



Seabird Colony Survey Report 2012

Kenai Fjords National Park and Alaska Maritime National Wildlife Refuge

Natural Resource Data Series NPS/KEFJ/NRDS—2013/471





ON THIS PAGE

Glaucous-winged gulls fly in front of Aialik Glacier.

Photograph by: Jennifer Curl, KEFJ

ON THE COVER

Jennifer Curl observes a glaucous-winged gull colony on Grotto Island (AMNWR).

Photograph by: Elisa Weiss, KEFJ

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The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado, publishes a range of reports that address natural resource topics. These reports are of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

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 work toward establishing permanent monitoring protocols for breeding seabirds at colonies in KEFJ and adjacent areas of AMNWR. In 2012, we tested three methods for surveying glaucous-winged gull (*Larus glaucescens*) breeding populations: boat-based observer counts, boat-based photographic surveys, and aerial photographic surveys. Data from these surveys will be analyzed this winter to determine the most accurate, feasible, and cost-effective methodology. In addition, we deployed a time lapse camera to observe variation in nest attendance of gulls at a single plot, and a Song Meter, a passive acoustic recording device, to identify nocturnal crevice or burrow nesting seabirds at two locations within the park. We continued boat-based surveys of established black-legged kittiwake (*Rissa tridactyla*) photo plots in the Chiswell Islands.

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*: Jamie Thompson, Melissa Knight, and Jason Flowers; resource management staff: Mark Kansteiner, Leslie Adams and Elisa Weiss; and law enforcement rangers: Sarah Cowell, Colby Olson and Mark Giddens. We would also like to thank Heather Renner and Leslie Slater at AMNWR for their support and input and Heather Coletti and Sharon Kim for helpful reviews of this report.

Introduction

Most seabird species are colonial nesters (Wittenberger and Hunt 1985) and the concentration of birds at colonies makes population survey efforts feasible during the breeding season. Breeding seabirds return to the same breeding sites within colonies (nests, ledges, crevices or burrows) throughout a single breeding season to feed and tend to their young. Because of these colonial aggregations of attending adults, the breeding season is an optimal time of the year for conducting population surveys. 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. 2007). Seabirds are species of management concern in Kenai Fjords National Park (KEFJ) due to their management significance, popularity with visitors, sensitivity to climate-driven ecosystem changes, and importance as indicators of marine ecosystem health.

1976 - 2010

Seabird colonies on the southern Kenai Peninsula have not been surveyed frequently or consistently; however, a 2006 General Agreement between the National Park Service (NPS), U.S. Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration (NOAA) sought to increase cooperation and efficiency between agencies where they share nearby coastal waters (USDI 2006). This agreement prompted a 2007 interagency survey of fourteen seabird colonies along the southwest coast of the Kenai Peninsula by NPS at KEFJ and USFWS at Alaska Maritime National Wildlife Refuge (AMNWR) (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 (n=17) and on islands within the AMNWR (n=18, McFarland et al. 2009). In 2010 KEFJ staff surveyed four colony locations in KEFJ and seven colony locations in AMNWR (Phillips and McFarland 2012). In contrast to USFWS protocols (USFWS 2000) that AMNWR uses to determine population trends, 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).

Previous to the 2006 Agreement, the coastline of the southern Kenai Peninsula was surveyed by Bailey (1977) prior to the designation of KEFJ and AMNWR by Alaska National Interest Lands Conservation Act (ANILCA 1980). A resurvey 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 coastal units, grouping nesting birds, roosting birds, and those on the water. Surveys were also conducted in the Pye Islands (AMNWR) in 1990 and in the Chiswell Islands (AMNWR) in the early 1990s to identify potential impacts to seabirds from the Exxon Valdez Oil Spill (Nysewander et al. 1993, Dragoo 1994).

2011

In 2011, KEFJ, in cooperation with AMNWR and University of Alaska Fairbanks, began a three-year seabird study to establish long term monitoring protocols for colonial breeding seabirds in KEFJ and adjacent areas of AMNWR. The goals of this three-year study are 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.

KEFJ researchers surveyed the entire coastline of the park (Yalik Point to Bear Glacier Point), recorded species presence and location of seabird colonies detected, and mapped colonies in ArcGIS (Parsons et al. 2012). KEFJ researchers visited select colonies within AMNWR opportunistically. Researchers narrowed the scope of the original proposal to focus on ledge-nesting seabirds and began a pilot effort to test monitoring methods for black-legged kittiwakes, pelagic cormorants (*Phalacrocorax pelagicus*), red-faced cormorants (*Phalacrocorax urile*), double-crested cormorants (*Phalacrocorax auritus*), common murre, thick-billed murre (*Uria lomvia*), and glaucous-winged gulls. Researchers conducted repeated observer counts of plots within colonies of these species.

2012

We developed a study plan for 2012 field work by considering the time, logistical constraints, and differences observed among species during the 2011 season and concluded that efforts should focus on one species and then, once refined, expanded to include others. We chose glaucous-winged gulls as our 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 which provides a better sampling framework for testing methods, and their colony locations are reasonably stable and numerous (Curl 2012).

Historically, monitoring of colonial breeding seabirds has fallen into two categories: less reliable counts of multiple sites conducted at irregular, infrequent intervals over time, and more intensive and consistent counts over time at a single (often smaller and/or more accessible) colony (Angehr and Kushlan 2007, Williams et al. 2000). Survey methods used to assess abundance include visual estimation, visual counts, photography, or videography and have variously been conducted from land, sea or air (Hutchinson 1980, Byrd 1989, Johnson and Krohn 2001). As such, surveys of seabird breeding distribution and abundance vary greatly in methodology, intensity and spatial scale. Due to logistical constraints, access to colonies in KEFJ is only by sea or by air.

We conducted replicate surveys using three different survey methods: boat-based observer counts, boat-based photography and aerial photography, at select sites across a large spatial scale of the park. Additionally, we deployed a time lapse camera to record data within a single plot to evaluate patterns in daily and seasonal nest attendance by adult gulls. 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.

In 2012, we also continued to record species presence in areas historically surveyed by KEFJ employees within the park and AMNWR, including glaucous-winged gull colonies and black-legged kittiwake plots. We deployed a passive acoustic device to document the presence of nocturnal burrow and crevice nesting seabirds that may not be detected visually. In addition, we recorded incidental observations of seabird species encountered during field work. 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.

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.

Methods

Study Area

The south coast of the Kenai Peninsula is characterized by steep fjords composed of greywacke, slate, or 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 (Figure 1) was established in 1980 to protect the Harding Icefield, its associated fjords and the marine mammals and birds that depend on them along its 800km of coastline (ANILCA 1980). KEFJ administers approximately 2,450 km²; its boundaries include an additional 225 km² managed primarily by the State of Alaska and Port Graham Native Corporation.

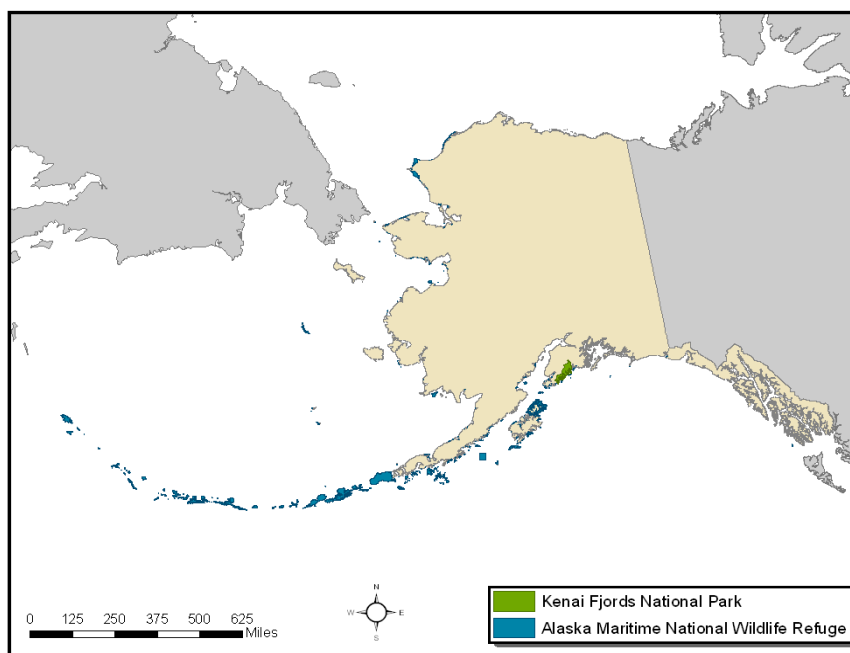


Figure 1. Location of Kenai Fjords National Park and the Alaska Maritime National Wildlife Refuge in Alaska.

The study area stretched from Yalik Point in Nuka Bay (59.918°N, 150.586°W) to No Name Island in Resurrection Bay (59.7171°N, 149.5121°W) and encompassed nearby islands including the Chiswell Island group and numerous other islands under the jurisdiction of AMNWR (Figure 2). The Chiswell Islands have some of the largest and most diverse breeding seabird colonies in the Kenai Fjords region (Bailey 1977).

AMNWR (Figure 1) 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 of the seabird colonies we surveyed in 2012 were within KEFJ or AMNWR. The study

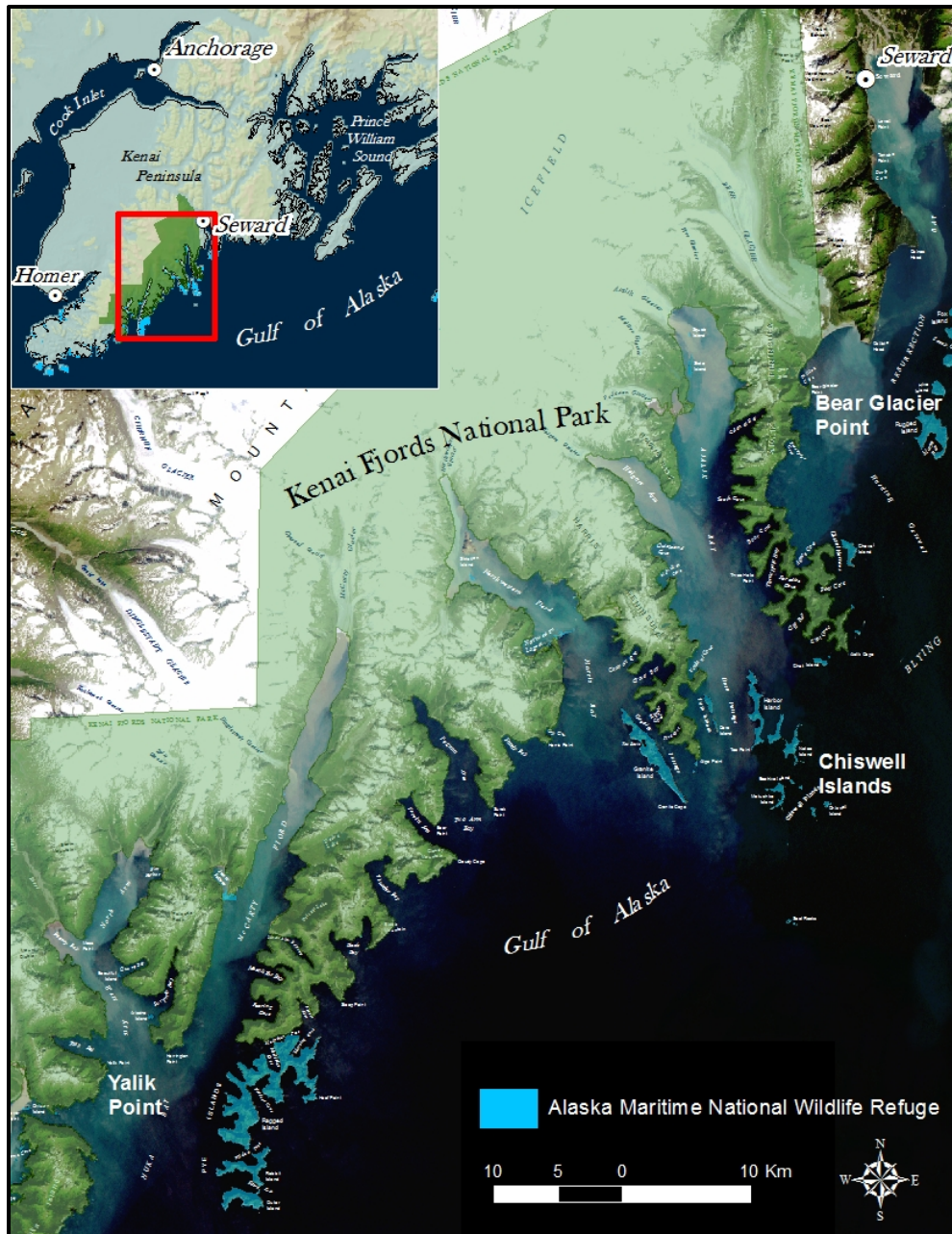


Figure 2. Map of study area in Kenai Fjords National Park and Alaska Maritime National Wildlife Refuge with place names.

Ledge-nesting Seabird Surveys (adapted from Curl 2012)

Sampling Design

The number of birds attending a colony and the location of a colony along the coastline may influence survey results; therefore, we selected glaucous-winged gull colonies using a stratified sampling design by both colony size and location. We categorized colony location into two strata: colonies in the northeast section of the park accessible by a small boat, and colonies in the

southwest section of the park requiring a larger research vessel for access. In the northeast section of the park, we surveyed sites on Notoa Island, Grotto Island, Chat Island, Squab Island, and No Name Island. In the southwest section of the park, we surveyed Yalik Point, Cloudy Cape, Surok Point, and Striation Island.

Colonies were delineated into three size categories: small (2-99 individuals), medium (100-300 individuals), and large (>300 individuals). We based the categorization of colony size on historical colony census data. However, given the large variation in colony size from year to year at most colony sites, we used this stratification as a general guide to help determine what colonies we should target in what areas in the park. Our results are categorized by the colony size (determined by whole colony censuses) for this season (2012). Determination of a “large” colony size was guided by USFWS ledge-nesting seabird protocols which suggest that colonies larger than 300 individuals should be subdivided into plots in order to accurately count birds (USFWS 2000). The other size classifications are based on qualitative observations of what differences in colony size might affect colony function or structure and our ability to accurately conduct counts. The results of counts conducted in 2012 will be used to help determine if there are effects of colony size on counts across all three survey methodologies, and if there are more appropriate colony size strata that we should consider for surveys in 2013.

Table 1. Categorization of seabird colonies surveyed in 2012.

Colony Name	Location	Size
Chat	Northeast	Medium (100-300)
Cloudy	Southwest	Small (<100)
Grotto	Northeast	Medium (100-300)
Notoa	Northeast	Small (<100)
No Name (300 Island)	Northeast	Large (>300)
Squab	Northeast	Large (>300)
Striation	Southwest	Large (>300)
Surok	Southwest	Medium (100-300)
Yalik	Southwest	Medium (100-300)

Survey Schedule

Murphy et al. (1984) documented nest initiation for glaucous-winged gulls as May 21 – June 21, hatch from June 20 – July 16, and fledging from the end of July into the middle of August. Surveys were targeted to occur during the period from late nest initiation throughout hatching, with the goal to survey during the periods with highest breeding adult attendance. We conducted a minimum of seven (for photographic aerial surveys) or nine (for boat-based observer surveys, boat-based photographic surveys, and photographic “ground truth” surveys) and up to twelve replicate surveys of each plot within a few days of each other. We conducted replicate counts between 0800 and 2000 hours to capture the potential variation in colony attendance throughout the day. At a subset of sites (Chat Plot, No Name Plot, Squab Plot 1, Squab Plot 2), we repeated a series of replicate surveys later in the breeding season to account for variation in colony attendance throughout the season.

We conducted boat-based surveys of the northeast sites using a rigid-hull inflatable, the RM Naiad *Auklet*, during the incubation (11 June – 1 July) and hatching/early chick rearing periods (1 – 27 July). We used the M/V *Serac*, a 53' research vessel, to conduct surveys during the late incubation/hatching period for colonies on the southwest side of KEFJ (3 – 11 July). We conducted aerial photographic surveys during two consecutive days in June. Time lapse camera surveys spanned two multiday periods in June and July (Table 2). For boat-based surveys, we alternated replicate counts between two or more sites in close spatial proximity during a single day. We conducted replicate counts a minimum of an hour apart (Christine Hunter, UAF Assistant Professor, personal communication). Following analysis, it may be determined that more or less time is needed between surveys to increase survey independence.

Table 2. Schedule of colony and plot surveys conducted in Kenai Fjords, 2012.

Colony Name	Survey Date	Plot Name	Plot Survey Period
Chat	20 Jun	Chat Plot	19-21 Jun, 18-25 Jul
Cloudy	9 Jul	Cloudy Plot	9-10 Jul
Grotto	26 Jun	Grotto Plot	26 Jun - 4 Jul
Natoa	26 Jun	Natoa Plot	26 Jun - 4 Jul
No Name (300 Island)	20 Jun	No Name Plot	19-21 Jun, 18-25 Jul
Squab	22 Jun	Squab Plot 1	22-24 Jun, 17-24 Jul
Squab	22 Jun	Squab Plot 2	22-24 Jun, 17-24 Jul
Striation	5 Jul	Striaton Plot 1	5-6 Jul
Striation	5 Jul	Striation Plot 2	5-6 Jul
Surok	9 Jul	Surok Plot	9-10 Jul
Yalik	7 Jul	Yalik Plot	7 Jul

Conducting Surveys

Replicate Counts

We surveyed both whole colonies and plots within colonies using replicate counts. We defined a count as the number of adult glaucous-winged gulls present, or attending, a colony or plot. We excluded adults standing in the intertidal zone (defined as anything below the vegetation or storm tide line) and chicks.

Colony

We censused the entirety of each colony once during the season. We conducted a single boat based observer survey and boat based photographic survey of the entire glaucous-winged gull population at each colony. We defined a colony of glaucous-winged gulls as more than one attending adult gull within 100 meters of each other. We did not include in the survey any adult gulls located more than 100 meters away from the colony.

We recorded characteristics of each surveyed colony including cliff aspect, maximum cliff height, approximate percent vegetation cover, cliff substrate, and whether the colony was located on an island or on the mainland. The presence/absence of all seabird species occurring at each glaucous-winged gull colony visited was also recorded and compiled with data from previous surveys in 2011 (Parsons et al. 2012), 2010 (Phillips and McFarland 2012), 2009 (McFarland et al. 2009), 2008 (Hahr 2009), 2007 (Hahr 2008), 1986 (Nishimoto and Rice 1987), and 1976 (Baily 1977) to describe apparent changes in colony size and composition (Appendix A). The data for 2007-2010 are single counts of each colony. The 1986 surveys lumped sections of coastline together as single counts, and the 1976 surveys included counts of birds on the water near the shore as well as burrow surveys for puffins. From these past surveys, we only used counts of observed nests and adults on land for comparisons among years, omitting birds otherwise accounted for in the original reports (Parsons et al. 2012).

Creation of Plots

Within colonies, we selected one to two plots to conduct replicate counts (Figure 3). Creating plots allowed us to subsample part of the colony and made a high number of replicate surveys logistically feasible. Surveying smaller plots increases accuracy of counts by reducing observer error associated with counting large colonies (>300 individuals) and by limiting survey time therefore decreasing the opportunity for individual birds to leave or return to the colony during the count. Plot establishment also benefits photographic surveys where it is necessary to use a high powered zoom lens to distinguish individuals in photos and the photographer may lose their relative place on a large surface. Also, when photographing large colonies, we may not have the ability to achieve clear images on a large scale under inclement environmental conditions.

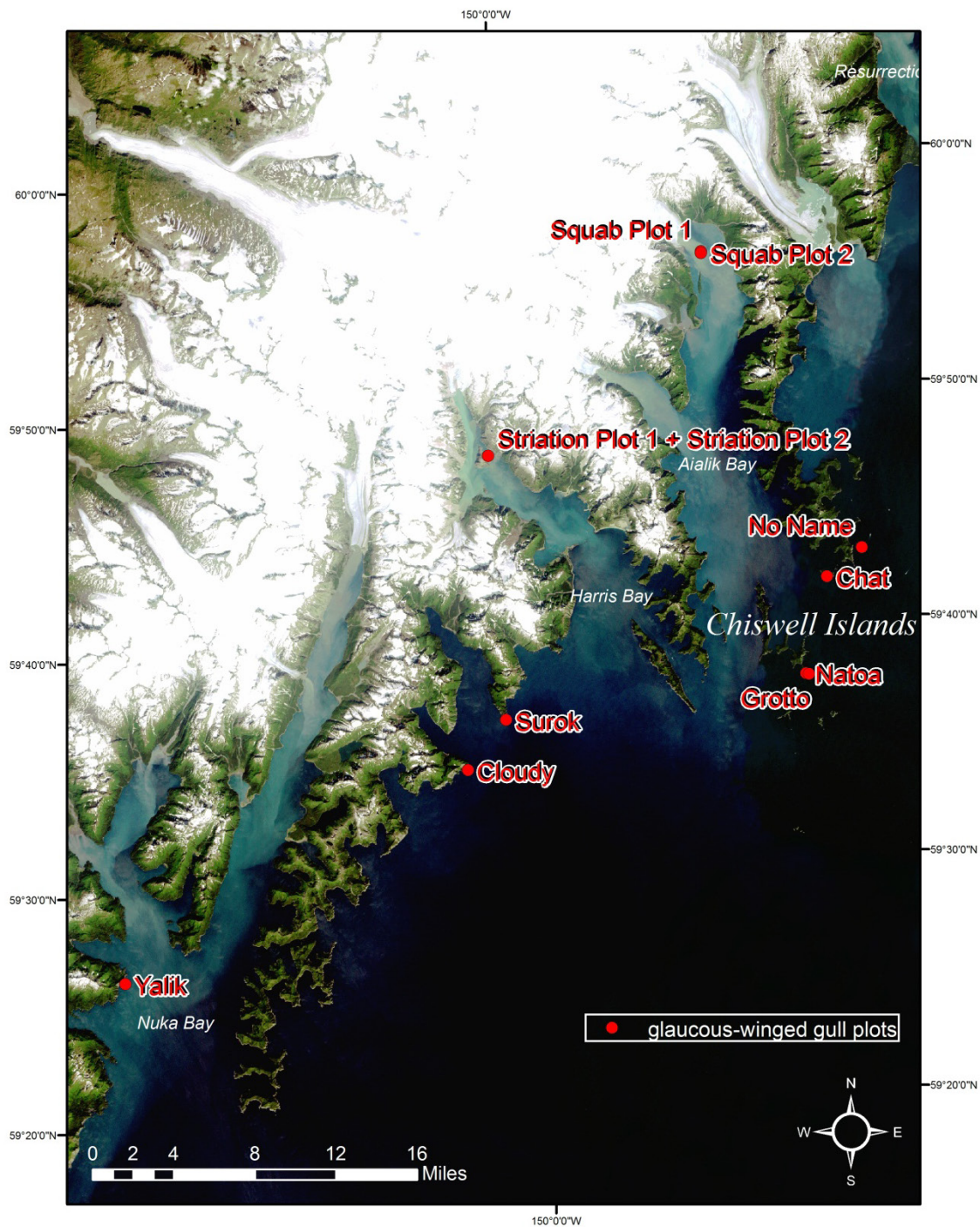


Figure 3. Location of glaucous-winged gull plots surveyed during the summer of 2012 within Kenai Fjords National Park and the Alaska Maritime National Wildlife Refuge, AK.

We created plots that included 30-100 attending adult gulls and had clear physical boundaries (Christine Hunter, UAF Assistant Professor, personal communication). If a colony contained <100 individuals, the entire colony was included within one plot. If a colony contained >100

individuals, we created a plot within the colony. We printed photos of plots and marked plot boundaries for reference. We tried to select plots that were representative of the colony by choosing large spatial areas for plots that encompassed both edges and center of the colony in the same plot, and so that each plot contained more than 10% of the entire colony.

We created and surveyed two plots at Squab and Striation colonies because their geographic isolation from other colonies prevented us from surveying other colonies the same day. Counting two plots at these sites allowed us to maximize the number of plots sampled.

Boat-Based Observer Counts

We positioned the *M/V Serac* or *Auklet* directly in front of a plot at varying distances to the cliff depending on cliff topography and visibility of colonies (Table 4). We measured the distance between the observers and the cliff base beneath the plot with a Bushnell rangefinder and recorded the location with a Garmin GPSmap 76CSx. We conducted each replicate count as close to the same position as possible given the difficulty of navigating to and remaining positioned on an exact waypoint in the open ocean.

Two observers simultaneously but independently counted individual gulls attending the plot using Canon 10x40 image stabilizer binoculars. Observers began counts at the same location within the plot and repeated counts until they obtained counts within 5% of each other (USFWS 2000). We recorded environmental conditions including tide, swell, precipitation, cloud cover, temperature, wind speed, and glare for each count.

Table 4. Distance (m) between base of cliff and survey location for each plot.

Plot Name	Distance (m)
Chat Plot	100
Cloudy Plot	200
Grotto Plot	150
Natoa Plot	150
No Name Plot	150
Squab Plot 1	100
Squab Plot 2	150
Striaton Plot 1	225
Striation Plot 2	225
Surok Plot	300
Yalik Plot	200

Boat-Based Photographic

We conducted boat-based photographic surveys immediately after boat-based observer counts. We photographed plots from the same vantage point where the counts were conducted. The resolution of images was 21.1 megapixels and the magnification varied according our distance

from the cliff, cliff height, and other physical obstacles that determined the position of our vantage point.

Photographic “Ground Truth”

We conducted a photographic “ground truth” survey after each boat based photographic survey. Unlike photographs used to conduct survey counts, for a “ground truth” survey we took a series of photographs with angles and zooms that varied for each plot, ranging 100 to 300 millimeters based on distance from and size of the plots. We conducted photographic “ground truth” surveys to obtain the best estimate of the total number of adult gulls attending a plot at that particular moment in time. These “ground truth” surveys are our best known assessment of total plot attendance, and we will determine the accuracy of the boat-based observer surveys and boat-based photographic surveys using our photographic “ground truth” survey results.

This is not a true ground truth survey because we cannot physically access and move across the ground of these steep and often vertical cliffs along a rugged coastline. Photographing a plot extensively will not allow us to confirm every adult gull in attendance within a plot at a given moment. Adult gulls may not be detected in “ground truth” photographs because they are hidden in vegetation, and adult gulls frequently leave and arrive at a plot, even during the brief time between a count and photograph, or between the survey photograph and ground truth effort. Therefore, “ground truth” surveys are not a truly accurate basis on which to assess the accuracy of our other survey methods, but will give us a reference as to how many individuals we are missing in counting from a single photograph.

Aerial Photographic

We surveyed plots from a Bell 206-B3 helicopter chartered with Pathfinder Aviation in Homer, Alaska, on June 29 - 30. We selected plots in the northeast section of the study area to minimize flight time from Seward and maximize sampling effort. We photographed Chat Plot, No Name Plot, Squab Plot 1, Squab Plot 2, Natoa Plot, and Grotto Plot at an average height of 800 feet above sea level. The pilot removed the front passenger side door and rear passenger side door to allow both passengers room to maneuver the camera without the obstruction of windows. Photographers took photos at each site using a range of exposures to ensure that, in various light conditions, individual adult glaucous-winged gulls can be clearly identified. A series of photographs were taken at each plot from a single vantage point. Seven replicates were conducted at each site during six hours of survey flight time. Each replicate of colony surveys took between 40 and 65 minutes each to complete and depended on flight speed in between colonies, flight height, and wind speed/direction. We prioritized completing a high number of replicate surveys given financial constraints. We scheduled flights on two days [3.5 hours the afternoon of June 29 (2:30-6:00pm) and 3.5 hours the morning of June 30 (9am-12:30pm)] to cover as wide of a range of times of day for surveys as possible. These surveys were an initial investigation into the feasibility of using aerial photographs for seabird monitoring surveys, and we hope to continue and expand aerial surveys in 2013, funding dependent.

Camera Settings and Image Analysis

We used the same camera and similar settings for all photographic surveys except the time lapse camera and will use similar image processing techniques on all digital photos. We used a Canon 5D Mark II digital SLR camera and a Canon Ultrasonic 100 to 400 millimeter Image Stabilized lens. We set the camera aperture between 4.0 and 5.0; slow enough to provide the image clarity

necessary to accurately identify individual adult gulls in photographs but fast enough to compensate for motion on boats and helicopters. Under particularly bright or dark light conditions, we took multiple exposures with different shutter speeds to ensure individual adult gulls are distinguishable in photographs of all areas of the plot. We will post process the photographs at a later date by stitching images together, adjusting image quality, and counting individual adult gulls. We anticipate testing different software to conduct this work including Adobe Photoshop, ESRI ArcGIS, and HugIn. We will count individuals from photographs by marking adult gulls digitally, printing photos, or projecting photos onto a mark-able surface and circling individuals. As image quality is directly affected by focal length, aperture, shutter speed, glare, number of photos stitched together, number of exposures, and image resolution, we will record this information for each survey replicate and develop an image processing protocol.

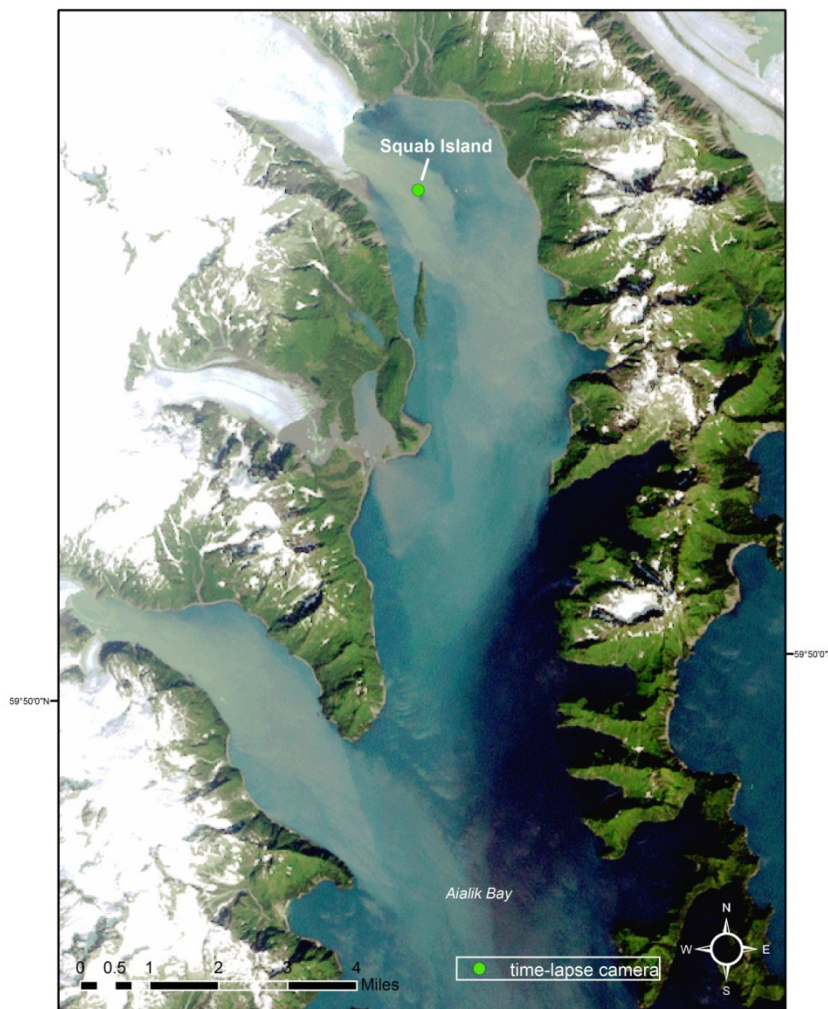


Figure 4. Location of time lapse camera deployment on Squab Island (AMNWR), June 20 - 26 and July 17 - 23, 2012.

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

Time Lapse Camera

We deployed a Canon EOS Rebel XS with a Canon EF-S 18 to 55 millimeter zoom lens contained in a Harbortronics, Inc. housing unit, at Squab Island to observe patterns in the attendance of adult glaucous-winged gulls at a single plot (Figure 4). The time-lapse plot is in addition to the two plots already established on Squab Island for the population surveys. We deployed the camera June 20 – 26 and June 17 - July 23 when logistics and weather conditions allowed. We programmed the camera with a DigiSnap device by Harbortronics Inc. to take images every 15 minutes, 24 hours per day (439 photos). We will post-process images using methods similar to survey photographs.

Song Meter

We initiated a pilot study to determine how, when, and where to deploy a passive

(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, Figure 5).

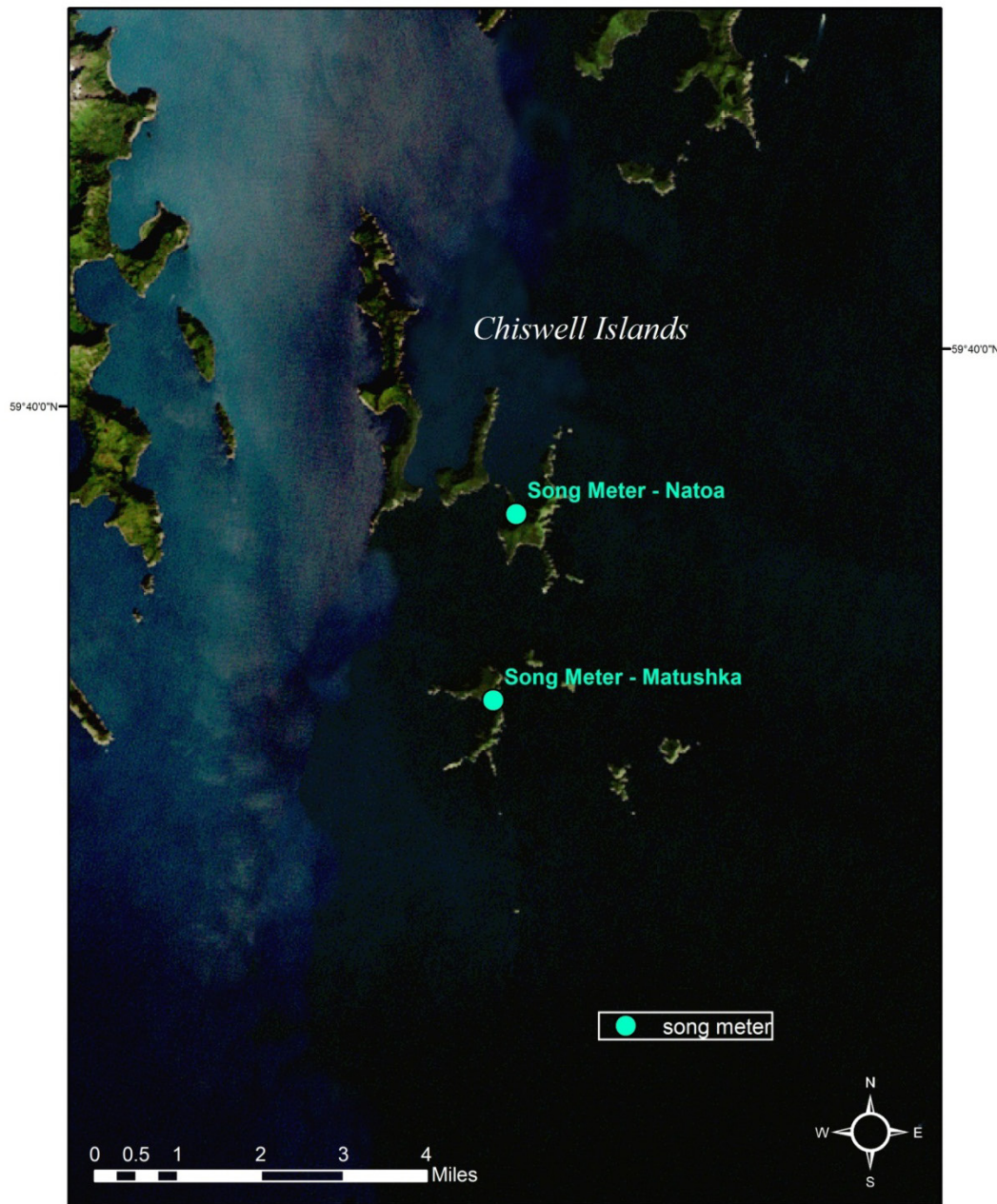


Figure 5. Locations of Song Meter deployment during the summer of 2012 in the Chiswell Islands, AK

At each location we mounted the Song Meter on small sturdy trees located among the highest concentration of accessible burrows we found on each island. Prior to mounting the meter, we taped closed all unused exterior connections. We attached the meter to a tree using wire and zip ties. We installed the meter at the northwest end of Notoa Island on 3 July for one night. We

programmed the meter to record continuously for six hours from approximately two hours before sunset to two hours after sunrise (21:30 to 03:30). The meter recorded the greatest number of nocturnal seabird calls during the middle of the night and recorded only diurnal species before sunset and after sunrise. Accordingly, we modified the scheduled recording on Matushka Island. We programmed the meter to run continuously for eleven hours from approximately one hour before sunset to one hour after sunrise (20:45 to 07:45) during the evenings of August 14 – 23.

We reviewed the Song Meter recordings using Raven Lite software. We listened to the entire recording from Notoa Island, and then listened to the entire first night of the recording from Matushka Island. For the remainder of the recordings from Matushka Island, we listened to two 15 minute on/off cycle segments for every recorded hour following the methods of Buxton and Jones (2012). For each location we noted the presence of each seabird species heard. We did not quantify calls or individuals.

Black-legged Kittiwake Plots

We conducted a single survey of historic black-legged kittiwake plots in the Chiswell Islands on July 18. AMNWR established the plots in 1992 (Figure 6). Two observers simultaneously counted individuals and nests within plot boundaries from the RM Naiad *Auklet*, a 16' rigid hull inflatable boat. The observers independently counted individual birds attending a colony 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 Rebel XS and a Canon EF-S 18-55 millimeter zoom lens, and 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 2012 to surveys conducted in 1992, 2008, and 2011. Summary statistics compare average counts from three replicates in 1993, one replicate in 2008, ten replicates in 2011, and one replicate in 2012.

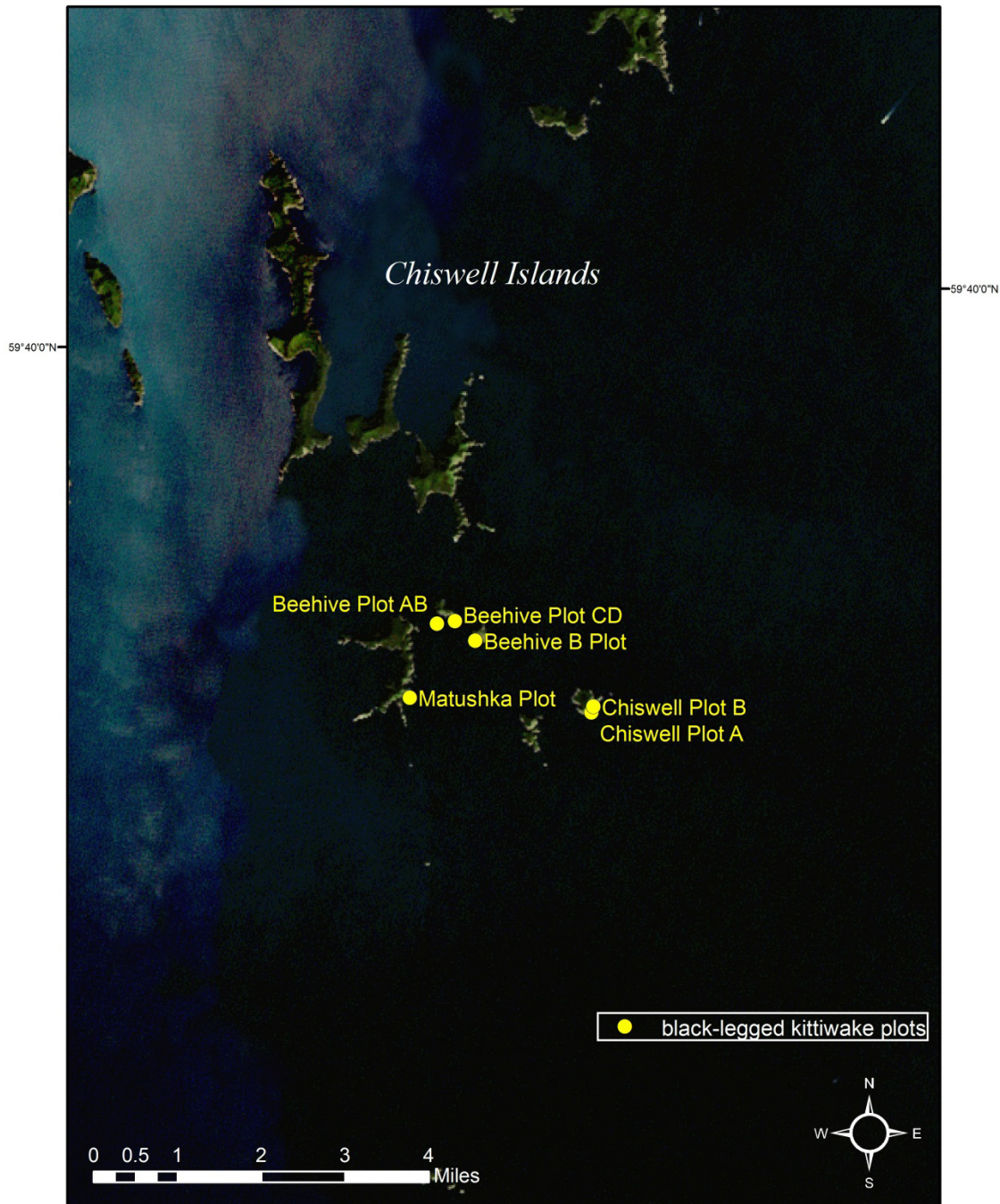


Figure 6. Location of black-legged kittiwake plots surveyed during the summer of 2012 in the Chiswell Islands, AK.

Permits and Archiving

All related materials will be permanently housed in the KEFJ museum and archive collection under accession number KEFJ-00269.

Results

Ledge-nesting Seabird Surveys

Colony Replicates

The presence of all seabird species was recorded and compiled with data from previous surveys in Appendix A. Because we conducted surveys targeted at establishing protocols for ledge nesting species and focused specifically on a single species, glaucous-winged gulls, we did not survey as many locations as we did in 2011.

The number of glaucous-winged gulls attending colonies varied from 71 at Nattoa to 410 at Striation (Table 5). The number of glaucous-winged gulls counted at colonies in 2012 was lower than previous counts in 2011 and 2010 (Figures 7-8). These results are apparently counter to the previous increase in the number of gulls recorded at colonies since the 1976 and 1986 surveys.

Table 5. Number of glaucous-winged gulls counted at colonies in the Kenai Fjords area, 2012. Numbers are an average of one simultaneous count conducted by two observers in which the observers obtained counts within 5% of each other.

Colony Name	Count
Chat	205.5
Cloudy	86.5
Grotto	183
Nattoa	71
No Name (300 Island)	403
Squab	301
Striation	410
Surok	242
Yalik	156

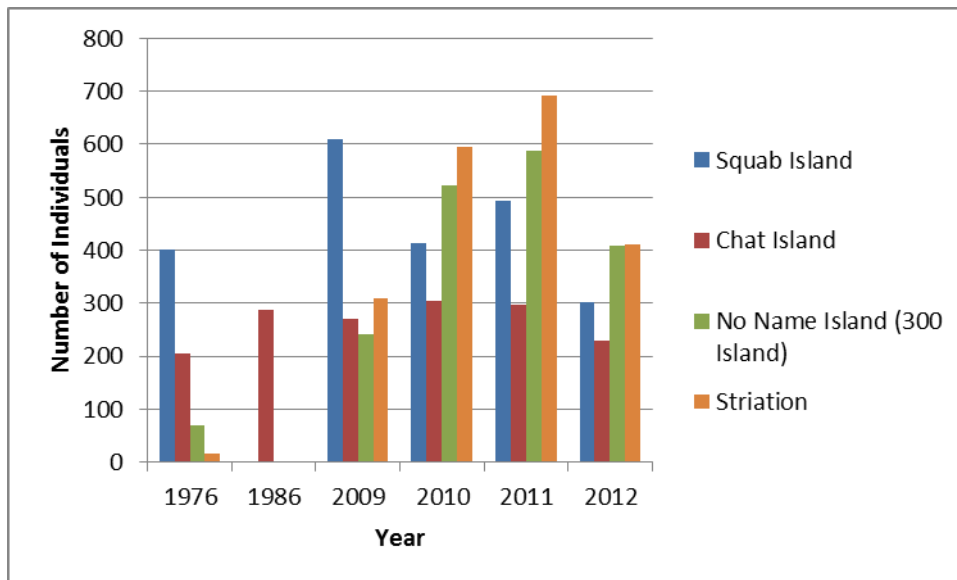


Figure 7. Observed number of breeding of glaucous-winged gulls at five colonies in AMNWR for five years of count data. All counts are from single visits.

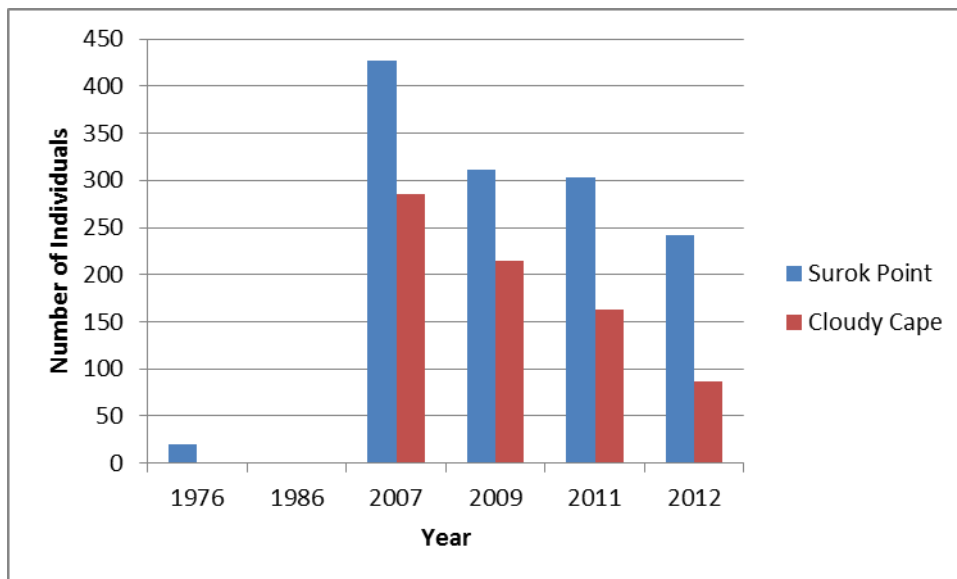


Figure 8. Observed breeding population of glaucous-winged gulls at two colonies in KEFJ for six years of count data. Counts for 1976-2009, 2012 are from single visits. In 2011 counts are an average from multiple visits: Cloudy Cape nine times and Surok Point four times.

Plot Replicates

Counts of plots varied from 28.6 individual glaucous-winged gulls at Chat Plot to 80.3 adult gulls at Squab Plot 1 (Table 6).

Table 6. Average number of glaucous-winged gulls counted in plots in the Kenai Fjords area, 2012. Averages are presented with standard deviation (SD) and number of replicates (in parentheses).

Plot Name	June	July
	Average, SD (n)	
Chat Plot	38.1, 9.4 (10)	54.8, 12.5 (8)
Cloudy Plot		79.7, 46.6 (9)
Grotto Plot	66, 20.9 (9)	
Natoa Plot	63.2, 11.7 (10)	
No Name Plot	50.6, 19.4 (8)	94.5, 23.8 (8)
Squab Plot 1	110.2, 25.3 (11)	136.6, 50.52 (9)
Squab Plot 2	115.9, 27.9 (11)	104.1, 46.8 (9)
Striaton Plot 1		88.8, 28.4 (9)
Striation Plot 2		63.4, 25.6 (9)
Surok Plot		58.7, 14.0 (9)
Yalik Plot		74.7, 54.0 (9)

Song Meter

On Natoa Island we identified the calls of fork-tailed storm petrels. On Matushka Island we identified the calls of fork-tailed storm-petrels and rhinoceros auklets.

Black-legged Kittiwake Plots

In 2012, our single survey of black-legged kittiwake plots showed the highest record of adult attendance for all locations except one. Conversely, the number of kittiwake nests in 2012 is among the lowest on record (Figure 9). We observed chicks in a small number of nests during our survey.

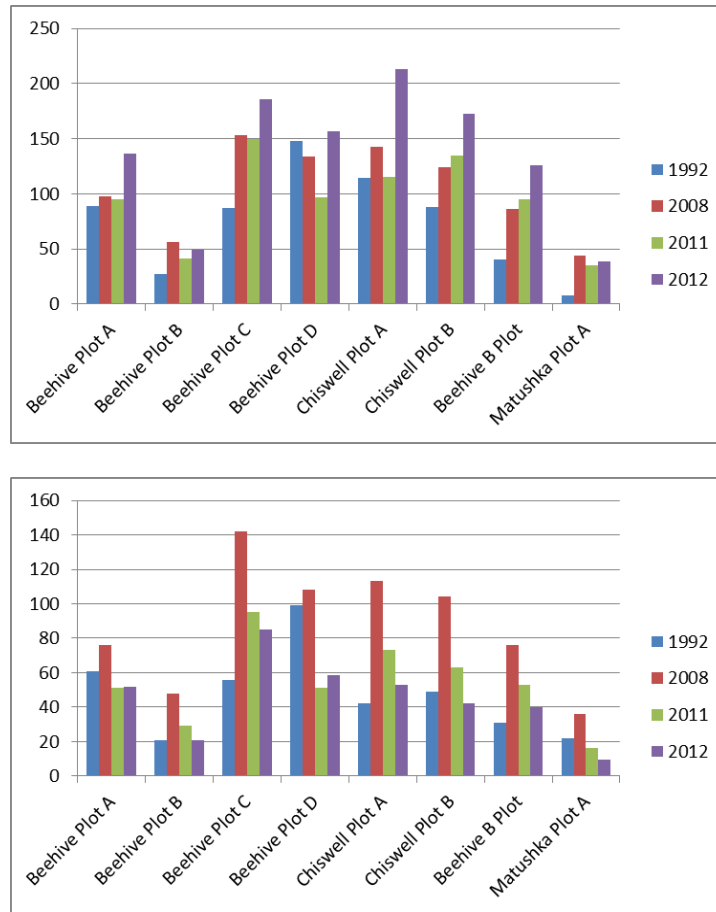


Figure 9. Total number of adult black-legged kittiwakes (bottom) and nests (top) for eight historic plots in the Chiswell Islands, AK. Data from 1992 are of the average counts from three visits, data from 2008 is of a count from a single visit, data from 2011 is of the average count from ten visits, and data from 2012 is of the average of a double observer count from a single visit.

Discussion

Conducting field work in KEFJ presents a number of logistical challenges we must consider for future surveys. The timing of our boat-based replicates throughout the season was greatly influenced by availability of the *M/V Serac* and unpredictable and inclement weather. We had to shorten trips due to rough seas, and could not use binoculars and cameras during periods of moderate to severe rain as the raindrops quickly covered the lenses and obstructed our view. Birds of prey flush seabirds off colonies and plots during surveys, and we must determine a way to account for or work around these events.

The relative number of glaucous-winged gulls in Kenai Fjords has apparently increased between 1976 and 2007 but has remained 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).

The Chiswell Islands have historically been a location of high seabird breeding productivity. In 1976, Bailey observed the presence of fork-tailed storm-petrels on Notoa Island, and that same year he observed fork-tailed storm-petrels and rhinoceros auklets on Matushka Island. Decades later we detected the presence of these same species on the same islands, and this is consistent with the high site fidelity exhibited by nocturnal burrow nesting seabirds (Rachel Buxton, pers comm.).

After pilot testing the song meter this year, we will expand nocturnal acoustic monitoring temporally and spatially in 2013. We will deploy the meters earlier during the summer breeding season based on expected arrival dates of nocturnal seabird species to the study area. We will record at optimal periods during the night, according to additional research on nocturnal acoustics monitoring and on target species' phenology. Improvements may include using larger capacity batteries, using larger memory cards, 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 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.

It is uncertain how the timing of our single set of black-legged kittiwake surveys reflects on the true number of nests for the season. Therefore, we cannot draw any conclusions when we compare this set of surveys to previous years in terms of the relatively high number of individuals and relatively low number of nests. We will continue to collaborate with AMNWR and monitor historic black-legged kittiwake plots during 2013.

Based on future analysis of our 2012 plot data, we will refine our ledge-nesting survey methods for the final field season of this study in 2013.

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Appendix A: Summary Tables

Table 1. 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. * 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
35 Point								
Glaucous-winged gull	30	-	95	*	90	*	33	*
Red-faced cormorant	10	-	-	*	-	*	27	*
<i>Nests</i>	-	-	-	*	-	*	2	*
Double-crested cormorant	-	12	5	*	-	*	-	*
<i>Nests</i>	-	3	-	*	-	*	-	*
Pelagic cormorant	-	25	-	*	1	*	1	*
<i>Nests</i>	-	1	-	*	-	*	0	*
Cormorant sp.	-	-	-	*	-	*	-	*
<i>Nests</i>	-	-	10	*	-	*	-	*
Harrington Point								
Glaucous-winged gull	-	-	166	*	1	*	-	*
Red-faced cormorant	-	29	-	*	-	*	-	*
<i>Nests</i>	-	21	-	*	-	*	-	*
Double-crested cormorant	-	-	18	*	-	*	-	*
<i>Nests</i>	-	-	5	*	-	*	-	*
Pelagic cormorant	-	12	-	*	-	*	-	*
<i>Nests</i>	-	17	-	*	-	*	-	*
Horned puffin	10	-	-	*	-	*	-	*
Harrington Point West								
Glaucous-winged gull	-	85	-	*	4	*	50	*
Red-faced cormorant	-	-	-	*	-	*	5	*
<i>Nests</i>	-	-	-	*	-	*	0	*
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, 1976-2012.
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
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	*
Red-faced cormorant	-	-	-	*	-	*	19 ¹	*
<i>Nests</i>	-	-	-	*	-	*	0 ¹	*
Double-crested cormorants	-	-	-	*	1	*	-	*
Pelagic cormorants	40	46	-	*	27	*	11 ¹	*
<i>Nests</i>	-	2	-	*	12	*	6 ¹	*
Tufted puffin	-	*	-	*	11	*	-	*
Cormorant Spp	-	-	-	*	-	-	8 ¹	*
<i>Nests</i>	-	-	-	*	-	-	5 ¹	*
Black Bay								
Glaucous-winged gull	-	-	-	*	91	*	237 ²	*
Red-faced cormorant	-	-	-	*	14	*	4 ²	*
<i>Nests</i>	-	-	-	*	11	*	0 ²	*
Double-crested cormorant	-	-	20	*	69	*	-	*
<i>Nests</i>	-	-	12	*	42	*	-	*
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, 1976-2012.
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
Thunder Bay East B								
Pelagic Cormorant	*	*	*	*	*	*	2	*
<i>Nests</i>	*	*	*	*	*	*	2	*
Nack Triangle								
Glaucous-winged gull	-	-	-	*	11	*	-	*
Red-faced cormorant	40	-	-	*	3	*	9	*
<i>Nests</i>	*	-	-	*	*	*	0	*
Black-legged kittiwake	-	-	-	*	-	*	0	*
<i>Nests</i>	-	62	-	*	-	*	0	*
Pelagic cormorant	20	-	-	*	-	*	23	*
<i>Nests</i>	*	-	-	*	-	*	9	*
Nack Triangle B								
Pelagic cormorant	*	*	*	*	*	*	11	*
<i>Nests</i>	*	*	*	*	*	*	9	*
Cloudy Cape								
Glaucous-winged gull	-	-	285	*	215 ³	*	163 ⁴	86.5
Black-legged kittiwake	-	22	-	*	-	*	-	*
Red-faced cormorant	-	-	-	*	2 ³	*	-	*
Double-crested cormorant	-	-	40	*	35 ³	*	-	*
<i>Nests</i>	-	-	27	*	26 ³	*	-	*
Pelagic cormorant	-	-	-	*	70 ³	*	1 ²	*
<i>Nests</i>	-	-	-	*	24 ³	*	1 ²	*
Cormorant <i>sp.</i>	-	-	-	*	-	*	-	*
<i>Nests</i>	-	-	-	*	7 ³	*	-	*
Horned puffin	-	-	-	*	2 ³	*	5	present
Tufted puffin	-	-	-	*	7 ³	*	9	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
Cloudy B								
Glaucous-winged gull	*	*	*	*	215 ³	*	-	*
Red-faced cormorant	*	*	*	*	2 ³	*	-	*
Double-crested cormorant	*	*	*	*	35 ³	*	23 ⁴	*
<i>Nests</i>	*	*	*	*	26 ³	*	21 ⁴	*
Pelagic cormorant	*	*	*	*	70 ³	*	5 ⁵	*
<i>Nests</i>	*	*	*	*	24 ³	*	5 ⁵	*
Cormorant <i>sp.</i>	*	*	*	*	-	*	-	*
<i>Nests</i>	*	*	*	*	7 ³	*	-	*
Horned puffin	*	*	*	*	2 ³	*	-	*
Tufted puffin	*	*	*	*	7 ³	*	3 ¹	*
Surok Point								
Glaucous-winged gulls	20	-	427	*	311	*	303 ⁶	242
Red-faced cormorant	-	-	-	*	2	*	2	-
<i>Nests</i>	-	-	-	*	1	*	-	-
Double-crested cormorant	-	-	9	*	27	*	2 ⁶	-
<i>Nests</i>	-	-	9	*	6	*	1 ⁶	-
Pelagic cormorant	140	1	33	*	72	*	3 ⁶	present
<i>Nests</i>	-	1	33	*	55	*	2 ⁶	*
Tufted puffin	-	-	-	*	15	*	5	present
Horned puffin	-	-	-	*	4	*	4 ¹	present
Surok B								
Pelagic cormorant	*	*	*	*	*	*	5	*
<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
NW Glacier (Striation)								
Glaucous-winged gulls	*	*	*	*	*	82	180	410
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	*	-	*
Cormorant sp.	-	8 ⁷	-	-	2	-	-	*
Nests	-	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, 1976-2012.
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
Porcupine Cove								
Horned puffin	*	*	*	*	*	*	8	*
Spire Cove C								
Horned puffin	*	*	*	*	*	*	5	*
Spire Cove B								
Horned puffin	*	*	*	*	*	*	3	*
Spire Cove								
Red-faced Cormorant	-	-	-	*	-	-	3 ⁸	*
<i>Nests</i>	-	-	-	*	-	-	1 ⁸	*
Pelagic cormorant	-	-	-	*	11	-	10 ⁸	*
<i>Nests</i>	-	-	-	*	2	-	6 ⁸	*
Cormorant sp.	-	-	-	*	-	15	-	*
<i>Nests</i>	-	-	-	*	-	*	-	*
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	-	*	-	*
<i>Nests</i>	-	-	-	(8 chicks)	-	*	-	*
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, 1976-2012.
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
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, 1976-2012. 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
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	*
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, 1976-2012. Colony survey locations are listed west to east, from Nuka Bay to Resurrection Bay.
(continued)

Colony/Spp	1976	1986	2007	2009	2010	2011	2012
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							
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, 1976-2012. Colony survey locations are listed west to east, from Nuka Bay to Resurrection Bay.
(continued)

Colony/Spp	1976	1986	2007	2009	2010	2011	2012
28 Section West							
Cormorant sp.	*	*	*	*	*	19	*
Nests	*	*	*	*	*	4	*
NW Glacier Island (Striation)							
Glaucous-winged gulls	16	-	-	309	594	410	*
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	*	-	*	*	*
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, 1976-2012. Colony survey locations are listed west to east, from Nuka Bay to Resurrection Bay.
(continued)

Colony/Spp	1976	1986	2007	2009	2010	2011	2012
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
Abra							
Mew Gull	*	*	*	*	*	16	*
<i>Nests</i>	*	*	*	*	*	5	*
Chat Island							
Glaucous-winged gull	205	286	*	270	303	298	205.5
Red-faced cormorant	34	-	*	-	-	*	-
Double-crested cormorant	-	17	*	9	-	*	-
<i>Nests</i>	-	-	*	4	-	*	-
Pelagic cormorant	43	7	*	24	-	present	present
<i>Nests</i>	-	1	*	4	-	present	*
Cormorant sp.	-	1	*	-	29	present	-
<i>Nests</i>	-	-	*	2	-	present	-
Horned puffin	80	76	*	24	17	present	present
Tufted puffin	30	70	*	2	29	*	-
Common murre	80	14	*	6	-	present	present

Table 12. Species composition and count at seabird colonies in AMNWR 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	2009	2010	2011	2012
Chicken Pass							
Glaucous-winged gull	*	*	*	*	*	22	*
300 Island (No Name)							
Glaucous-winged gull	70	-	*	242	522	588	403
Red-faced cormorant	-	74 ¹	*	16	-	*	present
Nests	-	43 ¹	*	7	-	*	*
Pelagic cormorant	-	63 ¹	*	36	14	*	-
Nests	-	23 ¹	*	14	*	*	-
Cormorant sp.	-	8 ¹	*	-	17	*	-
Nests	-	12 ¹	*	1	*	*	-
Horned puffin	60	-	*	13	12	*	-
Tufted puffin	500	-	*	51	80	present	present
Common murre	-	-	*	13	-	*	present ²
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
Red-faced cormorant	100	-	*	3	-	*	present
Nests	-	-	*	2	-	*	*
Double-crested cormorant	36	-	*	18	3	*	-
Nests	-	-	*	4	-	*	-
Pelagic cormorant	20	-	*	31	17	*	present
Nests	-	-	*	11	-	*	-
Cormorant sp.	-	7	*	1	-	*	-
Nests	-	-	*	20	-	*	-
Horned puffin	210	-	*	58	59	present	present
Tufted puffin	140	-	*	32	8	*	present
Common murre	-	-	*	4	1	*	-

Table 13. Species composition and count at seabird colonies in AMNWR 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	2009	2010	2011	2012
Lone Rock							
Northern Fulmar	40	30	*	*	-	*	*
Glaucous-winged gull	24	50	*	*	-	*	*
Horned puffin	40	2	*	*	-	*	*
Tufted puffin	80	20	*	*	-	*	*
Natoa							
Glaucous-winged gull	*	*	*	*	*	*	71
Horned puffin	*	*	*	*	*	*	present
Tufted puffin	*	*	*	*	*	*	present
Grotto							
Glaucous-winged gull	*	*	*	*	*	*	183
Horned puffin	*	*	*	*	*	*	present
Tufted puffin	*	*	*	*	*	*	present
Black-legged kittiwake	*	*	*	*	*	*	present
Common murre	*	*	*	*	*	*	present

¹ Average of counts from two visits

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