FY21 EVOSTC NEW PROJECT PROPOSAL

Does this proposal contain confidential information? ☐Yes ☒No

Project Number and Title

Project 21210128

Status and trends of EVOS injured seabirds in the Kenai Peninsula coast and Kachemak Bay

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Date Proposal Submitted

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Project Abstract

We propose an integrated study of status and trends of Kittlitz's murrelet (*Brachyramphus brevirostris*), marbled murrelet (*B. marmoratus*), and pigeon guillemot (*Cepphus columba*) in two regions impacted by the *Exxon Valdez* Oil Spill (EVOS): Kenai Peninsula Coast and Kachemak Bay. Our overall goal is to provide information about trends in abundance and productivity of these three injured seabird species that are not recovering from EVOS or whose recovery status in unknown, thus supporting the EVOSTC in assessment of their recovery status. Kittlitz's murrelet and marbled murrelet two seabird species that were impacted by EVOS, with an estimated 5-10% and 6-12% of the spill zone population killed by acute oiling, respectively. Recovery status of Kittlitz's murrelets following the EVOS remains unknown, while marbled murrelets have not recovered to their pre-Spill numbers. Kittlitz's murrelet became a candidate species for listing under the Endangered Species Act in 2004 and was found not warranted for listing in 2013 due to insufficient or inconclusive knowledge, but remains a species of conservation concern for the US Fish and Wildlife Service. The marbled murrelet is more abundant and widespread in Alaska but remains a species of conservation concern due to evidence of population declines and is listed as a Threatened species from British Columbia to California. Pigeon guillemot populations in Prince William Sound have declined by an estimated 67% since the 1970s, and an estimated 10-15% of the spill area population died from acute oiling. Pigeon guillemots will be monitored in the Kenai Peninsula coast study area.

Our objectives for murrelets are to 1) Estimate current population sizes and decadal trends in abundance, 2) Characterize abundance patterns and identify factors influencing patterns, and 3) Estimate productivity trends. Knowledge gained about population levels and trends in productivity will provide information to assess recovery status of these species. Our objectives for pigeon guillemot are to estimate current population size, trends in distribution, and trends in relative abundance in the Kenai Peninsula coast study area.

This would be the first proposed effort to bring together data on both murrelet species, in conjunction with oceanographic data, from all sub regions of the spill zone. Available historical data provide a cost-efficient opportunity to examine decadal trends, patterns of distribution over time, and habitat use. Furthermore, historical and on-going oceanographic and zooplankton studies in the region will enable us to examine potential influences of environmental conditions on murrelet and guillemot population trends. Our project builds a team of expertise and partnerships among multiple state and federal agencies, private non-profit entities and the university to accomplish scientific, management, and education objectives outlined in the proposal.

Kenai Peninsula Coast Component

EVOSTC Funding Requested* ***(must include 9% GA)***					
FY21	**FY22**	**FY23**	**FY24**	**FY25**	**TOTAL**
160,708	**160,245**	**156,145**	**117,230**	**121,708**	**716,036**

Non-EVOSTC Funds to be used, please include source and amount per source:					
FY21	**FY22**	**FY23**	**FY24**	**FY25**	**TOTAL**
52,190	**37,813**	**41,102**	**TBD**	**TBD**	**131,105**

**If the amount requested here does not match the amount on the budget form, the request on the budget form will considered to be correct.*

Kachemak Bay Component

EVOSTC Funding Requested* ***(must include 9% GA)***					
FY21	**FY22**	**FY23**	**FY24**	**FY25**	**TOTAL**
$117,938	**$129,566**	**$138,748**	**$135,366**	**$55,565**	**$577,184**

Non-EVOSTC Funds to be used, please include source and amount per source:					
FY21	**FY22**	**FY23**	**FY24**	**FY25**	**TOTAL**
$48,144	**$49,408**	**$50,711**	**$52,052**	**$47,433**	**$247,748**

**If the amount requested here does not match the amount on the budget form, the request on the budget form will considered to be correct.*

1. PROJECT EXECUTIVE SUMMARY

This study will focus on status and trends of marbled murrelet (*Brachyramphus marmoratus*), Kittlitz's murrelet (*Brachyramphus brevirostris*), and pigeon guillemot (*Cepphus columba*) which were impacted by direct mortality following the spill. Our overall goal is to provide information about trends in abundance and productivity of injured seabird species that are not recovering from EVOS or whose recovery status is unknown, thus supporting the EVOS Trustee Council (EVOSTC) in assessment of their recovery status.

An estimated 6-12% and 10-15% of marbled murrelet and pigeon guillemot populations in the area, respectively, were killed from acute oiling and both are not recovering from the effects of the spill (EVOSTC 2014). An estimated 5-10% of the world population of Kittlitz's murrelets died because of the spill, and their current recovery status remains unknown (EVOSTC 2014). Factors considered in lack of recovery include decrease in habitat availability, shifts in forage fish prey populations (herring, sand lance), and climatic factors.

In Alaska, recent surveys have indicated population declines (75-90%) of Kittlitz's murrelet at several locations since the 1980s and recent analyses indicate murrelets continue to decline in Prince William Sound (U.S. Fish and Wildlife Service 2009, Cushing et al. 2018). The species' habitat appears to be restricted to tidewater glaciers, glaciated fjords, outflows of glacial streams, and recently deglaciated areas during the breeding season (Day and Nigro 1999, Day et al. 2003, Kuletz et al. 2003). In Alaska, glaciers have experienced a rapid and increased rate of retreat during the 20th century (Arendt et al. 2002) and recent estimates predict that Alaska's glaciers will lose 30-60% of their total volume by 2100 (Huss and Hock 2015). The observed population declines, dependence on glacially-influenced habitats, and rapid retreat of glaciers have raised increasing concerns about the status of the Kittlitz's murrelet in Alaska (Kissling et al. 2007). The proposed study will provide data to assess the status of the species in the spill area. The study also will contribute to US Fish and Wildlife Service (USFWS) data to evaluate the conservation status of the species, which was a candidate for listing under the US Endangered Species Act (ESA) in 2004 and found not warranted for listing in 2013 due to lack of sufficient population trend data. Kittlitz's murrelet remains a species of concern for the USFWS, and for international professional and conservation groups (Pacific Seabird Group, International Union for Conservation of Nature).

The marbled murrelet is also of conservation concern, due to declining populations in core nesting areas (Piatt et al. 2007, Kuletz et al. 2008, Kuletz et al. 2011). The proposed study will assess current status to address the question of recovery. The marbled murrelet is a species of conservation concern for the USFWS in Alaska and is federally listed as Threatened under the ESA in Washington, Oregon, and California, State-listed as Endangered in California, State-listed as Threatened in Oregon and Washington, and a species of concern in British Columbia.

Pigeon guillemot populations in Prince William Sound (PWS) have declined by an estimated 67% since the 1970s (Agler et al. 1994, Golet et al. 2002). The reason for the decline is not well understood, but changes in marine ecosystems could affect food availability and regional population trends. The proposed study will provide information about the current status and trends of pigeon guillemot in the spill area on the Kenai Peninsula coast.

The Gulf of Alaska (GOA) has undergone periods of ocean warming and most recently, massive and persistent heatwaves, resulting in cascading trophic effects affecting fish abundance and distribution (Zador and Yasumiishi 2018). In 2014-2016, other fish-eating seabirds, primarily common murres, had wide-spread mass mortality events and breeding failures in the GOA (Piatt et al. 2020). Long-term trends in PWS indicate that pelagic feeding marine birds (such as murrelets) have not recovered as well as benthic-feeding coastal birds (Cushing et al. 2018). The impact of these changes on *Brachyramphus* murrelets and pigeon guillemot is unknown, although there is evidence from the GOA Seward Line off-shore surveys that murrelets respond to warmer oceans by moving closer to coastal and fjord habitats (Kuletz et al. 2018). By examining murrelet trends across the broader EVOS affected area, in conjunction with oceanographic conditions, we seek to determine if there are differences in murrelet trends among regions that may coincide with environmental conditions, thereby identifying factors potentially inhibiting murrelet recovery. Improved understanding of environmental influences on murrelet trends and distribution patterns across the area may also inform the fisheries management process in the GOA.

Available historical data for murrelets and pigeon guillemot in our study area provide a cost-efficient opportunity to examine decadal trends, patterns of distribution over time, and habitat use for all these species.

In summary, we will create long-term data sets on abundance and productivity for these species, and explore hypotheses related to population response to environmental variability in the spill area. Replication of robust survey protocols provides high power to detect trends and understand spatial patterns of change. The proposed study will provide new data for integrated analyses of seabird status and recovery in the spill area.

Kenai Peninsula Coast Component

Our proposed study area in Kenai Fjords contains glacially-influenced fjords used by both Kittlitz's and marbled murrelets, although many of the tidewater glaciers are currently on the cusp of receding above sea level. Murrelet surveys in the Kenai Fjords date back to 1970s, but surveys have not been conducted in the area since 2006-2008 (Van Pelt and Piatt 2003, Arimitsu et al. 2011). Marine surveys conducted year-round in Resurrection Bay since 2011 indicate changes in seasonal abundance of marbled murrelet, suggesting a decline during the summer seasons of 2017-2019. These observed declines coincide with reproductive failure of other seabird species in the area that have been linked to the warming anomaly of 2015-2016.

Pigeon guillemot occupy the waters in Resurrection Bay during spring and summer seasons, and nest in small colonies throughout the bay. Since 2011, seasonal distribution and abundance of guillemots has been monitored in year-round surveys of the bay.

This component will study the status and trends of marbled murrelet, Kittlitz's murrelet, and pigeon guillemot along the southeast coast of the Kenai Peninsula, a region impacted by EVOS. For Kittlitz's murrelet, we will provide an assessment of population size and trends in the Kenai Fjords, and information to understand abundance patterns in glacially-influenced fjord habitats. For marbled murrelet and pigeon guillemot, we will provide an assessment of population size and trends in the Kenai Fjords and Resurrection Bay, and information about productivity. For marbled murrelet, we will also provide information to understand their abundance patterns in the fjords area.

Building on data from fjord surveys conducted in 2006-2008 and the only year-round marine bird survey ongoing in Alaska since 2011, our study offers a unique opportunity to assess status of three seabird species at a comparison site in Kenai Fjords, with a study design that lends itself to seamless comparison with other survey efforts being conducted in the spill region.

Kachemak Bay Component

This study component will provide current population estimates for Kittlitz's and marbled murrelet species, along with distribution and habitat use in Kachemak Bay. Kachemak Bay and the greater LCI region are critically important areas for Kittlitz's murrelets, with an estimated 9% of the total world population (U.S. Fish and Wildlife Service 2013). The goal of this component is to provide an updated population estimate for *Brachyramphus* murrelets in Kachemak Bay and to conduct integrated analyses with collaborators to identify high density areas and provide trend information for the species across the spill zone.

Integration of Components

Data collection methods are coordinated between the two component areas, allowing for integrated data analysis to compare murrelet densities and population trends between the study areas. Coordination efforts will be continued throughout the project, including coordination of training of observers and regular meetings among the team of investigators. A workshop focusing on current research and techniques to investigate murrelet abundance, productivity, and habitat associations will be hosted by our research team, to further facilitate discussions and collaborations among study areas, trophic levels, and interested resource managers.

2. PROJECT HISTORY

This is a new project.

The Kenai Peninsula Coast component builds on work reported in Arimitsu et al. (2011) and surveys conducted in Resurrection Bay since 2011. The Kachemak Bay component builds upon previous murrelet surveys in Kachemak Bay, dating from 2004-2007 (July and August surveys, funded by an Alaska Department of Fish and Game, State Wildlife Grant), and July surveys in 2011 and 2016 (funded by USFWS). This study will contribute data comparable to the EVOSTC funded project on marine birds in PWS (EVOSTC Project 21120114-M), and offshore data from the Seward Line project (2006-2022; funded by FWS and the North Pacific Research Board). The Seward Line was expanded in 2018 and will provide data throughout the northern GOA via the Northern GOA Long-term Ecological Research project (Figure 1), established in 2018 (https://nga.lternet.edu/).

The Kachemak Bay component includes two surveys: 1) a July population survey (Figure 2), which captures peak murrelet abundance of adults after-hatch-year (AHY) birds; and 2) the August juvenile surveys (Figure 3), to derive a population estimate of juvenile hatch year (HY) murrelets in Kachemak Bay. The latter component of the study builds upon prior Kachemak Bay studies in 2004-2007 that determined HY densities and HY: AHY ratio estimates (Kuletz et al. 2008). The ratio is a productivity index commonly used for *Brachyramphus* murrelets (Kuletz and Kendall 1998; Kissling et al. 2013).

3. PROJECT DESIGN

A. Objectives

Kenai Peninsula Coast Component

Our overall goal for this component is to provide information about current population size and trends in abundance, distribution, and productivity of seabird species impacted by EVOS but not considered recovered to date: marbled murrelet, Kittlitz's murrelet, and pigeon guillemot. We propose to investigate decadal trends of the study species in dynamic tidewater glacier habitats by replicating murrelet surveys most recently conducted throughout Kenai Fjords in 2006-2008; investigate patterns in seasonal abundance and distribution by building on the only year-round marine bird survey conducted in Alaska; and estimate trends in productivity. We will also provide recommendations for future monitoring of these seabird species in our study area, as a comparison site to other studies conducted in the region.
Objectives:

1. Estimate current population size for Kittlitz's murrelet, marbled murrelet, and pigeon guillemot in the Kenai Fjords, and determine decadal trends in abundance for murrelets
2. Characterize current distribution of Kittlitz's and marbled murrelet in Kenai Fjords, investigate temporal changes in density patterns, and identify factors that influence density patterns
3. Estimate current population size, trends in distribution, and trends in relative abundance of pigeon guillemot in Resurrection Bay
4. Estimate juvenile densities and age ratios as an index of productivity for marbled murrelet and pigeon guillemot in Resurrection Bay

5. Develop recommendations for future monitoring of population size and abundance patterns for Kittlitz's murrelet and marbled murrelet in Kenai Fjords, and pigeon guillemot in Resurrection Bay

Murrelet surveys in Kenai Fjords were most recently conducted in 2006-2008, using a robust survey method. Since then, the Gulf of Alaska has experienced a warming event that was unprecedented in both its magnitude and duration, a large unprecedented seabird die-off (an estimated 1 million common murres *Uria aalge*), and significant changes in tidewater glaciers (Hoover-Miller and Armato 2018, O'Neel et al 2019, Piatt et al. 2020). Our ability to replicate the surveys conducted in 2006-2008 will provide a timely reassessment of status and trends in an important concentration area for these species. Replication of robust survey methods offers high power to detect trends, and spatial analysis of density patterns offers timely information about potential temporal change in distribution and insights into drivers of change. Additionally, new information will be generated about productivity and trends in productivity. Trend in productivity is considered an indicator of recovery status for murrelets and pigeon guillemot, and the Restoration Plan (2014) identifies needs for more information on productivity to support assessments of recovery status. Finally, the robust sampling methods employed (distance sampling and systematic, random design) will provide data that enable integration of results to surveys conducted at other locations (e.g., Kachemak Bay) and can be used in integrated analyses of status and recovery of the species in the spill area.

Kachemak Bay Component

Objectives

1. Obtain current population estimates and long-term trends for Kittlitz's murrelets and marbled murrelets in Kachemak Bay.

This component will provide information on *Brachyramphus* murrelets that were impacted within the EVOS region. Surveys conducted in Kachemak Bay during 2005-2007 estimated the Kittlitz's' murrelet population to be 2,020 birds (SD ± 1108), and marbled murrelets at 11,060 birds (SD ± 1245) (Kuletz et al. 2008). In 2011, both Kittlitz's and marbled murrelet estimates were considerably lower, although confidence intervals were large (Table below). Due to a more clustered distribution in the bay, Kittlitz's murrelet had larger confidence intervals, indicating a need to increase survey coverage in identified hot spots of activity for that species (Figure 4). In contrast, marbled murrelets were more widely distributed across the bay (Figure 5). To address the issue of Kittlitz's murrelet distribution we will add additional systematic transects, 2 km apart, in the hot spot areas to improve confidence intervals.

	Estimated population (95% CI) in July	
Year	Kittlitz's Murrelet	Marbled Murrelet
2005	1776 (2059)	12 244 (4931)
2006	3277 (3100)	11 227 (6728)
2007	1086 (1824)	9651 (8015)
2011	397 (422)	4169 (3701)

2. Estimate annual abundance of adult and juvenile Kittlitz's murrelets and marbled murrelets in Kachemak Bay during the fledgling period.

Kittlitz's and marbled murrelets differ from most seabird species in that they do not nest in colonies, rather they are dispersed at inland nest sites. We will conduct juvenile murrelet surveys in Kachemak Bay during August, which is the murrelet fledging period, to obtain juvenile and adult murrelet densities, and generate population estimates, and HY:AHY ratios as a supplementary index to gauge productivity. We will also investigate if previously detected nursery areas are still being used, identify potential new juvenile murrelet nursery areas, and compare results to prior studies.

3. Describe the distribution of murrelets within Kachemak Bay, and identify marine habitats used by murrelets.

Kachemak Bay is an ideal location to study both Kittlitz's and marbled murrelets because the marine areas used are readily accessible and occupy a diverse marine habitat. We propose using spatial murrelet distribution data to identify high murrelet density areas, and key habitat characteristics preferred by murrelets in Kachemak Bay. We will also examine whether murrelets respond to changing environmental conditions by shifting their distribution within the Bay.

4. Synthesize results from Kachemak Bay with those from other regions in the spill zone, including Resurrection Bay and Prince William Sound.

This component will provide current population and trend information for Kittlitz's and marbled murrelets that can be compared to other regional vessel-based murrelet surveys. Coordinated efforts to standardize survey methods, data sharing, and integrated analysis of murrelet survey results will provide a comprehensive overview of *Brachyramphus* murrelets in the EVOS impacted areas.

B. Procedural and Scientific Methods

Kenai Peninsula Coast Component

1. Estimate current population size for Kittlitz's murrelet, marbled murrelet, and pigeon guillemot in Kenai Fjords, and determine decadal trends in abundance for murrelets

To estimate current population size and characterize current distribution of *Brachyramphus* murrelets in Kenai Fjords we propose to conduct coast-wide, small-boat surveys for Kittlitz's and marbled murrelets, and pigeon guillemot over a three-year period. Using a systematic survey design established by Arimitsu et al. (2011) we will conduct a coast-wide survey during the middle of the murrelet breeding season (late June to mid-July). Transects will cover an area from Nuka Bay in the west to Bear Glacier, Resurrection Bay in the east. By following the survey design established by Arimitsu et al. (2011) our results will be directly comparable with the result of their previous work, conducted in 2006-2008.

During the same three years, we will also survey a subset of the coast-wide transects located in areas of high Kittlitz's murrelet density (Aialik Bay and Northwestern Fjord/Harris Bay) during the early (late May to mid-June) and late (early to mid-August) portions of the breeding season (breeding phenology for Kittlitz's murrelet is based on Day 1996). In Aialik Bay, up to three late season surveys will be conducted per year for three years. Based on previous work in our study area showing that Kittlitz's murrelet density and distribution vary in relation to marine sills and distance to shorelines (Van Pelt and Piatt 2003, Arimitsu et al. 2011), we will separate our survey into four strata *a priori* based on the location of the transect. Transect will be classified as either coastal (<200 m from shore) or offshore (>200 m from shore) and either inner bay (north of marine sills in Aialik Bay and Northwestern Fjord) or outer bay (south of marine sills and in all other bays other than Aialik Bay and Northwestern Fjord).

We will use the same transects conducted by Arimitsu et al. (2011), including coastal transects that were created by dividing the coastline into 4 km segments (from a random starting point) using GIS software, and offshore transects composed of parallel lines running from east to west, spaced every 0.93 km (30" of latitude), within each major bay along the Kenai Fjords coast. From the random starting point, one of every three coastal segments and one offshore line every 3.7 km (2' of latitude) were systematically selected for inclusion in the survey. Because historical surveys indicated that Kittlitz's murrelet distribution was generally restricted to the upper section of Aialik Bay and Northwestern Lagoon (Van Pelt and Piatt 2003, Arimitsu et al. 2011), survey coverage will be increased by spacing offshore transects every 1.8 km (1' of latitude) in those two areas (the inner bay stratum defined above).

Surveys will be conducted following methods outlined by Gould and Forsell (1989), with modifications for working in coastal nearshore waters from small boats (Agler et al. 1998) and for counting flying birds continuously (Raphael et al. 2007). We will use line transect sampling, estimating perpendicular distance to murrelets to the nearest meter within a maximum of 150 m forward and 300 m lateral to either side of the transect line. Before each survey, observers will complete training in distance estimation that will include a combination of calibrating estimates with measurement of distances to fixed objects using rangefinders on fixed objects and estimation of distances to bird-sized buoys strung at known distances on a line towed behind the vessel. Shoreline transects will be conducted approximately 100–150 m from shore or in the shallowest navigable waters, depending on the vessel size. Ground speed while conducting surveys will generally be held between 10 and 20 km/h, although survey crews will have the option to slow the vessel as needed to confirm the identification of murrelets.

We will count all murrelets and guillemots and identify them to species whenever possible. Identification of *Brachyramphus* murrelets can be challenging so experienced observers will be used, and training will be conducted prior to the surveys. All observed murrelets and guillemots will be assigned a behavior code depending on whether they are sighted on the water or flying within the transect. We will record juvenile murrelets and guillemots when they can be positively identified. We will record all sightings using a real-time computer data-entry system that will log sightings, with their position coordinates, continuously. Weather and sea state will be constantly monitored, and surveys will be ceased if wave height exceeds 0.5 m.

2. Characterize current distribution of Kittlitz's and marbled murrelet in Kenai Fjords, investigate temporal changes in density patterns, and identify factors that influence density patterns

Distribution of murrelets will be characterized based on survey data obtained for objective 1. We will estimate within-season densities using methods described in Kissling et al. (2007) and Arimitsu et al. (2011) and correcting for imperfect detection using spatial distance sampling (Miller et al. 2013). The spatial density estimates will be computed in program DISTANCE (Thomas et al. 2010) through the R package dsm (Miller et al. 2019). We will compare historical (2006-2008) distribution within and among fjords to current distribution, separating within year spatial variation from long-term trends in habitat hot spots and hot spots of change (e.g., Kissling et al. 2007). The late season surveys are timed to coincide with the fledging period for murrelets and will provide information about density and distribution of HY birds, and location of potential nursery areas.

We will incorporate a suite of spatially explicit covariates with spatial density analyses to explore factors influencing abundance patterns within and among fjords. The suite of covariates, at a minimum, will include: fjord, year, season/Julian date, time of day, distance to glacier, distance to glacial stream, distance to sill, depth, ice cover, tidal stage, tidal current velocity, sea conditions, turbidity, salinity, and temperature. The bathymetric features with interactions with currents are considered as indicators of potential forage conditions (Kissling et al. 2007, Arimitsu et al. 2010). Marine habitat data will be collected along transects in conjunction with seasonal fjord surveys. Additional data sources are available through collaborations with the National Park Service and other ongoing research as described in section 4.

We will explore hypotheses relating to the overall distribution of Kittlitz's and marbled murrelet within Kenai Fjords. We predict that 1. Kittlitz's murrelet density will be highest in areas influenced by tidewater glaciers, at the heads of fjords, and 2. marbled murrelet will be widely distributed along nearshore habitats in the fjords. Thus, Kittlitz's murrelet occurrence will be related to distance from glacier, distance from glacial stream, relationship to sill (inner/outer fjord), ice cover, water depth, water turbidity, and water salinity. Marbled murrelet occurrence will be negatively related to depth and ice cover.

We also predict that "hot spots" (high densities) of Kittlitz's and marbled murrelet are associated with bathymetric features (including sills and shallow areas at mouths of side bays), interacting with currents (the combination of which likely aggregate prey; Coyle et al. 1992).

We predict that these overall distribution patterns remain similar since the previous surveys in 2006-2008, so that Kittlitz's murrelet remain more closely associated with heads of fjords and marbled murrelet remain more widely distributed in the fjords.

An assessment of the status of tidewater glaciers in Kenai Fjords is planned for 2020-2021. Information from this assessment would allow us to explore additional hypotheses relating to potential change in Kittlitz's murrelet density in relation to stability of the tidewater glaciers.

3. Estimate current population size, trends in distribution, and trends in relative abundance of marbled murrelet and pigeon guillemot in Resurrection Bay

Since 2011, nearshore surveys have been conducted monthly along a 44 km route in Resurrection Bay in the only current year-round marine bird survey in Alaska, and this project will supplement surveys to provide a 15-year data set. For the Resurrection Bay survey, the vessel travels approximately 100 m from the shore at a speed of 7-14 km/hour. We will use line transect sampling, estimating perpendicular distance to birds to the nearest meter within a maximum of 100 m lateral to either side of the transect line. Surveys are conducted in sea conditions of 3 or less of Beaufort scale. Weather data is recorded at the start of each transect; seas (feet), wind (knots), cloud cover (%), and precipitation. For each bird sighting we record GPS coordinates (latitude/longitude), species, age (when feasible using plumage characteristics), sex (when feasible using plumage characteristics), location (inshore/offshore), distance to observation, and behavior (on water, flying, on land, on floating object, or feeding). All data are collected using a real-time data entry system as for objective 1. Pigeon guillemot is a seasonal occupant in Resurrection Bay, with birds arriving in March-April and present until October. Marbled murrelet is a year-round occupant. Results since 2011 indicate changes in seasonal abundance of marbled murrelet, suggesting a decline during the summer seasons of 2017-2019 (Figure 6).

Building on the existing survey data collected since 2011, we propose to generate a 15-year data set on seasonal abundance and distribution of marbled murrelet and pigeon guillemot in Resurrection Bay. We will incorporate line transect sampling to estimate current population size in the Bay and characterize seasonal patterns of distribution and relative abundance using the long-term data set. For analysis including the early historical data, we will apply detection functions developed in later years to estimate abundance, or estimate trends in relative abundance. The survey period includes years of recent warming events since 2014 in the Northern Gulf of Alaska and years prior to warming anomalies, allowing us to explore potential influences of a warming event on murrelets and guillemots. As mentioned before, the lowest summer season counts of marbled murrelet observed to date follow the warming event and coincide with reproductive failures documented for common murre and black-legged kittiwake (*Rissa tridactyla*) in the area (Hollmen et al. 2017). Continuing surveys will extend the data set to cover the time period following the warm water anomaly, offering an opportunity to characterize avian community response to the warming event and explore hypotheses about how murrelet and guillemot occurrence may co-vary with other species. The Resurrection Bay survey effort will be leveraged from funding and partnership with the National Park Service.

4. Estimate juvenile densities and age ratios as an index of productivity for marbled murrelet and pigeon guillemot in Resurrection Bay

Using techniques described in previous objectives, we will conduct small boat surveys during the fledging and early juvenile period with focus on estimating juvenile densities. In addition, we will also estimate juvenile-to-adult age ratio counts as an index of productivity (Kuletz and Kendall 1998). Identification of juvenile (hatch-year) birds will be based on plumage and behavioral characteristics (Kuletz and Kendall 1998, Kuletz et al. 2008, Arimitsu et al. 2010, Corcoran 2015). Each bird observed on the survey will be assigned to one of four potential categories: definite hatch year (HY), probable HY, definite after hatch year (AHY) or probable AHY. Attempts will be made to photograph all probable or definite HY birds and all probable AHY birds to provide additional support for age-class confirmation. Surveys will be conducted at weekly intervals throughout the fledgling and early juvenile season in July-September along the inner and outer Resurrection Bay coastline.

We will estimate densities and distribution of HY birds and attempt to identify nursery areas. While our focus is on estimating juvenile densities, we also will calculate a HY:AHY ratio and percentage of juveniles in the population as an index of productivity following methods in Kuletz and Kendall (1998). Survey data from pre- and early incubation period (May-June) will be available to estimate the population of locally breeding adults as described in Kuletz and Kendall (1998). We will assume that HY birds recorded in Resurrection Bay originated from nests in the area. We acknowledge uncertainties associated with age-ratio data, and the HY:AHY ratio is considered an index of productivity and not an absolute measure. The method does not provide a measure of fledglings per breeding pair due to the unknown proportion of breeding to non-breeding adults observed during the surveys. Other factors that may influence numbers of adults encountered and interpretation of ratios include post-breeding dispersal, timing of nesting events, and adult mortality (Kuletz and Kendall, 1998, Kuletz 2005, Kuletz et al. 2008). We note that juvenile densities also will be estimated in this study, as described in previous objectives.

5. Develop recommendations for future monitoring of population size and abundance patterns in Kenai Fjords

Our project will deliver the first replication of statistically robust surveys conducted in 2006-2008, and analysis of trends and changes in spatial distribution specific to Kenai Fjords. The outcomes will facilitate recommendation for scope and frequency of future monitoring efforts to monitor population size, trend, and distribution of Kittlitz's and marbled murrelet in Kenai Fjords. Results from this project will provide information to determine sample sizes and survey intervals for future monitoring of murrelet trends in Kenai Fjords, with desired power to detect a specified change. The project will provide information to develop a monitoring plan for murrelets in the Kenai Fjords.

Kachemak Bay Component

1. Obtain current population estimates and long-term trends of *Brachyramphus* murrelets in Kachemak Bay.

Kachemak Bay provides a unique logistical opportunity to study murrelets, since the entire study area can be safely accessed on a daily basis via small boat from Homer (weather permitting), and does not require additional support vessels to reach remote study site locations. Our study builds off our prior surveys in Kachemak Bay during a three-year time period in 2005-2007, and surveys in 2011 and 2016. To integrate prior survey data, we will conduct analysis using distance sampling methodology. Distance data was collected in the past surveys using a modified strip transect methodology, which will be used to generate detection curves. Therefore, both past and proposed survey data will be calibrated by the use of distance sampling methods. The four-year study was designed to characterize murrelet habitat association, including environmental covariate analysis, and to investigate if previous murrelet hot spots are still important murrelet areas in Kachemak Bay today. We have designed a robust survey protocol and added transects in hot spots to decrease variance.

Annual boat-based surveys in Kachemak Bay will be conducted in July from 2021-2024. We will complete one full survey of Kachemak Bay using systematically placed transects at 4 km apart (based on historical transects) perpendicular to the prevailing coastline, from north to south (Figure 2). Additional transects will be place at 2-km apart in identified hot spots of murrelet activity (Figure 4). The historical Kachemak Bay surveys used a modified strip transect method, wherein each murrelet sighting was categorized to a distance bin, with a maximum of 100-m either side of the vessel (Kuletz et al. 2008). For the new surveys, we will use distance sampling consistent with the methodology used in the Kenai Fjords and Resurrection Bay study. Survey crews will undergo training to refine murrelet species identification and distance estimation. Observers will practice estimating distances to the closest meter from the boat to decoys on the water using a laser rangefinder to check accuracy.

Areas of high Kittlitz's murrelet density were similar in 2011 and 2016 to the distributions we recorded during 2005-2007 surveys. However, we will evaluate distributions during the 2021-2022 surveys to determine if additional 2-km transects should be included in the sampling design. ArcGIS will be used to generate track lines for each transect and to calculate individual transect lengths.

The July surveys will be conducted once per year and take 5-7 days to complete, which includes an extra 1-2 days to accommodate the added transect lines in the Kittlitz's murrelet hot spots. Surveys will be conducted between 0600 and 1700 hours by two observers and one boat driver using an 8-m fiberglass boat. GPS referenced transects will be surveyed at approximately 5-7 knots. Two observers will stand on opposite sides of the boat and record all birds observed on each side, and use 10x42 binoculars to aid identification as needed. The observers will enter sightings directly into a laptop computer using ABR survey software (ABR, Inc., Fairbanks, AK), integrated with a Global Positioning System (GPS). The program logs latitude and longitude for each record, and automatically writes to record location data at 20 second intervals to track effort and associated environmental conditions (weather, observing conditions, Beaufort sea state, glare, fog). For each murrelet or murrelet group we will estimate the murrelet's distance from the centerline of the boat to the closest meter. Species' behavior will be recorded as on water, in air, or foraging. Flying birds will be counted continuously, similar to PWS marine bird surveys (Kaler et al. 2018). This four year study in Kachemak Bay will coincide with two years of the Prince William Sound marine bird survey (2021 and 2022), which will also be collecting data on murrelets, and allow for comparisons of murrelet populations within the EVOS impacted areas.

2. Estimate annual abundance of adult and juvenile Kittlitz's murrelets and marbled murrelets in Kachemak Bay during the fledgling period.

August surveys are designed to estimate juvenile (HY) and adult (AHY) murrelet densities, and spatial variation in the study area. We will primarily use distance sampling to estimate the number and spatial variation of juvenile murrelet density (birds/km^2). This will allow us to understand if there are 'hotspots' for juvenile abundance and if these areas are similar to past surveys. The ratio of HY:AHY murrelets will only be used as a supplementary index to gauge productivity, in the context of population size, given the potential biases associated with HY:AHY ratios during the fledgling period (Kuletz and Piatt 1999, Kuletz et al. 2008). The HY surveys will focus on the southern shore of Kachemak Bay in areas that have been previously identified as nursery areas (Figures 7 and 8). August surveys will be conducted three times, at approximately weekly intervals, to account for spatial and temporal variability and to capture the peak fledgling period (Kuletz and Kendall 1998, Kuletz et al. 2008). Prior surveys detected the highest density of HY Kittlitz's murrelet in the middle of August, while HY marbled murrelet density peaked later in the month from August 16-25 (Kuletz et al. 2008). The new HY murrelet surveys will follow a similar time frame but will increase the number of transects in the nursery areas to improve spatial resolution therein and improve the density estimates of HY and AHY murrelets during the fledging period. We will examine results from the 2021 survey to evaluate the need for additional survey replicates and/or transects for the August HY estimates. By adapting our survey effort to the distribution properties of juvenile murrelets in Kachemak Bay, we will improve estimates of juvenile murrelet density and better describe habitat use.

Each August replicate survey will take approximately four days each to complete. We will follow similar survey protocol as the July surveys with the exception that transect pauses will be allowed for murrelet age class confirmation if necessary (HY birds resemble adults going into basic plumage). During the deviation from a transect we will cease survey effort, enter a waypoint into the navigation system, and go off transect to confirm age class of the bird. The distance traveled during this time will not be included in the transect route used later to calculate densities. After age class is confirmed, the vessel will return to the waypoint and resume "on transect" effort.

3. Describe the distribution of murrelets within Kachemak Bay and identify marine habitats used by murrelets.

We will examine the relationship between murrelet distribution and environmental variables in Kachemak Bay to identify marine habitat characteristics and use for both species and by AHY and HY murrelets of each species. During the vessel-based surveys we will collect environmental data at the start of each transects and at systematically placed stations. We will record weather conditions, sea conditions, wind speed, sea surface temperature, salinity, water depth, and Secchi depth to classify turbidity. Additionally, we will incorporate tidal influence on murrelet distribution, and identify kelp bed extent in Kachemak Bay. Geo-spatial data for Kachemak Bay will also be used to reference the additional variables of water depth, distance to shore and chlorophyll a.

In earlier studies conducted in 2004-2007 the distribution of marbled murrelets indicated that they use a variety of marine habitats within the bay, from the mixed waters of the outer bay to the highly stratified waters of the inner bay (Kuletz et al. 2008). Kittlitz's murrelets were clustered in two specific regions including the south shore of the inner bay and along the north shore of the outer bay. Overall Kittlitz's murrelet densities were highest in the inner bay near Grewingk Glacier, an area of highly stratified waters, where glacial outflow was most intense (Kuletz et al. 2008). A particular feature of these areas was a layer of clear water typically < 5 m below the surface layer of turbid water. In the Kittlitz's murrelet hot spot along the north shore of the outer bay, we recorded turbid surface water flowing over a relatively shallow shelf forming a front below turbid glacial water with clear water starting at approximately 5-10 m in depth (Kuletz et al. 2008). Thus, there were physical similarities between these two hot spots, which we will examine and compare relative to the presence and relative abundance of Kittlitz's and marbled murrelets. In addition, water depth appears to be an important factor, as most murrelets occurred in water < 60 m deep (Kuletz et al. 2008).

We will also examine the distribution and abundance of murrelets relative to areas where gillnet fishing is taking place in Kachemak Bay. We will conduct surveys within the bay's setnet districts, to compare with areas with no setnets. We will incorporate the presence of setnets as a factor that could influence murrelet distribution or abundance, as fishing could potentially displace murrelets from foraging areas.

4. Synthesize results from Kachemak Bay with those from other regions in the spill zone including Resurrection Bay and Prince William Sound.

Our goal is to coordinate with other marine bird survey projects within the EVOS region in core *Brachyramphus* murrelet sites to ensure consistency in data collection and survey methodology to facilitate comparison among regions. We have engaged to identify potential opportunities to collaborate region-wide. The collaborative opportunities could provide valuable comparisons regarding *Brachyramphus* murrelet abundance, population trends, indices of productivity, and habitat use among regions. Further, it would provide a comprehensive overview of population trend data in southcentral Alaska.

Power to detect change

Based on the results and methods reported in Arimitsu et al. (2011) and Kuletz et al. (2008), we conducted a power analysis to detect a trend in population estimate between past estimates and the proposed surveys. Because of the large within and between year variation in population estimate of murrelets and other seabirds (Kissling et al, 2007, Hatch 2003), we do not expect a short term variation in population estimates to be biologically meaningful, other than that due to distributional changes within the study areas. Therefore, we conducted a power analysis to detect a change in the mean of population estimates between historical and proposed surveys, where we average over the within and between year variation within each study area (e.g., average population estimates for Kenai Fjords 2006-2008 compared to average population estimates for the proposed surveys in 2021-23). We assumed that the between year variation was as observed in past surveys and that the standard deviation of population estimates increased with the mean, as estimated from a linear model (regression through origin) of past estimates. We then simulated a starting population size from the average historical population estimates, projected this forward to the proposed survey years, and simulated observations of population estimates. We then averaged these and conducted a t-test for differences between two means (assume equal sample size but unequal variance) and repeated this 3000 times. We calculated power using a Type I error rate of 5% and 10% and all tests were two-sided. We did not explore spatial simulations of distance sampling and generalized additive models because the time and computation resources were not available.

Overall, we found good power for very large trends (~50% power for Type I error of 10% and annual trends > 10% absolute magnitude), and we found relatively low power (< 50%) for trends < 10% per year (absolute value in magnitude) (Figure 9). Exceptions were for Kittlitz's murrelet in Kenai Fjords, where power was > 50% for a 10% per year trend when Type I error of 10% and approached 50% for Type I error rate of 5%, and for marbled murrelet in Kachemak Bay, where power was > 50% for trends 5% per year. In general, population increases were predicted to be harder to detect than population decreases (probably because of the positive relationship between mean and standard deviation of the estimate).

While the power to reject a null hypothesis of no change is generally low for both surveys, except marbled murrelet in Kachemak Bay, we would generalize the concept of change to include additional aspects of evaluating the existence and stability of high density "hot spots", as described for objectives investigating temporal changes in density patterns of murrelets, and characterizing the variance in population estimates among and within years and across study areas. In Kenai Fjords, the planned three-year replication of repeated surveys allows us to evaluate the existence and stability of the hot spots. Also as noted in objective 1, we have added up to two replicates per year for the Kenai Fjords survey. For Kachemak Bay, we will be able to investigate the stability between years. The power to detect such hot spots is increased over previous surveys by allocating additional transects to areas of historically higher densities (inner bays in Kenai Fjords and the south side of Kachemak Bay). From a statistical perspective, a hypothesis testing approach to "trend detection" is less appropriate than is an estimation approach where we are interested in estimating the source of random effect variation in a generalized linear mixed model due to location, year (or replicate), and location-by-year (or replicate) interactions. Describing and estimating this source of variation would be key to understanding the dynamics of murrelet populations, interpreting results, and designing future population surveys, including use of additional and new survey methods being developed.

Coordination of methods

We are coordinating survey efforts and methods between study areas to facilitate site comparisons with data on murrelet abundance. We will coordinate training of observers, distance sampling techniques, and data entry systems to ensure data streams are comparable among regions and years.

C. Data Analysis and Statistical Methods

Synchronization of methods allows for integrated data analysis to compare murrelet densities and population trends between the study areas.

Kenai Peninsula Coast Component

We will calculate annual population estimates of Kittlitz's, marbled and all *Brachyramphus* murrelets combined, along with pigeon guillemot, in the program DISTANCE (Laake et al. 1996, Buckland et al. 2001, Thomas et al. 2010), using line transect methods for birds on the water and strip transect methods for flying birds. We will separate the analyses by behavior (on water or flying) because flying birds are more conspicuous than birds on the water, and we therefore assume that all flying birds will be detected to a maximum distance of 100 m. We will estimate detection functions for all on water seabird observations combined using half- normal and hazard-rate keys with cosine, polynomial or Hermite adjustment terms and include species (marbled murrelet, Kittlitz's murrelet, unknown murrelet, or pigeon guillemot) as a covariate for the detection function. Weather (percent cloud cover and precipitation) and sea state (Beaufort scale and wave height) covariates also will be included as main effects and, for those that prove to be important on average, will be included as interaction effects with species so that the detection function can vary by species and weather or sea state if justified by the data. The full candidate set of models, then, includes two key functions, three adjustment terms, and all main and a limited number of 2-way interactions between species and weather or sea state. We will also include a full model with all main effect and 2-way interactions. We will select the most parsimonious model based on Akaike

Information Criterion. Following Kissling et al. (2007), we will assume the probability of detection on coastal transects is the same as that of the offshore transects, in the respective stratum (inner bay and outer fjords). We will fit detection functions for offshore observations to a maximum distance of 300 m (i.e. the maximum distance for which birds will be counted). For each of four geographic strata, we will calculate variances empirically, using the mean group size, and determine within-stratum confidence intervals using a non-parametric bootstrap (Efron and Tibshirani 1986). For each behavior, we will calculate density as the mean of stratum density weighted by stratum area, and population size as the sum of stratum density multiplied by stratum area. We assume independence between observations, and therefore will sum behavior-specific estimates of population size and variance to estimate total population size and variance (Cochran 1977).

We will estimate within-season densities for the subset of transects that will be repeated during each survey period (early, middle, late) in Aialik Bay and Northwestern Fjord/Harris Bay. For each survey, we will estimate a detection function for all *Brachyramphus* murrelets combined, and for Kittlitz's murrelet, marbled murrelet, and pigeon guillemot individually, on offshore transects included within the subset. We will compute stratified density estimates using a uniform key and cosine adjustment in the program DISTANCE (Thomas et al. 2010).

Spatial density maps will be produced using the 'two-stage' spatial density estimation method (Miller et al. 2013, 2019). In the first stage, standard distance sampling is used to estimate a detection probability along strip transects (described above). The detection probability then serves as an offset in a generalized additive model (GAM, Wood 2017) to estimate a spatial density surface and the effect of other covariates on counts (Miller et al. 2013). Variance of estimates across both stages is then propagated using a parametric bootstrap procedure. Covariates (described above) will be included to describe density and the change in density within and between years. Specifically, we will use the GAM to explore changes in the density surface as a function of time to estimate temporal variance within and between years (e.g., Kissling et al. 2007). Long-term changes in density will be estimated as an average effect of study (Arimitsu et al. 2011 versus that proposed here) and shorter term variance will be estimated as random effect variation within a study across years and as a spatial smooth of date within a season, including examining space-by-time interactions (e.g., Kissling et al. 2007).

Methods applied to coastal transects in Kenai Fjords will be followed to estimate seasonal abundance patterns in Resurrection Bay over a 15-year period (2011-2025). Detection functions to be estimated in the present study will inform past survey data that has relied on within-season replicate surveys to assess variation in count data. Transect densities (birds/km^2) will be used to estimate overall nearshore abundance in upper Resurrection Bay. Data will be log-transformed to estimate long-term (15-year) trends in relative seasonal abundances of the three focal species with simple regression analysis.

Productivity indices based on fledgling surveys are calculated using methods described in Kuletz and Kendall (1998). For each year, core survey period will be selected based on criteria in Kuletz and Kendall (1998), and HY:AHY ratio will be examined. We will explore densities of HY birds, and relationship between densities of HY birds and AHY birds using regression analysis and trends using models described in Gerrodette (1987) and Kuletz and Kendall (1998).

Kachemak Bay Component

Key murrelet habitats will be identified by incorporating environmental covariates when describing murrelet distribution and abundance. The comparable data collected among the murrelet projects will be used to conduct environmental covariate analyses, using both specific physical/biological features (e.g., bathymetry, depth of pycnocline, sea surface temperature, salinity, chlorophyll a, presence of kelp) and each site (Kachemak Bay, Resurrection Bay, etc.) as a proxy for the cumulative effects of location. Using these covariates, we will identify murrelet habitat use and predictors of murrelet abundance.

We will generate population estimates for Kittlitz's and marbled murrelet populations in Kachemak Bay using the program DISTANCE (Thomas et al. 2010). Surveys will follow distance sampling protocol by estimating the perpendicular distance of the murrelet observations on the water to the centerline of the vessel out to 100 m.

A detection function will be estimated for all *Brachyramphus* murrelets. Detection models with species specific detection functions will be estimated and evaluated using model selection techniques. We will also reanalyze murrelet data collected during surveys in 2005-2007, 2011, and 2016 in Kachemak Bay using similar statistical methodology and derive a detection function to provide consistent population estimates for comparison among years, thereby allowing us to analyze long-term trend data for both murrelet species.

We will use spatial distance sampling (Miller et al. 2013) implemented through the R package dsm (Miller et al. 2019) to estimate murrelet density across the study area. These density maps can be used to identify murrelet hot spots in the bay that are consistent across years. In addition, we propose reanalyzing prior historical data using the same spatial distance methodology to determine if there have been changes in murrelet density since 2005. Specifically, the generalized additive model (GAM, Wood 2017) methods used in spatial distance sampling allow for estimation of among years trends and space-time interaction in the density surface (e.g., Kissling et al. 2007).

As we develop our field plans, we will continue to address variance and factors that influence variance in murrelet abundance. Recognizing the power detect change in murrelet populations within a given site, we think that planned integration of information from multiple southcentral Alaska sites will provide a more robust indicator of murrelet trends in the region.

D. Description of Study Area

The Kenai Peninsula Coast Component will take place in the northern Gulf of Alaska along the southeast Kenai Peninsula coast. The study area is located within the spill area and covers coastal areas of the Kenai Fjords from Cape Resurrection to Gore Point (Figure 10). The north, east, south and west bounding coordinates are approximately 60.2475, -149.2892, 59.2784, and -150.8995. The study area contains fjords with tidewater glaciers (Aialik Bay, Northwestern Fjord, and McCarty Fjord), deglaciated fjords (Resurrection Bay and Nuka Bay), a convoluted coastline, and numerous islands. The study area encompasses state and federal lands (including the Alaska Maritime National Wildlife Refuge and the Kenai Fjords National Park). These fjords generally run north-south with open exposure at their southern entrances and island sites which are largely influenced by the physical conditions in the Gulf of Alaska.

The contrasting habitats throughout the study area, including deep water fjords with varying degrees of glaciation, deglaciation and protected riparian versus open marine influences, offer opportunities to investigate preferred habitats of selected species and potential changes that will occur with further glacial recession. In these fjord systems, shallow marine sills mark former submerged glacier termini and separate ocean basins into inner and outer fjords. The outer fjords are exposed to the oceanic conditions of the Gulf of Alaska, while the inner fjords are somewhat estuarine and influenced by runoff from glaciers extending from the Harding Icefield. The uplands at the head of Resurrection Bay possess old-growth forest that provide nesting habitat for marbled murrelet both near the bay and up to at least 15 km inland. While the uplands of Aialik, Northwestern, and

McCarty Fjords have not yet developed old-growth cover suitable to support marbled murrelet nesting, the steep slopes and exposed scree fields of the recently deglaciated upland areas provide nesting habitat for Kittlitz's murrelet. Pigeon guillemot nest in rocky areas along much of the coastline and islands of the inner and outer fjords. All of these differing habitats within our overall study area will provide a rich ecological dataset for meaningful comparisons and contrasts among the three seabirds in the proposed study.

The Kachemak Bay Component will take place in Kachemak Bay, Alaska, a large bay located northeast of the Kennedy Entrance into LCI (Figure 11); the latter is a large tidal estuary that exchanges water with the GOA via the Alaska Coastal Current. Compared to the outer bay (mouth of the bay to Homer Spit), the inner bay (roughly Homer Spit to head of the bay) is characterized by higher surface water temperatures, lower salinity levels, and highly stratified layers with high turbidity (Speckman et al. 2005, Renner et al. 2017). These marine features are largely the result of melting snowpack and glacial runoff along the south shore, and river runoff at the bay head, which flows westward along the north shore. The heterogeneity within the bay results in strong habitat gradients affecting murrelet distribution (Kuletz et al. 2008, Renner et al. 2017). On a broader scale, the range in coastal and marine habitats among the study sites in the spill zone (Figure 1) will allow for robust comparisons in murrelet trends and habitat use throughout the region.

The study area will be bounded in Kachemak Bay by the following coordinates: NW Boundary: 59.698 N, 151.810 W; SW Boundary: 59.437 N, 151.810 W; SE Boundary: 59.721 N, 151.060 W; NE Boundary: 59.788 N, 151.060 W.

4. COORDINATION AND COLLABORATION

We have coordinated collaboration efforts with other programs for the integrated project. We outline the collaboration efforts for both components in this section.

Kenai Peninsula Coast Component

A. Within an EVOSTC Funded Program

Gulf Watch Alaska

We will closely coordinate and collaborate with several related Gulf Watch Alaska (GWA) programs. Our study area overlaps with the GWA study area, which provides opportunities to coordinate directly on field logistics, data collection, and data sharing. Principal Investigators of the Nearshore Benthic Systems in the Gulf of Alaska project (Esler, Coletti, Weitzman), in collaboration with NPS, are conducting research documenting variation in nearshore physical oceanography in relation to tidewater glacial input and quantifying biological responses to that variation across trophic levels in nearshore areas of the Kenai Fjords National Park. This work, focusing on nearshore marine processes, and the proposed project are very complementary and offer strong synergy opportunities on data sharing. Information about forage fish status and trends is available from the GWA Forage Fish project monitoring efforts in Prince William Sound and the Middleton Island research site in the Gulf of Alaska. In addition, we will collaborate with the Oceanographic Conditions in Lower Cook Inlet and Kachemak Bay project conducting oceanographic and plankton monitoring in Kachemak Bay. Investigators of our study will participate in annual GWA PI meetings, facilitating coordination and interactions with the GWA program investigators.

Herring Research and Monitoring

We will coordinate with the Herring Research and Monitoring (HRM) program on opportunities to collaborate and coordinate field plans, data collection, and data sharing efforts to build research and logistical synergies.

Brachyramphus murrelets rely on herring and other small forage fish during the summer breeding season and may therefore be impacted by low herring numbers. Data provided by the HRM program would offer insight into prey availability in southcentral Alaska. We will coordinate collaboration and data sharing opportunities with the program lead.

Data Management

We will provide all data from our project to EVOSTC-funded Data Management program initiatives and produce FGDC compliant metadata in accordance with data management requirements. Data will be archived at the AOOS Workspace and the North Pacific Pelagic Seabird Database (https://www.usgs.gov/centers/asc/science/north-pacific-pelagic-seabird-database?qt-science_center_objects=0#qt-science_center_objects).

B. With Other EVOSTC-funded Projects

Prince William Sound Marine Bird Population Trends (EVOSTC Project 21120114-M)
Marine bird surveys in Prince William Sound will be conducted in July using similar survey methods as we will use. We will coordinate data sharing and analysis to determine murrelet population estimates and trends among the areas and examine environmental conditions and habitats with respect to those trends. These comparisons will only address adult populations, as the PWS surveys do not include August juvenile surveys.

Pigeon Guillemot Restoration Project (EVOSTC Project 21110853)
The proposed project will collaborate with the Pigeon Guillemot Restoration Project for comparisons on available data on pigeon guillemot abundance and trends.

The Seward Line Project (*EVOSTC Project 21120114-L*)
Ongoing research by University of Alaska Fairbanks (Seward Line and Long-Term Ecological Research site) will provide substantial collaborations and opportunities for data sharing on environmental conditions in the study area. The data maps from Ecosystem Observatory buoys will provide a real-time data source for oceanographic conditions in the Gulf of Alaska. Collaboration will be coordinated with PI S. Danielson.

C. With Trustee or Management Agencies

We partner and collaborate with several EVOSTC agencies on the project, including the U.S. Fish and Wildlife Service (USFWS), the National Park Service (NPS), the U.S. Geological Survey (USGS), and the Alaska Department of Fish and Game (ADFG).

Both marbled and Kittlitz's murrelet are species of concern for the USFWS. We will collaborate and coordinate surveys and data sharing with the USFWS and particularly with the Alaska Maritime National Wildlife Refuge (AMNWR), with whom we will partner on both research and public outreach components of the project. Our surveys that include all species of seabirds will provide added value to AMNWR by providing at-sea data of a variety of USFWS trust species, including tufted puffin, a species undergoing a Species Status Assessment.

The USFWS Alaska Region Migratory Bird Management Office (USFWS-MBM) supports this project, and will commit personnel time of the co-investigators for the Kachemak Bay component, ensuring close coordination with other MBM projects in terms of methods, data collection, and data sharing. The project addresses several goals prioritized in the Kittlitz's Murrelet Conservation Action Plan published by the USFWS-MBM Office in 2009 (https://www.fws.gov/migratorybirds/pdf/management/focal-species/KittlitzsMurrelet.pdf).

Kenai Fjords National Park (KEFJ) has an interest in seabird status and trends in the area. The majority of the proposed study area is within or adjacent to the Park. Kittlitz's murrelet breeds in glacial habitats that are changing, and the NPS has a long-term interest in understanding impacts of glacial habitat change on the species. The NPS has committed funding to seabird survey projects that are complementary with the proposed project. In addition to updated data about population status and trends, our project will provide information about murrelet distribution, habitat "hot spots", and potential nursery areas within KEFJ to Park resource managers.

The NPS Southwest Alaska Inventory and Monitoring Program (SWAN) consists of five parks National Parks in Southwest Alaska, including the KEFJ. This project will collaborate with SWAN to coordinate field work and data sharing. In addition, long-term survey data from SWAN will be made available to incorporate into the analytical framework of the proposed project. Efforts are coordinated with H. Coletti (NPS).

The USGS and the NPS are co-leading a research program in Kenai Fjords (Nearshore Ecosystem Response to Deglaciation), offering logistical and research synergies between our proposed project and the ongoing field program. The project is collecting oceanographic data along mid-fjord transects in all the fjords, and we are coordinating collaborations on data collection and sharing with PIs D. Esler (USGS) and D. Kurtz (NPS).

The USGS is conducting research on status of forage fish in Lower Cook Inlet. We will collaborate with PIs M. Arimitsu and J. Piatt.

The ADFG supports our research goals and we will collaborate with the State biologists on data collection and data sharing. The project will open opportunities to develop collaborative research with state biologists on the ecology and status of three seabird species listed as Species of Greatest Conservation Need in Alaska. We are coordinating collaborations with ADFG Biologist K. Christie. We are collaborating with Michelle Kissling and results from her PhD research will inform interpretation of data from our surveys.

The National Oceanic and Atmospheric Administration (NOAA) conduct regular fish surveys in the Gulf of Alaska, providing a source for regional data on trends, abundance, and distribution of forage fish important to murrelets and pigeon guillemots.

To facilitate integration of research, we will organize a workshop focusing on murrelets and their marine habitats and prey. We will invite researchers involved in investigation of murrelets and their prey, as well as resource managers to the workshop to discuss and facilitate integration of data collection and analyses.

D. With Native and Local Communities

The Alaska SeaLife Center, the AMNWR, and KEFJ, are partnering to engage the public and local communities through diverse outreach, education, and community science programs.

With the AMNWR, we will incorporate our seabird project into school lesson plans that the refuge educators are delivering in schools in Homer and Sitka. We will participate in Discovery Labs offered to students and other members of the community in Homer. We will present at local events, including the Kachemak Bay Shorebird

Festival and the Seward Seabird Festival. We will distribute updates about our work and findings in the AMNWR monthly newsletter.

In the Kachemak Bay area, we will work with local communities of Homer, Port Graham, and Seldovia to inform them of our surveys, share results, and potentially integrate regional citizen science data when applicable. We will look to engage in local community outreach events including giving educational talks, informational flyers, coordinating with the Center for Alaska Coastal Studies.

Kenai Fjords National Park has the unique ability to provide high quality and engaging interpretation and education specific to this project. This is due in large part to the park's interpretive operations being delivered via ranger-led boat programming on tour boats within Resurrection Bay and the fjords that make up Kenai Fjords National Park—the specific study areas for this project. Boat programming can reach thousands of visitors and provide an "in the resource" perspective of the project. This is a truly unique opportunity as visitors will learn about the project in the actual study area, have the opportunity to see the Kittlitz's murrelet, marbled murrelet, and pigeon guillemot first-hand and have a National Park Service ranger explain the impacts of the *Exxon Valdez* Oil Spill, long-term study and recovery efforts as well as the positive impact people can have via this continued work. In addition, Kenai Fjords National Park features an award winning distance learning education program that can bring the fjords to life for students during the academic year, serving youth that might otherwise never learn about the *Exxon Valdez* Oil Spill, see the fjords or understand the value of these unique ecosystems. This element can reach an additional one thousand students. In total, Kenai Fjords National Park programming reached 321,596 visitors in 2018. Our contact with Kenai Fjords National Park is Shauna Potocky.

Researchers at the Alaska SeaLife Center will continue a successful community science program with the Seward high school, engaging students as seabird observers to collect fine scale count data along Resurrection Bay shoreline. The student scientists will contribute weekly shore-based bird count data throughout the year, corresponding with marine survey transect adjacent to the Seward shoreline. The Alaska SeaLife Center education team delivers classroom programs in area schools, including Native communities, and our project will provide materials for a seabird module. Video streaming will be available for broadcasting at the SeaLife Center exhibits.

Kachemak Bay Component

A. Within an EVOSTC Funded Program

Gulf Watch Alaska

This project will work closely with the Gulf Watch Alaska program, including attending the annual PI meetings. We will coordinate with Gulf Watch Alaska projects (PWS marine bird surveys, Project 21120114-M; Nearshore monitoring, Project 21120114-H) to collect comparable data on murrelets, permitting more comprehensive inferences on broader populations of Kittlitz's and marbled murrelets in the spill affected area. In addition Dr. Kathy Kuletz is the PI for the marine bird survey component of the LTER Project, and Robb Kaler is the PI for the PWS Marine Bird Survey. Both projects will have field seasons in 2021 and 2022 (and longer for LTER). We will compare data sets among regions to provide a broad perspective on conditions affecting marine birds in the northern Gulf of Alaska. Further, we will collaborate with the LCI oceanographic and plankton monitoring projects of the Kachemak Bay Research Reserve, the USGS forage fish study in LCI, and the Northern Gulf of Alaska Long Term Ecosystem Research project (funded primarily by National Science Foundation and North Pacific Research Board).

Herring Research and Monitoring

Brachyramphus murrelets rely on herring and other small forage fish (Bishop et al. 2015, Day et al. 1999, Piatt et al. 2007) during the summer breeding season and may therefore be impacted by low herring numbers. Data provided by the HRM program would offer insight into prey availability in southcentral Alaska, which may also be reflected in murrelet densities and annual HY population estimates. We have been in contact with the program lead Dr. Scott Pegau to discuss the objectives of the proposed murrelet studies and will look to engage in future collaborative data sharing opportunities.

Data Management

The proposed project will submit data to the EVOSTC-funded Data Management program and produce FGDC compliant metadata in accordance with data management requirements. Data will be archived at the AOOS-Gulf Watch Alaska Workspace and the North Pacific Pelagic Seabird Database (NPPSD) (https://www.usgs.gov/centers/asc/science/north-pacific-pelagic-seabird-database?qt-science_center_objects=0#qt-science_center_objects).

Starting in May 2020 the FWS has been in discussions with partners including, the Alaska SeaLife Center, USGS, and NSP on how to improve data sharing and archival in the NPPSD. We are currently in the process of developing a shared standardize survey software package to conduct marine bird surveys. We anticipate delivery of a beta version of the software by September 2020, which will be tested over the winter, and we plan on using the software for marine bird surveys starting in 2021. The shared data entry platform will standardize the output files and the type of information that is collected during different surveys. Additionally, we are developing a shared data processing software package that all partners will use to conduct data QA/QC, generate densities, and expedite data archival and sharing among projects.

B. With Other EVOSTC-funded Projects

Prince William Sound Marine Bird Population Trends (EVOSTC Project 21120114-M)
Marine bird surveys in Prince William Sound will be conducted in July using survey methodology similar to our Kachemak Bay surveys. We will coordinate data sharing and analysis to determine murrelet population estimates and trends between PWS, Kachemak Bay, and Kenai Fjords/Resurrection Bay and examine environmental conditions and habitats with respect to those trends. These comparisons will only address adult populations, as the PWS surveys do not include August juvenile surveys. We will examine the potential to improve the PWS survey population estimates for Kittlitz's murrelets by adding additional systematic transects in fjords identified as key Kittlitz's murrelet habitat; these transects would be added in 3 to 5 fjords identified as having Kittlitz's murrelet aggregations (Allyn et al. 2012, Kuletz et al. 2003). The PWS Marine Bird Survey will overlap temporally with the Kachemak Bay project in 2021 and 2022. We propose adding systematic transects in known Kittlitz's murrelet regions in PWS during those two years.

Pigeon Guillemot Restoration Project (EVOSTC Project 21110853)
The proposed project will collaborate with the Pigeon Guillemot Restoration Project to share available data on pigeon guillemot abundance and trend data in Kachemak Bay with those obtained in PWS. USFWS-MBM will explore conducting pigeon guillemot colony counts in Kachemak Bay as part of our efforts with AMNWR to recensus seabird colony sites across Alaska. Pigeon guillemot colony counts would be coordinated with methods and standards used by AMNWR and the Kenai Peninsula Coast component.

C. With Trustee or Management Agencies

The proposed project supports the USFWS-MBM mission to advance the conservation of migratory birds. In addition to informing the EVOSTC regarding recovery of impacted resources, the project will inform other management agencies (ADFG, AMNWR, and NPS) with lands and waters adjacent to the proposed study area.

The project has also reached out to ADFG to identify potential opportunities to collaborate on analysis that had been previously conducted by Kelly Nesvacil before she left the agency. We have been informed that ADFG is working with Michelle Kissling to integrate the ADFG data into her current analysis at the University of Montana. We have already been working cooperatively with Michelle Kissling and have involved her in discussions focused on improving our study design based on her work in Glacier Bay. One component of Ms. Kissling's study may be development of a "detection availability" function, based on rate of movement in and out of a study area. If successful, this would further improve our ability to detect population trends. We will continue to maintain this cooperative effort and identify further opportunities for collaboration.

The projects will also coordinate with Kris Holderied at the NOAA Kasitsna Bay Laboratory to identify supplemental sources of oceanographic data being collected in Kachemak Bay. In addition, the impact of tidal influence on murrelets will be quantified during the analysis by incorporating tidal information from the NOAA tide station located in Seldovia.

D. With Native and Local Communities

We will work with local communities of Homer, Port Graham, and Seldovia to inform them of our surveys, share results, and potentially integrate regional citizen science data when applicable. We would look to engage in local community outreach events including giving educational talks, informational flyers, and coordinating with the Center for Alaska Coastal Studies and AMNWR, based in Homer, to identify other cooperative outreach opportunities.

5. DELIVERABLES

Kenai Peninsula Coast Component

Data and metadata: survey count data, habitat variable data, still photo imagery.

Data products: Population size and density estimates, productivity estimates, bird distribution patterns, population trend estimates, phenology.

Reports, publications and presentations: Annual and final programmatic reports, anticipated three peer-reviewed publications, presentations at conferences including the Alaska Marine Science Symposium.

Outreach and education products: Project website, interpretative ranger talks, distance education module, school lesson plan module, project highlight updates in AMNWR Newsletter, project presentations at Kachemak Bay Shorebird Festival, Seward Seabird Festival, and Homer Discovery Labs.

Kachemak Bay Component

Data and metadata: survey data delivered to AOOS/GWA site and submitted to the North Pacific Pelagic Database.

Data products: Reports, summarizing survey results (e.g., murrelet densities, murrelet population estimates, murrelet distribution maps for both species and age groups).

Outreach and education products: Presentations at the Alaska Marine Science Symposium and other seabird or marine-oriented professional meetings.

Integrated research

Final synthesis examining abundance, trend, distribution and habitat use of *Brachyramphus* murrelets throughout the EVOS region.

6. PROJECT STATUS OF SCHEDULED ACCOMPLISHMENTS

Kenai Peninsula Coast Component

Project milestone and task progress by fiscal year and quarter, beginning February 1, 2021. Yellow highlight indicates proposed fiscal year Work Plan. Fiscal Year Quarters: 1= Feb. 1-April 30; 2= May 1-July 31; 3= Aug. 1-Oct. 31; 4= Nov. 1-Jan 31.

	FY21				FY22				FY23				FY24				FY25			
Milestone/Task	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Kenai Fjords surveys																				
Annual planning and preparation	X	X			X	X			X	X										
Surveys		X	X			X	X			X	X									
Annual data summary and submission				X				X				X								
Resurrection Bay surveys																				
Annual planning and preparation	X	X			X	X			X	X			X	X			X	X		
Surveys	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Annual data summary and submission				X				X				X				X				X
Data analysis and synthesis																				
Current population size and trends													X	X	X	X	X	X	X	X
Spatial analysis													X	X	X	X	X	X	X	X
Productivity indices																	X	X	X	X
Reporting																				
Annual reports					X				X				X				X			
FY work plan			X				X				X				X				X	
Final report*																				

Deliverables																				
Peer reviewed paper 1 – Current population size and trends																				X
Peer reviewed paper 2 – Density patterns																				X
Peer reviewed paper 3 - Productivity																				X
Data posted online						x				x				x				x		X

*Final Report will be submitted by March 1, 2025 according to the EVOSTC reporting policy.

Kachemak Bay Component

Project milestone and task progress by fiscal year and quarter, beginning February 1, 2021. Yellow highlight indicates proposed fiscal year Work Plan. Fiscal Year Quarters: 1= Feb. 1-April 30; 2= May 1-July 31; 3= Aug. 1-Oct. 31; 4= Nov. 1-Jan 31.

	FY21				FY22				FY23				FY24				FY25			
Milestone/Task	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Milestone Logistics																				
Field Work Preparations	X				X				X				X							
Conduct July Survey		X				X				X				X						
Conduct August Survey			X				X				X				X					
Milestone 2 Data Management																				
Data QAQC & Metadata			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Analysis & Summary					X				X				X				X			
Reporting																				
Annual reports					X				X				X				X			
FY work plan			X				X				X									
Final report*																				
Annual PI meeting				X				X				X				X				X
Deliverables																				
Peer reviewed paper 1																				X
Data posted online						X				X				X				X		

*Final Report will be submitted by March 1, 2025 according to the EVOSTC reporting policy.

7. Budget

Budget Forms are attached.

Kenai Peninsula Coast Component Budget Summary

Budget Category:	Proposed FY 21	Proposed FY22	Proposed FY23	Proposed FY24	Proposed FY25	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$29,263.0	$30,141.0	$31,045.0	$31,977.0	$32,935.0	$155,361.0	
Travel	$1,585.0	$1,008.0	$1,027.0	$0.0	$670.0	$4,290.0	
Contractual	$72,300.0	$80,469.0	$76,702.0	$49,500.0	$50,985.0	$329,956.0	
Commodities	$5,000.0	$0.0	$0.0	$0.0	$0.0	$5,000.0	
Equipment	$5,000.0	$0.0	$0.0	$0.0	$0.0	$5,000.0	
Indirect Costs (*will vary by proposer*)	$34,291.0	$35,395.0	$34,479.0	$26,073.0	$27,069.0	$157,307.0	
SUBTOTAL	$147,439.0	$147,013.0	$143,253.0	$107,550.0	$111,659.0	$656,914.0	
General Administration (9% of subtotal)	$13,270	$13,231	$12,893	$9,680	$10,049	$59,122	
PROJECT TOTAL	**$160,709**	**$160,244**	**$156,146**	**$117,230**	**$121,708**	**$716,036**	
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	N/A

Kachemak Bay Component Budget Summary

Budget Category:	Proposed FY 20	Proposed FY21	Proposed FY22	Proposed FY23	Proposed FY24	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$51,500.0	$62,933.0	$64,821.4	$66,765.4	$37,704.9	$283,724.7	
Travel	$12,000.1	$15,300.1	$15,696.8	$16,105.9	$9,773.0	$68,875.9	
Contractual	$0.0	$30,000.0	$30,000.0	$30,000.0	$0.0	$90,000.0	
Commodities	$9,500.0	$10,635.0	$12,774.0	$11,317.0	$3,500.0	$47,726.0	
Equipment	$35,200.0	$0.0	$4,000.0	$0.0	$0.0	$39,200.0	
Indirect Costs (*will vary by proposer*)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
SUBTOTAL	$108,200.1	$118,868.1	$127,292.1	$124,188.4	$50,977.9	$529,526.6	
General Administration (9% of subtotal)	$9,738.0	$10,698.1	$11,456.3	$11,177.0	$4,588.0	$47,657.4	
PROJECT TOTAL	**$117,938.1**	**$129,566.2**	**$138,748.4**	**$135,365.3**	**$55,565.9**	**$577,184.0**	
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	N/A

Sources of Additional Funding:

Kenai Peninsula Coast Component. A grant from the NPS will support seasonal coastal surveys in Resurrection Bay during 2021-2023, contributing to year-round survey data and providing data from the outer Bay area. This project also will be supported via Kenai Fjords National Park by providing time for the Chief of Interpretation and Education to guide the development of the interpretive and educational outreach elements based on the research conducted during this study. Contribution is valued at $5,105 (1 pay period of Chief of Interpretation and Education). The Chief of Interpretation will provide supervision to staff who will be responsible for the development and delivery of interpretive and educational programming and all associated resource teaching kits and tangibles. Teaching kit supplies will be purchased via the park's interpretive supply budget. Additional support will include featuring the project, programs and work via Kenai Fjords National Park website and social media. Additional in-kind contributions involve partner staff time to conduct surveys and data analysis.

Kachemak Bay Component. The FY21 estimated budget has been modified to omit the purchase of a new survey vessel, and instead includes the costs of refurbishing the AMNWR's Boston Whaler, which is stored in Homer, AK. The vessel will be loaned to USFWS-MBM to conduct murrelet surveys in Kachemak Bay. The MBM fleet was recently reduced due to age and deterioration of boats and motors. The three boats retained by MBM are required during July to conduct the PWS surveys and therefore not available for this project. Total salary request from EVOSTC over five years is $283,724, and $90,000 for contractual services; the remainder is for operational survey costs, synthesis, and publication. Total request from EVOSTC with 9% GA is $577,184.

The USFWS-MBM, will provide In-kind support of salaries, travel, equipment, lodging, and administrative support, beyond that requested in our budget. Total contributions for contributed salaries and survey support are estimated at $247,748. Specific items of in-kind contribution include:

- Salaries and administrative support for Co-PIs and Biometrician
- Two ruggedized laptops with hand-held GPS (as backups; will require new purchases)
- Develop updated survey software to standardize data collection among partner agencies
- Use of USFWS truck for travel to Homer, AK and hauling boat as necessary
- Use of AMNWR vessel to conduct surveys in Kachemak Bay
- Lodging for field crew at AMNWR bunkhouse in Homer, AK (when available)
- Safety gear for vessel use, misc. equipment as backup
- Historical and concurrent data already available and processed for the study area

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9. Project Personnel

Kenai Peninsula Coast Component

Curriculum vitae for senior personnel is provided.

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Short Curriculum Vitae

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EDUCATION

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PROFESSIONAL INTERESTS

Physiological ecology, marine ornithology, marine ecology, conservation biology, decision analysis

PROFESSIONAL EXPERIENCE

Research Associate Professor of Marine Science (University of Alaska Fairbanks) (2005-)
Research Assistant Professor of Marine Science (University of Alaska Fairbanks) (2002-2005)
Visiting Scientist, U.S. Geological Survey, National Wildlife Health Center,WI (1997-2002)
Assistant Professor of Basic Veterinary Sciences (University of Helsinki) (1992-1996)
Visiting Scientist, National Biological Survey, Pacific Islands Science Center, HI (1994)

SELECTED RELATED AND OTHER PUBLICATIONS

Tanedo, S, and Hollmén, T.E. 2020. Refining remote observation techniques to estimate productivity of Black-legged Kittiwakes *Rissa tridactyla* in Resurrection Bay, Gulf of Alaska, Marine Ornithology 48: 61-69.

Miller, M.W.C., Lovvorn, J.R., Matz, A.C., Taylor, R.J., Latty, C.J., Brooks, M.L., and T.E. Hollmén. 2019. Interspecific patterns of trace elements in sea ducks: Can surrogate species be used in contaminants monitoring? Ecological Indicators 98: 830-839.

Christie, K.S., Hollmén, T.E., Flint, P.L., and D. Douglas. 2018. Non-linear effect of sea ice: Spectacled Eider survival declines at both extremes of the ice spectrum. Ecology and Evolution DOI: 10.1002/ece3.4637.

Churchwell, R.T., Kendall, S. Brown, S.C., Blanchard, A.L., Hollmén, T.E., Powell, A.n. 2017. The first hop: Use of Beaufort Sea deltas by hatch-year semi-palmated sandpipers. Estuarines and Coasts DOI 10.1007/s12237-017-0272-8.

Nichols, J.D., Hollmén, T.E., and J.B. Grand. 2016. Monitoring for the Management of Disease Risk in Animal Translocation Programmes, EcoHealth DOI: 10.1007/s10393-015-1094-4.

Sethi, S.A. and T.E. Hollmén. 2015. Conceptual models for marine and freshwater systems in Alaska: Flexible tools for research planning, prioritization, and communication. Arctic 68:422-434.

Ulman, S.E.G., Hollmén, T.E., Brewer, R., and A.H. Beaudreau. 2015. Predation of seabirds by Pacific cod Gadus macrocephalus near the Aleutian Islands, Alaska. Marine Ornithology 43:231-233.

Hollmén, T.E., and J.C. Franson. 2015. Infectious Diseases, Parasites, and Biological Toxins. In: Sea Ducks in Ecology and Conservation of North American Sea Ducks, Studies in Avian Biology, CRC Press/Taylor & Francis Group.

Rosenberg, D.H., Petrula, M.J., Schamber, J.L., Zwiefelhofer, D., Hollmén, T.E., and D.D. Hill. 2014. Seasonal movements and distribution of Steller's eiders (Polysticta stelleri) wintering at Kodiak Island, Alaska. Arctic 67(3):347-359.

Frost, C.J., Hollmén, T.E., Reynolds, J.H. 2013. Trends in annual survival of Steller's eiders molting at Izembek Lagoon on the Alaska Peninsula, 1993-2006. Arctic 66:173-178.

RECENT COLLABORATORS

Amundson, C. Alaska Science Center, USGS
Christie, K. Alaska Department of Fish and Game
Churchwell, R. Alaska Department of Fish and Game
Coletti, H. Southwest Alaska Network, National Park Service
Counihan, K. Alaska SeaLfe Center
Esler, D. Alaska Science Center, USGS
Flint, P. Alaska Science Center, USGS
Frost, C. Migratory Bird Management, Alaska Region, USFWS
Grand, B. Auburn University
Hatch, S. Institute for Seabird Research and Conservation
Huntington, H. Huntington Consulting
Kutz, S. University of Calgary
Latty, Christopher, Arctic National Wildlife Refuge, USFWS
Lovvorn, J. Southern Illinois University
Maniscalco, J. Alaska SeaLife Center
Matz, A. Fairbanks Fish and Wildlife Field Office, USFWS
Miller, M. Southern Illinois University
Nichols, J. Patuxent Wildlife Research Center, USGS
Oksanen, A. Finnish Food Authority
Powell, A, University of Florida
Reynolds, A. University of Alaska Fairbanks
Romano, M. Alaska Maritime National Wildlife Refuge, USFWS
Schamber, J. Alaska Department of Fish and Game
Sethi, S. Cornell University
Ward, D. Alaska Science Center, USGS
Wilson, H. Migratory Bird Management, Alaska Region, USFWS
Winsor, P. World Wildlife Fund

John M. Maniscalco
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EDUCATION

University of Alaska Fairbanks – Doctor of Philosophy in Marine Biology, May 2015
University of Alaska Fairbanks – Master of Science in Fisheries, May 1997
University of Alaska Southeast – Bachelor of Science in Biology, May 1992

RESEARCH EXPERIENCE

Research Scientist – Alaska SeaLife Center (ASLC) - 6/2000 to present

- Supervise/manage studies of Endangered Steller sea lions including remote video monitoring (behavioral, population, and vital rate studies), scat collection, biopsy darting, brand resightings, and capture, sampling, and branding of pups, video equipment installation/maintenance/repair
- Assist with and supervise seabird monitoring studies including monthly at-sea surveys and remote monitoring research of nesting murres and kittwakes
- Coordination and collaboration with ASLC, NMFS, and ADF&G personnel on a variety of wildlife research objectives, publications, policy considerations, and exchange of technical information
- Apply for and maintain permits for endangered species and land use with USFWS, NMFS, USFS, USCG, and Alaska State Agencies based on environmental assessments and impact statements
- Collect, analyze, publish data, provide conclusions and technical advice on species of concern
- Biopsy dart and collect blubber samples from walrus, work with Alaskan native hunt community for scientific samples and studies, analyze data, write reports
- Supervise diet studies of sport caught fish, analyze data, write reports
- Convey findings of research through oral and poster presentations locally and at international conferences and symposia
- Apply for grants; major and minor grants have been awarded
- Review manuscripts for scientific journals, proposals, and symposium publications
- Operate and service vessels as needed

Researcher – U.S. Fish and Wildlife Service and National Park Service – 5/1992 to 9/1998 –

- At-sea seabird, marine mammal, and acoustic fish surveys – south coastal Alaska
- Pigeon Guillemot nesting and productivity research – Prince William Sound
- Marbled Murrelet dawn watches – Kenai Fjords
- Operating vessels as needed – south coastal Alaska
- Monitoring numbers and behaviors of Steller sea lions and harbor seals – Glacier Bay N.P.

SELECTED PUBLICATIONS

Tanedo, S.A., T.E. Hollmen, **J.M. Maniscalco**, S.E.G. Ulman. *In Review*. Using remote video techniques to identify environmental factors influencing annual productivity of a colony of black-legged kittiwakes (*Rissa tridactyla*) in the Northern Gulf of Alaska.

Maniscalco, J.M., W.D. Ostrand, R.M. Suryan, and D.B. Irons. 2001. Passive interference competition by glaucous-winged gulls on black-legged kittiwakes: a cost of feeding in flocks. Condor. 103(3):616-619.

Maniscalco, J.M., W. Ostrand, and K. Coyle. 1998. Selection of fish schools by flocking seabirds in Prince William Sound, Alaska. Colonial Waterbirds. 21(3):314-322.

Ostrand, W.D., K.O. Coyle, G.S. Drew, **J.M. Maniscalco,** D.B. Irons. 1998. Selection of forage-fish schools by murrelets and tufted puffins in Prince William Sound, Alaska. The Condor 100:286-297.

Maniscalco, J.M., W.D. Ostrand. 1997. Seabird behaviors at forage fish schools in Prince William Sound, Alaska. Pages 175-189 *In*: Proceedings – Forage Fishes in Marine Ecosystems, Alaska Sea Grant College Program, AK-SG-97-01.

Jemison, L.A., G.W. Pendleton, K.K. Hastings, **J.M. Maniscalco,** L.W. Fritz. 2018. Spatial distribution, movements, and geographic range of Steller sea lions (*Eumetopias jubatus*) in Alaska. PLoS ONE 13(12):e0208093.

Maniscalco, J.M., P. Parker. 2018. Maternal and offspring effects on the timing of parturition in Steller sea lions. Canadian Journal of Zoology 96:333-339.

Maniscalco, J.M., A.M. Springer, M.D. Adkison, P. Parker. 2015. Population trend and elasticities of vital rates for Steller sea lions (*Eumetopias jubatus*) in the eastern Gulf of Alaska: A new life history table analysis. PLoS ONE 10(10):e0140982.

Maniscalco, J.M., A.M. Springer, P. Parker, M.D. Adkison. 2014. A longitudinal study of Steller sea lion natality rates in the Gulf of Alaska with comparisons to census data. PLoS ONE 9(11):e111523.

Maniscalco, J.M. 2014. The effects of birth weight and maternal care on survival of juvenile Steller sea lions (*Eumtopias jubatus*). PLoS ONE 9(5):e96328.

Maniscalco, J.M., A.M. Springer, P. Parker. 2010. High natality rates of endangered Steller sea lions in Kenai Fjords, Alaska and perceptions of population status in the Gulf of Alaska. PLoS ONE 5(4):e10076.

Maniscalco, J.M., A. Hoover-Miller, D. Zatz. 2008. Remote monitoring of pinnipeds in Kenai Fjords National Park. Alaska Park Science 7:12-17.

Maniscalco, J.M., D.G. Calkins, P. Parker, S. Atkinson. 2008. Causes and extent of natural mortality among Steller sea lion (*Eumetopias jubatus*) pups. Aquatic Mammals 34:277-287.

Maniscalco, J.M., C. O. Matkin, D. Maldini, S. Atkinson, D.G. Calkins. 2007. Assessing killer whale predation on Steller sea lions from field observations in Kenai Fjords, Alaska. Marine Mammal Science 23:306-321.

Maniscalco, J.M., P. Parker, S. Atkinson. 2006. Interseasonal and interannual measures of maternal care among individual Steller sea lions. Journal of Mammalogy 87:304-311.

Recent Collaborators

Adkison, M. D. – University of Alaska Fairbanks
Fritz, L. W. – National Marine Fisheries Service, Alaska Fisheries Science Center
Hastings, K. K. – Alaska Department of Fish & Game
Hollmen, T. E. – Alaska SeaLife Center
Jemison, L. A. – Alaska Department of Fish & Game
Parker, P. – Alaska SeaLife Center
Pendleton, G. W. – Alaska Department of Fish & Game
Springer, A. M. – University of Alaska Fairbanks
Tanedo, S. A. – U.S. Fish and Wildlife Service, Alaska Maritime National Wildlife Center
Ulman, S. E. G. – Alaska SeaLife Center

Current Licenses & Certificates

- USCG Licensed Captain of vessels up to 100 gross tons on near coastal waters
- First Aid, CPR/AED
- 24 hr HAZWOPER

Marc D. Romano
Curriculum Vitae

Wildlife Biologist, Alaska Maritime National Wildlife Refuge, 95 Sterling Highway Suite 1, Homer AK 99603

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Education

M.Sc., Wildlife Science, Oregon State University, December, 1999
Thesis topic: Effect of diet on growth and development of seabird chicks
B.S., Environmental Studies, SUNY Environmental Science and Forestry College, May, 1993

Relevant Work Experience

April 2012 – present: Wildlife Biologist, USFWS, Alaska Maritime National Wildlife Refuge

Currently the lead biologist in charge of wildlife monitoring and research activities on refuge islands in the Bering Sea Unit of the Alaska Maritime NWR. Supervise field camps and a staff of seasonal wildlife technicians who conduct inventory and monitoring work in the Pribilof Islands. Lead point of contact for Refuge partners contributing to our work in the Bering Sea including state and federal agencies, Tribal governments, non-profit organizations, and university researchers.

September 2009 – April 2012: Marine Biologist, NMFS, Protected Resources Division

Was responsible for endangered species listing, critical habitat designation, and recovery planning for threatened and endangered marine species. Supported NEPA assessments and biological consultations for activities that had the potential to affect listed species.

October 2006 – September 2009: Wildlife Biologist, USFWS, Migratory Bird Management

Served as Project Leader in charge of a large-scale, long-term biological research and monitoring program within Papahanaumokuakea Marine National Monument. Coordinated field activities and supervised technicians at three remote monitoring sites within the monument. Authored a species status assessment for Laysan and black-footed albatross. Represented USFWS Region 1 Office of Migratory Bird Management at scientific meetings, including meetings of the North Pacific Albatross Working Group.

January 2003 – October 2006: Wildlife Biologist, USGS-BRD, Alaska Science Center

Coordinated and led seabird and fisheries research and monitoring projects in Glacier Bay and Kenai Fjords National Parks. Recruited, trained, and supervised several crews of biological technicians conducting fieldwork. Designed and conducted seabird and marine mammal surveys in the Gulf of Alaska and Aleutian Islands.

Select and Relevant Professional Publications

Robinson, B.W., Johnson, A.S., Lovette, I.J., Romano, M.D. 2019. Potential northward expansion of the breeding range of Red-legged Kittiwake *Rissa brevirostris*. Marine Ornithology 47: 229-234.

Sydeman W.J., Thompson S.A, Piatt J.F., Garcia-Reyes M., Zador S., Williams J.C., Romano, M., Renner, H.M. 2017. Regionalizing indicators for marine ecosystems: Bering Sea–Aleutian Island seabirds, climate, and competitors. Ecological Indicators; 78: 458–469.

Renner, H.M., Romano, M.D., Renner, M., Pyare, S., Goldstein, M.I. & Arthukin, Y. 2015. Assessing the breeding distribution and population trends of the Aleutian Tern Onychoprion aleutica. Marine Ornithology 43: 179–187.

Edwards A.E., Fitzgerald S.M., Parrish J.K., Klavitter J.L., Romano M.D. 2015. Foraging Strategies of Laysan Albatross Inferred from Stable Isotopes: Implications for Association with Fisheries. PLoS ONE 10(7): e0133471.

Gutowsky, S.E., L.F.G. Gutowsky, I.D. Jonsen, M.L. Leonard, M.B. Naughton, M.D. Romano and S.A. Shaffer. 2014. Daily activity budgets reveal a quasi-flightless stage during non-breeding in Hawaiian albatrosses. Movement Ecology. 2:23.

Arimitsu, M., J. Piatt, E. Madison, M. Romano, and T. van Pelt. 2011. Status and distribution of the Kittlitz's Murrelet in Kenai Fjords, Alaska. Marine Ornithology 39:13-22

Madison, E., J. Piatt, M. Arimitsu, M. Romano, T. van Pelt, K. Nelson, J. Williams, A. DeGange. 2011. Status and distribution of the Kittlitz's Murrelet along the Alaska Peninsula, Kodiak, and Aleutian Islands, Alaska. Marine Ornithology 39:111-122

Piatt, J., M. Arimitsu, G. Drew, E. Madison, J. Bodkin, and M. D. Romano. 2011. Status and trends of the Kittlitz's Murrelet Brachyramphus Brevirostris in Glacier Bay, Alaska. Marine Ornithology 39:65-75

Arimitsu, M. L., J. F. Piatt, M. D. Romano, E .N. Madison, and J. S. Conaway. 2010. Kittlitz's and Marbled Murrelets in Kenai Fjords National Park, south-central Alaska: At-sea distribution, abundance, and foraging habitat, 2006–08: U.S. Geological Survey Open-File Report 2010-1181, 68p.

Romano, M.D., J.F. Piatt, H.R. Carter. 2007. First successful radio-telemetry study of Kittlitz's murrelet: problems and potential, in Piatt, J.F., and Gende, S.M., eds., Proceedings of the Fourth Glacier Bay Science Symposium, October 26–28, 2004: U.S. Geological Survey Scientific Investigations Report 2007-5047.

Select Recent Collaborators

Dr. Aaron Christ – U.S. Fish and Wildlife Service, Alaska Maritime National Wildlife Refuge
Dr. Douglas Causey – University of Alaska, Anchorage
Dr. Robert Gill – U.S. Geological Survey, Alaska Science Center
Dr. Dennis Griffin – Oregon State Historic Preservation Office
Dr. Tuula Hollmen – Alaska SeaLife Center
James Johnson – U.S. Fish and Wildlife Service, Office of Migratory Bird Management
Robert Kaler – U.S. Fish and Wildlife Service, Office of Migratory Bird Management
Dr. Nabuo Kokubun – National Institute of Polar Research, Japan
Dr. Kathy Kuletz – U.S. Fish and Wildlife Service, Office of Migratory Bird Management
Dr. Irby Lovette – Cornell University, Laboratory of Ornithology
Dr. John Maniscalco – Alaska SeaLife Center
Dr. Steve Matsuoka – U.S. Geological Survey, Alaska Science Center
Dr. Rachael Orben – Oregon State University
Dr. John Pearce - U.S. Geological Survey, Alaska Science Center
Dr. John Piatt – U.S. Geological Survey, Alaska Science Center
Dr. Julia Parrish – Universtiy of Washington
Heather Renner – U.S. Fish and Wildlife Service, Alaska Maritime National Wildlife Refuge
Dr. Martin Renner – Tern Again Consulting
Rachel Richardson – U.S. Geological Survey, Alaska Science Center
Dr. Daniel Ruthrauf – U.S. Geological Survey, Alaska Science Center
Dr. Joel Schmutz - U.S. Geological Survey, Alaska Science Center
Dr. William Sydeman – Farallon Institute
Dr. Akinori Takahashi - National Institute of Polar Research, Japan
Dr. Audrey Taylor - University of Alaska, Anchorage
Gerrit Vyn – Cornell University, Laboratory of Ornithology
Dr. Stepahni Zador – National Marine Fisheries Service, Alaska Fisheries Science Center

Erik E. Osnas
Division of Migratory Bird Management, U.S. Fish and Wildlife Service, Alaska Region

EDUCATION

2004 *Ph. D. – Ecology, Evolution and Behavior,* Indiana University.
1998 *Master of Science - Zoology,* University of Western Ontario.
1995 *Bachelor of Science - Wildlife and Fisheries Biology,* University of California, Davis.

PROFESSIONAL EXPERIENCE

2015 to present, Wildlife Biologist (Biometrician), Division of Migratory Bird Management, U.S. Fish and Wildlife Service, Alaska Region
2012 to 2015, Wildlife Biologist/Post-doctoral Research Associate, USGS Patuxent Wildlife Research Center, Laurel, Maryland
2012 Lecturer, Department of Ecology and Evolutionary Biology, Princeton University
2008 to 2012, Post-doctoral Research Associate, Princeton University
2005 to 2008, Assistant Scientist, Department of Forest and Wildlife Ecology, University of Wisconsin

SELECTED PUBLICATIONS

Kuletz, K. J., Cushing, D. A., Osnas, E. E., Labunski, E. A., & Gall, A. E. (2019). Representation of the Pacific Arctic seabird community within the Distributed Biological Observatory array, 2007–2015. *Deep Sea Research Part II: Topical Studies in Oceanography*.
Jennelle, C. S., Walsh, D. P., Samuel, M. D., Osnas, E. E., Rolley, R., Langenberg, J., ... & Heisey, D. M. (2018). Applying a Bayesian weighted surveillance approach to detect chronic wasting disease in white-tailed deer. *Journal of applied ecology*, *55*(6), 2944-2953.
Fleming-Davies, A. E., Williams, P. D., Dhondt, A. A., Dobson, A. P., Hochachka, W. M., Leon, A. E., Osnas, E.E. & Hawley, D. M. (2018). Incomplete host immunity favors the evolution of virulence in an emergent pathogen. *Science*, *359*(6379), 1030-1033.
Cohen, J. B., Hecht, A., Robinson, K. F., Osnas, E. E., Tyre, A. J., Davis, C., ... & Melvin, S. M. (2016). To exclose nests or not: structured decision making for the conservation of a threatened species. *Ecosphere*, *7*(10), e01499.
Osnas, E. E., Zhao, Q., Runge, M. C., & Boomer, G. S. (2016). Cross-seasonal effects on waterfowl productivity: Implications under climate change. *The Journal of wildlife management*, *80*(7), 1227-1241.
Osnas, EE, P Hurtado, and AP Dobson. 2015. Evolution of virulence across space during an epidemic. *American Naturalist*, *185*(3), 332-342.
Heisey, DM, EE Osnas, P Cross, DO Joly, JA Langenberg, and MW Miller. 2010. Linking process to pattern: estimating spatiotemporal dynamics of a wildlife epidemic from cross-sectional data. *Ecological Monographs,* 80: 221-240.
Osnas, EE, DM Heisey, R Rolley, and MD Samuel. 2009. Spatial and temporal patterns of chronic wasting disease: fine scale mapping of a wildlife epidemic in Wisconsin. *Ecological Applications,* 19: 1311-1322.

COLLABORATORS

Boomer, Scott, Division of Migratory Bird Management, U.S. Fish and Wildlife Service
Cushing, D. A., Pole Star Ecological Research, LLC. Anchorage, AK
Dhondt, Andre. A., Corrnell Lab of Ornithology & Department of Ecology and Evolution, Cornell University

Dobson, Andrew P., Department of Ecology and Evolution, Princeton University
Fischer, Julian, Division of Migratory Bird Management, U.S. Fish and Wildlife Service
Fleming-Davies, A. E, Department of Biology, University of San Diego
Frost, Charles, Division of Migratory Bird Management, U.S. Fish and Wildlife Service
Gall, A. E, ABR, Inc., Environmental Research & Services
Hawley, Dana M., Department of Biological Sciences, Virginia Tech
Heisey, D. M., USGS National Wildlife Health Center (retired)
Hochachka, W. M., Cornel Lab of Ornithology, Cornell University
Hurtado, Paul, Department of Mathematics and Statistics, University of Nevada, Reno
Jennelle, C. S., Minnesota Department of Natural Resources
Kuletz, Kathy, Division of Migratory Bird Management, U.S. Fish and Wildlife Service
Labunski, Elizabeth A., Division of Migratory Bird Management, U.S. Fish and Wildlife Service
Runge, Michael, USGS Patuxent Wildlife Research Center
Samuel, M. D., USGS Cooperative Wildlife Research Unit, University of Wisconsin (retired)
Walsh, D. P., USGS National Wildlife Health Center
Zhao, Qing, Department of Wildlife Ecology, University of Missouri

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Education

M.S. Wildlife Ecology, University of Delaware, Newark, Delaware, 2011
Thesis: Migratory Shorebird and Vegetation Evaluation of Chickaloon Flats, Kenai National Wildlife Refuge, Alaska
B.A. Zoology, University of Wisconsin, Madison, Wisconsin, 2004

Work Experience

2015– present Research Associate, Alaska SeaLife Center, Seward, Alaska
2013–2015 Research Coordinator, Alaska SeaLife Center, Seward, Alaska
2011–2013 Research Technician, Alaska SeaLife Center, Seward, Alaska
2008–2011 Graduate Research Assistant, Department of Entomology and Wildlife Ecology, University of Delaware, Delaware
2007 –2008 Assistant Aviculturist- AmeriCorps, Alaska SeaLife Center, Seward, AK
2007 Sandhill Crane Research Field Technician, Northern Prairie Wildlife Research Center, U.S.G.S., Jamestown, North Dakota
2006 Grassland Bird Research Field Technician, Wisconsin DNR and UW-Madison Department of Wildlife Ecology, Madison, Wisconsin
2005 Ruffed Grouse Surveyor, UW-Madison Department of Wildlife Ecology, Chatfield, Manitoba, Canada
2005 Wild Turkey Research Field Technician, Wisconsin DNR and UW-Madison Department of Wildlife Ecology, Madison, Wisconsin
2003–2004 Undergraduate Research Assistant, William Karasov Laboratory, UW-Madison Department of Wildlife Ecology, Madison, Wisconsin
2003 Purple Loosestrife Biological Control Intern, Wisconsin DNR Research Center, Monona, Wisconsin
2002 Mentored Undergraduate Field Research, Center of Limnology, UW- Madison, Madison, Wisconsin

Relevant and Other Publications

Tanedo, S.A., Hollmen T.E., Maniscalco, J.M., and S.E.G. Ulman. *in review.* Using remote video techniques to identify environmental factors influencing annual productivity of a colony of Black-legged Kittiwakes (*Rissa tridactyla*) in the Northern Gulf of Alaska. Condor.

Hollmen, T.E., Ulman, S.E.G., Tanedo, S., and Maniscalco, J. M. 2017. Seabirds as indicators of coastal ecosystem condition and change. Final Progress Report to Ocean Alaska Science and Learning Center, National Park Service.

Ulman, S.E.G., T. E. Hollmén, R. Brewer, and A. H. Beaudreau. 2015. Predation on seabirds by Pacific Cod (*Gadus Macrocephalus*) near the Aleutian Islands, Alaska. Marine Ornithology, 43, 231-233.

Ulman, S.E.G., Williams, C. K., Morton, J. M., DeLiberty, T. L., and B. N. Ness. 2019. Vegetation change on an Alaska estuary after the 1964 Great Alaska Earthquake. Northwest Science, 93, 16-22.

Recent Collaborators
Tracy DeLiberty, University of Delaware
Dan Esler, U.S.G.S- Alaska Science Center
Paul Flint, U.S.G.S- Alaska Science Center
Tuula Hollmen, Alaska SeaLife Center and University of Alaska- Fairbanks
John Maniscalco, Alaska SeaLife Center
John Morton, U.S. Fish and Wildlife Service
Brenna Ness, University of Delaware
Sarah Tanedo, Alaska SeaLife Center
Chris Williams, University of Delaware

Kachemak Bay Component

Curriculum vitae for senior personnel is provided

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EDUCATION

2013 *Post Baccalaureate Degree*- Geographic Information Systems and Remote Sensing, University of Alaska

2000 *Bachelor of Science*- Wildlife Biology, State University of New York College of Environmental Science and Forestry

PROFESSIONAL EXPERIENCE

2001-present Wildlife Biologist, U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage Alaska

2000-1999 Wildlife Biologist, U.S. Geological Survey, Alaska Science Center, Anchorage Alaska

SELECT PUBLICATIONS

Kuletz, K. J., Cushing, D. A., Osnas, E. E., **Labunski**, E. A., & Gall, A. E. (2019). Representation of the Pacific Arctic seabird community within the Distributed Biological Observatory array, 2007–2015. *Deep Sea Research Part II: Topical Studies in Oceanography*.

R. Kaler, E. **Labunski**, and K. Kuletz. 2018. Prince William Sound marine bird population trends, 2012-2016. Exxon Valdez Oil Spill Long-term Monitoring Program Final Report.

Renner, M, Kuletz, K. J, **Labunski**, E. 2017. Seasonality of Seabird Distribution in Lower Cook Inlet. US Dept. of the Interior, Bureau of Ocean Energy Management, Alaska OCS Regional Office, Anchorage, AK. OCS Study BOEM 2017-011 Available at: https://www.boem.gov/2017-011/

Kuletz, K.J., Speckman, S.G., Piatt, J.F. & **Labunski**, E.A. 2011. Distribution, population status and trends of Kittlitz's Murrelet *Brachyramphus brevirostris* in Lower Cook Inlet and Kachemak Bay, Alaska. *Marine Ornithology* 39: 85–95.

Kuletz, K.J., **Labunski**, E.A. & Speckman, S.G. 2008. Abundance, distribution, and decadal trends of Kittlitz's and marbled murrelets and other marine species in Kachemak Bay, Alaska. Final Report, Project No. 14. Anchorage, AK: US Fish and Wildlife Service.

Kuletz, K. J., S.W. Stephensen, D.B. Irons, E.A. **Labunski**, & K.M. Brenneman. 2003. Changes in distribution and abundance of Kittlitz's murrelets *Brachyramphus brevirostris* relative to glacial recession in Prince William Sound, Alaska. *Marine Ornithology* 31:133-140.

Kuletz, K.J., M.C. Ferguson, B.H. Hurley, A.E. Gall, E.A. **Labunski**, & T.C. Morgan. 2015. Seasonal spatial patterns in seabird and marine mammal distribution in the eastern Chukchi and western Beaufort seas: Identifying biologically important pelagic areas. *Progress in Oceanography* 136:175-200.

Suryan, R.M., K.J. Kuletz, S.L. Parker-Setter, P.H. Ressler, M.T Renner, J.K Horne, E.V. Farley, & E.A. **Labunski**. 2016 Temporal shifts in seabird population and spatial coherence with pretty in the southeastern Bering Sea. *Marine Ecology Progress Series* 549:199-215.

RECENT COLLABORATORS

Adrian Gall (ABR Inc.), Dan Cushing (Pole Star Ecological Research), Ed Farley (NOAA Fisheries), Megan Ferguson (NOAA Marine Mammal Program), Jackeline Grebmeier (University of Maryland), Kris Holderied (NOAA Kasitsna Bay), Russ Hopcroft (University of Alaska), Katrin Iken (University of Alaska), Robb Kaler (USFWS Migratory Bird Management), Kathy Kuletz (USFWS Migratory Bird Management), Sue Moore (NOAA), Erik Osnas (USFWS Migratory Bird Management), Heather Renner (Alaska Maritime NWR), Martin Renner (Tern Again Consulting), R. Suryan (NOAA).

Dr. KATHY J. KULETZ

U.S. Fish and Wildlife Service (USFWS)

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PROFESSIONAL PREPARATION

Ph.D. Biology Univ. of Victoria, B.C., Canada (2005)

M. S. Ecology & Evolutionary Biology University of California, Irvine (1983)

B. S. Wildlife Ecology CA State Polytech. U., San Luis Obispo (1974)

APPOINTMENTS

2014-current Seabird Coordinator, Migratory Bird Management, USFWS, Anchorage, Alaska

2009-current Expert member, Circumpolar Seabird Group (CAFF Arctic Council)

2004-current Short-tailed Albatross Recovery Team (Endangered Species/ USFWS)

2015-2016 Chair, Pacific Seabird Group (http://www.pacificseabirdgroup.org/)

2007-2012 Science & Statistical Committee of North Pacific Fisheries Management Council

2000–2006 NOAA/N. Pacific Fisheries Manage. Council Groundfish Fisheries Plan Team

1998-2014 Seabird Specialist, Migratory Bird Management, USFWS, Anchorage, Alaska

SYNERNISTIC ACIVITIES RELEVANT TO THE PROPOSED PROJECT

- PI -'Seabird Distribution in the Offshore Environment' (2010–current; BOEM IA)
- Co-PI for 'Seward Line Long-term Monitoring Project' (2014-2024; NPRB grants)
- Co-PI for GulfWatchAlaska surveys, Prince William Sound (2012-2022; EVOS grants)
- Co-PI on multiple Arctic research programs (AMBON, AIERP, ArcticEIS, SOAR)
- PI for 'Aleutian Islands Seabird Risk Assessment' (2012- 2015; USFWS special grant)
- PI for Seabirds, Bering Sea Integrated Research Program (2008-2012; NPRB grant)
- Co-PI for 'Seabirds as Predators on Juvenile Herring' (2006-2013; EVOS grant)
- PI for North Pacific Pelagic Seabird Observer Program (2006-2008; NPRB grant)
- PI and Co-PI for multiple *Exxon Valdez* Oil Spill (EVOS) projects, 1989 - 1999
- Co-PI for seabird projects in Lower Cook Inlet (BOEM, EVOS, ADFG, USFWS)
- Assisted NOAA & NPFMC with Programmatic Environmental Impact Statements
- Collaboration with NOAA and Univ. of Washington, studies of fisheries seabird bycatch
- Detailed during Deepwater Horizon Oil Spill – assisted implementation of studies

- Marine Important Bird Areas Committee (Audubon working group)
- Reviewer for several peer-reviewed journals and lead reviewer for seabirds for United Nations World Ocean Assessment (http://www.worldoceanassessment.org/)
- Lead author, seabird sections, for State of the Arctic Marine Biodiversity Report (CAFF/Arctic Council) and the Central Arctic Ocean Assessment (ICES/PAME)

SELECTED PUBLICATIONS RELEVANT TO THIS PROJECT

Allyn, A.J., A. McKnight, K. McGarigal, C.R. Griffin, K.J. **Kuletz**, and D.B. Irons. 2012. Relationships among Kittlitz's murrelet habitat use, temperature-depth profiles, and landscape features in Prince William Sound, Alaska, USA. *Marine Ecology Progress Series* 466:233-247.

Day, R.H., **Kuletz**, K.J. & Nigro, D.A. 1999. Kittlitz's Murrelet (*Brachyramphus brevirostris*). In Poole, A. (Ed). The birds of North America, No. 435. Philadelphia, PA, & Washington, DC: Academy of Natural Sciences & American Ornithologists' Union.

Kuletz, K., D. A. Cushing, E.E. Osnas, E.A. Labunski, A.E. Gall. 2019. Representation of the Pacific Arctic seabird community within the Distributed Biological Observatory array, 2007-2015. *Deep Sea Research II,* 162:191-210.

Kuletz, K.J., Speckman, S.G., Piatt, J.F. & Labunski, E.A. 2011. Distribution, population status and trends of Kittlitz's Murrelet *Brachyramphus brevirostris* in Lower Cook Inlet and Kachemak Bay, Alaska. *Marine Ornithology* 39: 85–95.

Santora, J.A., L.B. Eisner, K.J. **Kuletz**, C. Ladd, M. Renner, G.L. Hunt Jr. 2018. Biogeography of seabirds within a high-latitude ecosystem: Use of a data assimilative ocean model to assess impacts of mesoscale oceanography. *J. Marine Systems* 178: 38–51.

Other relevant publications:

Kuletz, K., M. Ferguson, A. Gall, B. Hurley, E. Labunski, T. Morgan. 2015. Seasonal Spatial Patterns in Seabird and Marine Mammal Distribution in the Eastern Chukchi and Western Beaufort Seas: Identifying Biologically Important Pelagic Areas. *Progress in Oceanography* 136:175-200.

Kuletz, K. J., S.W. Stephensen, D.B. Irons, E.A. Labunski, & K.M. Brenneman. 2003. Changes in distribution and abundance of Kittlitz's murrelets *Brachyramphus brevirostris* relative to glacial recession in Prince William Sound, Alaska. *Marine Ornithology* 31:133-140.

Kuletz, K.J., Nations, C.S., Manly, B.F.J., Allyn, A., Irons, D.B. & Mcknight, A. 2011. Distribution, abundance, and population trends of the Kittlitz's Murrelet *Brachyramphus brevirostris* in Prince William Sound, Alaska. *Marine Ornithology* 39: 97–109.

Moore, S. and K. **Kuletz**. 2019. Marine birds and mammals as ecosystem sentinels in and near Distributed Biological Observatory regions: an abbreviated review of published accounts and recommendations for integration to ocean observatories. *Deep Sea Research II,* 162:211-217. https://doi.org/10.1016/j.dsr2.2018.09.004

Smith MA, Sullender BK, Koeppen WC, **Kuletz** KJ, Renner HM, et al. 2019. An assessment of climate change vulnerability for Important Bird Areas in the Bering Sea and Aleutian Arc. *PLOS ONE* 14(4): e0214573. https://doi.org/10.1371/journal.pone.0214573

RECENT COLLABORATORS

C. Ashjian (Woods Hole Ocean. Inst.); M.A. Bishop (Prince William Sound Science Center); Kelly Benoit-Bird (Oregon State U.); R. Day (ABR, Inc., Fairbanks); E. Farley (NOAA); M. Ferguson (NOAA); A. Gall (ABR); J. Grebmeier (U. Maryland); R. Hopcroft (U. of Alaska, Fairbanks); G. L. Hunt, Jr. (U. Washington); A. Kataysky (UAF); S. Moore (NOAA); F. Mueter (UAF); S. Parker-Stetter (U. Washington); J. Piatt (Alaska Science Center, USGS); H. Renner (USFWS); M. Renner (Tern Again Consulting); M. Sigler (NOAA); R. Suryan (NOAA); A. Trites (U. British Columbia).

Graduate Students advised (on their committees and using data collected during my projects):

Athina Catherine Pham (MS, 2016) – Hawaii Pacific University, Honolulu, HI

Nathan Jones (MS, 2012) – Moss Landing Marine Lab, Moss Landing, CA

Brian Hoover (MS, 2012) - Moss Landing Marine Lab, Moss Landing, CA

Andrew Allyn (MS, 2011) - University of Massachusetts Amherst, MA

ROBERT (ROBB) KALER

CURRICULUM VITAE

WILDLIFE BIOLOGIST, US FISH AND WILDLIFE SERVICE, 1011 EAST TUDOR ROAD, ANCHORAGE ALASKA 99503

EDUCATION

2007 – M.Sc, Kansas State University, Manhattan, KS (Biology)
1997 – B.Sc, The Evergreen State College, Olympia, WA (Wildlife Biology)

WORK EXPERIENCE (2002-present)

2010-present ~Wildlife Biologist, Migratory Bird Management, US Fish and Wildlife Service (USFWS), Anchorage, Alaska
2008-2011 ~ Principle Investigator: Kittlitz's murrelet breeding biology study at Agattu Island, Alaska Maritime National Wildlife Refuge-USFWS, Homer, Alaska
2005-2007 ~ Graduate Research Assistant, Kansas State University, Kansas. Project: Restoring Evermann's Rock Ptarmigan at Agattu Island, Western Aleutian Islands, Alaska

PUBLICATIONS (2009-present)

Dragoo, D.E., H.M. Renner, and R.S.A. **Kaler**. 2019. Breeding status and trends of seabird in Alaska, 2018. U.S. Fish and Wildlife Service Report AMNWR 2019/03. Homer, Alaska.

R. Kaler, E. Labunski, and K. Kuletz. 2018. Prince William Sound marine bird population trends, 2012-2016. Exxon Valdez Oil Spill Long-term Monitoring Program Final Report.

Savage, S., L. Tibbitts, K. Sesser, and **R. Kaler**. 2018. Inventory of lowland-breeding birds on the Alaska Peninsula. Journal of Fish and Wildlife. Accepted May 2018.

Kenney, L.A., R. **Kaler**, M. Kissling, A.L. Bond, and C.A. Eagles-Smith. 2018. Mercury concentrations in multiple tissues of Kittlitz's murrets (Brachyramphus brevirostris). Marine Pollution Bulletin 129:675-680.

Dragoo, D.E., H.M. Renner, and R.S.A. **Kaler**. 2017. Breeding status and trends of seabird in Alaska, 2015. U.S. Fish and Wildlife Service Report AMNWR 201/02. Homer, Alaska.

Esler, D., B. Ballachey, C. Matkin, D. Cushing, R. **Kaler**, J. Bodkin, D. Monson, G. Esslinger, and K. Kloecker. 2017. Timelines and mechanisms of wildlife population recovery following the Exxon Valdez oil spill. Deep Sea Research Part II 147:36-42.

Felis, J.J., M.L. Kissling, R.S.A. **Kaler**, L.A. Kenney, and M.J. Lawonn. 2016. Identifying Kittlitz's Murrelet nesting habitat in North America at the landscape scale. Journal of Fish and Wildlife Management.

Dragoo, D.E., H.M. Renner, and R.S.A. **Kaler**. 2016. Breeding status and trends of seabird in Alaska, 2015. U.S. Fish and Wildlife Service Report AMNWR 2016/03. Homer, Alaska.

Kaler, R.S.A., L.A. Kenney, A.L. Bond, and C.A. Eagles-Smith. 2014. Mercury concentrations in breast feathers of three upper trophic level predators from the western Aleutian Islands, Alaska. Archives of Environmental Toxicology.

Kenney, L.A. and R.S.A. **Kaler**. 2013. Identifying nesting habitat of Kittlitz's Murrelet Brachyramphus brevirostris: Old nests lead to a new breeding record. Marine Ornithology 41:95-96.

Gregory, A.J., R.S.A. **Kaler**, T.J. Prebyl, B.K. Sandercock, and S.M. Wisely. 2012. Influence of translocation strategy and mating system on the genetic structure of a newly established population of island ptarmigan. Conservation Genetics 13:465-474.

Kaler, R.S.A., and B.K. Sandercock. 2011. Effects of translocation on the behavior of island ptarmigan in B.K. Sandercock, K Martin, and G. Degelbacher (eds.). Ecology, conservation, and management of grouse. Studies in Avian Biology 39:295-306.

Manning, J. A. and R.S.A. **Kaler**. 2011. Effects of survey methods on Burrowing Owl Behaviors. Journal of Wildlife Management 75:525-530.

Braun, C.E., W.P. Taylor, S.E. Ebbert, R.S.A. **Kaler**, and B.K. Sandercock. 2011. Protocols for successful translocation of ptarmigan. In R. T. Watson, T. J. Cade, M. Fuller, G. Hunt, and E. Potapov (eds.). Gyrfalcons and ptarmigan in a changing world. The Peregrine Fund, Boise, Idaho, USA.

Kaler, R., S. Ebbert, C. Braun, and B. Sandercock. 2010. Demographic measures of translocation success: reintroduction of an island population of Evermann's Rock Ptarmigan. Wilson Journal of Ornithology 122:1-14 (Winner of 2010 Edwards Prize (Best Paper of the Year).

Kaler, R., L. Kenney, and B. Sandercock. 2009. Breeding ecology of Kittlitz's Murrelets at Agattu Island, Aleutian Archipelago, Alaska. Waterbirds 32:363-373.

HONORS AND AWARDS

2016 Regional Director's Award for External Costumer Service, USFWS
2010 Edwards Prize for Best Article of the Year in The Wilson Journal of Ornithology (Vol. 122), Wilson Ornithological Society <http://www.wilsonsociety.org/awards/edwardsprize.html>
2010 Recipient, Star Award, U.S. Fish and Wildlife Service, Division of Migratory Birds, Region 7, Alaska
2007 Recipient, Best Student Presentation Award, The Wildlife Society annual meeting, Tucson, Arizona
2007 Nominee, Golden Key Award for Excellence in Undergraduate Teaching, Kansas State University
2007 Recipient, James Ackert Award for Outstanding Student Presentation, Division of Biology, Kansas State University

GRANTS

2012 North Pacific Seabird Data Portal expansion, National Fish and Wildlife Foundation, Alaska Fish & Wildlife Fund, $40,000
2012 FWS Fisheries and Ecological Services Endangered Species Branch, $18,750
2011 Mercury and feathers in three avian species at Agattu Islands, Avian Health and Disease Program, U.S. Fish and Wildlife Service, $15,125
2011 Agattu Island Kittlitz's murrelet breeding biology study, Ecological Services Endangered Species Branch, $50,000
2010 Kittlitz's murrelet Monitoring Plan, Avian Health and Disease Program, U.S. Fish and Wildlife Service, $25,000
2010 Kittlitz's murrelet breeding biology at Agattu Island, National Fish and Wildlife Foundation, Alaska Fish & Wildlife Fund, $15,600
2010 Kittlitz's murrelet breeding biology at Agattu Island, U.S. Fish and Wildlife Service, Challenge Cost-share Grant, $5,000
2010 North Pacific Seabird Information Network, Alaska Department of Fish and Game, Wildlife Diversity Program, $375,000

SERVICE

2015-present, East Asian Australasian Flyway Partnership Seabird Working Group, Chair
2014-2017, Pacific Seabird Group Alaska/Russia Regional Representative, Executive Committee member
2014-present, Pacific Seabird Group Seabird Monitoring Committee, Chair
2013 Reviewer, The Condor; ICES Journal of Marine Science
2009 Reviewer, Studies in Avian Biology
2008 Reviewer, Wilson Journal of Ornithology
2007 Webmaster, Biology Graduate Student Association, Kansas State University
2006-2007 Secretary, Biology Graduate Student Association, Kansas State University
2006-2007 Chair, Fundraising Committee, Biology Graduate Student Association Kansas State University
2006 Assistant Webmaster, Biology Graduate Student Association, Kansas State University
2006 Chair, Travel Grant Committee, Biology Graduate Student Association, Kansas State University

MEMBERSHIPS TO PROFESSIONAL SOCIETIES

American Ornithologists' Society (2005), Pacific Seabird Group (2007), Wilson Ornithological Society (2005), Cooper Ornithological Society (2010)

COLLABORATIONS

Barb Bodenstein and Robert Dusek (USGS National Wildlife Health Center), Alex Bond (Royal Society for the Protection of Birds), Collin Eagles-Smith (USGS-Corvallis), David Irons (US Fish and Wildlife Service, retired), Julia Parrish (University of Washington), John Piatt (USGS, Alaska Science Center), Heather Renner (Alaska Maritime National Wildlife Refuge), Frank von Hippel (University of Alaska Anchorage)

ERIK E. OSNAS

Division of Migratory Bird Management, U.S. Fish and Wildlife Service, Alaska Region
EDUCATION

2004 *Ph. D. – Ecology, Evolution and Behavior,* Indiana University.

1998 *Master of Science - Zoology,* University of Western Ontario.

1995 *Bachelor of Science - Wildlife and Fisheries Biology,* University of California, Davis.

PROFESSIONAL EXPERIENCE

2015 to present, Wildlife Biologist (Biometrician), Division of Migratory Bird Management, U.S. Fish and Wildlife Service, Alaska Region

2012 to 2015, Wildlife Biologist/Post-doctoral Research Associate, USGS Patuxent Wildlife Research Center, Laurel, Maryland

2012 Lecturer, Department of Ecology and Evolutionary Biology, Princeton University

2008 to 2012, Post-doctoral Research Associate, Princeton University

2005 to 2008, Assistant Scientist, Department of Forest and Wildlife Ecology, University of Wisconsin

SELECTED PUBLICATIONS

Kuletz, K. J., Cushing, D. A., Osnas, E. E., Labunski, E. A., & Gall, A. E. (2019). Representation of the Pacific Arctic seabird community within the Distributed Biological Observatory array, 2007–2015. *Deep Sea Research Part II: Topical Studies in Oceanography*.

Jennelle, C. S., Walsh, D. P., Samuel, M. D., Osnas, E. E., Rolley, R., Langenberg, J., ... & Heisey, D. M. (2018). Applying a Bayesian weighted surveillance approach to detect chronic wasting disease in white-tailed deer. *Journal of applied ecology*, *55*(6), 2944-2953.

Fleming-Davies, A. E., Williams, P. D., Dhondt, A. A., Dobson, A. P., Hochachka, W. M., Leon, A. E., Osnas, E.E. & Hawley, D. M. (2018). Incomplete host immunity favors the evolution of virulence in an emergent pathogen. *Science*, *359*(6379), 1030-1033.

Cohen, J. B., Hecht, A., Robinson, K. F., Osnas, E. E., Tyre, A. J., Davis, C., ... & Melvin, S. M. (2016). To exclose nests or not: structured decision making for the conservation of a threatened species. *Ecosphere*, *7*(10), e01499.

Osnas, E. E., Zhao, Q., Runge, M. C., & Boomer, G. S. (2016). Cross-seasonal effects on waterfowl productivity: Implications under climate change. *The Journal of wildlife management*, *80*(7), 1227-1241.

Osnas, EE, P Hurtado, and AP Dobson. 2015. Evolution of virulence across space during an epidemic. *American Naturalist*, *185*(3), 332-342.

Heisey, DM, EE Osnas, P Cross, DO Joly, JA Langenberg, and MW Miller. 2010. Linking process to pattern: estimating spatiotemporal dynamics of a wildlife epidemic from cross-sectional data. *Ecological Monographs,* 80: 221-240.

Osnas, EE, DM Heisey, R Rolley, and MD Samuel. 2009. Spatial and temporal patterns of chronic wasting disease: fine scale mapping of a wildlife epidemic in Wisconsin. *Ecological Applications,* 19: 1311-1322.

COLLABORATORS

Boomer, Scott, Division of Migratory Bird Management, U.S. Fish and Wildlife Service
Cushing, D. A., Pole Star Ecological Research, LLC. Anchorage, AK
Dhondt, Andre. A., Corrnell Lab of Ornithology & Department of Ecology and Evolution, Cornell University
Dobson, Andrew P., Department of Ecology and Evolution, Princeton University
Fischer, Julian, Division of Migratory Bird Management, U.S. Fish and Wildlife Service
Fleming-Davies, A. E, Department of Biology, University of San Diego
Frost, Charles, Division of Migratory Bird Management, U.S. Fish and Wildlife Service
Gall, A. E, ABR, Inc., Environmental Research & Services
Hawley, Dana M., Department of Biological Sciences, Virginia Tech
Heisey, D. M., USGS National Wildlife Health Center (retired)
Hochachka, W. M., Cornel Lab of Ornithology, Cornell University
Hurtado, Paul, Department of Mathematics and Statistics, University of Nevada, Reno
Jennelle, C. S., Minnesota Department of Natural Resources
Kuletz, Kathy, Division of Migratory Bird Management, U.S. Fish and Wildlife Service
Labunski, Elizabeth A., Division of Migratory Bird Management, U.S. Fish and Wildlife Service
Runge, Michael, USGS Patuxent Wildlife Research Center
Samuel, M. D., USGS Cooperative Wildlife Research Unit, University of Wisconsin (retired)
Walsh, D. P., USGS National Wildlife Health Center
Zhao, Qing, Department of Wildlife Ecology, University of Missouri