

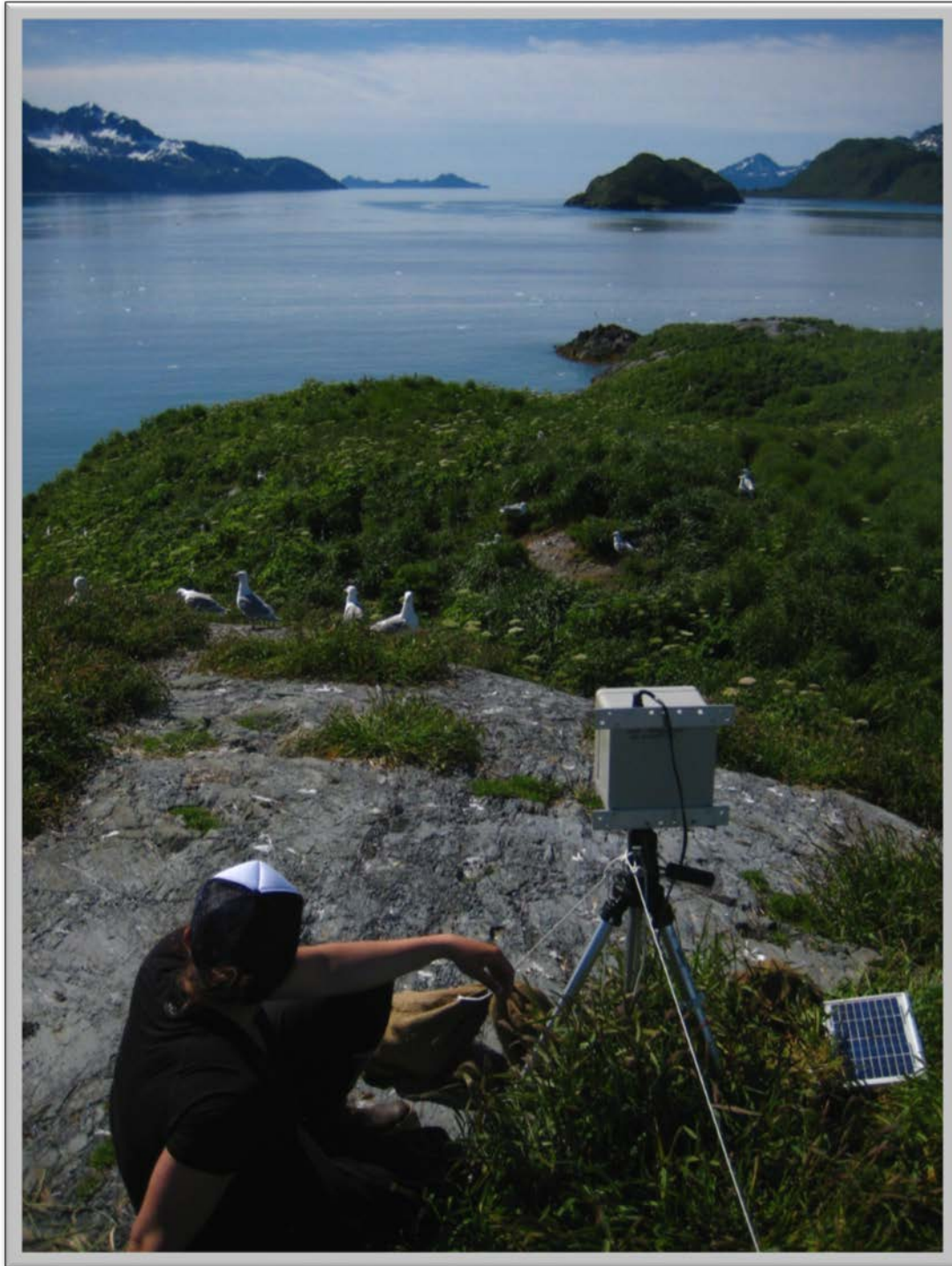


# **Monitoring for Trends in the Distribution and Abundance of Colonial Nesting Seabird Populations on the Kenai Fjords Coast**

## *Final Project Completion Report*

Natural Resource Data Series NPS/KEFJ/NRDS—2014/734





**ON THIS PAGE**

Field researchers set up time-lapse cameras on Squab Island.  
Photograph by: Elisa Weiss, NPS.

**ON THE COVER**

A researcher counts seabirds from a boat in Kenai Fjords.  
Photograph courtesy of KEFJ, NPS.

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## *Final Project Completion Report*

Natural Resource Data Series NPS/KEFJ/NRDS—2014/734

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Fort Collins, Colorado

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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 2011, we conducted shoreline surveys of the KEFJ coast to identify new seabird colonies and performed whole colony counts of most historic colonies. In 2012-2013, we tested three methods for surveying colonial seabird breeding populations using glaucous-winged gull (*Larus glaucescens*) as a focal species. We collected data to compare methods using boat-based observer counts, boat-based photographic surveys, and aerial photographic surveys. Data from these surveys will be analyzed winter/spring 2015 to determine the most accurate, feasible, and cost-effective methodology for long term monitoring.



**Photo 1.** Seabirds fly through the fog over the Cheval Island seabird colony. NPS Photo/J. Curl

## Acknowledgments

We would like to thank the many people that have made this a successful and safe project since 2011. Monika Parsons, Nicole Dewberry, Leslie Adams and Elisa Weiss assisted with data collection and annual report writing. For logistical support on the coast, we thank the crew of the M/V *Serac*, Jamie Thompson, Marybeth Phillis, Melissa Knight, Luke Robert, and Jason Flowers, as well as, Mark Kansteiner, Jeff Carpenetti, Travis Fulton, Mark Giddens, Sarah Cowell, Sam Stark and Brian Robinson. We would also like to thank Christine Hunter, Mark Lindberg, Christa Mulder, Josh Schmidt, Heather Renner, Leslie Slater, Fritz Klasner, Heather Coletti and Sharon Kim 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).

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 special 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).

Marine birds are specifically mentioned in Kenai Fjord National Park (KEFJ) enabling legislation as a resource the National Park Service (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. Geological 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 murrelet (*Brachyramphus brevirostris*) and marbled murrelet (*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 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 islands. The primary objective of this ongoing study is to produce statistically valid protocols for long-term monitoring of colonial seabirds in the park.

### Seabird Surveys in KEFJ

#### 1976-2010

Historically, seabird colonies in Kenai Fjords had 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, the 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).

### **2011-2013**

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.

In 2012, UAF cooperators developed a research proposal around a single species (glaucous-winged gulls) to test basic methods for developing long term monitoring protocols (Curl 2012). 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 2012-2013 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 effects 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 this report, we detail methods and summarize results used during the 3 years of field work on this project. We will describe our accomplishments, lessons learned and conclusions at this point in the project, as well as detail the final budget.

# 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 km<sup>2</sup> 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 800 km of coastline (ANILCA 1980). KEFJ administers approximately 2,450 km<sup>2</sup>; its boundaries include an additional 225 km<sup>2</sup> managed by in-holders. The park boundary does not extend to offshore islands which are managed by AMNWR.

AMNWR encompasses almost 20,000 km<sup>2</sup> 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).

## Coastline Survey

In 2011, we conducted coastline surveys from Yalik Point to Bear Glacier Point to inventory the current location and distribution of colonies within KEFJ. We surveyed the mainland shoreline for seabird colonies from the flying bridge of the 53' M/V Serac, from the 19' ridged hulled inflatable "Auklet", or from a 14' inflatable zodiac. Nearshore islands were surveyed opportunistically, usually in locations where historic colonies were documented. See Parsons et al. (2012) for detailed methods.

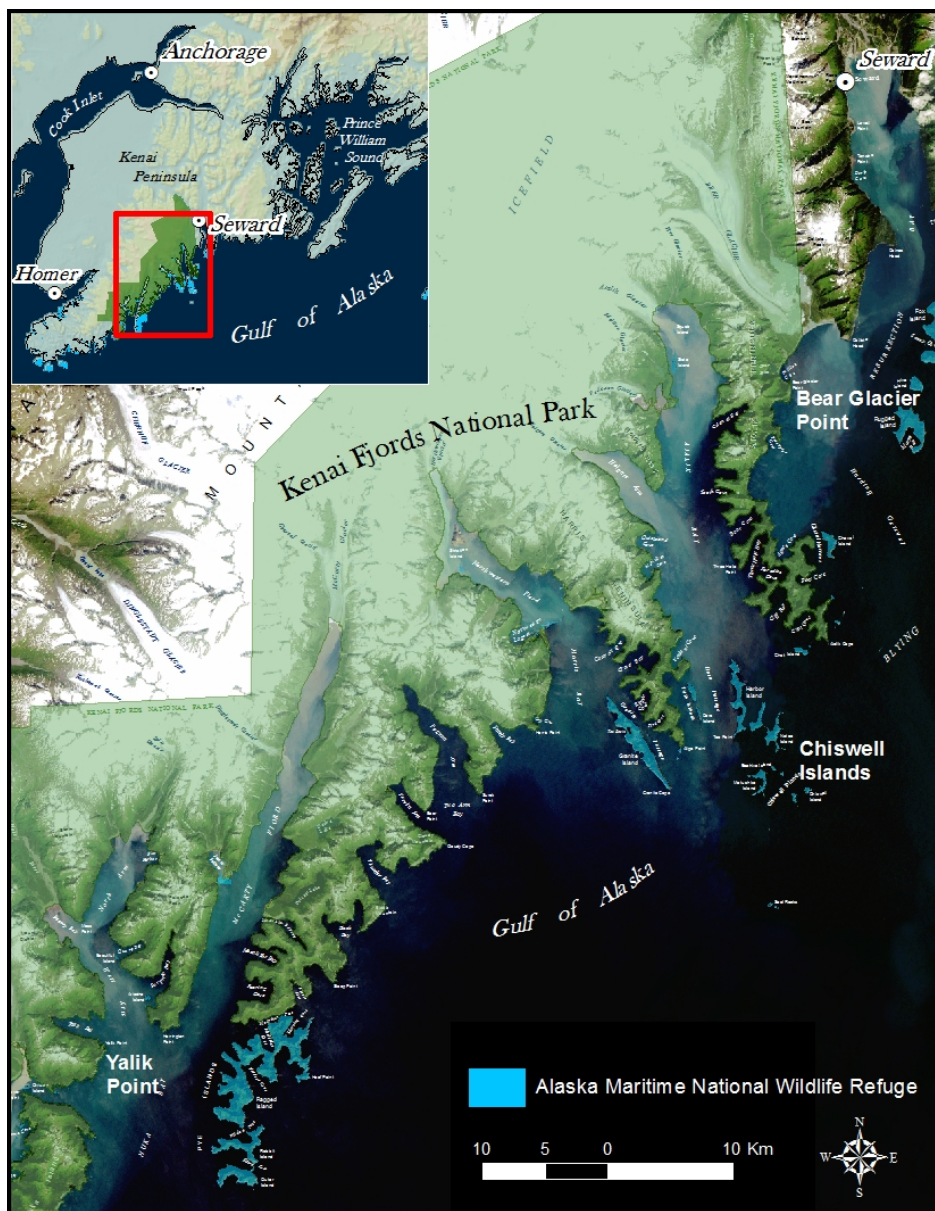


**Figure 1.** Map of study area in Kenai Fjords National Park and Alaska Maritime National Wildlife Refuge with study site place names.

## Colony Counts

### 2011

In 2011, we conducted whole colony counts of known colonies identified from the USFWS Seabird Colony Database, surveys conducted in the Kenai Fjords area between 1976 and 2010, and colonies identified during shoreline surveys. For each survey, we considered all adults of every species present within the colony area to be attending the colony. For black-legged kittiwakes and all cormorant species, we also counted nests with an attending adult or chick. When a break of more than 100 meters occurred between neighboring birds, we designated a new colony location and counted the adjacent colony separately. We conducted replicate counts of adults and nests at colonies on separate days, generally following the protocols outlined in the USFWS protocols for population

inventories of ledge-nesting seabirds (USFWS 2000). For abundant species (glaucous-winged gulls, cormorant species, and common murre) two observers independently counted individuals attending a colony during each visit and repeated counts until they obtained counts within 10% of each other.

We found that black-legged kittiwake, common murre, glaucous-winged gull and double-crested, red-faced and pelagic cormorant colonies were very large in some areas making counting the entire colony prohibitively time consuming. Due to logistical constraints associated with visiting remote colonies, we designated subsets of colonies as plots according to protocols outlined by the USFWS (2000) to facilitate long term population monitoring. See Parsons et al. (2012) for detailed methods.



**Photo 2.** Glaucous-winged gulls were selected as a focal species for comparing potential monitoring methods. NPS Photo/K. Thoresen

## **2012**

In 2012, we surveyed both whole colonies and plots within colonies using replicate counts. We surveyed a sample of 9 colonies in the Kenai Fjords area. 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 to survey using a stratified sampling design by both colony size and location.

We conducted a single boat based observer survey and boat based photographic survey of the entire glaucous-winged gull population at each colony. Within colonies, we selected one to two plots to conduct surveys using three different methods: boat-based observer counts, boat-based photography, and aerial photography. Creating plots allowed us to subsample part of the colony and made a high number of replicate surveys logistically feasible. Plot establishment also benefited photographic surveys where it was 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. “Ground-truthing” photos were taken of each plot. This series of photos will be used as a remote sensing method to compare observer counts and counts made from survey photographs. We also 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. Squab is a large colony (>300 birds) and the only land-accessible colony in the park. See Dewberry et al. (2013) for detailed methods.

## **2013**

In 2013, we selected 11 colonies to survey using a stratified sampling design based on colony size and location in either Aialik Bay (northeast region) or the Outer Coast (southwest region). 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. Again we conducted surveys using three different methods: boat-based observer counts, boat-based photography, and aerial photography. To look at the probability that we will detect nest sites based on presence of an adult, we also deployed six time-lapse cameras (Reconyx 3MP trail cameras) on Squab Island in Aialik Bay. 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 understand how these patterns may have influenced our counts in the field and in our photographs. See Weiss et al. (2014) for detailed methods.

## **Administrative**

### ***Cooperators and Budget***

This project was the collaborative effort of KEFJ, UAF and the AMNWR. The initial proposal was developed with the input of Leslie Slater at AMNWR. We developed the project study plan, hired a graduate research assistant (Jennifer Curl), and administered a cooperative agreement with Dr. Christine Hunter at UAF in FY11. Heather Renner at AMNWR has been a participant in all graduate student committee meetings and continues to provide review and input.

In FY12, Christine Hunter left her position at UAF and the project, graduate student supervision and cooperative agreements were taken over by Dr. Christa Mulder and Dr. Mark Lindberg at UAF. In all, we administered three cooperative agreements totaling \$115,887 to fund a graduate research assistantship, graduate student travel to scientific meetings, and miscellaneous supplies. Remaining funds were used to support field data collection including biological field technicians, backcountry travel to field sites, vessel support and field equipment (Table 1).

**Table 1.** Project budget details.

| <b>Fiscal Year</b> | <b>Personnel Services</b> | <b>Travel</b> | <b>Supplies and Equipment</b> | <b>Agreements</b> | <b>Total</b> |
|--------------------|---------------------------|---------------|-------------------------------|-------------------|--------------|
| 2011               | \$33,195                  | \$2,975       | \$6,933                       | \$47,977          | \$91,080     |
| 2012               | \$38,380                  | \$1,586       | \$7,397                       | \$31,834          | \$71,197     |
| 2013               | \$41,800                  | \$505         | \$813                         | \$36,076          | \$79,194     |
| Total              | \$113,375                 | \$5,066       | \$15,143                      | \$115,887         | \$241,471    |

### ***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].

## Results and Discussion

### Coastline Survey

We located 35 known colony locations within KEFJ and AMNWR during coastline surveys, and discovered an additional 18 new colonies in 2011 (Parsons et al. 2012; Figure 3-4). All but one of the newly discovered colonies were single species colonies. We were unable to detect any breeding activity at seven historic sites. Colony locations can be fairly stable for many species; however, others, most notably cormorants, move colonies frequently (Denlinger 2006). Using GIS coordinates has improved our ability to accurately identify colony locations, although time of day, season and weather during which the surveys are performed might affect the ability to identify locations and may affect the number of individuals observed at colonies. Shifting of individuals from one colony to another among years may also affect count estimates for populations if the area surveyed does not adequately monitor potential breeding habitat. The discovery of 18 new breeding sites in 2011 and the lack of breeding at seven historic sites illustrate the ephemeral nature of some seabird colonies.

### Colony Counts

In 2011, we revisited most KEFJ colonies one to four times but completed seven to eight replicates at four colonies. Descriptive comparisons of limited count data available for select seabird species at colonies with multiple years of data reflect the apparent variability of colony attendance since 1976. Generally, the number of breeding glaucous-winged gulls at colonies in KEFJ and AMNWR has increased since surveys in 1976 and 1986.

In 2012, we conducted counts targeted at establishing protocols for ledge nesting species and focused specifically on a single species, glaucous-winged gulls; therefore, we did not survey as many locations as we did in 2011 and instead focused on repeated surveys of plots (Dewberry et al. 2013). We did conduct complete counts of glaucous-winged gulls at colonies at select colonies in 2012 and found that the number of gulls attending was lower than previous counts in 2011 and 2010. These results are apparently counter to the previous increase in the number of gulls recorded at colonies since the 1976 and 1986 surveys.

In 2013, focus of surveys was once again on replicate surveys of plots (Weiss et al. 2014). We did complete counts of entire select colonies and found the number of glaucous-winged gulls counted at colonies in 2013 was similar to counts in 2012.

The number of glaucous-winged gulls in the Kenai Fjords area appears qualitatively to have increased between 1976 and 2007 but has remained relatively stable since 2007 (Figures 4-5). 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 20<sup>th</sup> 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).

### **Work in Progress**

Currently, ground-truth photographs and time lapse photos are undergoing analysis and will be completed by the end of the fall semester 2014 at UAF. “Ground-truth” photographs are being counted using remote sensing methods to get an asymptotic estimate over repeated surveys of the true number of birds nesting within a given plot to compare observer counts and counts made from survey photographs. These asymptotic counts will be analyzed using a mark-recapture framework (i.e. removal sampling or a super-population approach) to create a capture history for individual nests over the period of the repeated surveys. This method will help us determine how many nests there are within a closed area of a colony so we can compare the number of birds detected in each observer count or photographic count with the actual number of nests present. After compiling capture histories, the abundance and detection probabilities of surveyed populations will be calculated using Bayesian hierarchical models. Observer counts and photographic counts will be compared using tests within a Bayesian framework. The graduate student is currently taking a Bayesian statistical course, and will analyze project data as part of the class.

The graduate student will write manuscripts for a thesis and publication in the spring of 2015, with a targeted graduation date of summer 2015. A final report including quantitative results will be completed by the summer of 2015.

### **Considerations**

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 addition to logistically challenging field work, the completion of this project requires collaboration with cooperators highly skilled and experienced in advanced analytical techniques for modeling wildlife populations. Christine Hunter was an ideal cooperator for this study; however, when she left her position at UAF early in this project this caused a significant delay in the progress of data analyses.

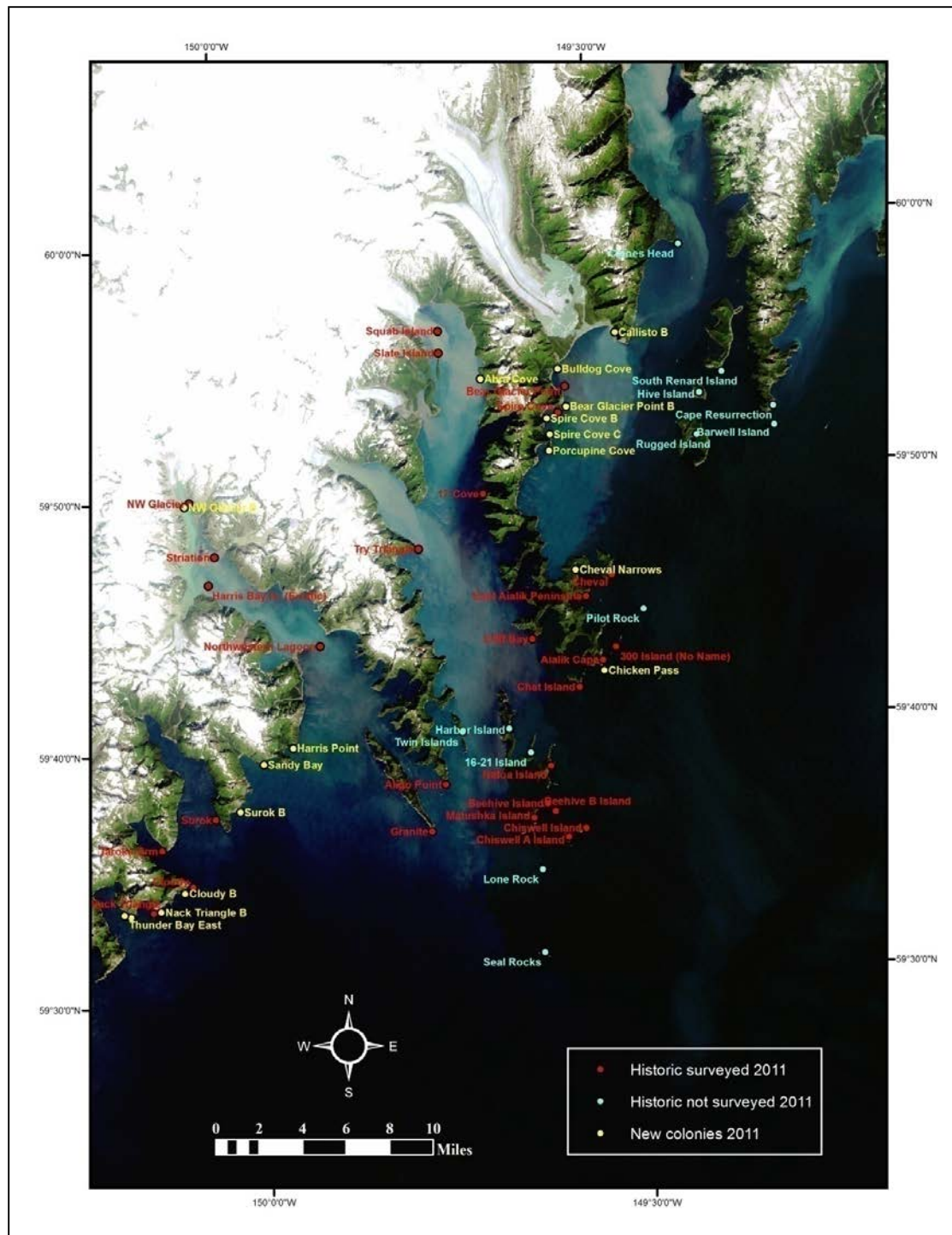


**Figure 2.** Seabird colonies in or adjacent to the northern half of the Kenai Fjords National Park coastline. Red dots represent known colonies in the area that were resurveyed in 2011, blue dots represent known colonies that were not surveyed in 2011, and yellow dots represent new colonies discovered in 2011.

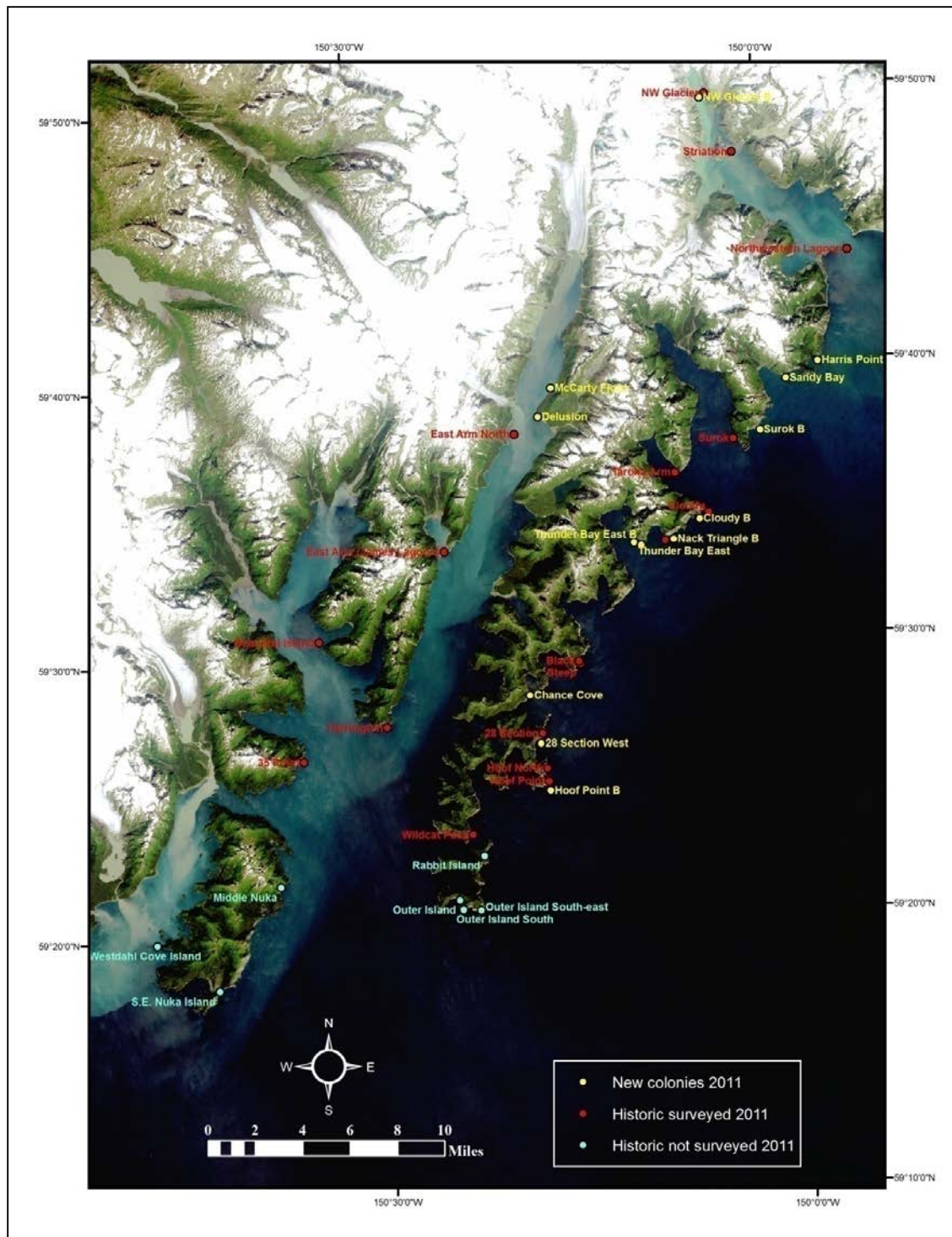


**Figure 3.** Seabird colonies in or adjacent to the southern half of the Kenai Fjords National Park coastline.

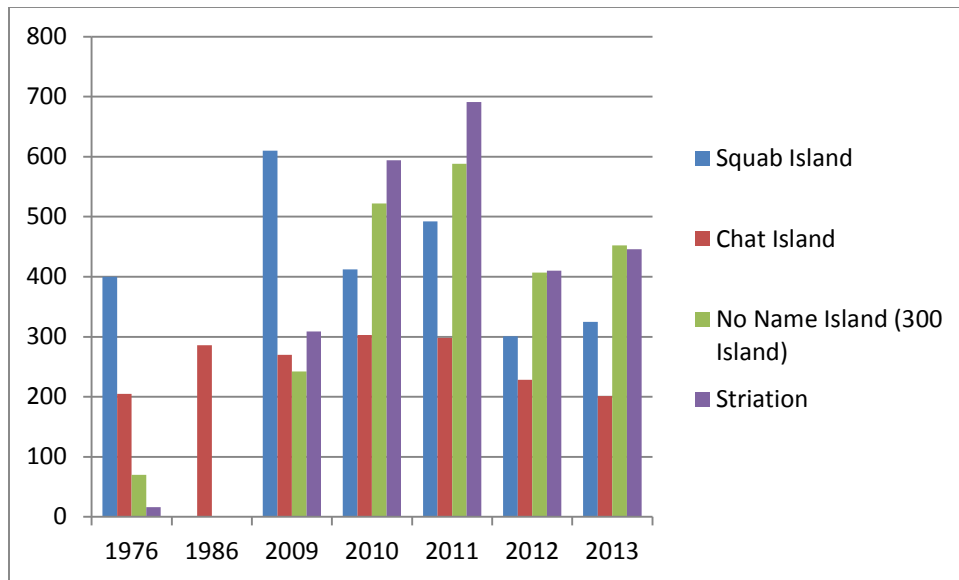


**Figure 4.** Observed number of breeding glaucous-winged gulls during counts of the entire colony at a subset of four colonies in AMNWR for seven years of count data. All counts are from single visits, except Chat (n= 2), Squab (n=2) and No Name (n=2) in 2013.

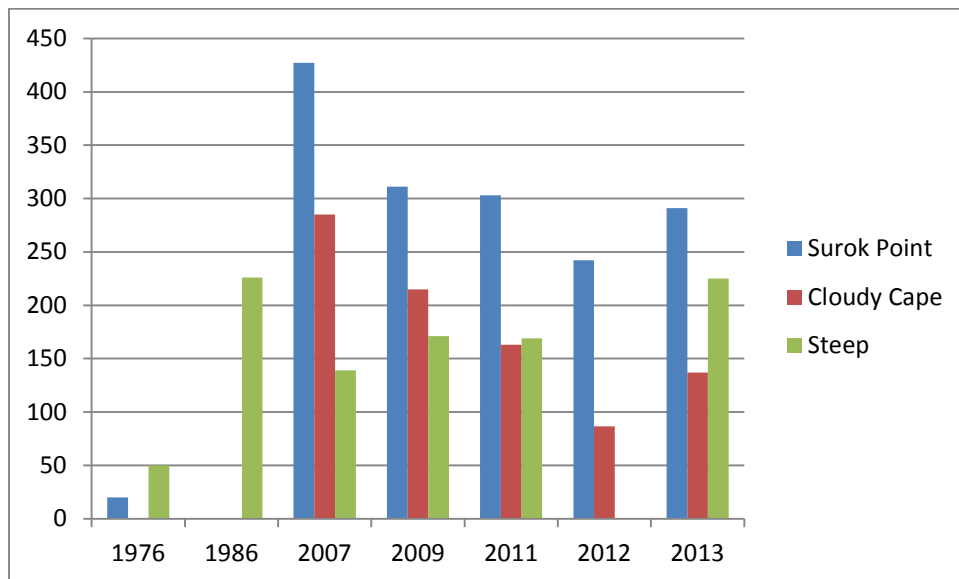


**Figure 5.** Observed number of breeding glaucous-winged gulls at a subset of three colonies in KEFJ for seven years of count data. Counts for 1976-2009, 2011, 2012 and 2013 are from single visits.

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