



Seabird Colony Survey Report 2013

Kenai Fjords National Park and Alaska Maritime National Wildlife Refuge

Natural Resource Data Series NPS/KEFJ/NRDS—2014/616





ON THIS PAGE

The “Ruddy Duck” survey vessel travels toward the Chiswell Islands to perform seabird surveys.
Photograph by Elisa Weiss, KEFJ, NPS.

ON THE COVER

Jennifer Curl checks time-lapse cameras on Squab Island in Aialik Bay.
Photograph by Elisa Weiss, KEFJ, NPS.

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The Natural Resource Data Series is intended for the timely release of basic data sets and data summaries. Care has been taken to assure accuracy of raw data values, but a thorough analysis and interpretation of the data has not been completed. Consequently, the initial analyses of data in this report are provisional and subject to change.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

This report received informal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data. Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols.

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Abstract

In 2011, Kenai Fjords National Park (KEFJ), in cooperation with Alaska Maritime National Wildlife Refuge (AMNWR) and University of Alaska Fairbanks (UAF), began a three year study to develop long-term monitoring protocols for breeding seabird colonies in KEFJ and AMNWR. In 2013, we tested three methods for surveying glaucous-winged gull (*Larus glaucescens*) breeding populations using boat-based observer counts, boat-based photographic surveys, and aerial photographic surveys. Data from these surveys will be analyzed to determine the most accurate, feasible, and cost-effective methodology. In addition, we deployed time-lapse cameras to observe variation in nest attendance of gulls at 6 plots on one colony, and a bioacoustic recording device to identify nocturnal burrow-nesting seabirds on Matushka Island of AMNWR. We continued boat-based surveys of established black-legged kittiwake (*Rissa tridactyla*) photo plots in the Chiswell Islands in collaboration with United States Fish and Wildlife Service (USFWS).

Acknowledgments

We would like to thank KEFJ staff for making this work possible. For logistical support on the coast, we thank the crew of the M/V *Serac*: Melissa Knight, Luke Robert, and Jason Flowers; resource management staff: Mark Kansteiner and Leslie Adams; visitor and resource protection rangers: Jeff Carpenetti, Travis Fulton and Mark Giddens; Aialik Bay Ranger Station field crew: Sam Stark and Brian Robinson. We would also like to thank Heather Renner and Leslie Slater at AMNWR for their support and input.

Introduction

Seabirds are vital and highly visible members of marine ecosystems and are valued indicators of healthy oceans (Piatt et al. 2007a). Various species of seabirds use different portions of the marine food web, and their productivity and abundance provide insight into the health and status of marine resources at multiple trophic levels (e.g., kittiwakes are surface-feeding fish feeders; cormorants are shallow water coastal divers; auklets are deep diving plankton-feeders, etc.; Springer 2005).

Marine birds are specifically mentioned in Kenai Fjord National Park (KEFJ) enabling legislation as a resource the NPS is charged to protect (ANILCA 1980). Despite this, for the first 20 years after KEFJ was designated a national park, research and monitoring of seabird populations was limited (Bailey 1977, Nishimoto and Rice 1987). However, in the last decade, KEFJ has collaborated with the U.S. Geologic Survey (USGS) and the U. S. Fish and Wildlife Service (USFWS) to improve knowledge of seabird population ecology and status by conducting studies of Kittlitz's (*Brachyramphus brevirostris*) and marbled murrelets (*Brachyramphus marmoratus*), (Van Pelt and Piatt 2003, Arimitsu et al. 2010) and implementing pilot surveys of colonial nesting seabirds (Hahr 2008, McFarland et al. 2009). These studies suggested that dramatic declines have occurred in Kittlitz's murrelet populations and that the relative abundance of most colonial seabirds may have decreased since 1976. To better determine the status of colonial nesting seabirds in KEFJ, the National Park Service (NPS), in cooperation with Alaska Maritime National Wildlife Refuge (AMNWR) and the University of Alaska Fairbanks (UAF), began a three year study in 2011 to obtain accurate population estimates of colonial nesting seabirds in the park and adjacent refuge lands. The primary objective of this ongoing study is to produce statistically valid protocols for long-term monitoring of colonial seabirds in the park.

Most seabird species are colonial nesters (Wittenberger and Hunt 1985) and the concentration of birds at colonies makes population survey efforts more feasible during the breeding season than other times of the year. Seabird population surveys can aid region-wide ecosystem analyses as seabirds can be useful indicators of long- and short-term marine conditions, including regime shifts and changes due to climate change (Piatt et al. 2007b). Seabirds are species of concern in KEFJ due to their management significance, popularity with visitors, sensitivity to climate-driven ecosystem changes, and importance as indicators of marine ecosystem health (Hahr 2008).

Seabird Surveys in KEFJ

1976-2010

Historically, seabird colonies in Kenai Fjords have not been frequently monitored nor intensively studied. The remote nature, size, and abundance of seabird colonies combined with limited staff and vessel support have precluded consistent survey efforts.

Prior to the designation of KEFJ and AMNWR by Alaska National Interest Lands Conservation Act (ANILCA 1980), the coastline of the southern Kenai Peninsula was first surveyed for seabirds in 1976 (Bailey 1977). Another survey of this area, encompassing 610 miles, was performed by NPS and USFWS in 1986 (Nishimoto and Rice 1987). The 1986 survey focused

on total species counts within 11 coastline units, lumping together nesting birds, roosting birds, and individuals on the water. Surveys were also conducted in the Pye Islands and the Chiswell Islands of AMNWR in the early 1990s to identify potential impacts to seabirds from the Exxon Valdez Oil Spill (Nysewander et al. 1993, Dragoo 1994).

After a 30-year absence in systematic seabird monitoring efforts, NPS, USFWS and the National Oceanic and Atmospheric Administration (NOAA) signed a General Agreement to increase interagency management to establish an integrated network of coastal refuges, reserves, parks and sanctuaries (USDI 2006). This agreement prompted an interagency survey of 14 seabird colonies along the southwest coast of the Kenai Peninsula by NPS in KEFJ and USFWS in AMNWR during 2007 (Hahr 2008). In 2008, a second cooperative effort completed surveys of colonies at Bear Glacier Point and Aialik Cape, as well as black-legged kittiwake and common murre (*Uria aalge*) colonies in the Chiswell Islands (Hahr 2009). In 2009, staff from both agencies conducted surveys of breeding seabirds at colonies on the mainland within KEFJ and on islands within the AMNWR (McFarland et al. 2009). In 2010, KEFJ staff surveyed 4 colony locations in KEFJ and 7 colony locations in AMNWR (Phillips and McFarland 2012). Logistical constraints limited 2007, 2009, and 2010 surveys to single visits to determine presence of nesting seabirds at historic colony sites (McFarland et al. 2009, Phillips and McFarland 2012).

2011

In 2011, KEFJ, in cooperation with AMNWR and UAF, began a three-year study to establish long-term monitoring protocols for colonial breeding seabirds in the Kenai Fjords region which included KEFJ and adjacent areas of AMNWR. The goals of this study were to:

- 1) Document previously undetected seabird colonies by systematically surveying the coastline within KEFJ.
- 2) Determine the status [occupied (more than two individuals present) or unoccupied] and species composition of all seabird colonies documented in surveys from 1976-2010.
- 3) Produce GIS maps of the locations of seabird colonies in KEFJ and adjacent AMNWR islands.
- 4) Develop statistically valid protocols for monitoring long term presence and abundance of colony nesting seabirds within KEFJ and adjacent AMNWR islands.

During 2011, KEFJ biologists surveyed the entire coastline of the park (Yalik Point to Bear Glacier Point, Figure 1), recorded species presence and location of seabird colonies detected, and mapped colonies in ArcGIS (Parsons et al. 2012). Biologists visited select colonies within AMNWR opportunistically. The scope of objective #4 was narrowed to focus on ledge-nesting seabirds, and a pilot study to test monitoring methods for black-legged kittiwakes, pelagic cormorants (*Phalacrocorax pelagicus*), red-faced cormorants (*Phalacrocorax urile*), double-crested cormorants (*Phalacrocorax auritus*), common murres, thick-billed murres (*Uria lomvia*), and glaucous-winged gulls (*Larus glaucescens*) was begun. Biologists conducted repeated observer counts of plots within colonies of these species.

2012

In 2012, UAF cooperators developed a research proposal around a single species (glaucous-winged gulls) to test basic methods with the possibility of including additional species later in the project. Glaucous-winged gulls were chosen as a model species because they have reasonably high visibility (white adult gulls against a dark background), they are among the most populous seabird species in the KEFJ region (providing a better sampling framework for testing methods) and their colony locations are reasonably stable and numerous (Coletti et al. 2011, Curl 2012, Parsons et al. 2012). To meet the goal of developing a rigorous method of quantifying populations of cliff nesting seabirds the objectives of the fieldwork in 2012 were to:

- 1) Determine the effect of number of colonies counted, colony size, frequency, time of day and seasonal timing on our ability to estimate the regional abundance of glaucous-winged gulls along KEFJ coastline using each method: boat-based double observer counts, boat-based photographic surveys, and aerial photographic surveys. Commonly used land-based methods would not work well in this environment where the vast majority of adult gulls nest on vertical cliff ledges. We chose methods for this study based on a literature review.
- 2) Compare the tradeoff between cost and accuracy (bias and precision) of abundance estimation from boat-based observer, boat-based photographic and aerial photographic survey data.
- 3) Use an occupancy or super population approach (Royle and Nichols 2003, Williams et al. 2011) to determine the effect of sample plot unit, number of sites chosen, number of replicate site visits, time of day and time of season on our ability to reduce error associated with our estimate of glaucous-winged gull abundance within the Kenai Fjords region (Curl 2012).

In 2012, designated survey methods to estimate regional abundance of glaucous-winged gulls were field tested (Dewberry et al. 2013). We also continued to record species presence in areas historically surveyed within the park and AMNWR for any colonies visited during the field season. We deployed a passive acoustic device to document the presence of nocturnal burrow and crevice nesting seabirds that may not be detected visually. Finally, we took photographs and conducted observer counts of historic plots of black-legged kittiwakes in the Chiswell Islands as part of our continuing collaboration with AMNWR.

2013

In 2013, the objectives for the project remained the same, but some adjustments were made to methods based on results and observations from 2012, such as not counting nests in glaucous-winged gull plots. In addition to gull colony surveys, we continued to record species presence in areas historically surveyed in KEFJ and AMNWR. We deployed a passive acoustic recording device to document the presence of nocturnal burrow and crevice nesting seabirds that may not be detected visually. Finally, we took photographs and conducted observer counts of historic plots of black-legged kittiwakes in the Chiswell Islands.

In this report, we detail methods and summarize results for all surveys of glaucous-winged gulls, nocturnal crevice and burrow nesting species, and black-legged kittiwakes for field work completed in 2013.

Methods

Study Area

The south coast of the Kenai Peninsula is characterized by rugged fjords composed of greywacke, slate and granite. The Harding Icefield and associated glaciers cover approximately 1,900 km² of the Kenai Peninsula (Giffen et al. 2009). The climate along the coast is maritime, with mild temperatures and high rainfall due to orographic uplift and driven by the Aleutian Low (Lindsay and Klasner 2009). Numerous steep islands and island groups are located close to the mainland.

KEFJ was established in 1980 to protect the Harding Icefield, its associated fjords and the marine mammals and birds that depend on the fjords along its 800km of coastline (ANILCA 1980). KEFJ administers approximately 2,450 km²; its boundaries include an additional 225 km² managed by in-holders. The park boundary does not extend to offshore islands which are managed by AMNWR.

AMNWR encompasses almost 20,000 km² and 2,500 islands, stretching along most of the coastline of Alaska. The AMNWR was established primarily to conserve the animals and habitats found within its boundaries, and to provide for subsistence use, conduct research on marine resources, and ensure water quality within the refuge (ANILCA 1980).

All seabird colonies surveyed in 2013 were within KEFJ or AMNWR. The study area stretched from Yalik Point in Nuka Bay (59.918°N, 150.586°W) to Cheval Island in Resurrection Bay (59.774°N, 149.503°W) and encompassed nearby islands including the Chiswell Island group and numerous other islands under the jurisdiction of AMNWR (Figure 1). The Chiswell Islands include some of the largest and most diverse breeding seabird colonies in the Kenai Fjords region (Bailey 1977).

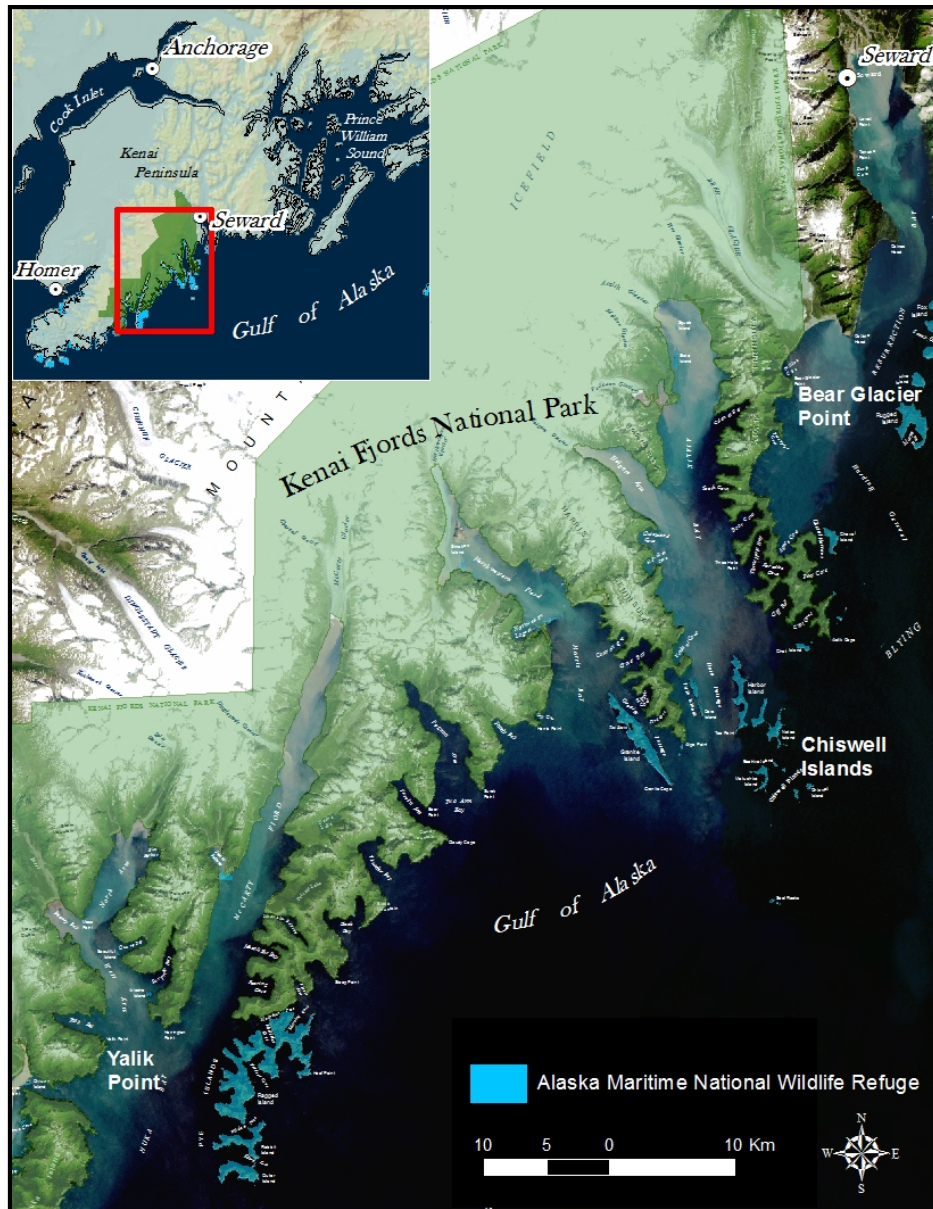


Figure 1. Map of study area in Kenai Fjords National Park and Alaska Maritime National Wildlife Refuge with study site place names.

Ledge-nesting Seabird Surveys

Study Species

Glaucous-winged gulls are an abundant piscivore in the northern Pacific Ocean and are one of the most populous colonial ledge-nesting seabird species within the borders of the park (Dewberry et al. 2013). Historically, there have been glaucous-winged gull colonies in KEFJ at 30-40 sites, ranging in size from as few as 20 to more than 1,000 nesting pairs (Curl 2012). Most colonies are located on vertical cliffs roughly 15 to 500 meters in height with sparse vegetation. Due to the remoteness and inaccessibility of these sites, reliable information on nest initiation dates is not available for KEFJ. However, what records do exist suggest that the incubation

period for glaucous-winged gulls is roughly 20 May – 21 June, with peak hatch occurring mid-July and peak fledging occurring from late July into late August (Hayward and Verbeek 2008, Murphy et al. 1984).

Sampling Design

We assigned colonies to three size categories: small (2-99 individuals), medium (100-300 individuals), and large (>300 individuals, Dewberry et. al 2013). We selected 11 colonies using a stratified sampling design based on colony size and location in either Aialik Bay (northeast region) or the Outer Coast (southwest region, Table 1, Figure 2). Colony choice was based on and somewhat limited by proximity to other colonies, weather conditions, and limitations on the time of the season that we could access certain areas of the park. Colonies in the northeast section of the park were surveyed by boat from the 3-21 of June, 2013. Colonies in the southwest region of the park were surveyed by boat from the 2-11 of July, 2013. All colonies were surveyed via helicopter on the 17-18 of July, 2013. A subsection of the northeast colonies were surveyed a second time to examine the effects of time of the season on counts from the 20 July to the 2 of August, 2013 (see Table 4 in the Results section for a simplified summary of number of replicates completed for each set of surveys).

We created a plot of approximately 30-200 individuals that allowed us to subsample part of the colony. We delineated plots using permanent boundaries that could be reliably relocated for repeated surveys such as rock formations or edges of a cliff rather than temporary boundaries such as rain-influenced waterfalls or vegetation lines. We then outlined plot boundaries in archival photographs. Only one plot was selected for each colony we sampled.

Table 1. Seabird colonies surveyed in KEFJ, 2013.

Colony location	Colony size	# Colonies	Colony Name
Northeast (Aialik/Resurrection Bay)	Small (2-100)	1	Natoa
Northeast (Aialik/Resurrection Bay)	Medium (100-300)	2	Chat, Grotto
Northeast (Aialik/Resurrection Bay)	Large (>300)	3	Squab, No Name, Cheval
Southwest (NW Fjord/Outer Coast/Nuka Bay)	Medium (100-300)	2	Cloudy, Steep
Southwest (NW Fjord/Outer Coast/Nuka Bay)	Large (>300)	3	Surok, Striation, Black

Survey Methods

We conducted surveys using three different methods: boat-based observer counts, boat-based photography, and aerial photography. We designated each visit to a given colony (via boat or helicopter) a replicate. Each boat-based replicate consisted of one double-observer count and a set of photographs of the plot as described in sections below, while each aerial replicate only consisted of taking photographs of the plot. We surveyed colonies between the daylight hours of 8:00 to 20:00. For boat-based surveys, we divided fieldwork into three survey times; morning (8:00-12:00), afternoon (12:00-16:00), and evening (16:00-20:00), and tried to time surveys so that at least two (out of the set of 9-12) replicates occurred within each period (morning, afternoon, evening) for each colony. We conducted surveys by completing all replicates at a given colony within a few days. For each colony, we conducted replicate counts at a minimum of

two hours apart. For aerial replicate surveys, we were limited by helicopter availability and costs, which allowed us less control over the time of day that surveys occurred. Aerial surveys took place on two consecutive days and surveys spanned a morning and afternoon period each day. Restricted boat and helicopter availability for the southwest surveys coupled with time limitations prevented conducting replicate surveys using all three survey methods in every period of the season when we conducted surveys.

Boat-based Double-observer Counts

We conducted boat-based surveys of the northeast sites (3-21 June and 20 July – 2 Aug, 2013) using a 16' rigid-hull inflatable, the NPS Naiad *Ruddy Duck*. We used the NPS M/V *Serac*, a 53' research vessel, to conduct surveys of colonies on the southwest side of KEFJ (2-11 July, 2013). We designated a single GPS location as the sampling point for both boat-based observer and photographic surveys. We conducted all replicate counts for a given colony as closely to this point as possible. For each replicate, two observers simultaneously conducted a count of individuals present at a plot using Canon 10x42 imaged stabilized binoculars. Observer counts had to be within 5% of each other (Hutchinson 1980, Williams et al. 2000) for the count to be recorded. If not, both observers repeated counts until they were within 5% of each other. In 2012, we attempted to count nests by counting incubating adults. However, we found that number of gulls apparently incubating or sitting on a nest remained high even into the late hatching period of the breeding season. We understood this to mean that birds loafing or resting at colonies are indistinguishable from incubating adults. Therefore, we decided to count individuals only and try to identify nests spatially using another technique (see the ground-truthing (asymptotic counts) section below). We determined the location from which to conduct boat-based counts by finding the best vantage point and considering proximity to offshore rocks, cliff height, and aspect which varied from 100-300 meters from the base of cliffs containing colonies. We recorded ambient environmental conditions for each replicate, including: tide, swell, precipitation, cloud cover, temperature, and glare. We documented disturbances by avian predators including bald eagles (*Haliaeetus leucocephalus*) and common ravens (*Corvus corax*) during counts and photographs and recounted or paused photography until the disturbance passed. We recorded colony characteristics for each colony or plot, including: single or mixed seabird species, cliff aspect, cliff height, substrate, percent vegetation cover, and whether the colony was positioned on an island or the continental mainland.

We conducted complete colony counts of the 11 colonies containing plots early and late in the breeding season when possible. During these counts of entire colonies, we recorded all individual glaucous-winged gulls attending the colony and the presence/absence of all other seabird species.

Boat-based Photographic Surveys

We conducted boat-based photographic surveys after completing boat-based double observer counts using the *Ruddy Duck* or M/V *Serac*, a 53' research vessel. We photographed colonies with a Canon Mark II 5D digital SLR camera. We took one to four photographs to encompass a single plot or colony, and later merged photos (if necessary) using Microsoft Research Image Composite Editor Software. Aperture varied between f/4 to f/8, and ISO was 200-400 based on lighting conditions and sea state. We took at least three exposures of each series of survey photographs. White balance was set to either daylight or cloudy depending on the ambient weather. Zoom for boat-based surveys varied between 60mm and 100mm (using a Canon 24-105mm image stabilized lens) depending on the distance from the colony and height of the cliff.

Factors that affect images include focal length, aperture, shutter speed, glare, number of photos stitched together, number of exposures, and image resolution. We recorded data for each of these factors as part of every survey replicate. The sharpest and clearest versions will be chosen during image analysis. Attending adult gulls will be counted in photographs using the count tool in Adobe Photoshop CS 6.0.

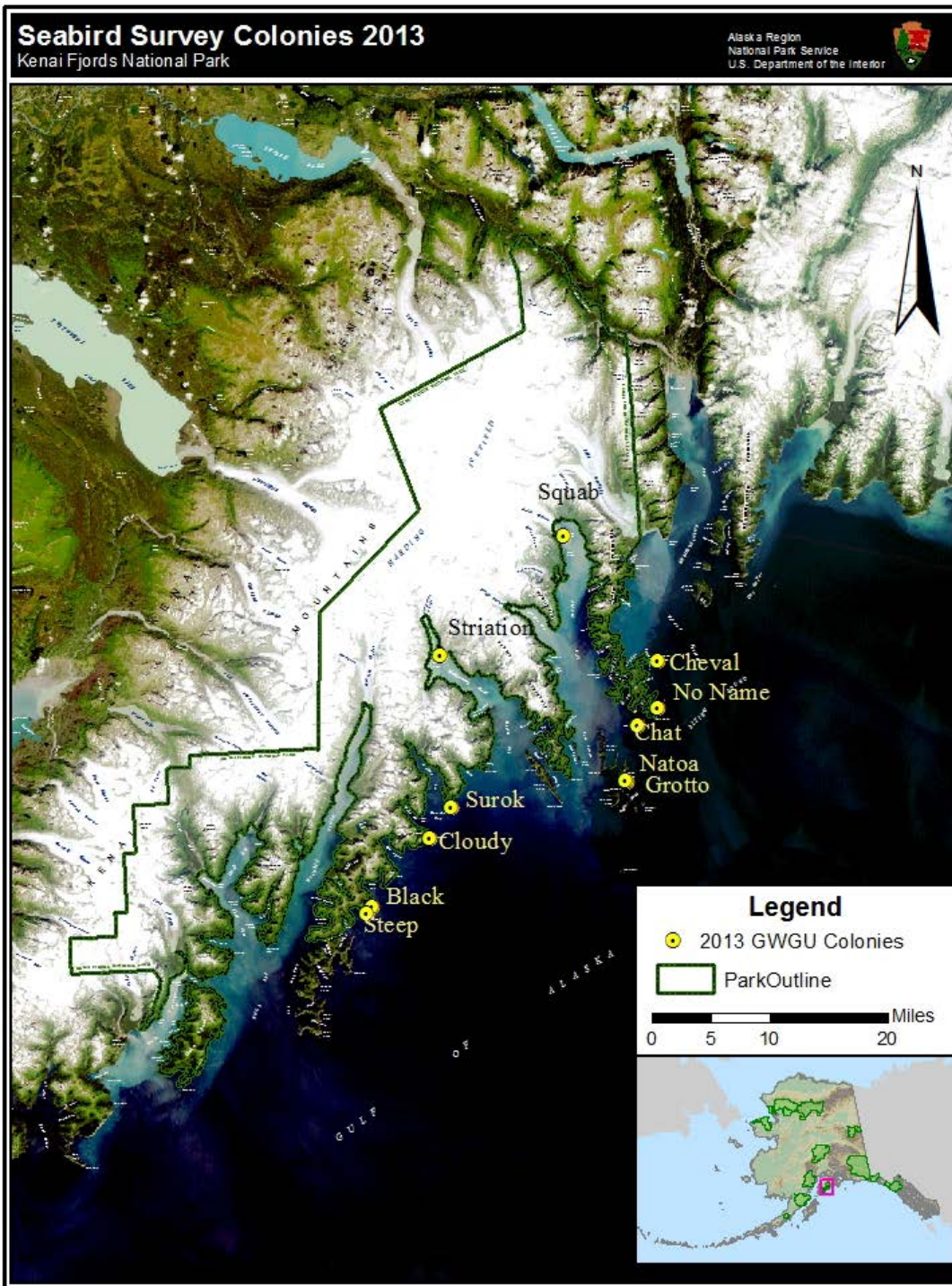


Figure 2. Location of glaucous-winged gull (GWGU) colonies surveyed in KEFJ, 2013.

Aerial Photographic Surveys

We conducted aerial photographic surveys on 17-18 July 2013 following completion of the initial boat-based surveys at each of the 11 colonies across the park. We surveyed from a Bell 206 B3 Jet Ranger helicopter chartered from Pathfinder Aviation in Homer, Alaska. At each colony, we took photographs with a Canon EOS 5D Mark II digital SLR camera. We took several series of photographs at different exposures (within seconds of each other) to try to obtain sharp photographs with an exposure that allows the photos to show birds within the colony. Aperture varied between f/4 to f/8, and ISO was 200-400 based on lighting conditions and sea state. We set white balance to either daylight or cloudy depending on the ambient weather. We surveyed six (Steep, Black, Surok, Striation, Squab, Chat) of the eleven colonies from three heights (200m, 400m, and 800m). Though flight height varied, we maintained a minimum distance of 800m from the colony. Zoom varied between 100-400mm (using a Canon Ultrasonic IS 100-400mm zoom lens). We had planned to conduct a survey using a boat and helicopter simultaneously; however, we could not conduct boat-based surveys the days we flew due to poor sea state conditions. Instead, we conducted surveys aerially from different flight heights, so we can examine how the detection probability of identifying individuals on the cliff changes with an elevation gradient of vantage points. Attending adult gulls will be counted in photographs using the count tool in Adobe Photoshop CS 6.0.

Ground-truthing (Asymptotic Counts)

Traditional “ground-truthing” is used to determine the true number of nests or individuals that exist to compare to various survey methods. The ruggedness of the coastline and location of colonies on vertical cliff-faces make land-based counts or nest searches impossible. To assess bias in estimates of abundance, two distinct series of photographs were taken for each replicate of each colony surveyed. One series is a “count” series in which individuals are counted similar to an observer survey. The second series consisted of photos in which spatial sites (potential nest sites of consistently attendant adult individuals (representing nest sites) will be identified and compared for an overall count of total nesting sites. At some number of replicates, counts should no longer identify new sites and should be close to the true number of detectable nests in the plot (counts will approach an asymptote). This can only be done with boat-based photographs to accurately identify potential nest sites spatially throughout the season. Photographs for this approximate “ground-truthing” effort will be analyzed in ESRI ArcGIS for comparison of replicate photographs. Birds will be counted by creating an ESRI shape file with all “points” or sites where adult gulls are observed within plot boundaries. This point file will be overlaid on each plot photo, which will be orthorectified (using plot boundaries so that all photos of the same plot are as close to spatially identical as possible), and new sites will be added to the master point file as photos are counted. This will create a shape file with all the potential sites where adults have been observed across a set of replicates, giving a ground-truth or maximum number of potential nest sites.

Time-lapse Cameras

To look at the probability that we will detect nest sites based on presence of an adult, we deployed six time-lapse cameras (Reconyx 3MP trail cameras) on Squab Island in Aialik Bay (Figure 3). Squab is a large colony (>300 birds) and the only land-accessible colony in the park. We placed cameras to monitor a small number (5-10) of sites with consistently attendant adults

(as a proxy for nests) in a plot of a maximum of 25x25 meters. This will help us determine if there are patterns in adult attendance and for each potential nest site how often we will see a bird present. This information will help us to understand how these patterns may have influenced our counts in the field and in our photographs. We will define nests as sites occupied by attending adults consistently throughout the breeding period. We programmed cameras to take a photo once an hour from the beginning of June until the beginning of August, 2013. Analysis will be in a mark-recapture framework, and sites where an adult has consistently attended (which we will call nest sites) will be the “captured” entity. We will construct a capture history for each identified nest site based on the attendance of at least one adult at each site for each hour.

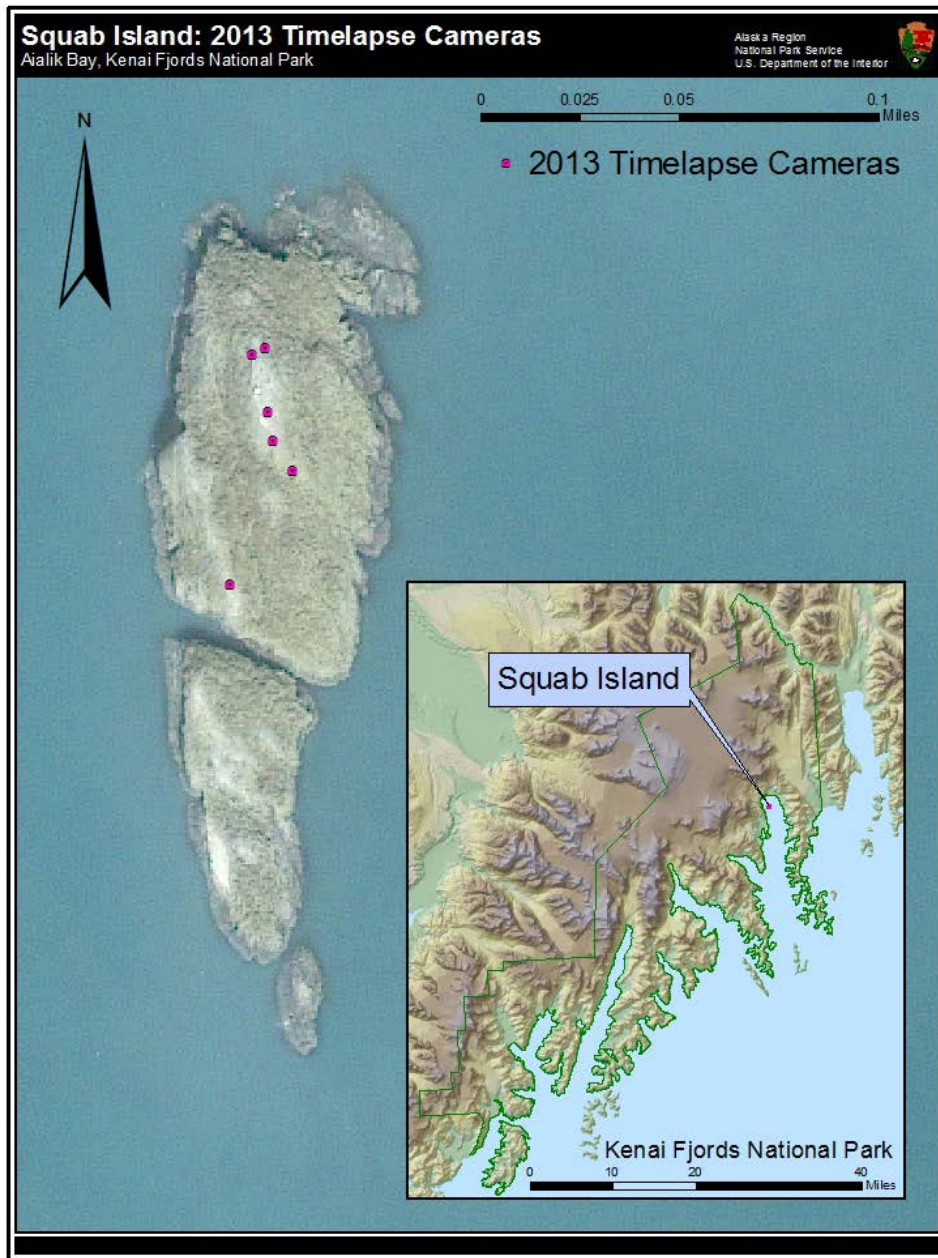


Figure 3. Location of time-lapse cameras deployed on Squab Island in Aialik Bay, KEFJ, 2013.

Song Meter

In 2012, we initiated a pilot study to determine how, when, and where to deploy a passive acoustic recorder (Song Meter, model SM2, Wildlife Acoustics, Inc.) to record the presence of nocturnal burrow and crevice nesting seabirds in the Kenai Fjords area that are difficult to visually detect from a boat. We deployed the recorder on Notoa and Matushka Islands (AMNWR) because we had historic records of two nocturnal seabirds, rhinoceros auklets (*Cerorhinca monocerata*) and fork-tailed storm petrels (*Oceanodroma furcata*), nesting on them (Bailey 1977).

In 2013, we returned to Matushka Island to deploy the Song Meter, as there was a higher call rate of burrow-nesting species as compared to Notoa Island in 2012 (Dewberry et al. 2013). We mounted the Song Meter on a small sturdy tree located among the highest concentration of accessible burrows we found on the island (N 58.611, W 149.628, Figure 4). We attached it to a tree using zip ties. During the first deployment from 20 May to 3 June, we programmed the meter to record continuously for 9 hours, approximately two hours before sunset to two hours after sunrise (21:30 to 06:30). During the second deployment, we used the same protocol of two hours before sunset and two hours after sunrise (23:00 to 04:55), but recorded for only 6 hours from 9 June to 30 June.

We reviewed the Song Meter recordings using Raven Lite software which is available from the Cornell Lab of Ornithology, Bioacoustics Research Program. The program also has a visual component that displays the bioacoustics via spectrogram. We listened to the entire first night of the recording from Matushka Island. We noted the presence of each seabird species heard, but did not quantify calls or individuals.

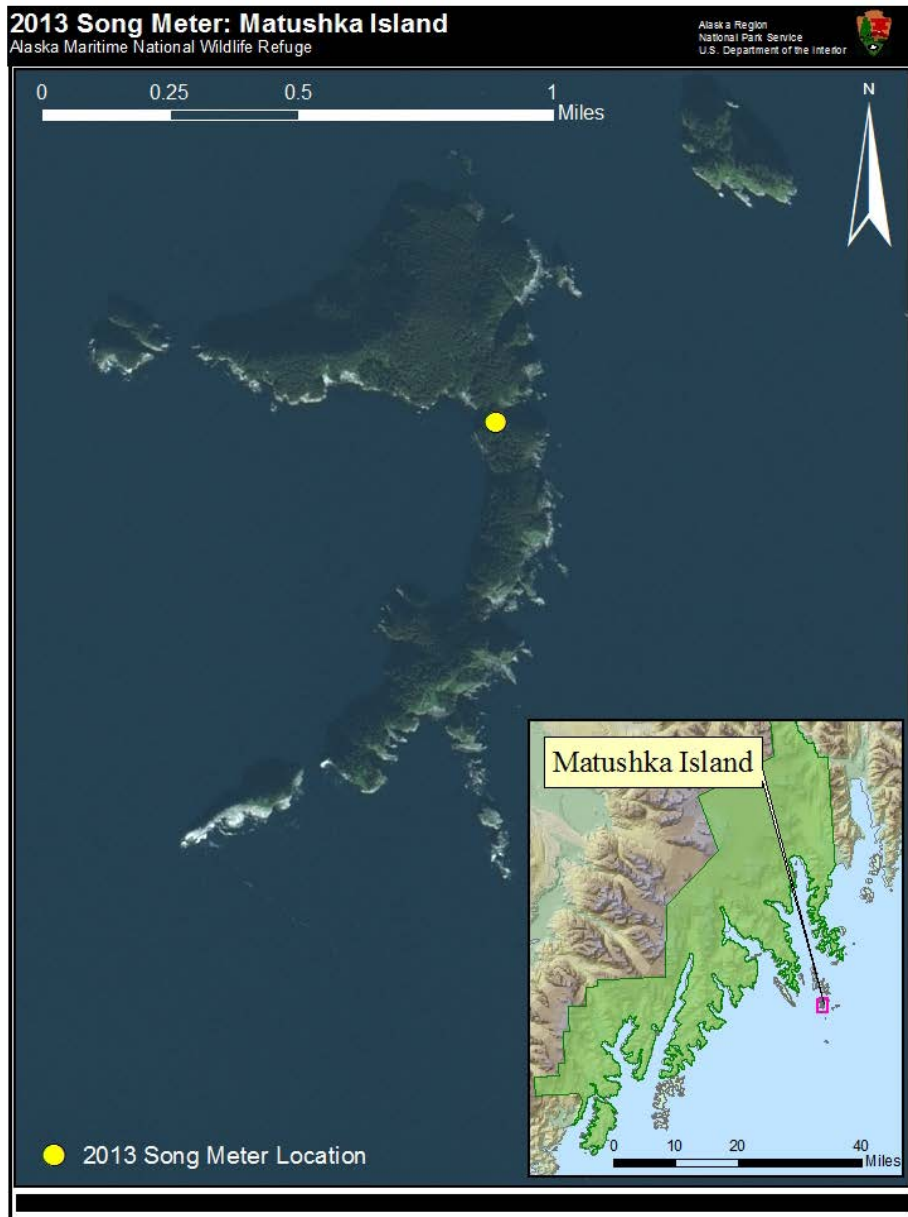


Figure 4. Location of song meter deployment in 2013.

USFWS Black-legged Kittiwake Plot Survey

We conducted surveys of historic black-legged kittiwake plots in the Chiswell Islands on 9-10 July 2013. AMNWR established the plots in 1992 (Figure 5). Two observers simultaneously counted individuals and nests within plot boundaries from the *Ruddy Duck*, a 16' rigid hull inflatable boat. The observers independently counted individual birds attending a plot and repeated counts until they obtained counts within 5% of each other. We conducted counts at the closest position to the plot that allowed us to safely view the entire plot at once (10-100 meters). At the closer distances observers did not need to use binoculars. We took photographs of each plot with a Canon EOS 5D Mark II digital SLR camera with a focal length of 60mm and 100mm using a 24-105mm IS lens. We will compare our observer counts to the number of individuals counted in the photographs at a later date. We will compare apparent number of black-legged

kittiwakes counted within plots in 2013 to surveys conducted in 1992, 2008, 2011 and 2012. Summary statistics compare average counts from three replicates in 1993, one replicate in 2008, 10 replicates in 2011, one replicate in 2012 and two replicates in 2013.

Permits and Archiving

All related materials will be permanently housed in the KEFJ museum and archive collection under accession number KEFJ-00269. This project was reviewed and approved as UAF IACUC permit number [460969-1].

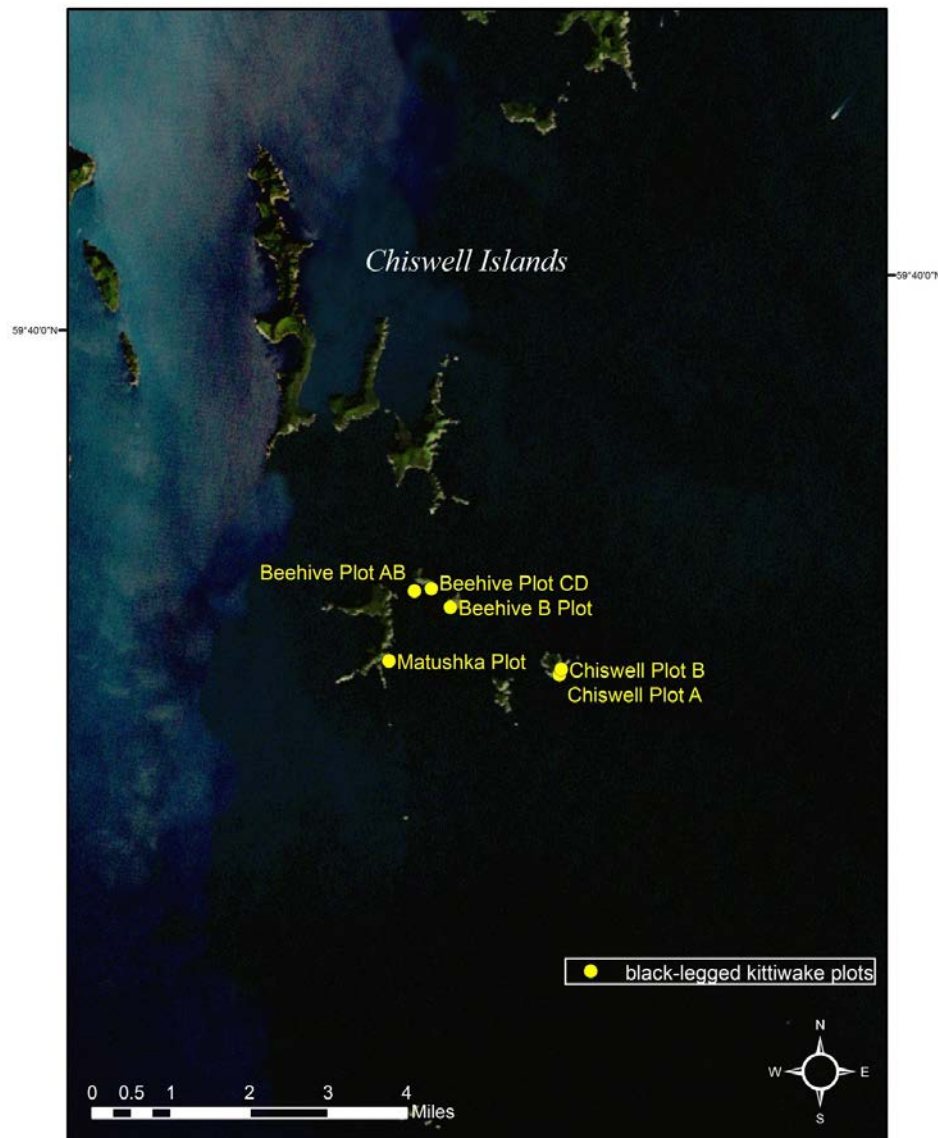


Figure 5. Location of black-legged kittiwake plots in the Chiswell Islands of AMNWR.

Results

Ledge-nesting Seabird Surveys

Boat-based Observer Counts

We conducted 9-12 replicate surveys of plots at the six northeast colonies during the incubation/early hatching period (5 –20 June, 2013), 9-12 replicate surveys of the five southwest colonies during the late hatching/early chick-rearing period (20 June -11 July), and 9-12 replicates of a subset of four of the northeast colonies (Squab, Cheval, No Name and Chat Islands) in the later chick rearing period (20-30 July; Table 4). Counts of plots varied from 43.67 individual glaucous-winged gulls at the Steep colony plot to 136.48 adult gulls at the Squab colony plot (Table 2).

Table 2. Average number of glaucous-winged gulls counted in plots in the Kenai Fjords area, 2013. Averages are presented with standard deviation (SD) and number of replicates (n).

Colony	Avg. Count	n	SD
Cheval	55.2	19	9.7
No Name	67.8	19	16.2
Chat	56.8	19	14.0
Squab	136.5	20	44.9
Grotto	55.6	9	9.3
Natoa	48.1	9	12.0
Surok	93.2	9	7.3
Cloudy	125.2	9	9.4
Black	72.3	9	9.7
Steep	43.7	9	11.9
Striation	66.5	9	13.0

Our counts of entire colonies varied from 45 individuals at Natoa to 451.5 individuals at Striation (Table 3). The number of glaucous-winged gulls counted at colonies in 2013 was similar to counts in 2012 (Figures 6-7).

Table 3. Number of glaucous-winged gulls counted at colonies in the Kenai Fjords area, 2013. Numbers are an average of one simultaneous count of the entire colony conducted by two observers in which the observers obtained counts within 5% of each other.

Colony	Count	Colony size
Cheval	315	Large
No Name	452	Large
Chat	201	Medium
Squab	325	Large
Grotto	197	Medium
Natoa	45	Small
Surok	291	Medium
Cloudy	137	Medium
Black	298	Medium
Steep	225	Medium
Striation	446	Large

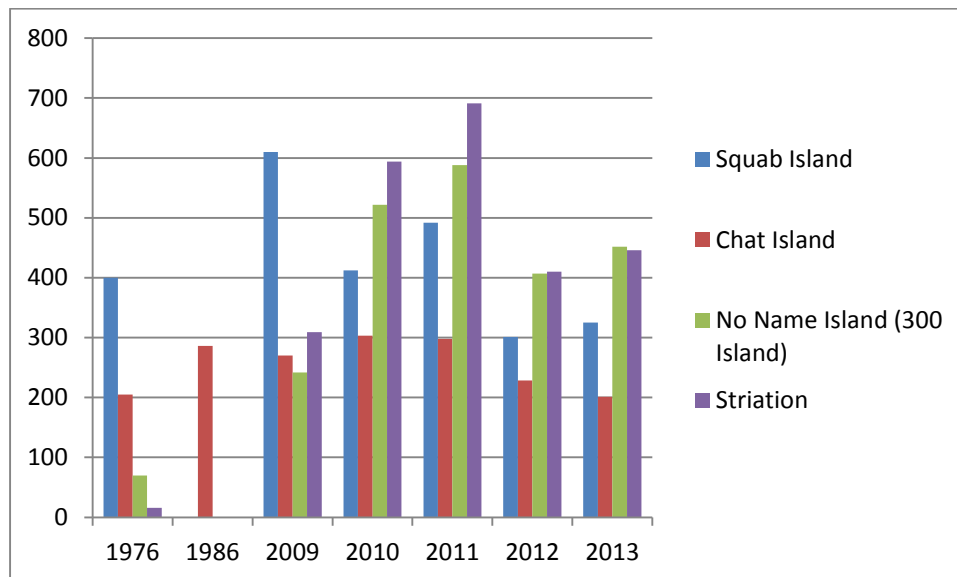


Figure 6. Observed number of breeding of glaucous-winged gulls during counts of the entire colony at a subset of four colonies in AMNWR for seven years of count data. All counts are from single visits, except Chat (n= 2), Squab (n=2) and No Name (n=2) in 2013.

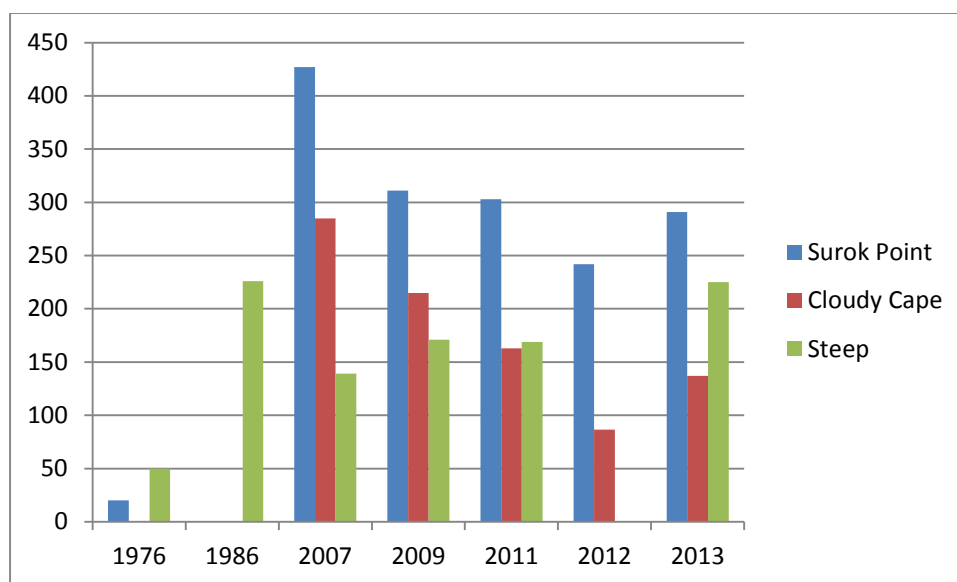


Figure 7. Observed number of breeding glaucous-winged gulls at a subset of three colonies in KEFJ for seven years of count data. Counts for 1976-2009, 2011, 2012 and 2013 are from single visits.

Boat-based Photographic Surveys

We performed 235 photo replicates at 11 colonies. We will compare our results of double observer counts to other methods in assessing feasibility, accuracy and cost-effectiveness in future reports.

Aerial Photographic Surveys

We completed two replicate aerial photographic surveys of southwest colonies and 8-9 replicates of northeast colonies (17-18 July; Table 4). Image analysis is ongoing and results will be presented in a later report.

Table 4. Dates and number of replicates of boat-based and aerial seabird colony surveys in 2013.

Dates	Park location	Phase of Breeding Season	Boat-based Replicates	Aerial Replicates
3-21 June	Northeast	Incubation	9-12	---
2-11 July	Southwest	End of Incubation/Hatching	9-12	---
17-18 July	Northeast	Hatching/Early Chick Rearing	---	8-9
17-18 July	Southwest	Hatching/ Early Chick Rearing	---	2
20 July-2 Aug	Northeast	Late Hatching/Chick Rearing	9-12	---

Ground-truthing (Asymptotic counts)

For each photo replicate we took at least three series of “ground-truth” photos of different exposures that will establish an asymptotic count of baseline of individuals present. The data is currently under analysis and will be presented in a later report.

Time-Lapse Cameras

Each time-lapse camera took up to 800 photos of each plot over the course of the breeding season. Photos are currently undergoing analysis and results will be presented in a later report.

Song Meter

We completed the analysis of one day of sound data (20 May 2013) sound data; however, due to lack of time, the other 34 days of recordings have yet to be analyzed. On 20 May 2013, the meter recorded fork-tailed storm petrel calls between 01:15 and 03:15 with the peak intensity of calling occurring around 01:30. Rhinoceros auklets were actively calling from 02:15 until 04:00 but not at the intensity of the fork-tailed storm petrels. Diurnal species such as varied thrush (*Ixoreus naevius*), unidentified passerines, bald eagle, glaucous-winged gull and parakeet auklet (*Thia psittacula*) were recorded after sunrise at 04:30.

USFWS Black-legged Kittiwake Plots

In 2013, the average number of individuals (Figure 8) in plots seemed to follow a similar pattern to that of previous years, but numbers were higher than those in 1992, 2008 and 2011 and similar to results of the single count in 2012. Counts of nests (Figure 9) were higher than 2011 and 2012 and more similar to the number of nests counted in 2008.

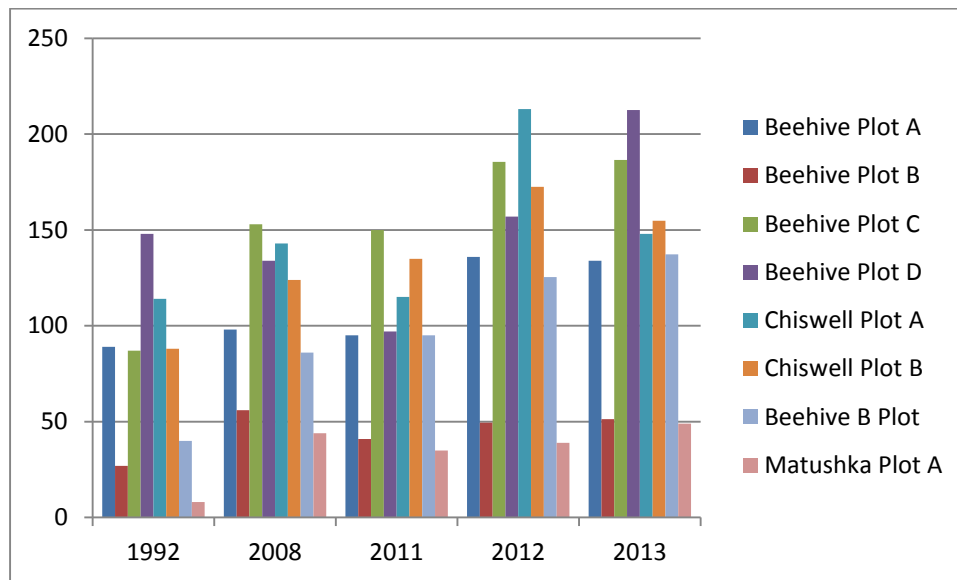


Figure 8. Number of black-legged kittiwakes at eight plots established by AMNWR in the Chiswell Islands from 2011 (n=10), 2012 (n=1), and 2013 (n=2).

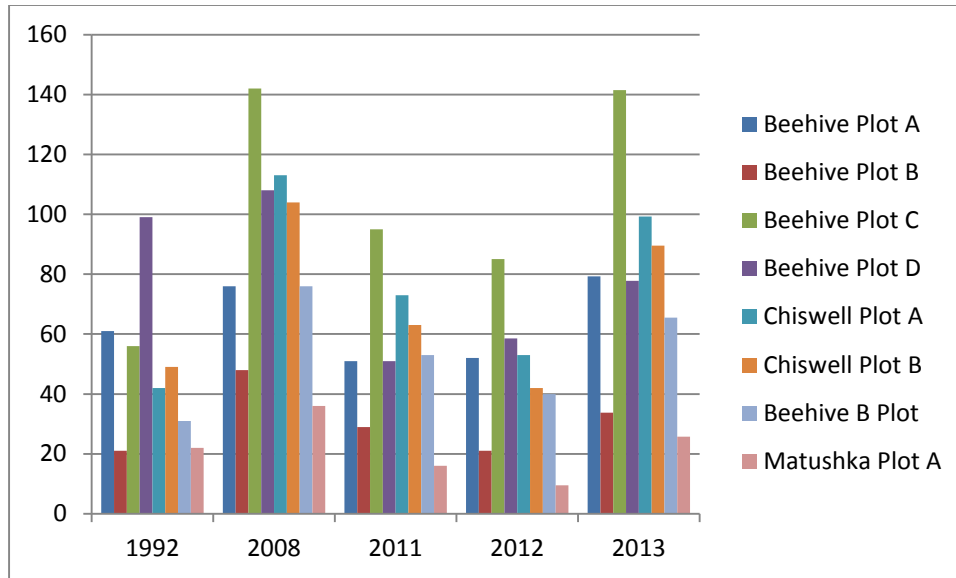


Figure 9. Number of black-legged kittiwake nests at eight plots established by AMNWR in the Chiswell Islands from 2011 (n=10), 2012 (n=1), and 2013 (n=2).

Discussion

Conducting field work in the Kenai Fjords area presents a number of logistical challenges that will affect planning of future surveys. The timing of our boat-based replicates throughout the season was influenced by availability of the *M/V Serac* and inclement weather. In rainy weather, it was difficult for us to survey with binoculars and cameras due to distortion of visibility by either water or fog obscuring the lenses. Additionally mechanical failure or permanent equipment damage can be an issue. At times, thick fog or thick sheets of rain prevented us from a clear view of colonies, even when protected by the overhang on the back deck of the *M/V Serac*.

In 2013, we surveyed more colonies than 2012. We completed a similar number of replicates for boat-based surveys, but we completed more aerial replicates (as more resources were acquired from additional UAF funded proposals), and all colonies surveyed by boat were also visited by helicopter (only a subset were visited in 2012). In 2013, we improved and further developed ground-truthing methods as our approach in 2012 proved ineffective and the images were difficult to process. Images taken with the single time-lapse camera deployed in 2012 were also difficult to analyze; as a result six time lapse cameras were deployed in 2013 to try and capture breeding adult attendance in smaller portions of the colony with more clarity and detail and in clearly marked plots.

The number of glaucous-winged gulls in Kenai Fjords appears qualitatively to have increased between 1976 and 2007 but has remained relatively stable since 2007. This is consistent with other colonies in Alaska where adult gull colonies are currently stable, and Middleton Island where glaucous-winged gull numbers increased from the mid-1980s to the mid-1990s but are now declining (Denlinger 2006). Growth of glaucous-winged gull colonies in the 20th century is often attributed to increases in gull use of anthropogenic food sources including open refuse dumps and fish waste discarded from fishing vessels (Denlinger 2006). While these sources are still used by gulls, the recent stabilization and even decline of some colonies has been attributed to increased predation pressure by bald eagles (Sullivan et al. 2002, Hayward et al. 2010).

In 2013, we deployed the song meter earlier during the summer breeding season based on expected arrival dates of nocturnal seabird species to the study area; however, we recorded no new species. The Chiswell Islands have historically been a location of high productivity for breeding seabirds. In 1976, Bailey observed fork-tailed storm-petrels and rhinoceros auklets on Matushka Island. Decades later we detected the presence of these same species on the island, and this is consistent with high site fidelity exhibited by nocturnal burrow nesting seabirds (Rachel Buxton, pers. comm.).

Future improvements to sound monitoring may include using batteries with larger power capacity, using memory cards with larger storage capacity, and finding software to aid in analysis of the extensive recordings. Since we will conduct these passive surveys throughout the breeding season, we not only expect to confirm presence or absence of species but we also hope to determine the timing of breeding stages throughout the season according to the types of calls we record: mating calls would indicate courtship, chick calls would indicate breeding success and the duration of chick calls would indicate the likelihood of fledging success (Buxton and Jones 2012).

Black-legged kittiwakes in the Chiswell Islands show that numbers of individuals and nest fluctuate over the years, which is consistent with literature describing the influence of both short-term and long-term changes in habitat, prey availability and the physical ocean environment on kittiwake populations (e.g. Suryans and Irons 2001, Piatt et al. 2007a). It is interesting to note that high numbers of attending adults do not necessarily coincide with high numbers of nests. This is apparent looking at the data from 2012 and 2013, where in both years there was a high number of attending adults, but in 2013 there were more nests detected.

The methods we developed during 2011, 2012 and 2013 will ultimately help to shape future seabird monitoring in KEFJ, particularly in providing statistically valid and economically feasible monitoring protocols for ledge-nesting species in the region. Results from the remaining methods described in this report will be forthcoming in a project summary report in 2014, as well as in a UAF M.S. thesis and any resulting publications.

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Appendix A: Summary Tables

Table 1. Species composition and count at seabird colonies in KEFJ for all surveys, 1976-2013. Colony survey locations are listed west to east, from Nuka Bay to Resurrection Bay. * Denotes lack of data for a site/year combination, - indicates no sightings for that category.

Colony/Spp	1976	1986	2007	2008	2009	2010	2011	2012	2013
35 Point									
Glaucous-winged gull	30	-	95	*	90	*	33	*	*
Red-faced cormorant	10	-	-	*	-	*	27	*	*
Nests	-	-	-	*	-	*	2	*	*
Double-crested cormorant	-	12	5	*	-	*	-	*	*
Nests	-	3	-	*	-	*	-	*	*
Pelagic cormorant	-	25	-	*	1	*	1	*	*
Nests	-	1	-	*	-	*	0	*	*
Cormorant sp.	-	-	-	*	-	*	-	*	*
Nests	-	-	10	*	-	*	-	*	*
Harrington Point									
Glaucous-winged gull	-	-	166	*	1	*	-	*	*
Red-faced cormorant	-	29	-	*	-	*	-	*	*
Nests	-	21	-	*	-	*	-	*	*
Double-crested cormorant	-	-	18	*	-	*	-	*	*
Nests	-	-	5	*	-	*	-	*	*
Pelagic cormorant	-	12	-	*	-	*	-	*	*
Nests	-	17	-	*	-	*	-	*	*
Horned puffin	10	-	-	*	-	*	-	*	*
Harrington Point West									
Glaucous-winged gull	-	85	-	*	4	*	50	*	*
Red-faced cormorant	-	-	-	*	-	*	5	*	*
Nests	-	-	-	*	-	*	0	*	*

Colony/Spp	1976	1986	2007	2008	2009	2010	2011	2012	2013
Double-crested cormorant	-	-	-	*	41	*	32	*	*
<i>Nests</i>	-	-	-	*	64	*	21	*	*
Pelagic cormorant	20	-	-	*	-	*	15	*	*
<i>Nests</i>	-	-	-	*	-	*	5	*	*
East Arm (James Lagoon)									
Glaucous-winged gull	120	-	-	*	-	*	-	*	*
East Arm North									
Arctic Tern	6	-	-	*	-	*	-	*	*
Glaucous-winged gull	40	162	-	*	4	*	7	*	*

Table 2. Species composition and count at seabird colonies in KEFJ for all surveys, 1976-2013. Colony survey locations are listed west to east, from Nuka Bay to Resurrection Bay (continued).

Colony/Spp	1976	1986	2007	2008	2009	2010	2011	2012	2013
McCarty Fjord									
Mew gull	*	*	*	*	*	*	9	*	*
Delusion									
Mew gull	*	*	*	*	*	*	18	*	*
Chance Cove									
Horned puffin	*	*	*	*	*	*	8	*	*
Steep Point									
Glaucous-winged gulls	50	226	139	*	171	*	169 ¹	*	225
Red-faced cormorant	-	-	-	*	-	*	19 ¹	*	*
Nests	-	-	-	*	-	*	0 ¹	*	*
Double-crested cormorants	-	-	-	*	1	*	-	*	*
Pelagic cormorants	40	46	-	*	27	*	11 ¹	*	*
Nests	-	2	-	*	12	*	6 ¹	*	*
Tufted puffin	-	*	-	*	11	*	-	*	*
Cormorant Spp	-	-	-	*	-	-	8 ¹	*	*
Nests	-	-	-	*	-	-	5 ¹	*	*
Black Bay									
Glaucous-winged gull	-	-	-	*	91	*	237 ²	*	297.5
Red-faced cormorant	-	-	-	*	14	*	4 ²	*	*
Nests	-	-	-	*	11	*	0 ²	*	*
Double-crested cormorant	-	-	20	*	69	*	-	*	*
Nests	-	-	12	*	42	*	-	*	*

Colony/Spp	1976	1986	2007	2008	2009	2010	2011	2012	2013
Pelagic cormorant	14	-	27	*	31	*	11 ²	*	*
<i>Nests</i>	60	-	21	*	22	*	8 ²	*	*
Cormorant Spp	-	-	-	*	-	*	3 ²	*	*
<i>Nests</i>	-	-	-	*	-	*	3 ²	*	*
Horned puffin	140	-	-	*	11	*	-	*	*
Tufted puffin	-	-	1	*	16	*	2 ²	*	*
Common murre	-	-	3	*	11	*	-	*	*
Thunder Bay East									
Glaucous-winged Gull	*	*	*	*	*	*	9	*	*

Table 3. Species composition and count at seabird colonies in KEFJ for all surveys, 1976-2013. Colony survey locations are listed west to east, from Nuka Bay to Resurrection Bay (continued).

Colony/Spp	1976	1986	2007	2008	2009	2010	2011	2012	2013
Thunder Bay East B									
Pelagic Cormorant	*	*	*	*	*	*	2	*	*
Nests	*	*	*	*	*	*	2	*	*
Nack Triangle									
Glaucous-winged gull	-	-	-	*	11	*	-	*	*
Red-faced cormorant	40	-	-	*	3	*	9	*	*
Nests	*	-	-	*	*	*	0	*	*
Black-legged kittiwake	-	-	-	*	-	*	0	*	*
Nests	-	62	-	*	-	*	0	*	*
Pelagic cormorant	20	-	-	*	-	*	23	*	*
Nests	*	-	-	*	-	*	9	*	*
Nack Triangle B									
Pelagic cormorant	*	*	*	*	*	*	11	*	*
Nests	*	*	*	*	*	*	9	*	*
Cloudy Cape									
Glaucous-winged gull	-	-	285	*	215 ³	*	163 ⁴	86.5	137
Black-legged kittiwake	-	22	-	*	-	*	-	*	*
Red-faced cormorant	-	-	-	*	2 ³	*	-	*	*
Double-crested cormorant	-	-	40	*	35 ³	*	-	*	*
Nests	-	-	27	*	26 ³	*	-	*	*
Pelagic cormorant	-	-	-	*	70 ³	*	1 ²	*	*
Nests	-	-	-	*	24 ³	*	1 ²	*	*
Cormorant <i>sp.</i>	-	-	-	*	-	*	-	*	*
Nests	-	-	-	*	7 ³	*	-	*	*

Colony/Spp	1976	1986	2007	2008	2009	2010	2011	2012	2013
Horned puffin	-	-	-	*	2 ³	*	5	present	Present
Tufted puffin	-	-	-	*	7 ³	*	9	present	present

Table 4. Species composition and count at seabird colonies in KEFJ for all surveys, 1976-2012. Colony survey locations are listed west to east, from Nuka Bay to Resurrection Bay (continued).

Colony/Spp	1976	1986	2007	2008	2009	2010	2011	2012	2013
Cloudy B									
Glaucous-winged gull	*	*	*	*	215 ³	*	-	*	*
Red-faced cormorant	*	*	*	*	2 ³	*	-	*	*
Double-crested cormorant	*	*	*	*	35 ³	*	23 ⁴	*	*
Nests	*	*	*	*	26 ³	*	21 ⁴	*	*
Pelagic cormorant	*	*	*	*	70 ³	*	5 ⁵	*	*
Nests	*	*	*	*	24 ³	*	5 ⁵	*	*
Cormorant <i>sp.</i>	*	*	*	*	-	*	-	*	*
Nests	*	*	*	*	7 ³	*	-	*	*
Horned puffin	*	*	*	*	2 ³	*	-	*	*
Tufted puffin	*	*	*	*	7 ³	*	3 ¹	*	*
Surok Point									
Glaucous-winged gulls	20	-	427	*	311	*	303 ⁶	242	290.5
Red-faced cormorant	-	-	-	*	2	*	2	-	-
Nests	-	-	-	*	1	*	-	-	-
Double-crested cormorant	-	-	9	*	27	*	2 ⁶	-	-
Nests	-	-	9	*	6	*	1 ⁶	-	-
Pelagic cormorant	140	1	33	*	72	*	3 ⁶	present	Present
Nests	-	1	33	*	55	*	2 ⁶	*	*
Tufted puffin	-	-	-	*	15	*	5	present	Present
Horned puffin	-	-	-	*	4	*	4 ¹	present	Present
Surok B									
Pelagic cormorant	*	*	*	*	*	*	5	*	*

Colony/Spp	1976	1986	2007	2008	2009	2010	2011	2012	2013
<i>Nests</i>	*	*	*	*	*	*	1	*	*
Sandy Bay									
Horned puffin	*	*	*	*	*	*	3	*	*
Tufted puffin	*	*	*	*	*	*	2	*	*
Northwestern Lagoon									
Arctic tern	150	-	-	*	*	*	-	*	*
Glaucous-winged gulls	170	-	-	*	*	*	-	*	*
Mew gull	90	-	-	*	*	*	-	*	*

Table 5. Species composition and count at seabird colonies in KEFJ for all surveys, 1976-2012. Colony survey locations are listed west to east, from Nuka Bay to Resurrection Bay (continued).

Colony/Spp	1976	1986	2007	2008	2009	2010	2011	2012	2013
NW Glacier (Striation)									
Glaucous-winged gulls	*	*	*	*	*	82	180	410	446
NW Glacier B									
Glaucous-winged gulls	*	*	*	*	*	*	32	*	*
Try Triangle									
Horned puffin	10	-	-	*	-	*	-	*	*
17 Cove									
Horned puffin	10	-	-	*	-	*	-	*	*
Cliff Bay									
Double-crested cormorant	-	-	30	*	-	-	-		*
Pelagic cormorant	-	-	17	*	-	11	4	*	*
Horned puffin	3	-	28	*	-	-	4	*	*
Aialik Cape									
Glaucous-winged gull	-	-	-	98	-	-	-	*	*
Black-legged kittiwake	-	-	-	3	-	-	-	*	*
Red-faced cormorant	-	74 ⁷	-	-	99	51	-	*	*
Nests	-	43 ⁷	-	-	72	*	-	*	*
Double-crested cormorant	-	-	-	9	66	26	23 ⁵	*	*
Nests	-	-	-	(2 chicks)	40	*	20 ⁵	*	*
Pelagic cormorant	-	63 ⁷	-	22	66	104	-	*	*
Nests	-	23 ⁷	-	(6 chicks)	47	*	-	*	*

Colony/Spp	1976	1986	2007	2008	2009	2010	2011	2012	2013
Cormorant sp.	-	8 ⁷	-	-	2	-	-	*	*
<i>Nests</i>	-	12 ⁷	-	-	7	-	-	*	*
Horned puffin	60	-	27	9	4	10	41	*	*
Tufted puffin	-	-	-	17	6	-	-	*	*
East Aialik Peninsula									
Horned puffin	20	-	-	*	12	*	-	*	*
Cheval Narrows									
Horned puffin	*	*	*	*	*	*	16	*	*

Table 6. Species composition and count at seabird colonies in KEFJ for all surveys, 1976-2013. Colony survey locations are listed west to east, from Nuka Bay to Resurrection Bay (continued).

Colony/Spp	1976	1986	2007	2008	2009	2010	2011	2012	2013
Porcupine Cove									
Horned puffin	*	*	*	*	*	*	8	*	*
Spire Cove C									
Horned puffin	*	*	*	*	*	*	5	*	*
Spire Cove B									
Horned puffin	*	*	*	*	*	*	3	*	*
Spire Cove									
Red-faced Cormorant	-	-	-	*	-	-	3 ⁸	*	*
Nests	-	-	-	*	-	-	1 ⁸	*	*
Pelagic cormorant	-	-	-	*	11	-	10 ⁸	*	*
Nests	-	-	-	*	2	-	6 ⁸	*	*
Cormorant sp.	-	-	-	*	-	15	-	*	*
Nests	-	-	-	*	-	*	-	*	*
Horned puffin	30	-	-	*	30	1	9	*	*
Bear Glacier Point B									
Horned puffin	*	*	*	*	*	*	2	*	*
Bear Glacier Point									
Glaucous-winged gull	-	-	-	32	-	*	-	*	*
Black-legged kittiwake	-	-	-	23	-	*	-	*	*
Double-crested cormorant	-	-	-	7	-	*	-	*	*
Nests	-	-	-	(8 chicks)	-	*	-	*	*

Colony/Spp	1976	1986	2007	2008	2009	2010	2011	2012	2013
Pelagic cormorant	-	-	12	14	-	*	-	*	*
<i>Nests</i>	-	-	6	(2 chicks)	-	*	-	*	*
Horned puffin	50	-	19	4	7	*	12	*	*
Bulldog Cove									
Horned puffin	*	*	*	*	*	*	4	*	*

Table 7. Species composition and count at seabird colonies in KEFJ for all surveys, 1976-2013. Colony survey locations are listed west to east, from Nuka Bay to Resurrection Bay (continued).

Colony/Spp	1976	1986	2007	2008	2009	2010	2011	2012	2013
Yalik									
Glacous-winged gull	*	*	*	*	*	*	*	156 ⁹	*
Pelagic cormorant	*	*	*	*	*	*	*	present	*
<i>Nests</i>	*	*	*	*	*	*	*	present	*
Horned puffin	*	*	*	*	*	*	*	present	*

¹ Average of counts from two visits

² Average of counts from three visits

³ Cloudy Cape and Cloudy B colonies are combined in the 2009 survey data.

⁴ Average of counts from nine visits

⁵ Average of counts from seven visits

⁶ Average of counts from four visits

⁷ 300 Island (No Name) and Aialik Cape colonies are combined in the 1986 survey data.

⁸ Average of counts from eight visits

⁹ Highest of all counts

Table 8. Species composition and count at seabird colonies in AMNWR for all surveys, 1976-2013. Colony survey locations are listed west to east, from Nuka Bay to Resurrection Bay. * Denotes a lack of data for a site/year combination, - indicates no sightings for that category.

Colony/Spp	1976	1986	2007	2009	2010	2011	2012	2013
Outer Island S to SE								
Glaucous-winged gull	190	1022	*	417	*	*	*	*
Red-faced cormorant	30	-	*	-	*	*	*	*
Pelagic cormorant	40	10	*	-	*	*	*	*
Cormorant sp.	-	-	*	15	*	*	*	*
Horned puffin	-	25	*	2	*	*	*	*
Tufted puffin	180	648	*	31	*	*	*	*
Common murre	-	2	*	-	*	*	*	*
Outer Island South-east								
Glaucous-winged gull	100	556	*	505	*	*	*	*
Black-legged kittiwake	1060	1089	*	759	*	*	*	*
Nests	*	501	*	70	*	*	*	*
Red-faced cormorant	20	36	*	-	*	*	*	*
Nests	*	9	*	-	*	*	*	*
Pelagic cormorant	80	28	*	26	*	*	*	*
Nests	*	12	*	-	*	*	*	*
Cormorant sp.	-	-	*	2	*	*	*	*
Horned puffin	100	30	*	10	*	*	*	*
Tufted puffin	500	58	*	109	*	*	*	*
Rabbit Island								
Pelagic cormorant	4	-	*	-	*	*	*	*
Cormorant sp.	-	-	*	72	*	*	*	*
Horned puffin	30	-	*	-	*	*	*	*
Wildcat Pass								
Glaucous-winged gull	-	4	*	242	*	22	*	*

Colony/Spp	1976	1986	2007	2009	2010	2011	2012	2013
Pelagic cormorant	40	11	*	-	*	3	*	*
Nests	*	*	*	-	*	2	*	*
Horned puffin	30	-	*	-	*	-	*	*
Tufted puffin	30	-	*	-	*	-	*	*

Table 9. Species composition and count at seabird colonies in AMNWR for all surveys, 1976-2013. Colony survey locations are listed west to east, from Nuka Bay to Resurrection Bay (continued).

Colony/Spp	1976	1986	2007	2009	2010	2011	2012	2013
Hoof Point								
Glaucous-winged gull	90	137	*	297	*	403 ¹	*	*
Black-legged kittiwake	-	59	*	68	*	-	*	*
Red-faced cormorant	60	-	*	-	*	-	*	*
Double-crested cormorant	-	-	*	28	*	-	*	*
<i>Nests</i>	-	-	*	16	*	-	*	*
Pelagic cormorant	12	4	*	165	*	-	*	*
<i>Nests</i>	-	-	*	29	*	-	*	*
Cormorant sp.	-	-	*	-	*	8	*	*
<i>Nests</i>	-	-	*	2	*	4	*	*
Horned puffin	40	-	*	4	*	3	*	*
Tufted puffin	20	-	*	7	*	-	*	*
Hoof Point North								
Glaucous-winged gull	80	-	*	731	*	353 ¹	*	*
Red-faced cormorant	40	-	*	-	*	-	*	*
<i>Nests</i>	*	18	*	-	*	-	*	*
Double-crested cormorant	-	-	*	4	*	-	*	*
<i>Nests</i>	-	-	*	1	*	-	*	*
Pelagic cormorant	160	-	*	86	*	-	*	*
<i>Nests</i>	*	48	*	26	*	-	*	*
Cormorant sp.	-	-	*	-	*	-	*	*
<i>Nests</i>	-	-	*	7	*	-	*	*
Horned puffin	1000	-	*	8	*	1	*	*
Tufted puffin	800	-	*	14	*	-	*	*
28 Section								

Colony/Spp	1976	1986	2007	2009	2010	2011	2012	2013
Glaucous-winged gull	-	-	*	58	*	51 ¹	*	*
Double-crested cormorant	-	-	*	124	*	-	*	*
<i>Nests</i>	-	-	*	100	*	-	*	*
Pelagic cormorant	10	present	*	33	*	-	*	*
<i>Nests</i>	-	-	*	23	*	-	*	*
Cormorant sp.	-	-	*	-	*	-	*	*
<i>Nests</i>	-	-	*	19	*	-	*	*
Tufted puffin	150	-	*	17	*	1	*	*

Table 10. Species composition and count at seabird colonies in AMNWR for all surveys, 1976-2013. Colony survey locations are listed west to east, from Nuka Bay to Resurrection Bay (continued).

Colony/Spp	1976	1986	2007	2009	2010	2011	2012	2013
28 Section West								
Cormorant sp.	*	*	*	*	*	19	*	*
Nests	*	*	*	*	*	4	*	*
NW Glacier Island (Striation)								
Glaucous-winged gulls	16	-	-	309	594	410	*	446
Harris Bay Island (Erratic)								
Arctic tern	80	present	-	-	*	-	*	*
Glaucous-winged gull	40	-	-	30	*	-	*	*
Mew gull	60	present	-	-	*	-	*	*
Granite Island								
Glaucous-winged gull	500	1280	*	495	1048	897	*	*
Black-legged kittiwake	100	43	*	-	-	-	*	*
Red-faced cormorant	400	-	*	-	17	-	*	*
Double-crested cormorant	-	-	*	32	-	1	*	*
Nests	-	-	*	17	-	0	*	*
Pelagic cormorant	72	29	*	40	167	5	*	*
Nests	*	4	*	29	*	2	*	*
Cormorant sp.	-	1	*	1	-	-	*	*
Nests	-	-	*	25	-	-	*	*
Horned puffin	130	80	*	24	-	10	*	*
Tufted puffin	100	14	*	26	-	11	*	*
Common murre	200	18	*	55	77	90	*	*
Twin Islands								
Glaucous-winged gull	-	284	*	-	*	*	*	*

Colony/Spp	1976	1986	2007	2009	2010	2011	2012	2013
Black-legged kittiwake	-	22	*	-	*	*	*	*
Double-crested cormorant	-	5	*	-	*	*	*	*
Cormorant sp.	-	1	*	-	*	*	*	*
Horned puffin	50	122	*	35	*	*	*	*
Tufted puffin	-	3	*	-	*	*	*	*
Common murre	-	3	*	-	*	*	*	*

Table 11. Species composition and count at seabird colonies in AMNWR for all surveys, 1976-2013. Colony survey locations are listed west to east, from Nuka Bay to Resurrection Bay (continued).

Colony/Spp	1976	1986	2007	2009	2010	2011	2012	2013
Aligo Point								
Red-faced cormorant	-	-	-	9	*	-	*	*
<i>Nests</i>	-	-	-	1	*	-	*	*
Double-crested cormorant	-	-	23	-	*	-	*	*
Pelagic cormorant	-	-	14	21	*	1	*	*
<i>Nests</i>	-	-	-	8	*	-	*	*
Cormorant sp.	-	-	-	-	*	-	*	*
<i>Nests</i>	-	3	-	4	*	-	*	*
Horned puffin	-	-	22	3	*	26	*	*
Puffin sp.	-	-	-	1	*	-	*	*
Slate Island								
Glaucous-winged gull	-	-	-	21	-	-	*	*
Mew gull	30	-	-	-	-	6	*	*
<i>Nests</i>	*	-	-	-	-	4	*	*
Horned puffin	56	-	-	1	-	-	*	*
Arctic tern	-	-	-	-	-	1	*	*
Squab Island								
Glaucous-winged gull	400	-	-	610	412	492	301	325.25
Abra								
Mew Gull	*	*	*	*	*	16	*	*
<i>Nests</i>	*	*	*	*	*	5	*	
Chat Island								
Glaucous-winged gull	205	286	*	270	303	298	205.5	201.25

Colony/Spp	1976	1986	2007	2009	2010	2011	2012	2013
Red-faced cormorant	34	-	*	-	-	*	-	*
Double-crested cormorant	-	17	*	9	-	*	-	*
<i>Nests</i>	-	-	*	4	-	*	-	*
Pelagic cormorant	43	7	*	24	-	present	present	Present
<i>Nests</i>	-	1	*	4	-	present	*	*
Cormorant sp.	-	1	*	-	29	present	-	Present
<i>Nests</i>	-	-	*	2	-	present	-	Present
Horned puffin	80	76	*	24	17	present	present	Present
Tufted puffin	30	70	*	2	29	*	-	Present
Common murre	80	14	*	6	-	present	present	Present

Table 12. Species composition and count at seabird colonies in AMNWR for all surveys, 1976-2013. Colony survey locations are listed west to east, from Nuka Bay to Resurrection Bay (continued).

Colony/Spp	1976	1986	2007	2009	2010	2011	2012	2013
Chicken Pass								
Glaucous-winged gull	*	*	*	*	*	22	*	*
300 Island (No Name)								
Glaucous-winged gull	70	-	*	242	522	588	403	451.5
Red-faced cormorant	-	74 ¹	*	16	-	*	present	Present
Nests	-	43 ¹	*	7	-	*	*	*
Pelagic cormorant	-	63 ¹	*	36	14	*	-	*
Nests	-	23 ¹	*	14	*	*	-	Present
Cormorant sp.	-	8 ¹	*	-	17	*	-	*
Nests	-	12 ¹	*	1	*	*	-	*
Horned puffin	60	-	*	13	12	*	-	*
Tufted puffin	500	-	*	51	80	present	present	Present
Common murre	-	-	*	13	-	*	present ²	Present
Pilot Rock								
Glaucous-winged gull	20	-	*	84	*	*	*	*
Horned puffin	30	-	*	11	*	*	*	*
Tufted puffin	10	-	*	14	*	*	*	*
Cheval Island								
Glaucous-winged gull	140	-	*	104	500	517	present	315
Red-faced cormorant	100	-	*	3	-	*	present	Present
Nests	-	-	*	2	-	*	*	*
Double-crested cormorant	36	-	*	18	3	*	-	*
Nests	-	-	*	4	-	*	-	*

Colony/Spp	1976	1986	2007	2009	2010	2011	2012	2013
Pelagic cormorant	20	-	*	31	17	*	present	Present
Nests	-	-	*	11	-	*		*
Cormorant sp.	-	7	*	1	-	*	-	*
Nests	-	-	*	20	-	*	-	*
Horned puffin	210	-	*	58	59	present	present	Present
Tufted puffin	140	-	*	32	8	*	present	Present
Common murre	-	-	*	4	1	*	-	Present

Table 13. Species composition and count at seabird colonies in AMNWR for all surveys, 1976-2013. Colony survey locations are listed west to east, from Nuka Bay to Resurrection Bay (continued).

Colony/Spp	1976	1986	2007	2009	2010	2011	2012	2013
Lone Rock								
Northern Fulmar	40	30	*	*	-	*	*	*
Glaucous-winged gull	24	50	*	*	-	*	*	*
Horned puffin	40	2	*	*	-	*	*	*
Tufted puffin	80	20	*	*	-	*	*	*
Natoa								
Glaucous-winged gull	*	*	*	*	*	*	71	45
Horned puffin	*	*	*	*	*	*	present	Present
Tufted puffin	*	*	*	*	*	*	Present	present
Grotto								
Glaucous-winged gull	*	*	*	*	*	*	183	197
Horned puffin	*	*	*	*	*	*	present	Present
Tufted puffin	*	*	*	*	*	*	present	Present
Black-legged kittiwake	*	*	*	*	*	*	present	Present
Common murre	*	*	*	*	*	*	present	Present

¹ Average of counts from two visits

² Seen flying into crevice and heard, but not actually seen on cliff