



Quality Assurance Plan for Amphibian Monitoring in the Great Lakes Network

Natural Resource Report NPS/GLKN/NRR—2018/1713



ON THE COVER

NPS biologist deploying song meter at Isle Royale National Park.
Photograph courtesy of the National Park Service.

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Contents

	Page
Tables.....	v
Abstract.....	vii
List of Terms.....	ix
Introduction.....	1
Protocol Overview.....	1
Specific objectives.....	2
Sampling Design	3
Data Analysis.....	3
Automated analysis process	3
Manual analysis process	4
Protocol Activities and Modules	4
Sampling Design	6
Data Quality Objectives.....	7
Literature Cited	11

Tables

	Page
Table 1. Protocol activity matrix for amphibian monitoring in the Great Lakes Inventory and Monitoring Program.....	5
Table 2. Activity-level sample design matrix for amphibian monitoring program.....	6
Table 3. Data Quality Values (DQVs) for amphibian monitoring program in the Great Lakes Inventory and Monitoring Network.....	7
Table 4. Measurement Quality Objectives table for amphibian monitoring program in the Great Lakes Inventory and Monitoring Network.....	8
Table 5. Activity-level sample design matrix for amphibian monitoring program in the Great Lakes Inventory and Monitoring Network.....	9
Table 6. Data protection standards for amphibian monitoring program in the Great Lakes Inventory and Monitoring Network.	10

Abstract

In accordance with guidelines set forth by the National Park Service Inventory & Monitoring Division, a quality-assurance plan has been created for use by the Great Lakes Inventory and Monitoring Network in the implementation of its amphibian monitoring program. This quality-assurance plan documents the standards, policies, and procedures used by the Great Lakes Network for activities related to the collection, processing, storage, analysis, and publication of monitoring data. The policies and procedures documented in this quality-assurance plan for activities complement the quality-assurance plans for other monitoring activities conducted by the Great Lakes Network and supplement the National Inventory & Monitoring Division Quality Management Plan.

List of Terms

Accepted Data—Data that have undergone all QA and QC procedures as defined in a published protocol and associated SOPs. Used in cases where a Quality Assurance Plan has not been developed and approved.

Accreditation—A formal recognition that an individual or organization (e.g., laboratory) is competent to carry out specific tasks or specific types of tests, and/or meets predetermined qualifications or standards. For labs, this is typically done on an analyte basis for a limited/specific period of time.

Accuracy—A measure of the degree of conformance of the values generated by a specific method or procedure with the true value. The concept of accuracy includes both bias (systematic error) and precision (random error). EPA recommends that this term not be used and that precision and bias be used to convey the information usually associated with accuracy. See Precision and Bias.

Bias—Systematic error that is manifested as a consistent positive or negative deviation from the known or true value. It differs from random error which shows no such deviation.

Calibration—Determination, by measurement or comparison with a standard, the correct value of each measure on a meter or other device, or the correct value for each setting of a control knob. The levels of the calibration standards should bracket the range of planned measurements.

Certified Data—Certified data are those data that a) have been through all QA/QC procedures as outlined in the QAP, b) meet expected quality standards, or are appropriately identified and annotated at the record level in cases where they do not meet those standards, c) have documented procedures for data collection, processing, and transformation in appropriate metadata formats, and d) are suitable for use.

Comparability—The degree to which different methods, data sets and/or decisions agree or can be represented as similar; a data quality indicator.

Data Quality Objectives (DQOs)—Qualitative and quantitative statements that clarify the objectives of observations, define the appropriate type of data, and specify levels of uncertainty that are acceptable to managers when using data. DQOs provide the statistical framework for planning data collection and management, and are used as the basis for establishing the quality and quantity of data needed to support decisions. Includes Qualitative Data Quality Values (DQVs), and informs development of Measurement Standards (or Measurement Quality Objectives; MQOs), Performance Standards, Accreditation Standards, and Policy Standards.

Data Quality Values (DQVs)—Desired qualitative characteristics of data and datasets related to intrinsic data quality (reasonability, accuracy, objectivity, credibility), contextual data quality

(relevance, timeliness, completeness, comparability), representational data quality (interpretability, understandability, consistency), and data accessibility (security, discoverability, utility).

Data Validation—Quality Control tools or processes designed to evaluate legitimacy of data as they proceed through the data management lifecycle. Typically data that do not pass validation procedures are either corrected using prescribed methods or flagged/graded to inform data users as to their appropriate use.

Data Verification—Quality Assurance tools or processes where data are checked for accuracy and inconsistencies as they migrate through the data management lifecycle. Data Verification helps to ensure that data are complete, properly formatted so that they can be processed, and accurately translated when transferred from one source to another.

Data Flagging / Data Qualification—A code or annotation that signals that data do not meet specified data quality standards so as to inform appropriate use.

Minimum Detection Limit (MDL)—The minimum concentration of an analyte that, in a given matrix and with a specific method, has a 99% probability of being identified, qualitatively or quantitatively measured, and reported to be greater than zero.

Minimum Quantification Limit (MQL)—The concentration of analyte in a specific matrix for which the probability of producing analytical values above the method detection limit is 99 percent.

Precision—The degree of similarity among independent measurements of the same quantity, without reference to the known or true value.

Provisional Data—Provisional data are those data that have undergone incomplete QA/QC procedures as defined in the QAP and are not suitable for general use. Provisional data may be used in some cases, however, depending on the amount of QA/QC completed, and the intended use.

Quality Assurance (QA)—The set of activities designed to ensure that data, products, or services meet defined standards of quality with a stated level of confidence. Quality Assurance focuses on ensuring that data are collected to and managed to the highest practicable quality, at or above stated data quality standards.

Quality Assurance Plan (QAP)—Documentation of Quality Assurance and Quality Control procedures for a protocol, program (inventory and overall I&M), and national database application (i.e., Data Store).

Quality Control (QC)—Operational techniques and activities that are used to ensure that data or products meet designated requirements for quality. Quality Control procedures focus on testing data for quality and can include both an evaluation of whether data quality meet data quality objectives and/or procedures to correct data.

Raw Data—Data in their state of original collection, either in the form of paper or electronic field forms, electronic sensor files, or digital media (photo, video, or audio). These data generally have been collected following some QA procedures, but have not undergone any QC procedures.

Sensitivity—The ability of a method or instrument to discriminate between minimally different levels of a variable of interest by producing a noticeably different measurement response.

Standards, Measurement (also Measurement Quality Objectives)—Data quality requirements specifying the level of precision, bias, sensitivity, resolution, etc. that data must meet to be accepted for use in analysis.

Standards, Performance—Data quality requirements specifying the detection ability, sensitivity, variability, etc., of equipment, sensors, or observers to reliably measure characteristics within target populations.

Standards, Accreditation—Data quality requirements related to individuals or organizations involved with data collection, analysis or processing to ensure desired data credibility and defensibility. Examples include professional accreditation/certificates, required training, chain-of-custody requirements and others.

Standards, Policy—Data quality requirements related to ensuring appropriate management, use, dissemination, qualification, and documentation of data.

Introduction

The purpose of this report is to document the standards used by the Great Lakes Network (GLKN) for activities related to the collection, processing, storage, analysis, and publication of monitoring data as described in the GLKN Amphibian Monitoring Protocol. The policies and procedures documented in this quality-assurance plan for activities complement the quality-assurance plans for other monitoring activities conducted by the GLKN and supplement National Inventory and Monitoring Division Quality Management Plan (DeVivo, unpublished document available at <https://sites.google.com/a/nps.gov/in2-imd-handbook/policy-and-guidance>). The plan also serves as a guide for all GLKN personnel who are involved in protocol/program activities and as a resource for identifying memoranda, publications, and other literature that describe associated techniques and requirements in more detail. Much of the verbiage contained within this standard operating procedure (SOP) was first written in the protocol narrative and other SOPs, and we wish to thank the authors of those sections.

Protocol Overview

The National Park Service's (NPS) Great Lakes Inventory and Monitoring Network (GLKN) has developed a prioritized list of indicators, termed 'Vital Signs,' for monitoring long-term ecosystem health in nine NPS units in the Great Lakes ecoregion (Route 2004). This amphibian monitoring protocol is one of several protocols that GLKN intends to implement under the umbrella of an overall monitoring plan (Route and Elias 2007). Amphibians were initially considered for monitoring under a combined Amphibians and Reptiles Vital Sign.

This protocol is implemented at seven network parks, Apostle Islands National Lakeshore (APIS), Grand Portage National Monument (GRPO), Indiana Dunes National Lakeshore, (INDU), Isle Royale National Park (ISRO), Mississippi National River and Recreation Area (MISS), Pictured Rocks National Lakeshore (PIRO), and Sleeping Bear Dunes National Lakeshore (SLBE). Amphibian monitoring at St. Croix National Scenic Riverway (SACN) and Voyageurs National Park (VOYA) are being conducted by staff with the USGS Amphibian Research and Monitoring Initiative (ARMI) in La Crosse, Wisconsin, using a similar and comparable protocol.

Guiding principles for survey method selection for this protocol were, a) maximizing detection probabilities, b) minimizing cost, c) practicality (in terms of non-experts being able to conduct surveys or collect data with minimal training, and practical logistics), and d) potential for partnering (in terms of using standard methods in widespread use to allow for data sharing)—all while meeting rigorous scientific standards for statistical power.

The program has been tested and refined over several years, and the first multi-year data analysis is scheduled for end of 2017. The program tracks occupancy trends in frogs and toads based on acoustic sampling using automated recording systems. Digital acoustic data are collected and archived annually. Data are analyzed using automated call recognition software with a manual proofing procedure, coupled with an independent manual survey of the same dataset. Resultant detection probabilities exceed 95% for most species. The large sample sizes achieved by this methodology ensure the program is scientifically meaningful, while remaining economically feasible. Annual

summary reports will be produced, along with periodic multi-year trend analyses. In addition, a supplemental protocol was developed to monitor salamanders, which may be implemented where resources permit.

Rationale for selecting amphibians as a group of species to monitor include:

Sensitivity—Amphibians generally are sensitive to changes in environmental factors, including temperature, precipitation, humidity, hydrology, land cover, nutrients, toxicants and exotic species.

Role as ecological integrators—Most species of amphibians require both terrestrial and aquatic habitats, and their fitness is a function of environmental conditions across habitats.

Ease of study—Various life stages of amphibians typically are available and accessible for study.

Conservation concern—Declines of populations of amphibians are among the most prominent global issues in conservation biology.

Regional relevance—All four states in which the GLKN is located, as well as Federal agencies in the region and neighboring Ontario, are currently monitoring amphibian populations.

The overall program goal is to design and implement a monitoring program that will track changes in the occupancy distribution of selected amphibian species over time, treating each park independently as well as pooling data regionally, and allowing for flexibility in the sampling design to address specific park species and habitats. The program aims to maintain high standards for statistical power and percent change.

It has been shown that acoustic frog surveys, with sufficient replicates, achieve sufficiently high and consistent detection probabilities for occupancy modeling of most species in the western Great Lakes. These surveys can be automated with Automated Recording Devices (ARDs) (i.e., Song Meters) to make them more feasible and economical, especially in more remote or inaccessible areas such as wilderness areas in national parks.

Specific objectives

1. Annually sample for the presence of amphibians at ten permanent locations in each park, using automated acoustic survey methods which maximize target species detection. Sampling may be supplemented by other methods subject to approved standard operating procedures as they become available.
2. Periodically assess the percent area occupied (PAO) over time to determine if the distribution or number of occupied sites of any monitored species changes significantly and compare results with results from other national and state programs. The PAO (MacKenzie et al. 2002, MacKenzie et al. 2003) will be the principal metric to quantify occupancy of sites for targeted species across parks, and requires analyzing data for each species independently for each sampling method used.
3. Where indicated by significant trends in PAO, use available measures of environmental conditions to test whether trends in occupancy are associated with environmental parameters

(i.e., as covariates for PAO analyses). For example, precipitation, drought index, habitat fragmentation, temperature, ice duration, snow cover, frost depth, water chemistry, etc. Some of these measures will be obtained during sampling for amphibians, and others may be available from other GLKN or partner monitoring programs (e.g., water quality, diatoms, and landscape disturbance monitoring, and various weather data sources).

Sampling Design

We have chosen to establish a *Core* monitoring protocol using calling surveys with ARS at a minimum of ten permanent sites per park (five for small parks), and add more sites over time as funding allows. Second, we provide a *Supplemental* SOP for time constrained visual searches for additional species if resources allow. Initial ARS deployment (65 units) will be: ten per park at INDU, SLBE, PIRO, ISRO, APIS, and MISS, and six at GPRO. Each unit will include external temperature sensors to monitor air (and optionally water) temperature. Photo documentation of water level and plant community are also recorded on each site visit, and water level meters may be considered as a future additional option.

The target species recommended for the initial *Core* protocol represent three breeding habitat classes: temporary to semi-permanent wetlands (Spring Peeper, both Chorus Frogs, Wood Frog), semi-permanent to permanent wetlands (Blanchard's Cricket Frog, both toads, both treefrogs, Northern Leopard Frog, Pickerel Frog), and permanent wetlands with fish present (American Bullfrog, Green Frog, Mink Frog). This habitat stratification is taken into account in the study design.

Data Analysis

Data analysis details can be found in SOP 7 Data Analysis. Analysis includes both an automated process, currently using SongScope software, to build recognizer files designed to identify the call signature of selected species. A second, independent analysis is done using trained observers to conduct manual identification of anuran calls.

Automated analysis process

For each site a stepwise process is performed to reduce raw data to subsets of samples for analysis. This procedure applies a sampling protocol that maximizes detection probabilities, and defines the sample subsets to be used for both automated and manual scanning. For automated scanning, sample batch files will be run through recognizers, with one auto-detection per species per site manually confirmed. For manual scanning, 30 samples will be selected and scored for species occupancy and phenology. This includes the following procedures.

1. Determine deployment and retrieval dates.
2. Delete extraneous recordings.
3. Delete blank files.
4. Document annual data collection.
5. Verify channel functionality.
6. Delete sample files recorded after the night of 31 July.
7. Determine number of nights sampled.

8. Delete sample files prior to sunset.
9. Record the number of samples analyzed.
10. Finish Form 1 data entry.
11. Run the file subset from Step 8 through the available species recognizers.
12. Filter recognizer output further for American Toad and American Bullfrog.
13. Confirm earliest auto-detections for each species.
14. Review the recognizer output results for anomalies. Prepare and deliver samples for manual scanning.

Manual analysis process

This process performs a survey independent of the automated analysis, and covering all possible species, including those for which automated recognizers have not been developed. It also contributes data for phenological analysis (e.g., tracking trends in first calling dates). Personnel performing these scans should be experienced in the methodology, and be familiar with Song Scope software and the spectrograms and audio calls of all anuran species in the network parks.

1. Open the first file (*.WAV) to be scanned in Song Scope software (File B> Open). Adjust settings for Song Scope (version 3.4 currently, see SOP 7))
2. Review the example sonograms in Appendix B to aid in visual scanning. Refer to these examples as needed.
3. Grabbing the slider with the mouse pointer, scroll slowly to the right until a sound wave is observed. Release the slider and click the Play button (triangle) to listen to confirm the species calling (headphones are recommended). Click the Pause button and enter the Call Index Value (CIV) of the species(s) heard in the Manual Scan Data Sheet (Form 3).
4. Occasionally samples may be found where the recordings are so noisy that they should be considered invalid samples. Both anthropogenic (traffic, airplanes, etc.) and natural (wind and waves from storms) noise can violate protocol, which requires that the species be detectable during the survey. If such samples are encountered, select alternate sample as per SOP 7.
5. Upon reaching the end of the acoustic sample, scroll back and for each species detected, find the highest call intensity and adjust the CIV previously entered to the maximum level encountered.
6. Repeat for each of the 30 samples, then move on to the next Site.
7. Return the Form 3 spreadsheet and a qualified second observer will verify every first and questionable detection for each species at each Site.

Protocol Activities and Modules

Data are collected or derived as a part of the GLKN Amphibian Protocol in 11 different activities or modules (Table 1).

Table 1. Protocol activity matrix for amphibian monitoring in the Great Lakes Inventory and Monitoring Program.

Activity Type	Activity	Description
Site Recon, Establishment, and Maintenance	1. Site Recon	Investigate suitability of sites to be used as sampling locations for each of three wetland types, ephemeral, semi-permanent, and permanent with fish present. This is done by initially creating a set of GRTS points for the area of interest, and locating potential wetlands using GIS data layers based on proximity within one kilometer of point. Further refinement, search for ephemeral wetlands and final selection must be done in the field.
	2. Plot Establishment	Site description, location of wetland sampling point, geolocation and establishment of witness trees.
	3. Plot Maintenance	Re-establishment/ change of song meter placement or witness trees.
Field Observations	4. Song meter deployment, mid-season check, recovery from field	Deploy song meter, mount either on post or tree. Turn on unit for recording. Mid-season check to ensure both temp logger and song meter are operational, retrieve units from field after 31 July.
	5. Ancillary data	Measure height of song meter from ground, distance to water, depth of water, (measure water parameters during each of 3 site visits), compass orientation of unit, presence of calling amphibians, egg masses, vegetation (wetland and adjacent upland), canopy closure, recent weather.
Sensor Data	6. Photo Monitoring	Photo point with photos at the 4 cardinal directions. Photo of temperature logger. Additional photos as needed.
	7. Song Meter	Wildlife Acoustics automated recording devices, record 5 minute sound files on the hour, (3pm to 3am local time) and on the 1/2 hour around sunset (7:30, 8:30, 9:30, 10:30).
	8. HOBO pendant logger	Records temperature (air or water) reading every hour
Field Sample Collection and Processing	9. Analysis of data	Analysis of data includes filtering sound files for valid samples, running samples through automated recognizer algorithms, manually verify species calls, then subsample and conduct independent manual review of samples.
	10. Report on findings	Compile results and report on findings annually. Conduct trend analysis and write synthesis report roughly every 5 years.
QA/QC Data	11. Repeat Measures	Enter data from field forms into Access database, conduct 100% check. Review data import from recognizer outputs in excel spreadsheet to Access database.

Sampling Design

Information regarding the sampling design is provided in Table 2.

Table 2. Activity-level sample design matrix for amphibian monitoring program.

Activity Type	Activity	Sampling Design	Revisit Design
Site Recon, Establishment, and Maintenance	1. Options	Select 10 sites/park, 3 in each coarse wetland type, ephemeral, semi-permanent, and permanent with fish, with tenth site located at park's choosing. Start by generating GRTS points distributed randomly across park area, number of points dependent on size of park. Generate 1km buffers around each point and select closest apparent wetland to centroid. Continue until all sites have been identified and verified in the field.	Sites are visited each year, deployment of song meters in early spring, mid-season check, early summer, and retrieval, after 31 July.
Field Observations	2. Wetland vegetation cover	Estimate cover to nearest 5% of trees, shrubs, emergent, open water, and other	Every year during mid-season check
	3. % Canopy closure	Estimate % of wetland shaded to nearest 5%, assuming full leaf-on at noon	Every year during mid-season check
	4. Observations of amphibians present	Record amphibian calls, egg masses, tadpoles, adults, including salamanders	Each of three visits/year
Sensor Data	5. Song meter recordings	Collected throughout breeding season	Revisit every 1 year
	6. HOBO Temp logger	Located with song meter deployment	Records reading every hour
	7. Photo point data	Four photos taken at song meter site to capture wetland and upland habitat	Revisit every 1 year

Data Quality Objectives

Data quality values and standards for implementation are provided in Tables 3–6.

Table 3. Data Quality Values (DQVs) for amphibian monitoring program in the Great Lakes Inventory and Monitoring Network.

Data Quality Type	Data Quality Value	Definition	Protocol Considerations
Intrinsic Data Quality	1. Accuracy	Measurements reflect the true value of the parameter being observed. This applies to measures (length, width, position) or classes (species, types, or categories). Includes components of precision and bias.	Measurements of equipment placement are recorded to the nearest centimeter. Measurements of vegetation and canopy closure are estimated to the nearest 5%. Sound file analysis includes rigorous assessment of detection probability and false positives as detailed in SOP 7 Data Analysis and Reporting.
	2. Representativeness	Measurements represent conditions at the time of sampling. Combined with accuracy, leads to repeatable data collection.	Placement of song meters may vary, depending on availability of trees or other mounting options, but should not affect recordings of amphibian populations being monitored.
Contextual Data Quality	3. Comparability	The degree to which data can be compared among sample locations, data sources, or periods of time.	The seasonal timing of song meter deployment affects the degree to which data can be compared among sample locations, especially for early calling species. All sample locations are monitored following the schedule and methods outlined in the protocol.
	4. Timeliness / Currency	How recent the data need to be to be considered valid for their intended use. Data represents conditions and/or is available and in a format for use at the appropriate time in the decision-making process.	Data are collected through the field season (March–July), and analyzed the following winter. Final report is then completed by spring or early summer. There is no urgency requirement for summary reporting.
	5. Completeness	All data/ measures required to evaluate accuracy representativeness are present; incomplete data sets (either at a location, across sampling locations, or over time) lose utility or relevance. Data records contain values as planned across the period of record.	Methods, sampling plans, and analyses are designed and implemented such that they result in a complete dataset across space and the planned period of record. Data gaps are expected to occur due to late deployment or equipment failure while in the field (vandalism, animals, software/hardware failure).

Table 3 (continued). Data Quality Values (DQVs) for amphibian monitoring program in the Great Lakes Inventory and Monitoring Network.

Data Quality Type	Data Quality Value	Definition	Protocol Considerations
Representational Data Quality	6. Consistent Representation	Use of standard definitions when describing data quality or resource quality based on data	Visual estimates (to nearest 5%) of vegetative cover are subject to significant observer bias, but combined with good photo-documentation, these data provide an adequate assessment of overall vegetative structure for needs of the program. Analysis of sound files provide a robust positive identification, to better than 95% confidence in detection and accuracy of results. HOBO temperature loggers are calibrated prior to deployment, and have been confirmed to be well within needed tolerances (+/- 0.7 degrees Celsius).
Data Accessibility	7. Available to public	Access to data, products, and systems provided as needed.	There should be no restrictions on data access, pending potential discovery of threatened or endangered species.

Table 4. Measurement Quality Objectives table for amphibian monitoring program in the Great Lakes Inventory and Monitoring Network.

Category	Measure / Quality Indicator	Quality Objective
Site Recon	Location Accuracy	Sample location within +/- 5m of established waypoint.
Site Establishment	Location Accuracy	+/- 5m Ideally use mapping grade receiver for formal locations
	Location Description Detail	Description should provide enough detail to relocate without use of GPS equipment
Amphibian Sightings	Taxonomic Resolution	Identifications made to the species level
	Identification Accuracy	95% accuracy for visual observations and 90% accuracy for audio observations
	Identification Completeness	95% of observations made to species level
	Distance accuracy	+/- 5m
Vegetation Measurements	Wetland vegetation	Categorical estimates of coarse morphological types to nearest 5%
	Canopy closure	Estimate to nearest 5%
Temperature – HOBO Pendant logger	Accuracy	±0.53°C at 25°C
	Resolution	0.14°C at 25°C
Photopoints	Image resolution	>2 megapixel
	Image format	.jpg, .tif or .raw

Table 5. Activity-level sample design matrix for amphibian monitoring program in the Great Lakes Inventory and Monitoring Network.

Activity Type	Activity	Standard to be Used	Reference / Authority
Options	–	<u>Scientific Publication</u> Or Gary Casper, Herpetologist with Great Lakes Ecological Services LLC	Powell, Robert, Roger Conant, and Joseph T. Collins. 2016. Peterson Field Guide to Reptiles and Amphibians of Eastern and Central North America, 4th ed. Houghton Mifflin Harcourt Herpetologist, Great Lakes Ecological Services, LLC
Collection of Observational Data	4. Sound files	Field Subject Matter Expert	Field crew lead w/ documented identification proficiency
	5. Temperature log	HOBO Pendant logger	–
	6. Vegetation – categorical estimates	Visual estimates to nearest 5%	–
	10. Amphibian egg masses, tadpoles, adults, calls	Identification dependent on skills, proficiency of field staff	–
Reporting of Observational Data	4. Sound file analysis	See SOP 7	Gary Casper, herpetologist
	5. Temperature log	Calibrated prior to field deployment	Onset HOBO Data Logger
	6. Vegetation – categorical estimates	Enter field form data into database, use as ancillary data for amphibian presence/absence analysis	–
	10. Amphibian egg masses, tadpoles, adults, calls	Enter field form data into database, as ancillary data to support amphibian presence/absence	Powell, Robert, Roger Conant, and Joseph T. Collins. 2016. Peterson Field Guide to Reptiles and Amphibians of Eastern and Central North America, 4th ed. Houghton Mifflin Harcourt.

Table 6. Data protection standards for amphibian monitoring program in the Great Lakes Inventory and Monitoring Network.

Data and Information Category	Type of Data	Level of Protection	Rules for Dissemination
All	All	<u>Legally Protected</u> . Only applicable if covered under existing statute as exempt from dissemination <i>Or</i> <u>Operationally Protected</u> . Data withheld from release to protect resources or site fidelity but may be subject to release upon request.	Specify any park-specific reporting & dissemination rules.
Resource Data and Information	T&E Species Locations	Legally Protected	Locations of observations reported at park centroid only.
	<i>Galax</i> species locations	Legally Protected	Commercially valuable; location information redacted from all dissemination
	T&E migratory shorebird locations	Legally Protected	Locations of observations reported at park centroid for three years; fuzzed to within 50m thereafter.
Location Data and Information	Permanent Sampling Locations	Operationally protected	Provided upon request only. Shown in reports
	Cave entrances	Legally protected	Redacted
	Spring locations	Legally protected	Redacted; features associated with protected archaeological sites.
Personally Identifiable Information	Non-NPS Staff Information	Legally Protected	All but first name and last initial redacted from public release

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