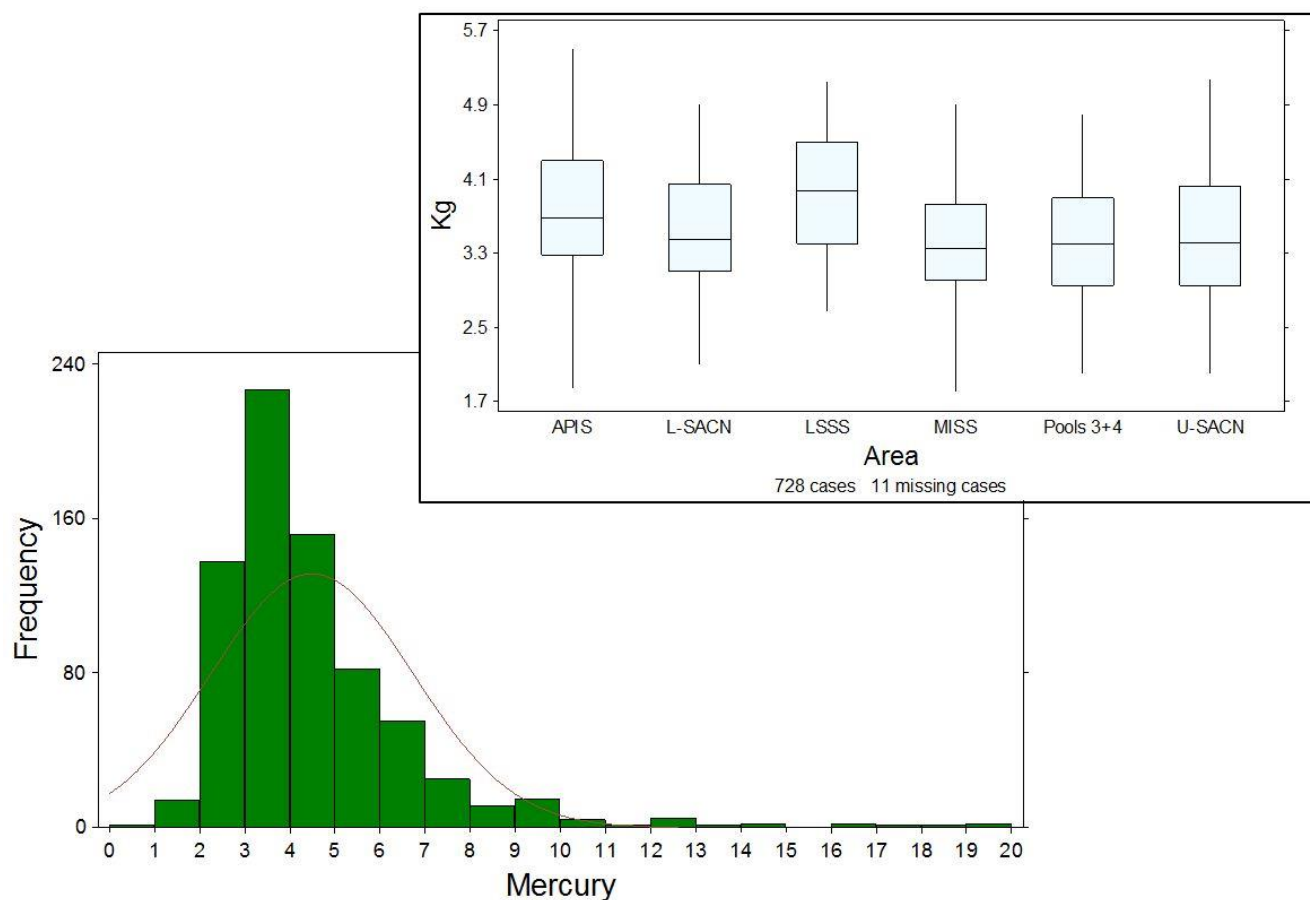




Quality Assurance Plan for Monitoring Environmental Contaminants in Bald Eagle Nestlings

Great Lakes Inventory and Monitoring Network

Natural Resource Report NPS/GLKN/NRR—2018/1848



ON THE COVER

Charts used to review data elements for quality assurance.

Quality Assurance Plan for Monitoring Environmental Contaminants in Bald Eagle Nestlings

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Natural Resource Report NPS/GLKN/NRR—2018/1848

Bill Route and David VanderMeulen*

National Park Service
Great Lakes Inventory and Monitoring Network
2800 Lakeshore Drive East
Ashland, Wisconsin 54806

*Corresponding author: david_vandermeulen@nps.gov

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Abstract

In accordance with guidelines set forth by the National Park Service Inventory and Monitoring Division, this quality assurance plan was developed by the Great Lakes Inventory and Monitoring Network (GLKN) in the implementation of a protocol for monitoring environmental contaminants in bald eagle nestlings. This quality assurance plan documents the standards, policies, and procedures used by the GLKN for activities related to the collection, processing, storage, analysis, and publication of monitoring data associated with monitoring environmental contaminants in bald eagle nestlings. The policies and procedures documented herein complement the quality assurance plans for other monitoring activities conducted by the GLKN and supplement the National Inventory and 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 DQVs, and informs development of Measurement Standards (or Measurement Quality Objectives), 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 and 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.

Limit of Detection (LOD). The limit of detection is the lowest quantity of a substance that an analytical laboratory can reliably (99% probability) distinguish from the absence of that substance in a laboratory blank. This is synonymous with Minimum Detection Limit.

Limit of Quantification (LOQ). The limit of quantification is the lowest concentration at which predefined criteria for bias and imprecision are met. The LOQ may be equivalent to the LOD or it could be at a much higher concentration. This is synonymous with Minimum Quantification Limit (MQL).

Method Detection Limit (MDL). The method detection limit is defined as the minimum measured concentration of a substance that can be reported with 99% confidence that the measured concentration is distinguishable from method blank results.

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

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 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.

Reporting Limit (RL). The reporting limit is the smallest concentration of an analyte that a laboratory agrees to report. The RL is often calculated by multiplying the LOD by some factor determined by the laboratory based on its ability to achieve precision and accuracy during routine operations.

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, 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, Measurement (see 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, Policy. Data quality requirements related to ensuring appropriate management, use, dissemination, qualification, and documentation of data.

Introduction

The National Park Service (NPS) Inventory and Monitoring Program was established by an act of Congress in 1999 to provide more than 270 national park system units a core suite of baseline inventories and to identify and implement long-term monitoring of high-priority natural resources (Fancy et al. 2009). The overarching purpose of natural resource monitoring in parks is to develop scientifically sound information on the current status and long-term trends in the composition, structure, and function of park ecosystems, and determine how well current management practices are sustaining those ecosystems.

The purpose of this quality assurance plan (QAP) is to document the standards, policies, and procedures used by the Great Lakes Inventory and Monitoring Network (hereafter network or GLKN) for the collection, processing, storage, analysis, and publication of data under the network's protocol for monitoring environmental contaminants in bald eagle (*Haliaeetus leucocephalus*) nestlings. This QAP serves as a guide for all personnel who are involved in field, lab, and office activities and as a resource for identifying memoranda, publications, and other literature that describe associated techniques and requirements in more detail. The policies, procedures, and activities documented herein complement the quality assurance plans for other monitoring activities conducted by the GLKN and supplement the National Inventory and Monitoring Division Quality Management Plan currently in development.

Protocol Overview

The protocol for monitoring environmental contaminants in bald eagle nestlings involves taking blood and feather samples from bald eagle nestlings to monitor trends in concentrations of contaminants that are persistent, bioaccumulative, and toxic (PBTs) to fish, wildlife, and humans. The field work occurs primarily at Apostle Islands National Lakeshore (APIS), Mississippi National River and Recreation Area (MISS), and the St. Croix National Scenic Riverway (SACN). Additional study areas may occasionally be sampled to put these park areas in context.

Human-made contaminants that are released into water, air, or on land often end up in aquatic systems through aerial deposition, runoff, and ground water. Bald eagles are high on the aquatic food web and are known to accumulate PBTs to high levels. Hence they sample the aquatic environment and act as integrators of human-made contaminants.

Under this protocol (versions 1.0 and 1.2; Route et al. 2009) a baseline of data was collected annually from 2006 through 2011 and again in 2014 and 2015. Henceforth this protocol will be repeated with a minimum of three consecutive years every ten years or as funding is available. We have targeted six contaminants that have caused impairment to water bodies within the three parks or which have been identified by regulatory agencies as contaminants of emerging concern (CECs). The six targeted contaminants are:

- Lead
- Mercury (total)
- DDT (including DDE & DDD)

- PCBs (total and 75 congeners)
- PBDEs (total and 9 congeners)
- PFCs (total and 16 telomers)

Additional contaminants can be added to this targeted list and the procedures and methods presented in this QAP and the associated protocol and SOPs are relevant in most cases. Laboratory and statistical methods may vary, but the concepts of conducting quality assurance/quality control (QA/QC) and good data management procedures will be the same. For example, in 2010 the Great Lakes Restoration Initiative provided funding to expand the list of contaminants to several contaminants of emerging concern (CECs). All procedures in this QAP were followed to verify, validate, and certify the resulting data.

Generically, the monitoring program is designed to answer the following questions:

1. What is the direction and magnitude of change in concentrations of target chemicals in blood plasma, feathers, and/ or eggs of nestling bald eagles within the study areas?
2. What is the incidence of developmental deformities observed in live and dead nestlings of bald eagles within the study areas?
3. What is the direction and magnitude of change in the number of young produced per occupied bald eagle nest within the study areas?

Each year occupied bald eagle nests are located by a pilot/observer team from a fixed-wing aircraft or helicopter in the spring. In May or June, field teams visit all occupied nests that can be safely climbed. Sampling is timed so that nestlings are five to nine weeks old. Each active nest has one to three, very rarely four, nestlings. The handling crew takes up to 11 ml of blood and three to four breast feathers from at least one, and often all, nestlings in each nest. One nestling is randomly selected as the “sample” and its blood and feathers are sent to a NELAP-certified analytical laboratory to measure the concentrations of target contaminants. Samples from the remaining siblings are archived and analyzed as funds allow. All eaglets are measured, weighed, checked for general health, banded, and placed back in the nest. All data are recorded on standardized forms.

Blood samples are kept in a cooler on ice while in the field. Samples are transferred to a refrigerator within ten hours and then processed within 12 hours. Processing involves centrifuging the whole blood and pipetting the plasma into separate vials. The prewashed, chemically inert sample vials are provided by the analytical laboratory. The resulting samples are frozen within 22 hours of collection and kept frozen until delivery to the laboratory. Feather and DNA samples are kept dry in individually marked envelopes. Following the field season both plasma and feather samples are hand-delivered in portable freezers to the designated lab. DNA samples are shipped to a genetics laboratory.

Resulting data are validated, assessed for quality, certified, and maintained in a Microsoft (MS) Access database. An authoritative copy of the dataset is available in the NPS IRMA Data Store, and a copy of the certified data is publicly available from IRMA. A working copy of the database is stored

on the GLKN server, and a backup copy of the MS Access database is kept off-site at APIS. Results of this work have been published in technical reports (Route et al. 2008, 2011) and science publications (Bruggeman et al. 2018, Dykstra et al. 2011, Elliot et al. 2018, Route et al. 2014a, Route et al. 2014b, Rutkiewicz et al. 2011).

Data Collection Activities

Data are collected under this protocol during seven distinct activities summarized below. Data collection within each of these activities are itemized in more detail in Table 1.

1. Occupancy and Productivity Surveys. These surveys are done by fixed-wing aircraft or helicopter. For APIS and SACN they are done by pilot and observer teams from the Wisconsin Department of Natural Resources (WDNR) in fixed-wing aircraft. The WDNR splits the surveys by county such that there are two or three different teams depending on the year and workload. For MISS the surveys have been done by the GLKN lead investigator with the VOYA fixed-wing pilot, but most recently they are done by a biologist from the Three Rivers Park District, Minneapolis, MN using a helicopter. Data are provided gratis through The Mississippi Park Connection, a friends group. Both the state and county biologists have been doing these surveys for many years (DNR for >30 years) so the data is considered to be of high quality. The GLKN data assistant enters the data provided by partners and asks questions of surveyors to resolve any discrepancies.
2. Nest Visits and Nestling Sampling. All nests found to be active from the occupancy/productivity surveys or from observations by park personnel are visited by GLKN biologists and contract climbers on the ground. This is a census of occupied nests with the exception of nests we are denied access to on private property (rare) and when the nest tree is found to be unsafe to climb. Nest visits result in a variety of nestling measurements, banding numbers, and biological samples. The field team is highly trained and standardized forms and detailed SOPs are used to ensure data quality.
3. Biological Samples. Nest visits result in several samples: 10cc vials of whole blood for organic chemicals, 1cc vials of whole blood for lead (Pb), breast feathers for heavy metals, addled eggs for organics, adult feathers for genetics, dead nestlings, and prey remains or other items of particular interest, such as fishing lures and lead sinkers found in a nest. Additional samples and data are generated when the blood samples are centrifuged each evening and split into individual aliquots of plasma in varying quantities depending on lab requirements. Feathers are also cataloged for later analysis. Occasionally addled eggs are found in nests and they are kept frozen and later measured for egg size and shell thickness before the contents are removed and sent to the analytical laboratory.
4. Chemical Laboratory Measurements. Whole blood, plasma, feathers, and occasionally egg contents and carcass tissues (heart, liver, and brain) are sent to a NELAP-certified analytical laboratory for measurements of target chemicals. Data are generated under a chain of custody for each time samples change hands. The lab generates measured results and QA/QC information upon delivery of the data. Data delivery is normally in electronic form such that the lab results are imported directly to the MS Access Master Bald Eagle Database.

5. Genetic Laboratory Analyses. A small blot of blood on a gauze pad is sent to a genetics lab for verification of the sex of each nestling. If adult feathers are found around the nest at least one feather is collected and archived for potential future population genetics studies (not addressed in this protocol but an easily collected sample that may have great historical value). Data are generated under a chain of custody for each time samples change hands. The lab generates measured results and QA/QC information upon delivery of the data.
6. Derivative and Miscellaneous Data. Within the Master Bald Eagle database some values are derived from the raw field data. For example, the number of young per occupied nest is calculated from occupancy surveys and productivity data after nest visits. Geometric means of contaminant levels can also be calculated within the database reporting system to summarize results.
7. QA/QC Data. The analytical laboratories provide QA/QC data on results for every batch of samples. Occasionally field staff conduct double-observations of measurements, such as foot pad length or eggshell thickness, to evaluate whether observer variability is within acceptable tolerance.

Table 1. Protocol activity matrix for bald eagle sampling.

Activity Type	Activity	Description
External Data	1. Occupancy and productivity surveys collected by partners	Location of nests, occupancy status, and occupancy evidence (presence of adults incubating eggs, number of adults at a nest, number of adults near a repaired nest, or presence of eggs or young).
Field Observations	2. Sampling event data and nest tree condition	Date, time, number of eaglets present, environmental conditions, tree species, tree and nest condition, and GPS coordinates of the nest tree.
	3. Eaglet morphology	Weight, bill length/depth, hallux claw length, foot pad size, and feather length. Presence of deformities, wounds or unusual markings, ear maggots and fullness of crop are also recorded.
	4. Eaglet banding	Band number recorded for all nestlings encountered.
Field Sample & Specimen Collection and Processing	5. Nestling whole blood samples, kept whole	Collection of 1 cc of whole blood for lead analysis
	6. Nestling whole blood samples, for plasma analysis	Collection of 10-12 cc of whole blood for centrifugation and splitting: plasma for measuring organic contaminants, and the remaining red blood cells retained as an archive for unplanned use or discard after 10 years
	7. Nestling feather samples	Collection of 3-4 breast feathers for mercury and lead analysis
	8. Nestling egg samples	Collection of addled eggs and associate measurements (egg size and shell thickness) and processing of egg tissue for contaminants analysis

Table 1 (continued). Protocol activity matrix for bald eagle sampling.

Activity Type	Activity	Description
Field Sample & Specimen Collection and Processing (continued)	9. Carcass tissue samples	Removal of heart, liver, or brain tissue from remains of deceased eaglets found in nests for contaminants analysis
	10. Other items of interest	Collection of prey remains or other items of particular interest, such as fishing lures and lead sinkers found in a nest.
Laboratory Data and Associated QA/QC Data	11. Whole blood analysis	Whole blood samples sent to an inorganics lab for measurement of elemental lead (Pb)
	12. Plasma analysis	Aliquot of 1 ml of plasma sent to an organics lab for measurement of PFCs
	13. Plasma analysis	Remaining plasma (usually 4-6 ml after 1 ml drawn off for PFCs) sent to an organics lab for measurement of DDT, DDE, DDD, PCBs, and PBDEs.
	14. Feather analysis	Breast feathers sent to a inorganics lab for analysis of lead and mercury
	15. Addled eggs and dead nestlings	When found in good condition any addled eggs or dead nestlings are sent to an organics lab for analysis of targeted organics: egg albumen, and samples of intact organs of nestlings including liver, brain, heart, and muscle
	16. DNA / gender identification	Blot of blood on gauze sent to a genetics lab for sex identification
Derived Data	17. Productivity estimates	Estimates of productivity for each study area are calculated each year including number of nestlings per occupied territory, number of nestlings per productive territory, and number of failed territories
Quality Control Data	18. Double observation data	Length of nestling footpads and eggshell thickness are critical measurements that have been checked by having two observers measure to determine inter-observer variability

Sampling Design

Sampling design details are more fully described in the protocol narrative and relevant standard operating procedures to monitor environmental contaminants in bald eagles. A sampling design summary follows.

Monitoring will occur at APIS, MISS, and SACN. Each park is a study area except that the St. Croix National Scenic Riverway (SACN) is divided into lower (L-SACN) and upper (U-SACN) study areas. The SACN is a 250-mile-long river system and the physical properties of the river and surrounding geology and human use make the two study area designations ecologically different. Additional study areas may occasionally be sampled to put these park areas in context.

The number of territories occupied by bald eagles (occupancy survey) are determined annually by analyzing data collected through aerial surveys by park partners, and has occurred every year since monitoring under an earlier version of this protocol began in 2006. Our partners also conduct separate aerial surveys to determine the number of young produced in each occupied territory (productivity survey). However, aerial productivity surveys are not always done annually; the State of Wisconsin cut funding for productivity surveys in many years and Minnesota ended them in the early 2000s. Note: an occupied “nest” and an occupied “territory” are considered the same. Individual nesting territories can be identified by delineating logical breaks between nests or groups of nests and examining occupancy over years. A territory has only one occupied nest, though alternate, un-occupied nests can be in the territory.

Both occupancy and productivity are determined by on-the-ground field crews in years when blood and feather samples are collected from bald eagle nestlings. Beginning in 2006, the intention was to sample bald eagle nestlings at each of the three parks on a two-years-on and two-years-off rotation, but to also sample in intervening years by seeking funding from other sources (Route et al. 2009). Indeed, from 2006 to 2015, additional funding allowed for sampling bald eagle nestlings in 2008 and 2009, and to analyze samples for a number of additional contaminants collected in 2010 and 2011 (Table 2). We again sampled in 2014 and 2015 and these were the last two “on-years” and field sampling of nestlings was then suspended pending this new protocol.

Table 2. Years in which bald eagle nestlings were sampled (X) for environmental contaminants at four study areas in three parks from 2006 through 2015 and proposed sampling period (S) in following years.

Year	APIS	U-SACN	L-SACN	MISS
2006	X	X	X	X
2007	X	X	X	X
2008	X	–	X	X
2009	–	–	X	X
2010	X	X	X	X
2011	X	X	X	X
2012	–	–	–	–
2013	–	–	–	–
2014	X	X	X	X
2015	X	X	X	X
2016	–	–	–	–
2017	–	–	–	–
2018	–	–	–	–
2019	–	–	–	–
2020	–	–	–	–
2021	–	–	–	–
2022	–	–	–	–

Table 2 (continued). Years in which bald eagle nestlings were sampled (X) for environmental contaminants at four study areas in three parks from 2006 through 2015 and proposed sampling period (S) in following years.

Year	APIS	U-SACN	L-SACN	MISS
2023	S	S	S	S
2024	S	S	S	S
2025	S	S	S	S

We now recommend sampling nestlings a minimum of three years in a row with a seven year gap (three in every ten years). Hence, we recommend that the four core study areas be sampled again, minimally in 2023, 2024, and 2025. It will be important to sample at least three years in a row to provide a mean for the period and to minimize the potential for hitting an unusual year (e.g., poor reproduction, high flooding, etc.). However, with additional funding and approval from one or more parks we could foresee re-initiating sampling sooner (e.g., 2020, 2021, and 2023). Note that bald eagle occupancy surveys will continue annually by partners and the GLKN will continue to acquire this information each year.

Ground crews use occupancy survey results to locate and sample nestlings in active nests. We attempt to get a complete census of all active nests; however, some nests are unsafe to climb (e.g., dead tree or unstable nest structure), and some landowners deny access. For these nests ground crews typically can still make an onsite verification of nest occupancy and a minimum estimate of productivity.

We collect blood and feather samples from at least one nestling at each productive nest that is safe to climb. When there is more than one young in the nest we attempt to collect samples from all nestlings, including collecting morphological measurements. The number of young produced per occupied nest will vary from one to three and rarely four.

Samples from only one nestling per nest will be analyzed for contaminants each monitoring year. Samples from siblings are archived (serum in freezers at -20°C .; feathers dried in envelopes) for future assessments of new and emerging contaminants. We have successfully measured concentrations in samples that are ten or more years old (Custer et al. 2009, Route et al. 2014a).

Data Quality Objectives

Data Quality Values

Data quality values and standards for implementation are provided in Tables 3 through 5.

Table 3. Data Quality Values (DQVs) for bald eagle measuring and sampling.

Data Quality Type	Data Quality Value	Definition	Protocol Considerations
Intrinsic Data Quality	Accuracy	Measurements reflect the true value of the parameter being observed. This applies to measures (length, width) or classes (species, types, or categories). Includes components of precision and bias.	Data collected in the field are assumed to be accurate representations of the true values. Repeated sampling provides reasonable estimates of the true variability in bald eagle morphology and demography. Laboratories provide measures of accuracy as part of method development and quality control.
	Representativeness	Measurements represent conditions at the time of sampling. Combined with accuracy, leads to repeatable data collection.	A near complete census of occupied nests in each study area assures the data are representative in any given year.
Contextual Data Quality	Comparability	The degree to which data can be compared among sample locations, data sources, or periods of time.	We sampled in eight of the first ten years, which provides an excellent baseline for future comparisons. Additionally, identical field collection methods have been used by WIDNR, MIDNR, and VOYA since the early 1980s. In the case of WIDNR, the same laboratory has applied consistent standards and methods since 1991.
	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.	Bald eagle nest occupancy and productivity data are provided to the parks within months of collection. Laboratory results can take up to two years to obtain, certify, and share. Preliminary results are provided on request.

Table 3 (continued). Data Quality Values (DQVs) for bald eagle measuring and sampling.

Data Quality Type	Data Quality Value	Definition	Protocol Considerations
Contextual Data Quality (continued)	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.	The protocol is designed to provide complete data sets across space and time. However, nestlings too small to sample or measure, failed nests, and other biological and logistical constraints result in missing values. Analytical procedures are used that are robust to missing values and unbalanced designs which are common in ecological datasets.
Representational Data Quality	Consistent Representation	Use of standard definitions when describing data quality or resource quality based on data.	This protocol builds upon several decades of monitoring of bald eagle productivity and contaminants in the upper Midwest. Standard terminology and measures are used across all states and federal agencies doing this work.
Data Accessibility	Security	Access to data, products, and systems limited to appropriate audiences.	Bald eagles are protected under the American Bald and Golden Eagle Protection Act (U.S.C. 668-668c) of 1940. Individual nest locations are provided to state and federal managers, but only the territory centroid is used in generally available reports and data sets. Protected data are released in limited cases only with park superintendent approval. Personally identifiable information (contact information for land owners) is redacted from all forms and databases.

Standards

The Measurement Quality Objectives (MQOs) for quantitative measurements taken in the field are defined in Table 4 and the MQOs for the target contaminants measured by analytical laboratories are found in Table 5. Not all data collected in this protocol require an MQO.

Table 4. Measurement Quality Objectives for bald eagle nest locations and nestling measurements. The number refers to the numbered activities found in Table 1.

Category	#	Data	Quality Objective
Nest Locations From Aerial Surveys	1	Location Accuracy	GPS locations from the air should be within +/- 100m of the actual location to be useful for ground crews to find the active nest.
Nest Locations on the Ground	2	Location Accuracy	GPS locations collected on the ground should be within +/- 10m of the base of the nest tree.
Territory Occupancy	1	Occupied territory	Bald eagle territories are correctly identified by observers in fixed wing aircraft as being occupied or not and they correctly assign occupancy based on when any of the following are present: 1) evidence of eggs or young, 2) an incubating adult, 3) 2 adults (or 1 adult and 1 sub-adult) near an empty nest or within a known breeding territory (this includes known territories where the nest is gone), and 4) a newly repaired nest with or without adults present. See SOP #4 for further explanation.
Nestling Measurements*	3	Weight	Weight is measured with a Pesola 10 kg spring scale and recorded to the nearest 0.1 kg. Of 346 females and 313 males sampled 2006-2015 the weights were significantly different (females larger) but the standard error (SE) was the same at 0.03 kg.
	3	Primary feather	The 8th primary is measured using a 35 cm aluminum ruler and data are recorded to the nearest 1mm. Double measurements should agree to within 2 mm. Of 659 nestlings measured from 2006-2015 the SE for the 8th primary for a 35 day-old nestling (low end of target) was 1.04 mm and for a 56 day-old nestling (high end of target) was 1.64 mm.
	3	Foot pad	The foot pad is measured with a 35 cm aluminum ruler to the nearest 1mm. Double measurements should agree to within 2 mm. Of 346 females and 313 males measured from 2006-2015 the SE for foot pad was 0.35 mm and 0.33 mm respectively.
	3	Hallux claw	The hallux claw is measured with a digital caliper and recorded to the nearest 0.1mm. Of 346 females and 313 males measured from 2006-2015 the SE for hallux claw was 0.18 mm and 0.14 mm respectively.
	3	Bill length and width	Bill length and width are measured with a digital caliper and recorded to the nearest 0.1mm. Of 346 females and 313 males measured from 2006-2015 the SE for bill length was 0.21 and 0.19 respectively: the SE for bill width was 0.10 mm and 0.10 mm respectively.

* A note on all physical measurements: measurements on soft tissue of wildlife are difficult to make consistently. They can differ by observer, animal behavior, stress, age, etc. For nestling eagles, measurements of bill depth, culmen length, and hallux are done with highly accurate calipers and there are hard anchor points on the nestling (e.g. tip of the hallux claw) to position the calipers. Therefore these measurements are considered accurate. The footpad measurement, however, is particularly susceptible to inconsistencies because of the tension in the nestling's tendons, making it difficult to stretch out the foot pad. Handlers differ in their ability and process of stretching the foot pad (see Route 2016).

Table 4 (continued). Measurement Quality Objectives for bald eagle nest locations and nestling measurements. The number refers to the numbered activities found in Table 1.

Category	#	Data	Quality Objective
Determining Sex	16	From DNA	DNA-derived sex determinations are considered definitive based on results of a blind comparison between two labs with 100% agreement.
	3	From Foot pad	This is the second choice for estimating sex and is used only if DNA data is unavailable. Based on previous studies we estimate this to be 80% accurate (unpublished data).
	3	From Visual	This determination depends on observer experience so is considered the estimate of last choice and only used if the foot pad and DNA data are unavailable.
Determining Age	3	8th primary	Age in days is derived from the bird's sex and the length of the 8th primary (Bortolotti 1984). This estimate is a relative index of age that has been consistently applied by several researchers, but has unknown accuracy for our population.
	3	Visual	This estimate of age should be accurate to within a week with experienced personnel. This estimate is used only when the 8th primary measurement is not available.
Specimen Collections	8	Addled eggs	Occasionally an addled egg or significant portions of egg shells are found in the nest and collected for analysis. Whole egg length and width are measured with a caliper to the nearest 0.1 mm (no estimate of precision available) and egg shell thickness is measured in 5-10 different locations around the equator of the egg with a digital micrometer to the nearest 0.001 mm (standard deviation of 118 measurements = 0.08 mm).

* A note on all physical measurements: measurements on soft tissue of wildlife are difficult to make consistently. They can differ by observer, animal behavior, stress, age, etc. For nestling eagles, measurements of bill depth, culmen length, and hallux are done with highly accurate calipers and there are hard anchor points on the nestling (e.g. tip of the hallux claw) to position the calipers. Therefore these measurements are considered accurate. The footpad measurement, however, is particularly susceptible to inconsistencies because of the tension in the nestling's tendons, making it difficult to stretch out the foot pad. Handlers differ in their ability and process of stretching the foot pad (see Route 2016).

Table 5. GLKN's Measurement Quality Objectives for concentrations of targeted chemicals measured by analytical laboratories. The method detection limit (MDL) is the minimum measured concentration of a substance that can be reported with 99% confidence that the concentration is distinguishable from method blank results (USEPA 2017). See narrative for further explanation.

Analyte**	Sample Type	Units	Method Detection Limits	Lab blanks	Percent Recovery
Lead	Whole Blood	ug/dL	≤0.60	ND	85% to 115%
	Breast Feathers	ug/g	≤0.05	ND	85% to 115%
Mercury	Breast Feathers	ug/g	≤0.004	ND	90% to 110%
	Whole Blood	ug/g	≤0.60	ND	90% to 110%
DDT	Plasma	ug/L	≤0.35	ND	70% to 130%
DDD	Plasma	ug/L	≤0.30	ND	70% to 130%
DDE	Plasma	ug/L	≤0.15	ND	70% to 130%
*PFCs	Plasma	ug/L	≤0.12	ND	70% to 130%
*Lower PBDEs: #28 to #100	Plasma	ug/L	≤0.20	ND	70% to 130%
*Higher PBDEs: #153 to #207	Plasma	ug/L	≤0.40	ND	70% to 130%
*PCBs	Plasma	ug/L	≤0.40	ND	70% to 130%

* The MDL for individual congeners or isomers in these groups of compounds will vary. The target MDL should be met for most congeners but may not be met for all of them.

** Chemical abbreviations and full names are consistent with the Chemical Abstracts Service (CAS) naming convention:

Lead = Refers to elemental lead (Pb), also known as alkyl-lead, a heavy metal that is highly toxic.

Mercury = Refers to total mercury (Hg; methyl and elemental), a highly toxic heavy metal.

DDT = Dichlorodiphenyltrichloroethane, used as an insecticide after World War II; banned in North America by 1972.

DDD = Dichlorodiphenyldichloroethane, a metabolite of DDT and used as an insecticide; also banned by 1972.

DDE = Dichlorodiphenyldichloroethylene, a highly persistent metabolite of DDT that has been shown to cause thinning of egg shells of many fish-eating birds; banned by 1972.

PFC = Perfluorinated compounds, including perfluorooctane sulfonate (PFOS), which was developed by 3M near Minneapolis/St. Paul. GLKN has monitored up to 16 PFC isomers, many of which are metabolites of PFOS.

PBDE = Polybrominated diphenyl ethers, a large group of industrial chemicals often used as flame retardants. These are similar to PCBs and there are over 200 possible congeners, of which GLKN has routinely monitored nine. PBDEs can be classified as lower-brominated or higher-brominated PBDEs referring to the number of attached bromines.

PCBs = Polychlorinated biphenyls, an industrial pollutant banned in the US by 1976. There are 209 possible PCB "congeners," which differ slightly from each other in their chemical and physical properties. GLKN has measured up to 75 congeners.

The method detection limits (MDL) shown in Table 5 are the desired maximum values that GLKN needs met by the analytical laboratory. Similarly, the percent recovery is the maximum range within which GLKN requires the lab's quality assurance measures to fall for spiked samples of known quantity. Measurements of lab blanks should always result in non-detections (ND).

Many labs can meet or exceed all of these standards, but others may be unable to meet them all. The NPS investigator may need to weigh the cost, logistics of sample delivery, past history of a laboratory's involvement, and the importance of the various chemicals. The limits in Table 5 should be viewed as target values for high quality data, but they may not be obtained in all cases. For example, within the PCB group there are 209 congeners and some are exceedingly difficult to differentiate from other similar congeners. As a consequence the lab's MDL will often reflect these difficulties and the NPS may settle for higher MDLs for some of the congeners. Moreover, in some cases the laboratory may choose to group colluding congeners and provide one result for pairs or groups of three or more congeners.

Laboratories may report detection limits in different ways, such as the Method Detection Limit shown in Table 5, or Limits of Detection (LOD), Limits of Quantification (LOQ), and/or Report Limits (RL). To make things more complicated, recent more advanced QA procedures will provide detection limits for each batch of samples rather than a static number that the lab uses for all batches. These varying limits can account for dilution factors, lab standards used in spike samples, tissue matrices, and the quantity of the original matrix.

These reporting limits also change over time. Laboratories get better at measuring certain chemicals and/or they adopt more rigorous QA/QC standards (e.g., move from using static LODs to variable MDLs over time). Limits can become lower as they become more proficient at measuring the chemical, or they can become larger (more conservative) if more rigorous quality assurance standards are set.

Each of these measures have specific definitions and meaning (see List of Terms), but they all lead to the same problem for statistical analysis. Essentially, anything below the lab's defined limit will be reported by the lab as a non-detection (ND) and the analyst must determine whether, and if so, how, to best replace this ND with a number for calculations.

The method for assigning a replacement value has changed over time as biometricians learn and adopt more rigorous procedures. Early investigators used static replacements such as half the LOD. More recent investigators use nonparametric Kaplan-Meier methods to model the results and calculate means, medians, and standard deviations. Which method is most appropriate should be determined in close consultation with a biometrician who understands left-censored data. GLKN's quality standard is to use the state-of-the-science and select the best method for the data at hand.

Taxonomic Standards

Consistency in naming species is essential for data sharing so that all parties agree on the species in question. It is especially important for comparability over time. This protocol will be limited to the identification of bald eagles, bald eagle eggs, bald eagle nest trees, and bald eagle prey categorized as simply bird, mammal, amphibian, or reptile.

Bald eagles in North America are taxonomically distinct and we will rely on the expertise of the individuals doing the sampling. Bald eagle eggs could be confused with osprey or geese, both which have been known rarely to use eagle nests. On the rare occasion there is a question, we will consult

The Bald Eagle (Stalmaster 1987) and/or *Nests, Eggs, and Nestlings of North American Birds: Second Edition* (Baicich and Harris 2005).

Bald eagles nest in super-canopy trees in the upper Midwest and use three species of tree almost exclusively: white pine (*Pinus strobus*), cottonwood (*Populus deltoides*) and silver maple (*Acer saccharinum*). Occasionally we have found nests in other tree species such as red pine (*Pinus resinosa*), quaking aspen (*Populus tremuloides*), and once in an oak (*Quercus* spp). We will depend on the knowledge of biologists doing the sampling, but when needed we will consult *Manual of Vascular Plants of Northeastern United States and Adjacent Canada: Second Edition* (Gleason and Conquest 1991). Prey remains are often limited to a few bones, scales, or feathers. It is not the intent of this protocol to determine the identity or monitor consumption of prey species. We will depend on the biologists doing the sampling to classify prey remains by taxonomic order only. When necessary we will consult *Peterson Field Guide to Freshwater Fishes, Second Edition* (Page and Burr 2011; *Mammals of the Great Lakes Region* (Kurta 2001); *Amphibians and Reptiles of the Great Lakes Region* (Harding 2000); and any of several bird guide books, e.g. *Field Guide to the Birds of North America* (Dunn and Alderfer 2006).

Accreditation Standards

The Great Lakes Network requires that employees, contractors, and analytical laboratories are permitted, certified, and/or accredited to ensure safety and quality of results. Table 6 lists the activities and requirements.

Table 6. Certification, accreditation, and permitting requirements for employees, contractors, and laboratories.

Type	Activity	Parameter	Requirement	Location of Documentation
Professional Permits and Certifications	Bald eagle research	Conducting research and collecting biological specimens	The NPS principal must have all of the following: US Fish and Wildlife Service Scientific Collecting Permit; State of Minnesota Special Permit; Minnesota State Parks and Scientific and Natural Areas Permits; and permits for each City and County Park where nests are located (if required).	Copies of all permits must be with each field team and the originals are kept on file in the network office. Note: the State of Wisconsin does not require a permit as long as they are considered collaborators on the project.

Table 6 (continued). Certification, accreditation, and permitting requirements for employees, contractors, and laboratories.

Type	Activity	Parameter	Requirement	Location of Documentation
Professional Permits and Certifications (continued)	Bald eagle research	Handling and sampling	Institutional Animal Care and Use Committee (IACUC) review and compliance.	Copies on file with the NPS IACUC and in the network office
	Bald eagle banding	Band acquisition and placement	The NPS principal must be a sub-permittee under a US Fish and Wildlife Service Master Bander.	Copy of permit must be with each field team and the original is kept on file in network office.
	Nest tree climbing	Safe, professional climbing	Documentation of climbing and handling experience, a climber safety and emergency rescue plan, and \$1M of liability insurance.	Copies on file in network office; this is required under contract.
	Boat operations	Traveling to and from nest sites	Boat operators must be MOCC certified. See GLKN Boat Safety Plan.	Web based certification records are maintained by DOI-NPS.
Lab Accreditations	Chemical analysis	All organic and inorganic chemicals	Accreditation by the National Environmental Laboratory Accreditation Program under the NELAC institute.	Copy of certification on file in network office.
	Avian genetics	Sex determination	Documentation of experience and >98% agreement in a double blind lab test of two laboratories.	Copy of lab results on file in network office.

Protected Data Standards

All relevant data are screened and flagged to ensure proper handling of protected data (Table 7).

Table 7. Data protection standards. All data collected under this protocol will be made publicly available in a timely fashion except as listed below.

Type	Data	Parameter	Requirement
Resource Data and Information	Location of bald eagle nests	Operationally Protected¹: Bald eagles are protected under the American Bald and Golden Eagle Protection Act (U.S.C. 668-668c), the Migratory Bird Treaty Act, and listed as sensitive in some states. Nest locations are not legally protected, but we avoid broadly disseminating accurate mapped locations to minimize disturbance.	Unless necessary for park management, education, or specific research purposes the locations are reported at the eagle territory level, i.e., the centroid of multiple nests. The Superintendent of each park has final say in how these locations are released.
	Bald eagle feathers, talons, and other body parts.	Legally Protected¹: Bald eagles are protected under the American Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. These laws prohibit the possession, use, and sale of bald eagle feathers and other body parts.	Bald eagle feathers and body parts that are not necessary for research and monitoring must be provided to Native Americans for traditional use through the National Eagle Repository. All feathers and body parts not needed are sent to the Repository in Denver, CO.
Personally Identifiable Information	Contact information for private property owners where bald eagle nests are located	Legally Protected²: PII is protected under the Privacy Act of 1974 (5 U.S.C. 552a) and guiding policy can be found under OMB Circular No. A-130, Appendix I, Federal Agency Responsibilities for Maintaining Records About Individuals.	All information on private individuals, including private land owners where nests are located, is omitted from electronic databases and redacted from original and scanned hard copy forms. No public release unless agreed to by the individual.

1 = Operationally Protected. Data withheld from release to protect resources or site fidelity but may be subject to release upon request.

2 = Legally Protected. Existing statute exempts this information for public from dissemination.

Quality Assurance Procedures

The following Quality Assurance procedures are designed to ensure that data meet specified requirements (Table 8).

Table 8. Quality assurance procedures to be conducted in the implementation of the Great Lakes Network bald eagle monitoring protocol. See individual SOPs for details.

Type	Activity	QA Procedure	Citation
Nest Locations	Aerial locations	Aerial observers read and adhere to methods outlined in SOP #4 to the extent possible. Locations of nests determined from the air are considered estimates and are corrected after being visited on the ground.	SOP # 4: Occupancy and Productivity Surveys.
	Nest tree ground location	The best available coordinates are pre-loaded in to a hand-held GPS. During ground visits the location accuracy is verified. Inaccurate locations are mapped using the averaging feature on hand-held GPS units and immediately hand entered in to the field data form.	SOP # 1: Eaglet Handling and Sampling.
	Territory occupancy	Territory occupancy determinations are obtained from partners (e.g. WIDNR flight data) or done by GLKN. Flight data are entered in the Master Bald Eagle database as provided by the pilot/observer team and then GLKN staff follow-up with observers on any questions. Occupied territories are queried in the Database to verify that only one nest is occupied each year in each territory.	SOP # 4: Occupancy and Productivity Surveys.
Field Observations	Nestling weight	Measured with a professional quality Pesola 10 kg spring scale. Two identical scales are used for field teams and the scales are tested and calibrated each year. Weight is recorded to the nearest 0.1 kg.	SOP # 1: Eaglet Handling and Sampling.
	Nestling physical measurements	Physical measurements of primary feathers, foot pad, and bill are done with rulers and calipers. Rulers have the English scale taped over so only the metric is used. Calipers are checked for accuracy against the ruler. Observers are experienced or are trained by experienced observers. During Day 1 of field work all personnel work together to ensure consistent application of techniques.	SOP # 1: Eaglet Handling and Sampling.
	Sex and age assessments	Observers rely on experience to estimate nestling sex and age. Nestlings with more robust bills and larger foot pads relative to body size are female. Age is estimated in weeks by feather development patterns. Both are highly subjective. These estimates are used as a last resort in case measurements or lab data are not obtained or lost (see below).	SOP # 1: Eaglet Handling and Sampling.
Derived Estimates	Sex	Foot pad length ≥ 135 mm is considered female and < 135 mm male. After data are entered in to the database and validated, the sex based on foot pad is automatically assigned. However, this estimate is only used if genetic verification is not obtained (see DNA below).	SOP # 1: Eaglet Handling and Sampling.

Table 8 (continued). Quality assurance procedures to be conducted in the implementation of the Great Lakes Network bald eagle monitoring protocol. See individual SOPs for details.

Type	Activity	QA Procedure	Citation
Derived Estimates (continued)	Age	The age of each nestling in days is calculated from the sex (best method available) and the length of the 8th primary. These calculations are done automatically in the database. Calculations are based on published equations (Bortolotti 1984) and comparable to other eagle researchers in the upper Midwest.	SOP # 1 and Bortolotti 1984
Specimen Collection and Processing	Added eggs and shells	Whole egg length and width are measured once with a caliper to the nearest 1 mm and egg shell thickness is measured in 5-10 different locations around the equator of the egg with a caliper to the nearest 0.001 mm. The average of the thickness measurements is used for analysis.	SOP #5: Egg Measurements.
Laboratory Data	Organic and inorganic chemicals	Only NELAP certified laboratories are used. Lab methods are EPA standard methods or are developed and tested by the lab under standard procedures for method development. Data from analytical laboratories are electronically imported to the GLKN Master database. The resulting data are checked against original electronic files.	Quality Assurance Plan and SOP #8: QA/QC and Data Certification.
	DNA	A blot of blood is obtained from each nestling and sent to a genetics laboratory for sex verification. We use only genetics laboratories with experience at sexing birds. Lab results are examined against the expected 50:50 sex ratio. Our two primary laboratories have been compared in a blind test with 100% agreement.	Quality Assurance Plan and SOP #8: QA/QC and Data Certification.

General or Shared QA Procedures

The following QA procedures are shared among activities or are consistently required as data migrate through the workflow.

Data Entry and Verification (All Activities)

To the greatest extent possible, data entry errors are minimized through automated methods within the computer entry forms, including pre-programmed calculations to fill in age from DNA and feather length, range limits for measurements, pick lists, and calendars.

Lab Processing Requirements

Labs must follow chain of custody requirements, including reporting of sample arrival data and time, condition of samples, and personnel handling the samples. Laboratory limits of detection and QA/QC data that include laboratory blanks, spiked samples, and duplicate samples, must be provided to GLKN with sample results for each batch. Laboratory notes and flagged data must also be made available to GLKN on a per sample basis. Other QA/QC information, including documentation of instrument calibration slopes, statement of instrument comparability, and standard reference material must be available upon request.

Agency Science Training Requirements

Although protocol-specific quality assurance procedures are documented above, Table 9 summarizes Division- or NPS-wide training requirements.

Table 9. Training and professional certification requirements for IMD scientific staff to achieve Division-wide data quality goals.

Training	Personnel	Purpose	Provider	Recurrence	Location of Records ¹
DOI Scientific Integrity Training	All IMD science employees	Ensure understanding of roles and responsibilities	DOI / DOI Learn	Once per year	DOI Learn
Masters of Science degree or higher	All IMD scientists	Ensure understanding of underlying biological and ecological processes	Accredited University or College	One time	Personnel files

¹ If training records and/or certificates are on file elsewhere, document their location in this column. If training records and/or certificates do not exist or are not available then this should be noted.

Quality Control Procedures

The following Quality Control procedures are designed to ensure that data collected or generated meet specified requirements and/or are appropriately annotated or corrected (Table 10).

Table 10. Quality control procedures to be conducted in the implementation of the Great Lakes Network bald eagle monitoring protocol.

Type	Activity	QA Procedure	Citation
Nest Locations	Aerial locations	The NPS data specialist reviews data and flight notes to assess correctness and gets clarification from observers when necessary. These locations are considered estimates and are superseded by ground visit data when/if it exists.	SOP # 4: Occupancy and Productivity Surveys.
	Nest tree ground location	Field staff verify accuracy of previously visited nests and get accurate locations for new nests by using the averaging feature on hand-held GPS units. Locations are mapped in GIS at the office and displayed to assess the validity of the location.	SOP # 1: Eaglet Handling and Sampling.
	Territory occupancy	A territory-level determination of occupancy is made at the office by the data specialist and project leader to ensure occupied territories contain no more than one active nest. If two nests, then a determination needs to be made to split the territory and name a newly formed territory. WIDNR biologists or other collaborators are consulted before territory splitting is done as this new territory must be adopted by all agencies concerned.	SOP # 4: Occupancy and Productivity Surveys.
Field Observations	Nestling weight	Nestlings are weighed in a sample bag and sometimes bags will get wet. Bags are of known weight and are numbered. Bag number and whether it is wet is entered on the capture form. Nestling weight is adjusted in the database by an automatic subtraction for the numbered bag, minus an additional amount if wet (also automated and estimated from weighing dry and wet bags).	SOP # 1: Eaglet Handling and Sampling.
	Nestling physical measurements	We have compared observer techniques in the field and have done blind tests on foot pad measurements, which are the most difficult. Resulting measurements are examined at the office for outliers and then scrutinized to ensure they are reasonable.	SOP # 8: QA/QC and Data Certification. QA Report (GLKN 2016a).
	Sex and age assessments	Field determinations are never changed. We intend that they stand as the observer's best estimate at the time of handling. However, these estimates are used as a last resort in the event measurements or lab data are lost (see below). The best possible estimate of sex and age is used as the final determination.	SOP # 1: Eaglet Handling and Sampling. QA Report (GLKN 2016a).
Derived Estimates	Sex	Foot pad length can be used to estimate sex with ≥ 135 mm being female and < 135 mm male. We evaluate the accuracy of this method by comparing against DNA. Preliminary data suggests these measurements are accurate about 80% of the time.	Bill Bowerman, unpublished data. QA Report (GLKN 2016a).

Table 10 (continued). Quality control procedures to be conducted in the implementation of the Great Lakes Network bald eagle monitoring protocol.

Type	Activity	QA Procedure	Citation
Derived Estimates (continued)	Age	The accuracy of age estimates for the Great Lakes eagle population is unknown and untested. It would require measuring nestlings of known age on a daily basis for 10 weeks. We assume this age estimate is a relative index of age based on research done on another northern eagle population (Bortolotte 1984).	Bortolotti 1984
Specimen Collection and Processing	Added eggs and shells	Egg shell thickness measurements are compared within the study and with other studies to assess if they are reasonable. Outliers are re-measured. Egg shells are numbered and kept as a working archive for comparisons and re-measuring if needed. Observer measurements have been blind tested and found not to differ significantly. Shell internal membranes have been measured for thickness so when shells with membrane attached are found and cannot be removed it can be subtracted.	SOP #5. QA Report (GLKN 2017b).
Laboratory Data	Organic and inorganic chemicals	Data validation is followed by a GLKN Internal Quality Assurance Review and Report. Stepwise procedures are used to look for systematic problems that may have arisen from changes in lab procedures or between years and batches. Limits of detection are checked and data are graphed to look for outliers. The labs QA/QC data are checked for exceedances and lab codes and flags are examined. Any questionable data are further noted and a determination is made whether they should be marked "Do Not Use".	SOP #8. QA Reports (GLKN 2016b, 2016c, 2017a, 2017c, 2017d).
	DNA	We use genetics laboratories with experience at sexing birds. We conducted a blind comparison of two laboratories and found a 100% match. We also calculate the sex ratio after receiving the lab results to ensure the results are reasonable (near 50:50).	SOP #8.

General or Shared QC Procedures

The following QC procedures are shared among activities or are consistently required as data migrate through the workflow.

Data are verified during data entry in a process which involves checking the accuracy of computerized records against the original source, mainly paper field records. Data entry personnel check 100% of the records to the original field forms. The primary goal of data entry verification is to correct errors and assess where errors are being introduced into the data entry forms. After the computerized data are verified to accurately reflect the original field data, the paper forms are scanned and archived.

Identification of Protected Data

Bald eagles are protected under the Bald and Golden Eagle Protection Act and are considered a protected species by all states. Moreover, some nests are on private property. Individual nest coordinates are provided to federal and state managers on an as needed basis; otherwise, the territory centroid is used as a means of mapping and displaying location data. Specimens of bald eagles, e.g. feathers and talons, must be provided to the National Eagle Repository managed by the U.S. Fish and Wildlife Service (www.fws.gov/eaglerepository/).

Geospatial Data Verification

All geospatial data (nest locations) are evaluated using ArcGIS to overlay locations with mapped features (boundaries, hydrology, roads, etc.) to ensure there were no errors in coordinates.

Data Set Certification

All data in the Master Bald Eagle Database, as with all data collected by the NPS Inventory and Monitoring Networks, go through a series of steps to verify, validate, and certify that the data are of sufficient quality for release. These steps are outlined in SOP# 8, QA/QC and Data Certification.

Data Annotations and Qualifications

Data that do not meet quality standards as described above are annotated as described in Table 11.

Table 11. Quality control (QC) codes, result types, and flags for data records. These codes are used for data that meet QC standards and for data that do not meet QC standards for the Great Lakes Network bald eagle monitoring protocol.

Category	Annotation Codes and Flags	Description
Great Lakes Network specific codes	Use	Data can be used, but may have flags that need to be considered
	Do Not Use	Records that have been reviewed and determined to be inaccurate or otherwise invalid
	Suspect	Records that have been reviewed and there are suspected, but unverifiable concerns for accuracy. These data are flagged as such so that analysts omit them or use with caution.
Wisconsin State Laboratory of Hygiene result types	0	Do not use, no data, lab error.
	1	Good results with concentrations above the established LOD or Report Limit as appropriate for the target chemical.
	2	The target chemical was not measurable, these are non-detections (ND).
	3	Good results with measured values between the LOD and LOQ.
	4	Results are above the lab's limits of quantification (LOQ). These results are considered good and used as the best estimate of high concentrations.

Table 11 (continued). Quality control (QC) codes, result types, and flags for data records. These codes are used for data that meet QC standards and for data that do not meet QC standards for the Great Lakes Network bald eagle monitoring protocol.

Category	Annotation Codes and Flags	Description
Wisconsin State Laboratory of Hygiene flags	B	Compound found in blank
	B_QL	Compound found in blank; lower calibration check exceeded
	B_QU or B_U	Compound found in blank; upper calibration check exceeded
	CCB	Continuing calibration blank exceeded
	D, DE, RPD	Duplicate did not pass QA limit; relative percent difference exceeded
	E or U	Estimation; result above calibration curve
	HT	Holding time exceeded
	I	Interference with another chemical; estimate is ND or an estimate
	IND	Internal standard not detected due to interference; no estimate
	LML	Lab matrix spike exceeds lower QC limit
	LRB	Lab reagent blank exceeds criteria
	MDE	Matrix duplicate exceeds limit
	MSL with _QL or _RPD	Matrix spike lower QC limit exceeded; may lead to exceedance of relative percent difference
	MSU, MSU_QU	Matrix spike upper QC limit exceeded
	NA, NM, SA	Not applicable, not measured, sample insufficient
	QL	Lower calibration check exceeded
	QP or QP_I	QC limit for precision exceeded may have Interference
	QU	Upper calibration check exceeded
	RL / RL_QL / RL_QU	Report limit adjusted due to dilution or chromatographic response / lower limit exceeded / upper limit exceeded
	RPD	Relative percent difference exceeded either matrix spike or matrix duplicate

Roles and Responsibilities

Organizations and individuals involved in the implementation of the bald eagle contaminants protocol include several federal and state agencies, non-profit organizations, and private contractors and are listed in Table 12.

Table 12. Roles, responsibilities, and contact information for organizations affiliated with implementation of the Great Lakes Network bald eagle contaminants program.

Position	Affiliation	Role	Contact Info
Regional Program Manager	National Park Service, Midwest Region	Approval of protocol and Quality Assurance Plan.	402-661-1876
Network Program Manager	National Park Service, Great Lakes I&M Network	Program coordination; ensuring that data meet quality objectives.	715-682-0631
Protocol Lead	National Park Service, Great Lakes I&M Network	Protocol implementation, data QA/QC and certification, data analysis, and reporting.	715-682-0631
Network Data Manager	National Park Service, Great Lakes I&M Network	Oversees the data management architecture.	715-682-0631
Network Data Specialist	National Park Service, Great Lakes I&M Network	Primary data steward, including database development, data entry, QA/QC, GIS mapping, and data extraction for use by the protocol lead and partners.	715-682-0631
Network Science-writer/Biologist	National Park Service, Great Lakes I&M Network	Public relations and outreach; oversight for safety and boat operations.	715-682-0631
Supervisor, Organic Chemistry	Wisconsin State Laboratory of Hygiene	Supervises analyses on all chemicals, including crossover with the inorganics section of the lab.	608-224-6269
Assistant Scientist, Trace Elements Clean Lab	Wisconsin State Laboratory of Hygiene	Consultation on laboratory quality control and interpretation of results.	608-224-6226
Climber/Research Scientist	Eco-Ascension Research and Consulting	Provides expert nest tree climbing and bald eagle handling services.	P.O. Box 202, Arcata, CA 95518; 707-498-9704
Senior Ecologist	Tetra Tech, Inc.	Master Bird Bander and nestling handler; banding is under his USFWS permit.	612-643-2245

Project Quality Assessment

Routine Data Quality Evaluations

Periodic data audits and quality control inspections will be conducted to maintain and improve data quality. Audits and checklists (Table 13) will verify conformance with data quality procedures and requirements as specified in this plan and by permitting agencies. These quality checks are designed to promote feedback and improvement of both the data and the quality planning process. Results will be documented in completed checklists or internal Quality Assessments. The protocol lead is responsible for ensuring that any nonconformities are corrected.

Table 13. Routine data quality evaluation reports and checklists produced as a part of implementing the Great Lakes Network bald eagle monitoring protocol.

Report/Checklist	Purpose & Description	Frequency
Laboratory Checklist; Appendix A.	Checklist of data products, certifications, and quality assurance requirements of the analytical and genetics labs. Ensures all products are received in conformance to the contract before payment.	As data are acquired from the lab. Should be used when the contract lab submits their data to GLKN and as a check that all products are accepted before the invoice is paid.
Permits and Permissions Checklist; Appendix B.	Checklist that ensures agency permits, private property permissions, and permit reporting is completed prior to field work.	Prior to each field season.
Nest and Territory Occupancy Maps	Provides an overview of the number of nests per study area; checks for reasonableness of nest locations within known territories; assists with planning for field sampling.	Immediately following occupancy surveys and prior to each field season when possible.
US Fish and Wildlife Service, Eagle Scientific Collecting Report	Report to permitting agency on numbers handled, sampled, banded, and found dead or alive.	After each sampling year.
Minnesota Department of Natural Resources, Scientific Permit Report	Report to permitting agency on numbers handled, sampled, banded, and found dead or alive.	After each sampling year.
Banding Report	List of bands placed on bald eagle nestlings, provided to the Master Bander who reports to the USGS Banding Lab.	After each sampling year.
Internal Quality Assurance Reports	To assess sample size, missing values, data flags, and quality objectives relative to goals for analysis and reporting	Conducted cumulatively for the period of record for each chemical and eagle morphology when data are certified. These precede all data analyses prior to publication.
Natural Resource and/or Issue Brief	1-2 page summary brief providing significant findings, trends, or status information for park managers and the public. Assists project investigators with periodic data summary for assessing quality.	As needed. Accompany all major reports or publications to summarize findings; may also be done on certified data as needed to provide parks with needed information.
Review of Data Quality Objectives	Ensures that data quality objectives are appropriate to meet stated monitoring objectives	During development of the QAP and at periodic protocol reviews (about every 5 years).

Communicating Data Quality

The protocol lead will reference this QAP and the appropriate Internal Quality Assurance Report when disseminating any data collected under this protocol, in addition to providing all data quality annotations and flags with the data.

Documentation

Records

NPS Director's Order 11D: Records and Electronic Records Management (NPS 2012) and its appendix, *NPS Records Schedule*, describe NPS activities and standards in maintaining and providing access to records at all levels of the Service. DO 11D states that all records of natural and cultural resources and their management are considered necessary for fulfillment of the NPS mission. The NPS Records Schedule provides guidelines on maintaining the results of Inventory and Monitoring programs and indicates that all natural resource records are considered “permanent” and need to be retained either in an appropriate NPS museum facility or at the National Archives.

Records to be maintained under this protocol include data collection forms, permit applications, and photographs (Table 14).

Table 14. Required records to be maintained as a part of implementing the Great Lakes Network bald eagle monitoring protocol. Records in bold are required of all NPS-IMD protocols or projects where field data are collected; others are specific for GLKN.

Sample Collection Documents and Records	On-site Analysis Documents and Records	Off-site Analysis Documents and Records	Data Assessment Documents and Records	Other
Data collection field forms – both original hard copy and scanned electronic versions	Reference files and small data sets used for statistical analyses and QA/QC reporting	Lab certifications and published methods maintained by individual labs	Internal Quality Assessment Reports and statistical output from analyses.	NPS manuscript submittal forms for reports published in the NPS natural resource series
Permit applications and resulting permit or acceptance memos	Personnel training certifications and documentation	Electronic versions of raw data and QA/QC results maintained by individual labs	Memos and emails documenting discussions with statisticians, co-authors or other specialists on data results and interpretations	Peer review memos and author responses for published reports and journal articles
Photographs of nestlings, nest sites, and sampling procedures	Reports to permitting agencies that include annual data collections or banding data done under permit	Analytical procedures and results maintained by statisticians and co-authors of reports, often federal (USGS) agencies with similar records requirements	–	–

Metadata

Metadata for all published data products are FGDC compliant. The metadata record can be found at the following link (<https://irma.nps.gov/DataStore/DownloadFile/541887>) and the protocol narrative

can be found at (<https://irma.nps.gov/DataStore/Reference/Profile/661149>). Data can be traced to methods used for collecting and processing through these links to the latest version of the protocol, this QAP, and all associated standard operating procedures.

Data Certification

Data certification is the process, detailed in SOP # 8, that confirms:

- Data have been through all QA/QC procedures;
- Data either meet specified quality standards and/or are appropriately identified and communicated at the record level;
- Procedures for data collection, processing, and transformation have been documented in appropriate metadata formats;
- Data are suitable for use.

NPS-IMD Data Certification Guidelines require that, in the absence of this QAP being approved, all data that have been through QA/QC as outlined in the approved protocol and SOPs are “acceptable.” After approval of this QAP, data certification will occur within one year of data processing.

Information Dissemination

All reports disseminated for general (public) use will be based on certified data, except as listed under “Use of Provisional Data” below. In general, data will be certified prior to internal use for supporting park-, regional-, or national-level resource management decisions. Users of the data, especially statisticians and partnering scientists, will sometimes find data that need to be excluded from analysis or qualified in some way. Such determinations will be evaluated by the project lead and if found valid then changes or notes will be incorporated in to the Master Bald Eagle Database and in revised or amended internal Quality Assurance Reports.

Use of Provisional Data

In some cases the use of provisional data (data that have not undergone complete QA/QC as defined in this QAP) may be warranted to base decisions on best-available science. For example, annual nest occupancy and productivity survey data are often time-sensitive and cannot be fully assessed for weeks and sometimes years. Within hours or days of completion, park staff and local media request results of surveys. Numbers of occupied nests are provided as provisional data, subject to change. As the field season progresses aerial survey data are sometimes corrected with findings from ground visits to the nests. Moreover, it can take two or more years to determine whether a territory should be split or not. The provisional data may result in erroneous information being provided to park staff and reported to the public by the media. We will provide corrected data as soon as practical. Fortunately the corrections are usually minor and make little difference in assessing the overall health and trends in the eagle population.

Provisional data may also be provided to internal and/or external science partners who are involved in data analysis. Findings from such analyses will be used in the quality assurance process: any errors found will result in changes to the database; any qualifications to data will be flagged; and all findings will be included in the QA Report.

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Appendix A. Checklist for laboratory quality control information and products.

Contract or Collaborating Laboratory Checklist

Laboratory: _____

Primary contact and phone/email:

Analyses to be conducted: _____

_____ The contract or agreement is signed and the budget is acceptable to both parties

_____ Have a copy or a link to the lab's most recent QAPP

_____ Have a copy of the lab's most recent certification(s)

_____ Have a citation and/or the actual publication of analytical methods for each analyte

_____ Calibration curves for each analyte cover the level of analytical interest

_____ Understand and accept the lab's limits of detection, quantitation, and/or reporting limits

_____ The lab's QA procedures and criteria are documented and meet project needs

_____ Methods of submission for raw laboratory results are understood and acceptable (electronic files that can be automatically harvested and incorporated into the Master Database are preferred)

_____ Results of inter-laboratory evaluations (if done) are documented and acceptable

_____ A Chain-of-Custody form is used for all sample handling

_____ The lab's result codes, data flags, and other qualifications to their results are communicated, accepted, and documented in the Master Bald Eagle Database

Reviewed by _____ Date _____

Appendix B. Checklist for ensuring permits, permissions, and reporting compliance are in order before going to the field.)

Year: _____

Permissions or compliance need	Prior season reporting completed?	Expiration date or date permission granted	Notes	Initial if good to go
IACUC review				
FWS scientific collecting permit				
FWS banding permit				
MN state DNR collecting permit				
MN state parks special permit				
MN state natural areas permit				
WDNR coop agreement				
City of St Paul written permission				
Anoka County Parks & Rec				
Ramsey County Parks				
Pig's Eye sanitary district				
Hastings city park				
Flint Hills				
Macalester College				
Bad River Tribe				
Prairie Island Tribe				
Red Cliff Tribe				
Warner Nat Center				
APIS private				
SACN private				
MISS private				

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 920/150076, December 2018

National Park Service
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1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525