



Monitoring Bald Eagles in Southwest Alaska Network Parks

Protocol Narrative

Natural Resource Report NPS/SWAN/NRR—2017/1382



ON THE COVER

An adult bald eagle in Kenai Fjords National Park

Photograph courtesy of the National Park Service, Kay White

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Executive Summary

This protocol outlines the methods for collecting, managing and reporting monitoring data for bald eagles in the Southwest Alaska Network (SWAN), as described in the SWAN Monitoring Plan (Bennet et al. 2006). The study design, data collection methods, and analytical protocols have been previously published in the *Journal of Wildlife Management* (Wilson et al. 2014) and in two National Park Service Natural Resource Technical Report (NRTR) series publications (Thompson et al. 2009, Thompson and Phillips 2011). The methods described here also closely follow those outlined in the United States Fish and Wildlife Service's post-delisting monitoring plan (USFWS 2009).

As apex predators, bald eagles are expected to be sensitive to changes in the food web that can affect population dynamics and productivity. As a result, bald eagle reproductive performance can be an important indicator of current and long-term changes in terrestrial, freshwater and marine systems (Thompson et al. 2009). To measure changes in bald eagle breeding populations, the following objectives will be addressed at sampling locations in the three largest park units in the SWAN: Lake Clark National Park and Preserve (LACL), Katmai National Park and Preserve (KATM), and Kenai Fjords National Park (KEFJ).

- 1) Estimate long-term trends in the abundance of bald eagle nests
- 2) Estimate long-term trends in the annual proportion of nests in which eagles attempt to reproduce (nest initiation)
- 3) Estimate long-term trends in annual nest productivity, defined as the mean number of chicks produced per initiated nest

A dual-frame sampling approach that combines two techniques (list and area frame) will be used to estimate abundance within a defined area of interest in each park (Haines and Pollock 1998; U.S. Fish and Wildlife Service 2009), as well as estimation of the dynamic properties of nest initiation status and productivity (e.g. nest survival, colonization, and extinction). This protocol and the SOPs in the accompanying document outline aerial survey methods used in the SWAN.

List of Terms (Acronyms)

AFF- Automated Flight Following

AICC- Alaska Interagency Coordination Center

AMD- Aviation Management Directorate

AGL- Above Ground Level

BAEA- Bald eagle

DOI- Department of Interior

DSLR- Digital Single Lens Reflex (Camera)

ENIS- Early Nest Initiation Survey

GPS- Global Positioning System

GIS- Geographic Information System

IAT- Interagency Aviation Training Center

KATM- Katmai National Park and Preserve

KEFJ- Kenai Fjords National Park

LACL- Lake Clark National Park and Preserve

LPS- Late Productivity Survey

NPS- National Park Service

OAS- Office of Aviation Safety

PASP- Project Aviation Safety Plan

PPE- Personal Protective Equipment

SOP- Stand Operating Procedure

SWAN- Southwest Alaska Network

VFR- Visual Flight Rules

Introduction / Background

Bald eagles (*Haliaeetus leucocephalus*) play an important ecological role in freshwater and marine coastal systems throughout Alaska. Eagles are sensitive to human disturbance, contaminant exposure, and oil spills, making them useful as a vital sign (Bennet et al. 2006; Thompson et al. 2009). Bald eagle populations in Alaska have been adversely affected in the past by indiscriminant harvest (DeArmond 2008) and the Exxon Valdez Oil Spill (Bowman et al. 1997), but have remained robust enough to avoid a federal listing under the Endangered Species Act. The parks in the Southwest Alaska Network (SWAN), including Lake Clark National Park and Preserve (LACL), Katmai National Park and Preserve (KATM), and Kenai Fjords National Park (KEFJ), contain large breeding populations of bald eagles. Annual surveys are used to monitor the status of, and trends in, bald eagle nest initiation¹ and chick productivity (Stalmaster 1987).

This protocol outlines how monitoring data will be collected, managed and reported for the bald eagle vital sign, as part of the NPS Inventory and Monitoring program, and as described in the SWAN Monitoring Plan (Bennet et al. 2006). The study design, data collection methods, and analytical protocols have been previously published in the *Journal of Wildlife Management* (Wilson et al. 2014) and in two National Park Service Natural Resource Technical Report (NRTR) series publications (Thompson et al. 2009, Thompson and Phillips 2011). The methods described here also closely follow those outlined in the United States Fish and Wildlife Service's post-delisting monitoring plan (USFWS 2009).

Conceptual Framework for Monitoring

As apex predators, bald eagles are expected to be sensitive to changes in the food web that can, in turn, affect population dynamics and productivity. Therefore, bald eagle reproductive performance can be an important indicator of current and long-term changes in terrestrial, freshwater and marine systems (Thompson et al. 2009). We anticipate that the SWAN vital signs: nearshore marine ecosystem, and salmon (*Onocorhynchus* sp.) will be useful for ecological analyses involving the bald eagle vital sign. Further, Bald eagle populations are sensitive to environmental contaminants (Buehler 2000), and monitoring of contaminant levels in resident lake fish could lead to insight if bald eagle population levels fall. Finally, we anticipate that climate vital signs will be critical for understanding how global climate change may affect bald eagle nesting phenology and prey abundance.

In addition to improving our basic understanding of bald eagle ecology, monitoring can also provide practical assistance to the parks. Bald eagle populations are continuing to be impacted by human

¹ Formerly referred to as 'nest occupancy.' We changed this term for the protocol because occupancy is variously described as an analytical method, and a raptor nesting term that we do not adopt exactly. The state variable 'nest initiation' is defined in the measurable objectives, and defined in the state variable descriptions.

disturbance that occurs within or immediately adjacent to the park boundaries. Using adaptive management and structured decision making, bald eagle monitoring can assist parks with making management decisions about season and duration of disturbances, such as those from recreational activities permitted within park boundaries. This process has been useful for managing human disturbance of golden eagle (*Aquila chrysaetos*) nests in Denali National Park (Fackler et al. 2014). Monitoring also plays a very important role in managing the response to catastrophic events such as the Exxon Valdez oil spill (EVOS). Data collected before, during, and after the event (so-called 'before-after-control-impact' [BACI] designs) are necessary for determining the overall impact and subsequent recovery from a large event (Parker and Wiens 2005). Well executed monitoring plans are a crucial step to making sure that BACI designs can be easily applied to assess recovery after a large, catastrophic disturbance.

Measurable Objectives

To measure changes in bald eagle breeding populations, the following three objectives will be addressed at sampling locations in the three largest park units in the SWAN: Lake Clark National Park and Preserve (LACL), Katmai National Park and Preserve (KATM), and Kenai Fjords National Park (KEFJ).

- 1) Estimate long-term trends in the abundance of bald eagle nests located within the sampled areas. Abundance is not directly observable, and will be modeled using data obtained using an estimator that uses observations from two observers.
- 2) Estimate long-term trends in the annual proportion of nests in which eagles attempt to reproduce (nest initiation). Nest initiation is not directly observable and will be modeled using data obtained during two nest initiation surveys conducted in May (See state variable descriptions below for a detailed definition).
- 3) Estimate long-term trends in annual nest productivity. Productivity is defined as the mean number of chicks produced per initiated nest, and is conditional on nest occupancy.

Methods

Sampling Design

In general, nest features can be sampled within a region of interest (ROI) by visiting all known nests (list frame), or by counting all nests within randomly selected areas (area frame; Bennett et al. 2006). Because the ROI can be the same for the list and area frame, the two sampling frames can represent different approaches to sampling the same ROI. List frame sampling yields valuable information about the sampled nests through time, such as nest initiation status, mean chick production, and the probability that nests will transition between initiation states (e.g., empty and initiated) between years. Without additional random sampling, the list frame does not provide inference to a wider population, or give information on population abundance. Area frame samples confer wider inference and give unbiased information about abundance, but do not track individual nests through time. Therefore, area frame surveys give no information about dynamic properties, such as the probability that nests transition between initiation states from one year to the next. Dual-frame sampling combines the two techniques (list and area frame) to estimate abundance within an area of interest (AOI; Haines and Pollock 1998; U.S. Fish and Wildlife Service 2009), while still allowing estimation of the temporal dynamic properties of nest initiation status and productivity (e.g. nest survival, colonization, and extinction). In the SWAN, all parks conduct list frame sampling, and two of the three parks (KEFJ, KATM) also sample an area frame (Table 1).

Surveys of wildlife are often prone to imperfect detection of the object or state of interest (Nichols et al. 2009). Counts of nest structures (U.S. Fish and Wildlife Service 2009), and determinations as to whether or not eagles have attempted to reproduce at observed nests (Booms et al. 2010) are both affected. In both cases, estimators that do not correct for imperfect detection will be biased, and inference about status and trends will be incorrect. Replicate sampling can be used to formally

account for imperfect detection, thereby controlling for observation bias in estimators (Nichols et al. 2009).

Table 1. Summary of sampling methods used in bald eagle surveys in SWAN parks.

Park	Sample frame		Double observer	Survey period
	List frame	Area frame		
KEFJ	x	x	x	2009-present
KATM	x	x	x	2010-present
LACL	x			1992-present

The U.S. Fish and Wildlife Service (USFWS) proposed a dual-frame sampling design (Haines and Pollock 1998) for monitoring bald eagle populations in the contiguous 48 United States after bald eagles were delisted in 2008 (USFWS 2009). Their proposed method incorporates a double-observer component (Nichols et al. 2000) meant to adjust estimates to account for nests that are missed during surveys (U.S. Fish and Wildlife Service 2009). The dual-frame aspect of this design requires an up-to-date list frame within the ROI (i.e., list frame), and data from new nests detected from a random sample within ROI (i.e., area frame). In SWAN we adopted this method in KEFJ and KATM with minor modifications to account for the uncertainty associated with observing eagle activity during survey flights. Our protocol uses two types of replicate sampling: 1- double observer (Nichols et al. 2000) to correct counts (objective 1) from nests that are missed during the surveys; and 2- modified occupancy sampling (Wilson et al. in press) to correct the proportion of nests occupied (objective 2) by missing the peak nesting period. We then construct Bayesian hierarchical models to produce robust estimates of the monitoring metrics listed in the objectives. With observation uncertainty accounted for, we combine data from list- and area- frame sampling as described by USFWS (2009) to obtain abundance of nests and initiated nests for objective 1.

Trend detection is an important part of a monitoring program. When the entire area of interest cannot be sampled, it is important to ensure that the area is sampled with enough replication to ensure that biologically relevant changes in system processes are measurable. The ability to detect trends in monitored state variables from sampled populations is directly related to sample size and the amount of random variation encountered in the study system. In the Frequentist statistical framework, power analyses are used to evaluate whether or not the number of sample units is adequate to reject the null hypothesis (no change), when there is a true change in system state; e.g. an increase or decline in species abundance. In addition to their basis in Frequentist inference, these types of analyses usually assume that the state variable of interest is measured directly by the survey. By contrast, we do not assume that our observations (i.e., counts) are unbiased estimators of the population parameters of interest (i.e., abundance). We therefore construct Bayesian estimators of population parameters that correct or account for known biases associated with our observed data. The difference between Bayesian and Frequentist methods of statistical inference make it so that estimators used in the bald eagle monitoring protocol do not lend themselves to traditional power analysis.

When using Bayesian hierarchical estimators, sample size is best optimized using simulations that address the probability that a given amount of change can be detected with the sampling design. Therefore, we used simulations to estimate the optimal number and size of area-frame transects needed to estimate the number of bald eagle nests (objective 1) in KEFJ (Thompson and Phillips 2011). The simulations used data obtained from a pilot survey in 2009 to estimate the optimum length (12.5 km) and number of transects (26) required to comprise an area frame sample in KEFJ that would be adequate for detecting biologically-relevant trends (12% coefficient of variation (CV); Thompson and Phillips 2011). Similar exercises to estimate the proportion of the area frame that should be sampled are not relevant for KATM, where the entire area frame is sampled, or for LACL, where area frame sampling is not currently conducted. Because we're sampling the entire population of interest in KATM, we expect that any measurable changes in the population will be detected using our methods. In LACL, we are not currently monitoring abundance.

Using three years of monitoring data from KEFJ, we reviewed bald eagle nest abundance data obtained from the dual frame estimator and found estimator precision to be sufficiently close to, or markedly less than, our modeled CV of 12% to detect a trend ($CV \leq 13\%$; Wilson et al. 2014). We also discovered that the double-observer method overestimated detection because annual counts of new nests were sensitive to aircraft position during the spring survey. This problem with the double-observer method led to erroneous inference regarding short-term trends, and to greater than expected interannual variation (Wilson et al. 2014). As mentioned above, the modified dual-frame estimator accounts for imperfect detection of nests by using data from two observers. This double observer correction assumes that observers are independent of one another, and that all nests are available for detections. Our analysis shows that all nests are not available for detection on any one survey flight, and that this may be an important source of error for annual bald eagle nest surveys. In this protocol, we address this source of error (availability) by repeating the survey in the spring, and by using a double-observer counting protocol in models that estimate abundance, i.e., using modified dual-frame sampling.

Obtaining the proportion of initiated nests (objective 2) directly from raw list frame observations assumes that all initiated nests will have an adult eagle incubating eggs on the nest, or that if eagles are absent, eggs will be visible during the survey flight. The surveys are timed carefully to ensure that eagles or eggs will be visible at a majority of the initiated nests. However, because nests are initiated over several weeks, it is unlikely that all initiated nests will be displaying one of the above cues (eagles or eggs) during any survey flight, no matter how well timed. We paired data from replicate surveys in KATM, KEFJ, and LACL with simulations to evaluate our ability to estimate the proportion of nests initiated using field observations. We demonstrated that sampling 100 nests resulted in CVs that were $\leq 11\%$ under conditions similar to those currently observed in all parks.

We also evaluated how use of field observations would affect inference about the proportion of initiated nests under different scenarios that mimic how climate change could affect eagle behavior during our survey window (objective 2). We demonstrated that nests could not be correctly classified as initiated or empty using a single spring survey, and that early or unpredictable arrival of the eagles to nests could lead to erroneous conclusions about a population decline (Wilson et al. in press). As a

result, we have begun conducting two spring surveys as part of this protocol so that the proportion of initiated nests is not biased by discrepancies in the timing of eagle nest initiation. Ability to detect trends in nest productivity (objective 3) has not been formally assessed. However, this metric was shown to be robust to sampling error associated with missing peak nesting, and has been shown to be adequately sampled (i.e. not overdispersed) at all SWAN parks using methods presented here (Wilson et al. in press).

The protocol outlined here includes methods to conduct a second spring survey that will provide the data necessary to solve both area- and list- frame deficiencies identified by our simulation work described above (Wilson et al. 2014; Wilson et al. in press). As such, this protocol describes the most recent and best sampling methods that will produce a minimum amount of sampling and observation variation, given the stated objectives within each park. We will periodically update simulations, and objectives (if warranted by management concerns), to evaluate the adequacy of sample sizes, determine sources of excess variance, and to refine methods as necessary (e.g. Thompson and Phillips 2011, Wilson et al. in press).

Region of Interest

The SWAN consists of five National Park Service (NPS) park units (Figure 1): Alagnak Wild River (ALAG), Aniakchak National Monument and Preserve (ANIA), Katmai National Park and Preserve (KATM), Kenai Fjords National Park (KEFJ), and Lake Clark National Park and Preserve (LACL). Collectively, these units comprise 3.9 million hectares (9.4 million acres) on the Alaska and Kenai Peninsulas. Bald eagle monitoring occurs in regions of interest within KATM, KEFJ, and LACL, described below.

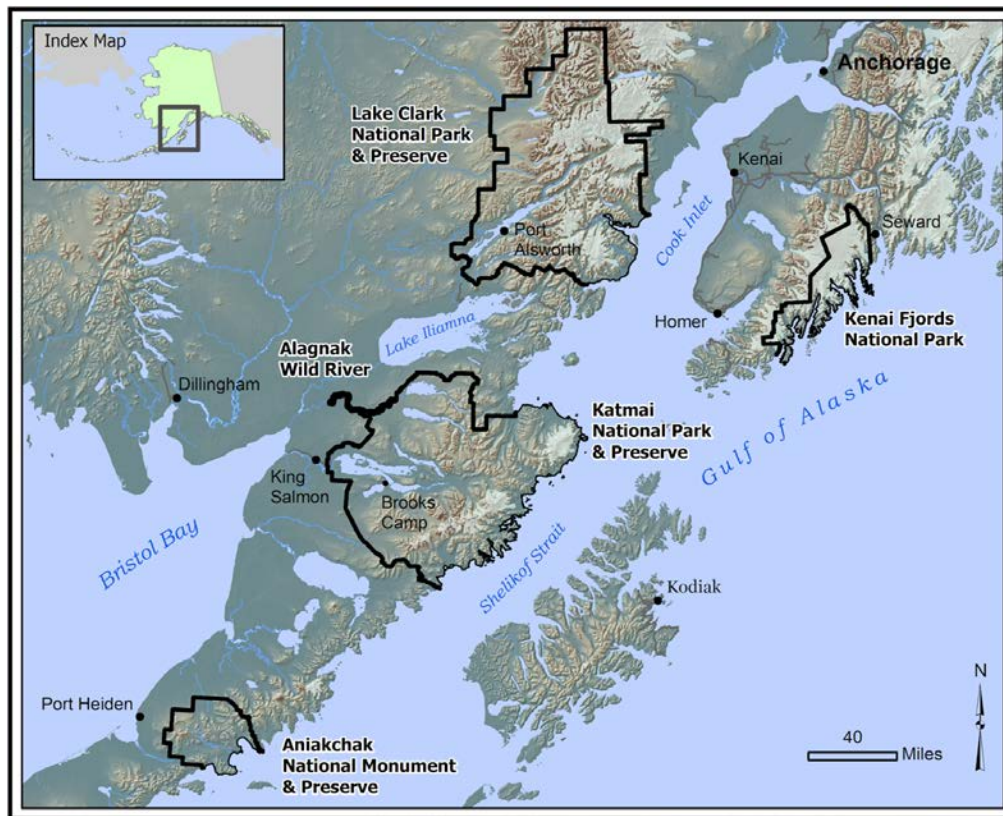


Figure 1. Map of the parks within the Southwest Alaska Network. Bald eagle surveys take place on the shoreline of Naknek Lake basin in KATM, along all forested rivers and coastlines in LACL, and on random transects on the KEFJ coastline.

Katmai National Park (KATM)

KATM is a 1,656,409 hectares (4,093,077 acres) park located on the Alaska Peninsula, north of Kodiak Island (Figure 2). The habitat in the park which bald eagles nest in consists of lakeshores, islands and streams. Eagles nest in white spruce (*Picea glauca*), and cottonwood (*Populus balsamifera*).

The region of interest in KATM includes most of the Naknek drainage. Specifically, surveys are flown along the entire shoreline of Naknek Lake, Brooks Lake, Coleville Lake, and Lake Grosvenor. Surveys are flown along both sides of the Savonoski River to the confluence of the American River, and the American River to the outlet of Lake Grosvenor. The whole sampling domain is surveyed by observers annually. Therefore the area frame comprises the entire region of interest. The list frame consists of nests previously found during surveys of nesting eagles (Table 1).

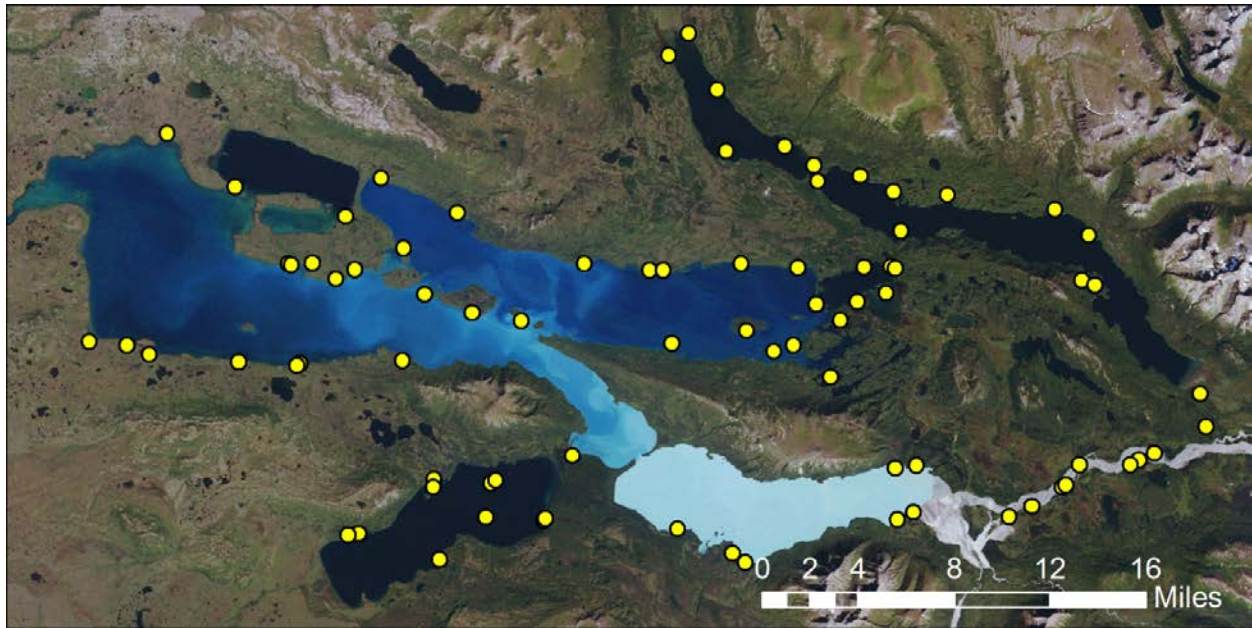


Figure 2. Sampling domain in KATM includes the shorelines and rivers connected to Naknek Lake within the boundaries of the map extent. Known bald eagle nests are shown with yellow points.

Kenai Fjords National Park (KEFJ)

KEFJ is a 271,200 hectares (670,149 acres) park located on the southeastern coast of the Kenai Peninsula in southcentral Alaska (Figure 3). The park contains approximately 800 km of coastline that is characterized by steep mountains reaching over 1,500 m above sea level, deep water fjords, and tidewater glaciers. Eagle nesting habitat in KEFJ is characterized by rugged coastal terrain. Bald eagles typically nest in Sitka spruce (*Picea sitchensis*) and western hemlocks (*Tsuga heterophylla*) based on cliff-side coastal forests, and occasionally create ground nests on sea stacks, points and islands.

The region of interest consists of the entire KEFJ coastline, excluding northern McCarty Fjord, which lacks sufficient bald eagle habitat. The coastline is further stratified into five regions based on the geography of the fjords: Northern Outer, Aialik Bay, Northwestern Fjord, Outer Coast, and Nuka Bay. Strata are sampled in proportion to their overall coastline length. Bald eagle nest sampling in KEFJ uses a dual-frame sampling design. The area frame consists of 51 transects, the length (12.5 km) of which were selected to minimize sampling variance (Thompson and Phillips 2011). Twenty-six transects were selected randomly from all possible coastline transects, and sampled annually. The list frame consists of all nests located in the area-frame sample, and is sampled and updated annually (Table 1).

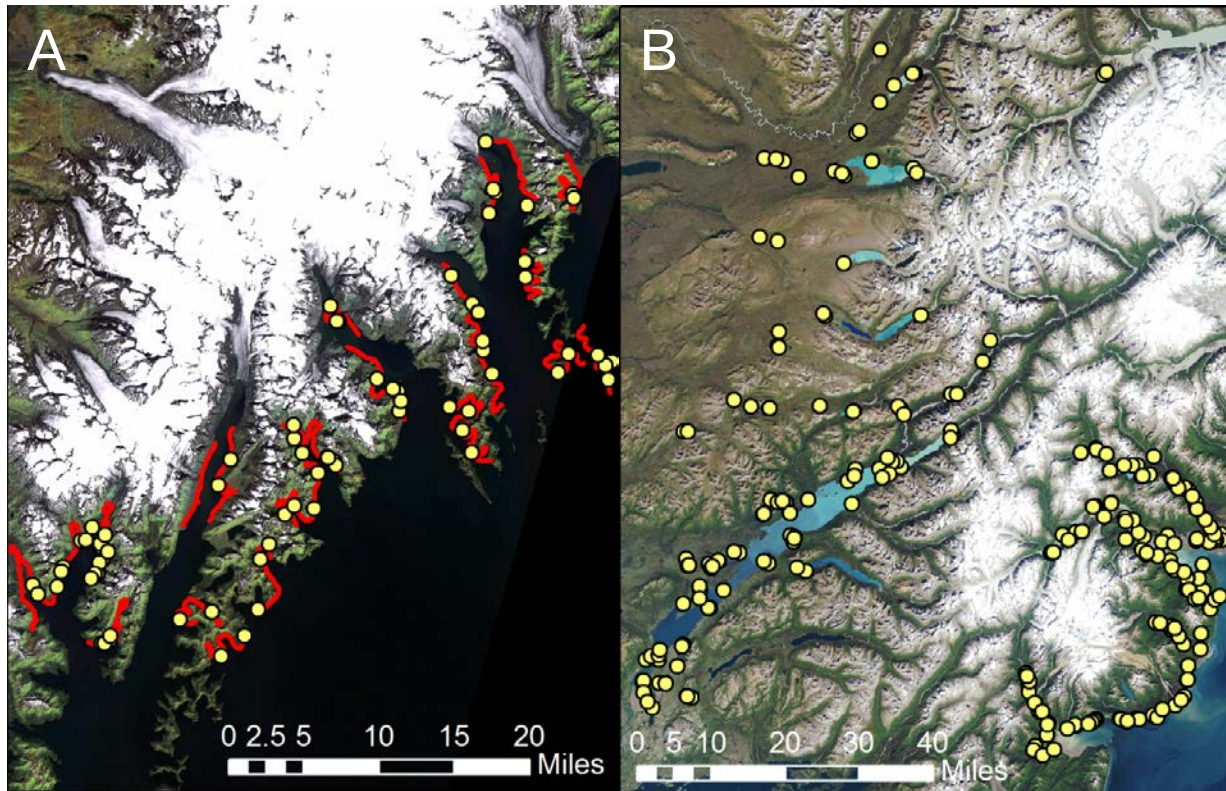


Figure 3. Sampling domain for KEFJ (A) includes the coastline. The area frame transects are shown by red lines, and the list frame nests are shown as yellow points. The sampling domain for LACL (B) includes all forested shorelines, coastlines, and rivers within the park. The list frame nests are shown by yellow points.

Lake Clark National Park (LACL)

LACL covers 1,630,889 hectares (4,030,015 acres) at the base of the Alaska Peninsula in southcentral Alaska (Figure 3). The park and associated national preserve extend from Cook Inlet across the Chigmit Mountains and the Neacola Mountains, on the northern end of the Aleutian Range, and into the Alaska interior. Bald Eagle habitat consists of lakeshores, islands, streams, and forested coastlines. Eagles nest in white spruce (*Picea glauca*), and cottonwood (*Populus balsamifera*). Survey areas are divided into coastal and interior, and encompass most of the bald eagle habitat in LACL. Area frame sampling does not currently occur in LACL. All list frame nests are surveyed annually. New nests are added to the list frame as they are observed. The list frame contains a majority of the bald eagle nests in LACL (Table 1).

Field Methods

Annual bald eagle nest monitoring occurs within the three largest SWAN parks (KATM, KEFJ, LACL). We conduct list frame surveys in LACL on a list of nests maintained by the park since 1992. In KEFJ and KATM, we use the dual-frame and double-observer monitoring approach of the U.S. Fish and Wildlife Service Post Delisting Monitoring plan (USFWS 2009) with a repeated visit survival model (robust design; Pollok 1982) to evaluate bald eagle nest initiation (Wilson et al. 2014) and productivity (Wilson in press). In all three parks formal nest surveys take place three times each year; twice during nest initiation in May, and once again prior to chick fledging in July/August

(Table 2). The SOPs associated with this protocol narrative provide information necessary to implement the bald eagle monitoring program in the Southwest Alaska Network.

- 1) Nest initiation surveys: Two aerial nest initiation surveys are conducted in the regions of interest described above for each park during peak bald eagle nest attendance in May.
- 2) Late productivity surveys: One aerial nest productivity survey is conducted just prior to chick fledging in late July or early August.
- 3) Aerial surveys are conducted with two observers and a pilot using a helicopter, or with one observer and a pilot-biologist in a small fixed-wing plane.
- 4) Data are collected on paper data sheets or approved electronic devices.
- 5) All nest locations are recorded using a resource-grade GPS device with an external antenna.

Table 2. Monitoring objectives, sampling methods, and variables measured at SWAN parks as a part of the protocol for monitoring bald eagle nesting activity.

Objective	Sampling method	Data Collected	Analysis Tool	Derived Data
Nest Abundance	Double observer	Detection/non detection of nest by pilot/observer 1 and observer 2	WinBUGS script	Nest abundance Probability of nest detection
Nest initiation	Replicate aerial survey	Eagle behavior and number of eggs observed	WinBUGS script	Probability of nest initiation Probability of cue availability
Nest initiation	Resource-grade GPS	Spatial location of nest	ArcMAP	Known nest list maintenance.
Nest initiation	Aerial survey	Ancillary nest data	WinBUGS or R	Covariate data to be used for modeling state parameters or ecological questions
Chick Productivity	Aerial survey	Chick count	WinBUGS script	Mean number of chicks per initiated nest
Chick Productivity	Aerial survey	Chick age	NA	Can be used to estimate nest initiation date, and used for advanced analyses of nest success. Can also be used to monitor changes in nesting phenology.

State Variable Definitions

Nest abundance: The total number of nests within the study area. This is a Poisson random variable that is not directly observed. It is obtained using the dual-frame method (USFWS 2009). This method uses double-observer samples to formally account for imperfect detection of nests during survey flights.

Nest initiation: The proportion of all nests where bald eagles initiate nesting within a given year. This is a binomial random variable that is not directly observed. It is obtained from models that use repeated observations of bald eagle behavior in nests during the nest initiation period. Nests where bald eagles are observed to be in incubating posture are recorded as ‘initiated,’ all others are considered ‘empty.’

Nest productivity: The number of chicks produced in each initiated nest. This is a Poisson mean that is conditional on nest initiation.

Monitoring Schedule

Monitoring of bald eagle nest initiation and productivity will be conducted annually in all park areas described above.

Field work for this protocol will be conducted in early spring during peak bald eagle nesting activity. The dates for the early nest initiation surveys (ENIS) typically occur in May, and are chosen annually by the park wildlife biologist or ecologist based on experience and nest initiation dates that are predicted from chick ages obtained during the productivity survey from the previous year (Table 3). The dates for the late productivity surveys (LPS) are chosen by the park wildlife biologist or ecologist based on nest initiation dates, typically in the last half of July or first week of August. Details of the sampling design in KEFJ are published in Thompson et al. (2009), and Thompson and Phillips (2011).

Table 3. Monitoring objectives, sampling frame, and scale of analyses at SWAN parks as a part of the protocol for monitoring bald eagle nesting activity.

Objective	Park Unit	Area Sampled	Spatial Design	Temporal Design	Scale of Analysis
Nest Initiation (ENIS) – 2 surveys	KATM	Naknek drainage	Full shoreline and rivers adjoining major lakes	Replicate annual spring surveys during peak nesting	Area of interest
	KEFJ	Coastline	23 coastal transects (Thompson et al. 2011)	Replicate annual spring surveys during peak nesting	Park, Area of interest, Transect
	LACL	All known eagle habitat	All eagle habitat	Replicate annual spring surveys during peak nesting	Park, Area of interest
Productivity (LPS) – 1 survey	KATM	All initiated nests	Full shoreline and rivers adjoining major lakes	Annual summer survey prior to fledging	Area of interest
	KEFJ	All initiated nests	23 coastal transects (Thompson et al. 2011)	Annual summer survey prior to fledging	Park, Area of interest, Transect
	LACL	All initiated nests	All eagle habitat	Annual summer survey prior to fledging	Park, Area of interest

Data Management, Analysis, and Reporting

The types and requisite processing steps for data collected as part of the SWAN bald eagle monitoring protocol are located in Table 4.

Table 4. Data processing and certification matrix for SWAN Bald eagle monitoring protocol. Procedures for certifying datasets are outlined in SOP 3.

Data Processing Level	Activities Performed
Level 0 (Unprocessed)	GPS locations of new nests; Data Sheets, Digital Photos
Level 1 (Entered, Validated)	GPS projected into Alaska Albers Equal Area Conic projection; Photos downloaded; Records checked for completeness and errors; Nests from ENIS 1 and ENIS 2 photo-matched and assigned a nest number; Datasheets entered into transferrable digital format;
Level 2 (Provisional)	Data imported into provisional database; Nest locations added to provisional shapefile; Queries run on database to locate errors.
Level 3 (Certified)	Digital photos archived; Data imported into master database; Nest locations imported into master shapefile; Data published to NPS DataStore
Level 4 (Analyzed)	List of known nests sent to parks; Nest shapefiles sent to parks; Custom queries sent to biometrician for WinBugs analysis.

Processing and Workflow

The data are collected during the survey electronically (automatically records coordinates) or on data sheets and using a GPS unit to record coordinates. As soon as the survey is finished, the data are reviewed by all observers. The data are reviewed to ensure that a Nest ID is recorded only once, and that the codes for behavior, numbers, chick age, etc. are correct and/or reasonable (e.g., 4 adults at one nest would seem high for number of adults and would be flagged as a potential error). The coordinates collected for new nests are displayed on a map immediately after the survey to see whether they occur where expected (e.g., over land and not in water, and in relation to previously known nests). The assigned nest identifiers for new nests are double checked to make sure that the next available number (consecutive identifier) has been used. For previously known nests, observers will check that the survey coordinates are near the assigned coordinates for the nest, if new coordinates were collected. Note that there is some horizontal error expected when collecting nest coordinates in a moving aircraft.

For data collected on data sheets, the data should be transcribed into an electronic format (i.e., either into an Excel spreadsheet or directly into the database). Cross-reference all records with the physical field forms to make sure transcription errors are corrected. Fix all errors at this sure all records are complete and error free. If data were not recorded in the field, make sure appropriate null data values will be included. Please reference SOP 3 for more detail about data management.

Once data are converted to an electronic format, the data file is uploaded into the bald eagle monitoring database, which is in development and will be managed by SWAN. Data uploading will fail if required fields are left blank or contain invalid entries. Therefore, it is very important to ensure proper quality assurance procedures are used, and codes followed at every data entry step. The data will be incorporated into a master database with the data published to the NPS Data Store once certified for quality and completeness of the data, following IMD standards.

Reporting

Resource briefs will be produced biennially. A technical publication summarizing multiple years of data collection will be produced every 3-5 years. This document will be of the quality and caliber to be published in a professionally respected peer-reviewed journal.

Safety

Implementation of this protocol has multiple complex risks. Staff will continuously evaluate all risks during the surveys at the programmatic, personnel, and site level. Programmatic-level safety information is presented in SOP 6, and summarized below.

Risks associated with implementation of this protocol are mainly associated with the low level aerial survey. Project Aviation Safety Plans (PASP) will be completed or updated prior to sampling each spring. The PASP includes all important information about the flight. This document should be available to all participants and supervisors involved in project. Flight plans are filed with Alaska Regional AICC (Alaska Interagency Coordination Center). Pilots and crew will take part in a pre-flight briefing covering the safety features of the aircraft. There may be other park-specific safety protocols required before takeoff (e.g. pre-flight go-no go checklist required by KEFJ). All biologists/ecologists supervising survey personnel will obtain the requisite aviation safety training (M3, DOI Aviation Management Training). The flight crew will complete basic aviation training, and wear the required personal protection equipment (PPE).

Budget

Estimated operating costs are shown in Table 5.

Table 5. Estimated SWAN annual operating cost (based on FY2015 dollars) for implementation of the SWAN bald eagle monitoring protocol. The budget assumes that IT equipment (e.g. GPS, camera, and computers) are available prior to protocol implementation. The budget does not include in-kind support provided by parks (e.g. park staff salary and fleet aircraft). As outlined in SOP 3, a portion of each person's time is devoted to data management tasks. The parks typically pay 50% of the survey costs, as outlined in Bennett et al. (2006).

Category	Parameter	Costs (FY 2015)†	Notes
Personnel	SWAN Biometrician*	16,000	0.15 FTE GS-12
	SWAN Ecologist*	15,000	0.15 FTE GS-12
	SWAN Data Manager	10,000	0.10 FTE GS-11
	SWAN Asst. Data Manager	11,000	0.10 FTE GS-9 (IT)
	Park Biologist (3)	Park funded	0.20 FTE GS-11
	Park Biological Technician (3)	Park funded	0.20 FTE GS-7
	Park pilot	Park funded	If available
Total Personnel Costs		52,000	—

* These roles are currently filled by the same person

† Costs rounded to the nearest \$1000

‡ This figure is reduced if park aircraft and pilots are available

Table 5 (continued). Estimated SWAN annual operating cost (based on FY2015 dollars) for implementation of the SWAN bald eagle monitoring protocol. The budget assumes that IT equipment (e.g. GPS, camera, and computers) are available prior to protocol implementation. The budget does not include in-kind support provided by parks (e.g. park staff salary and fleet aircraft). As outlined in SOP 3, a portion of each person's time is devoted to data management tasks. The parks typically pay 50% of the survey costs, as outlined in Bennett et al. (2006).

Category	Parameter	Costs (FY 2015)†	Notes
ENIS	KATM- aircraft	4,000	Fixed wing contract‡
	KEFJ- aircraft	13,000	Helicopter contract
	LACL- aircraft	4,000	Fixed wing contract‡
	Total ENIS Costs	21,000	—
LPS	KATM- aircraft	3,000	Fleet aircraft provided by Park
	KEFJ- aircraft	4,000	Helicopter contract
	LACL- aircraft	3,000	Fleet aircraft provided by Park
	Total LPS Costs	10,000	—
Total Protocol Implementation Cost		83,000	—

* These roles are currently filled by the same person

† Costs rounded to the nearest \$1000

‡ This figure is reduced if park aircraft and pilots are available

Standard Operating Procedures

To ensure consistent implementation of this protocol over time, the following Standard Operating Procedures (SOPs) have been identified or developed (Table 6).

Table 6. Standard Operating Procedures required to implement the SWAN bald eagle monitoring protocol.

SOP	Topic	Citation	Link
SOP 1	Field preparation	Wilson, T.L. et al. 2016. Preparing for bald eagle field sampling. Southwest Alaska Network Standard Operating Procedure NPS/SWAN/SOP-1.0.0. National Park Service, Anchorage, AK.	NPS Data Store Record
SOP 2	Conducting surveys	Wilson, T.L. et al. 2016. Conducting bald eagle aerial surveys. Southwest Alaska Network Standard Operating Procedure NPS/SWAN/SOP-2.0.0. National Park Service, Anchorage, AK.	NPS Data Store Record
SOP 3	Data management	Wilson, T.L. et al. 2016. Data management for bald eagle monitoring. Southwest Alaska Network Standard Operating Procedure NPS/SWAN/SOP-3.0.0. National Park Service, Anchorage, AK.	NPS Data Store Record
SOP 4	Reporting	Wilson, T.L. et al. 2016. Reporting bald eagle data. Southwest Alaska Network Standard Operating Procedure NPS/SWAN/SOP-4.0.0. National Park Service, Anchorage, AK.	NPS Data Store Record
SOP 5	Revising the protocol or SOP	Wilson, T.L. et al. 2016. Revising the bald eagle monitoring protocol or SOPs. Southwest Alaska Network Standard Operating Procedure NPS/SWAN/SOP-5.0.0. National Park Service, Anchorage, AK.	NPS Data Store Record
SOP 6	Safety	Wilson, T.L. et al. 2016. Safety considerations for bald eagle field sampling. Southwest Alaska Network Standard Operating Procedure NPS/SWAN/SOP-6.0.0. National Park Service, Anchorage, AK.	NPS Data Store Record

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