



Yellow-billed Loon monitoring protocol for the Arctic Network

Protocol narrative version 1.0

Natural Resource Report NPS/ARC/NRR—2018/1738



ON THE COVER

A Yellow-billed Loon (*Gavia adamsii*) swims in a deep Arctic lake in Alaska. Within the Arctic Network, these rare birds are monitored in Bering Land Bridge National Preserve and Cape Krusenstern National Monument.

(NPS/DEV DHARM KHALSA)

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Executive Summary

The National Park Service (NPS) has developed a long-term ecological monitoring program known as “Vital Signs Monitoring” to provide the minimum infrastructure and enable more than 270 national park units, organized into 32 networks nationwide, to identify and implement long-term monitoring of their highest-priority indicators of natural resource condition. The Vital Signs Monitoring Program is a major component of the National Park Service’s strategy to improve park management through greater reliance on scientific information. This protocol details the justification and procedures for Yellow-billed Loon monitoring (YBLO) (*Gavia adamsii*), a Vital Sign selected by the Arctic Network (ARCN). The ARCN includes five park units in northern Alaska: Bering Land Bridge National Preserve (BELA), Cape Krusenstern National Monument (CAKR), Noatak National Preserve (NOAT), Kobuk Valley National Park (KOVA), and Gates of the Arctic National Park and Preserve (GAAR) (Figure 1).

Preserving the condition of park resources unimpaired in perpetuity, including migratory birds and their habitats, is the fundamental management objective of the NPS. This management objective to “maintain unimpaired” captures the essence of the NPS mission and forms the foundation of the NPS long-term ecological monitoring program. The purpose of the Yellow-billed Loon monitoring protocol is to collect and analyze data and report information that will help park management assess the status of and/or maintain or improve the ecological condition of this resource. Because Yellow-billed Loons are large-bodied, long-lived and return to the same breeding sites each year, they are ideal for monitoring long-term population trends in lake occupancy, habitat use and distribution. Yellow-billed Loons utilize both freshwater and marine environments, may be indicators of water quality, and provide insight into the movement of marine-derived nutrients and shifts in riparian or coastal communities in BELA and CAKR. As a top-trophic level predators in freshwater ecosystems, Yellow-billed Loons can be an indicator species useful for representing the status of the freshwater waterbird community.

The primary monitoring objective of the ARCN Yellow-billed Loon monitoring protocol is to:

1. *Biennially estimate status and trends in distribution, occupancy, and habitat use of Yellow-billed Loons in freshwater subarctic lakes during the breeding season in BELA and CAKR.*

Approximately 25% of the Alaskan Yellow-billed Loon population occurs in and around CAKR and BELA in ARCN. The species’ summer range includes portions of both of these parklands as well as areas adjacent to them on the Seward Peninsula and Cape Krusenstern and the Kotzebue lowlands. Prior to 2005, population estimates and distribution data of Yellow-billed Loons in these NPS units were poorly documented. In 2005, the U. S. Fish and Wildlife Service (USFWS) designed new survey methods to improve detections of Yellow-billed Loons and nests. Their methods developed specific lake-circling techniques and random plots targeting Yellow-billed habitat preferences to optimize detections and improve population estimates (Stehn *et al.* 2005; Mallek *et al.* 2006). In 2009, the National Park Service (NPS) ARCN began conducting aerial long-term monitoring of Yellow-billed Loons in BELA and CAKR using small, tandem aircraft in which the observer is seated behind the pilot. These planes fly lower, more slowly and make tighter circles around lake

edges than other larger aerial survey aircraft (e.g. C185, Kodiak, C2016, etc.) to improve detections. In 2011, ARCN modified the aerial survey methods again to improve occupancy estimates by using two, tandem aircraft to conduct simultaneous repeated (duplicate) surveys of all plots to generate an estimate of detection probability. The data from the repeated counts are used to estimate distribution, occupancy and habitat use of Yellow-billed and Pacific Loons in CAKR and BELA through use of a multistate occupancy modeling approach.

The Yellow-billed Loon monitoring protocol consists of a narrative (this document), Data Quality Standards and Standard Operating Procedures (SOPs) that outline specific aspects of the monitoring protocol. The latest versions of the SOPs and additional supporting information can be accessed online at the National Park Service's Arctic Network website:

<https://www.nps.gov/im/arcn/index.htm> and the Integrated Resource Management Applications portal website: <https://irma.nps.gov/Portal>.



Photo: Aerial view of Bering Land Bridge National Preserve (NPS/MELANIE FLAMME)

Acknowledgments

The Arctic Network (ARCN) Inventory and Monitoring Program, in collaboration with the U.S. Fish and Wildlife Service (USFWS) surveyed available Yellow-billed Loon habitat in National Park Service (NPS) units in western Alaska in 2005, 2007, 2009, 2011, 2013, 2016, 2017 and 2018. Surveys were conducted to develop methods and occupancy models as a way to estimate park-wide, distribution and habitat use for long-term monitoring of population trends. These surveys resulted in the protocols, SOPs and Data Quality Standards comprising this vital sign. Survey funding was provided by ARCN, Gates of the Arctic National Park and Preserve (GAAR), the National Parks Foundation (PMIS #208957) and USFWS.

We would like to thank Nikki Guldager, Tamara Zeller, Ed Mallek, Angela Matz, Karen Bollinger, Robert Platte and Robert Stehn at USFWS, and Debbie Nigro, at Bureau of Land Management, for their assistance developing and implementing this protocol. We thank Joel Schmutz, U.S. Geological Survey, for his advice and guidance on this protocol. Eric Sieh of Arctic Backcountry Flying Service and Jesse and Jared Cummings of Golden Eagle Outfitters, Nikki Guldager, Tamara Zeller, and Ed Mallek have been invaluable in conducting and refining the aerial surveys. Stacia Backensto, Sarah Swanson, Jared Hughey and Marci Johnson from NPS have provided logistical and observer expertise. Nick Bywater has been essential for the database design and data management. Thanks to Johann Walker from Ducks Unlimited for development of analytical methods. We thank Kumi Rattenbury, Sarah Swanson, Patrick Knavel, Dylan Schertz, Stacia Backensto and Jared Hughey for the informal review of this protocol. Finally, we are grateful to the many hard-working field technicians and pilots who have helped to conduct these surveys.

List of Key Acronyms

ARLO:	Arctic Loon
ANILCA:	Alaska National Interest Lands Conservation Act
ARCN:	Arctic Network, Inventory and Monitoring Program
BELA:	Bering Land Bridge National Preserve
BLM:	Bureau of Land Management
CAKN:	Central Alaska Network
CAKR:	Cape Krusenstern National Monument
COLO:	Common Loon
GAAR:	Gates of the Arctic National Park and Preserve
I&M:	Inventory and Monitoring Program
IRMA:	Integrated Resource Management Applications Data Store
KOVA:	Kobuk Valley National Park
NPS:	National Park Service
NOAT:	Noatak National Preserve
NPR-A:	National Petroleum Reserve-Alaska
NRR:	Natural Resources Report
PALO:	Pacific Loon
PI:	Primary Investigator
QA/QC:	Quality Assurance and Quality Control of survey data
RTLO:	Red-throated Loon
SOP:	Standard Operating Procedure
UAF:	University of Alaska-Fairbanks
UNLO:	Unknown Loon
USFWS:	U. S. Fish and Wildlife Service

USGS: U. S. Geological Survey
WEAR: Western Arctic Parklands (NPS administrative unit for CAKR, KOVA and NOAT)
YBLO: Yellow-billed Loon

Background and Objectives

Background and History

Knowing the condition of natural resources in national parks is fundamental to the National Park Service (NPS) mission to manage park resources "unimpaired for the enjoyment of future generations." Park managers are confronted with increasingly complex and challenging issues that require broad-based understanding of the status and trends of park resources as a basis for making management decisions and working with other agencies and the public for the long-term protection of park ecosystems. The purpose of natural resource monitoring in parks is to collect scientifically sound information regarding the current status and long-term trends in the composition, structure, and function of park ecosystems, and to determine how well current management practices are sustaining those ecosystems (Fancy et al. 2009). Use of monitoring information will improve the ability of park managers to make science-based decisions and address legal and political issues involving parks and park resources for more effective park operations and management. The overarching goals of the NPS monitoring program are to:

1. determine the status and trends of selected indicators of park ecosystem conditions to make better-informed decisions and to work more effectively with other agencies and individuals for the benefit of park resources;
2. provide early warning of abnormal conditions of selected resources to help develop effective mitigation measures and reduce costs of management;
3. provide data to better understand the dynamic nature and condition of park ecosystems and to provide reference points for comparisons with other, altered environments;
4. provide data to meet certain legal and Congressional mandates related to natural resource protection and visitor enjoyment; and
5. provide a means of measuring progress towards performance goals.

This protocol outlines the justification and procedures for Yellow-billed Loon (*Gavia adamsii*) monitoring within the Arctic Network (ARCN). The ARCN includes five Arctic parks in northern Alaska: Bering Land Bridge National Preserve (BELA), Cape Krusenstern National Monument (CAKR), Noatak National Preserve (NOAT), Kobuk Valley National Park (KOVA), and Gates of the Arctic National Park and Preserve (GAAR) (Figure 1), which collectively represent 19.3 million acres or roughly 25% of the land area of NPS-managed units in the United States (Lawler *et al.* 2009). The ARCN parks contain a broad array of the ecosystems typical of the subarctic (boreal forest and taiga) and arctic (tundra) biomes of northern Alaska, stretching from tundra wetlands and coastline to the mountains. Because these parks encompass large areas of mountainous terrain, including a major portion of the Brooks Range, they also include examples of virtually every type of alpine situation to be found in northern Alaska (Lawler *et al.* 2009).

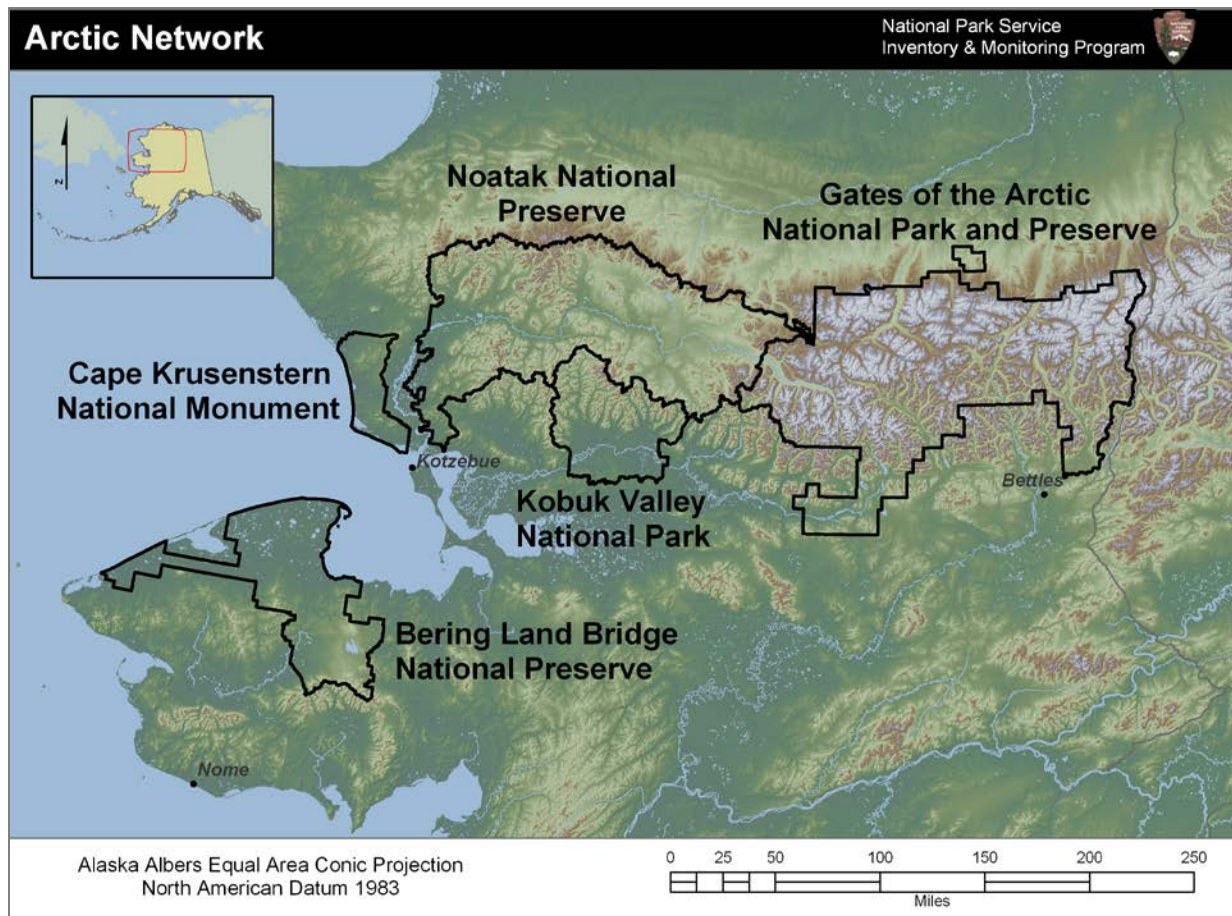


Figure 1. Location of the Arctic Network (ARCN) parklands in northern Alaska, USA: Bering Land Bridge National Preserve, Cape Krusenstern National Monument, Kobuk Valley National Park, Noatak National Preserve and Gates of the Arctic National Park and Preserve. Yellow-billed Loons are monitored in Bering Land Bridge National Preserve and Cape Krusenstern National Monument.

Rationale for Yellow-billed Loon Monitoring

The Alaska National Interest Lands Conservation Act (ANILCA) (U. S. Congress 1980) contains enabling legislation and mandates relevant to Yellow-billed Loon (YBLO) conservation in NPS units in Alaska. Management purposes include protection of “habitat for internationally significant populations of migratory birds” in BELA (ANILCA § 201(2)); and protection of “habitat for, and populations of, birds” in CAKR (ANILCA § 201(3)). In 2007, the Yellow-billed Loon population in western Alaska was selected for long-term monitoring in BELA and CAKR under the NPS Arctic Network (ARCN) Vital Signs Monitoring Plan (Lawler *et al.* 2009). The Yellow-billed Loon is a rare, international species of concern with an estimated global population of 16,650-21,000 (Fair 2002; Earnst 2004; Earnst *et al.* 2005; Earnst *et al.* 2006). Worldwide, the loon’s circumpolar breeding range includes Beringia and Arctic and near Arctic habitats between 60°- 74° N latitude across portions of northern Canada, Russia, and Alaska (Fair 2002; Federal Register 2014). The entire U. S. population of Yellow-billed Loons is seasonally located in Alaska where the total summer breeding population is estimated at 3,700-4,900 birds (North and Ryan 1989; Earnst 2004;

Earnst *et al.* 2005, Earnst *et al.* 2006; USFWS 2006; Federal Register 2014). The species' range in Alaska is restricted to tundra landscapes with large, deep, clear, freshwater, fish-bearing lakes with low-profile and convoluted shorelines and stable water levels (North and Ryan 1989; Earnst 2004; Earnst *et al.* 2006; Haynes *et al.* 2014; Schmidt *et al.* 2014). Most Yellow-billed Loons in Alaska are found on the Arctic Coastal Plain, in the National Petroleum Reserve-Alaska (NPR-A) on State of Alaska lands and on Alaska Native-owned lands within the North Slope Borough, however, smaller populations of 2,000-2,500 birds are located in western Alaska on the Seward Peninsula, Cape Krusenstern and Kotzebue lowlands (Fair 2002; Mallek *et al.* 2006; Bollinger *et al.* 2007; Schmidt *et al.* 2014; Mizel and Flamme pers. comm. 2017). This area includes two parklands, BELA and CAKR (Figure 1).

A Species of Concern

In 2004, the USFWS was petitioned to consider listing the Yellow-billed Loon as threatened or endangered under the Endangered Species Act, either throughout its range or as a Distinct Population Segment in the U. S. The agency was also petitioned to designate areas of critical Yellow-billed Loon habitat due to the species' small population size, restricted Alaskan distribution and low reproductive success (Evers 2004; Federal Register 2007, 2009). In 2009, the USFWS announced that it had determined "that listing the Yellow-billed Loon as a threatened or endangered species is warranted under the Endangered Species Act, but an immediate proposal to list this species is precluded by other higher priority listing actions" (Federal Register 2009). The species listing as "warranted but precluded" meant that the USFWS was required to review their finding annually until either the species was listed as a threatened or endangered species or the species is deemed "not warranted" for listing. Though the USFWS found that the listing of the birds as either endangered (in danger of extinction) or threatened (likely to become endangered within the foreseeable future) was not warranted at this time (Federal Register 2014), the loons continue to be considered an international species of concern by many organizations.

This species is of particular interest to the ARCN since the enabling legislation for all five ARCN parklands, including BELA and CAKR, specifies protection for birds, their habitats and populations under ANILCA (U.S. Congress 1980). Additionally, several international treaties, federal laws, agreements and initiatives provide protections and conservation guidance for migratory birds and require action by NPS. Conservation concerns that may impact Yellow-billed Loons in western Alaska include gravel extraction, road construction, proposed natural gas extraction with accompanying power infrastructure on the Kobuk River Delta, increased marine vessel traffic and potential for industrial spills in the Bering and Chuckchi seas, subsistence harvest, anthropogenic disturbance, shifts in fish species distributions and climate-induced water level changes (Smith 1995; USFWS 2006; Bollinger *et al.* 2007). Habitats in NPS units may become more important to maintaining nesting habitat for Yellow-billed Loon populations in Alaska as other areas become more developed.

Additional Benefits from Monitoring Yellow-billed Loons

Protecting Yellow-billed Loons and their habitat from the impacts of land management activities may also result in habitat protections for a variety of other tundra-nesting birds, including some of

conservation concern. Information gained from research and monitoring efforts may be applied to other loon species, including Arctic (*Gavia arctica*), Pacific (*G. pacifica*), Red-throated (*G. stellata*), and Common (*G. immer*) Loons. Two species classified as threatened under the Endangered Species Act, the spectacled eider (*Somateria fischeri*) and the Alaska-breeding population of Steller's Eider (*Polysticta stelleri*), nest within areas and habitats used by Yellow-billed Loons in Alaska and will benefit from management prescriptions to protect Yellow-billed Loons. Other species that may gain from Yellow-billed Loons habitat protections, including USFWS Species of Management Concern, are Northern Pintail (*Anas acuta*), Greater White-fronted Goose (*Anser albifrons*), Brant (*Branta bernicla*), Cackling Goose (*Branta hutchinsii*), Lesser Snow Goose (*Chen caerulescens*), Long-tailed Duck (*Clangula hyemalis*), Tundra Swan (*Cygnus columbianus*), King Eider (*Somateria spectabilis*), Arctic Tern (*Sterna paradisaea*), and shorebirds including Red Phalarope (*Phalaropus fulicarius*) and Red-necked Phalarope (*Phalaropus lobatus*) (USFWS 2006).

The Yellow-billed Loon is a K-selected species with a large body size, long life expectancy, low reproductive rate and a slow rate of sexual maturity to reproduction (3-7 years) (Evers 2004). The low reproductive success of this species requires high annual adult survival to maintain population levels (Evers 2004). In addition, this long-lived top-level species is piscivorous, predisposing it to bioaccumulation of contaminants over its lifetime and causing concerns for subsistence users who may harvest the loons and their eggs for human consumption (Fair 2002; Matz *et al.* 2006; Schmutz *et al.* 2009). Consequently, Yellow-billed Loons may be indicators of water quality and provide insight into the movement of marine-derived nutrients and shifts in riparian or coastal communities in BELA and CAKR. Their large body size and strong nest-site fidelity make them easy to locate and spot from the air and ideal for tracking long-term trends in occupancy and habitat use. For these reasons, ARCN has selected the Yellow-billed Loon as a Vital Sign to assess ecosystem health under the Vital Signs Long-term Monitoring Program (Lawler *et al.* 2009).

Objective

The primary monitoring objective of the ARCN Yellow-billed Loon monitoring protocol is to:

1. *Biennially estimate status and trends in distribution, occupancy, and habitat use of Yellow-billed Loons in freshwater subarctic lakes during the breeding season in BELA and CAKR.*

Methods

Sampling Design

The USFWS Migratory Bird Division developed techniques for conducting aerial surveys specifically for breeding Yellow-billed Loons in northern Alaska (Stehn *et al.* 2005). Prior to 2005 (1986-2004), population indices for Yellow-billed Loons in Alaska were largely a by-product of the USFWS Arctic Coastal Plain Breeding Pair (ACP) straight-line transect surveys conducted to monitor the majority of waterfowl species (Mallek *et al.* 2003 and 2004; Stehn *et al.* 2005). These transect surveys were also conducted in 1992-1993 in portions of BELA and CAKR (USFWS unpublished data). However, these straight-line transect methods neither specifically addressed nor adequately accounted for nesting Yellow-billed Loon populations because they could only establish presence, but not absence, of these loons and largely missed locating nesting sites (Stehn *et al.* 2005; Smith 1995). Given the species' status as potentially threatened or endangered in the early 2000s, the USFWS developed a new lake-circling methodology to optimize the detection of both the presence and absence of Yellow-billed Loons based on comprehensive surveys of lakes located within large randomly chosen plots (Earnst *et al.* 2005; Stehn *et al.* 2005; Mallek *et al.* 2006; Bollinger *et al.* 2007). The new methods were optimized for lake-habitat parameters indicated as likely to be significant for Yellow-billed Loons based on logistic regression analyses, including larger lakes, deeper lakes, hydrologic connectivity, presence of shoreline emergent vegetation and flooded tundra land cover classes, more complex lake shoreline shape, and absence of Pacific Loons (Earnst *et al.* 2005).

The ARCN Yellow-billed Loon aerial surveys are conducted biennially in late June, just after ice-off on the lakes and nest initiation, but before hatch (Table 1). The surveys are conducted in the same 24 randomly selected 12km × 12km plots scattered across BELA (n=18) and CAKR (n=6) (Figure 2; see Bollinger *et al.* 2007). The survey area overlapping large portions of CAKR and BELA has 1291 lakes >7ha in size and the selected plots contain approximately 35% of these lakes (n=447). Surveys are conducted at an altitude of 100-500 feet above ground level and at speeds between 60-80 knots. Although this protocol is focused on Yellow-billed Loons, data are collected on and all five species of loons known to occur in the area (Yellow-billed, Common, Red-throated, Pacific and Arctic) and their nests as well as other large waterfowl (grebes, ducks, swans, geese) both within and outside of the survey plots. The cost of recording the additional species is negligible and improves estimation for Yellow-billed Loons (see Data Analysis section herein, SOP 10 and Schmidt *et al.* 2014).

Table 1. Proposed biennial survey schedule to monitor Yellow-billed Loon distribution, occupancy and habitat use in BELA and CAKR. Some exceptions to this schedule include consecutive years, 2016 and 2018, to enable joint surveys with a three-year concurrent Red-throated Loon study (see table for details). Surveys are scheduled to be conducted biennially into the future.

Park Unit / Survey Area	2009¹	2011²	2013²	2015	2016²	2017²	2018²	2020	2022...
BELA	X	X	X	–	X*+	X*+	X*+	X	X
CAKR	X	X*	*	–	X*+	X*+	X*+	X	X

¹ The survey conducted in 2009 was a pilot survey, conducted with a single tandem aircraft on floats.

² In 2011, 2013, 2016, 2017 and 2018 we used two tandem aircraft on floats to conduct repeat surveys of plots and estimate detection probability. We will continue to do this for future surveys.

* In 2011, 2013, 2016, 2017 and 2018 some YBLO plots were not repeat sampled or not sampled at all (e.g., 2013 CAKR) due to weather.

In 2015, surveys were not conducted. This year was skipped so work could be conducted in 2016 instead.

+In 2016-2018, as a special exception to the monitoring schedule, surveys were done jointly with a three-year Red-throated Loon study (2016-2018). This enabled three consecutive surveys to be conducted to assess annual, rather than biennial, habitat use, occupancy, distribution and nest-site fidelity. Surveys are scheduled to be conducted biennially for future surveys beyond 2018.

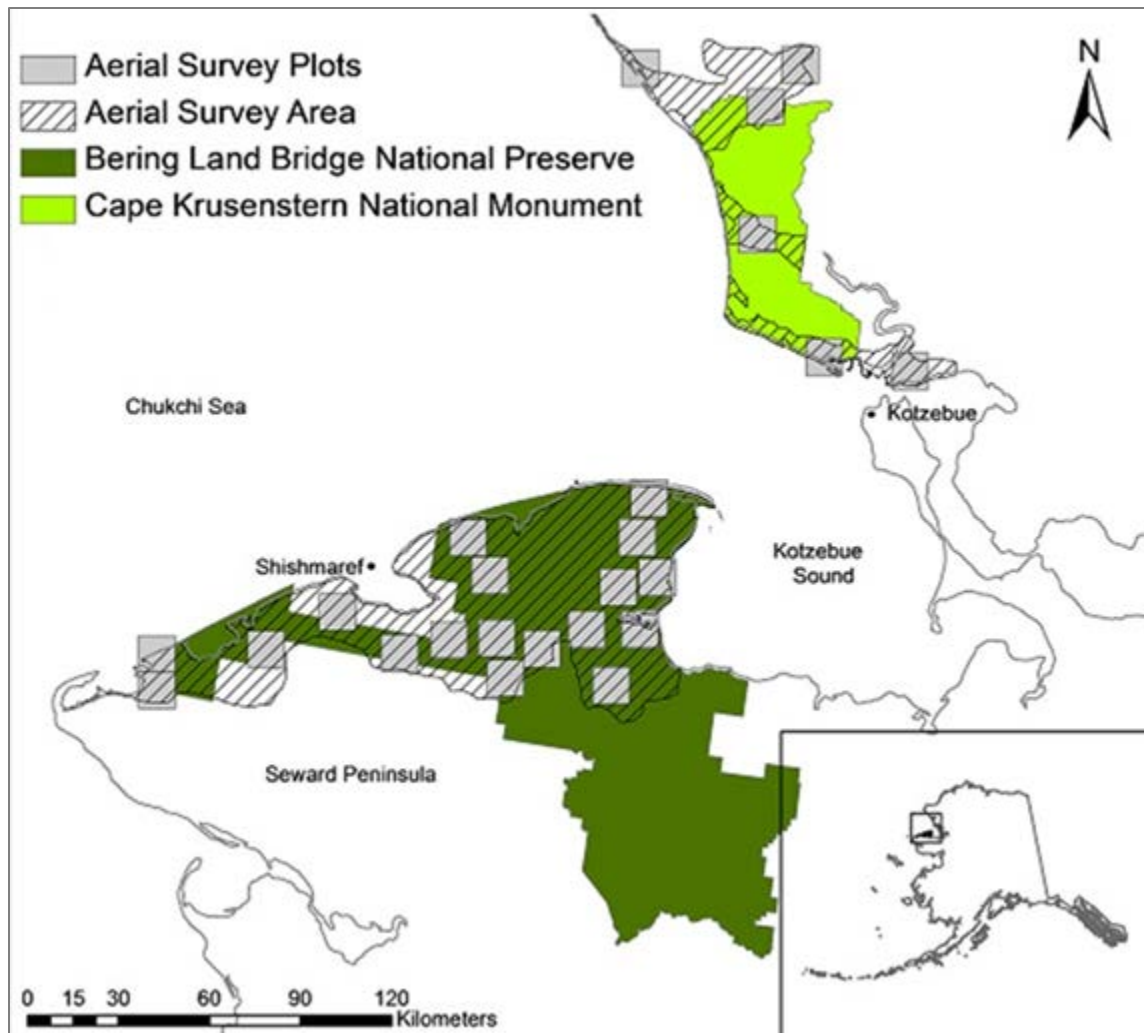


Figure 2. Location of survey area on the northwestern coast of the Seward Peninsula, Alaska, USA. Squares indicate sampled plots, hatched lines indicate the survey area boundary, and colored areas indicate U.S. National Park Service units for Bering Land Bridge National Preserve (dark green) and Cape Krusenstern National Monument (light green).

Aerial surveys are conducted via tandem aircraft on floats using lake-circling methods to improve detection of both the presence and absence of Yellow-billed Loons and their nests based on comprehensive surveys of lakes located within the plots (see SOPs 1-8 for detailed field procedures). Lake-circling techniques (Figure 3) allow loons to be confidently associated with specific lakes and improve the detection of nests along shorelines as compared to straight-line transect surveys (Stehn *et al.* 2005). The lake-circling methods target lakes with habitat parameters likely to be attractive to Yellow-billed Loons for foraging and nesting (Earnst *et al.* 2006). The initial surveys by USFWS in 2005 and 2007 were conducted using amphibious Cessna 206 aircraft (Stehn *et al.* 2005; Mallek *et al.* 2006; Bollinger *et al.* 2007). Techniques were subsequently modified again by switching to two or more tandem aircraft on floats to increase the probability of detecting loons and loon nests. These planes can make tighter turns, fly lower and more slowly and seat the observer behind the pilot so both can view simultaneously out of the same side of the aircraft without obstruction from the pilot.

Five surveys (2011, 2013, 2016, 2017, 2018) using independent counts (repeats) of plots have been conducted to enable us to estimate detection probability (see Schmidt *et al.* 2014 for further details). These adjustments to the USFWS method were needed to address the lack of detection probability estimates and to improve detection of loons and nest sites by using the more maneuverable, slower and lower-flying aircraft.

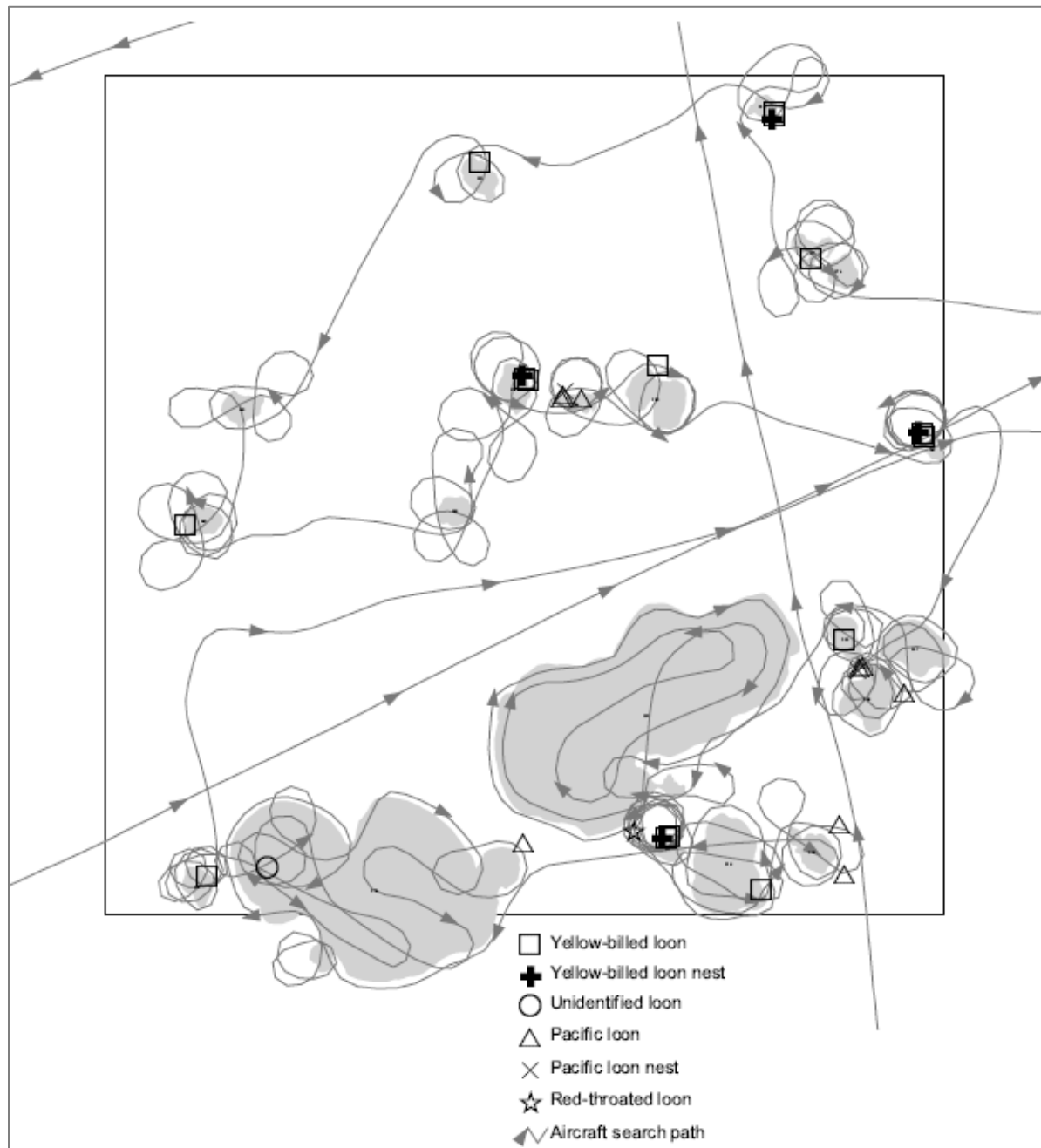


Figure 3. Example of an aircraft's GPS track file demonstrating the lake-circling technique within a survey plot to optimize detections of Yellow-billed Loons and their nests on and around lakes (from Mallek *et al.* 2006).

The USFWS lake-circling survey methodology (Stehn *et al.* 2005), ARCN Dall's Sheep Monitoring SOPs for conducting aerial surveys (Rattenbury *et al.* 2017), data collection and processing, and the multistate occupancy modeling approach (Schmidt *et al.* 2014) have all been adopted and modified for implementation in Yellow-billed Loon Monitoring. Modifications include:

1. ARCN Yellow-billed Loon monitoring will implement the USFWS published lake-circling methods (Stehn *et al.* 2005) except ARCN will use two or more, smaller tandem aircraft on floats (rather than one larger aircraft) that are capable of lower and slower flight and tighter turns to improve detection probability.
2. ARCN Yellow-billed Loon monitoring will implement repeat (duplicate) sampling of all 24 plots in BELA and CAKR to provide an estimate of detection probability (Schmidt *et al.* 2014).
3. ARCN Yellow-billed Loon monitoring surveys will occur biennially, not annually. Biennial surveys are a compromise between cost and adequate survey frequency.
4. ARCN Yellow-billed Loon monitoring surveys will not generate new random selections of possible plots to be sampled for each survey. Rather, the same 24 plots that were surveyed by USFWS in 2007 (Bollinger *et al.* 2007) will be sampled in perpetuity for the long-term monitoring. Yellow-billed Loons have strong nest-site fidelity and return to the same breeding sites each year. Using the same plots and lakes for the long-term will enable us to examine long-term lake occupancy and habitat use by various species of loons over time.
5. A multistate occupancy modeling analyses (Schmidt *et al.* 2014) will be used, rather than the analytical methods developed by USFWS (Stehn *et al.* 2005; Mallek *et al.* 2006; Bollinger *et al.* 2007).
6. The ARCN Yellow-billed Loon monitoring program utilizes many of the same methods developed for the ARCN Dall's Sheep protocols (Rattenbury *et al.* 2017; <https://irma.nps.gov/DataStore/Reference/Profile/2238929>), including GPS set up, the Park Observer application for data collection on the iPad and data downloading and processing methods.

Survey Area

The survey area includes 13,572 km² of potential Yellow-billed Loon habitat in portions of BELA and CAKR in western Alaska (Figure 2). All lakes >7 ha in size are included as selected lakes in the survey (Earnst *et al.* 2006). The minimum lake size of >7 ha was based on data from the Colville River Delta, where the smallest lake found with a brood of Yellow-billed Loons was 13.4 ha (North and Ryan 1989). Additionally, spring Yellow-billed Loon Surveys on the Arctic Coastal Plain (Mallek *et al.* 2003 and 2004) indicated that out of 479 Yellow-billed Loon observations, 98% were on lakes larger than 10 hectares; just 2% were on lakes 7-10 ha.

Monitoring Schedule

ARCN Yellow-billed Loon monitoring surveys are conducted during the last 10 days of June in northwestern Alaska, after subarctic lakes have largely thawed and loon nesting has commenced, but eggs have not yet hatched. The surveys occur biennially in BELA and CAKR. Biennial surveys are a

compromise between cost and adequate survey frequency. Yellow-billed Loons have strong nest-site fidelity and tend to return to the same breeding sites each year on nesting lakes, making biennial sampling feasible and appropriate for generating occupancy estimates, even with a gap in survey years. Typically, Yellow-billed Loon surveys are conducted biennially. However in 2016 and 2018, we also conducted surveys to collect three consecutive years of data (2016 - 2018) in conjunction with a concurrent Red-throated Loon (RTLO) study. By combining efforts with the three-year RTLO study (2016-2018), which includes an additional 31 plots scattered over BELA, we can assess annual, rather than biennial habitat use, distribution and nest-site fidelity of YBLO and RTLO. Further, we cover a larger area of loon habitat across BELA, which will be useful for understanding habitat use for the YBLO monitoring program.

Data Analysis

Data analysis will meet the monitoring objectives of estimating lake occupancy state, rates of transition between occupancy states (used, used for nesting and unused) and trend and will be conducted after each survey. The multistate occupancy modeling analyses (see Schmidt *et al.* 2014) allows us to examine occupancy and habitat use of the lakes in the survey area for several loon species simultaneously across years. Because Yellow-billed Loons are rare and the number of detections is relatively smaller than detections of other loons, we will leverage the detections of other loon species (that have similar habitat requirements, usage and behavior: e.g., Pacific Loons) to enhance the analysis of habitat use of lakes by loons across the survey area.

Data Management

Data management for the Yellow-billed Loon monitoring program will proceed through an ongoing life cycle as shown in Figure 4 (NPS 2008a). Major stages of the life cycle include data collection, data entry and import, quality control, data product documentation and archival, seasonal closeout, dataset certification, and data analysis and reporting (NPS 2008b). Protocol development and approval efforts will occur mostly in early years but adaptive management methods may require that protocol development is revisited as new techniques and technologies develop.

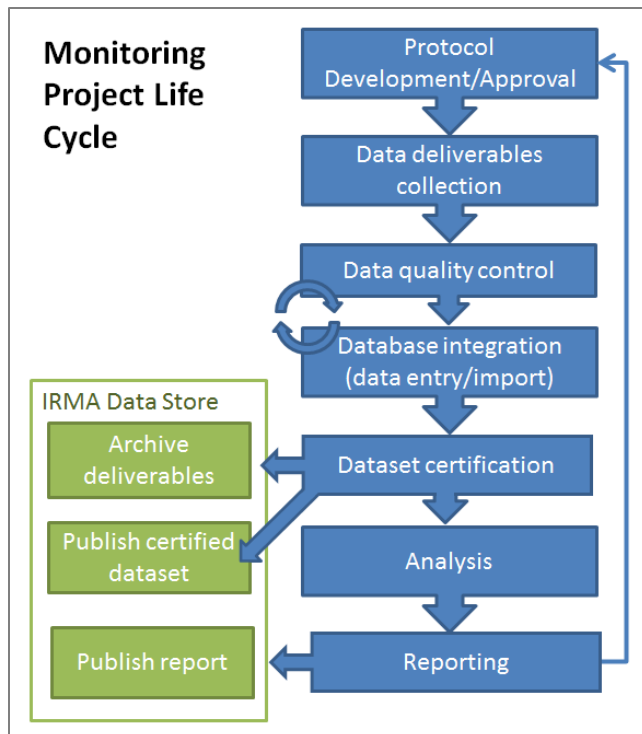


Figure 4. Long-term monitoring project data management life cycle.

An overview of major component of the loons monitoring data management life cycle follows. Specific procedures are given in the standard operating procedures accompanying this narrative.

NPS Standards

Data Quality

Director's Order #11B (NPS 2005c) mandates a high level of information quality from the service's scientific programs:

The National Park Service will ensure that information it releases will be developed from reliable data sources and will otherwise ensure information quality at each stage of information development. The NPS's methods for producing quality information will be made transparent, to the maximum extent practicable, through accurate documentation, use of appropriate internal and external review procedures, consultation with experts and users, and verification of the quality of the information disseminated to the public. The NPS will also keep users informed about corrections and revisions.

Information will be developed only from reliable data sources based on accepted practices and policies utilizing accepted methods for information collection and verification. It will be reproducible to the extent possible. Influential information will be produced with a high degree of transparency about data and methods. The information should include all pertinent information to allow the public to understand the park's legislative authorities, mission,

activities, organization, strategic plan, performance plan, and performance accomplishments.

Director's Order #11A section 5.8: Data Integrity Standards (NPS 2005a) outlines the NPS policy for accuracy, completeness and review:

All information owners will maintain all official NPS records and data in a manner which meets the highest data integrity standards, including timeliness, accuracy and completeness (also see DO #11D). Each information owner will take whatever steps necessary to ensure that NPS systems have sufficient data quality reviews and audits from both an internal system perspective, as well as externally thorough control reviews.

Adherence to the data management procedures in this monitoring protocol will ensure compliance with Director's Order 11 (DO#11).

Freedom of Information Act

The Network will comply with all FOIA restrictions regarding the release of data and information as instructed in NPS Director's Order #66B (NPS 2005b).

Records Management

Direction for managing physical and digital materials is provided in NPS Director's Order 11D (NPS 2012).

The NPS has a strong business need for excellent records management, in that the Service's mission is to care for natural and cultural resources so that they are left "unimpaired" for future generations. This requirement for managing resources in perpetuity sets a high standard for record keeping. No resources can be managed well in the future without complete records of how they were managed in the past. Because the NPS manages some of America's most significant cultural and natural resources, the public also has a significant interest in our records. Section 1.9.2 of NPS Management Policies (NPS 2006) states that the future of the Service depends on the availability, management, dissemination, and preservation of information, and directs the agency to implement professional quality programs to manage information resources.

Core Functional Model

Data generated by the ARCN Yellow-billed Loon monitoring program are managed according to the Core Functional Model which was developed by ARCN to illustrate data collection, certification, storage and dissemination (Figure 5).

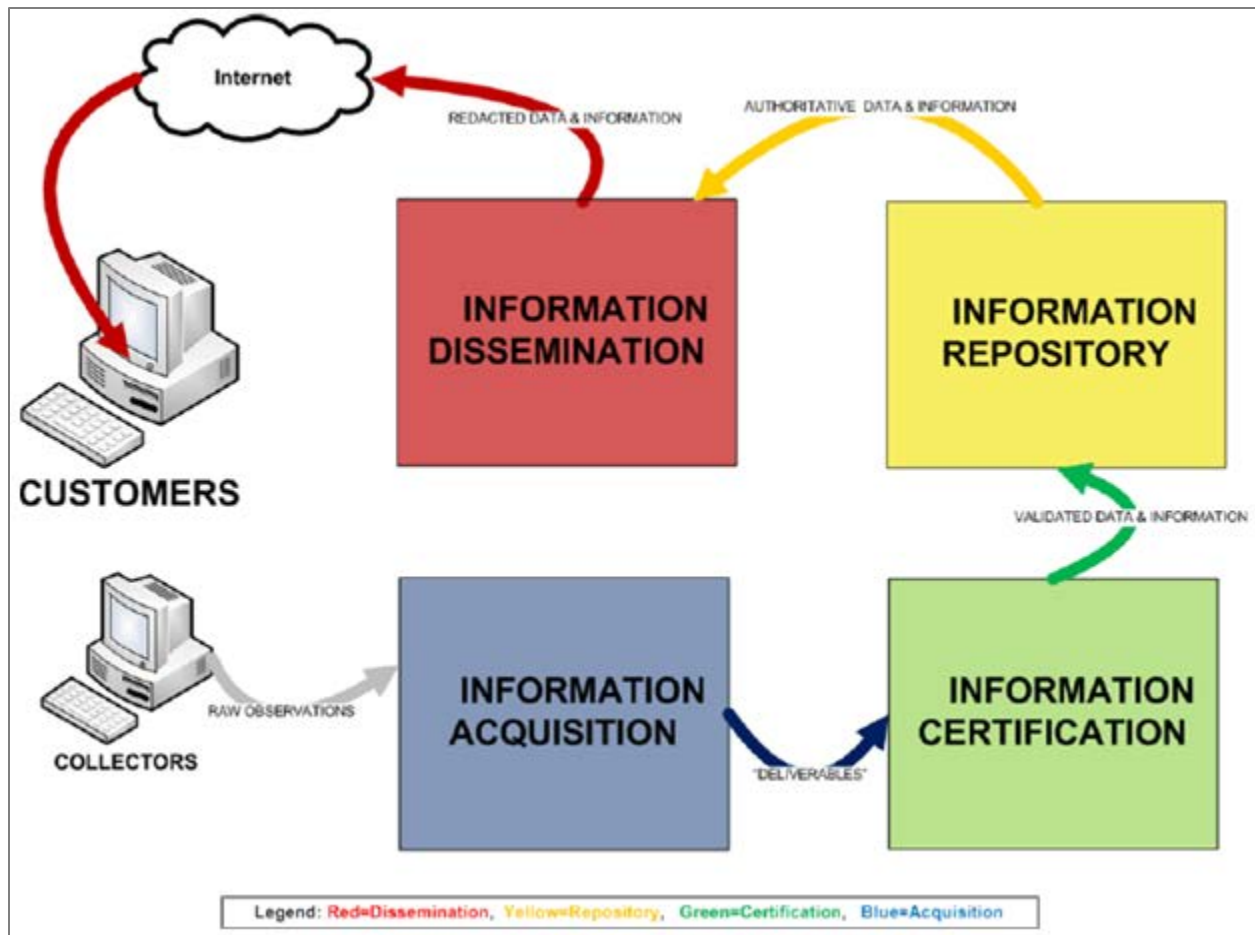


Figure 5. The ARCN Core Functional Model overview.

Data acquisition processes (blue) led by park staff and cooperators include a wide array of tasks, ranging from collecting raw data to composing reports on long-term trends. Certification processes (green) assure repositories have the highest quality data and that sensitive items are restricted to authorized users. Repositories (yellow) store the certified inventory and monitoring products called for in the protocols. Dissemination services (red, Figure 5) provide all deliverables to all customers using internet web sites and web services through the NPS Integrated Resource Management Applications (IRMA) Data Store.

Data Sensitivity Statement

The ARCN Yellow-billed Loon monitoring protocol defines the collection of sensitive data and requires special handling procedures.

The justification for this declaration of sensitivity is that the data deals with ‘rare, threatened, endangered, or commercially valuable species’ (National Parks Omnibus Management Act; NPS 1998). Because Yellow-billed Loons were evaluated as candidate species for listing under the Endangered Species Act (Federal Register 2014), they are still considered a rare and sensitive park resource and an international species of concern. We are cautious about releasing their nesting

locations because the birds return to the same nest sites from year to year and are documented to be very sensitive to human disturbance on the breeding grounds (Earnst 2004). This aligns with NPS policy 4.1.2 (NPS 2006).

Network staff must ensure that all references to protected information are removed or obscured in any reports, publications, maps, or other public forum. Following the standard for Freedom of Information Act (FOIA) requests, the ARCN will segregate the non-releasable information and where practical will not withhold associated releasable information. Metadata for that dataset and the IRMA citation must also be updated to reflect that the associated data is sensitive. Network staff must ensure that all references to protected information are removed or obscured in any reports, publications, maps, or other public forum.

The project leader is responsible for maintaining the security of data released to any NPS dataset catalog and ensuring confidentiality agreements are in place before sharing data with any non-NPS entity.

Roles and Responsibilities

Project Leader

- Ensures that the Yellow-billed Loon monitoring protocol and all of its standard operating procedures are current and up to date. If methods must be changed the project leader ensures that the standard operating procedures remain in sync with actual data management operations.
- Ensures data is collected, processed and integrated with the master database consistently and strictly according to the specifications and methods described in the standard operating procedures.
- Performs an annual closeout with the Network program manager and data manager.
- Certifies the Yellow-billed Loon monitoring dataset for analysis and publication and assures that the Yellow-billed Loon monitoring.
- Performs analytical procedures and reports on findings.
- Arranges technicians and budgets for data management costs, such as data entry and processing.

Data Manager

- Provides for the security, longevity and accessibility of the Yellow-billed Loon monitoring dataset.
- Maintains software and hardware for file backups and security, databases, custom and proprietary applications and GIS tools.
- Guides personnel in data processing techniques, metadata generation and product archival in NPS data stores and enterprise databases.

- The data manager is not responsible for data entry, processing, metadata generation or archiving data deliverables.

Quality Assurance

The Yellow-billed Loon vital sign plans for high data quality assurance by proactively deploying a system of administrative procedures and technological safeguards including:

- Standard operating procedures designed to minimize the introduction of errors during data collection and processing.
- Field crew training.
- Standard database security and integrity functions and data integrity constraints (Frakes *et al.* 2015) to enforce compliance with the Vital Sign's logical data model.
- Application level data entry checks and business rule enforcement.
- Periodic data quality audits and reports.

Data Collection

Data Collection Overview

The Yellow-billed Loon monitoring program creates and maintains specific data deliverables (Table 2 and Appendix A). Raw data deliverable files are collected during surveys and processed for quality (Figure 6). Processed files are certified by the project leader and analyzed. During seasonal closeout the raw deliverables are archived in separate IRMA Data Store references while certified data files are archived in the loon monitoring program's authoritative, public certified IRMA Dataset.

Each deliverable is disseminated directly from the IRMA Data Store, the single authoritative source for Network products. In the event that a data product ever diverges from that in the IRMA Data Store the latter version should be considered authoritative.

An existing file geodatabase (YBLO.gdb) containing all previous years' loon and nest detections, plots and selected lakes needed for the survey is used. A portable iPad with a specialized NPS enterprise application, Park Observer (<http://akrgis.nps.gov/Observer>) for data collection is used during the survey flights. After the day's survey flight, data from Park Observer, GPS waypoints and tracklogs, and photographs are downloaded and saved to a backup drive. They are organized into folders by date and survey crew (tail number of the aircraft). Data collected using the Park Observer are copied and saved to a backup drive and re-imported to the YBLO.gdb. The geodatabase therefore contains spatial data relevant to the survey and these data can be verified against the hard copy data and the pilots' GPS data and edited as needed using ArcGIS (ESRI, Redlands, CA).

Field deliverables will be processed for quality and incorporated into a file-based data management system on IRMA at this Master IRMA Project reference:

<https://irma.nps.gov/App/Reference/Profile/2216938>.

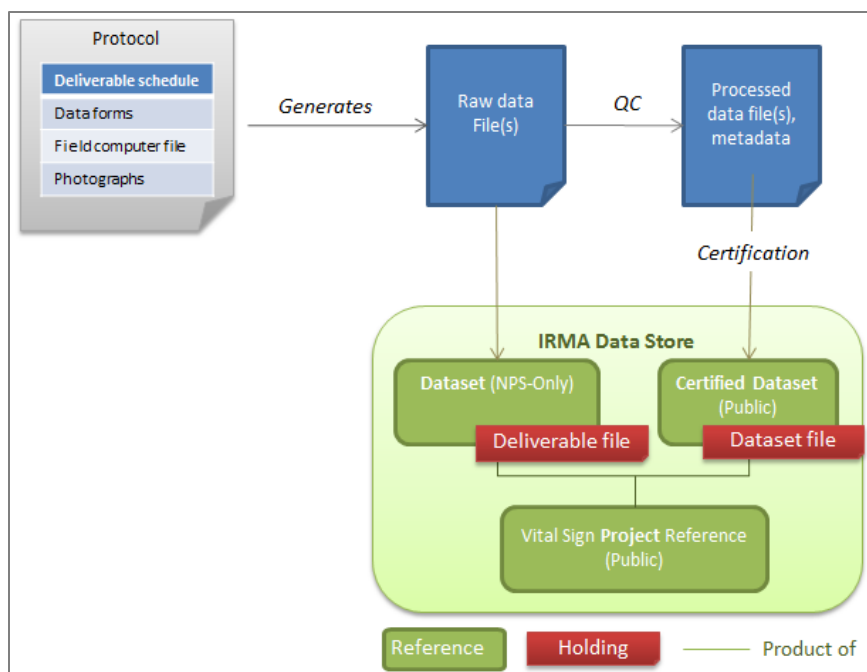


Figure 6. Data products processing and flow diagram. Data deliverables are collected on a cycle, processed to analytical quality, certified, and published to the IRMA Data Store. Raw deliverables are retained in separate IRMA Dataset references.

Deliverables Schedule

The Yellow-billed Loon monitoring program will create and maintain the data products shown in Table 2.

Table 2. Yellow-billed Loon monitoring data deliverables schedule.

Identifier	Deliverable	Format	Schedule	Responsibility*	Description
YB01	YBLO .gdb (by year)	Geospatial layer	Remeasurement + 2 years	PI	Geodatabase containing processed QA/QC-checked survey data from several temporary survey geodatabases, including feature classes/layers of the loon and nest data. There is a different geodatabase for each year.
YB02	YBLO Survey iPad Park Observer application files	.pov, files and affiliated .gdb	Remeasurement + 2 years	PI	Folder containing iPad Park Observer .pov files and affiliated geodatabase containing the raw, field- collected data prior to importing and processing those data in the GIS.

*PI = Principal Investigator

Table 2 (continued). Yellow-billed Loon monitoring data deliverables schedule.

Identifier	Deliverable	Format	Schedule	Responsibility*	Description
YB03	YBLO Survey waypoints	Shapefile	Remeasurement + 2 years	PI	Waypoints collected by the pilot or observer during a loon survey.
YB04	YBLO Survey data booklets and field notebooks	Physical forms and TIFF or PDF scans	Remeasurement + 2 years	PI	Annotated data collection forms in data booklets and field notebooks generated during loon survey.

*PI = Principal Investigator

Data Entry/Import

Field data collection involves aerial surveys to collect the majority of the products in the deliverables schedule above. The following is a brief summary of the data downloading, verification and editing processes; details can be found in SOP 8 (Data Downloading and Backup), SOP 9 (Data QA/QC and Formatting), and SOP 10 (Data Analysis).

At the end of each survey day, the observers will download their iPad Park Observer data into the geodatabase housed on another laptop and compare loon detections for accuracy with their respective pilot's tracklogs and waypoints, if necessary. They will note if the iPad Park Observer data differs greatly from the pilot's tracklogs and waypoints and if the geodatabase needs to be edited in GIS before the final QA/QC and data analysis. They will then verify tabular data from the iPad Park Observer with their data booklets. Any changes to the datasheets should be crossed out with a line, initialed, and the new information written below and should also be transferred to the geodatabase.

The project manager will assemble all data following the surveys and perform a final QA/QC (SOP 9). They will check all original data booklets for legibility and completeness, or will delegate this to a technician. Any remaining discrepancies between the pilots' shapefiles, the datasheets and the iPad Park Observer data will be discussed and corrected with the observer. The data booklets and observer notebooks will be scanned following the final QA/QC. tracklogs, waypoints collected on separate GPS units and photographs used for proofing will be discarded once QA/QC is completed. The final QA/QC proofed data and metadata will be incorporated into the IRMA file management system as a deliverable (see [Product Archival, Seasonal Closeout and Dataset Certification Procedures for the Arctic and Central Alaska Inventory and Monitoring Networks](#); ARCN/CAKN Data Management Standard Operating Procedure #1 (Miller 2017). All digital files should be transferred to the appropriate ARCN network drives for permanent storage (SOP 8).

All loon and nest location data within the geodatabase are processed and edited as needed before analysis. The project manager will verify the geodatabase with the hard copy data (datasheets and photographs) and the pilots' tracklogs and waypoints and edit the geodatabase as needed using ArcGIS (ESRI, Redlands, CA). The geodatabase is then queried and data are extracted into the file format used to run the WinBUGS or OpenBUGS models to generate estimates of occupancy and lake use (Schmidt *et al.* 2014). Refer to SOPs 8 and 9 for additional details about the data QA/QC,

geodatabase editing and formatting that are required for data certification and incorporation into the IRMA Data Store.

Yellow-billed Loon monitoring data is stored in a master IRMA Data Store file base management system at: <https://irma.nps.gov/App/Reference/Profile/2216938>.

Quality Control

Ensuring high data quality is a priority for the Yellow-billed Loon Vital Sign. Quality control procedures focus on verifying data as well as identifying and correcting errors in final data products. Quality control safeguards include:

- Data verification and/or double data entry procedures
- Spot checking
- Automated programmatic range, domain or impossible value checking
- Graphical and visual exploratory data analysis
- Statistical error or outlier identification
- Data quality audits and reporting.
- Dataset certification

Product Archival and Documentation

Director's Order 11D (NPS 2012) states that all records of natural and cultural resources and their management are considered mission-critical records (necessary for fulfillment of the NPS mission) and must be permanently archived. Mission critical deliverables are considered to be archived when they are uploaded to the IRMA Data Store. With few exceptions IRMA is the only authoritative repository for mission critical I&M products.

Data archiving is done in concert with seasonal close out and data certification (ARCN/CAKN DMSOP-1, Miller 2017). All data are archived in the following ways:

- IRMA Data Store. Formats may include:
 - Raw and processed data files described in this protocol's deliverables schedule.
 - Human readable text file of all loon monitoring databases. A SQL script is built that can recreate the entire database and all the data within it.
- Network file server

Loon monitoring program data are maintained on a network file share in the Fairbanks Administrative Center (FAC) in Fairbanks, Alaska and backed up to off-site storage at the NPS Natural Resource Stewardship and Science Directorate (NRSS) in Denver, Colorado and a separate NPS facility in Fairbanks. The NRSS and FAC use enterprise-level business continuity processes to maintain data security. In the event of catastrophe at one site, the original data may be restored from the other.

IRMA Data Store

The NPS IRMA Data Store is the primary organizational repository and publication platform for information related to the Yellow-billed Loon monitoring program. The Yellow-billed Loon Vital Sign has a single master IRMA project reference

(<https://irma.nps.gov/App/Reference/Profile/2216938>) to which all products are related (Figure 7).

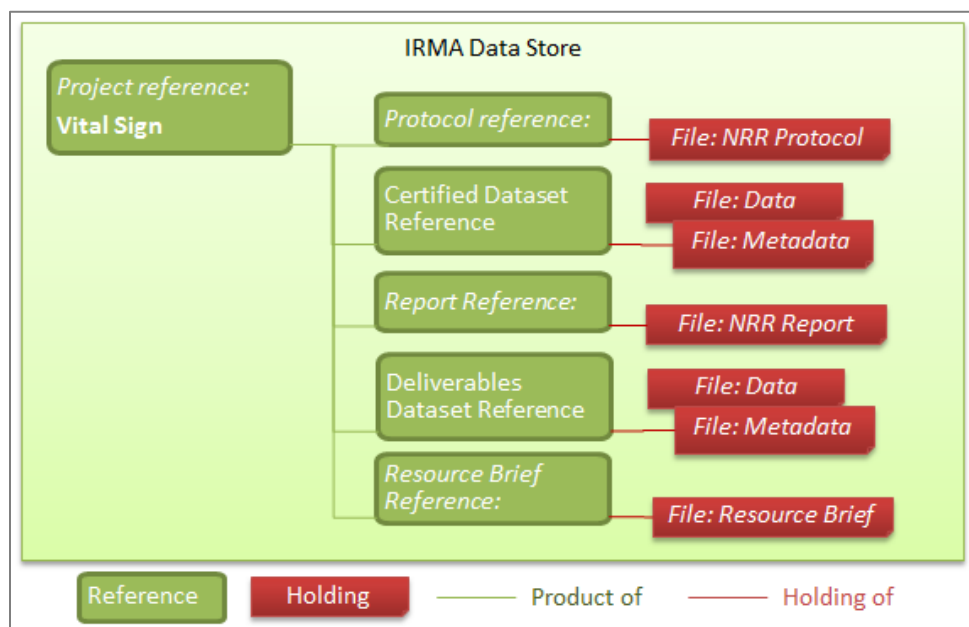


Figure 7. Standard ARCN Vital Sign Project reference architecture in the IRMA Data Store.

The public Vital Sign web page covering Yellow-billed Loon monitoring will publish the releasable contents of this reference and its related references via web services. It is the joint responsibility of the PI and the data manager to keep the system of related IRMA Data Store references up to date.

Reports

Reports are published in the NPS Natural Resource Report publication series

(<https://www.nps.gov/im/publication-series.htm>) or professional journals. Reports and journal articles reporting analytical results will be published in tandem with the dataset that was used.

The PI will create Data Store references for journal articles and reports related to monitoring, link them to the Vital Sign's IRMA Project reference (Figure 7) and notify Network staff of their presence.

Certified Dataset

All reports providing statistical results will also publish the data on which they were based. Metadata will be provided, as well as a link to the certified original dataset (DO 11A, NPS 2005a). Data are made available through IRMA in machine readable formats according to Director's Order #11A (NPS 2005a) and as mandated by the Federal Open Data Initiative (Executive Order No. 13642).

The Yellow-billed Loon vital sign will have a single public dataset reference in the IRMA Data Store to which certified data will be published (Figure 7). This reference will be the only authoritative data source available to the public.

Resource Brief

The I&M resource brief is the primary outreach document for the Yellow-billed Loon monitoring program. The principal investigator will revise any existing resource brief after new findings to reflect current understanding of the resource's trend and implications for park management. Resource briefs are made available on the Network web site through an IRMA Data Store Resource Brief product reference that is attached as a product of the main Vital Sign Project reference (Figure 7).

The Yellow-billed Loon resource brief can be found at:

<https://irma.nps.gov/App/Reference/Profile/2216938>.

Products Publication

Reports, datasets and other monitoring products are published through NPS websites using the Vital Sign's master Data Store Project reference via web services exposed by the IRMA Data Store.

Authoritative products will only be distributed through the IRMA Data Store (Figure 7).

Metadata

All project datasets, including spatial and non-spatial data, are archived in the IRMA Data Store with metadata (DO 11A, NPS 2005a; Figure 7). The mandate for adequate metadata comes from Director's Order #11A (NPS 2005a):

All NPS data systems will develop data dictionaries and conform to available NPS organization-wide dictionaries. Geographic Information and Metadata must meet all Federal standards, DOI standards and NPS standards.

Preferred metadata formats include [Federal Geographic Data Committee](#) (FGDC 1998) and [Ecological Metadata Language](#) (KNB 2017).

Line of Sight

Line of Sight is the informal name given to the I&M program's philosophy that every datum should be inextricably linked to the standard operating procedure and protocol version that guided its collection (Figure 8). This custodial chain is maintained through metadata columns in the main monitoring database coupled with metadata maintained in the protocols' and standard operating procedure's IRMA reference. A data consumer will be reliably able to access a data record and discover the standard operating procedure version that defined its collection and processing.

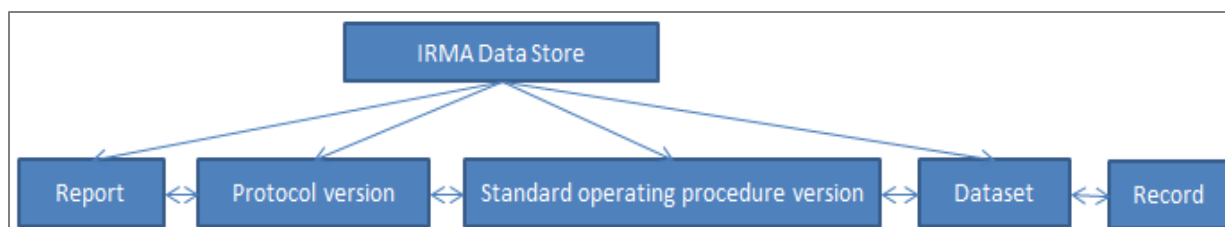


Figure 8. Line of Sight. Each informational component informs and is informed by other components. Discovery of one component leads to discovery of all other components in a formalized data management chain of custody.

Data and Information Security

Digital products produced by the Yellow-billed Loon monitoring program will be stored in the IRMA Data Store and the ARCN Network file server. Under no circumstances will any mission-critical information reside on individual I&M staff computers whether they are assigned to monitoring personnel by the NPS or not. Project materials will be secured and available on I&M servers at all times. The data manager, in conjunction with IT staff at FAC and with the Network support office in Ft. Collins, CO is responsible for backups, security and longevity of monitoring data.

Closeout

Closeout is the part of the loon monitoring data management life cycle through which seasonal data deliverables (Table 2 and Appendix A) and certified data are archived in the IRMA Data Store (Figure 6 and 7). The loon monitoring program will follow the procedures described in ‘[Product Archival, Seasonal Closeout and Dataset Certification Procedures for the Arctic and Central Alaska Inventory and Monitoring Networks](#)’: ARCN/CAKN Data Management Standard Operating Procedure #1’ (Miller 2017).

Closeout happens after a re-measurement cycle when data files have been collected, processed and certified. Deliverables and the certified dataset are archived as holdings of private and public Dataset References in the IRMA Data Store (Figure 6 and Figure 43; Miller 2017). Closeout is complete when seasonal Dataset holdings reconcile with the deliverables schedule (Figure 9).

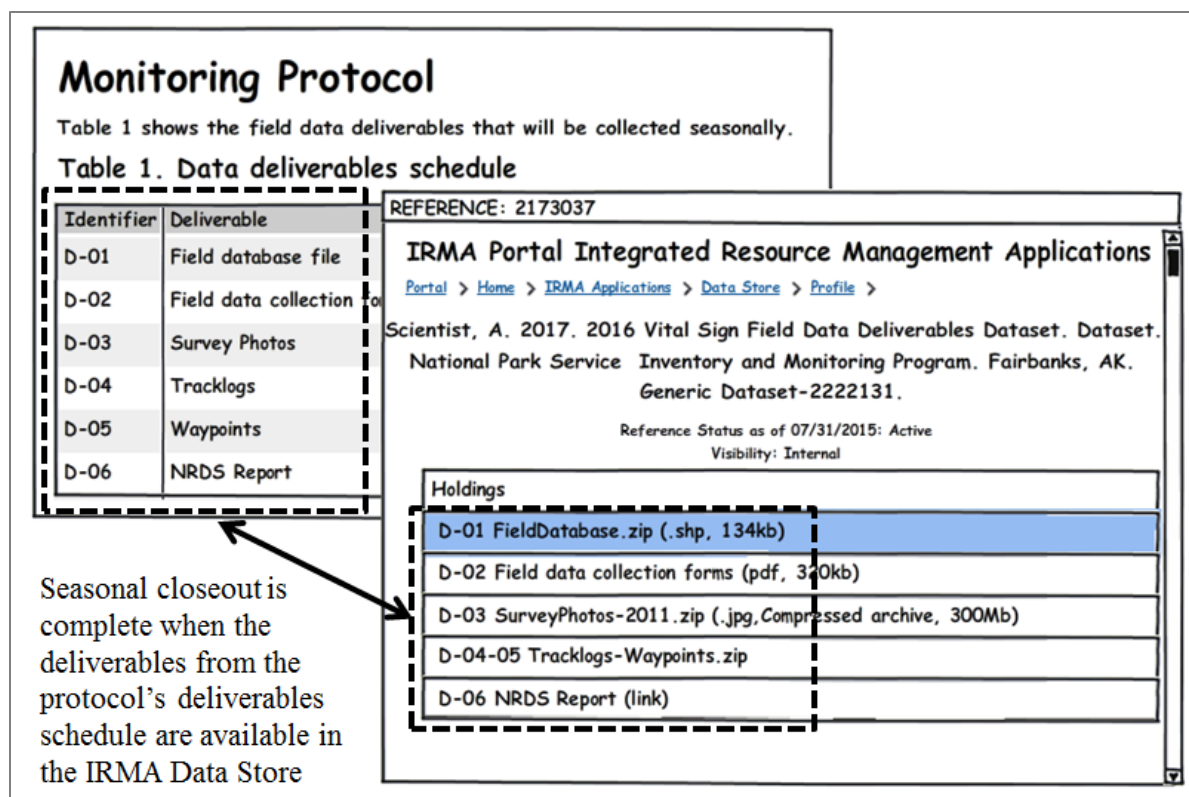


Figure 9. Example of reconciling loon monitoring published holdings in the IRMA Data Store with the protocol's data deliverables schedule. Data deliverables are defined in the monitoring protocol. These deliverables are archived in Dataset references in the IRMA Data Store. Closeout is complete when the holdings in the Dataset reference reconcile with the deliverables in the deliverables schedule.

After closeout all permissions are removed from references except for the project leader and data manager. The references are then linked to the main loon monitoring IRMA Project reference so that it becomes discoverable.

Certification

Certification is the phase of the Yellow-billed Loon monitoring data management life cycle where the principal investigator formally confirms that the Vital Sign's dataset is ready for analysis (NPS 2016). Certification also affirms the scientific, administrative and technical integrity of the program including:

- The protocol and standard operating procedures are current. All technical changes are up to date and documented.
- Raw and intermediate data deliverables have been processed via quality control procedures, have been integrated with the Vital Sign's database or data management system and have been archived and documented appropriately for posterity.
- Each data record is traceable to the protocol version and SOP version that guided its collection.

- All closeout activities have been performed.
- The certified database or data files have been published to the Vital Sign's public Dataset reference in the IRMA Data Store.
- The Vital Sign's IRMA Data Store references and cross-links are complete.
- The dataset is of sufficient quality that analyses may be performed on it and the results published.

Certification procedures will follow the instructions in '[Product Archival, Seasonal Closeout and Dataset Certification Procedures for the Arctic and Central Alaska Inventory and Monitoring Networks](#): ARCN/CAKN Data Management Standard Operating Procedure #1' (Miller 2017).

Analysis and Reporting

Analysis

Data analysis procedures are described in detail in Schmidt et al. (2014) and in SOP 10. In general, a Bayesian dynamic multistate occupancy modeling approach is used to estimate the number of lakes that are either used by loons or used by loons for nesting. Because Yellow-billed Loons are rare, observations of other species are included in this framework to add information on the detection process, improving estimation of the parameters of interest. Data from each year are included in the occupancy analysis, therefore trends can be assessed directly. Estimates will be presented as means with 95% Bayesian credible intervals.

Reporting

Written reports will consist of: 1) survey summary reports, 2) annual administrative reports, 3) resource briefs, and 4) peer-reviewed articles in scientific journals or the NPS Natural Resources Report series (NRR). These reports may be written by the PI and/or ARCN and park unit staff. Oral reporting may consist of presentations to the ARCN technical committee, subsistence committees, and presentations at scientific conferences. Detailed interpretation of estimates, including trend estimates, will occur at longer time intervals (e.g., after 3-4 surveys), and will be published as peer-reviewed articles or as NRR reports. The target audience for these more comprehensive publications will be the scientific community. Such publications will document long-term trends or further methodological advances and will include maps, graphs, figures, and other visuals to facilitate comprehension of findings. All products will be made available on the IRMA Data Store.

Budget

The estimated annual cost (based on FY2016 dollars) of implementation of the Yellow-billed Loon Monitoring Protocol is presented in Table 3. The budget is based on estimated sampling costs of two pilot/observer crews and one alternate observer/data manager team for all work. The ARCN may have sampling performed by non-NPS personnel due to limited staff or pilot availability and may have to increase costs to use partners (e.g., USFWS staff, vendor pilots) when developing those contracts and agreements. Parks may provide support for monitoring, including staff participation in sampling, funding, logistical support and housing. This budget does not include support provided by parks or other partners, other than indicated savings on lodging at federal bunkhouse in Kotzebue, Alaska.

Table 3. Estimated annual operating cost (based on FY2016 dollars) for implementation of the ARCN Yellow-billed Loon Monitoring Protocol.

Category	Item	Costs (FY 2016)	Notes
Personnel	YUGA Biologist	1,000	0.07 FTE GS-11-base salary, in kind
	ARCN Data Manager	1,000	0.06 FTE GS-12- base salary, in kind
	YUGA Biology technician	1,000	0.21 FTE GS-5- base salary, in kind
	USFWS Biologist	1,500	0.21 FTE GS-11-base salary, in kind
	2 x OAS Pilots	3,000	0.21 FTE GS-12-base salary, in kind
Total Personnel Costs	—	\$ 7,500	—
Equipment & Supplies	Aviation Fuel (2 planes)	5,000	Assuming that WEAR supplies fuel out of park tank. Includes fuel for ferrying both aircraft to Kotzebue
	Field Supplies	1,000	
	Freight	1,500	RT; Food and field gear
Total Equipment Costs	—	\$ 8,500	—
Travel	Lodging in Kotzebue	1,250	lodging provided at federal bunkhouse 5 people, 10 days
	Airfare	3,000	RT commercial seat fare for 3 crew members (pilots ferrying aircraft to and from Kotzebue)
	Group Food	1,000	Food for 5 people for 10 days
	OAS flights	18,500	2 OAS tandem aircraft flying surveys (80-90 hrs of combined flight time)

Table 3 (continued). Estimated annual operating cost (based on FY2016 dollars) for implementation of the ARCN Yellow-billed Loon Monitoring Protocol.

Category	Item	Costs (FY 2016)	Notes
Total Travel Costs per field year	–	\$ 20,250	–
Total Protocol Implementation Cost per field year	–	\$ 39,750	Estimated total implementation cost for each field-year

The YUGA Biologist (PI) provides project oversight. Aerial surveys are performed by 2 GS-11 permanent Biologist, 1 GS-05 bio-technician, and 2 GS-12 permanent OAS or vendor Pilots. Data management is supervised by the ARCN Data Manager (1 GS-12 permanent). Surveys occur biennially. Every other year is used for data analysis and reporting. A total of 48 plot surveys (2 visits x 24 plots) may be conducted per year. This requires approximately 45-50 hours of flight time per survey crew to fly all 24 plots. The following budget is for one (1) sampling year = 10 field-days and 24 plots sampled by two pilot/observer crews.

Safety

Implementation of this protocol has multiple complex risks. Staff will continuously evaluate all risks at the programmatic, personnel, and site level. Programmatic-level safety information is presented here and procedures to mitigate risks associated with specific activities related to protocol implementation (such as safe operations of aircraft, vehicle use and operation, injury reporting and accident reporting) are addressed in standard operating procedures below.

Job Hazard Analyses (JHAs) were completed for all personnel who implement portions of the protocol in which risks and risk abatement strategies (including training needs) were identified. Risks and abatement strategies for all staff were synthesized to develop a protocol-level JHA. The protocol JHA was then used to perform a programmatic-level Green-Amber-Red (GAR) risk analysis to assess whether implementation of this protocol could be accomplished within an acceptable level of risk.

Specific safety concerns include:

- Crew members will spend many hours (and miles) flying in small aircraft in remote areas and at low altitude over large water bodies between sampling locations to conduct the requisite sampling.
- Crew members may be working in remote, park areas outside of communications range (either by park radio or by cell phone).
- Crew members will be exposed to extreme inclement weather and will be working for extended periods of time in remote areas and at low altitude with potentially rapidly-changing and severe weather conditions.
- Crew members will be frequently exposed to hazardous wildlife (bears, muskoxen, moose, wolves, etc.), and potentially hazardous materials and equipment, (remote aviation fueling).

Injury or loss of life while in transit to and from field sites and during sampling activities within sites as well as while in transit to or from sampling sites via aircraft — are the most significant risks encountered when conducting this activity.

Based on the JHA and associated risk abatement measures it was determined that this protocol can be safely implemented provided that ARCN and partner staff implement it in accordance with the referenced SOPs and recommended risk abatement strategies. In addition to SOPs that have been developed to safely implement this protocol, specific training needs for all staff have been identified including certification in basic and wilderness first aid, aviation training, bear safety and remote communications. To increase the overall level of safety and awareness, obtaining additional levels of training beyond basic certifications will be encouraged.

Safety procedures will be routinely reviewed with Network staff and partners before field operations as prescribed in SOPs. Personnel-level JHAs for staff will be reviewed and revised annually as a part

of the performance review cycle. Safety SOPs are reviewed at least annually and updated as necessary to ensure that they adequately mitigate risks to personnel, property, and the public.

In addition to protocol-specific safety procedures and guidelines, ARCN and partner staff will follow the general guidelines set forth in the NPS Occupational Safety and Health Program (NPS 2008c).

Standard Operating Procedures

To ensure consistent implementation of this protocol over time, the following Standard Operating Procedures (SOPs) have been adopted from the ARCN Sheep SOPs, USFWS methods or developed as needed for ARCN Yellow-billed Loons (Table 4). To the greatest extent possible, SOPs are adopted from procedures approved and implemented programmatically through other monitoring efforts. All approved SOPs will be published in the NPS Natural Resource Report series and the latest approved versions of operational SOPs are always available for download at the NPS Integrated Resource Management Applications portal at <http://irma.nps.gov>. The SOPs will exist as separate stand-alone documents on the master IRMA Data Store in a file data management system: <https://irma.nps.gov/App/Reference/Profile/2216938>.

Table 4. Standard Operating Procedures required to implement the Yellow-billed Loon Monitoring Protocol in ARCN parks (CAKR and BELA). Table lists SOPs by task category. All Standard Operating Procedures available from the Data Store: <https://irma.nps.gov/App/Reference/Profile/2216938>.

Subject	SOP	Citation	Notes
Field Prep	1	Flamme, M. J. and K. L. Rattenbury. 2018. Standard Operating Procedure (SOP) 1: Preparations for Field Season. Protocol for Monitoring Yellow-billed Loons in Arctic (ARC�) Inventory and Monitoring Network. National Park Service, Fairbanks, Alaska.	Modified from SOP 1, ARCN Sheep: Rattenbury, K. L., and J. H. Schmidt. 2017. Standard Operating Procedure (SOP) 1: Preparations for the Field Season, Version 1.0. Protocol for Monitoring Dall's Sheep, Arctic (ARC�) and Central Alaska (CAKN) Inventory and Monitoring Networks. National Park Service, Fairbanks, Alaska. https://irma.nps.gov/DataStore/Reference/Profile/2238902
Field iPad Setup	2	Flamme, M. J., D. T. Schertz, and K. L. Rattenbury 2018. Standard Operating Procedure (SOP) 2: Field iPad Set up. Protocol for Monitoring Yellow-billed Loons in Arctic (ARC�) Inventory and Monitoring Network. National Park Service, Fairbanks, Alaska.	Modified from http://akrgis.nps.gov/observer/no-wifi.htm and SOP 3, ARCN Sheep: Rattenbury, K. L. and J. H. Schmidt. 2017. Standard Operating Procedure (SOP) 3: Field Computer Setup, Version 1.0. Protocol for Monitoring Dall's Sheep, Arctic (ARC�) and Central Alaska (CAKN) Inventory and Monitoring Networks. National Park Service, Fairbanks, Alaska. https://irma.nps.gov/DataStore/Reference/Profile/2238916
Training	3	Flamme, M. J. and K. L. Rattenbury. 2018. Standard Operating Procedure (SOP) 3: Training. Protocol for Monitoring Yellow-billed Loons in Arctic (ARC�) Inventory and Monitoring Network. National Park Service, Fairbanks, Alaska.	Modified from SOP 5, ARCN Sheep: Rattenbury, K. L. and J. H. Schmidt. 2017. Standard Operating Procedure (SOP) 5: Training, Version 1.0. Protocol for Monitoring Dall's Sheep, Arctic (ARC�) and Central Alaska (CAKN) Inventory and Monitoring Networks. National Park Service, Fairbanks, Alaska. https://irma.nps.gov/DataStore/Reference/Profile/2238919

Table 4 (continued). Standard Operating Procedures required to implement the Yellow-billed Loon Monitoring Protocol in ARCN parks (CAKR and BELA). Table lists SOPs by task category. All Standard Operating Procedures available from the Data Store: <https://irma.nps.gov/App/Reference/Profile/2216938>.

Subject	SOP	Citation	Notes
GPS Setup	4	Flamme, M. J and K. L. Rattenbury. 2018. Standard Operating Procedure (SOP) 4: GPS Setup. Protocol for Monitoring Yellow-billed Loons in Arctic (ARCN) Inventory and Monitoring Network. National Park Service, Fairbanks, Alaska.	Modified from SOP 4, ARCH Sheep: Rattenbury, K. L. and J. H. Schmidt. 2017. Standard Operating Procedure (SOP) 4: GPS Setup, Version 1.0. Protocol for Monitoring Dall's Sheep, Arctic (ARCN) and Central Alaska (CAKN) Inventory and Monitoring Networks. National Park Service, Fairbanks, Alaska. https://irma.nps.gov/DataStore/Reference/Profile/2238918
Equipment Lists	5	Flamme, M. J. and K. L. Rattenbury. 2018. Standard Operating Procedure (SOP) 5: Equipment Lists. Protocol for Monitoring Yellow-billed Loons in Arctic (ARCN) Inventory and Monitoring Network. National Park Service, Fairbanks, Alaska.	Modified from SOP 6, ARCN Sheep: Rattenbury, K. L. and J. H. Schmidt. 2017. Standard Operating Procedure (SOP) 6: Field Equipment Lists, Version 1.0. Protocol for Monitoring Dall's Sheep, Arctic (ARCN) and Central Alaska (CAKN) Inventory and Monitoring Networks. National Park Service, Fairbanks, Alaska. https://irma.nps.gov/DataStore/Reference/Profile/2238920
Flying Surveys	6	Flamme, M. J. 2018. Standard Operating Procedure (SOP) 6: Flying Surveys. Protocol for Monitoring Yellow-billed Loons in Arctic (ARCN) Inventory and Monitoring Network. National Park Service, Fairbanks, Alaska.	Modified from SOP 7, ARCN Sheep: Rattenbury, K. L. and J. H. Schmidt. 2017. Standard Operating Procedure (SOP) 7: Flying Transects, Version 1.0. Protocol for Monitoring Dall's Sheep, Arctic (ARCN) and Central Alaska (CAKN) Inventory and Monitoring Networks. National Park Service, Fairbanks, Alaska. https://irma.nps.gov/DataStore/Reference/Profile/2238927 ; Bollinger, K. S., R. Platte and R. Stehn, D. K. Marks. 2007. Western Alaska Yellow-billed Loon survey – 2007. Unpubl. report, U. S. Fish and Wildlife Service, Fairbanks, Alaska. 14pp.
Data Collection	7	Flamme, M. J., D. T. Schertz, K. L. Rattenbury and J. H. Schmidt. 2018. Standard Operating Procedure (SOP) 7: Data Collection. Protocol for Monitoring Yellow-billed Loons in Arctic (ARCN) Inventory and Monitoring Network. National Park Service, Fairbanks, Alaska.	Modified from SOP 8, ARCN Sheep: Rattenbury, K. L. and J. H. Schmidt. 2017. Standard Operating Procedure (SOP) 8: Data Collection, Version 1.0. Protocol for Monitoring Dall's Sheep, Arctic (ARCN) and Central Alaska (CAKN) Inventory and Monitoring Networks. National Park Service, Fairbanks, Alaska. https://irma.nps.gov/DataStore/Reference/Profile/2238928 ; Bollinger, K. S., R. Platte and R. Stehn, D. K. Marks. 2007. Western Alaska Yellow-billed Loon survey – 2007. Unpubl. report, U. S. Fish and Wildlife Service, Fairbanks, Alaska. 14pp.

Table 4 (continued). Standard Operating Procedures required to implement the Yellow-billed Loon Monitoring Protocol in ARCN parks (CAKR and BELA). Table lists SOPs by task category. All Standard Operating Procedures available from the Data Store: <https://irma.nps.gov/App/Reference/Profile/2216938>.

Subject	SOP	Citation	Notes
Data Downloading And Backup	8	Flamme, M. J., D. T. Schertz, K. L. Rattenbury. 2018. Standard Operating Procedure (SOP) 8: Data Downloading and Backup. Protocol for Monitoring Yellow-billed Loons in Arctic (ARCN) Inventory and Monitoring Network. National Park Service, Fairbanks, Alaska.	Modified from http://akrgis.nps.gov/observer/no-wifi.htm ; SOP 9, ARCN Sheep: Rattenbury, K. L. and J. H. Schmidt. 2017. Standard Operating Procedure (SOP) 9: Data Downloading and Backup, Version 1.0. Protocol for Monitoring Dall's Sheep, Arctic (ARCN) and Central Alaska (CAKN) Inventory and Monitoring Networks. National Park Service, Fairbanks, Alaska https://irma.nps.gov/DataStore/Reference/Profile/2238929
Data QA/QC And Formatting	9	Schertz, D. T., M. J. Flamme, K. L. Rattenbury and J. H. Schmidt. 2018. Standard Operating Procedure (SOP) 9: Data QA/QC and Formatting. Protocol for Monitoring Yellow-billed Loons in Arctic (ARCN) Inventory and Monitoring Network. National Park Service, Fairbanks, Alaska.	Modified from ARCN Sheep: Rattenbury, K. L. and J. H. Schmidt. 2017. Standard Operating Procedure (SOP) 11: Data QA/QC, Formatting and Archiving, Version 1.0. Protocol for Monitoring Dall's Sheep, Arctic (ARCN) and Central Alaska (CAKN) Inventory and Monitoring Networks. National Park Service, Fairbanks, Alaska. https://irma.nps.gov/DataStore/Reference/Profile/2238931
Data Analysis	10	Schmidt, J. H. and M. J. Flamme 2018. Standard Operating Procedure (SOP) 10: Data Analysis. Protocol for Monitoring Yellow-billed Loons in Arctic (ARCN) Inventory and Monitoring Network. National Park Service, Fairbanks, Alaska.	Modified from ARCN Sheep: Modified from ARCN Sheep: Rattenbury, K. L. and J. H. Schmidt. 2017. Standard Operating Procedure (SOP) 12: Data Analysis, Version 1.0. Protocol for Monitoring Dall's Sheep, Arctic (ARCN) and Central Alaska (CAKN) Inventory and Monitoring Networks. National Park Service, Fairbanks, Alaska. https://irma.nps.gov/DataStore/Reference/Profile/2238933

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Appendix A. Deliverables Schedule

Deliverable YB 01: YBLO.gdb (Geodatabase)

YBLO.gdb is the field ESRI geodatabase from iPads with the Park Observer application containing 1) Survey_area layer, 2) Plots layer, 3) Lakes layer, 4) Centroid_lakes layer, 5) DB TrackLog layer, 6) Park_outline layer 7) Loon_Obs layer, 8) GPSPointsLog layer. Full processing instructions are in SOPs 8 and 9. Schedule: Remeasurement date + 2 year. Responsibility: PI

Deliverable YB 02: iPad Park Observer application survey files (.pov, .csv)

Deliverable YB 02 is the iPad application layers (set of shapefiles within a 'Survey' folder) exported from Park Observer on the iPad and pulled into the YBLO.gdb for ArcGIS after being converted to shapefiles. Data are collected within Park Observer (Loon and nest detections, Tracklog, GPSPointsLayer, Plots and Lakes) on the iPad in the survey planes and reimported into temporary survey geodatabase and then into the main long-term YBLO.gdb at the end of each survey day. Full processing instructions are in SOP 8 and 9. Schedule: Remeasurement + 2 years. Responsibility: PI.

Deliverable YB 03: Survey waypoints

Waypoints collected by the pilot or observer during a loon survey with a GPS unit by the pilots, observers or both. These are backup for points collected for the geodatabase as well as locations of loons and nests observed outside of plots or on non-selected lakes within plots, and other wildlife observations that do not go into the main analysis. Shapefile, .pov, .csv or text format. Full processing instructions are in SOPs#4 and 8. Schedule: Remeasurement + 2 years. Responsibility: PI.

Deliverable YB 04: Survey data collection forms and notebooks

Scanned, annotated data booklets, and yellow field notebook generated during a loon survey in TIFF or Portable Document Format (pdf). Physical files to be filed with PI and curated with regional curation. Full processing instructions are in SOP#7. Schedule: Remeasurement + 2 years. Responsibility: PI.

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.

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National Park Service
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