Alaska Park Science

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Anchorage, Alaska

Birds of Alaska's National Parks

In this issue:

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Table of Contents

Cover photo: A black oyster catcher in Kenai Fjords National Park protects its eggs.

NPS photo

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Opposite: Black oystercatcher.

NPS photo by K. Thoreson

Swan Song

By Robert Winfree

We're focusing this issue of *Alaska Park Science* (APS) on birds: their natural history, local and traditional knowledge, field studies, and scientific research in Alaska's national parks. Twice a year, *Alaska Park Science* publishes information from all pertinent disciplines of science, scholarship, and related humanities. Several previous issues have focused on subjects suggested by our readers, so it's only natural that we should include an issue devoted to birds. After all, people have been observing wild birds, and harvesting birds and bird eggs for food, utilitarian, and cultural purposes for much longer than anyone could write about it. Birders like John James Audubon and Roger Tory Peterson were leaders in the American conservation movement, and I'm probably not the only APS reader whose interests in nature, science, and conservation were sparked by their interactions with wild birds as a child.

In this issue, Carol McIntyre and Laura Phillips discuss migratory birds and biology. Davyd Betchkal et al. describe new approaches for recording and identifying bird vocalizations and using sound data for population monitoring. Mary Beth Moss and Tania Lewis explain the cultural importance of gull egg harvests in Alaska. Rachel Mason and Eileen Devinney, Don Callaway, and Carrisa Turner and Dennis Bailey demonstrate how citizen scientists have made important ornithological contributions for a very long time, and still do. John Dennis describes the pre-ANILCA, or Alaska National Interest Lands Conservation Act, days of park science in Alaska from personal experience.

My apologies for the double entendre—*Swan Song*—as the title of this introduction, but I couldn't resist. The very first issue of APS was almost complete when my family arrived in Alaska in 2002. With publication of this 29th issue; my tenure at the helm of APS has come to an end. I retired from the National Park Service (NPS) last summer (July 2015) and have moved on to new challenges. APS will of course continue to publish more issues about science in Alaska's national parks, with my colleague and friend Dr. Lois Dalle-Molle serving as the new NPS point of contact for publishing with Alaska Geographic.

Producing APS has been an exciting, educational, and personally rewarding journey. Creating new issues has involved working with authors, editors, designers, photographers, artists, supporters, webmasters, publishers, and distributors of printed and digital editions; while continuously incorporating insightful suggestions from board members, readers, reviewers, and critics. I think that it's fair to say that every new issue has been a learning process for us, always by choice but sometimes also by necessity—such as when we went paperless in 2015, to keep pace with evolving technologies, reading habits, accessibility standards, and escalating printing and mailing costs.

The most rewarding aspect for me has been the opportunity to explore and share the amazing wealth of scientific and scholarly activities underway in Alaska. A few months ago, I was also invited to write a chapter on national parks for a new book about southwestern Alaska. I was delighted to discover that much of the information that I needed for my chapter was readily available in the archives of APS articles and images.

We hope that our efforts to produce *Alaska Park Science* have also been rewarding for our readers and that you continue to make good use of new issues as they continue to be produced, new formats for portable reading devices, and new digital distribution channels. May your own explorations always lead to exciting discoveries and new questions.

Figure 1. Swans

Photo by Bob Winfree.

Avian Soundscape Ecology in Denali National Park and Preserve

By Davyd Betchkal, Carol McIntyre, Melanie Roed, and Jason Reppert

Take a moment to imagine a misty June morning in Denali National Park. Now place yourself within the aural context: From all around you comes the spiraling song of Swainson's thrush, the mirror-image retorts of contested white-crowned sparrows, and the bell-like ringing of a dark-eyed junco. These, and the vocalizations of other species too distant to identify, combine to form the ambience of an open spruce woodland habitat.

It may surprise you to find the National Park Service recognizes and protects these songs as part of the entirety of the natural acoustic environment. Direction for management of the natural acoustic environment is represented in 2006 Management Policy 4.9: "The Service will restore to the natural condition wherever possible those park soundscapes that have become degraded by unnatural sounds (noise), and will protect natural soundscapes from unacceptable impacts" (*NPS 2006a*).

The initial push for Denali to inventory the acoustic environment was Director's Order 47 (*DO-47; NPS 2000*). Robert Stanton issued the order in 2000, stating that "natural sounds are intrinsic elements of the environment that are often associated with parks and park purposes…They are inherent components of 'the scenery and the natural and historic objects and the wild life' protected by the NPS Organic Act." DO-47 directed park managers to "(1) measure baseline acoustic conditions, (2) determine which existing or proposed human-made sounds are consistent with park purposes, (3) set acoustic management goals and objectives based on those purposes, and (4) determine which noise sources are impacting the park and need to be addressed by management." Furthermore, it requires park managers to "(1) evaluate and address self-generated noise, and (2) constructively engage with those responsible for other noise sources that impact parks to explore what can be done to better protect parks" (*NPS 2000*).

Since 2000, the Natural Sounds and Night Skies Division of the National Park Service has sought to improve the ability of parks to comply with these directions. Developing a method to collect relevant information on the acoustic environment was the first challenge. In the absence of readily-available commercial products for acoustic monitoring, the NPS has led the way for land management agencies by developing an autonomous system that can provide both American National Standards Institute (ANSI) certified acoustic levels (i.e., numeric measurements of sound pressure level in decibel units,) and audio recordings (i.e., sound that one can listen back to in headphones.) ANSI also recommends the collection of meteorological data concurrent with measurements of sound pressure level. Thus, a simple weather station incorporating wind speed, wind direction, temperature, and relative humidity is also part of the acoustic monitoring station. Figure 2 shows an external photograph of a typical station. A simplified schematic of the internal signal routing is presented in Figure 3.

Since 2006, Denali has been using such automated acoustic equipment to conduct a spatially balanced inventory of the park's acoustic environment on a grid at the 6.2 x 6.2 mile scale (10 x 10 kilometers.) The effort is part of the Central Alaska Network long-term monitoring program. At present, staff members have collected data at 85 unique sites, making the dataset the most expansive in the nation. Detailed descriptions of the soundscape at each of these sites can be found in annual Denali soundscape monitoring reports (*Withers and Hults 2006; Withers 2010; Withers 2011; Withers 2012; Withers and Betchkal 2013; Betchkal 2013a; and Betchkal 2013b*). We can infer much about Denali's natural acoustic environment from such data.

It is especially enticing to apply these data to the study of soundscape ecology, a field that has advanced rapidly in the last few decades. Soundscape ecology is the interface

Figure 1. Boreal chickadee

NPS photo by Tim Rains

Figure 2. Photograph of a standardized NPS acoustic monitoring station, deployed in Denali National Park atop Sushana Ridge, May 2012. Components necessary to power the station are the solar panel and 12-volt battery bank. Components necessary for the collection of acoustical data are the microphone/microphone housing, acoustic instrumentation/housing, and meteorological instrumentation.

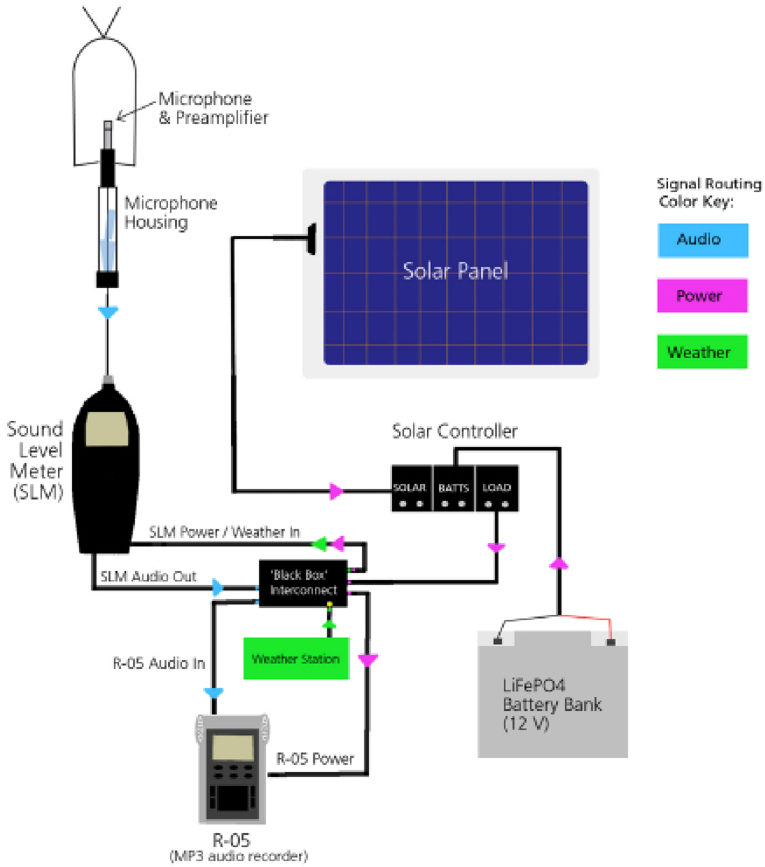

Figure 3. (right) Schematic of a standardized NPS acoustic monitoring station. The system is powered by 12-volt Lithium-Iron-Phosphate (LiFePO4) batteries that are replenished through a solar power system. The battery, in turn, powers several devices: a sound level meter (SLM), an MP3 audio recorder, and basic meteorological instruments. The audio signal begins with a carefully housed and calibrated microphone. Wires route the signal first through the SLM, and then into the audio recorder. The SLM logs acoustic and meteorological measurements every second.

between biology and acoustics that focuses primarily on community-based measures (*Pijanowski et al. 2011*). As such, it is concerned with the total assemblages of sound across a range of spatial and temporal scales. Contrast this with the role that sound recording has played historically in the study of bioacoustics: short clips documenting specific instances of communication or behavior in one or a few species. Though assemblages of short recordings or species-specific studies are valuable scientific information, the recent transition in scope reflects the increasing ability of sound recording devices to address previously unapproachable community scale questions. One thing is clear, at least. Since their inception in 1877, sound recording devices have become steadily more reliable as instruments of field science. More than ever, they are compact and resistant to the elements. They reproduce signals with greater fidelity. Their demand for power has dropped precipitously, while at the same time their memory capacity has expanded. Improved computation and file transfer speed has contributed to the feasibility of working with and archiving large audio recordings.

Ecologists have responded to these advances by rigorously testing the application of such systems. As early

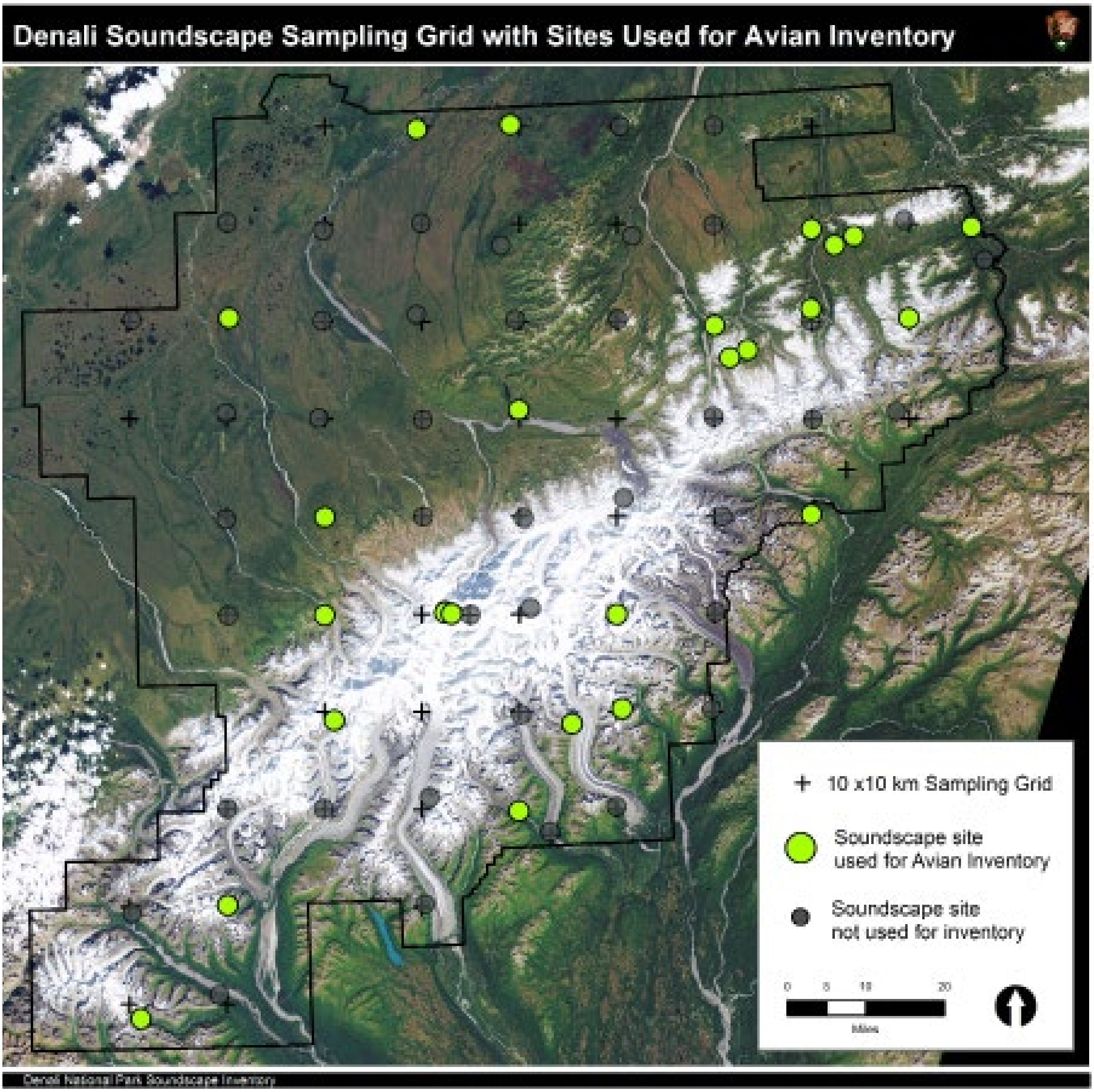

Figure 4. Map of Denali National Park and Preserve indicating the soundscape inventory grid, soundscape inventory sites with audio during the peak of avian breeding season (April 15 through June 30), and the remaining inventory sites.

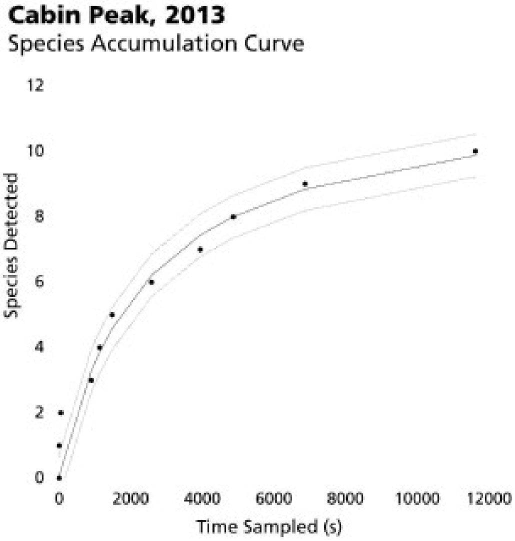

Photo by Davyd Betchkal

Figure 5. Species accumulation curve for Cabin Peak, 2013. The graph shows the effects of ecological rarefaction—a technique that relies on the tendency for lower density species to take longer to detect. (Physicists use the term rarefaction to describe a decrease in density.) In other words, the graph shows how the detection rate diminishes with continued sampling effort. After creating such a curve, species richness can be estimated from the asymptote. The adjoining photograph shows the open low scrub habitat at the Cabin Peak site, as situated above the spruce forests that line the Toklat River.

as 1957, ornithologists were using sound recording devices to estimate the density of nocturnally migrating songbirds (*Graber and Cochran 1959*). However, such early examples of audio-based avian ecology techniques are somewhat rare. It was not until the digital era of the 1990s that the scientific community began to fully realize audio recorders as tools. For instance, researchers recognized that audio recordings offer a permanent record that could be valuable in situations where many vocalizations overlap, allowing an analyst to listen to the same sound repeatedly in an effort to increase accuracy (*Haselmayer and Quinn 2000*). Other researchers saw the objectivity of microphones and the ability to archive audio data among the benefits of the technique (*Hobson et al. 2002*). The National Park Service itself has studied the effectiveness of acoustic monitoring equipment to supplement traditional avian point counts for over a decade (*Daw and Ambrose 2003*).

Research has shown that traditional metrics like species richness can be determined effectively from sound recordings (*Wimmer et al. 2013*); while others have envisioned methods for deriving density estimates from audio techniques (*Marques et al 2013*). Some researchers have proposed new metrics calculated directly from the audio data, such as the Acoustic Complexity Index (ACI). ACI quantifies the variability contained within the sound of diverse assemblages of birds (*Pieretti et al. 2011*). Changes in variability offer a rapid indirect assay of richness or biological behavior through time.

Many of these research projects are inextricable from another topic suitable to study via sound recording: human noise. An eagerness to understand the effects of noise on avifauna has led many people to learn and use acoustic methods. Again, over time research has trended away from a short-term organismal-scale focus toward the study of broader scale effects. Instead of focusing on behavioral reactions of an individual to intense noise, researchers now recognize that chronic noise at low-to-moderate levels generally has more impact to wildlife populations over the long term (*Vistnes and Hellemann 2008*). Studies show that noise may displace animals from otherwise suitable habitat, or force them to reallocate energy from foraging to anti-predator behavior (*Barber et al. 2010*). If they don't—or can't—relocate, they risk prolonged exposure to noise, a well-recognized physiological stressor. Noise pollution has been shown to change avian communities and species interactions throughout an area (*Francis et al. 2009*), as well as landscape patterns of habitat use and nest success (*Francis et al. 2011*). Furthermore, in a study controlling for other effects of roads, migrating birds specifically avoided the sound of traffic noise and were less abundant in areas where it was prevalent (*McClure et al. 2013*).

At the contemporary cutting edge of audio technology is the ability to automatically detect and identify sounds within a recording. Software such as Raven (Cornell Lab of Ornithology) and SongScope (Wildlife Acoustics, Inc.) are among the most powerful and user-friendly tools of this kind currently available to science. Though completely automated detection is not feasible at this time, it was within the Raven computing environment that Denali decided to approach a retrospective analysis of soundscape recordings as part of our park-wide avian inventory. Traditionally, we conduct avian inventories by sending research teams into the field, where they use a variety of survey methods to collect data on the presence of species. Now we are combining the use of such traditional methods as point counts with audio recordings to complete our avian inventory.

Methods

The first step in using recordings involved assessing the available data. We first determined that only continuous MP3 audio was useful for identification purposes. This ruled out recordings made before 2010, when memory constraints limited the station to capturing only five-second audio clips every five minutes. Second, we determined that the first phase of the project should focus on the dates of the year with the most intense period of singing, historically between April 15 and June 30. This reduced the number of acoustic monitoring sites available for the inventory to a subset of 25. These avian inventory sites (green circles) are shown in Figure 4 within the context of the original 10x10 kilometer sampling grid (cross-hatches) and sites that did not meet the sampling criteria (grey circles.)

In an attempt to add value to future attempts at automatic recognition, the Denali survey implemented a computer aided detection (CAD) approach. The first step involves a carefully tuned general detector designed for passerine vocalizations. The detector runs in Raven software, and returns spectrograms of potential songs and calls. This approach is important for two reasons. First, it provides an objective basis to dismiss faint, difficult to identify signals from consideration. Second, each detection is carefully delineated in time, which can be used to quantify the sampling effort at each site. Sampling effort is the dependent variable used when plotting a species accumulation curve, a technique used to estimate species richness. (Figure 5 shows an example of a species accumulation curve for a site in Denali.)

After the computer provides the list of detections, a human observer combs through the spectrograms and uses visual, auditory, and analytical tools to identify birds as accurately as possible. Because the recording is permanent, individual signals can be listened to multiple times and compared to reference recordings as time allows. This places the balance of time-cost versus

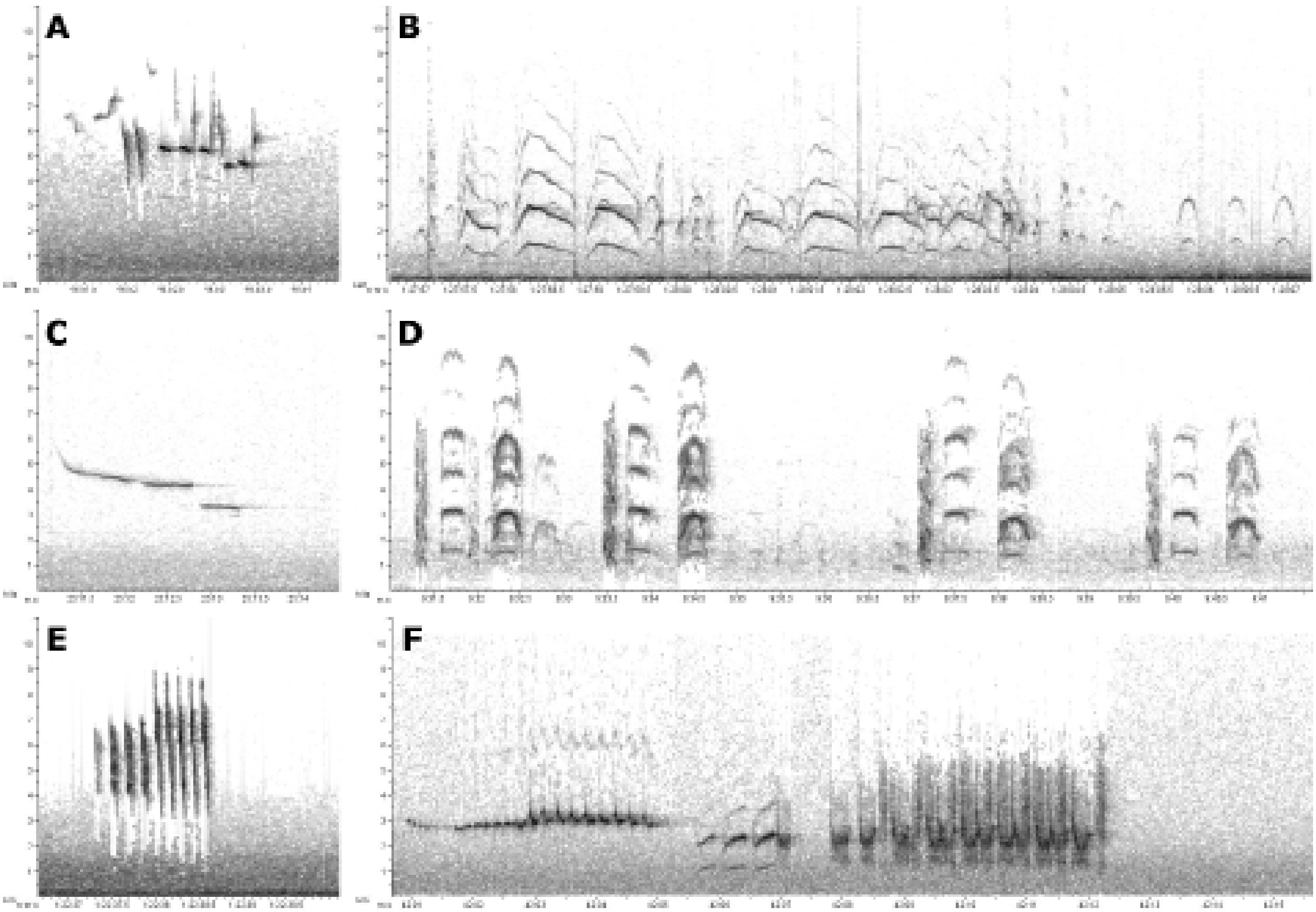

Figure 6. Spectrogram representations of the vocalizations of several avian species. The variable-scale horizontal axis represents elapsed time, while the static-scale vertical axis represents frequency in kilohertz, from 0 to 10 kHz. Darker shading indicates a greater sound pressure level at that time and frequency. The following species are depicted: (A) American tree sparrow (*Spizella arborea*) song recorded at Polychrome Mountain 06/16/12, beginning 02:46:51; (B) long-tailed jaeger (*Stercorarius longicaudus*) calls recorded at Sushana Ridge 06/12/12, beginning 03:27:57; (C) golden-crowned sparrow (*Zonotrichia atricapilla*) song recorded at Backside Lake 06/06/14, beginning 02:25:11; (D) white-tailed ptarmigan (*Lagopus leucura*) male ground challenge call recorded at Mount Lee 05/18/13, beginning 03:09:31; (E) Wilson's warbler (*Cardellina pusilla*) song recorded at Kichatna Mountains 06/03/12, beginning 02:22:37; and (F) surfbird (A*phriza virgata*) male mating display call recorded at Fang Mountain 06/28/13, beginning 02:42:01. Explore additional examples from Denali and other Alaska NPS units on the collaborative avian sounds website Xeno-Canto.

accuracy on the human analyst. Maximization of such a trade-off occurs when staff are very familiar with the auditory detection of local species. Adopting such a technique might enable locally skilled ornithology technicians to continue their survey work throughout the fall and winter seasons. Composite figure 6 shows the vocalizations of several species visualized as a spectrogram in Raven. Explore additional examples from Alaska NPS units on the collaborative avian sounds website Xeno-Canto.

Future Plans

After annotating the audio records collected from 2010 through 2014, we will use the survey results to further understand the diversity of Denali's avian communities across a variety of spatial scales and habitats. Species richness, especially, will be explored as a metric. Furthermore, staff will seek greater efficiencies in the computer aided detection process. Identifying species from the recordings is currently arduous and requires repetitive annotations. However, if we use the thousands of detections already labeled by staff to automatically identify common species, we would substantially reduce future time costs. Two approaches to leveraging existing annotations are "machine learning" and "supported decision" techniques. Machine learning – such as random forest clustering – can be used to filter out and annotate common signals (*Ross and Allen 2014*). The "supported decision" technique shows the analyst previously validated signals that are similar to the one they are currently viewing so they can rely on the knowledge of others to support their decision. (*Truskinger et al. 2014*).

The project also allows for the study of detection itself. An understanding of how the entire acoustic environment affects an observer's ability to quantify diversity is an important consideration of any auditory-based wildlife survey. Because we use the same microphone to record audio and numeric measurements of sound pressure level, we can use the data to understand the limitations of animal detection in different acoustic environments. Once we address such scientific concerns, we will be better equipped to quantify changes in avian communities across the entire park.

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Critical Connections: Conserving Migratory Birds in Alaska's National Parks

By Laura M. Phillips and Carol L. McIntyre

"May the migrants survive the many new hazards in the south and continue returning each spring in the future, to contribute beauty and spirit to this northern wilderness."
(Adolph Murie, 1963)

Alaska is a land that showcases the important connections between migratory animals and people. Whether it is the excitement raised by seeing thousands of migrating sandhill cranes (*Grus Canadensis*) (*Figure 1*) returning in spring, the activities of preparing for fish camp or the anticipation of an upcoming caribou (*Rangifer taradus*) hunt, Alaskans are strongly tied to animal migration. Visitors are also drawn to Alaska to see animal migration, and by observing and learning about these migrations they begin to understand some of the connections between where they live and some of Alaska's migratory animals.

Alaska's national parks, encompassing nearly 54 million acres (about 22 million hectares), play an increasingly important role in conserving migratory animals, including migratory birds. Here, migratory birds that overwinter across the world return each spring to nest and raise their family. These include some of the longest distance migrants in the world such as the Arctic tern (*Sterna paradisaea*) and northern wheatear (*Oenanthe oenanthe*). It may be that Alaska's national parks provide critical nesting habitat for a greater abundance and diversity of migratory birds than nearly all the other National Park Service (NPS) areas in the United States. Nearly 80 percent of the bird species that nest in Alaska's national parks are migratory, yet, while the NPS prepares to celebrate its centennial, we still lack some of the most fundamental ecological information about most of these species.

Figure 1. The bugling calls of sandhill cranes as they migrate high overhead are sure signs seasons are changing in Alaska.
NPS photo

Figure 2. Declines observed in the breeding success of golden eagles in Denali National Park and Preserve suggest that factors along their migration routes or in wintering areas may be negatively impacting golden eagles' ability to breed when they return to Alaska.
NPS photo

The Need for Information

Conserving migratory species is one of the greatest challenges facing the NPS, particularly as human activities spread across areas used by migratory animals (*Berger et al. 2010*). Migratory birds nesting in NPS areas present unique conservation challenges because they are influenced by conditions and events in more than one part of the world, including along their migration routes and wintering areas that are often thousands of miles away from their protected breeding grounds. For instance, the abundance of fish off the coast of Antarctica may influence the ability of Arctic terns to return to Denali and reproduce successfully. Many migratory birds range across extraordinary distances and encounter a wide range of risks to survival and reproduction throughout their lifetime. Recent studies documented declining breeding populations of long-distance migratory birds (*Both et al. 2006; Sanderson et al. 2006; Faaborg et al. 2010; Reif 2013*). Recent evidence indicates that, in particular, mortality during migration may be a major demographic factor affecting population dynamics (*Newton 2008; Faaborg et al. 2010*). Even in Alaska, significant declines were documented in the reproductive success of golden eagles (*Aquila chrysaetos*) (*Figure 2*) (*McIntyre and Schmidt 2012*) and the abundance of Wilson's warblers (*Wilsonia pusilla*) (*Schmidt et al. 2013*) in Denali National Park and Preserve (Denali). The causes of these recent declines are likely to be found either along their migration routes or on their wintering grounds.

A New Era of Tracking Birds Across Time and Space

The miniaturization of tracking devices in the early 1990s launched a new era of bird migration research and conservation efforts. The use of lightweight tracking units is changing some of the major assumptions about bird movements (*McKinnon et al. 2013*) and has challenged current paradigms about bird behavior in migration including sleep and dehydration (*Gill et al. 2008*). Satellite and GPS telemetry has greatly enhanced the study of bird migration in Alaska, allowing biologists to follow individual migratory birds where they travel and investigate their behavior, movement patterns, and seasonal distribution.

In the Alaskan Arctic, scientists used satellite telemetry to identify nonbreeding areas of declining eider species (*Petersen et al. 1999; Phillips et al. 2006*). Spectacled eiders (*Somateria fischeri*) (*Figure 3*) nest in remote coastal areas of western and northern Alaska. Dramatic declines in breeding populations prompted the listing of the U.S. population as threatened; however, little change had been occurring on their breeding grounds and scientists hypothesized that wintering area conditions may be affecting survival of eiders (*Stehn et al. 1993*). For over 100 years, the wintering areas of spectacled eiders were a complete mystery—scientists did not know their location. Researchers worked with engineers to develop small implantable satellite transmitters that wouldn't interfere with the deep diving behavior of these sea ducks. The location data from tagged birds eventually revealed that the entire North American and Russian populations of spectacled eiders winter in polynyas, naturally occurring openings in the winter sea ice, in the Bering Sea (*Petersen et al. 1999*). Such a discovery would have been highly unlikely without the use of satellite telemetry.

In Denali, a three-year telemetry study of golden eagles revealed more about their movements than did 10-plus years of banding (*Figure 4*)(*McIntyre et al. 2008*) providing new information on annual ranges and survival. Previous studies had identified the importance of Denali as a nesting area for golden eagles (*McIntyre and Adams 1999*), but little information existed about their migratory paths or wintering areas. Study results showed that Denali's golden eagles range over a vast area of western North America and that the probability of survival is much lower during autumn migration and early winter than during the rest of the year (*McIntyre et al. 2006, 2008*). Long-term monitoring of golden eagle populations at Denali has detected a decline in egg-laying and fledgling production (*McIntyre and Schmidt 2012*). Researchers suspect anthropogenic factors on the wintering ranges may be driving the decline (*McIntyre and Schmidt 2012*) and they are currently addressing some of those topics with new tracking studies.

Scientists have also used telemetry to identify sources of environmental contaminants in migratory birds in Alaska. For instance, USGS scientists used telemetry to study the blood lead concentrations in tundra swans (*Cygnus columbianus*) breeding in Alaska (*Ely and Franson 2014*). Like many species of waterfowl, tundra swans are susceptible to lead poisoning. While waterfowl may be exposed to lead by ingesting spent lead shot, they may also be exposed by ingesting fishing weights and other lead tackle, and when foraging in habitats exposed to sediments contaminated with lead by mining and smelting activities. Using satellite telemetry, researchers tested hypotheses related to possible relationships between blood lead concentrations and migratory movements. By marking tundra swans across Alaska, they found that differences in blood lead concentrations across breeding areas was likely influenced by differential exposure on staging and wintering areas (*Ely and Franson 2014*).

While these studies all highlight different aspects of bird ecology that have been answered using satellite telemetry, perhaps some of the most exciting results of studying bird migration using this technology comes from research on bar-tailed godwits (*Limos lapponica baueri*) breeding in Alaska. Here, researchers documented the amazing navigational abilities and endurance of these long-distance migrants (*Gill et al. 2008*). Before their research, the longest documented nonstop flight of any land bird was a distance of approximately 4,000 miles (6,437 kilometers) with an overwater crossing of about 2,800 miles (4,506 kilometers) completed in three to five days between Australia and China by far eastern curlews (*Numenius madagascariensis*) (*Driscoll and Ueta 2002*). The bar-tailed godwits tagged by Gill et al. (2008) flew non-stop up to 4,600 miles (7,403 kilometers) and 9.4 days across the central Pacific Ocean from Alaska to New Zealand and eastern Australia. Further, their research showed that Pacific wind regimes presented bar-tailed godwits with numerous decisions related to when and where to fly during each of the three legs of their annual migration, and that the tagged birds were able to assess both the predictability and variability of atmosphere conditions, particularly wind (*Gill et al. 2014*).

Figure 3. For over 100 years the wintering area of spectacled eiders was a mystery. Researchers used satellite telemetry to locate tagged eiders on wintering grounds in the Bering Sea, a discovery that would have been unlikely without the use of new technology to track migrating birds.

New Tools for Tracking Smaller Birds

The development of small satellite and GPS transmitters was revolutionary technology that has provided phenomenal data about animal movements around the world. But, as small as some of the devices have become, they are still too large for many animals including many smaller migratory birds. The development of geolocators, archival light-recording devices that record light levels in relation to time allowing researchers to calculate latitude and longitude based on day length and sun elevation angle, has changed that situation. Currently, geolocators are small (0.02 ounces/0.75 grams) enough to be used effectively on warblers, and they are providing data that is challenging some of the long-held theories about bird migration as well as providing some amazing stories.

Banding studies and observations suggested Arctic terns (*Figure 5*) may undergo the longest seasonal movements of any species breeding in high latitudes of the northern hemisphere. Recent research using geolocators confirmed that Arctic terns travel much farther than scientists originally thought, with some birds moving more than 49,700 miles (79,980 kilometers) annually from nesting areas in Greenland and the Netherlands to wintering sites in the oceans off Antarctica (*Egevang et al. 2010; Fijn et al. 2013*). This study also identified a previously unknown oceanic hotspot foraging region of deep water in the eastern portion of the Newfoundland Basin and the western slope of the mid-North Atlantic Ridge, where the terns foraged for an average of 25 days before continuing their southward migration. Arctic terns are likely using global winds to reduce flight costs and complete the longest animal migration known in the world (*Egevang et al. 2010*).

Geolocators have also provided surprising discoveries about large-scale bird movements outside migration. Declines in breeding populations of golden-winged warblers (*Vermivora chrysoptera*) prompted a study of their migration

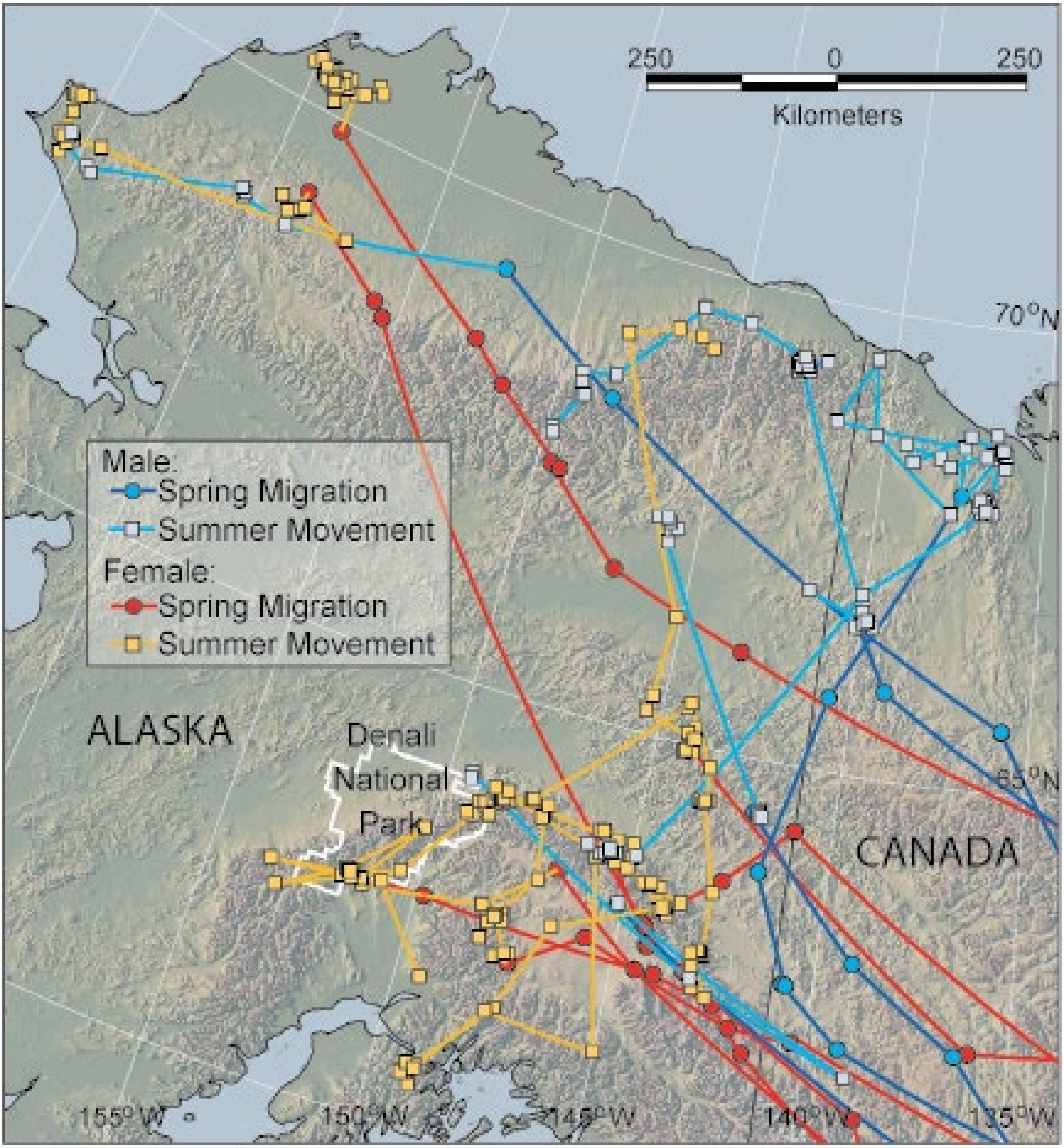

Figure 4. Using satellite telemetry, researchers discovered that juvenile golden eagles raised in Denali National Park and Preserve spent their first summer after fledging wandering the Coastal Plain of Alaska. Figure adapted from McIntyre et al. 2008

Photo by Erik Hendrickson

Figure 5. Geolocators proved what people had suspected for a long time: Arctic terns are the world's longest migrants flying up to 49,710 miles (80,000 kilometers) annually.

NPS photo

Figure 6. Critical Connections Team attaching a geolocator to a Swainson's thrush in Denali National Park, Alaska, in July 2015.

and overwintering ecology (*Streby et al. 2015*). Researchers were astounded to find that after traveling 3,100 miles (4,989 kilometers) from their wintering areas in Colombia to their breeding grounds in eastern Tennessee, golden-winged warblers evacuated their breeding territories in apparent anticipation of an approaching storm system that spawned 84 confirmed tornadoes and caused more than $1 billion in property damage (*Streby et al. 2015*). During this period, the birds left their breeding territories and flew 930 miles (1,497 kilometers) in five days along routes that were similar to the northern portions of their fall and spring migration routes. The birds returned to their breeding territories after the storm system passed through the area.

Expanding Our Knowledge of Migratory Animals in Alaska's National Parks

Results of these and many other studies clearly show that efforts to conserve migratory species in Alaska's national parks must extend outside their boundaries. The NPS needs to greatly increase its efforts at understanding the movements of species outside park boundaries, identify important habitats and threats outside these boundaries, and work with partners at local, regional, national, and international scales to both identify and mitigate threats and protect the resources necessary for migratory species to persist. With the support of the NPS, the Denali Education Center, and Alaska Geographic, we are launching the Critical Connections Program to expand our knowledge about the year-round needs of the migratory wildlife of Alaska's national parks and to provide park managers and others with information essential for implementing effective conservation strategies for these migratory species. The first stage of the program focuses on (1) studying the year-round movements of migratory birds that nest in Denali and assessing how conditions across their year-round range affect their ability to return to their northern breeding grounds and successfully produce young; and (2) building the Alaska National Parklands Migratory Animal Atlas, an online tool that will contain all available information about the migration routes, stopover areas, wintering areas, and conservation issues of migratory animals of Alaska's national parks.

Alarming declines of many species of migratory passerine bird species in North America and elsewhere heighten the urgency of accurately mapping migration routes and wintering locations (*Stutchbury et al. 2009*). In the pilot year of the Critical Connections Program (2015), we along with our program collaborators Scott Weidensaul and Iain Stenhouse, captured and tagged 12 gray-cheeked (*Catharus minimus*) and 19 Swainson's thrush (*C. ustulatus*) with lightweight geolocators (*Figure 6*). These two species are long-distance migrants that commonly nest in Denali and winter in Central and South America. In 2016 we will recapture tagged thrushes to recover the geolocators and document their migration patterns and wintering areas. We will share results with other scientists studying the same and similar species to increase our knowledge of the migratory connectivity of these species.

Another important component of the Critical Connections Program is the development of the Alaska National Parklands Migratory Animal Atlas. Through the atlas, we will provide NPS managers with the information they need to understand the complexities of animal migration and support conservation efforts while also providing the public with new and exciting information about animal migration. We began working on the atlas by compiling information about migratory species in Denali to develop a bibliography of known information and identify data gaps. We will expand our efforts to include information about migratory species in all Alaska national parks.

The Future

Understanding the factors influencing survival and reproduction of migratory birds has reached new levels of urgency, particularly with the mounting evidence that global climate change is currently affecting the timing and behavior of migration, and resource availability of migratory birds. The Critical Connections Program will provide new information for developing conservation strategies for the migratory birds that nest and use Alaska's national parks, and open up new opportunities for learning more about the factors that affect survival and reproduction of migratory birds in Alaska's national parks and collaborating with others to conserve migratory birds.

The members of the National Parks Science Committee challenged the NPS to make every conceivable effort to marshal the necessary resources to protect the integrity of our national parks and the life residing in them (*National Parks Science Committee 2009*). The Critical Connections Program will help us meet this challenge by expanding our scientific knowledge, increasing our capacity for place-based science and education, and strengthen our ability to protect the resources under our stewardship.

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Black Oystercatchers in Kenai Fjords National Park: A Keystone of the Intertidal Zone

By Laura M. Phillips, Heather Coletti, and Brian Robinson

Approach a rocky secluded beach in Kenai Fjords National Park (Kenai Fjords) and you will likely be noisily greeted by a large black shorebird with a long, bright red bill (*Figure 1*). During the summer months, black oystercatchers (*Haematopus bachmani*) defend their territories, narrow strips of beach between low tide and the upper coastline, where they forage, lay eggs, and raise young. Explore the gravel beaches of Kenai Fjords and you may have an opportunity to watch black oystercatchers use their long flattened bill to pry open mussels or wrest limpets off rocks exposed at low tide or to find one of their well camouflaged nests, a shallow depression in the gravel containing two or three speckled eggs.

While the black oystercatcher's reliance on a narrow band of shoreline for feeding and breeding makes them conspicuous and easy to observe, it also makes them vulnerable to both natural and human disturbances that occur within the nearshore ecosystem (*Figure 2*). Flooding destroys nests during extreme high tides and storm surges, and predators such as black bears, mink, and common ravens eat eggs and chicks they find while hunting along the shoreline. In Alaska, the Exxon Valdez oil spill killed up to 20 percent of the breeding population in the spill area and lingering oil left on beaches continued to affect oystercatchers for years afterwards (*Andres 1994; Sharp et al. 1996; Andres 1997; and Weins et al. 2004*). Frequently, human development and recreation is concentrated in coastal areas and oystercatchers may be particularly vulnerable to human-caused disturbance and habitat loss. With only 10,000 individuals scattered along the Pacific coastline between the Aleutian Islands and Baja Mexico, black oystercatchers have one of the smallest population sizes among shorebirds in North America (*Tessler et al. 2014; Brown et al. 2001*). As a consequence of their small population size and dependence on coastal habitats, black oystercatchers are recognized as a species of conservation concern by federal and state agencies and have been the focus of various research efforts including a number of studies at Kenai Fjords (*U.S. Fish and Wildlife Service 2008; Tessler et al. 2010, 2014; and Bodkin 2011*).

Figure 1. Black oystercatchers are conspicuous large shorebirds in coastal areas of Alaska, distinguished by their noisy whistling call and bright red bill.

Photo by K. Thoreson

Increasing use of coastal areas by visitors kayaking and boating in Kenai Fjords prompted the park to initiate research and monitoring projects to examine possible negative impacts to black oystercatchers (*Tetreau 2004; Morse 2006*). Researchers examined the ability of black oystercatchers to hatch eggs and successfully raise chicks (*Figure 3*) in relation to the level of recreational disturbance at nest areas. While breeding success was generally low, it was comparable to success rates observed in other studies of black oystercatchers (*Andres and Falxa 1995; Murphy and Mabee 2000; and Hazlitt 2001*) and did not seem to be affected by visitor disturbance. In Kenai Fjords, as in other areas where black oystercatchers nest, predators were the primary cause of egg mortality. Because of the nature of their research, Morse et al. (*2006*) were not able to identify the primary predators responsible for eating eggs and chicks; however, they noted that the suite of potential nest predators in the park was extensive.

Recent research utilized remote camera technology at black oystercatcher nests to identify sources of disturbance and mortality to eggs, chick, and adults (*Figure 4*) (*Robinson and Phillips 2013; Stark et al. 2015*). Cameras captured images of oystercatcher egg mortality due to predation by common raven, black bear, and domestic dog (*Figure 5*). A nest camera also photographed a peregrine falcon depredating an oystercatcher brood before they were able to leave the nest scrape. Though peregrine falcons have been identified as predators of black oystercatchers (*Bechaver and Gehrig 2011; Tessler et al. 2010*), this was the first evidence of falcons preying on black oystercatchers in the Kenai Fjords area (*Figure 6*).

To continue to monitor black oystercatcher populations in the park, Kenai Fjords managers in cooperation with Southwestern Alaska Inventory and Monitoring Network (SWAN) staff developed a long-term monitoring program to evaluate trends in breeding population densities, nesting success and diet (*Bodkin 2011; Coletti et al. 2014*). Black oystercatchers prey on a variety of intertidal invertebrates

Photo by K. Thoreson

Figure 2. Black oystercatchers find food, nest, and raise young in a narrow strip of shoreline between low tide and the upper coastline.

Photo by K. Thoreson

Figure 3. Black oystercatcher eggs and chicks are vulnerable to contamination, flooding, and predators.

Photo by K. Thoreson

Figure 4. Researchers set up a remote camera at a black oystercatcher nest in Kenai Fjords National Park to identify causes of nest failure.

NPS photo

Figure 5. A black bear is caught on camera eating the eggs of a black oystercatcher nest in Kenai Fjords National Park.

NPS photo

Figure 6. A remote camera caught this image of a peregrine falcon preying on newly hatched black oystercatcher chicks.

that they bring back to their nest areas to feed chicks. To examine oystercatcher diet, researchers collect the shells of prey items left around nest sites, which provides estimates of the relative abundance and size classes of invertebrates that adults are feeding their chicks. Determining what black oystercatchers eat is important because their consumption of ecologically important invertebrates, such as limpets and mussels, can have cascading impacts on the structure of intertidal communities. Limpets are herbivores that graze on algae, and when, as a consequence of oystercatcher foraging, limpets are removed from a system it may result in increased algal populations. The impact black oystercatchers have as top level consumers in structuring nearshore ecosystems has led them to be classified as “keystone” species (*Power et al. 1996*), a species whose influence is disproportionate to its abundance. The monitoring program has found that three species of limpets and the Pacific blue mussel were the prey items most frequently found at black oystercatcher nests between 2007 and 2012 and that oystercatchers were eating mussels and limpets that were larger in size than those generally available (*Figure 7*) (*Coletti et al. 2014*).

The monitoring program has provided some important insight about the black oystercatcher's role as a keystone predator in Kenai Fjords; however, using the collection of prey remains to evaluate diet may have some limitations. Although a widely used method for estimating diet composition of chicks, these estimates may be subject to biases based on prey body type, nesting habitat, and collection date. To determine the accuracy of monitoring methods, researchers initiated studies using direct foraging observations and stable isotope analyses to further examine black oystercatcher diet (*Carney 2013; Robinson et al. in prep*). Using stable isotopes, Carney found that in the spring and early summer adult black oystercatchers were eating a diet with a ratio of mussels and limpets that corresponded to previous observation-based studies in Alaska. In 2013-14, researchers observed black oystercatcher parents feeding chicks, and captured chicks to collect samples for stable isotope analyses and examine growth rates (*Figure 8*). They compared the results of direct observations and stable isotope analyses to those obtained through the more traditional method of collecting prey remains and found that prey collection over-estimated limpet abundance, under-estimated the proportion of barnacles, and failed to detect soft bodied prey such as worms in the diet (*Robinson et al. in prep*).

Black oystercatchers play a vital role in the nearshore ecosystem and a visit to the Kenai Fjords coast wouldn't be the same without their colorful presence and the sound of their piping call. While Kenai Fjords will continue to monitor the health of and support research on black oystercatcher populations, visitors play a crucial role in ensuring the long-term persistence of these birds in the park. Keeping a safe distance from nests and not allowing dogs to run free on beaches are two steps everyone can take to protect black oystercatchers wherever they live.

Photo by K. Thoreson

Figure 7. Black oystercatchers feed solely on marine invertebrates, like these mussels and barnacles, they find in intertidal areas at low tides.

Photo by K. Thoreson

Figure 8. Researchers measure and take samples from a black oystercatcher chick to determine what the chick eats and how fast it's growing.

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Conserving Migratory Golden Eagles in a Rapidly Changing World: What Role Will the NPS Play?

By Carol L. McIntyre

Golden eagles (*Aquila chrysaetos*) that nest and are raised in Denali National Park and Preserve, Alaska, (Denali) are among some of the most traveled individuals of this species in the world. Within just six weeks of fledging (leaving their nest), some of Denali's juvenile eagles fly over 4,000 miles to spend the winter in central Mexico. Here they are in the company of other migratory golden eagles from interior and northern Alaska and northwest Canada. In spring, these eagles fly back to Alaska with some spending their first independent summer ranging hundreds of miles in search of food across Alaska's North Slope (*McIntyre et al. 2008*). Come autumn, they leave Alaska and fly south to their wintering grounds. If a golden eagle raised in Denali lives to age 20 and repeats similar migrations, showing some fidelity to both its natal range in interior and northern Alaska and its winter range in central Mexico, it will travel over 250,000 miles in its life.

Over the nearly 30 years that I have studied golden eagles in Denali there have been noticeable changes in the landscapes used by these eagles both in Denali and across their vast year-round range (from Alaska's North Slope to central Mexico). These changes create new challenges, and perhaps new opportunities, for conserving Denali's migratory golden eagles.

Golden eagles have soared over Denali for thousands of years, but recently we started to have concerns over their future in a rapidly changing world (*McIntyre et al. 2002; McIntyre et al. 2006*). Present and future generations of Denali's golden eagles face many new challenges to their survival. Understanding what factors affect their population persistence becomes more urgent as the spread of human-activities across western North America is transforming the landscapes used by these eagles. Concern over the conservation status of golden eagles in North America has recently increased as threats to populations, including the direct and indirect effects of human activities, become better understood (*Katzner et al. 2012; Millsap et al. 2013*). Here, I review some of those threats and discuss how the National Park Service (NPS) can play an important role in the conservation of this species.

Figure 1. One of the highest nesting densities of golden eagles occurs in the northern foothills of the Alaska Range in Denali National Park and Preserve, Alaska (*see Kochert et al. 2002*).

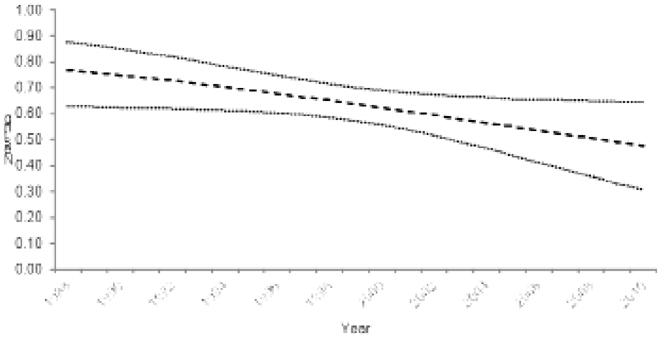
Photo by Carol McIntyre

Multiple Challenges at Multiple Scales

Golden eagles prefer terrain that is at "odds with the horizon" (*Figure 1*) (*Dunne et al. 1989*), but the horizon is being obscured by the rapid construction of new power lines, power poles, wind turbines, other human-made objects, and by habitat alteration. Many different types of human activities result in both direct and indirect threats to migratory golden eagles from Denali and other Alaska national parks. Direct threats, which occur primarily during migration and winter when eagles are away from Denali, include death from electrocution, poisoning, shooting, and collisions with human-made structures. While much recent attention has focused on the direct threats associated with wind farms (i.e., collisions with turbines), perhaps bigger threats to migratory golden eagles are the increased risk of electrocution from power poles (*Millsap, pers. comm.; Kemper et al. 2013*) and the loss of suitable foraging habitat (*Katzner et al. 2012*) across their winter ranges.

Habitat loss, viewed as an indirect threat, has been substantial across the wintering range of Denali's migratory golden eagles. Sagebrush communities that once covered nearly 63 million hectares (155,700,000 acres) of western North America have decreased by nearly 60 percent (*Knick et al. 2003*) primarily due to human activities (*West and Young 2000*). Important prey species for golden eagles, such as black-tailed jackrabbits (*Lepus californicus*), are associated with these shrub habitats (*Kochert et al. 1999*). The loss of prey habitat can result in decreased prey availability for golden eagles, leading to decreased survival and reproduction.

Landscape-scale changes are also evident on the breeding grounds in Denali and across much of interior and northern Alaska in areas where Denali's golden eagles spend much of their early years before they enter the breeding population (*McIntyre et al. 2008*). Here, rapid expansion of woody vegetation across open landscapes and into higher elevation is transforming once open landscapes into more closed landscapes (*Sturm et al. 2001; Tape et al. 2012; Roland and*



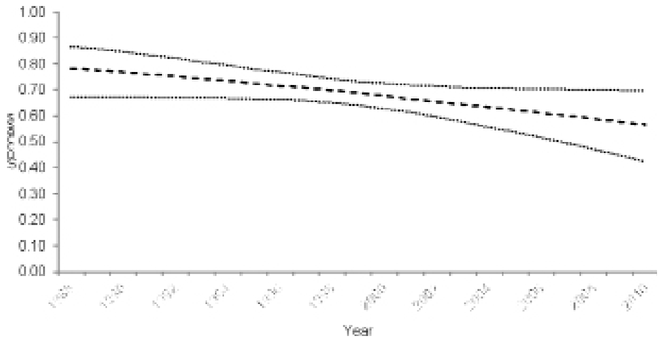


Figure 2. Trends for probability of nesting (top) and nesting success (bottom) for golden eagles in response to the mean number of snowshoe hares, Denali National Park and Preserve, Alaska, 1988-2010. Nesting (top) is the proportion of occupied nesting territories where eggs were laid. Nesting success (bottom) is the proportion of nesting pairs that raised ≥1 fledgling. (From McIntyre and Schmidt 2012).

Stehn 2014). In Denali, trees are expanding into once treeless areas and woody vegetation is expanding across terraces and floodplains (*Roland and Stehn 2014*). The expansion of shrubs and trees across the breeding grounds in Denali could present challenges for golden eagles that often forage and capture prey in more open landscapes. Further, increased vegetation cover is likely to have a negative effect on important prey species, such as Arctic ground squirrel (*Urocitellus parryii*) (*Wheeler and Hik 2014; Wheeler et al. 2015*). Sturm et al. (*2001*), Tape et al. (*2012*), and Roland and Stehn (*2014*) postulate that vegetation expansion in interior and northern Alaska is associated with elevated temperatures during the twentieth century (*Hinzman et al. 2005*).

It is beyond the scope of this article to hypothesize about the responses of golden eagles and their prey to a warming climate. However, it would be remiss not to at least touch on this subject and offer a few examples of some direct and indirect effects of a warming climate on golden eagles and their prey. Direct effects include reduced golden eagle nestling survival due to increases in rainfall during the breeding season (*Anctil et al. 2014*). Further, warmer temperatures could provide new avenues for infectious disease and parasites that may kill golden eagle nestlings and adults (V*an Hemert et al. 2014*). Indirect effects include changes in snowshoe hare (*Lepus americanus*) demography caused by a warming climate (*Kielland et al. 2010*) and higher overwinter mortality of Arctic ground squirrel caused by mid-winter rains flooding their hibernacula (*Werner et al. 2015*). This could lead to decreases in the number of hares and squirrels available as prey for golden eagles during the breeding season and lead to reductions in golden eagle reproductive success. Further, there could be climate-induced seasonal variation in the life history strategies of Arctic grounds squirrels that may result in loss of breeding opportunities and lead to declines in population size (*Sheriff et al. 2013*). Additionally, extended drought on the golden eagle wintering areas could result in reduced prey availability and decreased survival. These are just a few of the many examples of how human-related activities could both directly and indirectly affect Denali's golden eagles. It is unknown how golden eagles and their prey species will respond to long-term directional change such as global warming (*Boonstra 2004*). Some golden eagles in Idaho have exhibited resiliency to large-scale changes in prey availability in southwest Idaho (*M. Kochert, pers. comm.*). But, it is currently unknown if Alaska's migratory golden eagles have the demographic resiliency to absorb additional mortality from increasing threats or if their environment is changing at a rate that exceeds their ability to adapt (*Millsap et al. 201*3).

Long-term Data Shows Decline in Reproductive Success of Golden Eagles in Denali

Golden eagles have been the focus of study at Denali National Park and Preserve since 1987 (*McIntyre and Adams 1999; McIntyre et al. 2006; McIntyre and Schmidt 2012*). In the northern foothills of the Alaska Range, we have documented territory occupancy and reproductive success at nearly 80 territories annually for 27 consecutive years, resulting in one of the longest-running studies of a migratory population of golden eagles in North America. Audubon designated this area as an Important Bird Area specifically because of the high density of nesting golden eagles.

Monitoring of territory occupancy and a series of reproductive metrics including nesting rate, nesting success, and fledgling production began in Denali in 1988. In 2002, the species was selected as one of the vital signs for the National Park Service Central Alaska Monitoring Network, providing a means to continue to monitor golden eagles in Denali into the future. Currently, the Denali and Snake River programs are among the longest-running monitoring studies of golden eagles in the world. These long-term data sets provide unique opportunities to study how golden eagles respond to changes in their environment that many shorter-term studies would miss (*Steenhof et al. 1997*).

Golden eagles are relatively long-lived and do not attempt to raise offspring every year (*Kochert et al. 2002; Watson 2010*). In Denali, there is a close link between snowshoe hare abundance and golden eagle reproduction, with more female eagles laying eggs in years when hares are in the high phase of their population cycle than when hare populations crash (*McIntyre and Adams 1999; McIntyre and Schmidt 2012*). This link was expected since snowshoe hare are one of the only sources of live prey in Denali early in the breeding season. However, the probability of a female eagle laying an egg and raising a fledgling in Denali has decreased by about 25 percent over our study period (*McIntyre and Schmidt 2012*) (*Figure 2*). These declines were not expected and were not explained by conditions on the breeding grounds (*McIntyre and Schmidt 2012*). This suggests that conditions on the wintering grounds, where Denali's golden eagles spend up to 40 percent of the year, maybe be influencing their reproduction. This is known as a carry-over effect (*Harrison et al. 2011*), where conditions and events before the breeding season (i.e., during migration and winter) influence reproduction (*Steenhof et al. 1997; Harrison et al. 2011*)

Conserving Denali's Golden Eagles Requires a Collaborative Approach Across Multiple Scales

Declines in reproduction may eventually lead to a reduction in the number of golden eagles nesting in Denali and perhaps to a situation where management actions cannot reverse a decline. The future of Denali's golden eagles hinges on our ability to collaborate with others to reduce mortality by human-driven causes, and conserve habitat across their year-round range, not just in Denali. Our success also depends on making sure our park managers are clearly aware of how conditions and events outside of Denali's boundaries can negatively affect Denali's golden eagles. For instance, park managers need to understand how the construction of new power poles in Canada (*Kemper et al. 2013*) or northern Mexico, that were not designed to avoid raptor electrocutions, could reduce survival rates of Denali's golden eagles and perhaps lead to a reduction in the number of golden eagles nesting in Denali.

To identify the factors affecting golden eagle reproduction in Denali, NPS scientists are collaborating with other scientists on local, regional, and continental scales. On the local scale, we are continuing to monitor territory occupancy and a series of reproductive metrics of golden eagles on their breeding grounds. We are also investigating if the age structure of the territory holders is changing, if intrusions by non-breeding eagles into territories interfere with reproduction and, in collaboration with the U.S. Geological Survey (USGS), nesting territory fidelity. To link reproduction with conditions and events during migration and winter, we are collaborating with U.S. Fish and Wildlife Service (FWS) scientists to track the movements of Denali's golden eagles, identify the resources they use across the year, and identify sources of mortality. Further, starting in 2016, we will be collaborating with USGS scientists to expand these studies to assess conditions of wintering ranges and how they influence reproduction. These studies use cutting-edge Global System for Mobile communications-Global Positioning System (GSM-GPS) tracking technology that will provide us with high-resolution data on eagle movements and behavior. We are also supporting a graduate study at West Virginia University to quantify landscape-scale change in areas used by Denali's juvenile golden eagles. Results of this graduate study will provide new insight into the decadal change on the wintering grounds. In addition to Denali-specific studies, we are also collaborating with FWS and Alaska Department of Fish and Game (ADFG) scientists on studies of the year-round movements of Alaska's migratory golden eagles. We are also collaborating with scientists from the FWS, USGS, Bureau of Land Management (BLM), universities, state agencies, and many non-governmental organizations to describe the temporal and spatial movement patterns of golden eagles across North America.

In addition to these studies, NPS scientists are collaborating with FWS scientists to conduct surveys across Alaska to provide an estimate of the size of Alaska's golden eagle population. It is likely that Alaska national parks contain a substantial proportion of the breeding population of migratory golden eagles in Alaska. For instance, there are at least 150 pairs of nesting golden eagles in Denali (*McIntyre, unpublished data*). Based on preliminary survey data and availability of habitat, there may be similar numbers in Lake Clark National Park and Preserve and perhaps more in Gates of the Arctic National Park and Preserve and Wrangell-St. Elias National Park and Preserve (*NPS, unpublished data*). Overall, more than 600 pairs of golden eagles may be nesting in Alaska's national parks.

In addition to these studies, NPS scientists continue to seek support to expand studies to understand the climate-induced responses by important golden eagle prey species. For instance, despite their broad range and considerable functional role as drivers and indicators of environmental change (*Wheeler and Hik 2013*), little is known about the ecology of Arctic ground squirrels in Alaska's national parks, including Denali.

Photo by John Wright

Figure 3. What does the future hold for Denali's golden eagles? Our collaborative and landscape-scale studies will provide essential information for conserving these eagles in the twenty-first century.

Why are Alaska's National Parks Important for Golden Eagle Conservation?

Alaska's national parks encompass over 54 million acres (21,850,000 hectares), including many that protect important nesting and foraging habitat for migratory golden eagles. Alaska national parks hold in trust the closest approximation to complete ecosystems left on this planet—a protected land base unsurpassed anywhere (*Brown 2005; Brown and Elder 2005*). As such, they also hold in trust present and future generations of migratory golden eagles. As the NPS prepares to celebrate its 100th anniversary it has renewed its commitment for large landscape conservation (*NPS 2014*)—a model that should increase our ability to conserve golden eagles and other migratory birds.

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Glaucous-winged Gull Monitoring and Egg Harvest in Glacier Bay, Alaska

By Tania Lewis and Mary Beth Moss

"Gathering eggs in Glacier Bay was something especially the family looked forward to. It was like Easter. Family and cousins gathered up there and we collected eggs, and it was a joyous occasion…" (Huna Tlingit elder)

In July 2014, President Obama signed the Huna Tlingit Traditional Gull Egg Use Act (P.L. 113-142) into law marking an important step in a long journey to authorize the harvest of glaucous-winged gull eggs by the Huna Tlingit in their traditional homeland of Glacier Bay National Park (*Figure 1*). The science behind the law—both ethnographical and biological—stretches long into the past and will presumably continue long into the future. (*Figure 2*).

Egg Harvesting Traditions

For centuries, the Huna Tlingit harvested gull eggs at rookeries scattered throughout the recently deglaciated islands of lower Glacier Bay. While gull eggs never comprised a major portion of the traditional Tlingit diet, they were nonetheless a prized spring food source for the Huna people. Family harvest trips once served as an important mechanism for maintaining ties with homeland and transmitting stories, moral codes, and cultural traditions to the younger generation (*Hunn et al. 2002*). The period from mid-May to mid-June is called 'Going to Get Eggs Moon' in the Huna Tlingit calendar, signifying the importance of this activity during the late spring and early summer (*Figure 3*).

For traditional people, the first spring harvests of gull eggs mark the transition from a season of confinement, scarcity, and reliance on stored foods to a season of activity, abundance, fresh foods, and good travel weather. Harvests typically involved the whole family, providing a unique opportunity for children to learn from their parents, grandparents, and extended family—in the context of an actual harvest activity—both practical and moral lessons. Such trips may have been the first opportunity Tlingit children had to experience the self-esteem that comes from successfully gathering and sharing foodstuffs.

Traditional harvest at Glacier Bay rookeries likely began as early as glacial retreat created suitable gull nesting habitat in the lower bay (perhaps the mid-1800s) and continued well into the mid-twentieth century. Members of the 1899 Harriman expedition were treated to a meal that included gull eggs (*Goetzmann and Sloan 1982*) and early National Park Service (NPS) representatives described egg harvest practices occurring in the Bay (*Traeger 1939; Been 1940*). Throughout the 1940s, 1950s, and early 1960s, NPS policy toward this traditional use was "to permit the Indians to continue to take hair seals and to collect gull eggs and berries as they have done in the past until a definite wildlife policy can be determined." By 1965, however, the NPS began enforcing the Migratory Bird Treaty Act and related NPS regulations and policies, which prohibited egg harvest. The eventual enforcement of these laws and regulations strained relationships between the Huna Tlingit and the NPS. While some level of harvest continued at rookeries outside of park boundaries, the Huna Tlingit longed for the opportunity to return to rookeries on the islands that dot lower Glacier Bay called K'wát' Aaní, the Land that Belongs to the Seagull Eggs. Harvest centered on these islands for many reasons: they were relatively close to permanent settlements; the calm waters and comparatively gentle shores of Glacier Bay allowed easy access for elders and youth in spring; rookeries in these "inside waters" were thought to produce eggs earlier than rookeries in Icy Strait or outer waters; and the productive, pristine waters of Glacier Bay are thought to produce particularly tasty, pure, and rich eggs.

Figure 1: Nesting glaucous-winged gulls on South Marble Island, Glacier Bay.

Photo by Mary Beth Moss

Glaucous-winged Gulls

Glaucous-winged gulls (*Larus glaucescens*) are common in southeast Alaska throughout the year and begin nesting in Glacier Bay as early as mid to late May (*Patten 1974; Zador 2001*). They typically lay three eggs per clutch and will often replace eggs lost to harvest, predation, or natural events such as flooding until the clutches are complete (*Brown and Morris 1996*). Under the aegis of John Piatt of the U.S. Geological Survey (USGS), graduate student Stephanie Zador studied the potential effects of human harvest as well as predation on the glaucous-winged gull population nesting on South Marble Island in Glacier Bay. Using ethnographic data collected by Hunn and others (2002), Zador simulated a traditional harvest and developed population models based on observed parameters (*Zador 2001; Zador and Piatt 1999 and 2002; Zador et al. 2006*). Zador's model concluded that egg harvest would have little impact on the reproductive success of gulls if infrequent harvests occur early in the laying season (*Figures 4 and 5*).

Legislative Environmental Impact Statement

Following a 1997 meeting, NPS and the Hoonah Indian Association (HIA, the federally recognized tribal government) agreed to focus energy on a range of programs designed to encourage and reinvigorate cultural activities within the park, including the traditional harvest of gull eggs. Glacier Bay staff identified the need for both ethnographic and biological data to inform the preparation of an Environmental Impact Statement and collaborated with ethnologists through the Pacific Northwest Cooperative Ecosystem Studies Unit and biologists at USGS to acquire both. Section 4 of the Glacier Bay National Park Resource Management Act of 2000 further directed the NPS to determine whether customary egg harvest practices could be authorized in the park.

Zador and Piatt's results as well as Hunn and others' ethnographic study guided NPS's development of the preferred alternative in a 2010 Legislative Environmental Impact Statement (LEIS) which determined that egg harvest could occur within the park without impacting gull populations or other park resources. The LEIS Record of Decision (ROD) outlined an alternative that would authorize egg harvest at up to five nesting locations in Glacier Bay with a first harvest occurring within five days of the onset of laying and a second harvest occurring within nine days of the first. Harvests could not take place after June 15 to maximize gulls reproductive success by allowing adequate time for re-laying after harvest.

The gull harvest LEIS ROD also specifically mandates that NPS monitor gull colonies to inform decision making and mitigate potential negative effects of the harvest. Yearly monitoring requirements include (1) identifying the onset of laying, (2) determining breeding colony size, (3) determining number of eggs in nests during harvest, (4) determining number of eggs available for harvest or hatching, and (5) documenting other bird and marine mammal species present that may be impacted by harvest activities. Harvest sites are to be selected based on the colony size (with larger colonies preferred as harvest locations); population parameters including productivity, population status, recent egg harvest, and age of colony; and whether other species are present or not.

Monitoring Methods

To fulfill the LEIS ROD requirements, Glacier Bay resource management staff monitored glaucous-winged gulls in 2012, 2013, and 2014. We conducted ground surveys consisting of a full census of harvestable nests and nest contents mid-incubation (early June). We surveyed each site at least once during incubation to determine the maximum number of eggs available for harvest or hatching. Two trained observers conducted surveys by quickly moving through the colony while taking care not to step on nests or eggs. To minimize impacts to incubating eggs, we did not conduct surveys on cold rainy days and terminated surveys when the first hatchling was observed at each location to minimize disturbance and chick mortality. We classified eggs as predated when we observed broken egg fragments with consumed contents (*Figure 6*).

To determine size of breeding colony and number of chicks, we conducted one to two vessel surveys at potential gull egg harvest sites from June 15 to August 30 of each year. Vessel surveys consisted of at least two observers circumnavigating the island at close distances (~100 yards) to record species present and nesting behavior, and estimate the number of adults, nests, chicks, and fledglings using high-powered image-stabilizing binoculars. During ground and vessel surveys we also documented the abundance and distribution of other bird and marine mammal species that could potentially be impacted by gull egg harvest activities.

Results

We conducted repeat vessel and ground surveys from May 20 to August 21 of 2012, 2013, and 2014. We documented over 1,100 glaucous-winged gulls at seven rookeries, ranging from seven to 144 harvestable nests per colony (*Figure 7*). Although

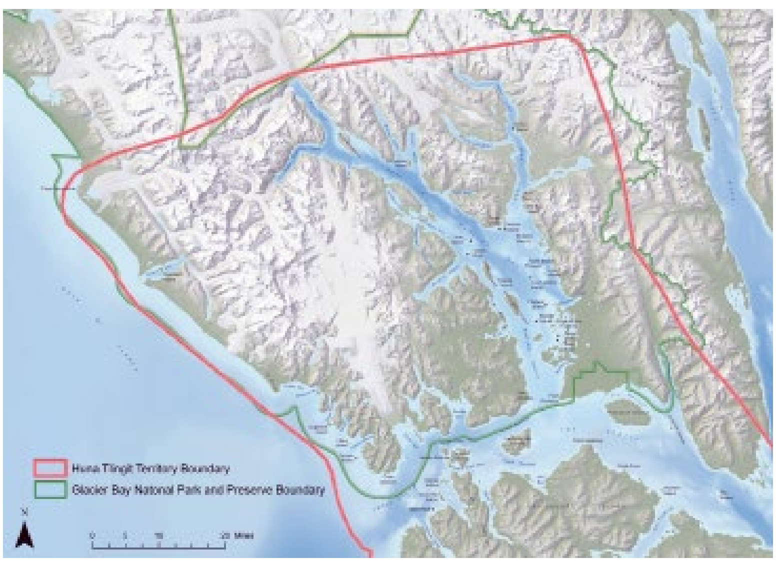

Figure 2: Boundaries of Glacier Bay National Park and Preserve and the Huna Tlingit Homeland.

Photo courtesy of the Mills family

Figure 3: Gilbert and Katherine Mills of Hoonah, Alaska, gathering eggs on South Marble Island in 1959.

Photo by Tania Lewis

Figure 4: Glaucous-winged gull nest with the typical three-egg clutch.

the number of nests at each colony remained relatively stable through time, we found a substantial difference in productivity as evidenced by the number of eggs and fledglings between 2012, 2013, and 2014 (*Figure 8*). In 2012, we observed a total of 187 eggs in 672 nests (0.28 eggs per nest) and only one hatched chick in all colonies combined. In 2013, we observed 1,403 eggs in 664 nests (2.11 eggs per nest) and 437 hatched chicks in all colonies. In 2014, we observed 904 eggs in 366 nests (2.47 eggs per nest) and 67 hatched chicks in all colonies. The mean number of adult gulls during mid-laying season (June 15 to July 15) across the three years varied by colony from a low of 45 (± 8 SE) at Tlingit Point to a high of 586 (± 49 SE) at South Marble Island with Boulder and Lone islands exhibiting the greatest variance between years (*Figure 9*). It is important to note that the number of chicks/fledglings observed during the vessel surveys represent a larger nesting area that that of the nests and eggs counted during the ground surveys because terrain and marine mammals limit access to portions of several colonies for ground surveys (*Figures 7, 8, and 9*).

Hauled-out harbor seals (*Phoca vitulina richardii*), sea otters (*Enhydra lutris*), and Steller sea lions (*Eumetopias jubatus*), which are protected under the Marine Mammal Protection Act (and for Steller sea lions the Endangered Species Act), prevented surveys to multiple rookeries on multiple visits. These species may be vulnerable to disturbance during egg harvest at several locations. Nesting seabirds that may be disturbed by harvest include black oystercatchers (*Haematopus bachmani*), Arctic terns (*Sterna paradisaea*), pigeon guillemots (*Cepphus columba*), mew gulls (*Larus canus*), Canada geese (*Branta Canadensis*), and Caspian terns (*Hydroprogne caspia*) (*Figure 10*).

Next steps

These monitoring results suggest considerable variation between years and nesting sites in the number of eggs that might be available for harvest. Importantly, gull nesting distribution at traditional harvest sites such as South Marble Island appears to have declined, presumably as a result of vegetative successional processes that reduce the suitability of habitat.

Photo by Christopher Behnke

Figure 5: Glaucous-winged gull research was initiated in 1999 to determine the best egg harvest strategies to minimize impacts to gull productivity. This gull, seen nesting on South Marble Island by researchers in 2014, was banded during early studies and is now at least 18 years old!

NPS Photo

Figure 6: A National Park Service wildlife biologist collects GPS positions on glaucous-winged gull nests in Glacier Bay.

We also suspect from anecdotal observations, that egg predation on South Marble Island has increased in recent years, perhaps due to the increased availability of large trees used as predator perches (*Figure 11*). In addition, several potential harvest locations now support large numbers of hauled-out marine mammals, which may preclude access by harvesters.

With the long-awaited passage of the gull egg legislation, NPS can now promulgate the necessary regulations to implement the law. Meanwhile, a collaborative working group comprised of NPS staff and tribal members have begun meeting to discuss the practicalities of implementing harvests in the park, brainstorming various solutions to logistical challenges. Group discussions will inform the development of the annual harvest plans required by the LEIS. These annually prepared harvest plans will allow NPS to incorporate monitoring results as well as feedback from HIA into an adaptive management framework. Adaptive management incorporates a flexible structure to incorporate new information gained through experimentation, monitoring, and/or modeling to redefine objectives and make management decisions (*Allen et al. 2011*). This approach requires a broad visionary goal with specific measurable objectives (*Tear et al. 2005*). Goals and measurable objectives for gull egg harvest in Glacier Bay will be developed inclusive of both the cultural and natural resources.

Within the next several years, Huna Tlingit will once again be able to legally harvest gull eggs in Glacier Bay for the first time in over 50 years. Although it has been more than 18 years since NPS and HIA began the conversation about reauthorizing gull egg harvest, the long process itself has served to heal strained relationships and strengthen our partnership. By combining western and traditional sciences; committing to open and honest dialog; and agreeing to respect our diverse, sometimes divergent, traditions and approaches, the National Park Service and a tribal community are collaboratively stewarding resources we are both mandated to protect and preserve.

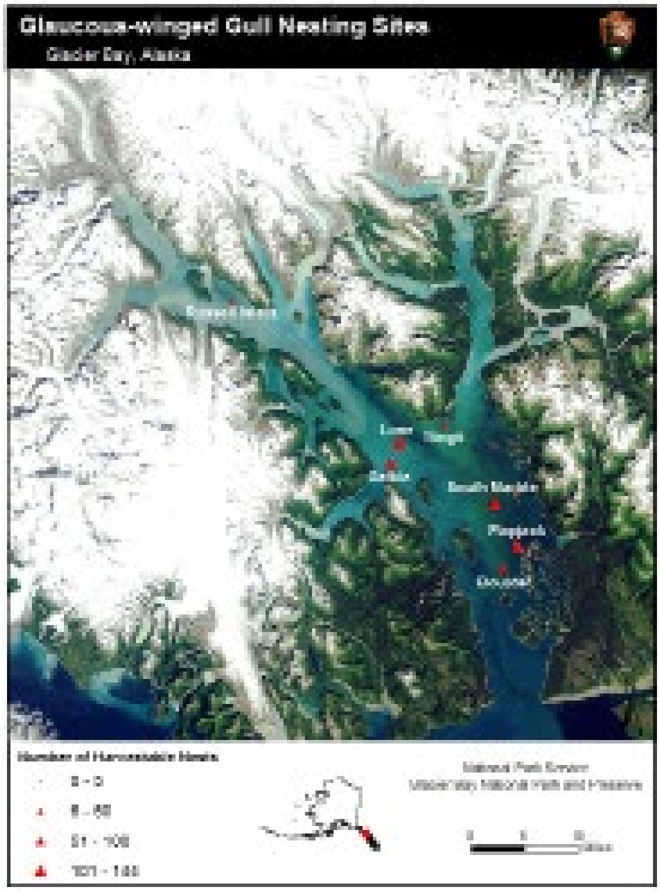

Figure 7. Mean number of glaucous-winged gull nests accessible to harvesters from 2012-2014 in Glacier Bay National Park.

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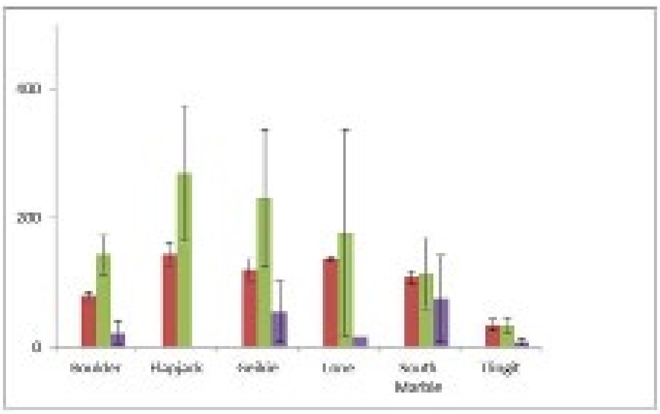

Figure 8. Mean yearly high counts of nests, eggs, and chicks/fledglings observed across study sites from 2012-2014 during glaucous-winged gull monitoring in Glacier Bay. Error bars represent standard errors. The number of chicks/fledglings at Flapjack is not obtainable due to terrain restrictions that prevent vessel surveys. Lone Island chick counts lack error bars as only one count was obtained over the course of three years because harbor seals hauled out on the island prevented surveys.

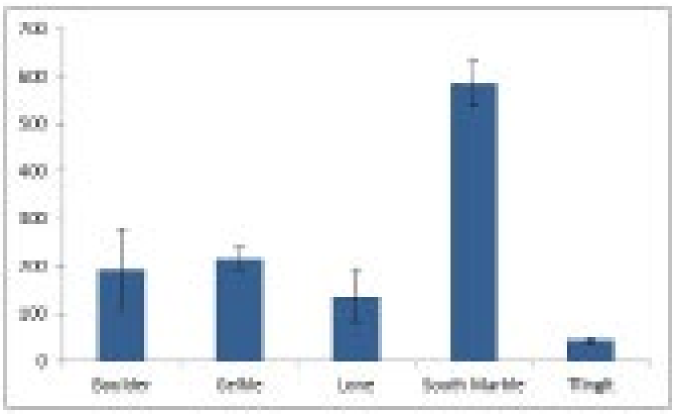

Figure 9. Mean yearly mid-season (June 15-July 15) high counts of adult glaucous-winged gulls observed across study sites from 2012-2014 in Glacier Bay. Error bars represent standard errors. The number of adult gulls at Flapjack is not obtainable due to terrain restrictions that prevent vessel surveys.

Figure 10: A harbor seal and group of pigeon guillemots rest on Geikie Rock amidst nesting glaucous-winged and herring gulls.

Figure 11: A predated glaucous-winged gull egg discovered on South Marble Island. Common ravens, bald eagles, and land otters are among the many egg predators.

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Birds of the Arctic—Simon Paneak and Laurence Irving: Collaborators in Arctic Research

By Don Callaway

Simon Paneak, a Nunamiut hunter, spent most of his adult life living in Anaktuvuk Pass in the Brooks Range. Simon was a fountain of traditional ecological knowledge, as were other adults within his community. However, Simon spoke, read, and wrote English, which facilitated his long collegial relationships with a variety of researchers interested in Arctic cultural and biological ecosystems. This article presents a brief overview of some of these research relationships but focuses on Simon's work with Laurence Irving and their collaborative and long-term research agenda concerning the birds of Anaktuvuk Pass.

"The Eskimo word *Nunamiut*, in fact, means "land people" (*nuna* = land; *miut* = people) or more particularly, inland people thus distinguishing them from other Eskimo tribes, the great majority of whom dwell on seashores" (*Campbell 1998*).

Nunamiut territory was approximately 66,000 square miles lying north of the tree line along the northernmost flanks of the Brooks Range extending less frequently into the Arctic slope. Before the middle of the nineteenth century the Nunamiut population was estimated to be 1,000-1,500 individuals sparsely distributed across their territory in 20 bands.

The principle component of the Nunamiut diet was caribou. The remaining flora and fauna, including moose, mountain sheep, birds, fish, and plants were insufficient, even in the aggregate, to sustain Nunamiut populations for any length of time.

Large caribou herds in Arctic Alaska, such as the Western Arctic Caribou Herd (WACH), cycle through dramatic changes in herd size. For example, the WACH, according to Alaska Department of Fish and Game figures, were estimated to be 250,000 animals in 1970 but six years later were estimated to be 75,000 (*Callaway 2005*) Although these particular figures have been disputed, it is clear historically that the WACH has undergone drastic shifts in population. Most biologists think that, for a herd this size, the shifts are due to abiotic (e.g., climatic) events. However, one ethnographer, Gubser (*1965*) also felt herd size was dramatically decreased between 1890 and 1905 by Nunamiut hunters, who harvested huge numbers of caribou to trade to the whalers for rifles, ammunition, knives, tobacco, flour, tea, and other items. Gubser also noted that during this period the Nunamiut suffered from a variety of epidemics, including flu, fevers, and measles: "A flu and fever epidemic killed over a hundred Nunamiut at a feast at the upper Noatak River where Nunamiut, Noatak, and Utukok Eskimos were trading."

John Martin Campbell (*1998*) also cites Charles Brower, who witnessed the deaths of some 200 Nunamiut in 1899. The Nunamiut contracted a disease in Point Barrow and over the span of a few days died on their way back to the interior.

It was in this context of starvation and disease that Simon Paneak was born in 1900 in the Killik Valley of the central Brooks Range to a Nunamiut father and a mother from Point Hope. Simon grew to be a young man in the Brooks Range; however, by 1920 all the Nunamiut had either died of disease or, facing starvation, had migrated to the coast, which was rich with marine mammals. Simon resided on the coast for about 15 years. It was here that he married his first wife, a coastal Eskimo woman, trained by missionaries to be a schoolteacher. It was from her that Simon learned to speak, read, and write English. Some three decades later, Gubser (*1965*), during a long hunting trip, tells of Simon, recounting the death of his first wife in childbirth and his subsequent despondence lasting several years.

In the mid-1930s as the trade value of furs declined, a few Nunamiut families returned inland to live their lives as caribou hunters among the headwater valleys of the central Brooks Range. One of these families included Simon and his second wife, Susie, a Nunamiut.

For slightly over a decade after his return to the Brooks Range, Simon lived the life of a subsistence hunter and

Figure 1. The Wind River area in the eastern Brooks Range is home to a variety of bird species.
Photo by Sally Andersen/Arctic Wild

Figure 2. Simon Paneak.
Photo courtesy of North Slope Borough Inupiat History, Language and Culture Department

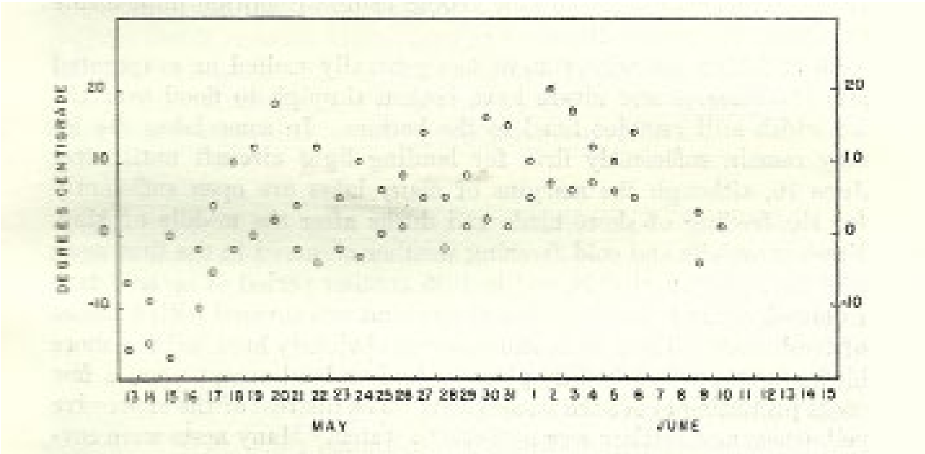

Image from Irving 1960

Figure 3. In addition to keeping a detailed journal of his bird observations, Simon Paneak kept records on weather.

Photo courtesy of IAB

Figure 4. John Krog, left, then of the University of Olso, and Laurence Irving during a joint physiological field study. Circa 1952.

continued to be a keen observer of the natural world. It is important to note that during this period Simon, like his congener Homer Mekiana, kept a journal; unfortunately, the contents of those journals have been lost to us. It is also important to realize that during the period of the 1940s Simon kept abreast of events in the world outside by listening to his mahogany-veneered Zenith all-wave receiving set—listening to "G.I. Jill," "Voice of America," and "Tokyo Rose."

In 1945 at Chandler Lake, a plane piloted by Sig Wien dropped off a party of four geologists seeking to make stratigraphic maps of the area. Simon Paneak met the group, and thus began a long series of professional relationships between Simon and a variety of Arctic researchers. In 1947 Wien brought the noted Arctic physiologist Laurence Irving, who had decided that the nearby passes, based on information relayed by Charlie Brower and others, was a likely route for migrating birds. After initial meetings, Irving became increasingly impressed with Simon's diligence, memory, and knowledge of the natural area. Irving said in his memorial article about Simon:

> Numbers and dates characterized his observations and provided exact communication from his remarkable memory. This accuracy of memory fixed the position and appearance of geographical features, so that he could sketch maps free-hand of coasts and streams that he had not seen for years. (*1976*)

Irving dramatically underscores the acuity of Simon's memory. In a passage in his book he tells the following anecdote:

> In the winter of 1908 or 1909 (when Simon was 8 or 9 years old), Simon Paneak recalled, he and some other boys, who were then near the head of the west branch of the Kuparuk River (lat. 68° 35' N., long. 149° 20' W.) found over a hundred mud nests built against the rock cliffs. When these were knocked down or examination they were found to contain frozen young birds, which were well feathered and nearly ready to fly when they had died. Paneak and I discussed this story again as we watched the cliff swallows building their nests against the houses at Bettles. (*1960*)

In 1950 Irving asked Simon to initiate a journal on birds, which Simon did until his death in 1975. In this journal, after consultation with Irving, Simon made systematic observations on the number and sex of all specimens collected; the date on which they were collected; weight in grams; fatness on a scale ranging from fat (F), medium fat (MF), little fat (LF), to very little fat (VLF); and where important, certain measurements.

Simon performed these and other observations such as taking the temperature at 8 am every morning for a year (*Irving 1960*) or the high and low temperature every day for the month of May and June in 1951.

In addition, Simon recorded for years the first arrival of nesting and migrating birds by species. In 1951 Krog (a colleague of Irving's) and Paneak carefully observed the arrivals and obtained weights of over 500 birds during a spring season that started slightly earlier, was drier, and was more variable in weather than usual.

Simon's journals were detailed:

> …from May until fall the journals focus on the migratory birds that nest in the Arctic, Simon tallies the sightings of different species reported by himself and other family members; he notes when birds are singing and mating, he comments on their nests and eggs, and when the young of various species first take flight. Over the years he collected numerous bird specimens for Irving, recording, in his journal the weight, length, and sex of each along with the contents of their crops (*Blackman 2004*).

Numerous tables in Irving's book are a direct consequence of Simon's careful observations and documentation. For example, one figure in Irving's book documents first arrivals at Anaktuvuk from 1948 to 1953 for 69 species of migrant birds and also provides detailed information on nesting and egg laying. This data is further refined in another figure where the frequency of first arrivals is plotted against month and day from April through June (*1948*).

Previous to this Simon's observations provided the data necessary to classify the status of 106 species of birds as to whether they were resident, resident and migrating, migrating to nest, visitor, or winter visitor (*Irving 1960*).

In 1960, shortly after the beginning of Simon's intensive ethnographic work with Nicholas Gubser, Irving requested that Simon concentrate his observations on willow ptarmigan. As Blackman (*2004*) states, "by 1963 his journals are dominated by ptarmigan." Blackman writes, "They (notes on ptarmigan) appear by the hundreds, by the thousands. Simon's activities are focused on tracking every one of theirs and they loom so large on the landscape that one wonders how anyone could discuss the Arctic without mentioning ptarmigan."

From these detailed notes and observations comes one of Simon's major scientific publications, *Migration of Willow Ptarmigan in Arctic Alaska* (*Irving et al. 1967*). Interestingly, Cornell Lab's *Birds of North America*, the go-to source for a current overview of North American bird species written by Hannon et al. (*1998*), cites this article no fewer than three times, noting it as a major source on migratory behavior, including flock size and winter range. It also serves as a singular source on food capture and consumption (i.e., Simon's analysis of crop content).

Hannon et al. (*1998*) raise several key issues concerning willow ptarmigan in their section "Priorities for Future Research":

- However, the relative remoteness of their habitats, the harsh weather conditions in autumn and winter, and shrinking research budgets in governments and universities have left a number of research questions unresolved.
- There is a need for cross-disciplinary work with archaeologists and anthropologists to determine changes in distribution and habitats occupied historically.
- Finally, we need to determine responses of Willow Ptarmigan to global environmental changes such as the impact of climate change on distribution, abundance and breeding.

With respect to the unresolved research questions, Simon and Irving's partnership was a fairly inexpensive approach and the only real way to have a researcher on the ground every day of the year. As Irving says:

> Their hospitality has greatly eased the burden of working in remote regions while their extensive knowledge of the movements of the various birds has helped me to distinguish the regularity common to populations from the deviations of occasional individuals (*1960*).

This quote also highlights the special social and cultural context that Irving found himself in:

> Adding to the effectiveness of Eskimo observation was their pleasant social custom of spending long periods in conversation and discussion upon the events of natural history. In this way all observations made in the village were brought into a pool from which Simon Paneak and I could study in careful, critical discussion the details and circumstances by which the migration was marked (*1960*).

There was simply no way for such systematic data to be collected without this partnership. Simon's work also demonstrates the key contribution of baseline data to measuring the impacts of climate change on migrating birds.

As a digression I might also mention the difficulties I had, as a grant reviewer of climate change proposals, in trying to convince specialists in one science, in this case botany, to include ornithological data in their research design on phenology. The Paneak-Irving partnership was not only a melding of the academic and a local world—it was highly illustrative of Campbell's openness to interdisciplinary research and Simon's expertise in and contribution to a number of disciplines. Campbell, trained in archeology, ethnography, biology, and zoology, notes that "Because of

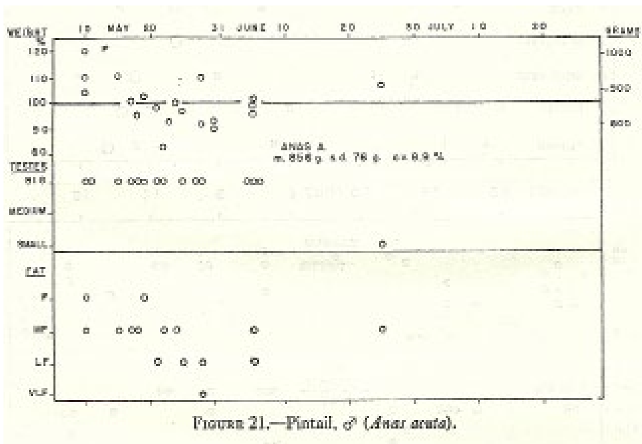

Image from Irving 1960

Figure 5. Another example of Paneak's bird documentation.

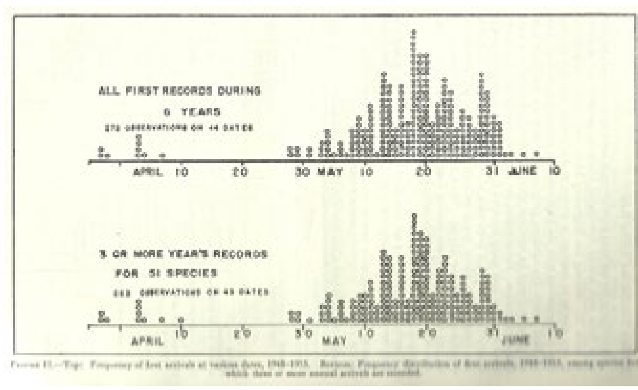

Image from Irving 1960

Figure 6. Paneak chart showing frequency of first avian arrivals at various dates.

the eclectic nature of our Brooks Range work, help from biologists and earth scientists was essential" (*1998*).

Their research design included Stephen C. Porter, a field geologist; Loren D. Potter, a plant ecologist; James E. Morrow, an ichthyologist; and Robert L. Rausch, a mammalogist and parasitologist. Simon Paneak served as both a field associate and long-distance adviser to all of them. About Simon Paneak, Campbell summarizes:

> Throughout his life he had taken special interest in Nunamiut cultural and natural history. He was expert in native technology and in the manufacture of its artifacts. He had extraordinary knowledge of Brooks Range flora and fauna; so extraordinary, in fact, that our colleague the physiologist Laurence Irving, once remarked to us that had Paneak belonged to our society he undoubtedly would have been a professional biologist (*1998*).

One quick example of the complementary nature of interdisciplinary research revolves around the issue of the utility of willow ptarmigan to the Nunamiut diet. Irving, a physiologist, and Campbell thought that despite the availability of ptarmigan during the winter, the birds' low fat content made them an insignificant contribution to the Nunamiut diet. Gubser (*1965*), however, following up on this topic, found that willow ptarmigan were an important supplement to the diet in late spring when food from other sources was in extremely short supply. In addition, in the 1960s "many Nunamiut still set snares for ptarmigan day after day during the lean months of the winter" (*Gubser 1965*). Gubser continues:

> Many Nunamiut speak of the ptarmigan as an invaluable dietary supplement, especially in hard times which are not unusual in the Brooks Range. The only problem with ptarmigan, however, is that they have very little fat, and eating boiled ptarmigan without blubber or fat of some kind 'is like eating moss.' Many older Nunamiut can remember a winter when, if there had been no ptarmigan, some people would have starved to death.

To this point we have concentrated on Simon's work with Irving on birds that resulted in three peer-reviewed articles with Simon as a junior author and Irving's book *Birds of Anaktuvuk Pass, Kobuk, and Old Crow* (*1960*). However, we would be remiss not to mention Simon's contribution to the ethnography of the Nunamiut.

In 1949, Helge Ingstad arrived in the Brooks Range and stayed with Simon for several months and then in 1989 when, at the invitation of the community, he returned to be celebrated for his contributions to their preservation of their cultural heritage. His book, *Nunamiut, Among Alaska's Inland Eskimos* (*1954*), was a popular best seller, especially in his home country of Norway. A commemorative edition was published in 2006, with a preface by Grant Spearman

Wikipedia

Figure 7. Male willow ptarmigan.

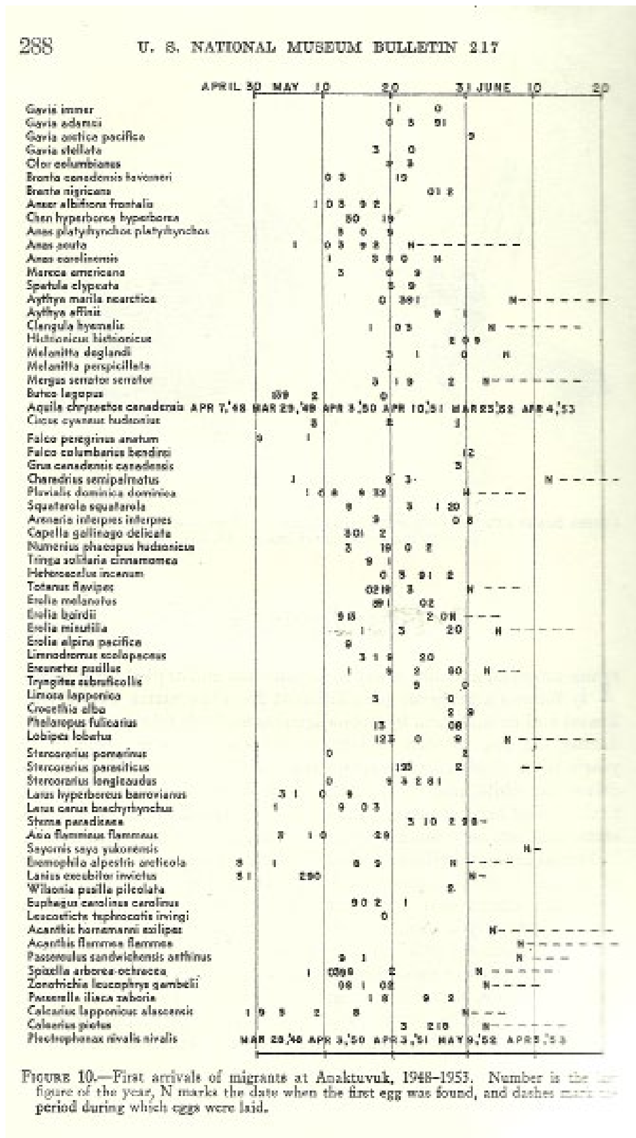

Image from Irving 1960

Figure 8. First arrivals of birds in Anaktuvuk Pass.

(the preface is a must read). Ingstad was also instrumental in getting Dr. Knut Bergsland, a highly regarded linguist, to transcribe the texts of stories he had recorded from Simon. Simon's stories were eventually published by the North Slope Borough as *Nunamiut Stories*. Finally, Helge's (*2006*) description of a sheep hunt with Simon is not to be missed.

In addition, John Martin Campbell, a member of the 1956 Yale North Alaska Expedition, became a long-term friend, colleague, and collaborator with Simon for nearly 20 years. Campbell's *North Alaska Chronicle* (*1998*) is a compilation of 62 drawings done by Simon with both individuals providing ethnographic notes as to their content. In addition, Campbell edited a book of essays by Simon, In a Hungry Country (*2004*). This book also contained contributions from Robert L. Rausch, Stephen C. Porter, and Grant Spearman; all but Grant were research collaborators who worked with Simon as described above.

Finally, the most definitive and detailed ethnographic work on the Nunamiut was written by Nicholas J. Gubser, entitled, *The Nunamiut Eskimos: Hunters of Caribou* (*1965*). Gubser, a precocious Yale senior, spent nearly a year with Simon Paneak in 1960. This is a remarkable and professional ethnography written by what was essentially an undergraduate student.

Simon Paneak died in 1975 a cherished friend and colleague to multiple generations of Arctic researchers representing contributions to a broad span of disciplines.

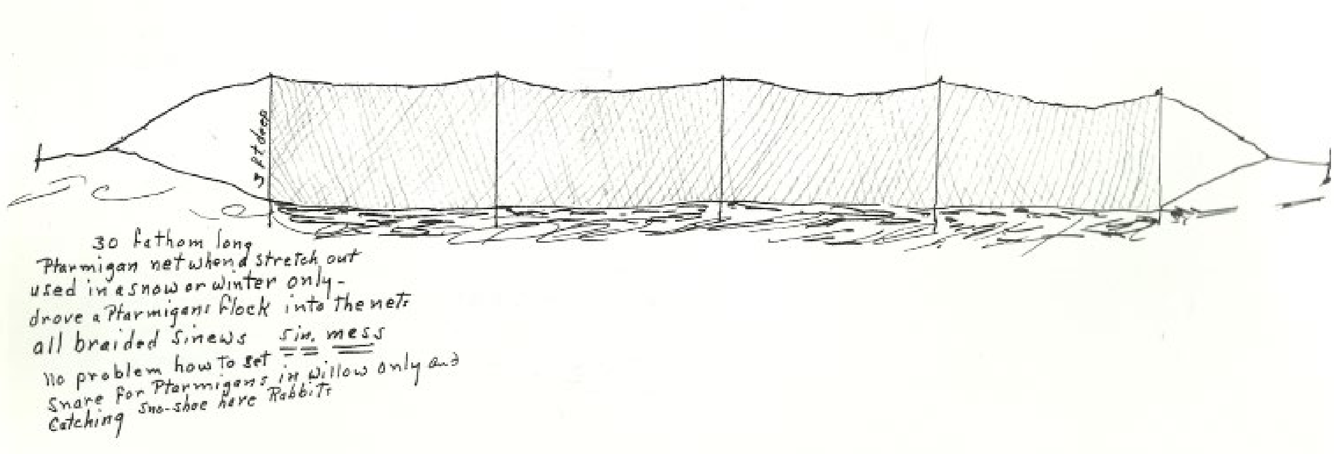

Figure 9. Drawing by Simon Paneak of a net for catching ptarmigan.

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KOTZEBUE
ALASKA

The Birds of Bob Uhl's Journals

By Rachel Mason and Eileen Devinney

Bob Uhl and his late wife, Carrie (*Figure 1*), lived in remote sites in Cape Krusenstern National Monument for more than 50 years (*Figure 2*). Bob first arrived in Kotzebue in 1948 while serving in the Army, and stayed in the area. Carrie grew up in a traditional Iñupiaq family in Kotzebue Sound. For many years, the couple lived at Sisualik in the summer and moved inland to a cabin amid the trees at Sanningaruq during the winter. From 1990 to 2004 Bob kept journals of daily observations; these unique accounts provide a wealth of information about weather, climate, flora, and fauna.

Birds appear in almost every day's entry. As a subsistence user, Bob related to the birds as a source of food. As a fellow dweller of the natural world, he also saw them as friends. Above all, however, Bob was a naturalist who knew changes in certain populations affected other parts of the ecosystem. His journal records the birds' seasonal migrations, deviations from expected behavior, and connections between birds and other species.

Birds as Food Sources

In a 1977 report about subsistence patterns of residents of the Cape Krusenstern area, Bob and Carrie Uhl asserted that birds and eggs were among the most essential local foods. They pointed out that migratory birds arrived in the spring after seven months of a practically birdless sky. Not surprisingly, although bird hunting was then only allowed in the fall, "this regulation goes against practical subsistence living and is widely disregarded" (*Uhl and Uhl 1977*). A 1997 bird harvest survey conducted by the Alaska Department of Fish and Game (ADFG) in Kotzebue shows that this pattern continued: while 27.6 percent of the households that regularly hunted birds harvested ducks in spring, only 17.6 percent took ducks in the fall (*ADFG 1997*). Fortunately, a spring subsistence hunting season for migratory birds went into effect in 2003, recognizing the long tradition of spring bird hunting in rural Alaska.

Figure 1. Bob and Carrie Uhl.
Photo by Greg Gusse

The northern pintail (*Anas acuta*, Iñupiaq *kuruġaq*), one of the first ducks to arrive in May, was probably the most important subsistence bird species in the Cape Krusenstern area. "He usually has a thin layer of fat left from his long flight and makes a delicious pot of soup that you can almost feel course strength through your winter-tired body." Elderly Iñupiat were particularly fond of it (*Uhl and Uhl 1977*).

Eggs of all kinds were gathered in the spring. Glaucous gulls (*Larus hyperboreus*, Iñupiaq *nauyasugruk*) produced the largest number of eggs used for subsistence, although Arctic tern (*Sterna paradisaea*, Iñupiaq *mitqutailaq*) eggs were considered the most delicious (*Uhl and Uhl 1977*). In 1997, 23.7 percent of Kotzebue bird-hunting households harvested gull eggs, showing the continued popularity of this resource (*ADFG 1997*).

Willow ptarmigan (*Lagopus lagopus,* Iñupiaq *agargiq*) live year-round in the area (*Figure 3*). The Uhls said everyone liked this bird: "It eats willow buds, berries, and a few insects, and has a delicious energy-giving meat." (*Uhl and Uhl 1977*). According to anthropologist Ernest S. Burch, Jr., in the late 19th century, people stayed alive in late winter by catching ptarmigan with snares. Young boys learned to hunt by shooting ptarmigan with bows and arrows (*Burch 2006*).

Uhl's journals are full of references to willow ptarmigan. As one of the few birds that wintered over in the area, it was reliably one of the species recorded in the Audubon Christmas Bird Count conducted at the Uhl's cabin in Sanningaruq. The numbers of ptarmigan varied greatly over the years. When it was available, Bob and Carrie ate willow ptarmigan throughout the winter. Frequently they received ptarmigan as a gift from a young hunter, suggesting the bird's continuing role as a training species. In 1997, 37.4 percent of bird-hunting Kotzebue households harvested ptarmigan (*ADFG 1997*).

The Uhls trapped snowy owls (*Bubo scandiacus,* Iñupiaq *ukpik*) when they arrived for a short season (*Figure 4*). Like some older Iñupiat, they liked the flavor of snowy owl soup. Owl traps were constructed of driftwood posts with an

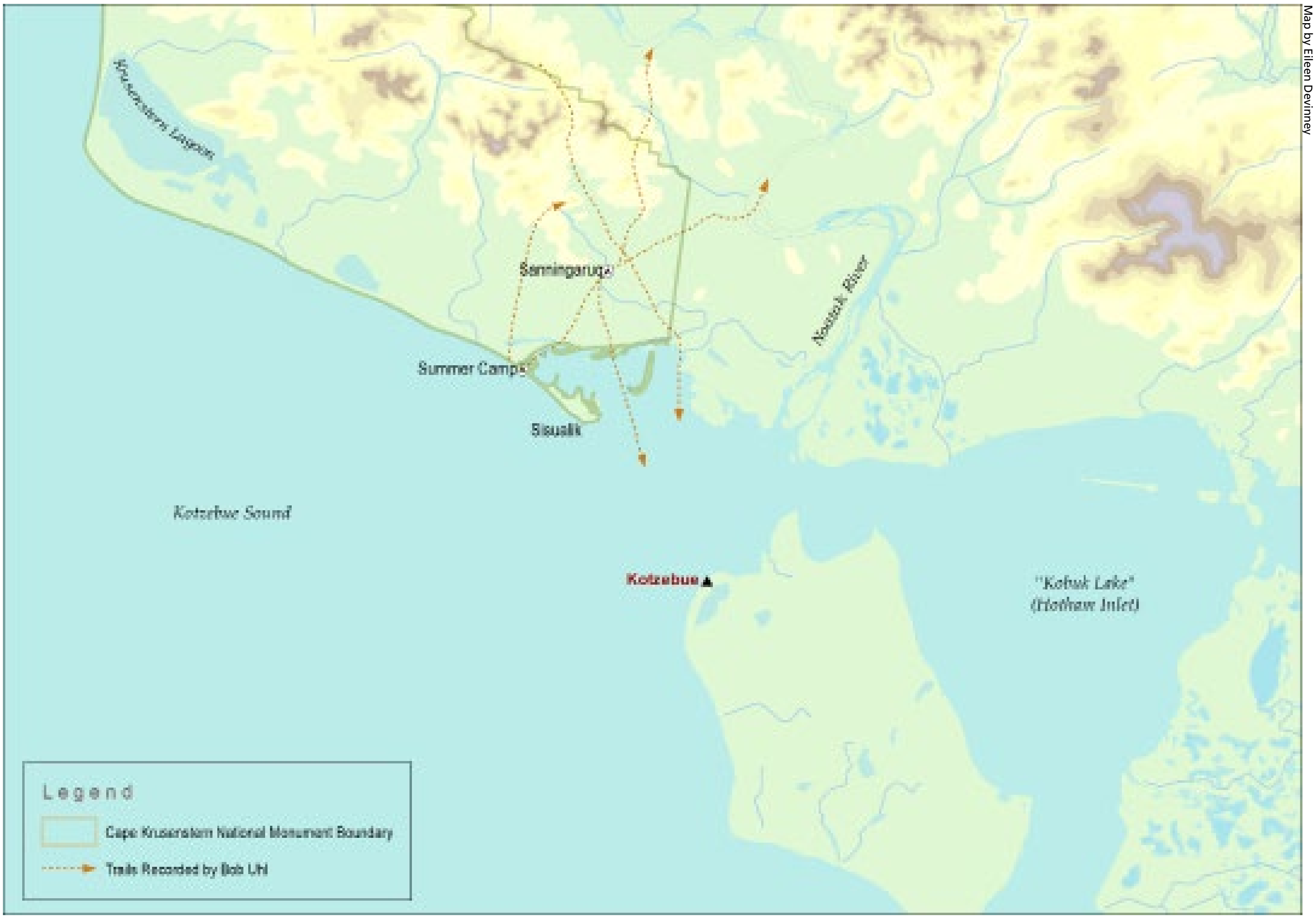

Figure 2. Kotzebue Sound area and trails recorded by Bob Uhl.

attached chain that caught the bird's leg (*Uhl and Uhl 1977*). In October 1992, Bob wrote, "Set four Snowy Owl traps today. Haven't seen our two summer owls for some time. Hope they have gone far away" (*Uhl 1990-2004*). He evidently hoped their resident owls wouldn't end up in the soup pot. No Kotzebue households reported taking any owls in 1997 (*ADFG 1997*).

Birds as Friends

Some of the most frequent "characters" appearing in Bob's journals are birds. He and Carrie recognized many birds that stayed around their camp for days or weeks, including some who returned year after year. They assigned names to a few: Jonathan Livingston Seagull, a glaucous gull; Lucinda, his mate; Peg, a glaucous gull with a lame leg; Pipsqueak, a mew gull; Sweetie Pie the chickadee. Others, like the tree swallows, the snowy owl, and the hawk owl, did not acquire names but were nevertheless treated as friends.

Occasionally Bob reflected on human-caused or natural tragedies in the birds' lives. He once found a dead boreal chickadee that had flown into the cabin window. "Such a sad ending for a friendly little creature that has come by for a visit every day for six months," he wrote (*Uhl 1990-2004*). When he saw a glaucous gull with a broken wing seeking food in the slushy edge of the frozen lagoon, Bob commented, "The Death Angel that will relieve his condition and situation will likely be one of the numerous Sisualik foxes that patrol the beach and marshes for that very purpose" (*Uhl 1990-2004*).

The tree swallows (*Iridoproene bicolor*, Iñupiaq *tuluġaġnauraq*) came back to the Uhls' summer camp every spring, and raised their young in a box Bob made for them (*Figure 5*). In July, after they fledged their hatchlings, the parents proudly lined up their family to show off before they all flew away. Not all the youngsters survived. One year, after the birds departed, Bob found the remains of two hatched birds that had apparently succumbed to unusual freezing temperatures earlier that year (*Uhl 1990-2004*).

The Uhls' glaucous gull friend Jonathan habitually perched atop the swallow box and surveyed the landscape (*Figure 6*). The tree swallows and Jonathan maintained an uneasy co-existence. Bob praised the bravery of the mother tree swallow who sat on her nest with a huge gull sitting above her.

Jonathan, who first appeared in the journals in 1991, was the most loyal of avian friends. He must have been growing elderly, as were the Uhls, when they last saw him in 2004. Every year, they anxiously awaited Jonathan's arrival around April 30, and were always eventually rewarded when he returned, initially shy.

NPS photo

Figure 3. A willow ptarmigan perched amid branches.

Jonathan became tamer after the first few days in camp each year, following Bob around in hopes of fish scraps. He would not eat food from Bob's hand, but his mate Lucinda did. Once she impressed Bob greatly by using him for protection from other gulls in order to get food to her offspring. Lucinda took some food from Bob, then regurgitated it for her young to eat right at his feet, where the other gulls would not dare to approach (*Uhl 1990-2004*).

Each year, Jonathan and Lucinda started to tend a nest of eggs soon after arrival. The Uhls always ate the gulls' first clutch of eggs, but left the second group for them to hatch. In 1994, the gulls' nest on an island in the lagoon was flooded and the nearly hatched eggs swept away (*Uhl 1990-2004*).

Every fall, Bob and Carrie worried because Jonathan and some of his family stayed in camp after other gulls had left, hoping for handouts that would end abruptly when the Uhls moved to their winter home. One October, after even Jonathan was gone, Bob wrote of the five remaining young glaucous gulls, "Most of these are probably not going to survive. They have focused on the camp as a food source and that is going to fail. We don't know how to remedy the situation since it involves their basic instincts" (*Uhl 1990-2004*).

The Christmas Bird Count

The Audubon Society sponsors an annual Christmas Bird Count (CBC) in locations throughout North America. Bob hosted the Sanningaruq count for many years. Most years, despite the brutal cold, possible blizzards, and lack of daylight, he could rely on helpers who traveled 18 miles from Kotzebue by snowmachine to take part.

After the 1997 count, Bob reflected: "We had a

Photo courtesy of Jim Dau

Figure 4. A snowy owl perched amid rocks and grasses.

fine crew of ten brave people who found 554 birds of ten species in an apparently bird-less landscape" (*Uhl 1990-2004*). The "best birds" were the gyrfalcon and northern goshawk, whose presence suggested that avian predators were returning to the area. The same count yielded 421 willow ptarmigan, revealing an abundance of this winter subsistence staple (*Uhl 1990-2004*).

The primary draw for the CBC, according to ADF&G biologist Jim Dau, was Bob and Carrie's warm hospitality. After the count, the participants sat down to moose roast, smoked salmon, and a variety of traditional Iñupiaq foods. Over the meal, they discussed happenings and changes in the world of nature and resource management. Jim, his wife Randy Meyers, and one or both of their sons participated in the Sanningaruq count every year (*Dau email 2015*).

In 1994, the weather was so bad that Bob and Carrie did the CBC by themselves. Thanks to a flock of 20 white-winged crossbills, they sighted 34 birds of four species (*Uhl 1990-2004*). The 2003 count was cancelled due to extreme weather; in February, however, an intrepid crew of five came from Kotzebue to do a belated count for Bob's journal record. They counted 44 birds of six species, but no birds of prey and few ptarmigan (*Uhl 1990-2004*). The Sanningaruq CBC became inactive when Bob and Carrie moved to Kotzebue later in 2004.

Bob said he did the CBC because he enjoyed learning about birds from people who knew more about them than he did (*Hess 2010*). Birders, however, had a different kind of knowledge than Bob's. The goal of the CBC was to record as many birds as possible—not to eat the birds, or befriend them. Bob always hoped for unusual birds to appear in the CBC; he was excited in 1990 when two three-toed woodpeckers were first counted in the Sanningaruq event (*Uhl 1990*). One year a northern hawk owl not seen for several years- hung around camp in December but did not show up on count day (*Uhl 1990-2004*). It came back on New Year's Day. Bob hoped the return of the northern hawk owl meant that its snowshoe hare prey base was returning. He speculated that the good spruce cone crop was attracting passerines, which were in turn feeding birds of prey (*Uhl 1990-2004*).

Patterns and changes over the years in CBC observations are valuable for assessing trends in populations of subsistence resources. For example, the Sanningaruq counts revealed dramatic fluctuations in counts of willow ptarmigan. A record 1,023 willow ptarmigan were sighted in the 1988 bird count (during whiteout conditions), and 421 in the 1997 count, but between those years were low counts of only 10 (1992), 17 (1993), and 0 (1994) (*CBC Results 1978-2014*).

Bob Uhl as Naturalist

Bob's perspective on birds came from living with them every day of the year. He noticed patterns over time that showed how parts of the ecosystem were related. In April 1990 he wrote:

This was a very silent winter for birds in the Monument. A poor white spruce cone crop combined with the continued presence of a few Northern Hawk Owls kept woodland species (White-winged Crossbills, Pine Grosbeaks, Redpolls, Gray Jays, Boreal Chickadees) at a bare minimum. Heavy wet snow during the winter depressed seed heads of ocean beach vegetation (Elymus, Angelica, Artemisia) resulting in a scarcity of Snow Buntings and Redpolls also. Ptarmigan were present in moderate numbers and their predators were occasionally observed (Gyrfalcon, Goshawk, Snowy Owl). Bird noise was pretty much restricted to Raven croak, Ptarmigan cackle and Gray Jay scold (*Uhl 1990-2004*).

Jim Dau said of Bob Uhl:

. . .[He] was unequivocally the best naturalist I've ever known. . .He epitomized the curious scientist and, despite the remoteness of his home, managed to mine the technical literature to learn daily what others had to say about the things that he observed. But unlike most academics, Bob lived in and observed nature daily over more than 50 years, and he was a keen observer. Additionally, Bob was as interested in human cultures as he was the natural world. . . His intellect was exceeded only by his kindness. There haven't been many like Bob Uhl (*Dau 2015*).

Photo by Donna Dewhurst

Figure 5. A tree swallow emerging from the safe haven of a nest box.

Figure 6. A glaucous gull in flight near Camp Sivu, northwest Alaska.

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Birding is for Everyone!

By Carissa Turner and Dennis Bailey

Interested in getting involved in bird-related projects and activities near you? There are some great opportunities out there to participate in annual events and long-term citizen science monitoring activities. Whether you are a skilled birder or just beginning, here are some great resources to get involved!

The Great Backyard Bird Count and FeederWatch

The Great Backyard Bird Count (GBBC), organized by the Cornell Lab of Ornithology and the Audubon Society, is a great way to bird from the comfort of home and contribute to a long-term data set. Held annually, the count helps form a snapshot of bird populations all across the globe. Participation is as easy as counting and identifying birds in your backyard for at least fifteen minutes on one or more days within the count dates. This study has helped scientists identify the distribution of snowy owl (*Bubo scandiaca*) populations during the 2015 polar vortex and various other population dynamics using crowdsourcing techniques. The next GBBC will take place from February 12 to 15, 2016. For more information and to register, visit gbbc.birdcount.org.

For those interested in recording and submitting species lists and numbers of the birds they see at their feeders throughout the winter (November to early April), check out Project FeederWatch. Data gathered through Project FeederWatch provides information on the long-term trends in abundance and distribution of birds throughout North America. Participants are asked to identify, count, and record the bird species they see at their feeder during a two-day window that the participant chooses. Participants can choose multiple two-day schedules in which to record their observations throughout the winter.

International Migratory Bird Day

Celebrate bird migration each spring during International Migratory Bird Day (IMBD), a project of Environment for the Americas. Although officially recognized as the second Saturday in May in the United States and Canada, Migratory Bird Day activities happen at different times throughout spring. Activities are sponsored by a variety of agencies and organizations, including bird walks, festivals, and other special IMBD programs and events. The goal of IMBD events is to give the public opportunities to learn about birds and bird conservation. In Alaska, 2015 activities and events included the Kachemak Bay Shorebird Festival in Homer, bird walks in Anchorage, a migratory bird count in King Salmon, bird banding demonstrations in Juneau, and an IMBD roundtable at Glacier Bay National Park.

If you find yourself soaking up the sun south of the U.S. border in the fall, you might be able to take part in other IMBD activities and events celebrated in Latin America and the Caribbean in October. To learn more about IMBD and to find events near you, visit www.migratorybirdday.org. Anyone can take part in these activities and all skill levels are welcome.

Christmas Bird Count

Every year since 1900 (the same year the last wild passenger pigeon {*Ectopistes migratorius*} was sighted) citizen scientists spend a day out birding in what is known as the Christmas Bird Count. What started as an annual hunting tradition to see who could collect the most, largest, and greatest variety of species was changed to an annual Christmas bird census; the longest running citizen science project to date. With such a long detailed history of sighting and population data, the Christmas Bird Count is a tool used by scientists to identify trends in bird populations and forecast future change. It has also been instrumental in the development of conservation strategies and initiatives. The 2013 Christmas Bird Count included 2408 count areas from the Arctic to the Andes. Over 66 million birds were tallied; 2,403 species in total! Thirty-seven counts were compiled in Alaska.

To learn more about the great annual event, visit the Audubon website. Registration opened in November 2015 for the 116th Christmas Bird Count, which will take place between December 14, 2015, and January 5, 2016. Sign up then for count activities near you.

Figure 1. Lesser yellowlegs

NPS photo by Tim Rains

NPS photo by Tim Rains

Figure 2. White-crowned sparrow

NPS photo by Steve Thomas

Figure 3. Pine grosbeak

NPS photo by Steve Thomas

Figure 4. Black-billed magpie

Coastal Observation and Seabird Survey Team

If you live near the coast, love to walk on the beach, and want to contribute to a long-term monitoring effort, COASST is for you! The Coastal Observation and Seabird Survey Team (COASST) collects baseline data on seabird mortality through a dedicated group of volunteer citizen scientists committed to monthly data collection. Participants walk their designated beach each month to look for dead birds. When encountered, the birds are identified by species, marked, photographed, and then left in place. Each month, the beach is re-surveyed by the dedicated team; new birds are marked and re-found birds are recorded. All in all, this effort provides information on trends in seabird mortality and carcass persistence on beaches, and helps scientists identify natural and human-caused mortality events.

COASST was founded by Dr. Julia Parrish in 1998, and is based out of the University of Washington. To participate, COASSTers take part in a six-hour training session and sign a contract to walk the same designated beach each month. A small deposit fee is used to provide the training and field materials. For more information, check out the COASST website.

Whether you are interested in participating in annual bird-related activities or festivals, contributing to science by recording bird sightings from your living room, or participating in monthly beach walks to document seabird mortality, there are plenty of ways to get out and bird!

NPS photo by Steve Thomas

Figure 5. Black-capped chickadee

NPS photo by Steve Thomas

Figure 6. American robin

Looking Back—A Heady Time for National Park Service Science in Alaska

By John G. Dennis

Introduction

Congress passed the Alaska Native Claims Settlement Act (ANCSA) in December 1971 to establish a mechanism for resolving land claims of the Native peoples of Alaska and for encouraging the State of Alaska to complete its land claims as provided in the Alaska Statehood Act. The stimulus behind ANCSA was economic pressure to provide a corridor for an oil pipeline that would carry Prudhoe Bay oil to an accessible year-round marine port. One compromise that helped make passage of the act possible was inclusion of two conservation-focused provisions that came to be known as D1 and D2. These provisions authorized federal managers to identify up to 80 million acres (D2) of lands that would be set aside for study as possible additions to national forest, park, wildlife refuge, and wild and scenic river systems plus additional lands (D1) that could be considered in such study.

ANCSA prescribed a formula for determining what lands would be identified for possible selection by the Native corporations. The State had been developing a strategy and conducting analyses of lands in which it had interest for a number of years since passage of the Alaska Statehood Act in 1958. The federal agencies and conservation communities for a number of years had been developing ideas about areas of Alaska that might warrant conservation status. The National Park Service (NPS), for example, had conducted a variety of field surveys and natural and historic theme studies in Alaska from as far back as 1938 and had recommended several national monument proclamations to the Secretary of the Interior that the Secretary recommended to the President. A June 1972 NPS summary of past NPS activities identified 22 reports and a long list of registered, eligible, recommended, and potential Natural Landmarks (National Park Service 1964 and National Park Service 1972a are examples of published discussions about possible additions to the National Park System and Sanchez 1967 and Schmidt 1969 are examples of natural landmark eligibility reports). As a result of these various efforts, the interested parties were able to identify and map a tentative distribution of the then mostly federal lands and waters of Alaska into Native, State, conservation interest, and residual categories, and the federal land management agencies sorted out among themselves which agency would be assigned to study which components of the identified conservation-potential lands. NPS by mid-March 1972 had identified 14 conceptual study areas and several principal values for each of those study areas. The overall time line for this study activity required NPS to establish final study area boundaries by September 1972 and submit final recommended study packages (each containing conceptual master plan, legislative support data, and environmental impact statement) by mid-December 1973.

Figure 1. Misty morning.

NPS photo

Through its very active role in this process, NPS thus succeeded in receiving authorizations to study identified areas either for addition to the existing Glacier Bay National Monument, Katmai National Monument, and Mount McKinley National Park or for establishment as additions to the National Park System. These new-addition study areas included what are now Aniakchak National Monument and Preserve, Bering Land Bridge National Preserve, Cape Krusenstern National Monument, Gates of the Arctic National Park and Preserve, Kenai Fjords National Park, Kobuk Valley National Park, Lake Clark National Park and Preserve, Noatak National Preserve, Wrangell-St Elias National Park and Preserve, and Yukon-Charley Rivers National Preserve.

The intense state and national pressure for quick action spurred NPS by early 1972 to establish an Alaska Task Force with headquarters in Washington, D.C., the bulk of the work force in a bustling project office based in Anchorage, Alaska, and administrative support provided in part by the regional office in Seattle, Washington. The project office by mid-May had developed five study teams, four four-person teams that each addressed a separate part of the new area field work and a fifth team that explored cultural sites that had been identified as warranting consideration. Each team included a team captain, landscape architect, biologist, and interpretive planner. The biologist's role was to incorporate natural science thinking into the planning. Headed by a project leader and an administrative officer, the project office also had a cadre that included an engineer, several archeologists, a sociologist, representation for park management, a support data and service center liaison, a photographer, and land and mineral specialists. It developed this work force through reassignments and part-time details of personnel from other areas of the NPS. Having just joined NPS in October, 1971, as the Katmai biologist and being duty stationed in Anchorage, I became one of the five biologists. Being totally green to the ways of NPS, I found my entry into NPS being split between park and task force science to be extremely educational, heady, and rewarding. The following overview highlights elements of this heady science effort.

Science Strategy

Early on, the task force recognized that there were great differences of pre-existing knowledge about the different study areas and that the new area proposals that would emerge from the study process would be analyzed in part through procedures of the then new National Environmental Policy Act (NEPA) of 1969. Given that these procedures would be undergoing development even as the planning and analysis process progressed, it was observed that the Alaska planning would provide NPS an early opportunity to benefit from environmental impact analysis for planning. For example, an April 1972 memorandum (*NPS 1972*) pointed out the need to address historic—including archeological and paleontological—resources in NEPA documents and a court decision that was circulated to the task force in August 1972 (*Lybecker and Lloyd 1972*) discussed the necessity of backing up comments with existing data or with research results from new studies. These factors contributed to the task force setting aside funds to support library and field scientific activities that would inform and complement the new area planning studies that had gotten underway.

In addition to their new area planning work, the individual planning team biologists also served as a science team to help plan the task force science effort. In this role they encouraged acquisition of an annotated bibliography of relevant literature and identified high priority ecological science needs for many of the study areas, developed cost estimates for studies to address those needs, identified possible performers of the studies, and served as technical representatives in the contracting process. In the spring of 1972 they arranged for rapid production of the bibliography and in December 1972 they identified two different pathways for deciding how to allocate the limited funds set aside for conducting scientific work—one focused on short term responses for resolving identified, possible near-term planning and management concerns in the potential new areas, the other focused on the longer-term task of expanding basic knowledge about the natural resources of the study areas with emphasis on the least-known areas. Given the go ahead to structure a biological science program primarily to advance basic knowledge, the team in early 1973 began to establish project plans and identify project personnel for Chukchi-Imuruk (Bering Land Bridge), Gates, Kobuk, Lake Clark, Noatak, Yukon-Charley, and the proposed Katmai and McKinley extensions. Project personnel eventually recruited for these studies included scientists in Alaska and in other areas of the country, some of whom previously had conducted studies in Alaska and others who had not.

By early 1974, the science team had expanded the scope of their deliberations based on a variety of suggestions for scientific studies that came from many sources together with the team's broader perspective that had evolved once the start-up phase had gotten underway. This broader perspective advocated that studies for additions to existing park areas be incorporated into the existing research plans for those areas while planning for the proposed new areas focus on science needs common to all the areas plus specific needs unique to individual areas. The common needs they recognized encompassed all disciplines—climate, vegetation, fauna, aquatic and marine physical and biological elements, geology, soils, archeology and history, and visitor characteristics and needs.

The bibliographic work received the first contract, getting underway in late June 1972 and two months later producing annotated bibliographies for archeology, biology, climatology, geology, hydrology, pedology, and recreation.

Contract field work in 1973 included Chukchi-Imuruk (biological survey), Gates (flora and vegetation in an Alatna-Killik transect), and Noatak (biological survey), with the quirk that the Chukchi-Imuruk and Noatak projects were funded across two fiscal years, given that the fiscal year in 1973 ended on June 30. Because of this two-year funding, both projects were told that, if the fiscal year 1974 funds did not become available, they would have to leave the field as soon after June 30 as possible. Contract field work in 1974 involved Chukchi-Imuruk (plant ecology impact of winter ice road in Cape Espenberg, archeological survey, archeological investigation in the adjacent St. Lawrence Island), Katmai (eagle nesting and brown bear denning surveys), Kobuk (biological survey, subsistence-related activities—the latter jointly funded by the Northwest Alaska Native Association), and Yukon-Charley (biological survey). Contract field work in 1975 included a second summer in Yukon-Charley. Contract field work in 1976 included Katmai (biological survey of proposed western extension), Lake Clark (ecosystem survey), and subsistence studies in a number of areas.

Summaries of Selected Field Projects

Chukchi-Imuruk: A field survey team of up to 11 people during the period June 20 through August 20, 1973, used eight base camps, six spike camps, and 12.4 hours (covering approximately 1,072 miles {1,725 kilometers}) of large mammal observation flights to conduct field observations regarding flora and vegetation, soils, terrestrial mammals, birds, aquatic ecology and aquatic and terrestrial invertebrates, and locations of archeological sites they encountered. Their changes of camps involved a total of 72 hours flight time covering about 8,295 miles (13,350 kilometers) total distance. While in each camp, their walking radius ranged from 3 to 6.2 miles (5 to 10 kilometers). They were blown out of their Kuzitrin Lake camp after experiencing 95 hours of severe wind and rain, including wind speeds of 30 to 54.6 miles per hour (48 to 88 kilometers per hour), during the course of which they lost a field notebook and the data it contained. They recovered by drying out and warming up in a loft in Deering. At another camp, Serpentine Hot Springs, they arrived on multiple

Figure 2. NPS biologist A.R. Weisbrod on ridge in Serpentine Hot Springs portion of the Chukchi-Imuruk study area, looking northwest. August 2, 1973.

flights later on the same day that a solitary young woman from the area around Taylor arrived after about a 10-mile (16-kilometer) walk over the tundra, seeking to cure a cold by having some time to herself soaking in the hot springs. One of four major sets of soil samples they collected never made it back to the home university—uninformed and humorous speculation at the time opined that the airline that accepted the samples for shipment out of Alaska ended up using them as ballast for flights around the world (the responsible airline eventually reimbursed the NPS contractor a total of $109 for freight charges plus a value of $50 since no excess value had been declared, even though the contractor had filed a claim for a value of $8,304). In their May 1974 final report, the team provided their observations by each study topic.

The botanical team collected specimens of 318 of the estimated 350 vascular plant species, with 20 species representing range extensions into the Seward Peninsula, and about 60 species of foliose and fruticose lichens, 45 of which they found on a single lava flow (the Lost Jim), and one of which was the first record for the species in Alaska. They sampled about 50 vegetation stands, mostly as transects up slopes because they felt that interior upland slopes were the predominant land form in the study area. They observed 30-36-foot-tall (9-11 meters) spruce forest and woodland to the south and east and the same height range for cottonwood forest to the south and west of the study area, as well as four kinds of shrub thickets from 3 to 20 feet tall (1 to 6 meters) in drainages throughout, three types of tussock-shrub tundra, five dwarf shrub tundra types, and seven meadow types.

The soils team conducted studies at six of the base camps. At four of the camps, the studies included landscape transects that ranged from 0.8 to 2.3 miles (1.3 to 3.8 kilometers) in length and involved up to seven different drainage conditions (excessively drained to wet). They observed that, because of slow downslope soil creep, the older surface materials are at the bottoms of slopes, the younger surface materials are near the tops of slopes, and the differences in surface age could be tens of thousands of years, resulting in changes in soil characteristics from tops to bottoms of slopes and soils at slope bottoms having experienced greater and more varied climatic and biotic environments than soils near the tops of slopes. Overall, they recognized eight kinds of soils in the study area and observed that development of soil morphological features was weak due to ongoing frost action.

The terrestrial mammal team found direct evidence for presence of 15 species and indirect evidence for an additional three species of the total of 23 species thought to occur in the study area. The study's author attributed an absence of sightings of wolves and wolverines and a scarcity of sightings of grizzly bears to the pre-existing predator control program that had been in place on the Seward Peninsula for a number of years to benefit the reindeer industry.

The bird team visited 14 sites in the summer and three (two of which were outside the immediate study area, one to the north, the other to the west) during the migratory period in September, resulting in their sampling all of the avian habitats. They observed 108 of the total 170 bird species reported for the Seward Peninsula, but 20 species they saw only once or twice. In terms of their primary affinities, almost two-thirds of the bird species are tundra biome species, 25 species are Aleutican, 8 are old world, 17 are boreal forest, 10 are marine, and 15 are other non-tundra. The study area contains all the tundra habitats and abuts both marine and spruce forest habitats; as a result, it has an unusual variety of bird species. The author found the diversity and quantity of birds on the Cape Espenberg Peninsula to be striking, and observed that the geographic location of the Seward Peninsula makes the area highly interesting because of the two-way movement of breeding migrants between old and new worlds.

The aquatic ecology team was unable to spend much study time on physical characteristics of the larger lakes due to the adverse weather. The ponds and lakes they sampled were mostly less than 11.5 feet (3.5 meters) deep, except for Devil Mountain, greater than 36 feet (11 meters) and, as reported in the literature, Kuzitrin, 21.3 feet (6.5 meters). As a result, the lakes were well mixed by wind and had maximum temperatures of less than 50 degrees Fahrenheit (less than 10 degrees Celsius) and, for all water bodies examined, dissolved oxygen ranging from 80 to 100 percent saturation and no unusual chemical features. The study found 7 of the expected 24 fish species distributed in 11 families and, during the period July 7 to August 21 collected aquatic and terrestrial invertebrates in 10 study areas and found species representing 16 classes and, within the insect class, species representing 45 families, among which were 15 butterfly species and at least one moth species.

The survey team did not include an archeologist, so it limited its archeological work to noting locations of possible sites. It found three historic and two prehistoric sites not previously reported in the literature. NPS built on this beginning by sponsoring a focused, four-person field survey in 1974 that spent six weeks in the study area, mostly in the interior but also some time in coastal areas around Deering. The 1974 team explored 37 sites, many of which had not previously been reported, but did not have time to conduct any detailed excavations. It had somewhat better luck in the Kuzitrin Lake area than did the 1973 team, including being able to conduct a land transect from Imuruk Lake to Kuzitrin Lake, before being weathered out and having to retreat to the coast at Deering. The team found ample evidence that humans in the past had made thorough use of the interior portions of the study area, but could not determine whether that use had been only seasonal or had been year round. Based on reports by other investigators combined with their own survey work, the team concluded that the study area coupled with the broader Seward Peninsula has a rich human prehistory dating back to perhaps 13,000 to 15,000 years before present.

The 1973 survey team's report suggests 15 future studies that it identified as recommended, highly recommended, or urgent; the urgent studies focus on ecological effects of reindeer herding, ecological effects of tundra fire, observed recent ecosystem change from the late 1940s to the early 1970s, and ecology of fish and their food resources.

A follow-up paleontological reconnaissance study in 1974 examined the potential for obtaining cores from a number of the maar lakes and surroundings in the Espenberg area. This study concluded that cores recovered from Whitefish Lake, the Goose Pasture area adjacent to the northeast boundary of the Chukchi-Imuruk study area, and other areas may permit gaining an overview of biological change through time back into the early Pleistocene. Other follow-up studies conducted in 1974, 1976, and 1978 addressed effects of a winter road and drilling operation in the Cape Espenberg area associated with land available both for conservation area study and possible withdrawal under ANCSA as Native Village deficiency land. These studies included vegetation and aquatic ecology analyses of effects of the winter drilling operation and also of off-road vehicle use for reindeer herding activities.

Gates: A four person botanical field party visited four base camp areas in the Brooks Range during the period June 18 through August 5, 1973. The study area included the upper Alatna River on the south slope, the upper Killik River on the North Slope, and the alpine divide between them, thus sampling two climatic regions—subarctic and arctic—and a great amount of variation in landscapes and vegetation related to glacial history, erosion processes, rock types, topographic relief and aspect, and geomorphologies. The lowest latitude camp provided access to both coniferous forest and alpine vegetation, the other three camps gave access to medium and upper elevation arctic vegetation. The field collections documented 313 taxa of vascular plants, with 28 taxa being beyond ranges identified in the literature; at least 99 bryophyte taxa, of which 25 were new records for the Brooks Range; and at least 100 lichen taxa, of which 55 were new for the region. One preliminary observation included a sense that, even though the Brooks Range is an end point of the Rocky Mountains range, the flora is related more to Asian and Alaska-Wrangell-Chugach-St. Elias Range floras than Rocky Mountain Range floras. Another is that the flora of the study area represents the calcareous nature of this section of the Brooks Range and that there would be value in comparing the Alatna-Killik flora with the flora of the nearby, granitic Arrigetch Peaks area and with the Kurupa and Cascade Lakes area, which contains alpine tundra with some ice-wedge polygons, small scale cirque glaciers, and meltwater-irrigated alpine valleys. Finally, the study team's report also provides

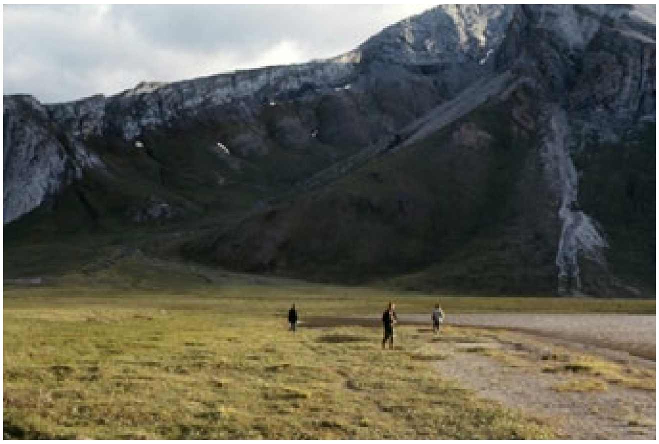

Figure 3. NPS new area study team members on shore of southeast end of Kurupa Lake, Gates of the Arctic study area. July 27, 1973.

Figure 4. NPS field assistant Sam Bemiss near base of the Buttress Range in the Valley of Ten Thousand Smokes, Katmai National Monument. July 1973.

Figure 5. Noatak study team botanist Steve Young checking weather conditions along stony shore at the southeast end of Desperation Lake. August 4, 1973.

notes about mammals, birds, butterflies, and archeological features of the area and a narrative of a walking and boating journey across the alpine tundra and down the Alatna River.

Katmai: A study in 1974 assessed the distributions and densities of brown bear denning and bald eagle nests. Two people spent nine days in mid-August 1976 conducting a quick survey of flora, vegetation, and some mammal species in an area to the west and southwest of the existing Katmai National Monument. Their purpose was to determine whether the ecology of the area differed from the ecology within the existing monument. A separate study conducted in 1976 assessed human subsistence and resource uses in the general vicinity.

Kobuk: A year-long, in-residence subsistence-use study of the valley involved a total of 13 people, mostly visiting researchers together with some residents of several of the five communities situated along the Kobuk River. The four-person biological study involved three separate visits to learn about flora, vegetation, and vertebrates—September 15-20, 1973, July and August 1974, and March 11-15, 1975. The biological final report also includes information about physiography, climate, and fire. Subsequent to the field work, one of the authors worked with a colleague to author a report discussing the flora and vegetation of the Quaternary environment of the Kobuk valley.

Lake Clark: A four-person team occupied eight base camps to develop a preliminary assessment of the ecosystems in the study area during the period July 10 through August 13, 1976. Although this study focused on flora, vegetation (including a vegetation map), and west slope treeline conditions, it also reported observations about some of the area's mammals, birds, and a few freshwater fishes. A separate study conducted in 1976 assessed resident resource use in the vicinity.

Mt. McKinley: This study focused on the large mammals in the area north of the then-existing Mt. McKinley National Park in an effort to understand better the relationship of park animals to the habitat north of the park. Observations the study made during winter and early spring of use of areas north of the park by sheep, moose, grizzly bears, and wolves coupled with its synthesis of existing information led the study's authors to conclude that large mammal species depend on areas to the north of the park for winter and early spring range, especially during winters having heavy snowfall in the park. The study also observed that the park's caribou herd was declining and that land to the west and north of the then west end of the park provided valuable caribou habitat. Finally, the study worked on mapping vegetation types that could be related to caribou range quality criteria.

Noatak: The Noatak study sampled a 12,000-square-mile (31,080-square-kilometer) watershed containing a 435 mile-long (700-kilometer-long) central river and engaged 11 people representing seven disciplines: flora and vegetation, soils, mammals, birds, insects, aquatic ecology, and archeology. In occupying nine different field camps during the period June 13 through August 24, 1973, these scientists used 15,000 miles (24,140 kilometers) of aircraft flight involving six to ten flights per camp relocation, 3,000 total miles (4,828 kilometers) of foot travel, and 200 miles (322 kilometers) of boat travel. Their aircraft support came from Kotzebue and their boat support came from Noatak Village. One perhaps apocryphal story that emerged from the aircraft use was an experience in the upper reaches of the watershed on a hot day with trying to take off from too small a lake—the solution allegedly was to power around in a circle on the lake surface twice to gain enough ground speed to be able to then shoot straight across the lake and lift off the lake near the far shore with enough elevation for the floats to clear the tundra margin at the lake's edge. Overall, in their 1974 report, the survey team confirmed existing knowledge in a number of areas and added new information.

The botanical work, for example, found 413 of a total expected vascular plant flora of 435-440 species, documented range extensions or infilling of distribution gaps for collected specimens of more than 100 miles for 46 species, and discovered one species thought to be previously undescribed. The analysis showed these species to be distributed among three types of tundra, three of tundra brush, four of fell field and barrens, one of coastal marsh, and two of forest. The survey also singled out rare species distributions in the serpentine barrens north of Feniak and Desperation lakes and the habitat diversity and key migration route between coastal and interior Alaska present in the Noatak Canyon area as topics worth further botanical exploration. Finally, the botanical work also identified 47 bryophyte species.

The soils work involved 126 soil profiles and determined that, because of the variety of ecosystems in the watershed, there is greater diversity of soil types in the Noatak compared to valleys on the north side of the Brooks Range or to coastal areas of Arctic Alaska.

The study of the mammals of the area found that the rodent population densities were too small to permit random sampling methods, collected 297 specimens representing 14 species, used 22 specimens from seven species for chromosome analyses, found one more species than the anticipated 28 non-marine species but did not observe any evidence of two of the new total of 29 species, and concluded that heavier than normal 1972-73 winter snow coupled with a cold spring reduced the population sizes of small mammal species. The small number of small mammals was associated with low numbers of weasel, fox, raptor, and other predator species that depend on small mammals. In addition to all these other factors impinging on the study, Arctic ground squirrels were an "irritatingly persistent" problem because they triggered snap traps and partially ate mice caught in the traps.

The bird studies were hampered by heavy rain at one camp and by the fact that bird singing decreased rapidly after the third week in June, making it harder to locate nesting birds.

Figure 6. Noatak study team conducting late night lake study at Camp VII, Anuk Lake, near Cutler River. August 3, 1973.

Seasonal migrants started appearing by mid-July. Overall, the work observed 111 species of the 120 species recorded for the Noatak watershed. Although raptor sightings were few, assumed due to the low rodent population density, suitable raptor habitat with old nests was locally abundant in parts of the headwaters region. Finally, despite the sampling problems, the study made an effort to estimate relative abundances of some species by habitat type.

Although the cool and rainy weather at many of the camps reduced insect activity, the survey of insects found expected Arctic conditions—large numbers of some species, overall low species diversity, and a number of range extensions from across Alaska. The study also observed an expected shift of species roles, such as greater pollination by flies than by bees; a segregation of some spruce bark beetles by vertical position on the boles of trees; and a preference by those bark beetle species for laying eggs on southeast and southwest facing quadrants of tree boles. Finally, the study observed 29 butterfly species representing six families.

The study of aquatic ecology not only sampled an extensive array of 49 lakes and ponds and nine river and stream segments, it also conducted experimental analyses involving phytoplankton primary production and limiting nutrients. Because it sampled in different areas through the season, it missed the late emerging adults at the early sample sites. Overall, the study involved 10 different specialists to help identify collected species and, above all, the investigators thanked their wives, "…who tried very hard to understand why we wanted to do the project…"

The archeologist who participated in the study previously had worked a number of years in the Noatak watershed and so not only served as a major logistician for the team but also followed up on promising leads from his previous work. He focused his archeological work on finding new sites for future study, evaluating the research potential of known sites, and completing a previously initiated excavation of one site. He also took advantage of the soil scientist on the team to consult about what information soil characteristics of sites could help to reveal about the sites. The ongoing studies in the watershed reveal that several places in the watershed may have been used by humans as long as 5,000 years before the present, that Arctic Small Tool tradition peoples may have used the upper portion of the watershed for both small summer camps and more established winter villages, and that there is evidence for people of a coastal culture having used areas in interior Alaska as well as the coast.

Yukon-Charley: A total of 15 field participants served short- to long-term roles during one or two summers of the two-year study. The study team gathered inventory and in some cases process information about weather patterns; flora and vegetation, including characteristics of white spruce forest in the forest-tundra ecotone and observations about the Arctic steppe biome; paleontology and paleobotany; mammals including mountain sheep; birds; insects associated with spruce forest and possible relict Arctic steppe vegetation, butterflies, and bark beetle host selection behavior; lake and stream limnology; and a synthesis of pre-existing knowledge about aboriginal sites and their peoples. The study team's workhorse mode of transportation was the riverboat—an estimated 3,000 miles (4,828 kilometers) of travel in 1974 and another 1,500 miles (2,414 kilometers) in 1975, mostly on the Yukon River. The team also used a canoe on the Charley River, a horse pack-string to gain access to higher elevations, a float plane to reach several lakes, and a helicopter to reach the highest elevations. Although most transportation modes worked well, the team did experience a near disaster due to the helicopter at one point trying to reach an upper elevation while overloaded and short of fuel, resulting in the field crew becoming separated, with one person being left with almost all of the food and gear and the other three about five miles away having to survive on limited rations.

The vegetation and flora studies mapped seven vegetation types consolidated from three forest, three woodland, three scrub, bog, marsh, alpine tundra, and rockland and fellfield types. It reported observing 402 of the expected 445 species of vascular plants. Its white spruce treeline study in the Twin Mountain area revealed an absence of wind training of the trees, presence of tree vegetative reproduction through layering, and absence of fire, all of which led the authors to conclude that the treeline is not yet in stable equilibrium with the physical environment. Finally, the authors observed that vegetation on Kathul Mountain and similar areas appears to be Arctic-steppe that is a relict from the late Quaternary, a conclusion that is suggested by presence of several narrowly endemic species in the same community. Future study of this relict vegetation could advance knowledge of biogeography and a nearly vanished biome.

The study area contains fossil and more recent deposits that provide great potential for studies of Earth's history over the past billion years, missing only the Pennsylvanian Period. The team found two sites that they report to be extremely intriguing for paleobotanical study. Some of the fossil resources are so close to the Yukon River that they may be at risk of over collecting. Some of the recent, especially Quaternary, deposits may be at risk of loss due to permafrost thawing and stream bank erosion.

Terrestrial vertebrate observations focused on mammals and birds. The study reported 21 mammal species observed in 1975 out of a total of 39 species expected or probably occurring in the study area and 101 bird species of the 160 expected to occur. Thirty-three of the observed bird species are considered to breed and another 44 possibly to breed in the study area.

The insect study collected at least 77 different species, with a number of the collections not yet identified at the time of the report. Of these, 32 species were collected on white spruce and 15 species were Lepidopterans, with two Lepidopteran species rare to

Alaska being collected in the Arctic steppe vegetation.

The two-week-long aquatic ecology study sampled nine different small ponds together with rivers and streams at 21 locations, all but three of which were in the Charley River drainage. It found eight orders of macroinvertebrates in the streams and rivers and 10 orders in lakes and ponds, 10 fish species, 26 phytoplankton species in three lakes, and 16 zooplankton species in nine lakes and ponds.

The team's report includes a literature review of the aboriginal occupation of the study area and the observation that the team's efforts to find historic and prehistoric sites yielded very little information. The literature review suggests that the study area might contain sites spanning 27,000 years of human residence.

Outcomes

This spurt of scientific activity gave experienced Alaska investigators additional access to remote field study sites and introduced investigators new to Alaska to exciting and challenging opportunities for conducting field study in remote places. The interim and final reports the investigators wrote provided NPS planners with recent scientific information about their planning areas, although in many cases the information arrived after much of the initial planning work had been completed, given that the Draft Environmental Statements were released in December 1973 and the Final Environmental Statements were released in October 1974.

Most of the study reports include literature surveys that reveal a much greater level of past scientific activity in the study areas than might have been expected, given the remoteness of the areas.

NPS reported on various aspects of these studies together with other NPS-sponsored studies in Alaska at an all-day session in Corvallis, Oregon, at the American Institute of Biological Sciences (AIBS) August 1975 annual meeting. The session—Research in Alaska's Present and Proposed National Parks—involved 21 different talks. The talks introduced the NPS role in Alaska, identified the current NPS research program, provided information about the major physiographic provinces and ecosystems present in Alaska, discussed how adaptation of the Native peoples to their environments can be considered integral to the ecosystems, addressed the relationship of proposed new national parks to the existing state wildlife management situation, and ended with disciplinary presentations regarding marine, fresh water, vegetation, wildlife management, ornithology, entomology, and anthropology information and management applications.

NPS also reported on the possible Alaska new areas by presenting an exhibit at the November 1976 AIBS co-sponsored First Conference on Scientific Research in National Parks. This exhibit included a recycling slide show, movie, and reprints and other information about the new area scientific studies.

Dennis (*1978*) summarized NPS-sponsored research in Alaska during the period 1972-76. In addition to reporting on studies in two existing park units, this summary included highlights from field studies in Chukchi-Imuruk, Kobuk, Noatak, and Yukon-Charley study areas.

As a member of the Lake Clark, Katmai, and Aniakchak study team, I expressed great interest in having Katmai represent the complete ecological transect from the Shelikoff Straits to the Bering Sea. This concept led to the study of the vegetation to the west and southwest of the existing monument. Much of the study area became incorporated into a conservation unit, but not Katmai. It now is part of the Becharof National Wildlife Refuge.

In a different vein, the Noatak valley studied by NPS contractors in 1973 became proposed in the 1974 final environmental statement as a national wildlife refuge but later ended up being included in the National Park System, first as a national monument then as a national preserve.

As early as May 1973, word came down that input from the biological study groups would be needed for Secretarial consideration by early to mid-August of that year. The demonstrated richness of the science related to the study areas helped show that the areas have scientific value, a result that in turn helped with decision-making to proclaim the study areas as national monuments, proclamations that I think in turn helped Congress finally take action to pass the Alaska National Interest Lands Conservation Act.

Finally, the baseline plant ecology data for the Nimrod Hill slope reported in the Chukchi-Imuruk report serendipitously became the "before data" for a long-term study of response of tundra to wild fire when Nimrod Hill burned in a 1977 fire. The plant ecologist for the Chukchi-Imuruk study was able to visit Nimrod Hill in 1978 (*Racine 1979*) and again in 1979 to establish permanent plots and then to conduct follow-up visits sporadically through the next 30 years, with his last visit being in 2009. His study builds on a David Hopkins observation (*Hopkins 1973*) that tundra fires are likely to increase. The hope is that NPS will incorporate these plots into a long term monitoring program.

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American dipper