objects best suited to attracting small species like salamanders and Northern Red-bellied Snakes. Eight groups of four COs each were deployed (eight arrays), with four arrays in grassland and four arrays in forest settings. Generally, one would expect shaded COs to attract amphibians (for thermal stability and dampness), and COs exposed to the sun to attract reptiles (for heat retention). Data analyses should subset points by habitat type. A second technique used was to deploy "tree cookies" (28-36 cm diameter, 5 cm thick, slices of tree trunks). Twenty-one pairs of tree cookies were placed in a forested site, and 23 pairs in a grassland site. This again would be biased for small species. See Section 4 for additional comments on CO sampling.

At ISRO, CO methods were proposed for salamander sampling (Romanski 1998), but it is unclear if they were implemented. Nevertheless, the methods espoused in Romanski (1998), are those of Droege et al. (1998). Validation studies of this method have found it useful for the Eastern Red-backed Salamander, and less so for Mole Salamanders (genus *Ambystoma*) (Monti et al. 2000). The success of this method appears to decline from east to west, as drier conditions increase (personal observation). At ISRO, Eastern Red-backed Salamanders are unconfirmed, and the only Mole Salamander confirmed is the Blue-spotted Salamander, although Spotted Salamanders are possible as well. At this time, it is recommended that inventory be advanced (as scheduled in 2005), and if Eastern Red-backed Salamanders are confirmed, then this method should be pursued. Monitoring of Mole Salamanders and Eastern Newts, however, is better suited to aquatic funnel trapping (see Section 4).

3.4 Amphibian Malformation Surveys

Both APIS and ISRO have conducted initial amphibian malformation surveys, with ISRO's effort more comprehensive. Both have used symmetry measures as an indicator, which require follow up surveys before conclusions can be drawn. Fluctuating asymmetry measures are problematic owing to difficulties in measurement precision and accuracy, and are not yet well accepted as a useful method. Less controversial are simple descriptions of malformations through gross examination, however, this misses internal malformations which may be common. These two initial surveys provide useful information, but surveys utilizing radiographs and dissection may be better for quantitative measures of malformations (see Section 4).

4. RECOMMENDED METHODS

A set of eight recommended monitoring methods are provided in Table 4 and reviewed below. These provide a tool box of methods of varying efficacy, equipment, and labor requirements, and which focus on various taxonomic groups. I recommend that weather logging stations be set up at each park, so that data analyses can account for weather variables. With the recent availability of inexpensive environmental logging technology (Onset Computers), logging air and water temperature, relative humidity, and precipitation should be included at each station. For pond sampling, recording water depths in sampling years is also recommended. New weather station siting may be coordinated with the existing network of National Oceanic and Atmospheric Administration (NOAA) stations, where data can be shared.

I strongly recommend that a herpetologist work with each park specifically to select sampling sites, fine tune timing of methods and target species, and provide quality assurance by reviewing and supervising initial data collection and results. Once established, most methods can be conducted by general biological staff or trained volunteers.

4.1 Anuran Calling Surveys

This method is well known and described in Mossman et al. (1998). Also see Appendix A, detailing protocol by the North American Amphibian Monitoring Program (NAAMP), administered by the USGS Patuxent Wildlife Research Center. Routes are set up with 10 stops on each route, where the surveyor listens for calling anurans. Training is minimal and fairly easy with the wide availability of audio compact disks and cassette tapes of calls, and no more than about a dozen species need to be learned at any single park. Standardized data forms are available from NAAMP.

American Toad, *Bufo americanus*, Wisconsin.

Species potentially captured by this technique in the GLKN parks are listed in Tables 4 and 5. Four of these species are problematic. Pickerel and Northern Leopard frogs have relatively weak calls, with poor carrying power, and short breeding seasons. Hence they are often missed on surveys. Furthermore, because distinguishing the calls of these two species from each other can be difficult, Pickerel Frog reports (the scarcer of the two species) should be verified by specimen collections at each site reported. Mink Frogs often call in the wee hours of the morning (midnight to 4 AM), and hence may be missed on surveys. Wood Frogs are explosive breeders with very short calling periods, often only 5-10 days. Wood Frogs should be used as a trigger species for conducting the first survey, especially where local weather (lake effects, abnormal variation) make phenology difficult to predict. Surveyors are advised to select a site where Wood Frogs are known, and informally monitor it frequently as soon as ice out begins. When Wood Frogs are heard, begin the first survey.

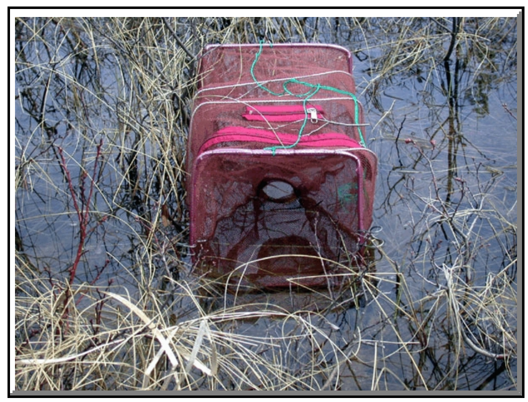
Many parks have remote and poorly accessible regions or islands, where logistics limit the implementation of monitoring programs. For anuran calling surveys, these constraints could be partially overcome by utilizing and improving upon automated frog loggers. These devices have become more sophisticated over time, but there is room for additional improvements, which could be pursued by electronic engineers, to make these automated units more useful. Ideally, a frog logger, once deployed, would "watch" for the right conditions to begin recording by using sensors (pre-programmed temperature thresholds), or "listen" for a target species' call before beginning recording (frog calls could be detected through voice recognition software). Such "smart" loggers could potentially be constructed from existing technology, utilizing portable computers with solar or battery power sources, sensors, timers, and voice recognition software. Once recordings are obtained, the time spent analyzing recordings may also potentially be reduced through development of automated "listening" routines using voice recognition software.

Call confusion issues are uncommon, but several are worth mentioning. The calls of the Cope's Gray Treefrog and the Gray Treefrog, are sometimes confused. Confirmation of these species typically is by tape recordings of calls with temperature data, or preparation of chromosomal slides. However, once learned, the calls of these species are easily separated in the field. Where surveyors have uncertainty separating these species, they should request that an experienced person accompany them in the field until confidence is obtained. Another frequent error, mostly in the north, is mistaking the trill call of the Northern Spring Peeper for a Western Chorus Frog or Boreal Chorus Frog. The two calls can be similar, but if Chorus Frogs are present they generally have full choruses, while the trill call of the Northern Spring Peeper is generally a lone call not often repeated. Where both species are common call confusion is not a problem, but at the range limits of the Chorus Frogs (i.e., Michigan's Upper Peninsula), surveyors should become familiar with Chorus Frog calls and verify any suspected records with specimen collections.

I strongly recommend that coordination among all the agencies and NGOs conducting anuran calling surveys in the region be achieved. If NAAMP or ARMI could act as a central data repository and analysis center, this would greatly streamline efficiency, maximize statistical analysis opportunities, and allow for analyses at various scales, including within individual parks, within buffers of individual parks, and at larger regional scales. This is especially important given that the greatest utility of these surveys is on a meta-population level, where analyses address trends by regional presence/absence of species from clusters of sampling points. Furthermore, the coverage of routes within parks should be partially determined by coverage outside of parks by other cooperators and NGOs. The goal should be an adequate number of routes to detect trends at the desired scale(s). Web based data submission is recommended, like that which NAAMP has achieved for the Wisconsin Frog and Toad Survey. The regional ARMI program is reportedly experimenting with supplementing anuran calling surveys with parabolic microphone technology (personal communication R. Hay, June 2004), but it is unclear whether this could contribute to already established large scale surveys that have already accumulated long-term data sets without audio supplementation.

I recommend analyses that track point changes (species lost or gained from route points over time) as trend indicators, on several geographic scales. The use of calling index values as a measure of abundance is problematic, given the high variance of this measure depending on local weather conditions, and the naturally high variance in abundance owing to longer term weather variation, coupled with the high reproductive potential of most anurans. Better measures of abundance can be had with other techniques (trapping, visual searches), and will probably be relegated to a few intensive sampling sites, owing to the high time and resource commitment necessary to quantify abundance.

4.2 Aquatic Funnel Traps



Collapsible minnow trap.

Aquatic funnel trapping is an efficient quantitative method for monitoring pond breeding salamanders, and may be equally useful for Common Mudpuppies and Western Lesser Sirens with further testing. Commercially available minnow traps can be set in breeding ponds when adults are breeding. Collapsible traps are available for easy deployment in remote areas. Individual parks may need to conduct some phenology research to time trapping appropriately, but generally Mole Salamanders should be targeted shortly after ice out, and Eastern Newts two weeks later. Thus two trapping periods of 5-10 days each are recommended. Traps should be set on the pond bottom along natural drift fences (logs or shorelines), or artificial underwater drift fences can be used. Leaving part of the trap above the water surface minimizes drowning of adult salamanders and frogs, whose mortality will increase with water temperature. Baiting is not necessary. Traps should be spaced equally along shorelines (5-10 meters apart), or in transects or arrays through ponds if only part of a pond is being sampled. The number and location of traps at a given site should remain consistent between sampling years, and sampling may be conducted annually, or at longer intervals if necessary. Wading into ponds for trapping causes sediment disturbance and possible plant community effects, so rotating among sites to achieve sampling of a single site only every second or third year may be desirable.

Common Mudpuppies are probably best trapped in November, when they are congregating at mating sites (typically submerged areas with large flat rocks), although trapping at sites with reported high numbers of Common Mudpuppies, even in deep lakes, may be successful at most times of year, especially winter. Box-type crawfish traps are probably best, although minnow traps can be successful. Traps should be baited with fish or liver. Some validation studies are recommended for this technique, which may be successful with Western Lesser Sirens as well. Sites selected for testing trapping efficacy should rely on visual surveys to identify areas of high abundance of these salamanders.

4.3 Aquatic Turtle Traps

Hoop net turtle trap.

Turtle hoop nets baited with fish are effective in sampling adult and juvenile turtles in ponds, lakes, and streams. Hoop nets with an approximately 76 cm hoop diameter, and three to five cm nylon mesh, are adequate for most adult turtles. Smaller box-style traps are recommended for juveniles and smaller species in shallower water. Mark recapture studies are easily accomplished by simple shell notching to identify recaptures, and allow for population estimates. Sampling intervals of every second or third year are recommended (so turtles do not habituate to or shy from traps), and annual sampling can stagger sites among years. Trapping site selection should concentrate on known populations where trapping will be effective. Trapping is most effective in May and June, and initial 10-day daily trapping periods are recommended (although this may be adjusted over time as data are returned), with consistency in coverage between sampling years, for both sites sampled and number of traps. Traps must be held partially above the water surface to prevent mortality.

4.4 Basking Turtle Surveys

Basking Painted Turtles, *Chrysemys picta*, Pictured Rocks National Lakeshore.

Time constrained visual searches with binoculars can be useful for several species (Table 5). Early spring is the best season. Consistent observation points, or discrete river or shoreline sections, should be established, with consistent observation methods by boat or shoreline walking. Data analyses should account for weather factors and time of day, and subset data by weather conditions and time of day, and by season. Useful indices include both species presence frequencies (by survey, weather parameters, and season), and trends in numbers of individuals observed per survey.

4.5 Cover Objects

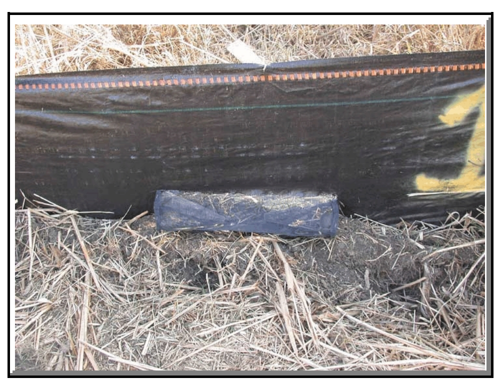
The placement of cover objects (CO) to attract herptiles is commonplace. Generally snakes and lizards seek warm, dry cover objects for nighttime retreats, and salamanders seek cool, moist cover objects for daytime retreats. Hence sampling protocols for these two groups differ.

Cover object for snakes.

For reptiles, I recommend approximately 81 X 122 cm sheets of 2 cm thick rough untreated plywood (do not use Oriented Strand Board, as it rots rapidly). These are fairly large, and size may be diminished to approximately 61 X 122 cm sheets where logistics are difficult. Alternatively, black landscaping fabric may be used where access is difficult. The latter can be cut in the field and staked down, and the thicker the better for heat retention properties. Placement should be in transects or arrays, in sunny grassed areas, preferably close to wetlands where available food resources may increase the likelihood of reptile presence. COs will attract reptiles in the evening, when they seek sun-warmed retreats, so CO surveys should be restricted to evening hours, and only on days with afternoon sun to warm the COs. COs should be deployed in early spring (April, May), and left in place undisturbed for a minimum of two weeks before surveys begin, to allow time for snakes to find them. If COs become wet underneath, they should be flipped to dry out. As long as they are adjacent to their original placement, reptiles using them will still locate them. Rotting vegetation should be cleared from underneath COs. Surveys should be discontinued when birthing begins (typically mid-July), at which time thermoregulation is less important to snakes and use of COs diminishes. Validation studies are recommended for this technique.

For salamanders, some validation studies have been performed, and methods are described in Droege et al. (1998) and Heyer et al. (1994). This method is probably useful only for Eastern Red-backed Salamanders in the GLKN region, and may or may not be better than simple visual searches of natural cover that are time or area constrained. Comparison of these two techniques is recommended in the GLKN region.

4.6 Drift Fences with Funnel or Pitfall Traps



Funnel trap on drift fence.

This method is highly effective for many species, but also highly time and resource intensive. Methods have been detailed in the literature (Heyer et al. 1994). Where this method is utilized in the GLKN, fine tuning of materials and protocols can be accomplished by a consulting herpetologist. It is recommended for use with species that cannot be effectively sampled by other methods, at intensive sampling sites, and at long-term reference sites to collect baseline data.

4.7 Malformation Surveys

For monitoring the prevalence of malformations in amphibians and reptiles, I recommend periodic sampling of sets of 50-100 individuals per site, and performing external and internal examinations, using dissection for examining internal soft organs, and radiographs for examining skeletal features. Radiographs of skeletal features can also be used to make precise measurements of long bones for fluctuating asymmetry analyses. Standardization of measurements and descriptive terms, and target species selection, should be achieved through stakeholder meetings, before a program is launched (NARCAM, USGS ARMI, Declining Amphibian Populations Task Force, National Wildlife Health Center, etc.). In some cases retroactive baseline data may be available from examining museum collections. A limited number of species will be available in the desired sample sizes, but an effort should be made to adequately sample (50-100 individuals per site) at least one species in each major group (salamanders, frogs and toads, lizards, snakes, turtles).

4.8 Visual Encounter Surveys (VES)

Visual encounter surveys.

A variety of time and area constrained VES methods are available for a large number of species (Heyer et al. 1994). However, results are often influenced by observer experience and enthusiasm, and are therefore more suited as inventory methods conducted by experienced persons. Nevertheless, for some species VES techniques are the only survey methods available. In other instances, VESs can be used to select sampling sites for use with more quantitative methods. Problems resulting from observer experience can be minimized by effective training of inexperienced observers by experienced personnel (who also select sampling sites).

Egg surveys are conducted by visiting breeding sites and counting egg masses. Problems include accessibility during often short egg stages, and difficulties in getting complete counts from large sites where deep water or poor visibility may limit coverage. Polarized “fishing” glasses should always be worn when surveying aquatic habitats, with light lenses. At reasonably accessible and small sites, complete egg counts may be suitable for monitoring Mole Salamanders and Wood Frogs.

Breeding surveys focus on congregations of breeding adults at discrete breeding sites. These include amphibian breeding ponds and communal turtle nesting sites. In the GLKN parks, variations include searching for Mole Salamanders under natural cover around breeding ponds, searching for

Four-toed Salamander nests within breeding ponds (special methods are available, G.S. Casper), and counting nesting turtles at communal nesting sites. This last variation may be somewhat automated in certain circumstances by using camcorders or time lapse photography, if conditions permit. Experienced herpetologists should select these sampling sites and train surveyors. Appropriate seasonal survey windows must be followed.

General habitat searches are useful for a few species using time or area constrained methods. This method is more dependent on observer experience than others, unless nearly complete habitat searches are performed (i.e., sift through all litter and woody debris on a forest floor transect). It is generally not recommended if other methods are available.

Shoreline surveys simply consist of walking shorelines and identifying and counting herptiles observed. For ranid frogs, late summer is best when abundance is highest. For snakes, weather conditions should be appropriate for encountering snakes actively foraging (warm, sunny conditions). Linear shoreline coverage and time spent searching are measures of effort.

5. PROGRAM RECOMMENDATIONS

Ideally, a GLKN herptile monitoring program should apply the same methods and metrics across all parks, but which methods are used in each park should be driven by species occurrences, logistics, and resources. Methods and sampling intensity should be selected to meet desired objectives on detection of trends and extirpations. A first step could be to select from available methods (some of which may require additional research, validation, and development of standard forms), and make decisions on data handling and analysis. Data analyses will likely be useful at several geographic scales, so networks of sampling points, both within and without the park properties, and the availability of cooperators, should be taken into consideration. Cooperation with other programs will maximize return. Feasible methods may then be selected for each park, based on the unique species lists, logistical issues, and resources. Next, development of a program for each park may proceed, within the larger GLKN framework. Specific park programs may benefit from engaging a consulting herpetologist to advise on site selection, perform any needed training, and provide some supervision, review, and quality assurance as work begins. Monitoring that provides results useful to resource management is a common request from resource managers. Selecting sampling sites where habitat management is ongoing may be useful in measuring wildlife response. Monitoring programs should be adaptive, and able to respond to incoming data to improve methods as appropriate.

Four useful monitoring methods are well developed, relatively inexpensive and efficient, typically have good data returns, and are probably immediately appropriate for all parks: anuran calling surveys, aquatic funnel traps, aquatic turtle traps, and cover object surveys for reptiles. Other methods are more species specific, and/or should be evaluated from a time and resources perspective for each park. Some parks may have particular species present that warrant special monitoring methods (i.e., Eastern Massasauga).

Trend determination is to some extent a function of sampling frequency, and sampling can be performed annually, or every second, third, or even fifth year. The amount of time needed to acquire data sufficient for analysis will be correspondingly longer with increasing intervals between sampling events. It is better to sample well in a few areas, than to sample less thoroughly in many areas. Balancing sampling frequency with sampling resources should follow this rule, with appropriate rotation of sampling effort. Sampling windows are generally clustered in the spring season. Coordination of all sampling (not just herptiles) will therefore be important to most efficiently utilize staff time and resources.

5.1 Individual Park Comments

APIS:

This park has many islands, contributing to logistic constraints. It is a prime candidate for frog logger development, and pooling of monitoring for herptiles, birds, and vegetation. Many potential sampling sites are already identified from past inventory work. Regional coverage of anuran calling surveys should be reviewed with potential partners. Aquatic funnel trapping and aquatic turtle trapping could be accomplished through coordinated island hopping, where traps are checked nearly every day over 5-10 day periods, at locations that have convenient landings (lagoons). Cover object surveys for snakes are feasible at some islands with grassed meadows or sandscapes, where they can be left in place permanently, and checked at the convenience of park staff throughout the season. Unlike most mainland sites, cover objects should attract snakes all season on the islands, owing to the typically cool nights and frequent lake breezes. This park has some high quality old growth forest acreage, which may be a good candidate for intensive site sampling, such as with drift fence arrays, to collect reference baseline data on amphibian abundance in a relatively undisturbed, natural setting.

GRPO:

The narrow corridor represented by this park restricts monitoring options. Many species may be best monitored on adjacent property where appropriate sites are present (wetlands). Cooperation with neighbors will be important. Anuran calling surveys may be limited to wetland sites on or adjacent to the park, as will aquatic funnel trapping. Regional coverage of anuran calling surveys should be reviewed with potential partners. Aquatic turtle trapping is probably feasible at the mouth of the Pigeon River and at the beaver pond. Sites for cover object surveys for snakes remain to be determined.

INDU:

INDU has the highest species richness of all GLKN park units (+35 species), with several past studies providing baseline data for pond breeding amphibian sampling (S. Cortwright studies; personal communications R. Grundel and A. Resetar, June 2004), and drift fence methods. Monitoring across successional gradients may help assess woody vegetation management, as well as the effects of burning. Monitoring wetland sites for herptile response to water level manipulations and vegetation restoration would also be useful. Existing and past anuran calling surveys should be evaluated for coverage, within and without the park, and expanded if necessary. Aquatic funnel trapping was probably used in Cortwright's studies and could resume. An aquatic turtle trapping program should be easy to begin. Some past cover object surveys for reptiles have been performed, as well as drift fence sampling with funnel traps. Repeating these past studies may be useful in utilizing past data for trend analyses, and information on good sampling sites should also be put to use. The wealth of existing herptile data should be reviewed and built on in establishing a monitoring program for the park.

ISRO:

Frog loggers may be useful in expanding coverage for anuran calling surveys, as logistic issues may constrain monitoring programs here. Research data on Boreal Chorus Frogs (David Smith unpublished) should be reviewed to determine if these data can contribute to trend analyses or guide monitoring for this species. Cover object surveys, aquatic funnel trapping, and aquatic turtle trapping may be feasible near stations where staff are seasonally available. More will be learned after ongoing herptile inventories are completed. This park may also have some high quality undisturbed habitats, suitable for intensive site sampling, such as with drift fence arrays, to collect reference baseline data on amphibian abundance.

MISS:

Like GRPO, the narrow corridor included within park boundaries restricts monitoring options, and cooperation with neighbors will be important. Being a river park, turtle monitoring should definitely be pursued, with both aquatic turtle trapping programs, and nest site monitoring. Automated monitoring of nesting beaches via camcorder or time lapse photography may be possible at some sites. Anuran calling surveys for the corridor should be reviewed with potential partners, and desired regional coverage completed. An evaluation of possible cover object survey sites for reptiles should be made.

PIRO:

Coverage of anuran calling surveys should be increased, with more routes within the park. Regional coverage should be reviewed with potential partners. Also, plenty of opportunities exist for other monitoring within the park and its buffer zone. Ongoing herptile inventory work will identify potential sites for additional anuran calling surveys, aquatic funnel trapping, aquatic turtle trapping, and cover object surveys.

SACN:

Anuran calling surveys for the corridor should be reviewed with potential partners, and desired regional coverage completed. Existing cover object survey data should be reviewed, and where appropriate, new arrays can be established targeting snakes rather than salamanders. The basking turtle surveys may be improved upon and supplemented with both aquatic turtle trapping programs, and nest site monitoring. Automated monitoring of turtle nesting via camcorder or time lapse photography may be possible at some sites. Aquatic funnel trapping opportunities should be available. Sadinski's suggestions for cooperative monitoring between ARMI and NPS should be forthcoming and will need to be reviewed as well. His recent data may well provide very useful site and method directions for the park. This park has fairly high herptile diversity and may be a good candidate for intensive site sampling, such as with drift fence arrays.

SLBE:

Anuran calling surveys should be reviewed with potential partners, and desired regional coverage completed. Monitoring should be conducted on the islands as well as the mainland, although methods may be more constrained on the islands due to logistic issues. Ongoing herptile inventory work will identify potential sites for additional anuran calling surveys, aquatic funnel trapping, aquatic turtle trapping, and cover object surveys.

VOYA

Anuran calling surveys should be reviewed with potential partners, and desired regional coverage completed. Monitoring that addresses herptile response to hydrology manipulations is desired. There should be opportunity to establish aquatic funnel trapping, aquatic turtle trapping, and cover object surveys in the park. Sadinski's suggestions for cooperative monitoring between ARMI and NPS should be forthcoming and will need to be reviewed. His recent data may well provide very useful sampling site and methods direction for the park.

Spotted Salamander, *Ambystoma maculatum*, Pictured Rocks National Lakeshore.

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7. TABLES

Table 1: Great Lakes Inventory and Monitoring Network Park Units (as of FY 2003)

Park	Acronym	Location	Approximate Size
Apostle Islands National Lakeshore	APIS	Twenty-two islands and a mainland parcel in Bayfield and Ashland counties, Wisconsin, in western Lake Superior.	27,923 hectares
Grand Portage National Monument	GRPO	Entirely within the Grand Portage Indian Reservation, Cook County, northeastern Minnesota.	287 hectares
Indiana Dunes National Lakeshore	INDU	Approximately 40 km along southern Lake Michigan, in Lake, Porter, and LaPorte counties in northwest Indiana.	631 hectares
Isle Royale National Park	ISRO	Large island in Lake Superior, Houghton County, Michigan.	231,395 hectares
Mississippi National River and Recreation Area	MISS	Approximately 116 km of the Mississippi River in Minnesota. A narrow corridor from Dayton and Ramsey on the north to Hastings, in the south.	21,762 hectares
Pictured Rocks National Lakeshore	PIRO	Approximately 64 km of Lake Superior shoreline and interior forest land, in Alger County, Michigan.	29,638 hectares
Saint Croix National Scenic Riverway	SACN	A narrow corridor of the St. Croix and Namekagon Rivers, in Minnesota and Wisconsin.	37,536 hectares
Sleeping Bear Dunes National Lakeshore	SLBE	Approximately 56 km stretch of Lake Michigan's eastern coastline, and North and South Manitou Islands.	28,813 hectares
Voyageurs National Park	VOYA	Approximately 89 km meander along the Minnesota/Canadian border.	88,302 hectares

Table 2: Existing Herptile Monitoring Programs in Great Lakes Network Park Units (current 2004)

Park	Monitoring Program
APIS	Anuran calling surveys Malformed amphibians surveys
GRPO	Anuran calling surveys
INDU	Anuran calling surveys
ISRO	Anuran calling surveys Terrestrial salamander survey Malformed amphibians surveys
MISS	Anuran calling surveys
PIRO	Anuran calling surveys
SACN	Anuran calling surveys Basking turtle surveys Cover object surveys Methods testing underway (W. Sadinski)
SLBE	Anuran calling surveys
VOYA	Methods testing underway (W. Sadinski)

Table 3: Amphibian and Reptile Species List for the Great Lakes Network Park Units (current 2004; taxonomy follows Crother 2000)

Standard Common Name	Scientific Name
SALAMANDERS	
Jefferson Salamander	*Ambystoma jeffersonianum*
Blue-spotted Salamander	*Ambystoma laterale*
Spotted Salamander	*Ambystoma maculatum*
Marbled Salamander	*Ambystoma opacum*
Eastern Tiger Salamander	*Ambystoma tigrinum tigrinum*
Eastern Newt[1]	*Notophthalmus viridescens*
Four-toed Salamander	*Hemidactylium scutatum*
Eastern Red-backed Salamander	*Plethodon cinereus cinereus*
Northern Slimy Salamander	*Plethodon glutinosus*
Common Mudpuppy	*Necturus maculosus maculosus*
Western Lesser Siren	*Siren intermedia nettingi*
ANURANS	
Eastern American Toad	*Bufo americanus americanus*
Fowler's Toad	*Bufo fowleri*
Canadian Toad	*Bufo hemiophrys*
Blanchard's Cricket Frog	*Acris crepitans blanchardi*
Northern Spring Peeper	*Pseudacris crucifer crucifer*
Boreal Chorus Frog	*Pseudacris maculata*
Western Chorus Frog	*Pseudacris triseriata*
Cope's Gray Treefrog	*Hyla chrysoscelis*
Gray Treefrog	*Hyla versicolor*
American Bullfrog	*Rana catesbeiana*
Northern Green Frog	*Rana clamitans melanota*
Pickerel Frog	*Rana palustris*
Northern Leopard Frog	*Rana pipiens*
Mink Frog	*Rana septentrionalis*
Wood Frog	*Rana sylvatica*
TURTLES	
Eastern Snapping Turtle	*Chelydra serpentina serpentina*
Painted Turtle[2]	*Chrysemys picta*
Spotted Turtle	*Clemmys guttata*
Wood Turtle	*Glyptemys (Clemmys) insculpta*
Blanding's Turtle	*Emydoidea blandingii*
Northern (Common) Map Turtle	*Graptemys geographica*
False Map Turtle	*Graptemys pseudogeographica pseudogeographica*
Ouachita Map Turtle	*Graptemys ouachitensis ouachitensis*
Eastern Box Turtle	*Terrapene carolina carolina*
Red-eared Slider	*Trachemys scripta elegans*
Stinkpot (Common Musk Turtle)	*Sternotherus odoratus*
Midland Smooth Softshell	*Apalone mutica mutica*
Spiny Softshell[3]	*Apalone spinifera*

Table 3, continued: Amphibian and Reptile Species List for the Great Lakes Network Park Units (current 2004; taxonomy follows Crother 2000)

Standard Common Name	Scientific Name
LIZARDS	
Western Slender Glass Lizard	*Ophisaurus attenuatus attenuatus*
Common Five-lined Skink	*Eumeces fasciatus*
Northern Prairie Skink	*Eumeces septentrionalis septentrionalis*
Six-lined Racerunner[4]	*Cnemidophorus sexlineatus*
SNAKES	
Northern Ring-necked Snake	*Diadophis punctatus edwardsii*
Eastern Ratsnake[5]	*Elaphe obsoleta*
Western Foxsnake	*Elaphe vulpina*
Eastern Hog-nosed Snake	*Heterodon platirhinos*
Eastern Milksnake	*Lampropeltis triangulum triangulum*
Northern Watersnake	*Nerodia sipedon sipedon*
Smooth Greensnake	*Opheodrys vernalis*
Bullsnake	*Pituophis catenifer sayi*
Queen Snake	*Regina septemvittata*
Texas Brownsnake[6]	*Storeria dekayi*
Northern Red-bellied Snake	*Storeria occipitomaculata occipitomaculata*
Northern Ribbonsnake	*Thamnophis sauritus septentrionalis*
Orange-striped Ribbonsnake	*Thamnophis proximus proximus*
Plains Gartersnake	*Thamnophis radix*
Eastern Gartersnake	*Thamnophis sirtalis sirtalis*
Kirtland's Snake	*Clonophis kirtlandii*
Eastern Racer[7]	*Coluber constrictor*
Eastern Massasauga	*Sistrurus catenatus catenatus*

1 - Two subspecies are represented in GLKN parks, Red-spotted Newt (*N. v. viridescens*), and Central Newt (*N. v. louisianensis*).

2 - Two subspecies are represented in GLKN parks, Western Painted Turtle (*C. p. belli*), and Midland Painted Turtle (*C. p. marginata*).

3 - Two subspecies are represented in GLKN parks, Eastern Spiny Softshell (*A. s. spinifera*), and Eastern Spiny Softshell (*A. s. hartwegi*).

4 - Two subspecies are represented in GLKN parks, Eastern Six-lined Racerunner (C. *s. sexlineatus*), and Prairie Racerunner (*C. s. viridis*).

5 - The subspecies of the *Elaphe obsoleta* group are in revision, with no consensus yet formed (Burbrink 2001).

6 - Two subspecies are represented in GLKN parks, Texas Brownsnake (*S. d. texana*), and Midland Brownsnake (*S. d. wrightorum*).

7 - Two subspecies may be represented in GLKN parks, Blue Racer (*C. c. foxii*), and Eastern Yellow-bellied Racer (*C. c. flaviventris*).

Table 4: Recommended Monitoring Methods for Amphibians and Reptiles in the Great Lakes Network Park Units (Casper 2004)

Method	Target Species / Season	Secondary Species[1]	Metric Used	Challenges
Anuran Calling Surveys	Most anurans in the region, with caveats for species in next column. April - July	Wood, Pickerel, N. Leopard, and Mink frogs	calling index value 0-3	Coordination and standardization among many agencies and NGOs, adequate coverage, island logistics.
Aquatic Funnel Traps	Jefferson, Spotted, Blue-spotted, and E. Tiger salamanders; E. Newt. March - May	Common Mudpuppy, Western Lesser Siren	N / trap day	Timing of trapping, identification of larvae. Sites must have easy access for daily visits
Aquatic Turtle Traps	E. Snapping, Painted, and Blanding's turtles; Softshell turtles, Red-eared Slider May - June		N / trap day	Sites must have easy access for daily visits.
Basking Turtle Surveys	Painted Turtle, Red-eared Slider, Map turtles April - June	Blanding's, Wood, and Spotted turtles	N / person hour	Restricted to shorelines and rivers.
Cover Objects - reptiles	Five-lined and N. Prairie skinks; N. Ring-necked Snake, Smooth Greensnake, Plains Gartersnake, E. Gartersnake, E. Milksnake, E. Ratsnake, W. Foxsnake, DeKay's Brownsnakes, and N. Red-bellied Snake April - July	Bullsnake, N. Watersnake, E. Hog-nosed Snake, E. Racer, E. Massasauga	N / object day	Validation studies, time of day constraints, theft.

Table 4, continued: Recommended Monitoring Methods for Amphibians and Reptiles in the Great Lakes Network Park Units (Casper 2004)

Method	Target Species / Season	Secondary Species[1]	Metric Used	Challenges
Cover Objects - salamanders	E. Red-backed Salamander Sept - Oct	Spotted, Blue-spotted, and E. Tiger salamanders; E. Newt	N / object day	Weather effects on results.
Drift Fences with Funnel or Pitfall Traps	most salamanders, most pond breeding and terrestrial frogs, most lizards and snakes April - June, Sept - Oct		N / trap day	High cost but high return. Requires daily checks and easy access.
Malformation Measures	all species varies with species		malformation frequency, fluctuating asymmetry	Time and resource intensive.
Visual Encounter Surveys - egg counts*	Jefferson, Spotted, E. Tiger, and Blue-spotted salamanders; Wood frogs March - April	E. American, Fowler's, and Canadian toads	N / sampling site	Getting complete counts, egg identification.
Visual Encounter Surveys - breeding sites*	Jefferson, Spotted, E. Tiger, Blue-spotted, Marbled, and Four-toed salamanders; Wood, Map, and Softshell turtles March - June	other communal nesting turtles, some anurans	N / unit effort (time or area constrained searches)	Labor intensive, observer experience.
Visual Encounter Surveys - habitat searches*	E. Red-backed and N. Slimy salamanders; Common Mudpuppy; Spotted Turtle; all lizards; E. Massasauga Apr - July	other snakes	N / unit effort (time or area constrained searches)	Labor intensive, observer experience.

Table 4, continued: Recommended Monitoring Methods for Amphibians and Reptiles in the Great Lakes Network Park Units (Casper 2004)

Method	Target Species / Season	Secondary Species[1]	Metric Used	Challenges
Visual Encounter Surveys - shoreline surveys*	Am. Bullfrog, Mink and N. Green frogs; N. Watersnake, Queen Snake June - Sept	N. Leopard Frogs, Gartersnakes	N / unit effort (time or area constrained searches)	Labor intensive, observer experience.

* - These target species are considered to have life history traits that make them amenable to visual encounter surveys under certain seasonal, climatic, and habitat constraints. Details of methods will be specific to each target species.

1- Species possibly detected but not necessarily with statistical rigor. May vary regionally.

Table 5: Recommended Monitoring Methods By Species for Great Lakes Network Park Units (Casper 2004)

	Anuran Calling Surveys	Aquatic Funnel Traps	Aquatic Turtle Traps	Basking Turtle Surveys	Cover Objects	Drift Fences with Funnel or Pitfall Traps	Malformation Measures[1]	Visual Encounter Surveys
SALAMANDERS								
Jefferson Salamander		X			O	X	X	E/B
Blue-spotted Salamander		X			O	X	X	E/B
Spotted Salamander		X			O	X	X	E/B
Marbled Salamander					O	X		B
Eastern Tiger Salamander		X			O	X	X	E/B
Eastern Newt ssp.		X			O	X	X	
Four-toed Salamander		O				X		B
Eastern Red-backed Salamander					X	X	X	C
Northern Slimy Salamander					X	X		C
Common Mudpuppy		X					X	C
Western Lesser Siren		X						
ANURANS								
Eastern American Toad	X					X	X	E
Fowler's Toad	X					X	X	E
Canadian Toad	X					X		E
Blanchard's Cricket Frog	X					O	X	
Northern Spring Peeper	X					O	X	
Boreal Chorus Frog	X					O	X	
Western Chorus Frog	X					O	X	
Cope's Gray Treefrog	X					O	X	
Gray Treefrog	X					O	X	
American Bullfrog	X					O	X	S
Northern Green Frog	X					O	X	S
Pickerel Frog	O					O		
Northern Leopard Frog	O					O	X	
Mink Frog	O					O	X	S
Wood Frog	O					X	X	E

Table 5, continued: Recommended Monitoring Methods By Species for Great Lakes Network Park Units (Casper 2004)

	Anuran Calling Surveys	Aquatic Funnel Traps	Aquatic Turtle Traps	Basking Turtle Surveys	Cover Objects	Drift Fences with Funnel or Pitfall Traps	Malformation Measures[1]	Visual Encounter Surveys
TURTLES								
Eastern Snapping Turtle			X				X	
Painted Turtles (both ssp.)			X	X			X	
Spotted Turtle				X				C
Wood Turtle				X				B
Blanding's Turtle			X	X				
Map Turtles (all *Graptemys* sp.)			X	X			X	B
Eastern Box Turtle						X		
Red-eared Slider			X	X				
Stinkpot			X				X	
Midland Smooth Softshell			X					B
Spiny Softshells (both ssp.)			X				X	B
LIZARDS								
Western Slender Glass Lizard						X		C
Five-lined Skink					X	X		C
Northern Prairie Skink					X	X		C
Six-lined Racerunners (both ssp.)						X		C
SNAKES								
Northern Ring-necked Snake					X	X		
Eastern Ratsnake					X	X		
Western Foxsnake					X	X		
Eastern Hog-nosed Snake					O	X		
Eastern Milksnake					X	X		
Northern Watersnake					O	X		S
Smooth Greensnake					X	X	X	
Bullsnake					O	X		
Queen Snake						X		S
Brownsnakes (both ssp.)					X	X	X	

Table 5, continued: Recommended Monitoring Methods By Species for Great Lakes Network Park Units (Casper 2004)

	Anuran Calling Surveys	Aquatic Funnel Traps	Aquatic Turtle Traps	Basking Turtle Surveys	Cover Objects	Drift Fences with Funnel or Pitfall Traps	Malformation Measures[1]	Visual Encounter Surveys
Northern Red-bellied Snake					X	X	X	
Northern Ribbonsnake					O	X		
Western Ribbonsnake					O	X		
Plains Gartersnake					X	X	X	
Eastern Gartersnake					X	X	X	
Kirtland's Snake					O	X		
Eastern Racer					O	X		
Eastern Massasauga					O	X		C

1 - species for which sufficient sample sizes are likely available. X - well suited to detection by method, O - detectable but problematic (see text), E - egg survey, B - breeding survey, C - time or area constrained habitat searches, S - shoreline surveys, BLANK - method not suited to species.

8. APPENDIX A

North American Amphibian Monitoring Program

(from U.S. Department of the Interior, U.S. Geological Survey, Patuxent Wildlife Research Center, Laurel, MD, USA 20708-4038. http://www.pwrc.usgs.gov/naamp. Contact: Linda Weir, email: naamp@usgs.gov. Last modified: 07/13/01)

Route Creation

Routes are generated in a stratified random block design at USGS Patuxent Wildlife Research Center. Routes are then distributed to Regional Coordinators. These roadside routes are then groundtruthed to determine suitability (not too dangerous, not too noisy to hear) and stop placement. There are 10 stops per route. Two methods of stop placement are permitted: equidistant stops or stratified by habitat. In equidistant stop placement, each stop is 0.5 miles apart. When stratified by habitat, the stops are at least 0.5 miles apart and are located at wetland habitats. The wetland habitat should be appropriate potential habitat (pond, vernal pool, roadside ditch, etc) but the presence or absence of amphibians should not be used as a selection factor. Some alteration of the route may occur during groundtruthing, see Groundtruthing Guidelines for more information. Stop locations and any route alterations should be shared with NAAMP to keep route maps accurate and up to date. Once a route has been groundtruthed and the 10 stops determined the route and stops are not changed, unless exceptional circumstances occur, see Stop Inaccessibility, Stop Relocation, and Stop Retirement section of this document. In addition, some regions may have nonrandom routes that were created by other methods.

Seasonal Sampling Periods

There are three seasonal sampling periods, separated by intervals of at least two weeks, and selected by each region to cover the calling periods of its local species. Regions may also elect to add an earlier sampling period, targeted towards very early breeding species, such as Wood Frogs that typically breed during a brief, relatively unpredictable period in early spring when vernal ponds first melt and fill. The optional sampling period for early breeding species has no required time interval between it and the next sampling period, and in some years these may overlap.

The total number of potential sampling days varies regionally in relation to the length of the calling season. The maximum number of potential sampling days is sixty percent of the calling season duration (i.e., from the beginning of the peak of the species with the earliest calling phenology, through the peak of the latest species). Thus the number of potential sampling days is greatest in southern states. Each sampling period is no longer than six weeks; for many regional programs the sampling periods are two to three weeks. The regional program may divide the available number of sampling days equally or unequally among the sampling periods.

Regional coordinators set the sampling periods based upon experience and the available data on breeding phenology. Different sampling periods may be set within a given regional program, for example in two or three bands within a given state, to accommodate phenological differences due to elevation or latitude. Neighboring regional programs coordinate sampling periods as much as possible, to encourage consistency across political boundaries.

Nightly Sampling Conditions

A survey may begin 30 minutes after sunset or later. No matter what time a route is started, it should be completed by 1 a.m. Appropriate sampling conditions are based upon wind, sky, and air temperature conditions. For most regions the wind code should be at level 3 or less, but the wind prone Great Plains region is permitted to sample at level 4 or less. Surveys should not be conducted during heavy rainfall, but light rainfall is acceptable (sound of the rain may impair hearing ability). The air temperature criteria are the minimum allowable temperatures, varying for each sampling period.

3 Run System	Minimum Temperature
Run 1	5.6 C (42 F)
Run 2	10 C (50 F)
Run 3	12.8 C (55 F)

4 Run System	Minimum Temperature
Run 1	5.6 C (42 F)
Run 2	5.6 C (42 F)
Run 3	10 C (50 F)
Run 4	12.8 C (55 F)

A regional program may choose to set higher minimum temperatures based upon regional phenology information.

Sampling should occur during "good frog weather" for the region. For some areas a humid night is sufficient, along with the above criteria. In southern states and the Great Plains, it is recommended that the survey occur after a rainfall event.

Data Collection

Stops are conducted in numerical order, in one night by one observer. We encourage, but do not require, that one observer conduct all surveys of a route in a given year. Because some observers have assistants who may also wish to collect data, multiple observers are instructed to each fill out their own datasheet, separately and independently. One observer is the official recorder of the route whose data will be entered into the NAAMP database. All datasheets are returned to the Regional Coordinator for archival purposes. This "one observer per datasheet" rule allows each survey conducted to be of equal effort.

Observers record the time, sky code, and wind code, at the beginning and end of each survey to verify that the sampling conditions were met on the evening of the survey. At each stop air temperature is recorded to verify that sampling conditions were met on the sampling night; at least eight of the 10 stops must meet temperature guidelines. For southern states that record air temperature only at the beginning and end of a survey, both temperature readings must meet these guidelines. Gulf Coast and Great Plains states require documentation of the last rainfall event, since possible routes should be conducted within 3 days of rainfall.

At each stop the observer listens for 5 minutes, and then records the amphibian calling index for each species heard. The 5 minute listening period has no initial waiting period. The observer indicates whether background noise impaired his/her ability to hear (most surveys use yes/no checkbox; some have adopted the noise index developed by Massachusetts). If there is a major noise disturbance, lasting one minute or longer, the observer may break the listening period to avoid sampling during the excessive noise. If such a time out is taken, this is noted on the datasheet. After the major disturbance ends, the observer resumes listening for the time remaining. The time out should not be used for background noise.

Stop Inaccessibility, Stop Relocation, and Stop Retirement

1. Stop Inaccessibility: Temporary stop inaccessibility may occur for some transient reason (i.e., traffic accident blocks road access).

    a. If only one stop will be missed, then route can be considered complete. The observer should write on the datasheet which stop was missed and note why in the comments section. When entering the data into the database, mark the checkbox indicating which stop was missed.
    b. If more than one stop would be missed, the route should be re-run on another night.

2. Stop Relocation: Stop relocation is when a stop needs to be shifted to a new location, after the groundtruthing phase has occurred. During groundtruthing the permanent stop locations are set (see groundtruthing guidelines). Stop relocations should be a rare event.

    a. Stop relocation should only occur for safety reasons (i.e., route was safe before-or appeared to be, but perhaps a homeowner fired a gun in the air as warning to observer).
    b. Stops should NOT be relocated because of habitat loss or lack of calling amphibians at the site.

c. To relocate (for safety reasons) a stop, the Regional Coordinator should use their best judgment on when it is necessary and where to relocate. If can be moved a short distance away, not impacting the 0.5 mile apart rule this is preferable. If that is not possible, then relocate by creating a new stop at the end of the route and renumbering all the stops. Keep a written record of when, why, and how a stop relocation occurred. If time permits we will build into the database a checkbox or someway to indicate that a route has had some post-groundtruthing alteration. When data are analyzed all the stops of a route are considered one unit (the route), so it is okay that the individual stops are renumbered.

3. Stop Retirement: Once the route has been groundtruthed and listening stations established, these locations are permanent and locations may not be changed unless a safety issue arises. If habitat destruction occurs at a listening station, and a local extinction of amphibians occurs, this is important information. To document habitat destruction the location should be surveyed for three seasons beyond the destruction date. After three seasons of non-activity, the listening station may be retired, and null data will be assumed for this site. A listening station cannot be retired merely because the wetlands are uninhabited by anurans. Retired stops should be visited periodically to verify that no suitable habitat exists, but five minutes of listening is no longer required.

Data Review Process
What checks on data collection and data entry will Regional Coordinators perform each year to ensure all data follows the same review procedures? Some checks and balances are incorporated into the database design (pop-up warning boxes, etc), while others are procedures Coordinators will need to do. These procedures were adopted at the Nashville NAAMP Coordinators meeting.

1. **All data entered same way:** All datasheets will be entered "as they appear" and then "checked" for any errors. This pattern is obvious if the volunteer did the data entry, the Regional Coordinator would not be able to "check" the data before it was entered. This pattern should be followed, even for datasheets that the Regional Coordinator will enter. That way all data goes through the same data review process. Also, the database documents changes, so by entering the data "as is" and then making the correction, the database will have a record of the correction and why it occurred.
   a. The only exceptions are "simple obvious errors" such as the observer wrote 70 degrees and then marked Celsius (when meant Fahrenheit). The database wouldn't let you enter such an error anyway, so the Coordinator may make that "correction" during the data entry process. If any such corrections are made to data, then these changes should be marked on the datasheet. The change should be initialed on the datasheet and the reason noted.
   b. An example of an error that should not be changed during data entry is the observer wrote down they heard a species that you know was highly unlikely they heard (you will handle this during step three - documenting other changes).

2. **Manual check of data:** After data are entered (by Volunteer or Coordinator), there will be a manual check - comparing the electronic entry to the physical datasheet. This will help catch any data entry errors. If a data entry error is found, the correction is made and since the data are already in the database, the database will be able to keep track of who did the change and why. To indicate data has been through the manual check, the database has a checkbox to mark when you have completed the review for each run of each route (see the NAAMP Regional Coordinator Database Guide).

3. **Documenting other changes**: How do we deal with other potential errors (i.e., misidentification)? Rule: Do not change the data until you have conferred with the volunteers. If the volunteer agrees that they made an error, then the entry should be changed using the edit button. If the volunteer does not agree, then the data can be flagged as suspect data. In either case it will be documented by the database as to who is making the change (or marking as questionable) and why.

    a. Reasons for changing data will be designated as: observer error or data entry error.
    b. Reasons for questionable data will be documented as: questionable identification, observer uncertainty, outside known distribution, or outside phenology.
    c. More details will be available in the NAAMP Regional Coordinator Database Guide once the Data Review section is completed.

4. **Deadline**: Data entry and review should be completed each year by December 15th. Review includes the physical comparison of the datasheet to the data entry, viewing the flags created by the database, and any subjective questions/review by Coordinator. Having a deadline for when to finish entry and review is helpful for your fellow Regional Coordinators. It allows report generation to be complete: other states may want to use information from neighboring states in newsletters, etc. Having one deadline allows everyone know when data should be finalized and available for use. Also, we can archive the year at that point. You can still enter a late datasheet after the deadline, it just will not be part of the year-end reports.

5. **Datasheet archiving**: State/provincial programs should maintain the original datasheets.

Groundtruthing

Placement of Stops Along Routes

You have a new route that has never been run. A provided map shows a set of initial roads, randomly chosen by the computer, but to complete the route 10 stops need to be established. The route needs to be groundtruthed during an early spring/late winter day to locate potential amphibian breeding sites that are within 200 meters of the road.

If the starting point is a potential amphibian-breeding site, then, that is Stop # 1. If not, then travel along the marked roads until a potential breeding site is found, this would be Stop # 1. To find Stop # 2, look at your car odometer and travel 0.5 miles. After traveling 0.5 miles begin looking for the next appropriate potential breeding site (which could actually be right there at this point); that becomes Stop # 2. This continues until all 10 stops are in place, described, and marked on the map.

The USGS NAAMP office has mapped each route; routes are approximately 15 miles long, which allows plenty of room for the placement of 10 stops, at least 0.5 miles apart. Once the route has been groundtruthed, please send a copy of any revisions to the USGS NAAMP office for re-mapping.

When might routes need to be altered?
Some example problems: road does not exist, road is private (no entry allowed), road too dangerous (due to traffic levels), or inability to hear (due to traffic or industry noise). All of these problems would require alterations to the route. Ideally, the Regional Coordinator would make any necessary alterations. When this is not possible, it is necessary for the Regional Coordinator to work with the volunteers to ensure the alteration guidelines are followed and to ensure duplicate use of roadways does not occur.

How to alter routes.
When a route has been determined to require alteration due to reasons listed above, please follow the guidelines listed here to ensure proper substitution. The site generation includes a starting point and direction of travel, to maintain these parameters please alter routes by shifting to the nearest set of appropriate roads that travel in the same direction. Busy connecting roads can be used to bridge sections of "good" roads. Some hypothetical examples are included with this guideline to help interpret the flexibility and intent of route alterations.

Example #1: Partial Alteration. Sometimes it is determined that only a part of the original route needs adjustment. In this case, preserve the portion of the route that is appropriate and then look for an intersection or adjoining road with suitable conditions that allows the observer to avoid the inappropriate portion of the original route. This more suitable road may or may not reconnect with the original route. Remember that the same general direction of the original route must still be followed and that the route must be at least 10 miles long.

Example #2: Complete Alteration. During groundtruthing, it is sometimes found that the entire assigned route is placed on roads that are either too busy or too dangerous to listen for amphibians. In this case it is necessary to completely alter the route. Look for a smaller road that is close to the original road in order to alleviate the traffic noise/danger issues. It is very important that the new route run in the same general direction and have a starting location that is as near as possible to the starting location of the original route. The new route does not have to be 15 miles long, but it must run at least 10 miles to allow enough space for the 10 stops.

Index and Code Definitions

Amphibian Calling Index

1	Individuals can be counted; there is space between calls
2	Calls of individuals can be distinguished but there is some overlapping of calls
3	Full chorus, calls are constant, continuous and overlapping

Beaufort Wind Codes

0	Calm (<1mph / <1.6 kmph) Smoke rises vertically
1	Light Air (1-3 mph / 1.6-4.8 kmph) smoke drifts, weather vane inactive
2	Light Breeze (4-7 mph / 6.4-11.3 kmph) leaves rustle, can feel wind on face
3	Gentle Breeze (8-12 mph / 12.9-19.3 kmph) leaves and twigs move around, small flags extend
4*	Moderate Breeze (13-18 mph / 20.9-29.0 kmph) moves thin branches, raises loose papers * Do not conduct survey at Level 4, unless in Great Plains
5**	Fresh Breeze (19 mph / 30.6 kmph or greater) small trees begin to sway ** Do not conduct survey at Level 5 in ALL REGIONS

Sky Codes (note 3 and 6 are not valid code numbers)

0	Few Clouds
1	Partly cloudy (scattered) or variable sky
2	Cloudy or overcast
4	Fog or smoke
5	Drizzle or light rain (not affecting hearing ability)
7	Snow
8	Showers (is affecting hearing ability). Do not conduct survey

Noise Index*

Yes/No system	Massachusetts Noise Index	Definition
No	0	No appreciable effect (e.g., owl calling)
No	1	Slightly affecting sampling (e.g., distant traffic, dog barking, one car passing)
No	2	Moderately affecting sampling (e.g., nearby traffic, 2-5 cars passing)
Yes	3	Seriously affecting sampling (e.g., continuous traffic nearby, 6-10 cars passing)
Yes	4	Profoundly affecting sampling (e.g., continuous traffic passing, construction noise)

*A regional program may choose whether an ambient noise is documented in yes/no format or by using the Massachusetts noise index.