August 24, 2016

Elise Hsieh, Executive Director
Exxon Valdez Oil Spill Trustee Council
4210 University Drive
Anchorage, AK 99508-4626

Dear Elise:

Final Proposal Package for the Gulf Watch Alaska Program 17120114

Gulf Watch Alaska (GWA), the long-term monitoring program of the *Exxon Valdez* Oil Spill Trustee Council (EVOSTC), has finalized our program and project proposals for fiscal years 2017-2021 based on comments received from the EVOSTC's Science Panel on May 19, 2016. Each proposal has a cover letter with Science Panel comments, our response and summary of appropriate revisions. For your convenience, the following table provides a quick summary of what you will find in the August 24, 2016 proposal package.

Number	Project	Lead PI	Status
17120114	GWA Program	Lindeberg	Revised
17120114-A	PM I	Lindeberg	Revised
17120114-B	PM II	Hoffman	Revised
17120114-C	Pelagic - Forage Fish	Arimitsu	Revised
17120114-D	Envir. Dr. - CPR	Batten	No revisions
17120114-E	Pelagic - Fall/Winter Marine Birds	Bishop	Revised
17120114-F	Envir. Dr. - PWS Nutrient Transport	Campbell	Removed
17120114-G	Envir. Dr. - PWS Oceanographic Conditions	Campbell	No revisions
17120114-H	Nearshore component	Coletti	No revisions
17120114-I	Envir. Dr. - GAK-1	Danielson	No revisions
17120114-J	Envir. Dr. - LCI-KB Oceanographic Conditions	Doroff	Revised
17120114-K	Nearshore - Mussels	Esler	Removed
17120114-L	Envir. Dr. - Seward Line	Hopcroft	Revised
17120114-M	Pelagic - Summer Marine Birds	Kuletz	No revisions
17120114-N	Pelagic - Killer Whales	Matkin	No revisions
17120114-O	Pelagic - Humpback Whales	Moran	No revisions

The overall cost of the program and the three component budgets within (Environmental Drivers, Pelagic Ecosystems, and Nearshore Ecosystems) have not changed since submittal on April 1, 2016. As a result of EVOSTC Science Panel comments, some project funds were adjusted.

Sincerely,

Mandy Lindeberg
Gulf Watch Alaska Program Lead designate

August 24, 2016

Elise Hsieh, Executive Director
Exxon Valdez Oil Spill Trustee Council
4210 University Drive
Anchorage, AK 99508-4626

Dear Elise:

Final FY 2017-2021 Proposal Submittal for Long-term Monitoring

17120114. Gulf Watch Alaska: Long-Term Monitoring of Marine Conditions and Injured Resources

Gulf Watch Alaska (GWA), the long-term monitoring program of the *Exxon Valdez* Oil Spill Trustee Council (EVOSTC), has finalized our program and project proposals for fiscal years 2017-2021 funding based on comments received from EVOSTC's Science Panel on May 19, 2016. Below is the final budget summary and response to Science Panel comments for the GWA Program Proposal.

EVOSTC Funding Requested *(must include 9% GA)*

FY17	FY18	FY19	FY20	FY21	TOTAL
$2,278,750	$2,574,930	$2,351,230	$2,496,920	$2,342,680	$12,044,500

Non-EVOSTC Funding Available

FY17	FY18	FY19	FY20	FY21	TOTAL
$1,671,000	$1,712,000	$1,658,000	$1,677,000	$1,622,000	$8,340,000

Science Panel comment: *Unfortunately, the proposed program did not seem to build off of the Program's 2013 Synthesis document. There is a lack of some descriptions of previous work where needed and an absence of depth of hypotheses, comparisons and evolving discussions on the work proposed, so much of which is a continuation from past or related projects. For example, there continues to be a lack of discussion in individual project designs of previous scientific work that may be used to develop their hypotheses or that could be treated as a contrasting interactive web of species.*

PI Response:

- Thank you for the comments. We fully intend to continue building off the three-year synthesis document and value the knowledge gained from that process during the first five-year increment of the program. Clarifications were made to the program proposal with respect to syntheses and scientific products. The Cross-program publishing group funds will also significantly complement syntheses efforts.
- Clarifications were made to project proposals that fell short in detail. Lead PIs carefully responded to all EVOSTC Science Panel comments for each GWA project.

Sincerely,

Mandy Lindeberg
Gulf Watch Alaska Program Lead designate

Attachment: Long-Term Monitoring Program Proposal: 17120114 – Gulf Watch Alaska: Long-Term Monitoring of Marine Conditions and Injured Resources

EVOSTC FY17-FY21 INVITATION FOR PROPOSALS
PROGRAM PROPOSAL SUMMARY PAGE

Program Title

17120114—Gulf Watch Alaska Program: Long-Term Monitoring of Marine Conditions and Injured Resources

Program Lead Name and Affiliation

Mandy Lindeberg, National Oceanic and Atmospheric Administration, Auke Bay Laboratories

Date Proposal Submitted

24 August 2016

Program Abstract

This program proposal directly addresses the *Exxon Valdez* Oil Spill (EVOS) Trustee Council's (EVOSTC's) focus area, long-term monitoring of marine conditions and injured resources. We are proposing to continue the successful Gulf Watch Alaska (GWA) long-term monitoring program into the next five-year period, FY 2017-21. The overarching goal of the GWA program is to continue to provide sound scientific data and products that inform management agencies and the public of changes in the environment and the impacts of these changes on injured resources. The organization of GWA includes: three monitoring components (environmental drivers, pelagic, nearshore), a program management team, a science review panel, a science coordinating committee, and an outreach steering committee.

The program has five primary objectives:

1. Sustain and build upon existing time series in the EVOS-affected regions of the Gulf of Alaska (GOA).
2. Provide scientific data, data products and outreach to management agencies and a wide variety of users.
3. Develop science synthesis products to assist management actions, inform the public and guide monitoring priorities for the next 15 years.
4. Continue to build on collaborations between the GWA and Herring Research and Monitoring (HRM) programs, as well as other Trustee program focus areas including the data management program, lingering oil and potential cross-program publishing groups.
5. Leverage partnerships with outside agencies and groups to integrate data and expand capacity through collaborative efforts.

Highlights from the first five years of the GWA program show significant development of program infrastructure and compilation of scientific information. Internal and external program communication tools were developed, including a program workspace, intranet, website and data portal. Four (soon to be five) years of monitoring data have been collected for the northern GOA ecosystem. A three-year program synthesis report was completed and submitted to the EVOSTC along with numerous peer reviewed journal publications and a special issue journal collaboration (GWA and HRM). Outreach highlights include three community outreach events each year, ongoing development of teaching resources for marine science such as virtual field trips, videos of scientists in the field, numerous classrooms visits, and over 200 presentations. Coordination and collaboration with the HRM program and many other research efforts has proven beneficial to all and these collaborations will continue to grow over time.

EVOSTC Funding Requested *(must include 9% GA)*

FY17	FY18	FY19	FY20	FY21	TOTAL
$2,278.75	$2,574.93	$2,351.23	$2,496.92	$2,342.68	$12,044.50

Non-EVOSTC Funding Available

FY17	FY18	FY19	FY20	FY21	TOTAL
$1,671.0	$1,712.0	$1,658.0	$1,677.0	$1,622.0	$8,340.0

1. Executive Summary

The *Exxon Valdez* Oil Spill (EVOS) Trustee Council (EVOSTC) initiated funding for the Gulf Watch Alaska (GWA) long-term monitoring (LTM) program in 2012 (McCammon et al. 2011). The program is designed to monitor key components that play important roles in the ecology of Gulf of Alaska (GOA) marine environments. These components include environmental drivers such as temperature and nutrient availability; pelagic populations of predators and prey; and the nearshore ecosystem. Through this monitoring effort scientists and resource managers will have a better understanding of the impacts from perturbations and a changing environment.

The program has been a consortium of 15 projects, ten of which started before 2012 and several with data sets extending prior to the EVOS. A wide array of information and tools have been effectively coordinated and synthesized by the GWA program to date. The program has fostered partnerships that include: professional administrative support, advanced data housing, scientific collaboration and synthesis across projects and disciplines, and a significant outreach capacity through agency partners. Collectively, this group of 24 scientists represents unsurpassed expertise and knowledge of the GOA ecosystem and spill-affected region.

Integrating numerous multi-disciplinary LTM projects under the GWA program has proven highly successful since implementation and is now a mature, functioning program moving toward expanding integration and linkages among the three components, with other EVOSTC-funded programs, and with outside research, monitoring, and management programs. GWA programmatic successes during the first five years include (but are not limited to):

- Extended long-term datasets on injured EVOS resources.
- Collected 5 years of ecosystem monitoring data laying the foundation for the next 15 years.
- Publication of findings in peer reviewed journals (see project proposals).
- Publication of a science synthesis report following the third year of the GWA program (GWA, 2015).
- Publication of annual reports on the findings of each project within the GWA program (GWA, 2012-2015).
- Creation of a GWA program work space where data, reports, metadata and other files are shared across multiple federal agencies, universities, and private organizations. The Ocean Workspace provides a collaborative site for all GWA program principal investigators (PIs) to share information and discuss findings.
- Creation of a GWA public Data Portal (http://portal.aoos.org/gulf-of-alaska.php). The Data Portal provides public and resource management agency access to GWA program data that are reviewed

following quality assurance and quality control procedures and include federally compliant metadata.
- Integration of GWA program data into agency management activities (see project proposals).
- Development of a GWA program website (http://www.gulfwatchalaska.org/) where information about LTM of the GOA can be shared with the public. The website is updated regularly with current scientific findings for each project.
- Outreach activities within the spill-affected area including local community presentations and school activities.
- Initiation, in collaboration with the Herring Research and Monitoring (HRM) program, of a special issue peer-reviewed journal to further synthesize and present findings of the first five years of monitoring to the scientific community.

This proposal requests continuation of the GWA LTM program for the next five-year funding cycle, FY 2017-21. As in the first 5 years, the GWA program remains structured into three scientific components: 1) environmental drivers; 2) pelagic monitoring, and 3) nearshore monitoring. The broader framework of the program also provides for administration, management services, science synthesis, and public outreach and community involvement. The overarching goals of the program are to:

A. Collect long-term ecological monitoring information from the GOA EVOS affected region
B. Make monitoring data publicly available for use by stakeholders, managers, and facilitate synthesis efforts
C. Assess monitoring data holistically across projects, components, and programs (i.e., HRM and Lingering Oil) to better understand the range of factors affecting individual species and the ecosystem

Our plans for the next five-year monitoring period include continuing the legacy of our LTM datasets and expanding our knowledge of the GOA ecosystem and its changing conditions. For FY 2017-2021, we are submitting thirteen project proposals, which include two program management proposals and eleven project proposals. Detailed individual project proposals and the proposed five-year budget plans are provided, as requested, in the program's Ocean Workspace to EVOSTC staff members.

Brief summaries of each project and their interim findings under the GWA program are provided below.

Integrated Program Management and Administration

Program coordination and science synthesis (GWA Program Management I) – Mandy Lindeberg, National Oceanic and Atmospheric Administration (NOAA) Auke Bay Laboratories

This project is established at the Program Management Team (PMT) level of the GWA program and explicitly provides for program coordination and oversight of science syntheses of data collected under the LTM program. Program coordination includes facilitating program planning and sharing of information between principal investigators, other Trustee funded programs, and non-Trustee organizations. High quality products and science synthesis efforts help communicate monitoring results by delivering reports, publishing data, developing scientific papers, supporting outreach and integrating information across the entire program.

Program administration, logistics, and outreach (GWA Program Management II) – Katrina Hoffman, Prince William Sound Science Center (PWSSC)

This project is also established at the PMT level of the GWA program. The PWSSC will serve as the Administrative Lead and fiscal agent for GWA. This continues PWSSC's role with GWA during FY12–16. As program administrator, PWSSC's role will include: fiscal management of non-Trustee Agency subawards; convening and management of the Outreach Steering Committee; engagement with EVOSTC staff, Trustees, and Public Advisory Committee (PAC) members; and travel and logistics support of the Science Review Panel, PI meetings, plus outreach and community involvement activities. PWSSC will coordinate the Outreach Steering Committee and Community Involvement component of the program. PWSSC is also the proposed administrative lead agency for the HRM program proposal.

ENVIRONMENTAL DRIVERS MONITORING COMPONENT

The Environmental Drivers component of the GWA program provides the spatial and temporal context for understanding change in the physical and chemical environment. Abiotic environmental changes will mediate lower trophic level (phytoplankton and zooplankton) productivity changes and subsequently propagate upwards to the mid and upper trophic level consumers. Combined with measurements and analyses that incorporate other broad-scale ocean, atmosphere and cryosphere datasets, the Environmental Drivers component positions itself to understand the ramifications of environmental perturbations such as El Niño and La Niña, the recent North Pacific warm water anomalies, longer-term trends of a warming climate, and altered species distributions and interactions. As in the first five years of GWA, this observation network consists of five separate, but interconnected components distributed across the spill-impacted GOA and are key to improving our understanding of the intersection of the Alaska Coastal Current with Prince William Sound, Resurrection Bay, and Lower Cook Inlet:

Gulf of Alaska mooring (GAK-1) monitoring – Seth Danielson and Tom Weingartner, University of Alaska Fairbanks (UAF)

The proposed GAK-1 monitoring project continues a 45-year time series of temperature and salinity measurements at hydrographic station GAK-1. The project monitors five important Alaska Coastal Current ecosystem parameters that quantify and help us understand hourly to seasonal, interannual, and multi-decadal period variability in temperature and salinity throughout the 250 m deep water column, near surface stratification, surface pressure fluctuations, fluorescence as an index of phytoplankton biomass, and along-shelf transport. Key results for data collected during oceanographic monitoring at GAK-1 from 1970 to present provide evidence for several long-term trends on the GOA shelf over that period, including: 1) an overall warming of shelf water (of nearly 0.8 °C in the upper 100 m over 40 years), with intermittent periods of cooler temperatures; 2) an increase in salinities in deeper waters (> 100 m); 3) a decrease in upper ocean (0 – 100 m) salinities; and 4) increasing stratification. The upper ocean salinity decrease is in agreement with the long-term trend toward increasing freshwater discharge throughout the GOA. The increase in stratification appears to be a response to surface freshening due to increased coastal freshwater discharge, a reduction in wind mixing, and an increase in deep salinity on the shelf; however, the reasons for the deep salinity increase are uncertain.

Seward line monitoring – Russ Hopcroft, UAF

For the 5-year period beginning in 2017, we propose continued multi-disciplinary oceanographic observations initiated in fall 1997 in the northern GOA. Cruises occur in early May and early September to capture the typical spring bloom and summer conditions, respectively, along a 150-mile cross shelf transect to the south of Seward, Alaska. The line is augmented by stations in the entrances and deep passages of Prince William Sound (PWS). We determine the physical-chemical structure, the distribution and abundance of phytoplankton, microzooplankton and mesozooplankton, and survey seabirds and marine mammals. One key finding from Seward Line data to date is that the quantity and composition of both late spring and summer zooplankton, appear to be significantly correlated with PWS hatchery pink salmon survival in this region. Thus, springtime abundance of zooplankton along the Seward Line appears to be an index of generally favorable years for higher trophic levels throughout the GOA.

Oceanographic conditions in Prince William Sound – Rob Campbell, PWSSC
This project proposes to continue physical and biological measurements that may be used to assess trends in the marine environment and bottom-up impacts on the marine ecosystems of PWS. Regular vessel surveys of PWS will be conducted to maintain ongoing time series observations of physical, biogeochemical and biological parameters in several parts of PWS. An autonomous profiling mooring will be deployed each year in central PWS to provide daily depth-specific measurements of the surface layer that will be telemetered out in near real-time. An in-development *in situ* plankton camera will also enumerate zooplankton, large phytoplankton and other particles, with some taxonomic discrimination. Overall findings to date from data assembled under this project are in line with a regional warming trend, with some indications of enhanced freshwater inputs at the surface that are sometimes accompanied by a reduction in temperature that can be attributed to inputs from melting ice. At depth, the trend is towards warmer and more saline water, which is consistent with increased entrainment of deep water caused by enhanced surface circulation, again due to increasing freshwater inputs.

Oceanographic monitoring in Cook Inlet – Angie Doroff and Kris Holderied, University of Alaska Anchorage/Kachemak Bay National Estuarine Research Reserve and NOAA Kasitsna Bay Laboratory
The lower Cook Inlet/Kachemak Bay oceanographic monitoring project assesses the effects of oceanographic variability on nearshore and pelagic species injured by the Exxon Valdez Oil Spill. We currently have oceanographic data from a 6-year time series within Cook Inlet/Kachemak Bay and 15-year record of continuous nearshore water chemistry observations in Kachemak Bay. Oceanographic monitoring in this area is important because variables change at different sampling scales, the strength and position of the Alaska Coastal Current, regional modes of climate variability, and nutrient conditions. Based on FY12-16 observations the project proposes to increase sampling frequency along the estuary gradient and add nutrient monitoring in the eastern portion of our study area, with an associated reduction in spatial coverage across Cook Inlet. Ship-based oceanographic surveys are proposed monthly, seasonally, and annually in Cook Inlet/Kachemak Bay, with conductivity-temperature-depth casts (including fluorescence, turbidity, and dissolved oxygen), phytoplankton, and zooplankton collected along repeated transects. These data will be augmented with continuous oceanographic measurements recorded at Kachemak Bay National Estuarine Research Reserve oceanographic stations in Seldovia harbor, Homer harbor, and at a Bear Cove mooring. This proposal fills data gaps in the monitoring not currently being met by monitoring of the Seward Line (spring/fall only) or the Continuous Plankton Recorder (April-October) in the northern part of the Gulf of Alaska and will provide context for shorter time scales of variability relevant to ecosystem-level monitoring in GWA. By sampling in both estuaries (PWS and Cook Inlet/Kachemak Bay), we strengthen the ability of the GWA program to evaluate local (within estuary) and remote (shelf, North Pacific) climate forcing effects on nearshore ecosystems.

Continuous plankton recorder –Sonia Batten, Sir Alister Hardy Foundation for Ocean Science (SAHFOS) and Robin Brown, North Pacific Marine Science Organization
This project proposes to maintain the Continuous Plankton Recorder (CPR) transect which samples the Alaskan shelf from lower Cook Inlet across the slope into the open Gulf of Alaska approximately

six times per year, usually between April and September. The CPR provides a record of taxonomically resolved, seasonal, near-surface zooplankton and large phytoplankton abundance over a wide spatial scale. Recent results show that interannaul variability in plankton dynamics is high and plankton responded clearly and rapidly to the recent warm conditions.

Pelagic monitoring component

The pelagic component research team is proposing to continue monitoring key pelagic species groups in PWS using the same five projects focused on killer whales, humpback whales, forage fish, and marine birds. However, modifications have been made to some projects for greater integration, increased precision of information, and achieving new goals. We propose to combine the humpback whale, fall and winter marine bird and forage fish (including euphausiids) projects into a single, integrated predator-prey survey which will also reduce vessel charter costs. In addition to providing a means to effectively monitor indices of forage fish trends, our integrated approach will also enhance our understanding of predator-prey relationships and help us identify some mechanisms of change in populations. The two over-arching questions for the pelagic component to answer in the next five years are: 1) what are the population trends of key upper trophic level pelagic species groups in PWS – killer whales, humpback whales, and marine birds? and 2) how do predator-prey interactions, including interannual changes in prey availability, contribute to underlying changes in the populations of pelagic predators in Prince William Sound and Middleton Island?

Long-term killer whale monitoring – Craig Matkin, North Gulf Oceanic Society (NGOS)
This is a continuation of the long-term killer whale monitoring program that was initiated in 1984 in PWS. A primary focus has been on resident killer whales and the recovery of AB pod, and the threatened AT1 population of transient killer whales which suffered serious losses at the time of EVOS and have not recovered at projected rates. Sampling procedures include photo-identification, annual skin biopsies, observing predation, sampling prey, remote acoustic monitoring, time-depth tags, photographic drones and relocating whales for feeding studies. One key finding from this project is that killer whales are good indicators of long-term trends and sensitive to perturbations such as oil spills for which consequences may include extinction.

Prince William Sound marine bird surveys – Kathy Kuletz and Robert Kaler, U.S. Fish and Wildlife Service (USFWS)
We propose to continue small boat-based surveys to monitor abundance of marine birds in PWS during July 2018 and July 2020. Historical data include fifteen surveys spanning 1989 to 2015 and have been used to monitor population trends for marine birds in PWS following the EVOS. Marine bird surveys compliment the benthic monitoring and forage fish monitoring aspects (including Middleton Island) of the LTM program by providing a population trend index useful for interpreting marine ecosystem patterns observed in PWS. Key findings thus far reveal that the strongest spatial pattern of summer marine bird community composition in PWS is related to water depth and distance from shore, paralleling the nearshore-pelagic structure of the marine food web. Analysis of 12 years of boat-based marine bird surveys spanning 25 years since 1989 found that during summer, changes in pelagic food webs likely contributed to the delayed recovery of some piscivorous marine bird taxa. This pattern of community change is indicative of changes in the pelagic prey base.

Forage fish distribution and relative abundance – Mayumi Arimitsu and John Piatt, U. S. Geological Survey (USGS) Alaska Science Center

The first 5 years of the forage fish project was a pilot study to determine feasibility and best approach for long-term monitoring of forage fish. The forage fish proposal will change directions in 2017-2021: we will integrate directly with the humpback whale and marine bird predation studies and apply the methods we have learned in the previous 5 years to provide estimates of forage biomass in the immediate vicinity of predator aggregations. By integrating with these projects, we will sample forage fish in the same locations and times, thus providing valuable prey information for two pelagic predator groups of key value to EVOSTC, governmental and nongovernmental groups, and the public while obtaining trend information for our forage fish monitoring program. Obtaining sound-wide forage fish population/biomass estimates is not feasible with the resources available; funds are insufficient to adequately sample the entire area, and the key forage species in PWS differ significantly in their life histories, habitats, and ease of detection (e.g., sand lance are shallow inshore, while euphausiids are usually deep and off shore), making defensible sound-wide holistic estimations impractical. For this reason, the proposed work focuses on smaller geographical areas within PWS and takes advantage of known persistent predator aggregations to locate prey that can then be well monitored over time within reasonable financial resources. Additionally, using predators as samplers of forage fish can provide an important index of changes in prey species composition over time. Thus we will incorporate into the GWA Pelagic Component a long-term seabird diet data collection program as a cost-effective means to monitor forage fish stocks in the northern Gulf of Alaska.

Humpback whale predation on herring – John Moran and Jan Straley, NOAA National Marine Fisheries Service (NMFS) Auke Bay Laboratory and University of Alaska Southeast (UAS)

Under the integrated predator-prey survey the humpback whale monitoring project will continue to evaluate the impact by humpback whale foraging on Pacific herring populations in PWS. Prey selection by humpback whales will be determined through acoustic surveys, visual observation, scat analysis, and prey sampling. Chemical analysis of skin and blubber biopsy samples will provide a longer term perspective on shifts in prey type and quality. Key findings by this project show that humpback whale predation in PWS can exert top-down controlling pressure equivalent to the impact of a directed fishery.

Fall and Winter habitat use and distribution of seabirds in Prince William Sound – Mary Anne Bishop (PWSSC)

Under the integrated predator-prey survey efforts, this project represents the continuation of a long-term data set on marine bird abundance and habitat associations during fall and winter in PWS initiated in 2007. As a cost-effective alternative to a dedicated vessel, surveys are conducted onboard research vessels already conducting oceanographic, fisheries, or marine mammal surveys. For 2017-2021 we have identified four cruises a year for fall and winter marine bird surveys. Results show that as much as 10% of the adult herring biomass can be removed by avian predators during winter months, suggesting that predation by marine birds also may exert a top-down effect on herring.

NEARSHORE MONITORING COMPONENT

Nearshore systems in the Gulf of Alaska – Heather Coletti, Daniel Esler, Kim Kloecker, Dan Monson, Ben Weitzman, Brenda Konar, and Katrin Iken, National Park Service (NPS), USGS Alaska Science Center, and UAF

The Nearshore Component of GWA investigates and monitors the nearshore environment of the greater EVOS area, with focus on selected elements of the nearshore food web. The nearshore component provides ongoing evaluation of the status of more than 200 species, including many of those recovering from EVOS. The monitoring design includes spatial, temporal and ecological features that support inference regarding drivers of change through testing of alternative hypotheses. For the next five years, we propose to fully integrate into a single project by merging the Nearshore Benthic Systems in the Gulf of Alaska (16120114-R) and Ecological Trends in Kachemak Bay (16120114-L) projects. This integration will further enhance our overarching goal: To understand drivers of variation in the GOA nearshore ecosystem. The foundational hypotheses of the Nearshore Project include: 1) What are the spatial and temporal scales over which change in nearshore ecosystems is observed? 2) Are observed changes related to broad-scale environmental variation, or local perturbations? 3) Does the magnitude and timing of changes in nearshore ecosystems correspond to those measured in pelagic ecosystems?

Findings from the first five years show varying results: patterns of changes in abundance differ among regions for sea otters, notable changes in several intertidal invertebrates and algae, no detected changes in abundance of black oystercatchers and little evidence of sea star wasting disease in the northern GOA. Key findings include: 1) local-scale drivers (static attributes) are important in determining composition of nearshore communities, and 2) over the period 2008-2013, mussel abundance declined at study areas across the GOA, suggesting the influence of large-scale drivers; although local variability in abundance was also important. The project documented anomalous events in collaboration with the environmental drivers and pelagic component, such as the sea bird die-off in 2015. We observed large increases in common murres during the summer of 2015 relative to previous years.

Our goals for the second phase of the long-term nearshore monitoring program are to continue to document the status of the nearshore system by continuing time series, some of which date more than five decades, and many that were initiated after the 1989 spill. This information will be synthesized with other components of GWA in order to identify potential causes of change, including those related to EVOS and climate change. We will continue to use existing and new information from this second phase to address our overarching hypotheses in communities across the GOA and to communicate those findings to the public and resource managers. This information will be critical for anticipating and responding to ongoing and future perturbations in the region, as well as providing for global contrast.

2. Relevance to the Invitation for Proposals

The GWA program was designed specifically in response to stated needs of the EVOSTC based on the previous and current invitations for the Long-term Monitoring of Marine Conditions and Injured Resources Focus Area, and on the priorities in the 1994 Restoration Plan. As stated in the invitation, the GWA program focuses on the EVOSTC's goals of monitoring the recovery of resources from the initial injury and monitoring how factors other than oil may inhibit full recovery or adversely impact recovering resources. The GWA program study area overlays the EVOS affected area, with project sites spanning from PWS, to the Kenai Peninsula, lower Cook Inlet, and the Alaska Peninsula. Projects included in the GWA program are designed to be consistent with the policies contained in the 1994 Restoration Plan and are organized based on EVOSTC areas of interest or ecosystem components: environmental drivers, pelagic monitoring, and benthic (nearshore) monitoring. Among the strengths of the GWA program are the spatial and temporal distribution of data collection at multiple scales. Long-term datasets across the diverse and distant habitats of the GOA allow scientists and managers to monitor changes over time and at different locations.

Expected results of the GWA program

During the FY 2017-2021 period the GWA program will build on the results of the first 5-year monitoring period. The results we expect to achieve during the next 5 years are detailed below.

Monitoring the EVOSTC areas of interest

Environmental Drivers

The GWA program includes five projects designed to monitor oceanographic conditions that include water temperature, salinity, and turbidity at representative sites throughout the EVOS affected area, including PWS (Seward Line and Oceanographic Conditions in PWS), Resurrection Bay (GAK-1 and Seward Line Monitoring), the Gulf of Alaska shelf (GAK-1, Seward Line and CPR), and lower Cook Inlet (Oceanographic Monitoring in Lower Cook Inlet and Kachemak Bay). These projects provide the environmental data needed to evaluate the biological environment and the duration of data collection (e.g., since 1970 for GAK-1) provides an invaluable time-series of information from which to evaluate species recovery and other ecosystem perturbations.

The GAK-1, Oceanographic Conditions of PWS, Seward Line, and Oceanographic Monitoring in Lower Cook Inlet and Kachemak Bay also assess the transport of nutrients between GOA and the shelf ecosystems of PWS, Resurrection Bay, and lower Cook Inlet. In addition, the CPR project provides critical data on the availability and abundance of phytoplankton and zooplankton to higher trophic level species in response to oceanographic conditions.

Pelagic Monitoring

As noted in the invitation, GWA monitoring projects for killer whales, humpback whales, seabirds, and forage fish in PWS have proven useful in addressing agency management objectives and LTM hypotheses. We propose to continue each of these projects and have added components intended to enhance management objectives and understanding of the interactions among pelagic species and their environment. Pelagic monitoring methods were specifically developed to assess population dynamics related to spill recovery and other ecosystem perturbations and evaluate diet, prey availability, and competition among species in GOA.

The EVOSTC's invitation points out that the humpback whale project may be submitted under the Herring Focus Area. We have maintained the humpback whale project under the GWA program's pelagic component, and added integrated sampling of seabirds, humpback whales, and herring (in collaboration with the HRM program) to improve our ability to understand species interactions, synthesize data, and support management of species. Linkages to the GOA pelagic ecosystem will be established by supporting the long-term seabird diet study at Middleton Island. This dataset has been a key contributor to detecting ecosystem change in the GOA for several agencies.

The GWA program tracked the 2013-2016 North Pacific warm water anomaly as it moved into GOA and the EVOS affected area. Because LTM projects were in place we documented changes in the pelagic system related to changes in ocean chemistry and lower trophic level species such as plankton. Our pelagic projects document changes in seabird diets, seabird mortality, and changes in humpback whale distributions. Continuing these projects will be important for understanding how the changing climate affects species recovery.

Nearshore Monitoring

The nearshore project proposal addresses the EVOSTC's request for LTM plans for the nearshore benthic ecosystem directly impacted by EVOS. It is a continuation of the first 5-year phase of the GWA program, which is built on previous projects: 16120114-R Nearshore Benthic Systems in the Gulf of Alaska and 16120114-L, Ecological Trends in Kachemak Bay. A restoration and ecosystem monitoring plan for the nearshore marine ecosystems affected by the EVOS in the GOA and recognized that 1) restoration efforts for resources injured by the spill will benefit from information on the status and trends of those resources on a variety of spatial scales within the GOA, and 2) changes independent of the oil spill are likely to occur in the GOA during the 21st century, and are likely to result from a number of different agents (e.g., natural variability, earthquakes, climate change, and shoreline development and associated inputs of pollutants). Further, to restore injured resources it is essential to separate EVOS-related effects from other sources of change. The GWA program initiated in 2011 supports the accomplishment of these goals.

We anticipate that global climate change may result in a gradual transition in the nearshore community that occurs over decades and has impacts over the entire GOA. Conversely, it is possible that climate change will lead to tipping points in the community where sudden changes or collapses can be observed over large spatial scales. In contrast, impacts from shoreline development or other human activities will likely be more episodic and localized. Thus, a suitable monitoring program was designed and implemented to detect ecological impacts on these various spatial and temporal scales. To this end, the nearshore monitoring program implemented over the last decade was designed to include: synoptic sampling of specific physical and biological parameters; hierarchical spatial sampling design; nearshore food web linkages and coordination with short-term (2-5 years) studies to identify important processes regulating a given system or subsystem. Continuing the nearshore LTM project, as well as supporting related process studies, will be critical for anticipating and responding to ongoing and future perturbations in the region, as well as providing for global contrast.

SCIENTIFIC COLLABORATION AND PARTNERSHIP

The GWA program is unique in the extent of its collaboration and partnerships. Within the program we bring together scientists from multiple agencies (including Trustee and non-Trustee agencies), universities, non-profit scientific research organizations, and private companies who work together to understand the GWA ecosystem as a whole. GWA PIs actively engage with the HRM program as well as other scientists in projects across the GOA and elsewhere to develop a better understanding of the marine ecosystem, injury and recovery from oil spills, and climate change and other perturbations. The GWA program also engages with management agencies to ensure that results from GWA projects are meaningful for species and habitat management.

INFORMATION SYNTHESIS

Three-year science synthesis report and workshop - science syntheses are an important part of the GWA program. GWA components will integrate information from multiple disciplines and programs to facilitate identification of factors other than oil that may be constraining recovery of injured resources or which may adversely affect their continued recovery. Synthesis exercises will also allow for a more comprehensive understanding of the GOA and the processes driving change. The following example questions posed by the

GWA program are not intended to be comprehensive, but illustrate specific examples of how integrated efforts and syntheses can advance our understanding of the GOA ecosystem.

Examples of Cross disciplinary research questions:

- *How do oceanographic patterns compare (and co-vary) between different locations in PWS, GOA shelf, and lower Cook Inlet?*
- *Are changes in oceanographic conditions in the outer GOA shelf mirrored in the nearshore marine environment and population trends of injured, recovering and recovered resources?*
- *Are recurring spatial patterns in predator foraging aggregations (hot spots) associated with particular oceanographic conditions?*
- *Will humpback whale and seabird predation rates on herring change as prey species composition and abundance change in response to environmental drivers?*
- *Are there significant inter-annual changes in the nearshore communities and are they synchronous across the GOA?*
- *Have injured resources in the nearshore environment recovered from EVOS? If not, can we identify other, non-spill related factors that are constraining their recovery?*

A program science synthesis represents a great deal of effort. Strategies for reporting scientific syntheses should be carefully considered. Although there was no directive in the first five years of the EVOSTC's long-term monitoring program, the creation of a GWA special issue journal publication was undertaken. It became apparent that a special issue was a preferred synthesis product for the program. The special issue includes contributions from the HRM and Lingering Oil programs. We propose that future science synthesis reporting could be the culmination of multi-project and cross-program publication groups packaged in a special issue peer reviewed publication rather than simply separate program reports. The three-year synthesis reports would be a draft of a special issue journal publication. The EVOSTC Science Panel would review and then the special issue would proceed through an external peer review process. We also propose a synthesis workshop. The workshop presents a valuable opportunity to discuss with the EVOSTC staff and Science Panel data availability, new scientific knowledge and future considerations to maintain a comprehensive ecosystem approach to monitoring. We look forward to further discussions on acceptable products and workshops for the program with the EVOSTC's staff and Science Panel.

In addition to synthesis reporting, publications and workshops, GWA has an array of mechanisms built into the program to produce monitoring data and information for a variety of users. Time-series data are acquired by PIs, quality checked, and posted on the Ocean Workspace provided by the Alaska Ocean Observing System (AOOS)/Axiom. The Ocean Workspace facilitates sharing of information to other PIs, as well as EVOSTC funded programs, EVOSTC staff, and ultimately the public through the data portal where QA/QC'd data files can be downloaded. Project datasets, once analyzed by PIs, will continue to report results to the EVOSTC annually and in a final 5-year report. PIs also regularly publish in peer reviewed journals and promote findings through various outreach venues (e.g., newsletters, presentations, posters, and handouts).

Outreach and Community Involvement

A key component of the GWA program is our outreach to the Trustee Agencies, to ensure that information generated by GWA is useful to their agency education and outreach efforts. This information may include products such as visualizations or brief publications highlighting key program issues and accomplishments. A primary source of information about the program is and will be the program web site (www.gulfwatchalaska.org), for which new and timely content will be produced throughout the five-year program. By rotating the location of annual PI meetings, the program will prioritize involvement with local communities. The public will be invited to observe PI meetings. Further, in at least two of the years, community involvement will be initiated through panels at PI meetings. Meetings in spill-affected Native communities will incorporate Traditional Ecological Knowledge listening sessions for opportunity of two-way exchanges of information between individuals with local or traditional ecological knowledge and members of the GWA team. Similarly, PMT members and select PIs may engage, when appropriate, the leaders of local organizations in the spill-affected area who may have a direct interest in the data or products generated by GWA (such as fishing groups or aquaculture associations).

Benefits of success related to the LTM Focus Area

The GWA program tracks management use of data as one measure of program success. The following are a few examples from the first 5 years to illustrate how GWA data are being used by federal, state and tribal agencies, as well as the public and how the data may continue to provide benefit in the coming 5 years:

- Data from GAK-1 and the Seward line have been used in over five dozen scientific investigations addressing topics in physical and biological oceanography relevant to fisheries management (websites: GAK-1 and Seward Line).
- Killer whale monitoring data is used in National Marine Fisheries Service (NMFS) killer whale stock assessment reports for marine mammal species in Alaska.
- Killer whale identification catalogues, guidance, and other data products are used by the tour boat industry in Kenai Fjords National Park, PWS, and Kachemak Bay.
- Humpback whale population and habitat use information are provided to the NOAA NMFS Protected Resources Division for evaluation of changes to the species listing under the Endangered Species Act. Humpback whales are currently listed as endangered throughout their range, but two populations (Central North Pacific and North Pacific) are under NMFS review for delisting. GWA data will be part of a limited dataset available on humpback whales in Alaska to assess listing status and, if delisted, whale status during the five-year post delisting review period.
- Under new interagency agreements, oceanography, marine bird and marine mammal observations in lower Cook Inlet will be provided to the Bureau of Ocean Energy Management (BOEM) to inform their environmental assessment for anticipated Cook Inlet oil and gas lease sales. BOEM is providing additional support to sustain quarterly Cook Inlet shipboard surveys and marine bird observations. Nearshore baseline data will also be used by BOEM for this assessment.
- Seasonal distribution patterns and trends in marine birds detected in the PWS, Seward Line, and Cook Inlet surveys are used by USFWS to inform management approaches for priority species.

- The marine bird survey data (PWS, Seward Line, lower Cook Inlet) are archived in the North Pacific Pelagic Seabird Database, which has multiple applications in management and conservation actions.
- Marine bird data are provided annually to the USFWS for migratory bird management applications.
- The GWA forage fish monitoring and associated marine habitat data are being incorporated into the North Pacific Research Board (NPRB) Gulf of Alaska Integrated Ecosystems Research Program (GOAIERP) synthesis efforts in cooperation with NOAA NMFS.
- Sea otter monitoring data are used in USFWS sea otter stock assessment reports for marine mammal species in Alaska and are available for use in management and conservation by state and tribal governments.
- The nearshore component has accumulated baseline data on important nearshore species that previously did not exist for areas across the GOA. These data are available for management and conservation purposes, including risk assessment and remediation in the event of future perturbations (e.g., vessels in distress, oil spills, and volcanic eruptions).
- Nearshore monitoring data are provided to the NPS at regular intervals to assist managers in a variety of decision-making processes as well as through community outreach and interpretation programs. Specifically, the nearshore data are used to produce the NPS State of the Park Reports. These reports are used by park managers to assess the status of important park resources and determine if changes are needed in future management plans.
- Nearshore monitoring has provided information for emerging high priority management needs, such as monitoring for invasive species from marine debris from Fukushima and documenting that, as of 2014, no sea star wasting disease has been observed in the GWA nearshore study areas. Potential recipients of benefits

Potential Recipients of Benefits

The list of potential recipients benefiting from the GWA LTM program includes state and federal resource management and regulatory agencies, communities impacted by EVOS, commercial fishermen, and private industry. The previous section lists numerous agencies and organizations that have already benefited from GWA data. The information provided by GWA or recipient agencies contributes to sustainable fishery management which benefits the Alaska economy through the commercial fishing industry, knowledge of subsistence fisheries, and an understanding of how human activities affect the marine ecosystem. GWA data also benefits the Alaska economy because federal and state agencies rely on the best scientific information available to make regulatory permit decisions. An example of this is the collaboration with BOEM to provide data on lower Cook Inlet for their oil and gas lease sale environmental assessment. Synthesis efforts by GOAIERP researchers funded by the NPRB are also discovering GWA datasets and additional ways to make linkages in the future.

3. Program Personnel

GWA senior personnel consist of a PMT, a Science Coordinating Committee (SCC) with representatives from the 3 monitoring components (environmental drivers, pelagic, and nearshore), and a Science Review Panel (SRP). This section describes their duties and lists the complete contact information for senior program personnel. Professional and academic credentials for our PMT and SCC are provided in curriculum vitae located in Attachment 1. A list of leadership staff (Table 1) and a program organizational chart in the next section (Figure 1) have been provided for quick reference.

Table 1. GWA key personnel listed by program group, name, affiliation, title and the percentage of time that person will devote to the role.

GWA Leadership Group	Name	Affiliation	Title/Role	% time
Program Management Team (PMT)	Mandy Lindeberg	NOAA	Program Lead	50%
	Katrina Hoffman	PWSSC	Administrative Lead	25%
	To Be Determined	NOAA	Science Coordinator	100%
	To Be Determined	NOAA	Program Coordinator	100%
Science Coordinating Committee (SCC)	Russell Hopcroft	UAF	Env. Drivers Lead	10%
	Mayumi Arimitsu	USGS	Pelagic Lead	10%
	Heather Coletti	NPS	Nearshore Lead	10%
	Seth Danielson	UAF	Env. Drivers Alt.	5%
	John Piatt	USGS	Pelagic Alt.	5%
	Daniel Esler	USGS	Nearshore Alt. and	5%
			Lingering Oil liaison	5%
Science Review Panel (SRP)	Harold Batchelder	PICES	Science Review	volunteer
	Richard Brenner	ADF&G	Science Review	volunteer
	Leslie Holland-Bartels	USGS ret.	Science Review	volunteer
	Terrie Klinger	UW	Science Review	volunteer
	Stanley (Jeep) Rice	NOAA ret.	Science Review	volunteer

PROGRAM MANAGEMENT TEAM (PMT)

Program Lead: **Mandy Lindeberg**, *Research Fisheries Biologist, NOAA Auke Bay Laboratories*
17109 Pt. Lena Loop Rd, Juneau, Alaska 99801
(907) 789-6616; mandy.lindeberg@noaa.gov

Mandy Lindeberg will serve as overall program and science lead and the primary point of contact for EVOS Trustee Council. She will ensure program coordination, collaborations and awareness with other agencies and monitoring initiatives in the region. This position combines the responsibilities held in the previous 5-year program by Molly McCammon (former program lead) and Kris Holderied (former science lead). If awarded another five years of funding, program and science leadership can be led by one individual instead of two now that the program has advanced to a more mature, operational state. We feel that this approach will lead to reduced program management costs. Lindeberg will be responsible for overseeing coordination of individual program components, science synthesis and integration, and ensuring a coordinated monitoring program that meets project milestones and deliverables. She will oversee project synthesis efforts and coordinate preparation of scientific reports and papers for the EVOSTC, and will work with investigators to support outreach efforts. She will also be responsible for coordinating the efforts of the GWA program with the HRM, other Trustee programs, and non-Trustee organizations. The Program Science Coordinator and Program Coordinator (both to be determined [TBD]) will report to Lindeberg.

Administrative & Outreach Lead: Katrina Hoffman, *President and CEO, PWSS*
300 Breakwater Ave., P.O. Box 705, Cordova, Alaska 99574
(907) 424-5800 x225; khoffman@pwssc.org

Katrina Hoffman will serve as program administrative lead as she did for the first 5 years of this program. However, in FY17-21 she will also pick up the role of Outreach Lead that was previously filled by McCammon. She will be responsible for logistical support for: the Science Review Panel; Outreach Steering Committee; PI meetings; and non-Trustee agency travel to some meetings as well as all teleconferences. Hoffman will oversee timely submission of all project reports and monitoring of overall program spending. As the fiscal agent for the non-Trustee Agency program cooperative agreement, the PWSSC will be responsible for financial administration of the EVOSTC award through NOAA, including all sub awards, timely submission of financial and progress reports, and annual audit completion. Outreach and community involvement efforts will be coordinated, developed, and implemented with input from Outreach Coordinator, Stacey Buckelew.

Science Coordinator: TBD PhD, *NOAA Term Funded FTE, Auke Bay Laboratories*

The Science Coordinator will be a NOAA employee located at the Auke Bay Laboratory in Juneau. The creation of a NOAA position has been approved and will be advertised in fall 2016. A qualified individual has been identified (see CV in program proposal Attachment I); however, the position will be advertised competitively and the most qualified individual will be hired.

The Science Coordinator will lead efforts to integrate and synthesize data collected under the program while also providing technical review, editing, research and writing of program documents. The Science Coordinator will work directly with the Science Review Team and SCC. In addition, the Science Coordinator will seek partnerships between GWA and external programs in order to leverage the data and platforms supported by GWA to increase the regional significance and prestige of the project. The Science Coordinator will work directly with journals' special issue process and EVOSTC staff to ensure publication of peer-reviewed articles and scientific reports, promote across component synthesis publications, and lead small working groups assembled to pursue specific scientific issues. The Science Coordinator provides technical feedback on data tools and user access, and works closely with the Program Lead, Administrative

Lead (PWSSC Director), and Program Coordinator on scientific meeting agendas, discussion facilitation, and more.

Program Coordinator: TBD, *NOAA affiliate, Auke Bay Laboratories*
The Program Coordinator will be a NOAA contractor. A request for proposals for a qualified contractor who can perform the work within the approved budget will be advertised in fall 2016. The current Science Coordinator, Donna Aderhold, has indicated interest in submitting a proposal for the Program Coordinator contract position (see CV in program proposal Attachment I); however, the contract will be awarded to the most qualified, cost effective proposer.

The Program Coordinator will work closely with PMT members to provide administrative assistance to the program and PIs with primary efforts toward compiling program reports and budgets. Duties include assisting the Science Coordinator and the Administrative Lead (PWSSC Director) with meeting and teleconference logistics, notifying PIs of due dates, facilitating communication between program groups, small working groups, and all program PIs. Providing content and updates to internet and program outreach materials, and assisting with annual program planning and travel.

Science Coordinating Committee (SCC)

The SCC is the guiding science body for the GWA Program and oversees all project PIs and collaborators. The SCC will help ensure coordinated work to be performed is in line with the approved statements and goals of the projects and program.

- **Russell Hopcroft – Environmental Drivers Component Lead**
  Professor, UAF School of Fisheries and Ocean Sciences; 905 N. Koyukuk Dr., Fairbanks, Alaska 99775; (907) 474-7842; rrhopcroft@alaska.edu
- **Mayumi Arimitsu – Pelagic Component Lead**
  Research Ecologist, US Geological Survey- Alaska Science Center; 250 Egan Dr., Juneau, Alaska 99801; (907) 364-1593; marimitsu@usgs.gov
- **Heather Coletti – Nearshore Component Lead**
  Marine Ecologist, Southwest Alaska Network (SWAN), National Park Service; 4175 Geist Rd., Fairbanks, Alaska 99709; (907) 455-0675; heather_coletti@nps.gov
- **Seth Danielson – Environmental Drivers Component Alternate**
  Assistant Professor, UAF School of Fisheries and Ocean Sciences; 905 N. Koyukuk Dr., Fairbanks, Alaska 99775; (907) 474-7834; sldanielson@alaska.edu
- **John Piatt – Pelagic Component Alternate**
  Research Biologist, US Geological Survey - Alaska Science Center; 4210 University Dr., Anchorage, Alaska 99508; (360) 774-0516; john_piatt@usgs.gov
- **Daniel Esler - Nearshore Component Alternate and Lingering Oil focus area liaison**
  Nearshore Marine Ecosystem Research Program Manager, US Geological Survey - Alaska Science Center; 4210 University Dr., Anchorage, Alaska 99508; (907) 786-7068; desler@usgs.gov

Science Review Panel (SRP)

The internal program SRP consists of five distinguished scientists with extensive research and publication experience in fisheries, oceanography, and marine ecology as well as research program management expertise. They have graciously volunteered to provide their expertise to the GWA program.

- **Dr. Harold Batchelder -** *Deputy Director, North Pacific Marine Science Organization (PICES)*
  Dr. Batchelder received his Ph.D. and M.S. in oceanography from Oregon State University, and his B.S. in biology from the University of Maine. He recently left a faculty position with the Oregon State University to accept the Deputy Director position for PICES, the North Pacific Marine Science Organization. Dr. Batchelder has served on several advisory boards, including serving as a science panel member for the EVOSTC. His research interests focus on coupling of physical circulation models of ocean transport with nutrient-phytoplankton-zooplankton ecological models and individual-based models of zooplankton energetics and demography, as well as biological-physical interactions in the pelagic and intertidal environments. He has expertise in large integrated research programs with past participation in the U.S. Global Ocean Ecosystem Dynamics (GLOBEC) Program.

- **Dr. Richard Brenner -** Salmon Stock Assess. Biologist, Alaska Department of Fish and Game (ADF&G) Division of Commercial Fisheries
  Dr. Brenner grew up in Southcentral Alaska where he worked on commercial fishing operations in PWS, Cook Inlet, Kodiak Island, and GOA. In 1989 he worked on EVOS, during which he collected oiled boom and delivered clean boom throughout PWS. Dr. Brenner received his bachelor and doctorate degrees in Biological Sciences from the University of Alaska Fairbanks and pursued post-doctoral research at the University of California Berkeley's Center for Stable Isotope Biogeochemistry. In 2007 Rich became a salmon and herring research biologist with ADF&G for PWS and the Copper/Bering River districts. In this role he has pursued investigations of fish population abundance, productivity, disease, diet, physiology, and dispersal behavior. Throughout his research, Rich has collaborated with current GWA investigators from NOAA, PWSSC, and USGS, as well as other researchers from universities, federal agencies, and non-profits. Rich continues investigations within the PWS region and in 2015 became a statewide salmon stock assessment biologist for ADF&G at the Juneau headquarters office.

- **Dr. Leslie Holland-Bartels -** *Scientist Emeritus***,** *USGS Alaska Science Center*
  Dr. Holland-Bartels received her Ph.D. in aquatic ecology from Purdue University, her M.S. in fisheries from Louisiana State University, and her B.S. in marine fisheries from the University of Massachusetts. Her distinguished career in federal service included serving in Director and Deputy Director positions with USFWS and USGS Alaska Science Center. She has served on numerous advisory panels, including serving as the science liaison to the EVOSTC for the USFWS and leading the Nearshore Vertebrate Predator Program, a four-year integrated ecosystem study. Dr. Holland-Bartels has also served in several adjunct and affiliate faculty positions, with her research focus on climate change and the effects to arctic ecosystems. Her range of publications, from salmonid life history work to climate change impacts on wildlife populations, demonstrate her broad experience and large-scale scientific viewpoint.

- **Dr. Terrie Klinger -** *Barer Prof. of Sustainability Science***,** *School of Marine and Environmental Affairs, University of Washington*
  Dr. Klinger received her Ph.D. in biological oceanography from Scripps Institution of Oceanography, her M.S. in botany from the University of British Columbia, and her B.A. in marine biology from the University of California, Berkeley. She is Professor of Marine and Environmental Affairs, Adjunct Professor of Aquatic & Fishery Sciences, and Co-Director of the Washington Ocean Acidification Center at the University of Washington. She serves on multiple science advisory panels, including the West Coast Ocean Acidification and Hypoxia Panel, the Northwest Straits Marine Conservation

Initiative, and Communication Partnership for Science and the Sea. Her research focuses on use of empirical data to test the application of ecological theory to marine environmental policy and management. In particular, her interests are in the effects of multiple environmental stressors (habitat loss, biological removals and invasions, global change) on marine ecosystem function, and in the development of management strategies to reduce the impact of stressors on marine communities.

- **Dr. Stanley (Jeep) Rice -** *Scientist Emeritus***,** *NMFS Auke Bay Laboratory Program Manager*
  Dr. Rice received his Ph.D. in comparative physiology and toxicology from Kent State University, and a B.S./M.S. in biological science from Chico State University. He started his career with NOAA in 1971 as a biologist and was assigned to work on the environmental impact statement for the pending Trans-Alaska Pipeline and to start a new program in oil toxicology that would be relevant to Alaska fisheries issues and form the cornerstone of lingering oil studies for the EVOSTC. He worked for over 40 years with NOAA's NMFS studying nearshore and marine ecosystems in the GOA and PWS. His many published works provide the foundation for the GWA program, focused on the impacts of EVOS on nearshore communities. Dr. Rice recently retired and continues to serve in an advisory capacity to researchers for the HRM program, GWA program, as well as students studying Alaskan nearshore ecology.

4. Program Administration

GWA's Program Management Plan was developed at the onset of the program (2012) and will be updated and revised during the first year of the next 5-year increment, FY 2017-2021. The Program Coordination and Science Synthesis proposal (GWA PM I) details GWA management and includes an attachment of the program and data management plan. Our program organizational structure includes a Program Management Team, Outreach Steering Committee, Science Review Panel, Science Coordinating Committee and three monitoring components (Figure 1).

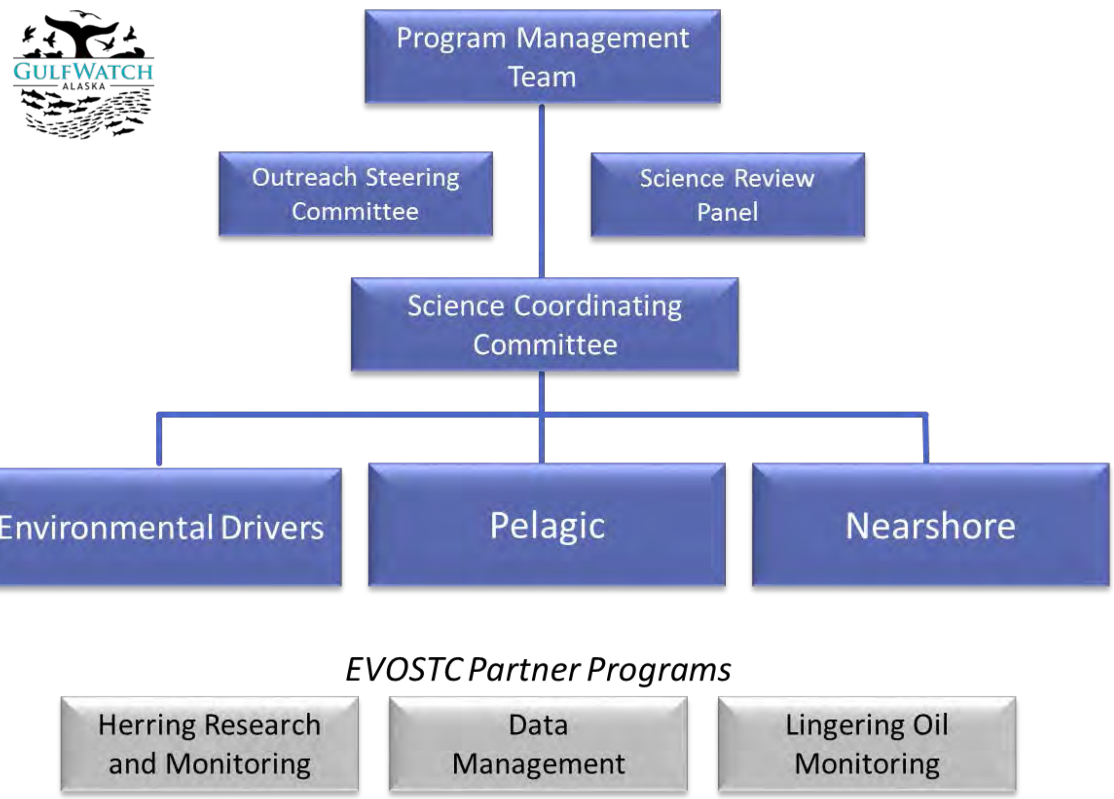

Figure 1. Gulf Watch Alaska organizational chart.

SERVICES COVERED BY INDIRECT RATE

The PWSSC has a negotiated indirect cost rate of 30%. PWSSC serves as the EVOSTC's fiscal agent administering all research funding to non-Trustee Agencies as subawards. However, federal indirect cost recovery regulations only permit an agency to recover indirect from the first $25,000 of any individual subaward. That scenario would not enable PWSSC to cover the expenses of administering millions of dollars in research subawards across a five-year long program. The compromise we arrived at allowed us to efficiently manage all non-Trustee Agency awards in the first five years of the program, alleviating a significant grants management burden that the EVOSTC staff and NOAA would otherwise incur. For FY17-21 of GWA, we again propose to waive our 30% indirect rate for all PWSSC PIs and apply a flat direct fee each year, adjusted annually for the cost of inflation. The flat fee equates to 10.8% of the total program cost. Expenses that PWSSC may cover include any expenses that would legally be covered by indirect costs, such as: administrative salaries and benefits; travel; insurance; office supplies; telephone and utilities; consultants; audit; legal fees; indirect cost proposal preparation; information systems and software support; repairs and maintenance of the organization's facilities that are used by programs funded by grants and contracts. As fiscal administrator of the program, we track all non-Trustee Agency spending; reimburse all non-Trustee Agency invoices; submit annual budget proposals and work plans to EVOSTC; submit annual reports including budget reports to EVOSTC, and file quarterly SF424-A financial reports with NOAA on behalf of all non-Trustee Agency awards, as well as semi-annual progress reports to NOAA on behalf of all non-Trustee Agency awardees.

SCHEDULE FOR PRODUCTION AND IMPLEMENTATION OF DATA AND REPORTING POLICIES

Scheduling for GWA production and implementation was successfully managed during the first five years of the program and there will be no major changes in the next five-year period. The PMT, which expects to meet at least monthly, will develop, implement, and track the policies and schedule for production of data and reports. The PMT will ensure that all data, documents, annual and final reports, and work plan proposals abide by the EVOSTC reporting requirements and deadlines are met. Fundamentals of GWA program scheduling and policies are as follows:

Meetings: PI meetings are scheduled every quarter: teleconferences and in-person at designated locations.

- *Mandatory Annual PI meeting* – this annual meeting is planned, tentatively in November, for all investigators to share information among themselves and potentially with investigators in other related programs, especially the EVOSTC'S HRM program, Lingering Oil and potential Cross-Program publishing groups. The meetings will provide an opportunity to update the Program Science Review Panel and, as appropriate, the EVOSTC Science Panel, improve coordination among projects, and provide outreach and public input opportunities. The in-person meetings will also ensure proper communication among the individual monitoring components and provide an opportunity to informally review results of field activities and develop initial work plans for the following year. The location for the annual PI meeting will rotate among communities in the spill area and Anchorage.

- In addition to the annual PI meeting, we will also provide for engagement and collaboration between and among GWA, HRM, Outreach and Data Management personnel at the Alaska Marine Science Symposium (AMSS), a second opportunity to advance program goals in person.

- PI teleconferences will round out the quarterly meeting schedule.

Reporting: A schedule of all report due dates will be posted on the GWA Program's internal administration website and reminders will be sent to all PIs.

- *Annual Reports* - GWA program and all project PIs will be required to submit annual progress reports to the EVOSTC. Program approved templates must be used, and they must be submitted on time, or the investigator may jeopardize annual transfer of project fund allocation (Due March 1). The PMT and the EVOSTC office will coordinate reporting and review requirements to streamline the process and minimize duplication.

- *Annual Work Plan and Funding Requests* – GWA program and all project PIs will be required to submit annual detailed project proposals and budgets to the EVOSTC (September 1). Program approved templates must be used, and they must be submitted on time, or the investigator may jeopardize annual transfer of project fund allocation. The PMT and the EVOSTC office will coordinate reporting and review requirements to streamline the process and minimize duplication.

- *Year 8 Science Synthesis Report* - GWA program and all project PIs will be required to produce a science synthesis report in the third year of the 5-year period (FY19; December 1). A special issue peer reviewed journal will be considered for science synthesis. The SCC will work with the Program Lead and Science Coordinator to organize a format and schedule for the Year 3 synthesis.

- *Year 10 Final Report* - GWA program and all project PIs will be required to produce final report at the end of the 5-year period (due FY22; 1st quarter). Program approved templates must be used, and they must be submitted on time, or the investigator may jeopardize annual transfer of project fund allocation. The PMT and the EVOSTC office will coordinate reporting and review requirements to streamline the process and minimize duplication.

Documentation and Publishing:

- *Standard Operating Procedures* - Each PI will document and keep up to date the key sampling standard operating procedures (SOPs) used for their monitoring component for posting on the Program website. If the PI of that component changes, the agreed upon sampling procedures must continue to be used by any new PI. The SCC and the SRT must agree upon any changes to standard protocols desired by the PI. Any changes must be noted at the annual PI meeting and in the annual reports.

- *Published Data* – as part of the GWA data management plan, all PIs will be required to make their data available to the public as soon as it has been QA/QC'd or within 1 year following collection (see section #6 program data management).

- *Scientific Publications and Presentations* - publishing of research results in primary peer-reviewed literature is critical for the success of the program and the SCC will work with PIs to promote collaborative publications. Scientists may publish in journals of their choice, or special issues organized by the PMT and the SCC. Principal investigators will forward titles and publication information for accepted manuscripts to the GWA science lead, who will maintain a web-based list of GWA publications.

Corrective Action:

- *Corrective Action* – Participants in the GWA program are encouraged to resolve disputes at the lowest internal level possible. Disputes that cannot be resolved through negotiation and compromise will be elevated for resolution either by the PMT or the SCC as appropriate. If corrective action is deemed advisable for any specific monitoring component, the GWA PMT will take the following escalating steps as they deem necessary and appropriate:
    - Inform the SCC of the need for corrective action and receive a signed acknowledgement from the investigator in question that the action will be taken;
    - Negotiate corrective action directly with the PI(s) and receive a signed acknowledgement from that investigator that the action will be taken;
    - If corrective action is not taken, consider withholding additional funds for that investigator's work until the problem is resolved; and
    - If resolution is not practical, respective agencies and organizations involved will be consulted to determine an appropriate solution. The PMT may withhold funds as necessary and allowable until disputes are resolved.

  To date, the GWA program has had no disputes and no instances in which corrective action was required.

COSTS AND STAFF TIME ASSOCIATED WITH MEETINGS

Meetings conducted by teleconference, such as quarterly PI and PMT planning meetings, will have minimal costs. PIs and the PMT are expected to spend 1-2 hours on the phone for these meetings. Two meetings a year are in-person and will incur travel costs: 1) mandatory annual PI meeting and 2) AMSS with concurrent GWA and HRM PI meeting. Annual PI meeting locations will be rotated annually to coastal communities in the spill-affected area or in Anchorage for two days. Anchorage meetings are held at our collaborator's conference room (AOOS) at no cost and meetings with EVOSTC staff can be easily facilitated. All project proposals have built into their budgets the necessary travel funds to meet these program meeting requirements. Timing of these in-person meetings have been scheduled to best fit program activities (e.g., PIs doing fieldwork), deadlines and cost effectiveness (e.g., some PIs are already funded to attend AMSS).

5. Science Program Design and Implementation

As described above and in the Program Coordination and Science Synthesis proposal (GWA PM I), the PMT will revise and update our Program and Data Management Plan to manage the GWA program scientific projects. GWA PIs will be required to read, agree to, and sign the revised Program and Data Management Plan.

EVALUATING & MEETING PROGRAM GOALS

Program Review:

The GWA PMT and SCC will assess the status and success of the program with the EVOSTC staff following review of progress reports and the PI meetings on an annual basis and make any program revisions as needed. In addition to the annual review, in-season and between-season reviews of operations may be convened as necessary to assess the success of field seasons and identify possible improvements that may be incorporated into revised annual work plans. The GWA SRP will also play a key role in program review.

Science Review Panel (SRP):

As stated in the previous section, the SRP will provide periodic external review and advice to the GWA program. The SRP will ensure proper design and evaluation of the GWA program are maintained. Each member will review program products such as reports, work plans, SOPs, and syntheses. SRP review comments will be given directly to PIs and PMT and SCC members will ensure reasonable responses have been documented. Recommendations from this panel may be incorporated into revisions to the annual work plans. This panel may also be invited to weigh in on any changes to program scientific design, synthetic analyses or collaborative papers (including cross-program publications that leverage data from both GWA and HRM).

6. Program Data Management

The GWA Program and Data Management Plan (see the Program Coordination and Science Synthesis proposal, GWA PM I) also includes a policy for data management and sharing practices during the FY 2017-2021 funding period. PI signatures are required for this document. Specifically, the program management plan states:

"The EVOSTC requires data sharing in its agreements among all principal investigators and program components. For this Program, all PIs shall adhere to these policies unless individual agency or legal

requirements require restrictions contrary to these policies. The LTM Program Workspace account on the AOOS Ocean Workspace will be password protected to ensure confidentiality among PIs.

- *All data should be posted on the LTM Program Workspace as they become available following collection in order to promote internal integration and sharing within the project.*
- *These data should be replaced with QA/QC'd data when available.*
- *Comprehensive metadata using FGDC (or ISO) standards are required for each dataset.*
- *Monitoring data will be made available to the public as soon as it has been QA/QC'd or within 1 year following collection, whichever is sooner.*
- *Anyone making public use of another team member's data should contact the collector of the data and provide appropriate attribution and credit.*
- *The Science Coordinating Committee must agree to any deviations from these policies in advance.*

As a program of the EVOSTC, all PIs and project managers are expected to adhere to EVOSTC policies regarding retention of all documents, correspondence (electronic and paper), samples and data per the terms of the EVOSTC court settlement."

As part of our program management plan, we propose to continue to use our data management provider at AOOS/Axiom to maintain the GWA data management systems and structure. During the previous five-year funding cycle, GWA and HRM programs worked collaboratively to provide user-based feedback that informed and improved the development of AOOS data and metadata management, access, and tools. We propose to use our partners at AOOS to continue to provide access to the tools and services with which the GWA program scientists have become familiar, have spent substantial time developing and editing content and upon which they depend.

We propose to continue to use the AOOS web-based data management platform, Ocean Workspace, to upload, organize, and document data, as well as to facilitate program administration. This platform is familiar to both the GWA and HRM PIs, and it allows data to be promptly and securely available to team members. Work completed during FY16 of the GWA program will further expand the publication capacity of the data management system. Published information will be shared beyond the programs through the AOOS Gulf of Alaska Data Portal, where it can be accompanied by any supplemental files or project documentation. Publishing through AOOS makes the data available to a wide-ranging and established network of resource managers, scientists, and the public. In addition, GWA and HRM program datasets will be ingested into DataONE for long-term preservation, where each dataset will be assigned a Digital Object Identifier (DOI) and made discoverable through other DataONE member nodes.

7. Program Outreach

The GWA program's Public Outreach Plan developed during the first five years of the program has been revised and updated for the FY 2017-2021 period. Public and Trustee Agency outreach activities will be managed under our Administration, Logistics, and Outreach project (GWA PM II proposal) and additional details about public and agency outreach can be found in that proposal. All participants in the GWA program are expected to participate in public outreach, and PI participation during the first five-year period has been enthusiastic.

The GWA program has a public website (http://www.gulfwatchalaska.org) that provides detailed information about the program and links to our public Data Portal. Our schedule for website updates includes regular reviews of information presented on the website to ensure it is up to date and accurate. PIs review their project descriptions each spring and provide updates based on the previous year's field season and the annual report submitted to EVOSTC.

The public Data Portal (http://portal.aoos.org/gulf-of-alaska.php) contains data and federally compliant metadata from each of the GWA program projects. Project data on the Data Portal are updated annually at a minimum, more frequently if needed by trust or management agencies. Currently we are ahead of schedule for posting year four data.

In addition to our website and Data Portal, GWA PIs participate in public outreach activities such as public presentations, radio programs, classroom presentations, and discovery labs. This suite of activities is accessible to all age levels. In FY 2017 we plan to hold a meeting with Trustee and management agency staff to learn about their priorities for data, data products, visualizations, and outreach products. We will query their preferences for additional engagement with GWA program projects.

8. Coordination and Collaboration

Within the Program

A primary objective of the integrated GWA program is to coordinate project monitoring, data management, outreach and administration. Below is a summary of proposed coordination and collaboration efforts within the GWA program including within each of the program components (many are continued from the first five-year program effort), beyond the regular phone conferences of the component leads. Additional details can be found in the individual project proposals.

Program Management Team (PMT)

The PMT meets at least monthly, on average, and sometimes weekly depending on the needs of the program. The PMT will coordinate and integrate with program principal investigators through e-mail, audio video teleconferences, webinars and/or one on one. PIs will meet quarterly with the PMT and SCC to ensure continuous communication and collaboration between program projects and monitoring components. PIs will review field season plans at annual PI meetings and identify potential collaborations. Field sampling and scheduling will be integrated among PIs and with other organizations whenever possible.

Environmental Drivers Monitoring Component

The Environmental Drivers component provides data for relational analyses for projects in both the Pelagic and Nearshore monitoring components (as discussed below) as well as working closely with the HRM program. These efforts all look to the Environmental Drivers observations to provide physical, chemical and lower trophic level context on how bottom-up forcing may explain the differences that they observe between years as well as long-term trends. We propose to continue these efforts, including providing expertise on interpreting observations from across the GWA program.

Pelagic Monitoring Component

The pelagic projects from the previous five-year monitoring program will continue but with improved integration. Under the next five year monitoring program, we are proposing to integrate predator-prey survey efforts by combining monitoring work from three of the PWS Pelagic Component projects. The simultaneous surveys will reduce vessel cost for the three projects while combining expertise with spatial and temporal consistency, allowing a more comprehensive understanding of the pelagic ecosystem. In addition to a planned research cruise in September/October, the proposed approach may also allow for in-kind contributions from NOAA for a vessel charter and an additional survey in March. The forage fish project has also teamed up with Scott Hatch (ISRC) in support of the long-term seabird diet monitoring effort at Middleton Island that will occur annually in April-August.

Nearshore Monitoring Component

Under the previous five-year program, the nearshore component consisted of two monitoring projects, each of which was highly integrated across trophic levels and monitored a wide array of nearshore species. We propose that these projects are further integrated into a single project, with two separate budgets to accommodate the multiple university and federal efforts. By doing this, the entire nearshore component is fully coalesced, facilitating collection of comparable data, coordinated data management, consistent reporting, and publication of integrated findings.

There are numerous opportunities for cross-component collaboration, some of which are ongoing. In particular, understanding the role of variation in physical and biological oceanography on nearshore species abundance and performance is a key issue that is facilitated by integration of the Nearshore and Environmental Drivers components. Also, contrasts of the spatial scale, timing, and magnitude of variation between pelagic and nearshore ecosystems offer important insights into the causes and consequences of ecosystem change.

With Other EVOSTC-funded Programs and Projects

Herring Research and Monitoring Program Focus Area

The GWA PMT will continue to work closely with the HRM team lead, Scott Pegau, and PIs to coordinate research activities, information, and reporting. Coordination and collaboration will be accomplished through joint PI meetings, sharing of expertise and analytical ideas, data sharing, and outreach events.

At the project level a prime example of collaboration with the HRM program is the pelagic component integrated projects. The GWA forage fish monitoring project will provide in-kind technical and analytical support to Scott Pegau and the HRM program's June aerial surveys for age-1 herring and other forage fish schools index. When NOAA-funded March integrated herring surveys occur we will also coordinate closely with ADF&G and the HRM program to share real-time information relevant to their pre-spawning herring biomass surveys. As in the past, the humpback whale project will work with the HRM program Lead and PIs (e.g., Kristen Gorman, PWSSC), to provide samples for various analyses including age at maturity. Similarly, the humpback whale PIs are dependent on estimates of herring abundance developed through the age-structured assessment conducted by the HRM Program.

Data Management Focus Area

We propose to use our partners within the AOOS/Axiom program for GWA data management. This partnership allows published information to be shared beyond the EVOS programs through the AOOS Gulf of Alaska Data Portal (http://portal.aoos.org/gulf-of-alaska.php) and the DataONE national archival system. Additionally, leveraging the AOOS data management system means leveraging the data management staff at AOOS and Axiom. These staff members have experience with the EVOS programs and their data and will be available to assist GWA and HRM project PIs with data management planning, system training, data formatting, and metadata content review.

LINGERING OIL FOCUS AREA

For the first 5 years of the GWA program, lingering oil studies were closely linked with the Nearshore Component, given that residual oil occurs in nearshore habitats and affects nearshore species. In the next 5 years, Lingering Oil studies will be proposed under the separate program focus area; however, the conceptual and collaborative linkages with the Nearshore Component will remain. Dan Esler (USGS) will coordinate with this project and act as a liaison between the GWA program and Lingering Oil.

Proposed lingering subsurface EVOS monitoring work (Carls and Lindeberg, project 16120114-S) under the Lingering Oil Focus Area will be pending on outcomes of future EVOSTC decisions. As stated in the EVOSTC FY 2017-2021 invitation, additional information is forthcoming from recent lingering subsurface oil surveys and additional reporting has been requested before further decisions are made for possible restoration measures. A long-term lingering oil monitoring project should coordinate and collaborate with the GWA program but currently established monitoring sites are also the primary candidates for future restoration. Our expectation is to help interested parties to propose another lingering oil monitoring survey off-cycle as decisions are made on restoration.

CROSS-PROGRAM PUBLICATION GROUPS FOCUS AREA

The GWA program can see the value in this focus area as a means to coordinate and collaborate on integrated cross-cutting publications. Already a concept manuscript has been discussed among senior scientists and recruitment of cross-program participants has begun.

WITH TRUSTEE OR MANAGEMENT AGENCIES

With over $8 million proposed in cost-share, in-kind, and direct funds for FY 2017-2021, the GWA program would not be possible without extensive leveraging of resources by Trustee and management agencies (see: Section 10 Budget, the GWA budget workbook, and individual project proposals for additional details). A summary of GWA project collaborations with other Trustee or management agencies is provided in Table 2.

Table 2. Summary of GWA projects and collaborations with Trustee or management agencies. Information is organized by the three program components: environmental drivers, pelagic, and nearshore.

PROGRAM GROUP	AGENCY	COLLABORATORS	DESCRIPTION
Environmental Drivers Component			
GAK-1	UAF	USGS, NOAA, ADF&G	GAK-1 data provide high-resolution long-term contextual environmental data for the GWA scientific team, other researchers and agency personnel and the public at large: halibut migrations, herring energetics, king crab, spiny dogfish, rock sole, and salmon forecasts. It also provides data to NOAA's new Ecosystems Considerations to be produced annually for the Gulf of Alaska.
	UAF	NPS	GAK-1 PIs have assisted the NPS in establishing a similar monthly sampling and data processing protocol in Glacier Bay National Park and Preserve through the Inventory and Monitoring program.

PROGRAM GROUP	AGENCY	COLLABORATORS	DESCRIPTION
Seward Line	UAF	ADF&G, NOAA, NPRB, NSF	Seward Line data are available for salmon forecasting and GOA Ecosystem Status reports. It also provides data to NOAA's new Ecosystems Considerations to be produced annually for the Gulf of Alaska. The Seward Line provides the platform and related data for the Gulf of Alaska's Ocean Acidification program funded by AOOS. It also supports several NSF-funded projects dependent on its infrastructure. The Seward Line is leverages heavily of funds from NPRB and NOAA (through AOOS).
Continuous Plankton Recorder	SAHFOS	ADF&G, NOAA	Steve Moffit with ADF&G in Cordova uses these data for forecasting salmon and herring populations. It also provides data to NOAA's new Ecosystems Considerations to be produced annually for the Gulf of Alaska.
PWS Oceanographic Monitoring	PWSSC	USGS	Plankton samples have been regularly sent to the USGS Marrowstone group (Paul Hershberger) for tests for the presence of Ichthyophonus life stages and other diseases.
	PWSSC	USGS	PIs are in discussions with John Crusius (University of Washington) about adding a low drift oxygen sensor to the moored profiler, which may be used to infer primary productivity from oxygen generation
Cook Inlet Oceanographic Monitoring	NOAA NOS NCCOS	AOOS/Axiom	PIs with National Centers for Coastal Ocean Science are partnering with AOOS/Axiom to develop a web-based paralytic shellfish poisoning risk management tool.
	NOAA Kasitsna Bay Laboratory	BOEM	BOEM is funding additional lower Cook Inlet oceanographic surveys and using existing survey data to support environmental analysis needs for potential oil and gas lease sales in the region.
	NOAA Kasitsna Bay Laboratory	NOAA Integrated Ocean Observing System and AOOS	PIs are coordinating to include additional oceanographic data for understanding climate change effects on food webs, harmful algal blooms, and ocean acidification.
Pelagic Component			
Killer Whales	North Gulf Ocean Society	NMFS Alaska Fisheries Science Center	PIs annually provide project data to Paul Wade, National Marine Mammal Laboratory, for killer whale stock assessments for Alaska.
	North Gulf Ocean Society	NOAA Northwest Fisheries Science Center	Killer whale genetic, contaminant, and lipid and fatty acid data are archived with Gina Ylitalo, Northwest Fisheries Science Center.
Humpback Whales	NOAA Auke Bay Labs	NOAA Protected Resources (PR)	Data collected on humpback whale abundance are of direct value to NOAA PR managers in the implementation of the De-listing Monitoring Plan for humpback whales.

PROGRAM GROUP	AGENCY	COLLABORATORS	DESCRIPTION
	NOAA Auke Bay Labs	ADF&G, NOAA PR	During humpback whale surveys, PIs photograph Steller sea lion brands whenever possible. These brand re-sights are of interest to both ADF&G and NOAA and are used in identifying movements of Steller sea lions.
Forage Fish	USGS	ADF&G, ISRC, USFWS, UAF, Univ. Manitoba, Alaska SeaLife Center, Farallon Institute	Herring information will be shared with ADF&G (Steve Moffit); Funds to partially support, along with collaborators, long-term monitoring of seabird diets on Middleton Island, (ISRC, Scott Hatch).
	USGS, NOAA	NPFMC	These data will be incorporated into the North Pacific Fishery Management Council's annual forage fish stock assessment and the NPRB funded Gulf of Alaska Integrated Ecosystem Program Synthesis.
Summer Seabirds	USFWS	USFWS	Supports the USFWS's Migratory Bird Management mission to advance the conservation of migratory birds.
	USFWS	NPRB	Seabird surveys are a sub-award of the Seward Line project funded in part by NPRB.
	USFWS	BOEM	Seabird surveys in Lower Cook Inlet funded by BOEM to collect data for the upper trophic level component of the BOEM environmental studies program.
Fall-Winter Seabirds	PWSSC	ADF&G, USFWS	This monitoring project uses vessels associated with other agencies as observing platforms.
Nearshore Component			
Sea otters	NPS	USGS, NPRB, USFWS	Our GWA nearshore data from Katmai National Park contributed to USGS and NPRB studies of the status of the southwest Alaska stock of sea otters, which is listed as threatened under the Endangered Species Act. These data are shared with the USFWS, Marine Mammals Management, who is responsible for sea otter management.
Bivalves	NPS	USGS, Alaska SeaLife Center	PIs work with NPS on the 'Changing Tides' project examining the linkages between terrestrial and marine ecosystems and is funded by the NPS. This project will increase our understanding of how various stressors may affect both marine intertidal invertebrates and bear populations at multiple spatial and temporal scales.
Lower Cook Inlet	NPS, UAF, NOAA	BOEM	PIs are working on development of nearshore community assessment and long-term monitoring for BOEM's Proposed Final Outer Continental Shelf Oil and Gas Leasing Program 2012-2017 includes proposed Lease Sale 244 in the Cook Inlet Planning Area in 2017.

WITH NATIVE AND LOCAL COMMUNITIES

We propose to incorporate community outreach and engagement activities, to the extent we can with the reduced budget for outreach work defined in the EVOSTC FY 2017-2021 invitation. This will include:

- Holding PI meetings in at least three different spill-affected communities across the five years (e.g., from among Cordova, Seward, Homer, Valdez, and Kodiak) and having open time for input each day on the agenda.
- Having a traditional ecological knowledge roundtable-type symposium in spill-affected Alaska Native communities in Years 7 and 9 where both scientists and Native community members exchange information about different ways of knowing, as well as changes they have observed in the systems. This can be done redundantly (in the same villages) in Years 7 and 9, and would ideally be in both PWS and the Kachemak Bay/Kenai Peninsula area (e.g., Chenega and Nanwalek in year 7; and then Chenega and Nanwalek again in Year 9).
- Taking advantage of opportunities to attend board meetings of organizations that are interested in program information and data.
- Using the expertise of the Outreach Steering Committee and Outreach Coordinator to ensure that our proposed activities are considered feasible, prudent, and impactful.

9. Schedule

PROGRAM MILESTONES

For consistency between all the projects, the program completion date for each year's monitoring work, publication of the previous year's work, and associated reporting activities for the program is proposed to be the end of the project fiscal year, January 31, unless otherwise noted.

At the program-level, GWA has the following objectives:

1. Sustain and build upon existing time series in the EVOS-affected regions of GOA
2. Provide scientific data, data products, and outreach to management agencies and a wide variety of users
3. Develop science synthesis products to assist management actions, inform the public, and guide monitoring priorities for the next 15 years
4. Enhance connections between GWA and HRM programs
5. Leverage partnerships with outside agencies and groups to integrate data from broader efforts

The milestones associated with these objectives are within the individual GWA project proposals under this program proposal.

MEASUREABLE PROGRAM TASKS FOR EACH YEAR BY QUARTER

The following provides a schedule for all measureable program tasks (e.g., field work, data management, meetings, and deliverables) proposed over the next five-year period, FY2017-21. Table 3 lists tasks by fiscal year and quarter in simple terms. Following the table, more detail is provided for specific tasks on a monthly basis. For project level tasks, please see the Program Coordination and Science Synthesis proposal (GWA PM I), the administrative proposal (GWA PM II), and each individual GWA project proposal (Project Proposal Form Section 6).

Table 3. Schedule of GWA measurable program tasks.

Task	FY17				FY18				FY19				FY20				FY21			
	EVOSTC FY Quarter (beginning Feb. 1)																			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Task 1 Field sampling																				
Environmental Drivers	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Pelagic	X		X	X	X		X	X	X		X	X	X		X	X	X		X	X
Nearshore	X	X			X	X			X	X			X	X			X	X		
Task 2 Data																				
Data to Workspace				X				X				X			X				X	
Prior Yr. Data to public					X				X				X				X			
Task 3 Meetings																				
PI Meetings	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Yr. 3 Joint Workshop													X							
Task 4 Reporting																				
Annual Reports					X				X				X				X			
FY Work Plan (DPD)			X				X				X				X					
Yr. 3 Synthesis Report												X								
5 Yr. Final Report																				X

FY 2017 (Year 6)

FY 17, 1st quarter (February 1, 2017 - April 31, 2017)
February *Conduct quarterly program teleconference*
April: *Submit 5-year program status summary and special issue manuscripts*

FY 17, 2nd quarter (May 1, 2017-July 30, 2017)
June *Conduct quarterly program teleconference*

FY 17, 3rd quarter (August 1, 2017 – October 31, 2017)
September 1: *Submit annual program work plans*
September 30: *PI data compliance on workspace*
October: *Conduct quarterly program teleconference*

FY 17, 4th quarter (November 1, 2017- January 31, 2018)
November: *Annual PI meeting and program review*
December-January: *Presentation of GWA program/projects at AMSS*
Conduct quarterly program teleconference

FY 2018 (Year 7)

FY 18, 1st quarter (February 1, 2018 - April 31, 2018)
February: *Compile/edit Year 1 annual report for EVOSTC and semi-annual NOAA Report*
PI data compliance prior year available to public

	Conduct quarterly program teleconference
March:	*Submit Year 1 annual report for EVOSTC and semi-annual NOAA Report*

FY 18, 2nd quarter	(May 1, 2018-July 30, 2018)
May:	*Complete updates to program website and outreach materials*
June-July:	*Conduct quarterly program teleconference*

FY 18, 3rd quarter	(August 1, 2018 – October 31, 2018)
September 1:	*Submit annual program work plans*
September 30:	*PI data compliance on workspace*
October:	*Conduct quarterly program teleconference*

FY 18, 4th quarter	(November 1, 2018- January 31, 2019)
November:	*Annual PI meeting and program review*
December-January:	*Presentation of GWA program/projects at AMSS*

FY 2019 (Year 8)

FY 19, 1st quarter	(February 1, 2019 - April 31, 2019)
February:	*Compile/edit Year 2 annual report for EVOSTC and semi-annual NOAA Report*
	PI data compliance prior year available to public
	Conduct quarterly program teleconference
March:	*Submit Year 2 annual report for EVOSTC and semi-annual NOAA Report*

FY 19, 2nd quarter	(May 1, 2019-July 30, 2019)
May:	*Complete updates to program website and outreach materials*
June-July:	*Conduct quarterly program teleconference*

FY 19, 3rd quarter	(August 1, 2019 – October 31, 2019)
September 1:	*Prepare and submit annual program work plans*
September 30:	*PI data compliance on workspace*
October:	*Conduct quarterly program teleconference*

FY 19, 4th quarter	(November 1, 2019- January 31, 2020)
November:	*Annual PI meeting and program review*
December-January:	*Submit Year 3 Science Synthesis Report; draft special issue concept*
	Presentation of GWA program/projects at AMSS

FY2020 (Year 9)

FY 20, 1st quarter	(February 1, 2020 - April 31, 2020)
February:	*Conduct quarterly program teleconference*
	PI data compliance prior year available to public
	Participate in Joint Science Workshop with HRM program
	Compile, edit, annual reports for Year 3 EVOSTC and semi-annual NOAA report

March:	*Submit annual reports for EVOSTC Year 3 and semi-annual NOAA report*

FY 20, 2nd quarter	(May 1, 2020-July 30, 2020)
June-July:	*Conduct quarterly program teleconference*

FY 20, 3rd quarter	(August 1, 2020 – October 31, 2020)
September 1:	*Annual work plans submitted to EVOSTC and semi-annual NOAA report*
September 30:	*PI data compliance on workspace*
October:	*Conduct quarterly program teleconference*

FY 20, 4th quarter	(November 1, 2020- January 31, 2021)
November:	*Annual PI meeting and program review*
December-January:	*Presentation of GWA program/projects at AMSS*
	Conduct quarterly program teleconference
	Draft program proposal for next five-year increment

FY2021 (Year 10)

FY 21, 1st quarter	(February 1, 2021 - April 31, 2021)
February:	*Compile/edit Year 4 annual report for EVOSTC and semi-annual NOAA Report*
	PI data compliance prior year available to public
	Conduct quarterly program teleconference
March:	*Submit Year 4 annual report for EVOSTC and semi-annual NOAA Report*
April:	*Submit next five-year program proposal*

FY 21, 2nd quarter	(May 1, 2021-July 30, 2021)
May:	*Complete updates to program website and outreach materials*
June-July:	*Conduct quarterly program teleconference*

FY 21, 3rd quarter	(August 1, 2020 – October 31, 2020)
September 1:	*Submit revised program proposal for FY 2022 invitation (pending EVOSTC)*
September 30:	*PI data compliance on workspace*
October:	*Conduct quarterly program teleconference*
	Compilation of draft five-year status summary or special journal issue manuscripts

FY 21, 4th quarter	(November 1, 2021- January 31, 2022)
November:	*Annual PI meeting and program review*
December-January:	*Presentation of GWA program/projects at AMSS*
	Conduct quarterly program teleconference

FY22, 1st quarter	(February 1-April 30)
	Submit program final report/publications for 2nd five-year funding period. Final datasets and upload for 2nd five-year funding period. If a third 5-year period is approved then planning for program activities.

10. Budget

BUDGET FORMS (ATTACHED)

Please see completed program workbook for program summaries and for each project's five-year budget. No costs are associated with international travel or outreach events unrelated to the program. Table 4 provides an overall program budget summarized by category rather than project.

Table 4. Proposed GWA program budget summary by category across all projects for FY 2017-2021. Numbers are presented in thousands.

Budget Category	FY 17	FY 18	FY 19	FY 20	FY 21	Total
Personnel	1,105.2	1,212.9	1,154.3	1,261.7	1,207.8	5,942.0
Travel	100.7	111.2	99.3	114.7	101.8	527.7
Contractual	610.7	691.9	649.4	640.5	594.6	3,187.2
Commodities	115.9	154.8	101.2	132.0	104.9	608.8
Equipment	56.6	88.9	49.1	38.2	32.4	265.2
Indirect Costs	101.5	102.6	103.8	103.6	107.7	519.2
Subtotal	**2,090.6**	**2,362.3**	**2,157.1**	**2,290.8**	**2,149.2**	**11,050.0**
General Admin. (9% of Subtotal)	188.1	212.6	194.1	206.2	193.4	994.5
Program Total	**2,278.8**	**2,574.9**	**2,351.2**	**2,496.9**	**2,342.7**	**12,044.5**
In-kind Funds	1,671.0	1,712.0	1,658.0	1,677.0	1,622.0	8,340.0

SOURCES OF ADDITIONAL FUNDING

Because of the diversity of agencies and organizations represented by the GWA program, we are able to leverage over $8 million in cost-share, in-kind, direct funds, and other support funding.

Each project proposal under the GWA program proposal provides more detail for these additional funds (see project budget forms).

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McCammon, M., K. Holderied, and N. Bird. 2011. Long-term monitoring of Marine Conditins and Ijured Resources and Services. Proposal to *Exxon Valdez* Oil Spill Trustee Council. 879 p. http://www.evostc.state.ak.us/Store/Proposal_Documents/2196.pdf

Online Resources:

Gulf Watch Alaska – http://www.gulfwatchalaska.org/

Gulf Watch Alaska Data Portal – http://portal.aoos.org/gulf-of-alaska.php

EVOSTC Long-Term Monitoring Program – http://www.evostc.state.ak.us/index.cfm?FA=projects.gulfwatch

GAK-1 – http://www.ims.uaf.edu/gak1/

Seward Line – https://www.sfos.uaf.edu/sewardline/

Attachment 1

Curriculum Vitae for Program Management Team

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Professional Experience
Leadership

- GWA Pelagic Component Lead (since 2013).
- Research Coordinator for Recruitment, Energetics, and Coastal Assessment Program (2011-current) - NMFS Auke Bay Laboratories (ABL).
- Acting Deputy Director for NMFS Auke Bay Laboratories, half a year (2013).
- Core team member of Habitat and Ecological Processes Program, Alaska Fisheries Science Center (AFSC) - developing RFPs, reviewing proposals for scientific merit, and recommendation for funding.
- Chair for Auke Bay Laboratories Data Coordination Committee and member of AFSC Public Access and Research Results (PARR) workgroup.
- Coordinator for Division FOIA responses – NMFS, Auke Bay Laboratories.

Research
1990 - Present: Mandy has been involved in oil spill research and nearshore habitat studies throughout Alaska's coastline, particularly Prince William Sound, for over 25 years. Her research includes damage assessment and long term monitoring of nearshore flora, fauna, and persistence of oil in the EVOS spill region. Mandy has been an integral part of the Gulf Watch Alaska Program serving as Pelagic Component Lead (2013-16), co-Principle Investigator for the Nearshore component (2011-16), and co-Principle Investigator for the Lingering oil component (2011-16). She has been a core steering committee member and a participant in the Alaska *ShoreZone* habitat mapping project for over 12 years. Mandy has also conducted research on essential fish habitat under the Magnuson-Stevens Act, focusing on nearshore forage fish throughout the state. Her specific scientific expertise lies with coastal ecology and specializes in the taxonomy and ecology of seaweeds. All of these studies have enabled her to not only develop a unique knowledge of Alaskan marine ecosystems but also manage all activities associated with a diverse array of research projects and collaborators.

Education: BS 1989, Marine Biology, Western Washington University, Bellingham, Washington.

Publications: *(selected)*

<u>*Research Highlights:*</u>
Lindeberg, M.R. and S.C. Lindstrom. 2016 re-print. Field Guide to Seaweeds of Alaska. Alaska Sea Grant College Program, University of Alaska Fairbanks, 192 p.

Lindeberg and Johnson, 2015. Alaska Chapter. Our living oceans: Habitat. Status of the habitat of U.S. living marine resources, 1st edition. U.S. Dep. Commer. NOAA Tech. Memo. NMFS-F/SPO-75.

Lindstrom, S. C., M. R. Lindeberg, and D. A. Guthrie. 2015. Marine Macroalgae of the Aleutian Islands: I. Bangiales. Algae, 30(4): 1-17.

Johnson, S. W., A. D. Neff, and M. R. Lindeberg. 2015. A handy field guide to the nearshore fishes of Alaska. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-293, 211 p.

Kawai, H., T. Hanyuda, M.R. Lindeberg, and S.C. Lindstrom. 2008. Morphology and molecular phylogeny of *Aureophycus aleuticus* gen. *et* sp. Nov. (Laminariales, Phaeophyceae) from the Aleutian Islands. J. of Phycol. 44:1013-1021.

EVOS Research Highlights:

Lindeberg, M. R. et al. 2014. Variability within pelagic ecosystems of Prince William Sound: introduction to pelagic ecosystem monitoring. Gulf Watch Alaska Program 3 year synthesis Report, *Exxon Valdez* Trustee Council.

Short, J. W., K. R. Springman, M. R. Lindeberg, L. G. Holland, M. L. Larsen, C. A. Sloan, C. Khan, P. V. Hodson, and S. D. Rice. 2008. Semipermeable membrane devices link site-specific contaminants to effects: Part II – A comparison of lingering *Exxon Valdez* oil with other potential sources of CYP1A inducers in Prince William Sound, Alaska. Mar. Environ. Res. 66:487-498.

Springman, K. R., J. W. Short, M. Lindeberg, and S. D. Rice. 2008. Evaluation of bioavailable hydrocarbon sources and their induction potential in Prince William Sound, Alaska. Mar. Environ. Res. 66:218-220.

Springman, K. R., J. W. Short, M. R. Lindeberg, J. M. Maselko, C. Khan, P. V. Hodson, and S. D. Rice. 2008. Semipermeable membrane devices link site-specific contaminants to effects: Part 1 – Induction of CYP1A in rainbow trout from contaminants in Prince William Sound, Alaska. Mar. Environ. Res. 66:477-486.

Thomas, R.E., M. R. Lindeberg, Patricia M. Harris, and Stanley D. Rice. 2007. Induction of DNA Strand Breaks in the Mussel (*Mytilus trossulus*) and Clam (*Protothaca staminea*) Following Chronic Field Exposure to Polycyclic Aromatic Hydrocarbons from the *Exxon Valdez* Spill. Marine Pollution Bulletin. 54: 726-732.

Short J.W., G. V. Irvine, D. H. Mann, J. M. Maselko, J. J. Pella, M. R. Lindeberg, J. R. Payne, W. B. Driskell, and S. D. Rice. 2007. Slightly weathered *Exxon Valdez* oil persists in Gulf of Alaska beach sediments after 16 years. Environ. Sci. Technol. 41:1245-1250.

Short, J.W., J.M. Maselko, M.R. Lindeberg, P.M Harris, and S.D. Rice. 2006. Vertical distribution and probability of encountering intertidal *Exxon Valdez* oil on shorelines of three embayments within Prince William Sound, Alaska. Environ. Sci. and Technol. Vol. 40, 3723-3729.

Short, J.W., M. R. Lindeberg, Patricia M. Harris, J. Maselko, Jerome J. Pella, and S.D. Rice. 2004. An estimate of oil persisting on beaches of Prince William Sound, 12 years after the *Exxon Valdez* oil spill. Environ. Sci. and Technol. Vol 38: 19-25.

O'Clair, Charles E., M. R. Lindeberg, and Joshua Millstein. 2001. "Mesoscale differences in mussel, *Mytilus trossulus*, population structure in Prince William Sound, Alaska in relation to oiling history and predation intensity." Journal of Experimental Marine Biology and Ecology. 262:155-176.

Highsmith, Raymond C., Rucker, T.L., Stekoll, M.S., Saupe, S.M., Lindeberg, M.R., Jenne, R.N., Erickson, W.P. 1996. Impact of the *Exxon Valdez* Oil Spill on Intertidal Biota. American Fisheries Society Symposium 18:212-237.

Collaborators:

Coon, Catherine (BOEM); Eagleton, Mathew (Alaska Regional Office, NMFS); Iken, Katrin (UAF); Hoffman, Christopher (USACOE); Jones, Tahzay (NPS); Konar, Brenda (UAF); Lewis, Steve (Alaska Regional Office, NMFS); Lindstrom, Sandra (UBC); Lauenstein, Gunnar (NOAA); Robertson, Tim (Nuka Research, Inc.); Saupe, Sue (Cook Inlet RCAC); Schock, Carl (Coastal and Oceans Research, Inc.); Stickle, William (LSU).

SCIENCE COORDINATOR

Intended Qualified Candidate
ROBERT M. SURYAN
Associate Professor – Senior Research
Department of Fisheries and Wildlife, Oregon State University
Lab website: hmsc.oregonstate.edu/research-labs/seabird-oceanography-lab
Current Address: Ted Stevens Marine Research Institute/Auke Bay Laboratories,
17109 Point Lena Loop Rd., Juneau, Alaska 99801 | office: 907-789-6065 | mobile: 541-961-7576

Research Interests: Long-term ecological investigations in marine environments working nationally and internationally. Primary interests include: marine ecosystem processes, food webs, foraging ecology, spatial ecology, population dynamics, human-resource interactions, education.

Professional Preparation

Humboldt State University	Wildlife Management	B.S. 1989
Moss Landing Marine Laboratories	Marine Science	M.S. 1995
Oregon State University	Wildlife Science	Ph.D. 2006

Professional Appointments

Associate Professor – Senior Research	Oregon State University	2012-present
Assistant Professor – Senior Research	Oregon State University	2006-2012
NOAA Fisheries Oceanography Fellow	Oregon State University	2003-2006
Graduate Research Assistant	Oregon State University	2001-2006
Faculty Research Assistant	Oregon State University	2001
Wildlife Biologist/Co-PI	U.S. Fish and Wildlife Service	1996-2001
Wildlife Biologist/Assistant PI	U.S. Fish and Wildlife Service	1995
Graduate Research Assistant	Moss Landing Marine Laboratories	1993-1995
Wildlife Biologist	Washington Department of Wildlife	1992
Contractor	National Marine Mammal Lab	1991
Wildlife Biologist	U.S. Forest Service	1989, 1990

Additional Academic Appointments

Affiliate Faculty: School of Fisheries and Ocean Sciences, University of Alaska Fairbanks	2016-present
Adjunct Assoc. Professor: College of Agriculture, Forestry, and Life Sciences, Clemson Univ	2014-present
Adjunct Associate Professor (Sr. Res.): Marine Resource Management, College of Earth, Ocean, and Atmospheric Sciences, Oregon State University	2009-present

Publications – selected from 45 peer-reviewed papers:

Suryan, R.M., K.J. Kuletz, S.L. Parker-Stetter, P.H. Ressler, M. Renner, J.K. Horne, E.V. Farley, E.A. Labunski. 2016. Temporal shifts in seabird populations and spatial coherence with prey in the southeastern Bering Sea. Marine Ecology Progress Series 549:199-215. **(BEST\BSIERP)**

Gladics, A.J., **R.M. Suryan,** R.D. Brodeur, L.M. Segui, L.Z. Filliger. 2014. Constancy and change in marine predator diets across a shift in oceanographic conditions in the northern California Current. Marine Biology. 10.1007/s00227-013-2384-4

Hazen, E.L., **R.M. Suryan**, J.A. Santora, S.J. Bograd, Y. Watanuki , R.P. Wilson. 2013. Scales and mechanisms of marine hotspot formation. Marine Ecology Progress Series 487:177-183.

Benoit-Bird, K.J., Battaile, B., S.A. Heppell, B. Hoover, D.B. Irons, N. Jones, K. Kuletz, C.A. Nordstrom, R. Paredes, **R.M. Suryan**, C.M. Waluk, A.J. Trites. 2013. Prey patch patterns predict habitat use by top marine predators with diverse foraging strategies. PLoS ONE 8(1):e53348. **(BEST\BSIERP)**

Paredes R., A.M.A. Harding, D.B. Irons, D.D. Roby, **R.M. Suryan**, R.A. Orben, H. Renner, R. Young, A. Kitaysky. 2012. Proximity to multiple foraging habitats enhances seabirds' resilience to local food shortages. Marine Ecology Progress Series 471:253-269. **(BEST\BSIERP)**

Suryan, R.M. and K.N. Fischer. 2010. Stable isotope analysis and satellite tracking reveal inter-specific resource partitioning of non-breeding albatrosses (*Phoebastria* spp.) off Alaska. Canadian Journal of Zoology 88:299-305 **(NPRB)**

Suryan, R.M., D.B. Irons, E.D. Brown, P.G.R. Jodice, and D.D. Roby. 2006. Site-specific effects on productivity of an upper trophic-level marine predator: Bottom-up, top-down, and mismatch effects on reproduction in a colonial seabird. Progress in Oceanography 68:303-328. **(EVOS-APEX)**

Jodice, P.G.R., D.D. Roby, K.R. Turco., **R.M. Suryan**, D.B. Irons, J.F. Piatt, M.T. Shultz, D.G. Rosenau, A.B. Kettle, J.A. Anthony. 2006. Assessing the nutritional stress hypothesis: the relative influence of diet quantity and quality on seabird productivity. Marine Ecology Progress Series 325:267-279 **(EVOS-APEX)**

Suryan, R.M., D.B. Irons, M. Kaufman, J. Benson, P.G.R. Jodice, D.D. Roby, and E.D. Brown. 2002. Short-term fluctuations in forage fish availability and the effect on prey selection and brood-rearing in the black-legged kittiwake (*Rissa tridactyla*). Marine Ecology Progress Series 236:273-287. **(EVOS-APEX)**

Suryan, R.M., D.B. Irons, and J. Benson. 2000. Prey switching and variable foraging strategies of black-legged kittiwakes and the effect on reproductive success. Condor. 102:375-385. **(EVOS-APEX)**

Leadership and Service (selected)

- Lead, Short-tailed Albatross Endangered Species Recovery Team, 2010-present
- Senator, Oregon State University Faculty Senate, 2015
- Co-Lead, Spatial Ecology, Marine Bird and Mammal Advisory Panel, North Pacific Marine Science Organization (PICES), 2011-2015
- Co-Chair, Learning Modules Working Group, Marine Studies Initiative, Oregon State University, 2014-2015.
- Co-Convener, Seabirds as Prey: Top-down control of seabird colony, population, and foraging dynamics. The 2nd World Seabird Conference, Cape Town, South Africa, 2015.
- Lead, educational program opportunity and needs assessment for Oregon State University's Hatfield Marine Science Center, 2013.
- Co-Convener, Workshop on integrating individual tracking and vessel-based survey data, North Pacific Marine Science (PICES) annual conference, Nanaimo, British Columbia, 2013
- Co-convener, *Special Paper Session on Mechanisms of Physical-Biological Coupling Forcing Biological 'Hotspots,'* North Pacific Marine Science Organization Annual Conference, 2011
- Guest Editor, Marine Ecology Progress Series theme section: *Mechanisms of Physical-Biological Coupling Forcing Biological 'Hotspots'*, 2013
- Peer Review Panel, Research Competitiveness Program, American Association for the Advancement of Science (AAAS), 2013
- Statistics and Technical Advisory Committee review of Oregon Department of Fish and Game's nearshore ecological data atlas for territorial sea planning, 2012
- Panelist, Forage Fish and The Food Web - Issues and Challenges, Public Interest Environmental Law Conference, 2011
- Science Representative, Cape Perpetua marine reserve community team, 2010

Collaborators

J Adams, U.S. Geological Survey (USGS); R Albertani, Oregon State University (OSU); L Ballance, NOAA; C Barger, U of Alaska Fairbanks (UAF); Benoit-Bird, OSU; E Bjorkstedt, NOAA; S Bograd, NOAA; R Brodeur, NOAA; D Croll, UC Santa Cruz; E Daly, OSU; T Deguchi, Yamashina Institute for Ornithology (YIO); K Courtot (Fischer), USGS; J Field, NOAA; E Farley, NOAA; L Filliger, U Rhode Island; A Gladics, OSU; A Harding, USGS; S Hayes, NOAA; E Hazen, UC Santa Cruz; RW Henry, UC Santa Cruz; S Heppell, OSU; M Hester, Oikonos; J. Horne, U of Washington (UW); C Horton, OSU; D Hyrenbach, Hawaii Pacific University; D Irons, USFWS; J. Jahncke, Point Blue Conservation Science, S. Jennings, U.C. Davis; P Jodice, Clemson University; M Kappes, OSU; A Kitaysky, UAF; K Kuletz, USFWS; E. Labunski, USFWS; E Melvin, UW; N Nakamura, YIO; R Orben, OSU; K Ozaki, YIO; S Parker-Stetter, NOAA; R Paredes, OSU; J Peterson, OSU; W Peterson, NOAA; E Phillips, UW; B Polagye, UW; H Renner, USFWS; M Renner, Tern Again Consulting; P Ressler, NOAA; D Roby, USGS/OSU; J Ruzicka, OSU; J Santora, NOAA & Farallon Institute (FI); F Sato, YIO; I Schroeder, FI; L Segui, OSU; S Shaffer, San Jose State University; SA Thompson, FI; A Trites, U of British Columbia; W Sydeman, FI; H Young, U.C. Santa Barbara; R. Young, UAF; L Young, Pacific Rim Conservation; B Wells, NOAA; Y Watanuki, Hokkaido University; J Zamon, NOAA

PROGRAM COORDINATOR

Intended Qualified Candidate
DONNA ROBERTSON ADERHOLD

NOAA Kasitsna Bay Lab
95 Sterling Highway Suite 2, Homer, AK 99603
907-226-4617 (office); donna.aderhold@noaa.gov

PROFESSIONAL EXPERIENCE

NOAA Kasitsna Bay Lab, Gulf Watch Alaska Program Science Coordinator (February 2016-present)
Support the management team, projects, and principal investigators that comprise the Gulf Watch Alaska Program, the long-term monitoring program of the Exxon Valdez Oil Spill Trustee Council (EVOSTC). Responsibilities include overseeing editing and compilation of project annual reports and the FY 2017-2021 proposal to the EVOSTC, coordinating (as the lead guest editor) the publication of a special issue of Gulf Watch Alaska and Herring Research and Monitoring program scientific papers in the journal Deep Sea Research II, organizing quarterly principal investigator meetings, leading annual updates to the Gulf Watch Alaska program website, and coordinating with the three-person management team, science review team, science coordinating committee, and principal investigators on day-to-day oversight of the Gulf Watch Alaska program.

HDR, Senior Wildlife Ecologist and Marine Science Practice Group Lead (2007-2016)
Led the Marine Planning and Science Practice Group within HDR's Environmental Science and Planning Business Class, championing the skills of the company's marine science practitioners to HDR's upper management and supporting business development nationally within the marine sciences. Led the Alaska wildlife and marine science team, including leading the charge to develop a marine science practice in the state. National Environmental Policy Act (NEPA) practitioner, leading multi-disciplinary scientific teams in the development of biological sections of environmental impact statements (EISs) and environmental assessments (EAs). Supported business development by meeting with clients and potential clients and developing proposals and cost estimates to provide wildlife and NEPA-related services. Promoted to Principal Associate, a designation HDR provides to senior level staff who exemplify their area of expertise and provide mentoring and support within the company.

HLA/MACTEC, Principal Environmental Scientist (1999-2007)
Served as a wildlife biologist, wetland scientist, and NEPA practitioner. As a wildlife biologist, conducted field investigations including aerial surveys for waterfowl and eagles and ground-based surveys for songbirds and mammals. Conducted wetland delineations following U.S. Army Corps of Engineers methods throughout Alaska. Led the development of EAs and prepared biological sections of EISs. Led preparation of figures for an EIS, including map-based figures based on a geographic information system (GIS) database. Managed environmental projects, supervised staff, and supported business development.

Western Ecosystems Technology, Project Manager (1997-1999)
Working with scientists in the Biological Resources Division of the U.S. Geological Society, developed relational and GIS databases of Bering and Chukchi seas to facilitate research on marine mammals and sea birds, and helped facilitate a marine mammal symposium and edit the resulting book—*Marine Mammal Survey and Assessment Methods*. As co-editor of *Marine Mammal Survey and Assessment Methods*, corresponded with chapter authors, coordinated peer review of the chapters, coordinated with the publisher, copy-edited all chapters, prepared copy-ready version of the complete manuscript, and submitted the copy-ready manuscript to the publisher.

U.S. Fish and Wildlife Service Fish and Wildlife Research Center/U.S. Geological Survey Biological Resources Division, Research Wildlife Biologist (1990-1996)
Co-investigator for a study of foraging ecology of lesser snow geese during fall migratory staging on the Arctic National Wildlife Refuge as part of a series of Congressionally mandated studies evaluating the potential impacts of oil development on the refuge. Participated in numerous other studies of migratory birds: presence of lead poisoning

in spectacled eiders on the Yukon-Kuskokwim Delta, habitat use of upper Cook Inlet coastal marshes by lesser snow geese and Canada geese, multi-agency study of western sandpiper migration along the Pacific Coast, and studies of neotropical migrant passerines in boreal forests in southcentral Alaska. Wrote research proposals, designed field experiments and vegetation surveys, guided field studies in remote regions, supervised biological technicians, analyzed data using SAS, Arc/INFO, and Atlas GIS, and wrote reports and scientific publications.

PUBLICATIONS

Hupp, J.W., **D.G. Robertson**, and A.W. Brackney. 2002. Section 9: snow geese. Pp. 71-74 in Arctic refuge coastal plain terrestrial wildlife research summaries. U.S. Geological Survey, Biological Resources Division, Biological Science Report USGS/BRD/BSR-2002-0001.

Hupp, J.W., A.B. Zacheis, R.M. Anthony, **D.G. Robertson**, W.P. Erickson, and K.C. Palacios. 2001. Snow cover and snow goose *Anser caerulescens caerulescens* distribution during spring migration. *Wildlife Biology* 7(2):65-76.

Hupp, J.W., **D.G. Robertson**, and J.A. Schmutz. 2000. Recovery of tall cotton-grass following real and simulated feeding by snow geese. *Ecography* 23(3):367-373.

Garner, G.W., S.C. Amstrup, J.L. Laake, B.J.F. Manly, L.L. McDonald, and **D.G. Robertson**. 1999. *Marine mammal survey and assessment methods*. A.A. Balkema, Rotterdam, Netherlands, 287pp.

Garner, G.W., L.L. McDonald, and **D.G. Robertson**. 1999. Comparison of aerial survey procedures for estimating polar bear density: results of pilot studies in northern Alaska. Pp 37-51 in, Garner, G.W., S.C. Amstrup, J.L. Laake, B.J.F. Manly, L.L. McDonald, and D.G. Robertson (eds) *Marine mammal survey and assessment methods*. A.A. Balkema, Rotterdam, Netherlands.

Hupp, J. W. and **D. G. Robertson**. 1998. Forage site selection by lesser snow geese in an arctic tundra ecosystem. *Wildlife Monographs* 138:1-40.

Robertson, D. G., A. W. Brackney, M. A. Spindler, and J. W. Hupp. 1997. Distribution of autumn staging lesser snow geese on the northeast coastal plain of Alaska. *Journal of Field Ornithology* 68(1):124-134.

Hupp, J. W., R. G. White, J. S. Sedinger, and **D. G. Robertson**. 1996. Forage digestibility and intake by lesser snow geese: effects of dominance and resource heterogeneity. *Oecologia* 108:232-240.

EDUCATION

M.S., Wildlife and Fisheries Sciences, Texas A&M University, 1991
B.S., Wildlife and Fisheries Sciences, North Carolina State University, 1987

COLLABORATORS

Arimitsu, Mayumi (USGS); Batten, Sonia (SAHFOS); Bishop, Mary Anne (PWSSC); Campbell, Robert (PWSSC); Danielson, Seth (UAF); Doroff, Angela (KBNERR); Coletti, Heather (NPS); Esler, Daniel (USGS); Hoffman, Katrina (PWSSC); Holderied, Kris (NOAA); Hollmen, Tuula (ASLC); Hopcroft, Russell (UAF); Iken, Katrin (UAF); Kaler, Robert (USFWS); Konar, Brenda (UAF); Kuletz, Kathy (USFWS); Lindeberg, Mandy (NOAA); Matkin, Craig (NGOS); McCammon, Molly (AOOS); Moran, John (NOAA); Pegau, Scott (PWSSC); Sigman, Marilyn (Alaska Sea Grant); Straley, Jan (UAS)

Administrative Lead

KATRINA C. HOFFMAN

President and CEO
Prince William Sound Science Center
907-424-5800 x225 (office); khoffman@pwssc.org
300 Breakwater Avenue, PO Box 705, Cordova, AK 99574

SELECT PROFESSIONAL EXPERIENCE

Prince William Sound Science Center; President and CEO and
Oil Spill Recovery Institute; Executive Director (November 2011-present)
Manage research, education, development, and administration staff dedicated to improving understanding and sustainable use of the northern Gulf of Alaska. Lead administrative PI of EVOSTC-funded Gulf Watch Alaska and the ADF&G-funded Interactions of Hatchery and Wild Pink and Chum Salmon. Facilitate collaborations to improve the quality and diversity of research and education programs relevant to the bioregion. For OSRI, ensure the use of funds to improve response to and recovery from oil spills and knowledge about the Arctic and sub-Arctic ecosystems where oil spills may occur.

Washington Sea Grant, Coastal Resources Specialist (2007-2011)
Secured $777K federal grant coordinate an international sustainable shoreline development initiative. Chaired Sustainable Coastal Communities Action Team for West Coast Governors' Alliance on Ocean Health; led creation of tri-state work plan focused on economic development, sustainable aquaculture, sustainable fisheries, non-consumptive tourism and recreation, green ports, and clean marinas. Created science-based seminars for ~350 member Shoreline and Coastal Planners Group. Co-developed nationally recognized climate adaptation training with the NERR Coastal Training Program. Coordinated Washington State Geoduck Aquaculture Research Program conference.

NEPTUNE Project, **Grant Writer and Research Assistant, University of Washington** (**2006-2007)**
Wrote education component of the largest (to date) federal grant awarded to UW ($126 million) from NSF/JOI to build and administer a seafloor cabled observatory, the Regional Scale Nodes of the Ocean Observatory Initiative (once known as NEPTUNE). Graduate thesis assessing the education potential of observatory-related engineering software.

University of Washington, Lead Instructor and Teaching Assistant (2006)
Lead instructor for marine resources unit in Program on the Environment course. Developed and taught lecture materials and fieldwork to 35 students from Japan and China in an intensive sustainable development institute. Managed 25 visiting scholars in graduate seminar at UW School of Marine and Environmental Affairs; co-designed syllabus, maintained course web site, grades and communications.

Occidental College, Grant Administrator, Program Coordinator, Resource Teacher (2003-2005)
Lead instructor, and administrator of $990,000 HHMI grant to train middle school and high school teachers and students about the nature of scientific research using oceanography and marine ecology (the T.O.P.S. Marine Science Experience; Teachers + Occidental = Partnership in Science). Led multi-week professional development courses for ~90 science teachers, conducted classroom site visits; led ~180 research cruises on Santa Monica Bay. Directed students in fieldwork to generate long-term, web-based data sets; guided research projects based on student-gathered data. Regularly used: CTD; secchi disk; trawl nets; Van Veen grab; nutrient analysis; video microscopy.

Mira Costa High School, Science Teacher (February 2001-June 2003)
Instructor of Marine Science and College Preparatory Biology to 9th-l2th graders. Quadrupled enrollment in marine science course and served as sole curriculum developer. Developed and coordinated annual 8-month long field-based marine ecology research projects. Arranged student service-learning experiences at numerous marine

facilities. Raised over $18,000 to facilitate four multi-day tall ship-based oceanographic field trips. Directed $10,000 grant for purchase of classroom aquarium system.

Monterey Bay Aquarium Research Institute, Assistant Researcher (2000)
Conducted biological and chemical oceanography research aboard a month-long NOAA Tropical Atmosphere Ocean monitoring cruise in the Equatorial Pacific. Collected data to: monitor plankton productivity; determine the effect of phenomena such as El Nino on biological processes in the Pacific Ocean; measure oxygen isotopes for Princeton University; measure dissolved organic nutrients for University of Washington. Research methods include 14C incubations, nutrient and chlorophyll analysis.

Catalina Island Marine Institute, Marine Science Instructor (1998-2000)
Taught interactive marine science and oceanography classes to students from five Southwestern states. Classes taught include: ichthyology, phycology, invertebrate biology, plankton biology, oceanography, island biogeography and astronomy. Assisted in the development of laboratory spaces and program curriculum. Coordinated volunteer non-native plant removal campaign. Led kayaking, hiking, snorkeling and outrigger canoeing youth trips. Primary rock climbing and rappelling instructor. Vessel skipper.

University of California Berkeley, Research Technician (1997-1998)
Conducted algae genomics and protein biochemistry research using molecular techniques to determine the structure and function of uncharacterized proteins in the photosynthetic pathway. Maintained sizable algal culture library using sterile technique and harvesting methods. Supervised and trained student employees. Methods used include gel electrophoresis, DNA sequencing and recombinant DNA.

Monterey Bay Aquarium Research Institute, Research Intern (1997)
Conducted ship- and lab-based research on primary productivity of Monterey Bay with Drs. Raphael Kudela and Francisco Chavez. Used 14C photosynthesis vs. irradiance curves, Pulsed Amplitude Modulation fluorometry, diode array spectrophotometry, chlorophyll and nutrient analysis methods. Maintained *Pseudo-nitzschia* cell cultures and chemostats.

PUBLICATIONS, ACTIVITIES & AFFILIATIONS

Daniel M, N. Faghin, **K. Hoffman.** 2009. Green Shores: LEED-style Rating System. *The Washington Planner*, Vol. 20, issue 4, 12-13.

Klinger, T., R.M. Gregg, K. Herrmann, **K. Hoffman**, J. Kershner, J. Coyle, and D. Fluharty. 2007. Assessment of Coastal Water Resources and Watershed Conditions at Olympic National Park, Washington. Natural Resource Technical Report NPS/NRPC/WRD/NRTR—2008/068.zNational Park Service, Fort Collins, Colorado.

Hoffman K.C., R.M. Kudela and F.P. Chavez. February 1998. Variable Fluorescence as a Biological Indicator of Primary Productivity. *Eos* abstracts.

- Advisory Board member, Alaska Ocean Observing System (2011-present)
- North Pacific Research Board member (2011-present)
- Have presented at international, national, regional, state and local science & policy conferences

EDUCATION
University of Washington, School of Marine and Environmental Affairs; M.M.A. (2007)
Chapman University: California Clear Teaching Credential, Biological Sciences (2004)
Oberlin College: B.A. Biology and B.A. Environmental Studies (1997)

Collaborators: Anderson, Emily (WSC); Beaudreau, Anne (UAF); Bochenek, Rob, (Axiom); Holderied, Kris (NOAA); Josephson, Ron (ret. ADF&G); Knudsen, Eric; McCammon, Molly (AOOS); Morse, Kate (CRWP); Morton, Kes (OTN-Dalhousie); Neher, Tammy (NOAA) O'Connell, Victoria (SSSC); Rabung, Samuel (ADF&G); Reynolds, Brad; Seitz, Andrew (UAF); Sigman, Marilyn (Alaska Sea Grant); Skorkowski, Robert (USFS—Cordova Ranger District); Walker, Seth (GreatBig.org)

RUSSELL ROSS HOPCROFT

Institute of Marine Science, University of Alaska Fairbanks
O'Neill Building
Fairbanks, AK 99775-7220
(907) 474-7842 Fax (907) 474-7204
rrhopcroft@alaska.edu

PROFESSIONAL PREPARATION:

University of Guelph, Ontario, Canada	Marine Biology	B.Sc. 1983
University of Guelph	Marine Ecology	M.Sc. 1988
University of Guelph	Marine Biology	Ph.D. 1997
Monterey Bay Aquarium Research Institute (MBARI)	Zooplankton Ecology	1997-1999
University of Massachusetts Dartmouth	Zooplankton Ecology	1999-2000

APPOINTMENTS:
Professor, Institute of Marine Science, University of Alaska Fairbanks, 2010-present
Associate Professor, IMS/UAF, 2005-2010
Assistant Professor, IMS/UAF, 2000-2005

MOST RELEVANT PUBLICATIONS: (out of 95)

Sousa, L., K.O. Coyle, R.P. Barry, T.J. Weingartner, & **R.R. Hopcroft**. *Accepted*. Climate-related variability in abundance of mesozooplankton in the northern Gulf of Alaska 1998-2009. *Deep-Sea Res. II.*

Li, K.Z., A.J. Doubleday, M.D. Galbraith, & **R.R. Hopcroft**. *Accepted*. High abundance of salps in the coastal Gulf of Alaska during 2011: a first record of bloom occurrence for the northern Gulf. *Deep-Sea Res. II.*

Ershova, E.A., **R.R. Hopcroft**, K.N. Kosobokova, K. Matsuno, R. J. Nelson & A. Yamaguchi. 2015. Long-term changes in summer zooplankton communities of the western Chukchi Sea, 1945-2012. *Oceanography* **28:**100-115.

Doubleday, A. & **R.R. Hopcroft.** 2015. Seasonal and interannual patterns of larvaceans and pteropods in the coastal Gulf of Alaska, and their relationship to pink salmon survival. *J. Plankton Res.* **37**:134-150.

Coyle, K.O., G.A. Gibson, K. Hedstrom, A. Hermann, & **R.R. Hopcroft.** 2013. Zooplankton biomass, advection and production on the northern Gulf of Alaska shelf from simulations and field observations. *J. Mar. Sys.* **128**: 185-207.

OTHER SIGNIFICANT PUBLICATIONS:

Mundy, P., D. Allen, J.L. Boldt, N.A. Bond, S. Dressel, E. Farley Jr., D. Hanselman, J. Heifetz, **R.R. Hopcroft**, M.A. Janout, C. Ladd, R. Lam, P. Livingston, C. Lunsford, J.T. Mathis, F. Mueter, C. Rooper, N. Sarkar, K. Shotwell, M. Sturdevant, A.C. Thomas, T.J. Weingartner & D. Woodby. 2010. Status and trends of the Gulf of Alaska Coastal region, 2003-2008. pp. 142-195. *In:* S.M. McKinnell & M. Dagg (ed.) Marine Ecosystems of the North Pacific Ocean; 2003-2008. *PICES Spec. Pub. 4. 393p.*

Pinchuk, A.I., K.O. Coyle & **R.R. Hopcroft**. 2008. Climate-related variability in abundance and reproduction of euphausiids in the northern Gulf of Alaska in 1998-2003. *Prog. Oceanogr.* **77**:203-216.
Liu, H. & **R.R. Hopcroft**. 2008. Growth and development of *Pseudocalanus* spp. in the northern Gulf of Alaska. *J. Plankton Res.* **30**: 923-935.
Pinchuk, A.I. & **R.R. Hopcroft**. 2007. Seasonal variations in the growth rate of euphausiids (*Thysanoessa inermis*, *T. spinifera*, and *Euphausia pacifica*) from the northern Gulf of Alaska. *Mar. Biol.* **151**: 257-269
Liu, H. & **R.R. Hopcroft**. 2006. Growth and development of *Neocalanus flemingeri/plumchrus* in the northern Gulf of Alaska: validation of the artificial cohort method in cold waters. *J. Plankton Res.* **28**: 87-101.

SYNERGISTIC ACTIVITIES:

Public outreach through contributions to magazines (National Geographic, Current: the Journal of Marine Education), radio, newspaper, and television on Arctic ecosystems

Educational web-pages:
http://www.arcodiv.org
http://www.sfos.uaf.edu/sewardline/

Steering Group – Gulf Watch Alaska, Gulf of Alaska Integrated Research Program, Census of Marine Life's (CoML) Arctic Ocean Biodiversity (ArcOD) & Census of Marine Zooplankton (CMarZ), Executive Committee member - Northeast Pacific GLOBEC, US member – Plankton Experts Lead, Circumpolar Biodiversity Monitoring Program

Editorial Board – Marine Biodiversity (Springer), Plankton and Benthic Research (Japan)

Reviewer: manuscripts reviewed for ~12 primary journals, proposals for 6 funding agencies, NSF OPP & BO panel member.

SUBMERSIBLE AND ROV EXPERIENCE:

Johnson-Sea-Link, Ventana, Tiburon, Global Explorer (~100 dives total)

RESEARCH CRUISE EXPERIENCE:

~1000 sea days on cruises up to 45 days duration aboard vessels ranging in size from 15-120 m.

COLLABORATORS & OTHER AFFILIATIONS

Collaborators: Ken Coyle (UAF), Ann Bucklin (UConn), Hans-Jurgen Hirche (AWI), Evelyn Lessard (UW), Ksenia Kosobokova (RAS), Jeff Napp (PMEL-NOAA), John Nelson (UVic), Torkel Nielsen (DMU), Kevin Raskoff (MPC), Suzanne Strom (WWU), Mike Vecchione (SI-NMNH)

Graduate advisor: John C. Roff (Acadia U)

Postdoctoral advisors: Bruce Robison & Francisco Chavez (MBARI), Brian Rothchild (UMass)

Graduate Students: Imme Rutzen, Jennifer Questel, Heather Oleson, Elizaveta Ershova (all Ph.D. *in progress*); Ayla Doubleday, Pallavi Hariaharan, Caitlin Smoot, Sterling Ulrich (all M.Sc. 2013); Jenefer Bell (M.Sc.2009), Laura Slater (M.Sc. 2004), Hui Liu (Ph.D. 2006), Alexei Pinchuk (Ph.D. 2006)

Science Coordinating Committee: Environmental Drivers (alternate)

SETH LOMBARD DANIELSON

Institute of Marine Science, School of Fisheries and Ocean Sciences
University of Alaska Fairbanks
905 N. Koyukuk Dr., Fairbanks, Alaska 99775-7220
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Professional Preparation

University of Alaska Fairbanks, Ph.D. Oceanography, 2012
University of Alaska Fairbanks; M.S. Oceanography, 1996
Lehigh University; B.S. Electrical Engineering, 1990, with honors

Appointments

Research Assistant Professor of Oceanography, IMS-UAF, Fairbanks, AK, 2013-present
Research Professional, IMS-UAF, UAF, Fairbanks, AK, 1997–2013
Driller, Polar Ice Coring Office, IMS-UAF, Fairbanks AK, 1993-1994 and UNL, Lincoln, NB, 1996-1997
Research Assistant, Institute of Marine Science, UAF, Fairbanks, AK, 1994-1996
Junior Engineer, Allen Organ Company, Macungie, PA, 1990-1992

Memberships

American Geophysical Union
The Oceanography Society

5 Selected Peer-Reviewed Publications

Danielson. S. L., L. Eisner, C. Ladd, C. Mordy, L. de Sousa, and T. J. Weingartner (in press) A comparison between late summer 2012 and 2013 water masses, macronutrients, and phytoplankton standing crops in the northern Bering and Chukchi Seas, Arctic Eis DSR-II Special Issue

Danielson, S. L., T. W. Weingartner, K. Hedstrom, K. Aagaard, R. Woodgate, E. Curchitser, and P. Stabeno, (2014), Coupled wind-forced controls of the Bering–Chukchi shelf circulation and the Bering Strait through- flow: Ekman transport, continental shelf waves, and variations of the Pacific–Arctic sea surface height gradient. Prog. Oceanogr. http://dx.doi.org/ 10.1016/j.pocean.2014.04.006

Grebmeier, J. M., B. A. Bluhm, L. W. Cooper, **S. L. Danielson**, K. R. Arrigo, A. L. Blanchard, J. T. Clarke, R. H. Day, K. E. Frey, R. R. Gradinger, M. Kedra, B. Konar, K. J. Kuletz, S. H. Lee, J. R. Lovvorn, B. L. Norcross, S. R. Okkonen. (2015) Ecosystem Characteristics and Processes Facilitating Persistent Macrobenthic Biomass Hotspots and Associated Benthivory in the Pacific Arctic, *Prog. Oceanogr*., V136, August 2015, pp. 92-114, doi:10.1016/j.pocean.2015.05.006

Danielson, S. L., K. Hedstrom, K. Aagaard, T. Weingartner, and E. Curchitser (2012), Wind-induced reorganization of the Bering shelf circulation, *Geophys. Res. Lett*., 39, L08601, doi:10.1029/2012GL051231.

Danielson, S. L., E. N. Curchitser, K. Hedstrom, T. J. Weingartner, and P. Stabeno (2011) On ocean and sea ice modes of variability in the Bering Sea, *J. Geophys. Res.*, doi:10.1029/2011JC007389

Other Publications Related to the Seward Line

Stabeno, P. J. S. Bell, W. Cheng, **S. L. Danielson**, N. B. Kachel, C. W. Mordy (in press) Long-term observations of Alaska Coastal Current in the northern Gulf of Alaska, *Deep-Sea Res. II*

Janout, M. A., T. J. Weingartner, T. C. Royer, **S. L. Danielson** (2010), On the nature of winter cooling and the recent temperature shift on the northern Gulf of Alaska shelf, JGR Oceans,

2009JC005774R, DOI: 10.1029/2009JC005774
Wu, J., A. Aguilar-Islas, R. Rember, T. Weingartner, **S. L. Danielson**, and T. Whitledge (2009), Size-fractionated iron distribution on the northern Gulf of Alaska, *Geophys. Res. Lett*., 36, L11606, doi:10.1029/2009GL038304.
Weingartner, T. J., L. Eisner, G. L. Eckert, **S. L. Danielson** (2008), Southeast Alaska: oceanographic habitats and linkages (p 387-400), *J. of Biogeography*, DOI: 10.1111/j.1365-2699.2008.01994.x.
Weingartner, T. J., **S. L. Danielson**, T.C. Royer (2005), Fresh Water Variability in the Gulf of Alaska: Seasonal, Interannual and Decadal Variability, Deep-Sea Res. II, 52 (1-2): 169-191
Okkonen, S. R., T. J. Weingartner, **S. L. Danielson**, D. L. Musgrave and G. M. Schmidt (2003), Satellite and Hydrographic Observations of Eddy-Induced Shelf-Slope Exchange in the Northwestern Gulf of Alaska, JGR Oceans, 108 (C2): Art. No. 3033

SYNERGISTIC ACTIVITIES

Participant and presenter at the Pribilof Island *Bering Sea Days* week of ocean exploration for St. Paul Island and St. George Island students and community members 2011-present.
Participant and presenter in the October 2010 BEST/BSIERP Professional Development Workshop in Anchorage, AK and the October 2009 Center for Ocean Science Education Excellence (COSEE) "Salmon in the Classroom" teacher workshops in Fairbanks AK.
Reviewer on the November 2008 technical final design review (FDR) panel for the NSF-funded Ocean Observatories Initiative (OOI) and in 2010 for the OOI program's awardee (WHOI) during the RFP phase in selecting manufacturers for the buoy power system.
Reviewer for peer reviewed journal articles in: *Geophysical Research Letters, Journal of Geophysical Research, Continental Shelf Research, Deep-Sea Research, Climate Dynamics*
Reviewer for peer-reviewed proposals submitted for funding to EPSCOR, NOAA, NSF, NPRB
Creator of numerous outreach-directed marine science web pages, including:

- Retrospective analysis of Norton Sound benthic communities (www.ims.uaf.edu/NS/)
- GAK1 long-term oceanographic monitoring timeseries (www.ims.uaf.edu/gak1/)
- GLOBEC NEP monitoring program (www.ims.uaf.edu/GLOBEC/)
- Real-time data and plot delivery webpage for community-based satellite-tracked drifter projects in the Bering and Chukchi Seas (www.ims.uaf.edu/drifters/)

THESIS TITLES

Variability in the circulation, temperature, and salinity fields of the eastern Bering Sea shelf in response to atmospheric forcing, 2012 Ph.D. Thesis
Chukchi Sea Tidal Currents: Model and Observations, 1996 Masters Thesis.

RELATED ACTIVITIES

1997-2004: Global Ocean Ecosystem Dynamics (GLOBEC) program in the Gulf of Alaska (NSF)
2008-2014: Bering Sea Ecosystem Study (BEST) moorings and larval transport modeling (NSF)
2008-2014: Chukchi Sea Environmental Studies Program (CSESP, Shell/Conoco Phillips/Statoil)
2009-present: PI, Advisor and analyst for Glacier Bay National Park and Preserve oceanographic monitoring and associated process studies (NPS)
2012-2015: co-PI, Arctic Ecosystem Integrated Survey (Arctic Eis, BOEM)
2013-present: PI, Cook Inlet Model Computations (BOEM)
2014-present: PI, Ecosystem monitoring and detection of wind and ice-mediated changes through a year-round physical and biogeochemical mooring in the Northeast Chukchi Sea (NPRB, AOOS, Olgoonik-Fairweather, UAF)
2014-present: co-PI Measuring the pulse of the Gulf of Alaska: Oceanographic observations along the Seward Line (NPRB)
2015-present: co-PI, Arctic Marine Biodiversity Observing Network (AMBON; NOPP)

SCIENCE COORDINATING COMMITTEE: PELAGIC

MAYUMI LYNN ARIMITSU
Research Ecologist, USGS-Alaska Science Center
250 Egan Dr. Juneau AK 99801, 907-364-1593, marimitsu@usgs.gov

EDUCATION

University of California, Santa Cruz CA	B.Sc. Biology (1998)
University of Alaska Fairbanks, Juneau AK	M.Sc. Fisheries (2009)
University of Alaska Fairbanks, Juneau AK	Ph.D. Fisheries (2016)

TECHNICAL TRAINING

UC Extension, Endangered Species Conservation Program, Chile, 1997
Secondary Education Credential Program, Humboldt State University, 2000
Principles of Modeling for Conservation Planning and Analysis, Anthony Starfield, 2007
Wildlife and Fisheries Survey Design and Analysis, Oz Garton, 2008
Experimental Design, University of Alaska Fairbanks, 2008
Physical Oceanography, University of Alaska Fairbanks, 2008
Fish Population Dynamics, University of Alaska Fairbanks, 2008
Community Ecology, University of Alaska Fairbanks, 2011
Spatial Statistics, University of Alaska Fairbanks, 2012
Advanced R programming for Fisheries Statistics, University of Washington, 2013
Fisheries Acoustics, John Horne University of Washington, 2013

RELEVANT RESERACH EXPERIENCE

Monitoring Strategies to Improve Detection of Change in Forage Fish Stocks (2011- present). Co-Principal Investigator on the Gulf Watch Alaska long-term monitoring program in Prince William Sound. Designed surveys that include broad-scale aerial surveys coupled with hydroacoustic-trawl surveys to assess status and trends of prey species such as capelin, sand lance, juvenile herring, and krill.

Glacial-marine Ecosystem Studies (2004 – present). Principal Investigator on a program to investigate the influence of freshwater runoff from melting glaciers on seabirds and forage fish in the Gulf of Alaska. Work includes field measurements of oceanography, nutrient, zooplankton, fish and seabirds to model trophic interactions, and stable isotopes and radiocarbon to estimate the contribution of terrestrial subsidies to marine food webs.

Seabirds as Indicators of Forage Fish Stocks in Alaska (2012 – present). Collaborator on project that compiled historical data and collected new data on the feeding ecology of Puffins throughout coastal Alaska. Field work involved visiting colonies to collect prey samples, measure chick health, conduct at-sea surveys of marine bird density, hydroacoustic surveys for forage fish and other indices of marine habitat. These data along with historical data from more than 30 sites over 30 years contributed to analyses of geographic structure, temporal variability and marine habitat of key forage fish from southeast Alaska to the western Aleutians.

Kittlitz's Murrelet Distribution, Marine Habitat Use and Seasonal Movements (2008 – present). Co-Principal Investigator on a range-wide study of the breeding ecology of murrelets, which are seabird species of conservation concern. Used line transect methods to estimate abundance at sea, conducted hydroacoustic-trawl and oceanography surveys to identify characteristics of prey availability and marine habitat, used satellite tags to document post-breeding movement.

Forage Fish Ecology in the Aleutian Islands (2005 – 2010). Co-Principal Investigator during a large-scale forage fish and oceanography study that sampled 1500 km along the Alaska Peninsula and

Aleutian Archipelago. I oversaw fishing, plankton and oceanography data collection efforts, data analysis and reporting.

Inventory and Monitoring in Southeast Alaska National Parks (2002 – 2006). Lead biologist during two inventory and monitoring projects in Alaska's national parks. I conducted a marine and estuarine fish inventory in Glacier Bay, Sitka, Klondike Gold, and Wrangell St. Elias National Parks, and was in charge of bottom and midwater trawl fishing operations, voucher specimen identification and curating, data analysis, interpretation, and reporting. I also led a ground-nesting marine bird inventory in Glacier Bay, and was responsible for all aspects of the work, including permitting, staffing, data collection, analysis and reporting.

SELECTED PUBLICATIONS

Arimitsu, M.L. 2016. Influence of Glaciers on Coastal Marine Ecosystems in the Gulf of Alaska. Dissertation. University of Alaska Fairbanks. 160 pp.

O'Neel, S., Hood, E., Bidlack, A., Fleming, S., Arimitsu, M., Arendt, A., Burgess, E., Sergeant, S. Beaudreau, A., Timm, K., Hayward, G., Reynolds, J. and Pyare, S. 2015. Icefield-to-Ocean Linkages across the Northern Pacific Coastal Temperate Rainforest Ecosystem. BioScience 65:499-512.

Fellman, J., Hood, E., Raymond, P., Hudson, J., Bozeman, M. and Arimitsu, M. 2015. Evidence for the assimilation of ancient glacier organic carbon in a proglacial stream food web. Limnology and Oceanography 60:1118-1128.

Arimitsu, M. and Piatt, J. 2015. Forage fish populations in Prince William Sound: Designing efficient monitoring techniques to detect change. In: Quantifying temporal and spatial variability across the Northern Gulf of Alaska to understand mechanisms of change (Hoem Neher et al., eds). Science Synthesis Report for the Gulf Watch Alaska Program, Anchorage AK. 247 pp.

Renner, M., M.L. Arimitsu, and J.F. Piatt. 2012. Structure of marine predator and prey communities along environmental gradients in a glaciated fjord. Canadian Journal of Fisheries and Aquatic Sciences. 69:2029-2045

Arimitsu, M.L., J.F. Piatt, E.N. Madison, J.S. Conaway, and N. Hillgruber. 2012. Oceanographic gradients and seabird prey community dynamics in glacial fjords. Fisheries Oceanography 21:148-169.

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

Arimitsu, M.L., J.F. Piatt, M.A. Litzow, A.A. Abookire, M.D. Romano, and M.D. Robards. 2008. Distribution and spawning dynamics of capelin (*Mallotus villosus*) in Glacier Bay, Alaska: A cold water refugium. Fisheries Oceanography 17:137-146.

Arimitsu, M. L., J. F. Piatt, M. D. Romano, and D. C. Douglas. 2007. Distribution of Forage Fishes in Relation to the Oceanography of Glacier Bay National Park. Pages 102–106 *in* J. F. Piatt and S. M. Gende, editors. Proceedings of the Fourth Glacier Bay Science Symposium. USGS Scientific Investigations Report 2007 – 5047.

COLLABORATIONS

Anne Beaudreau (UAF), Alison Bidlack (ACRC), Mary Anne Bishop (PWSSC), Gary Drew (USGS), Jason Fellman (UAS), Keith Hobson (University of Ottowa), Brielle Heflin (USGS), Eran Hood (UAS), Erica Madison (USGS), John Moran (NOAA), Franz Mueter (UAF), Shad O'Neel (USGS), Scott Pegau (PWSSC), John Piatt (USGS), Martin Renner (Tern Again Consulting), Sarah Schoen (USGS), Jan Straley (UAS), Bill Sydamen (Farralon's Institute), Darcy Webber (Quantifish, New Zealand).

SCIENCE COORDINATING COMMITTEE: PELAGIC (ALTERNATE)

JOHN F. PIATT
Curriculum Vitae
Research Biologist (GS-15), Marine Ecology Project Leader, Alaska Science Center, U.S. Geological Survey, 4210 University Drive, Anchorage, Alaska, U.S.A. 99508.
E-mail: john_piatt@usgs.gov
Web: http://www.absc.usgs.gov/research/seabird_foragefish/index.html

ACADEMICS:
Affiliate Professor, School of Aquatic and Fisheries Sciences, University of Washington, Seattle.
Ph.D., Marine Biology, 1987, Department of Biology, Memorial University of Newfoundland, St. John's, Canada. Thesis: Behavioural Ecology of Common Murre and Atlantic Puffin Predation on Capelin: Implications for Population Biology.
B.Sc. (Hons.) Biochemistry, 1977, Memorial University of Newfoundland, St. John's, Canada.

RELEVANT RESEARCH EXPERIENCE
Functional Response of Seabirds to their Prey (1995-2015). Principal Investigator of integrated studies of oceanography, forage fish (seining, trawling, hydroacoustics), and seabirds (e.g., diets, breeding, foraging behavior, genetics, etc.) in and around seabird colonies in Prince William Sound, Cook Inlet, Gulf of Alaska, Aleutians and Bering Sea. Work with an international group of scientists to examine the global responses of seabirds to fluctuations in prey abundance.
Endangered Species Studies (2001-2015). Principal Investigator for studies on rare and threatened seabirds in Alaska, including Kittlitz's Murrelet, Marbled Murrelet and Short-tailed Albatross. Studies include detailed investigations of marine ecology, forage fish and habitat use, radio and satellite telemetry, physiology, surveys for distribution and abundance in Alaska, etc.
North Pacific Pelagic Seabird Database (2002-2015). Principal Investigator responsible for the compilation of ca. 350,000 transects that document the distribution of seabirds at sea in the North Pacific Ocean. Work is proceeding to map seabird distribution at different spatial scales, and relate distribution to currents, sea temperature, productivity and prey abundance.
Studies (1991- 1999, 2012-2015) on Tufted and Horned Puffin population and feeding ecology at 40 colonies in the Aleutian Archipelago and Gulf of Alaska (chick diets and growth, adult diets, seabird distribution at sea, hydroacoustic surveys).
Participated in 43 research cruises in 1977-2014 to study oceanography, plankton, forage fish and seabirds in the North Atlantic, Labrador Sea, eastern Canadian Arctic, North Central Pacific, Gulf of Alaska, Aleutians, Bering Sea and Chukchi Sea.

OTHER ACTIVITIES
Contributing Editor, Marine Ecology Progress Series (2007- current)
Science Panel, North Pacific Research Board, Anchorage, Alaska (2005-2011)
Past or Current advisor and/or graduate committee member for: A. Agness *U. Washington*; S. Speckman, *U. Washington*.; M. Romano, *Oregon State U.*; M. Robards, *Memorial U. Newfoundland*; T. Van Pelt, *U. Glasgow*; M. Litzow, *U. California, Santa Cruz*; A. Kitaysky, *U. Washington*; Ann Harding, *Sheffield U.;* K. Kuletz, *U. Victoria*, S. Zador, *U. Washington*, M. Renner, *U. Washington*, Mayumi Arimitsu, *U. Alaska, Fairbanks*, J. Lawonn, *Oregon State U.*, J. Cragg, *U. Victoria*.

SELECTED PUBLICATIONS:
Drew, G.S., Piatt J.F., and M. Renner. 2015. User's Guide to the North Pacific Pelagic Seabird Database 2.0; U.S. Geological Survey Open-File Report 2015-1123, 52pp.

Piatt, John F., Mayumi Arimitsu, William Sydeman, et al. 2015. Geographic structure of coastal marine food webs in the Alaskan North Pacific. Marine Ecology Progress Series. (*In review*)

Renner, M., J.K. Parrish, J.F. Piatt, K.J. Kuletz, A.E. Edwards, and G.L. Hunt, Jr. 2013. Modeled distribution and abundance of a pelagic seabird reveal trends in relation to fisheries. Marine Ecology Progress Series 484: 259-277.

Drew, G.S., J.F. Piatt, and D.F. Hill. 2012. Effects of currents and tides in fine-scale use of marine bird habitats in a Southeast Alaska hotspot. Marine Ecology Progress Series 487: 275-286.

Renner, M., M.L. Arimitsu, and J.F. Piatt. 2012. Structure of marine predator and prey communities along environmental gradients in a glaciated fjord. Canadian Journal of Fisheries and Aquatic Sciences 69: 2029-2045.

Arimitsu, M.L, J.F. Piatt, E.N. Madison, J.S. Conaway, N. Hillgruber. 2012. Oceanographic gradients and seabird prey community dynamics in a glacial fjord. Fisheries Oceanography. 21: 148-169.

Cury, P.M., I.L. Boyd, S. Bonhommeau, T. Anker-Nilssen, R.J.M. Crawford, R.W. Furness, J.A. Mills, E. Murphy, H. Osterblom, M. Paleczny, J.F. Piatt, J.P. Roux, L. Shannon, W.J. Sydeman. 2011. Global seabird responses to forage fish depletion – one-third for the birds. Science 334: 1703-1706.

Kitaysky, A.S., J. F. Piatt, S. A. Hatch, E.V. Kitaiskaia, Z. M. Benowitz-Fredericks, M.T. Shultz, and J.C. Wingfield. 2010. Food availability and population processes: severity of nutritional stress during reproduction predicts survival of long-lived seabirds. Functional Ecology. 24:625-637.

Shultz, M.T., J.F. Piatt, A.M. A. Harding, A.B. Kettle, T.I. Van Pelt. 2009. Timing of breeding and reproductive performance in murres and kittiwakes reflect mismatched seasonal prey dynamics. Marine Ecology Progress Series 393: 247-258.

Piatt, J.F., A.M.A. Harding, M. Shultz, S.G. Speckman, T. I. van Pelt, G.S. Drew, A.B. Kettle. 2007. Seabirds as indicators of marine food supplies: Cairns revisited. Marine Ecology Progress Series 352: 221-234.

Harding, A.M.A., Piatt, J.F., Schmutz, J.A., Shultz, M.T., Van Pelt, T.I., Kettle, A.B., and Speckman, S.G. 2007. Prey density and the behavioral flexibility of a marine predator: the Common Murre (*Uria aalge*). Ecology 88: 2024-2033.

Piatt, J.F., and A.M.A. Harding. 2007. Population Ecology of Seabirds in Cook Inlet. Pp. 335-352 *in*: Robert Spies (ed.), Long-term Ecological Change in the Northern Gulf of Alaska. Elsevier, Amsterdam.

Speckman, S., J.F. Piatt, C. Minte-Vera and J. Parrish. 2005. Parallel structure among environmental gradients and three trophic levels in a subarctic estuary. Progress in Oceanography 66: 25-65.

Litzow, M.A., J.F. Piatt, A.A. Abookire, and M. Robards. 2004. Energy density and variability in abundance of pigeon guillemot prey: support for the quality-variability tradeoff hypothesis. Journal of Animal Ecology 73: 1149-1156.

Abookire, A.A. and J.F. Piatt. 2005. Oceanographic conditions structure forage fishes into lipid-rich and lipid-poor communities in lower Cook Inlet, Alaska, USA. Marine Ecology Progress Series 287: 229-240.

COLLABORATORS

During the past four years, I have collaborated with the following Principal Investigators on proposals or papers: Josh Adams (USGS), Mayumi Arimitsu (USGS), Alan Burger (U. Victoria, Canada), Robin Corcoran (USFWS), Philippe Cury (Ctr. Tropical Fish. Res., France), Vicki Friesen (Queen's U., Canada), Bob Furness (U. Glasgow, UK), Keith Hobson (U. Saskatchewan, Canada), David Irons (USFWS), Alexander Kitaysky (U. Alaska, Fairbanks), Kathy Kuletz (USFWS), Ellen Lance (USFWS), Bill Montevecchi (Memorial U., Canada), John Moran (NMFS), Scott Pegau (PWSSC), Bill Pyle (USFWS), Heather Renner (USFWS), Martin Renner (U. Wash.), Dan Roby (Oregon State U.), Jan Straly (UAS), Rob Suryan (OSU), William Sydeman (Farallon Inst.), Stephani Zador (NOAA).

SCIENCE COORDINATING COMMITTEE: NEARSHORE

HEATHER A. COLETTI
National Park Service
240 W 5th Avenue, Anchorage, Alaska 99501, USA
Phone: 907-644-3687
E-mail: Heather_Coletti@nps.gov

Current position: Marine Ecologist, National Park Service Southwest Alaska Network (SWAN) Inventory and Monitoring (I&M) Program.

Education: Master of Science, Natural Resources: Environmental Conservation (University of New Hampshire, Durham, New Hampshire). Bachelor of Science, Zoology (University of Rhode Island, Kingston, RI).

Current activities related to the proposed project: Monitoring resources that are explicitly linked to the marine nearshore along regions within the Gulf of Alaska through the NPS SWAN I&M program and Gulf Watch Alaska.

Selected Publications

Ballachey, B.E., J.L. Bodkin, K.A. Kloecker, T.A. Dean, and **H.A. Coletti**. 2015. Monitoring for Evaluation of Recovery and Restoration of Injured Nearshore Resources. *Exxon Valdez* Oil Spill Restoration Project Final Report (Restoration Project 10100750), U.S. Geological Survey, Alaska Science Center, Anchorage, Alaska.

Ballachey, B., J. Bodkin, **H. Coletti**, T. Dean, D. Esler, G. Esslinger, K. Iken, K. Kloecker, B. Konar, M. Lindeberg, D. Monson, M. Shephard, and B. Weitzman. 2015. Variability within nearshore ecosystems of the Gulf of Alaska. In: Quantifying temporal and spatial variability across the northern Gulf of Alaska to understand mechanisms of change. Gulf Watch Alaska Synthesis Report to the Exxon Valdez Oil Spill Trustee Council, Projects 14120114 and 14120120.

Bodkin, J., B. Ballachey, **H. Coletti**, G. Esslinger, K. Kloecker, S. Rice, J. Reed and D. Monson. 2012. Long-term effects of the Exxon Valdez oil spill: Sea otter foraging in the intertidal as a pathway of exposure to lingering oil. *Marine Ecology Progress Series*.

Bodkin, J. L., B. E. Ballachey, G. G. Esslinger, K. A. Kloecker, D. H. Monson, and **H. A. Coletti**. 2007. Perspectives of an invading predator: Sea otters in Glacier Bay. Pp.133-136 in J. F. Piatt and S. M. Gende (eds.), Proceedings of the Fourth Glacier Bay Science Symposium. U.S. Geological Survey Scientific Investigations Report 2007-5047, 246 p.

Coletti, H.A., J.L. Bodkin, D.H. Monson, B.E. Ballachey and T.A. Dean. In review. Detecting and inferring cause of change in an Alaska marine ecosystem. Ecosphere.

Coletti, H.A. and T.L. Wilson. 2015. Nearshore marine bird surveys: data synthesis, analysis and recommendations for sampling frequency and intensity to detect population trends. *Exxon Valdez* Oil Spill Restoration Project Final Report (Restoration Project 12120114-F), National Park Service, Anchorage, Alaska.

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Konar, B, K. Iken, **H. Coletti**, D. Monson, and B. Weitzman. In review. Influence of static habitat attributes on local and regional rocky intertidal community structure. Estuarine Coastal and Shelf Science

Collaborators

Dr. Brenda Ballachey (USGS), Mr. James Bodkin (USGS), Dr. Lizabeth Bowen (USGS), Dr. Katrina Counihan (ASLC), Dr. Thomas Dean, Dr. Dan Esler (USGS), Dr. Allan Fukuyama (FHT Enivironmental), Dr. Tuula Hollmen (ASLC), Dr. Katrin Iken (University of Alaska Fairbanks), Dr. Tahzay Jones (NPS), Mr. Robert Kaler (USFWS), Dr. Brenda Konar (University of Alaska Fairbanks), Ms. Mandy Lindeberg (NOAA), Dr. Daniel Monson (USGS) , Dr. John Piatt (USGS), Dr. Benajmin Pister (NPS), Ms. Susan Saupe (CIRCAC), Ms. Sarah Schoen (USGS) (Note: full listing of Gulf Watch Alaska PI’s not given here; available upon request).

Science Coordinating Committee: Nearshore (alternate)

DAN ESLER

Alaska Science Center-U.S. Geological Survey
4210 University Drive, Anchorage, Alaska 99508
(907) 331-8115; desler@usgs.gov

Education:

2000 Ph.D. Wildlife Science. Oregon State University, Corvallis, Oregon, USA.
1988 M.Sc. Wildlife Ecology. Texas A&M University, College Station, Texas, USA.
1985 B.Sc. Biology/Outdoor Education. Northland College, Ashland, Wisconsin, USA.

Recent Professional Experience:

August 2013 – present Project Leader and Research Wildlife Biologist, Nearshore Marine Ecosystem Research Program, Alaska Science Center, U.S. Geological Survey, Anchorage, Alaska

I lead the Nearshore Marine Ecosystems Research Program (NMERP) of the Alaska Science Center, USGS. My program conducts studies to document and understand underlying causes of change in nearshore marine systems.

February 2001 – May 2013 University Research Associate and Adjunct Professor, Centre for Wildlife Ecology, Department of Biological Sciences, Simon Fraser University, British Columbia

Responsibilities: I led a research team conducting a broad suite of studies related to wildlife conservation in western North America, particularly marine birds and their prey. This research was designed to generate findings relevant for management of populations and habitats at regional or continental scales.

Relevant Peer-reviewed Publications:

Esler, D., P. L. Flint, D. V. Derksen, J.-P.L. Savard, and J. Eadie. 2015. Conclusions, synthesis, and future directions: understanding sources of population change. *in* J.-P.L. Savard, D. Derksen, D. Esler, and J. Eadie, editors. Ecology and Conservation of North American Sea Ducks. Studies in Avian Biology.

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Lok, E. K., **D. Esler**, J. Y. Takekawa, S. W. De La Cruz, W. S. Boyd, D. R. Nyeswander, J. R. Evenson, and D. H. Ward. 2012. Spatiotemporal associations between Pacific herring spawn and surf scoter spring migration: evaluating a “silver wave” hypothesis. Marine Ecology Progress Series 457:139-150.

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Esler, D., K. A. Trust, B. E. Ballachey, S. A. Iverson , T. L. Lewis, D. J. Rizzolo, D. M. Mulcahy, A. K. Miles, B. R. Woodin, J. J. Stegeman, J. D. Henderson, and B. W. Wilson. 2010. Cytochrome P4501A biomarker indication of oil exposure in harlequin ducks up to 20 years after the Exxon Valdez oil spill. Environmental Toxicology and Chemistry 29:1138-1145.

Iverson, S. A., and **D. Esler**. 2010. Harlequin duck population dynamics following the 1989 Exxon Valdez oil spill: assessing injury and projecting a timeline to recovery. Ecological Applications 20:1993-2006.

Esler, D., and S. A. Iverson. 2010. Female harlequin duck winter survival 11 to 14 years after the *Exxon Valdez* oil spill. Journal of Wildlife Management 74:471-478.

Lewis, T. L., **D. Esler**, and W. S. Boyd. 2008. Foraging behaviors of Surf and White-winged Scoters in relation to clam density: inferring food availability and habitat quality. Auk 125:149-157.

Kirk, M., **D. Esler**, and W. S. Boyd. 2007. Foraging effort of surf scoters (*Melanitta perspicillata*) wintering in a spatially and temporally variable prey landscape. Canadian Journal of Zoology 85:1207-1215.

Kirk, M., **D. Esler**, and W. S. Boyd. 2007. Morphology and density of mussels on natural and aquaculture structure habitats: implications for sea duck predators. Marine Ecology Progress Series 346:179-187.

Lewis, T. L., **D. Esler**, and W. S. Boyd. 2007. Effects of predation by sea ducks on clam abundance in soft-bottom intertidal habitats. Marine Ecology Progress Series 329:131-144.

Žydelis, R., **D. Esler**, W. S. Boyd, D. Lacroix, and M. Kirk. 2006. Habitat use by wintering surf and white-winged scoters: effects of environmental attributes and shellfish aquaculture. Journal of Wildlife Management 70:1754-1762.

Peterson, C. H., S. D. Rice, J. W. Short, **D. Esler**, J. L. Bodkin, B. A. Ballachey, and D. B. Irons. 2003. Long-term ecosystem response to the *Exxon Valdez* oil spill. Science 302:2082-2086.

Esler, D., T. D. Bowman, K. Trust, B. E. Ballachey, T. A. Dean, S. C. Jewett, and C. E. O'Clair. 2002. Harlequin duck population recovery following the Exxon Valdez oil spill: progress, process, and constraints. Marine Ecology Progress Series 241:271-286.

Recent Collaborators:

Anderson, Eric (British Columbia Institute of Technology), Ballachey, Brenda (USGS-retired), Bodkin, James (USGS-retired), Bowen, Liz (USGS), Bowman, Tim (USFWS), Boyd, W. Sean (Environment Canada), Coletti, Heather (NPS), Derksen, Dirk (USGS-retired), Eadie, John (University of California Davis), Flint, Paul (USGS), Gorman, Kristen (Prince William Sound Science Center), Hogan, Danica (Environment Canada), Hollmen, Tuula (UAF/Alaska SeaLife Center), Hupp, Jerry (USGS), Konar, Brenda (UAF), Lok, Erika (Environment Canada), Matkin, Craig (North Gulf Oceanic Society), Lindeberg, Mandy (NOAA), Palm, Eric (Ducks Unlimited), Rice, Jeep (NOAA-retired), Schmutz, Joel (USGS), Thompson, Jonathan (Golder), Tinker, Tim (USGS/University of California Santa Cruz), Uher-Koch, Brian (USGS), Ward, David (USGS), Willie, Megan (Simon Fraser University), Ydenberg, Ron (Simon Fraser University)

Budget Category:	Proposed FY 17	Proposed FY 18	Proposed FY 19	Proposed FY 20	Proposed FY 21	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$1,105.2	$1,212.9	$1,154.3	$1,261.7	$1,207.8	$5,942.0	
Travel	$100.7	$111.2	$99.3	$114.7	$101.8	$527.7	
Contractual	$610.7	$691.9	$649.4	$640.5	$594.6	$3,187.2	
Commodities	$115.9	$154.8	$101.2	$132.0	$104.9	$608.8	
Equipment	$56.6	$88.9	$49.1	$38.2	$32.4	$265.2	
Indirect Costs (*will vary by proposer*)	$101.5	$102.6	$103.8	$103.6	$107.7	$519.2	
SUBTOTAL	$2,090.6	$2,362.3	$2,157.1	$2,290.8	$2,149.2	$11,050.0	
General Administration (9% of subtotal)	188.2	212.6	194.1	206.2	193.4	994.5	
PROGRAM TOTAL	**$2,278.75**	**$2,574.93**	**$2,351.23**	**$2,496.92**	**$2,342.68**	**$12,044.50**	
Other Resources (In-Kind Funds)	**$1,671**	**$1,712**	**$1,658**	**$1,677**	**$1,622**	**$8,340**	

COMMENTS: All amounts are given in 1,000 dollars.

FY17-21

Program Title: Gulf Watch Alaska

SUMMARY

August 24, 2016

Elise Hsieh, Executive Director
Exxon Valdez Oil Spill Trustee Council
4210 University Drive
Anchorage, AK 99508-4626

Dear Elise:

Final FY 2017-2021 Proposal Submittal for Long-term Monitoring

17120114-A. Program Management I – Program Coordination and Science Synthesis

Gulf Watch Alaska, the long-term monitoring program of the *Exxon Valdez* Oil Spill Trustee Council (EVOSTC), has finalized our program and project proposals for fiscal years 2017-2021 funding based on comments received from EVOSTC's Science Panel on May 19, 2016. Below is the final budget summary and response to Science Panel comments for the Program Management I project.

EVOSTC Funding Requested *(including 9% GA)*

FY17	FY18	FY19	FY20	FY21	TOTAL
$225,700	$225,400	$227,900	$236,600	$248,300	$1,164,000

Non-EVOSTC Funding Available

FY17	FY18	FY19	FY20	FY21	TOTAL
$69,000	$69,000	$69,000	$69,000	$69,000	$345,000

Science Panel comment: *The Panel is encouraged and gratified by Mandy Lindeberg's acceptance and participation in the role of Science Lead and looks forward to her leadership. The Panel did express concern that the science coordinator position is intended to be filled after the start of the Program. This key position will be responsible for the design and implementation of the Program and it may take longer than anticipated to find an individual with the appropriate education and skill sets. Is there a plan in place, if the hiring process takes longer than planned or a qualified candidate is not identified? If the position is not a NOAA employee as hoped, will this impact the projected five year cost?*

PI Response:

- The Science Panel's concern for filling this key position is very appropriate. We have not treated the issue of hiring a Science Coordinator or Program Coordinator lightly. National Oceanic and Atmospheric Administration (NOAA)/National Marine Fisheries Service leadership has now approved administration of these positions and there are options to deal with any delays without additional costs to the program.

  The Science Coordinator will be a NOAA employee located at the Auke Bay Laboratory in Juneau. The creation of a NOAA position has been approved and will be advertised in fall 2016. A qualified individual has been identified; however, the position will be advertised competitively and the most qualified individual will be hired. We hope to bring on Dr. Robert Suryan as our Science Coordinator who has recently moved to Juneau from Oregon State University's Department of Fisheries and Wildlife (Assoc. Prof.) and brings a wealth of knowledge on marine ecosystems and long-term population dynamics to our program. Dr. Suryan also has history with the EVOS and was part of the Alaska Predator Ecosystem Experiment (APEX) program during the 1990s.

  The Program Coordinator will be a NOAA contractor. A request for proposals for a qualified contractor who can perform the work within the approved budget will be advertised in fall 2016. The current Science Coordinator, Donna Aderhold, has indicated interest in submitting a proposal for the Program Coordinator contract; however, the contract will be awarded to the most qualified, cost effective proposer. Donna's understanding of the program and expertise with marine science practices and policies (including National Environmental Policy Act compliance and Marine Mammal Protection Act and Endangered Species Act regulatory processes), scientific groups, and being a wildlife ecologist will strengthen our program.

  Curriculum vitae for both candidates have been provided in the Program proposal Attachment I.

- $44K was moved laterally from PM II to PM I's budget in an effort to reduce costs in the PM II proposal and address unforeseen needs in the PM I budget (e.g., additional costs for program coordinator position recently required by NOAA).

Sincerely,

Mandy Lindeberg
Gulf Watch Alaska Program Lead designate

Attachment: Gulf Watch Alaska: Environmental Drivers Component Project Proposal: 17120114-A—Program Management I—Program Coordination and Science Synthesis

EVOSTC FY17-FY21 INVITATION FOR PROPOSALS
PROGRAM PROJECT PROPOSAL SUMMARY PAGE

Project Title

Gulf Watch Alaska:

17120114-A—Program Management I - Program Coordination and Science Synthesis

Primary Investigator(s) and Affiliation(s)

Mandy Lindeberg, NOAA Auke Bay Laboratories

Date Proposal Submitted

24 August 2016

Project Abstract

This project is the Program Management Component I of the integrated Long-term Monitoring of Marine Conditions and Injured Resources proposal submitted by Lindeberg et al. (2016) to the *Exxon Valdez* Oil Spill Trustee Council. This project explicitly provides for program coordination and science synthesis of data collected under the long-term monitoring program, which we refer to as Gulf Watch Alaska (GWA). The GWA Program Management II proposal compliments this proposal and addresses administration, logistics, and outreach. The leadership team of the GWA program (comprised of PM I and II) manage over two dozen principal investigators and collaborators producing a wealth of scientific information on the northern Gulf of Alaska ecosystem and spill-affected area. Program coordination and science synthesis is a key component that improves linkages between monitoring efforts spanning large regional areas (Prince William Sound, Gulf of Alaska shelf, lower Cook Inlet). Program coordination includes facilitating program planning and sharing of information between principal investigators, other Trustee funded programs, and non-Trustee organizations. High quality products and science synthesis efforts help communicate monitoring results by delivering reports, publishing data, developing scientific papers, supporting outreach and integrating information across the entire program. The GWA program has matured in the first five years and successful management of the program will continue into the next five-year increment.

EVOSTC Funding Requested *(must include 9% GA)*

FY17	FY18	FY19	FY20	FY21	TOTAL
$225.7	$225.4	$227.9	$236.6	$248.3	$1,164.0

Non-EVOSTC Funding Available

FY17	FY18	FY19	FY20	FY21	TOTAL
$69.0	$69.0	$69.0	$69.0	$69.0	$345.0

1. Executive Summary

The Gulf of Alaska (GOA) in the northeastern Pacific Ocean is considered to be one of the most productive marine ecosystems in the world, with numerous complex interactions and food webs (Spies 2006a). Primary and secondary production (phytoplankton and zooplankton) are considered to be key drivers of the overall ecological productivity and function within the region. The northern GOA watersheds, estuaries, and bays are part of a larger, interconnected oceanic system in which natural physical forces such as currents, upwelling, downwelling, precipitation and runoff, all play important roles in determining regional primary productivity (Mundy 2005, Harwell et al. 2010).

The northern GOA hosts a wide variety of commercially important species that support many of Alaska's coastal communities as well as the state-wide economy. The groundfish fisheries of the northern GOA contributed an estimated $375 million dollars in gross product value in 2012 (A'mar et al. 2013), while the Cook Inlet driftnet and Prince William Sound (PWS) purse seine salmon fisheries provided a five-year average of $61.4 million in real gross earnings to permitted commercial fishers from 2007-2011 (Shriver 2012). Tourism in these areas also plays a large role in the economies of the coastal communities of the GOA, home to six U.S. National Parks, the Alaska Maritime National Wildlife Refuge, and numerous Alaska State Parks and recreational areas. Charter fishing, wildlife and eco-tours, and cruise ships also capitalize on the amazing ecological diversity and productivity of the area.

Statement of the Problem

Several large-scale ecological perturbations have occurred within the northern GOA region over the past century. In March, 1964, a magnitude 9.2 earthquake shook Southcentral Alaska, causing areas of land to displace as much as 18 meters and areas of uplift as much as 9 meters near the epicenter in PWS (ADMM 1964). Large areas of uplifted terrain from the earthquake elevated nearshore habitats above the intertidal zone, changing these coastal ecosystems. In March of 1989, the *Exxon Valdez* oil tanker ran aground on Bligh Reef spilling an estimated 750,000 barrels of crude oil into PWS (Rice et al. 1996). The spill devastated coastal marine habitats and their occupants, as well as the dependent coastal communities of the area, from Cordova to Kodiak. In the 25 years following the *Exxon Valdez* oil spill (EVOS), numerous studies and efforts were conducted to understand the impacts of the spill on the region and restore injured resources through work funded by the *Exxon Valdez* Oil Spill Trustee Council (EVOSTC) (Mundy 2005, Spies 2006b, Harwell et al. 2010). As time has progressed, chronic effects directly related to the spill have become more difficult to ascertain due to attenuation of the oil within the environment, regime shifts, changing climate, natural variability, and anthropogenic changes.

Long-term observations are fundamental requirements to detect ecological changes due to natural or manmade drivers such as the EVOS. Full recovery from the EVOS will take decades and requires long-term monitoring of both the injured resources and factors other than residual oil that may continue to inhibit recovery or impact resources that have recovered. Long-term monitoring information is necessary for assessing recovery of injured species, managing those resources along with the services they provide, and informing the communities who depend on those resources. In order to accomplish this, a monitoring program must have strong program coordination that produces not only long-term datasets but informative synthetic interpretation of those datasets.

Background

Since the EVOS, there have been numerous planning efforts to develop a coordinated, long-term monitoring strategy for the oil spill affected area, including: the overall guidance in the 1994 Restoration Plan; the detailed ecosystem monitoring plans of the 2002 Gulf Ecosystem Monitoring and Research Program; and more specific plans such as the nearshore restoration and ecosystem monitoring plans (Schoch et al. 2002, Dean and Bodkin 2006). In addition, the National Park Service (NPS) has developed and implemented an ecosystem-monitoring program, under the Inventory and Monitoring Program, for national parks within the EVOS-affected region (Katmai and Kenai Fjords National Parks). The National Oceanic and Atmospheric Administration's (NOAA's) Alaska Fisheries Science Center has initiated a fisheries oceanographic survey to monitor the pelagic ecosystem over the continental shelf in the GOA and University of Alaska Fairbanks' (UAF's) long standing GAK-1 oceanographic station and Seward Line transect. This program builds on a decades-long time series established for the central and western GOA. All of these plans recognize that monitoring programs in this region face constraints from insufficient funding to meet all needs, the logistics of sampling in remote areas, and the challenge of monitoring a system known to experience broad ecosystem changes on decadal and multi-decadal scales. The recent tragedy of the Deepwater Horizon oil spill in the Gulf of Mexico further highlights the need for robust long-term observations of marine resources and conditions.

The EVOSTC initiated funding for the Gulf Watch Alaska (GWA) Long-Term Monitoring Program in 2012 (McCammon et al. 2011). The program has been a consortium of 15 field projects, ten of which started before 2012 and several with data sets extending prior to the EVOS. A wide array of information and tools have been coordinated and synthesized by the GWA program to date (published datasets for public access online; Annual Reports, 2012-15; Synthesis Report in 2015; principal investigator [PI] journal publications, etc.). The program has fostered partnerships that include: professional administrative support (PWSSC - Prince William Sound Science Center); advanced data housing (AOOS - Alaska Ocean Observing System); large-scale nearshore ecological monitoring under the NPS Southwestern Alaska inventory program (SWAN); oceanographic monitoring through the UAF/Kasitsna Bay Laboratory/National Estuarine Research Reserve System/PWSSC partnerships; multi-agency and Northern Gulf Oceanic Society pelagic ecosystem monitoring; and finally, a significant outreach capacity through the agency partners, AOOS and PWSSC. Student participation has provided for deeper investigations into marine bird abundances, forage fish sampling methods, oceanography and sea otter diets. Collectively, this group represents unsurpassed expertise and knowledge of the GOA ecosystem and spill-affected region. A monitoring program of this size requires a cohesive management team to provide leadership, administration, coordination, and communication at all levels.

OVERALL GOALS & OBJECTIVES

The overarching goal of the GWA program is to provide sound scientific data and products to inform management agencies and the public of changes in the environment and the impacts of these changes on injured resources and services. Specifically, the goals are to:

A. *Collect and analyze long-term ecological monitoring information from the Gulf of Alaska Exxon Valdez Oil Spill affected region;*
B. *Make monitoring data publicly available for use by stakeholders, managers, and in integrated analyses; and*
C. *Assess monitoring data holistically in order to better understand the range of factors affecting individual species and the ecosystem.*

The program coordination and science synthesis efforts support these goals by: documenting the overall scientific information from the monitoring program, improving information sharing between program PIs and with other EVOSTC programs (Herring Research and Monitoring (HRM), Data Management, Lingering Oil, and Cross-program Publishing Groups). There are three primary objectives for continuing the GWA program's coordination and science synthesis project:

1. *Provide communication and data sharing;*
2. *Provide and document integration of monitoring results; and*
3. *Provide communication of monitoring information to trustee agency, other resource managers and the public*.

2. Relevance to the Invitation for Proposals

This proposal has relevance to the invitation by facilitating program management and science synthesis of GWA's long-term monitoring program in the following categories:

1. Responds to priorities, focal areas, and areas of interest in the FY 2016 Invitation for Proposals;
2. Directly addresses the goals and priorities for "Monitoring and Research" outlined by the EVOSTC in the 1994 EVOS Restoration Plan; and
3. Follows additional EVOSTC guidance including the 2010 & 2014 Injured Resources and Services Update.

The GWA program directly responds to the focal area of long-term monitoring of marine conditions and injured resources. GWA is an integrated monitoring program with field projects nested within three monitoring components or areas of interest (environmental drivers, pelagic monitoring, and nearshore monitoring). The program has overarching program goals to collect ecological data and provide this information to resource managers, and to improve how information is used to manage species injured by the EVOS.

The GWA program coordination and science synthesis project proposes to continue providing leadership staff for researchers and to help develop program-level synthetic reports, scientific publications, and scientific presentations to managers and communities. The program management team of GWA will work collectively to ensure the program milestones are met and all proposed work is completed, including timely delivery of report and data products. A successfully managed program will benefit the EVOSTC, other EVOSTC focus areas (HRM, Data Management, Lingering Oil, and Cross-program Publication Groups), agencies, non-governmental agencies, educators, and the public as we face a changing GOA ecosystem.

Relevance to the 1994 Restoration Plan Goals and Scientific Priorities and Injured Resources

The 1994 Restoration Plan identifies the continuing need for a sustained and interdisciplinary monitoring system to inform restoration needs and activities for injured resources and services. Specific language in the 1994 Restoration Plan cites the need for monitoring to "understand the physical and biological interactions that affect an injured resource or service, and may be constraining its recovery," recommends an "ecosystem approach," and recognizes that "an ecosystem approach to restoring injured resources and services may require restoration activities that address a resource's prey or predators, or the other biota and physical surroundings on which it depends..." The management strategy we propose to implement for the overall long-term monitoring program maintains a priority for continuing long-term datasets of injured species and to use an ecosystem approach to determine recovery from the EVOS or other perturbations.

Guidance from the EVOSTC recognizes there are not sufficient funds to accomplish all necessary restoration and monitoring activities and that partnerships are necessary to meet EVOSTC goals. Specifically, the 1994 Restoration Plan states that "restoration will take advantage of cost-sharing opportunities where effective" and "priority shall be given to strategies that involve multi-disciplinary, interagency, or collaborative partnerships." Our proposed monitoring program will expand the efforts previously funded by EVOSTC through leveraging collaborations with multiple agency monitoring programs and other research programs (such as those of the North Pacific Research Board [NPRB] and the AOOS), and with HRM program under this funding opportunity.

The 1994 Restoration Plan included a policy that "restoration will include a synthesis of findings and results, and will also provide an indication of important remaining issues or gaps in knowledge." The GWA program management team will be key for accomplishing this policy which has an understanding of scientific project results and coordination with the data management program since the onset of the program (2012).

We are also committed to the 1994 Restoration Plan policy that "Restoration must reflect public ownership of the process by timely release and reasonable access to information and data." GWA has a data management policy that addresses this directly in a transparent and timely fashion. Participating PIs are required, at the beginning of each 5-year increment, to sign a GWA program and data management plan (see Attachment 1 at end of this document). Upon acceptance of this program by the EVOSTC, a GWA data management plan with signature sheet will be distributed to all PIs for review and acceptance via signature.

3. Project Personnel

The GWA program coordination and science synthesis personnel are part of the Program Management Team (PMT) and consist of the Program Lead, Mandy Lindeberg (in-kind contribution 0.5 full time equivalent [NOAA FTE]), the Program Science Coordinator (NOAA term-funded 1 FTE) and the Program Coordinator (NOAA affiliate) (Figure 1). These personnel will provide leadership and work closely with all program members.

Program Lead

Mandy Lindeberg (NOAA) *(Please see CV attached to program proposal)*

Fisheries Research Biologist
NOAA Auke Bay Laboratories
Alaska Fisheries Science Center, National Marine Fisheries Service (NMFS)
17109 Pt. Lena Loop Rd, Juneau, Alaska 99801
(907) 789-6616
mandy.lindeberg@noaa.gov

Lindeberg will serve as overall program and science lead and the primary point of contact for the EVOSTC. She will ensure program coordination, collaborations and awareness with other agencies and monitoring initiatives in the region. This position combines the responsibilities held in the previous 5-year program by Molly McCammon (former program lead) and Kris Holderied (former science lead). If awarded another five years of funding, program and science leadership can be led by one individual instead of two ow that the program has advanced to a more mature, operational state. We think this approach will lead to reduced program management costs. Lindeberg has been involved in oil spill research and nearshore habitat studies throughout Alaska's coastline for over 25 years. Her research includes oil spill studies on injury assessment and long term monitoring of nearshore flora, fauna, and persistence of oil in the spill region. Lindeberg has been a part of the GWA program serving as Pelagic Component Lead (2013-16), co-PI for the Nearshore component (2011-16), and co-PI for the Lingering oil component (2011-16).

Lindeberg will be responsible for overseeing coordination of individual program components, science synthesis and integration, and ensuring a coordinated monitoring program that meets project milestones and deliverables. She will oversee project synthesis efforts and coordinate preparation of scientific reports and papers for the EVOSTC, and work with investigators to support outreach efforts. She will also be responsible for coordinating the efforts of the GWA program with the HRM program, other Trustee programs, and non-Trustee organizations. Lindeberg will oversee the work of the Science Coordinator and Program Coordinator.

Science Coordinator

TBD, PhD, NOAA FTE

The Science Coordinator will be a NOAA employee located at the Auke Bay Laboratory in Juneau. The creation of a NOAA position has been approved and will be advertised in fall 2016. A qualified individual has been identified (see CV in program proposal, Attachment 1); however, the position will be advertised competitively and the most qualified individual will be hired.

The Science Coordinator will lead efforts to integrate and synthesize data collected under the program while also providing technical review, editing, research, and writing of program documents. The Science Coordinator will work directly with the Science Review Team and Science Coordinating Committee (See Figure 1). In addition, the Science Coordinator will seek partnerships between GWA and external programs to leverage the data and platforms supported GWA to increase the regional significance and prestige of the program. The Science Coordinator will work directly with journal's special issue process and EVOSTC staff to ensure publication of peer-reviewed articles and scientific reports, promote across-component synthesis publications, and lead small working groups assembled to pursue specific scientific issues. The Science Coordinator provides technical feedback on data tools and user access, and works closely with the Program

Lead, Administrative and Outreach Lead (PWSSC Director), and Program Coordinator on scientific meeting agendas, discussion facilitation, and more.

Program Coordinator

TBD, NOAA affiliate

The Program Coordinator will be a NOAA contractor. A request for proposals for a qualified contractor who can perform the work within the approved budget will be advertised in fall 2016. The current Science Coordinator, Donna Aderhold, has indicated interest in submitting a proposal for the Program Coordinator contract position (see CV in program proposal, Attachment 1); however, the contract will be awarded to the most qualified, cost effective proposer.

The Program Coordinator will work closely with PMT members to provide administrative assistance to the program and PIs with primary efforts toward compiling program reports and budgets, tracking progress and program accomplishments. Duties include assisting the Science Coordinator and the Administrative and Outreach Lead (PWSSC Director) with meeting and teleconference logistics, notifying PIs of due dates, facilitating communication between program teams (i.e., Science Coordinator, Science Review Team, and Science Coordinating Committee), small working groups (i.e., plankton working group, integrated pelagic surveys working group), and all of the program PIs, providing content updates to internet and program outreach materials, and outreach events.

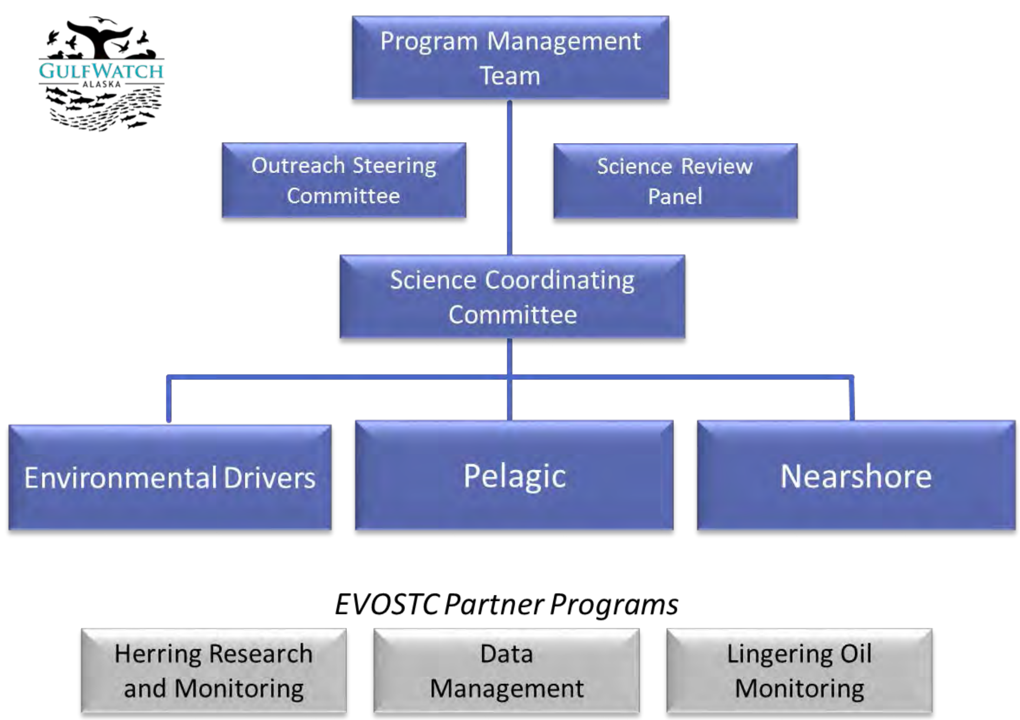

Figure 1. Gulf Watch Alaska organizational chart.

4. Project Design

A. Objectives

The program coordination and science synthesis project is not a hypothesis-driven component of the program. However, management of the GWA program has several objectives for the next five-year increment (FY2017-21). These objectives are to remain focused on:

1. *Provide* ***communication*** *and* ***data sharing*** *- this includes coordinated* ***planning*** *between PIs of the individual monitoring projects, as well as with other agencies and research organizations;*

2. *Provide and document* ***synthesis and integration of monitoring*** *results across programs - working with project PIs, data management, HRM, and lingering oil teams as well as other agencies and research organizations; and*

3. *Provide* ***communication of monitoring information*** *to Trustee agencies, other resource managers, and the public - this includes data management, data synthesis, presentation and outreach, as well as other agencies and research organizations.*

Program coordination and science synthesis efforts will be closely aligned with our program administration and outreach efforts, as well as from other EVOSTC-funded programs (HRM, data management, lingering oil and cross-program publication groups). The program coordination and science synthesis efforts of the GWA program will help fill a gap between data collection and synthetic analyses and communication needed to help understand drivers of ecological patterns and factors that may be limiting injured resources in the spill affected region. Science coordination and synthesis will bridge gaps between monitoring projects and other research in the spill-affected region, including NPRB, the Gulf of Alaska Integrated Ecosystem Research Program (GOAIERP), the NPS Inventory and Monitoring Program, Oil Spill Recovery Institute (OSRI), other agency monitoring programs. Additionally, relationships can include separately-funded projects of AOOS, and multi-agency and university collaborative programs such as the Geographic Information Network of Alaska (GINA), Alaska Statewide Digital Mapping Initiative, and Landscape Conservation Cooperatives (LCCs).

B. Procedural and Scientific Methods

Mandy Lindeberg will serve as the program lead for the GWA program and contribute approximately 6 months of in-kind labor (NOAA) to program coordination and synthesis efforts. Upon approval of funding by the EVOSTC, a full-time science coordinator will be hired to conduct the science coordination and synthesis efforts and program coordinator will be hired to assist with program planning, tracking, reporting and outreach efforts.

Objective 1: Provide communication and data sharing

The Program Lead, with support from the Science and Program Coordinators will:

a. Coordinate with the Administrative and Outreach Lead and program PIs on overall GWA planning, meetings, reporting, and evaluation.
b. Collaborate on ways to provide schedules, deadlines, and field work to interested parties (e.g., Google calendar, Google sites, public website, shared workspaces, etc.).
c. Facilitate quarterly PI meetings (teleconferences and gathering locations).
d. Ensure quality control and timeliness of program data to data management program.

e. Work to coordinate with the HRM program Lead on program implementation and joint information needs.
f. Communicate with other EVOSTC funded programs (e.g., Lingering Oil, Cross-Program Publication Groups).
g. Collaborate with groups outside the GWA program (NPRB GOAIERP, NPS, GINA, LCCs, etc.) on joint synthesis of information.

Objective 2: Provide and document Synthesis and integration of monitoring results across programs

The Program Lead, with support from the Science and Program Coordinators will:

a. Prepare and compile required NOAA semi-annual reports with Administrative Lead as part of cooperative agreement.
b. Compile annual and final reports on overall science monitoring effort, working with the Administration Lead, PIs, data management provider, and outreach team.
c. Prepare and compile Annual Work Plans with PIs and respond to EVOSTC review.
d. Assist PIs with data synthesis, small working groups and publications within the program.
e. Prepare a monitoring data synthesis report for Year 3 (8 years of monitoring) and/or special issue consideration with PIs for joint workshop between GWA and HRM programs.
f. Collaborate with Administrative Lead and HRM Lead to plan Year 3 joint workshop between GWA and HRM programs with EVOSTC staff.
g. Coordinate with PIs to improve integration of multi-disciplinary monitoring activities within geographic regions (PWS, outer Kenai Peninsula coast, lower Cook Inlet) and of monitoring within single disciplines between different regions.
h. Collaborate with other Trustee programs (HRM, Lingering Oil and Cross-Program Publication Groups) and non-Trustee organizations to share resources, data and foster partnerships to enhance monitoring efforts and cross-pollinate scientific knowledge.

Objective 3: Provide communication of monitoring information to Trustee agencies, other resource managers, and the public

The Program Lead, with support from the Science and Program Coordinators will:

a. Communicate directly with EVOSTC staff and their Science Review Panel on program activities and progress.
b. Work with program management team, outreach team and PIs to communicate program progress to EVOSTC and the public by continuing to develop current content online, new presentations and create outreach opportunities.
c. Work with data management team, outreach team and PIs to develop data exploration tools to better communicate technical and scientific information to stakeholders and the public.
d. Network with other monitoring programs and regional stakeholders to identify information needs that may be met by adopting new ways to communicate information.

C. Data Analysis and Statistical Method

The primary focus of the program-wide science synthesis effort will be the integration of data between multi-disciplinary projects and helping to provided improved access to that information for resource managers, coastal planners, the research community and the public. Please see the individual project proposals for details on data analysis and statistical methods (project proposals, section #4.C.)

D. Description of Study Area

The study area will be within the EVOS region as outlined in the invitation. Specific areas are identified in each project proposal housed under the program proposal "Gulf Watch Alaska: Long-Term Monitoring of Marine Conditions and Injured Resources" submitted by Lindeberg et al. (2016).

5. Coordination and Collaboration

Within the Program

The following outlines how the GWA leadership personnel will achieve coordination and collaboration activities within the program:

Program Lead - will be responsible for overseeing coordination of individual program components, science synthesis and integration, and ensuring a coordinated monitoring program that meets project milestones and deliverables. These duties include:

- Oversight of project synthesis efforts and coordinate preparation of scientific reports/ papers for the EVOSTC and the public.
- Coordinating efforts of the GWA program with the data management program, the HRM program, Lingering Oil program, and potential Cross-Program Publication Groups.
- Working with Outreach Coordinator and PIs to support outreach efforts.

Science Coordinator - will provide program technical writing, review, and science coordination, including:

- Author and lead production of program synthesis products and promote integration of GWA projects.
- Review and collation of reports and work plans.
- Integrate GWA data and platforms with external programs such as HRM and NOAA's Gulf Survey.
- Editorial review, website development/ updates, and assistance with coordination of outreach events for each project.
- Attendance and presentation of program information at scientific meetings will be encouraged if funding opportunities arise to facilitate coordination of ideas and information outside of the program.

Program Coordinator - will facilitate meetings, reporting, outreach, sharing, and publication of information from the various monitoring projects. These activities will include:

- Planning and documenting all quarterly teleconferences and meetings.
- Tracking and assisting with data and metadata publication in the GWA Data Portal.
- Tracking progress towards deadlines and program products.
- Assisting with maintenance and updates for program website for purposes of conveying important program goals and information to the group.
- Assist with outreach events.

Program Lead, Science and Program Coordinators - individual project activities will continue to be conducted as a coordinated effort for all of the following monitoring projects within the program:

- Gulf of Alaska mooring (GAK-1) monitoring - *UAF*

- Seward line monitoring - *UAF*
- Oceanographic conditions in Prince William Sound - *PWSSC*
- Oceanographic monitoring in Cook Inlet - *Kachemak Bay Research Reserve (KBRR)/ University of Alaska Anchorage (UAA) and NOAA Kasitsna Bay Laboratory*
- Continuous plankton recorder - *Sir Alister Hardy Foundation for Ocean Science (SAHFOS)*
- Long-term killer whale monitoring - *North Gulf Oceanic Society*
- Humpback whale predation on herring - *NOAA NMFS Auke Bay Laboratory*
- Forage fish distribution and abundance - *U. S. Geological Survey (USGS) Alaska Science Center*
- Prince William Sound marine bird surveys - *U.S. Fish and Wildlife Service (USFWS)*
- Nearshore systems in the Gulf of Alaska and Kachemak Bay - *USGS Alaska Science Center/NPS SWAN, UAF*

Administration and Outreach: PWSSC and AOOS - The Program Lead and Science and Program Coordinators will work closely with PWSSC staff to assist with overall administrative activities of the program, including developing reports and planning meetings and outreach events.

Data management provider - The Program Lead and Science and Program Coordinators will work closely with the data management staff to maintain data access tools, providing data and feedback in the data portal, and metadata generation tools. The Program Science and Program Coordinators will continue to work with all project PIs within the program to ensure new data are loaded to the portal, have undergone QA/QC measures, and have appropriate metadata available for public access.

WITH OTHER EVOSTC-FUNDED PROGRAMS AND PROJECTS

As part of GWA, the Program Lead, Science Coordinator, and Program Coordinator will continue to work closely with data management, HRM, and Lingering Oil program focus areas and PIs to maintain reporting consistencies in addition to sharing information. This would include out of cycle or above ceiling projects funded by the EVOTC. The GWA program management team and HRM program Lead will continue to participate in annual meetings and teleconferences, and will work closely to encourage information sharing and address shared questions between the programs and outreach efforts.

WITH TRUSTEE AND MANAGEMENT AGENCIES

As described in previous sections, the GWA program integrates ecosystem monitoring activities with NOAA, USFWS, USGS, BOEM and NPS in the GWA program. We also coordinate with Alaska Department of Fish and Game researchers and managers through coordination on synthesis activities with the HRM program.

WITH NATIVE AND LOCAL COMMUNITIES

The Program Lead and Science and Program Coordinators will work closely with the Administrative and Outreach Lead, Outreach Coordinator and Outreach Steering Committee (PWSSC, AOOS) to provide content and information for public outreach events. More information on the GWA programs plans for outreach with Native and local communities can be found in our Administration, Logistics, and Outreach, Program, and individual monitoring project proposals.

6. Schedule

PROGRAM MILESTONES

Objective 1. Provide communication and data sharing - this includes coordinated planning between PIs of the individual monitoring projects, as well as with other agencies and research organizations.

Ongoing throughout project.

Objective 2. Provide and document integration of monitoring results across programs - working with project PIs, data management, HRM, and Lingering oil teams as well as other agencies and research organizations.

Ongoing throughout project.

Objective 3. Provide communication of monitoring information to trustee agencies, other resource managers, and the public - this includes data management, data synthesis, presentation and outreach, as well as other agencies and research organizations.

Ongoing throughout project.

MEASURABLE PROGRAM TASKS

Measurable program tasks to meet the above objectives are presented in Table 1 and described in more detail below.

Table 1. Schedule of Measurable Program Tasks.

	FY17				**FY18**				**FY19**				**FY20**				**FY21**			
	EVOSTC FY Quarter (beginning Feb. 1)																			
Task	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Task 1 Planning																				
Coordinator hires	X																			
Web-Outreach review		X				X				X				X				X		
Data Compliance			X				X				X				X				X	
FY22-26 proposal																				X
Task 2 Meetings																				
PI Meetings	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Trustee Prog. review			X				X				X				X				X	
Yr. 3 Joint Workshop													X							
Task 3 Reporting																				
Annual Reports					X				X				X				X			
FY Work Plan (DPD)			X				X				X				X					
Yr. 3 Synthesis Rpt												X								
Yr. 17-21 Final Rpt																				X

FY 2017 (Year 6)

FY 17, 1st quarter	(February 1, 2017 - April 31, 2017)
February:	*Compile and edit program status summary*
April:	*Submit 5-year program status summary and special issue final manuscripts*
	Plan and coordinate quarterly program teleconference
FY 17, 2nd quarter	(May 1, 2017-July 30, 2017)
May:	*Complete updates to program website and outreach materials*
	Prepare and disseminate work plan templates to group
June-July:	*Plan and coordinate quarterly program teleconference*
FY 17, 3rd quarter	(August 1, 2017 – October 31, 2017)
August:	*Compile and edit work plans for Year 7and semi-annual report for NOAA*
September 1:	*Submit annual program work plans and NOAA semi-annual report*
September 30:	*Audit PI data compliance on workspace*
October:	*Plan annual PI meeting and workshops*
	Review EVOSTC work plan comments
FY 17, 4th quarter	(November 1, 2017- January 31, 2018)
November:	*Annual PI meeting and workshops*
December-January:	*Preparation for and attendance at the Alaska Marine Science Symposium (AMSS)*
	Plan and coordinate quarterly program teleconference
	Begin compilation of Year 6 annual report

FY 2018 (Year 7)

FY 18, 1st quarter	(February 1, 2018 - April 31, 2018)
February:	*Compile and edit Year 6 annual report for EVOSTC and semi-annual report for NOAA*
March 1:	*Submit Year 6 annual report for EVOSTC and semi-annual report for NOAA*
April:	*Plan and coordinate quarterly program teleconference*
FY 18, 2nd quarter	(May 1, 2018-July 30, 2018)
May:	*Complete updates to program website and outreach materials*
	Prepare and disseminate work plan templates to group
June-July:	*Coordinate review and response to comments from proposal*
	Plan and coordinate quarterly program teleconference
FY 18, 3rd quarter	(August 1, 2018 – October 31, 2018)
August:	*Compile and edit work plans for Year 8 and semi-annual report for NOAA*
September 1:	*Submit annual program work plans and NOAA semi-annual report*
September 30:	*Audit PI data compliance on workspace*
October:	*Plan annual PI meeting and workshops*
	Review EVOSTC work plan comments

FY 18, 4th quarter (November 1, 2018- January 31, 2019)

November: *Annual PI meeting and workshops*
December-January: *Preparation for and attendance at AMSS*
Plan and coordinate quarterly program meeting/teleconference
Begin compilation of Year 7 annual report

FY 2019 (Year 8)

FY 19, 1st quarter (February 1, 2019 - April 31, 2019)

February: *Compile and edit Year 7 annual report for EVOSTC and semi-annual report for NOAA*
March 1: *Submit Year 7 annual report for EVOSTC and semi-annual report for NOAA*
April: *Plan and coordinate quarterly program teleconference*

FY 19, 2nd quarter (May 1, 2019-July 30, 2019)

May: *Complete updates to program website and outreach materials*
Prepare and disseminate work plan templates to group
June-July: *Plan and coordinate quarterly program teleconference*
Outreach events

FY 19, 3rd quarter (August 1, 2019 – October 31, 2019)

August: *Compile and edit work plans for Year 9 and semi-annual report for NOAA*
September 1: *Submit annual program work plans and NOAA semi-annual report*
Coordinate compilation of special journal issue or program synthesis report
September 30: *Audit PI data compliance on workspace*
October: *Plan annual PI meeting and workshops*
Review EVOSTC work plan comments

FY 19, 4th quarter (November 1, 2019- January 31, 2020)

November: *Annual PI meeting and workshops*
December-January: *Plan Joint Science workshop, develop and present program content Preparation for and attendance at the Alaska Marine Science Symposium (AMSS)*
Begin compilation of Year 8 annual report

FY 2020 (Year 9)

FY 20, 1st quarter (February 1, 2020 - April 31, 2020)

February: *Participate in Joint Science Workshop with HRM program*
Compile and edit Year 8 annual report for EVOSTC and semi-annual report for NOAA
March 1: *Submit Year 8 annual report for EVOSTC and semi-annual report for NOAA*
April: *Plan and coordinate quarterly program teleconference*

FY 20, 2nd quarter (May 1, 2020-July 30, 2020)

May: *Prepare and disseminate work plan templates to group*
June-July: *Plan and coordinate quarterly program teleconference*

FY 20, 3rd quarter (August 1, 2020 – October 31, 2020)

August:	*Compile and edit program work plans for Year 10 and semi-annual report for NOAA*
September 1:	*Submit annual work plans to EVOSTC and semi-annual report to NOAA*
September 30:	*Audit PI data compliance on workspace*
October:	*Plan annual PI meeting and workshops* *Review EVOSTC work plan comments*

FY 20, 4th quarter (November 1, 2020- January 31, 2021)

November:	*Annual PI meeting and workshops*
December-January:	*Preparation for and attendance at AMSS* *Plan and coordinate quarterly program teleconference* *Begin compilation of Year 4 annual report*

FY 2021 (Year 10)

FY 21, 1st quarter (February 1, 2021 - April 31, 2021)

February:	*Compile and edit Year 9 annual report for EVOSTC and semi-annual report for NOAA*
March 1:	*Submit Year 9 annual report for EVOSTC and semi-annual report for NOAA*
April:	*Plan and coordinate quarterly program teleconference* *Submit next- year program proposal* *Continue planning for year 10 status summary report or special journal issue, in coordination with HRM lead and EVOSTC staff*

FY 21, 2nd quarter (May 1, 2021-July 30, 2021)

May:	*Complete updates to program website and outreach materials*
June-July:	*Coordinate review and response to comments from proposal* *Plan and coordinate quarterly program teleconference*

FY 21, 3rd quarter (August 1, 2020 – October 31, 2020)

August:	*Compile and edit semi-annual report for NOAA*
September 1:	*Submit revised program proposal for FY 2022 invitation (pending EVOSTC invitation to propose)*
September 30:	*Audit PI data compliance on workspace*
October:	*Plan annual PI meeting and workshops* *Review EVOSTC work plan comments* *Coordinate compilation of initial draft of five-year status summary or special journal issue manuscripts*

FY 21, 4th quarter (November 1, 2021- January 31, 2022)

November:	*Annual PI meeting and workshop*
December-January:	*Preparation for and attendance at AMSS* *Plan and coordinate PI program teleconference* *Coordinate preparation and submission date of five-year status summary or joint special issue with HRM program and EVOSTC staff*

7. Budget

BUDGET FORMS *(ATTACHED)*

Labor rates for program coordinators are escalated by approximately 3% each year of the proposed 5-year budget. Science Coordinator will be a benefited position, first year under contract with plans to try and convert to a NOAA Term-funded position. Program Coordinator will be a contracted position, no benefits. Funding is also requested for computers and minor supplies for these staff and travel for the program lead, science lead, and program coordinator to attend GWA meetings.

Please see program coordination and science synthesis project (GWA PM I) in the program budget workbook for details.

SOURCES OF ADDITIONAL FUNDING

NOAA will provide in-kind labor for Mandy Lindeberg to be Program Lead for GWA. Her in-kind labor will be supported for all 5 years of the EVOSTC funding cycle. She will devote a minimum of 6 months to the program each year (in-kind: 6 mos $69K; 5 years $345K).

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Online Resources

Gulf Watch Alaska – http://www.gulfwatchalaska.org/

Gulf Watch Alaska Data Portal – http://portal.aoos.org/gulf-of-alaska.php

EVOSTC Long-Term Monitoring Program – http://www.evostc.state.ak.us/index.cfm?FA=projects.gulfwatch

Attachment 1

DRAFT

Gulf Watch Alaska Program and Data Management

(FY 2017-2021)

Draft GWA Program and Data Management Plan (2017-21)

Purpose

The *Exxon Valdez* Oil Spill Trustee Council (EVOSTC) and state and federal agencies are supporting a second five-year block of a monitoring program in the Gulf of Alaska region impacted by the 1989 *Exxon Valdez* oil spill. This 20-year program is planned and funded in five-year increments. It builds upon the past 26 years of restoration research and monitoring funded by the EVOSTC and Federal and state agencies.

The Gulf Watch Alaska (GWA) Long-Term Monitoring Program management team considers it crucial that PIs have agreed on provisions and protocols that promote a consistent and seamless team effort for the collection and dissemination of data and scientific research results. The purpose of the program management plan is to support those efforts, and minimize administrative demands on researchers. The concurrence of the program management team, principal investigators, co-principal investigators and sub-contractors (hereafter referred to as principal investigators or PIs) in this consultative process is indicated by signature in Attachment A, which is revised as individuals join or leave the program. This plan is reviewed on an annual basis and can be amended by two-thirds vote of all PIs.

Requirements and Responsibilities

1. Internal program leadership and responsibilities

Key personnel for program leadership and component responsibilities are listed in Table A.1. Figure A.1 shows the GWA program organizational chart.

Table A.1. GWA key personnel listed by program group, name, affiliation, title and the percentage of time that person will devote to their role.

GWA Leadership Group	Name	Affiliation	Title/Role	% time
Program Management Team (PMT)	Mandy Lindeberg	NOAA	Program Lead	50%
	Katrina Hoffman	PWSSC	Administrative Lead	25%
	To Be Determined	NOAA	Science Coordinator	100%
	To Be Determined	NOAA	Program Coordinator	100%
Science Coordinating Committee (SCC)	Russell Hopcroft	UAF	Env. Drivers Lead	10%
	Mayumi Arimitsu	USGS	Pelagic Lead	10%
	Heather Colletti	NPS	Nearshore Lead	10%
	Seth Danielson	UAF	Env. Drivers Alt.	5%
	John Piatt	USGS	Pelagic Alt.	5%
	Daniel Esler	USGS	Nearshore Alt.	5%
			Lingering Oil liaison	5%
Science Review Panel (SRP)	Harold Batchelder	PICES	science review	volunteer
	Richard Brenner	ADF&G	science review	volunteer
	Leslie Holland-Bartels	USGS ret.	science review	volunteer
	Terrie Klinger	UW	science review	volunteer
	Stanley (Jeep) Rice	NOAA ret.	science review	volunteer

Program Management Team. The team consists of the Program Lead, the Program Administrative and Outreach Lead, the Program Science Coordinator, and the Program Coordinator. The PMT meets at least monthly, on average, and sometimes weekly depending on the needs of the program.

The Program Lead (Mandy Lindeberg, NOAA) will be responsible for overseeing coordination of individual program components, science synthesis and integration, and ensuring a coordinated monitoring program that meets project milestones and deliverables.

Program Administrative Lead and Outreach Lead (Katrina Hoffman, PWSSC) will be responsible for logistics for science review and principal investigator meetings and non-Trustee agency travel to those meetings, as well as timely submission of all project reports and monitoring of overall program spending. As the fiscal agent for the non-Trustee Agency program cooperative agreement, the PWSSC will be responsible for financial administration of that award and all sub awards, timely submission of financial reports, and any auditing activities.

Program Science Coordinator (TBD) will provide technical editing, research and writing of program documents, work directly with journals and EVOSTC staff to ensure publication of peer-reviewed articles and scientific reports, promote across component synthesis publications, provide technical feedback on data tools and user access, and work closely with the Program Lead, Administrative and Outreach Lead, and Program Coordinator on scientific meeting agendas, discussion facilitation, and more.

Program Coordinator (TBD) will work closely with Program Management Team members to provide administrative assistance to the program and PIs. This includes collaborating with the Administrative and Outreach Lead on meeting and teleconference logistics, notifying PIs of due dates, facilitating communication between program teams (i.e., Science Coordinator, Science Review Team, and Science Coordinating Committee), small working groups (i.e., marine birds working group, plankton working group), and all of the program PIs, providing content updates to program outreach materials, and assisting with annual program planning and travel.

Program Outreach Steering Committee - Katrina Hoffman (PWSSC) will be Outreach Lead and Outreach Coordinator will be Stacy Buckelew (PWSSC & Axiom). Outreach Steering Committee members will include staff from the following organizations: Alaska Ocean Observing System (AOOS), PWSSC, and OSRI based in Cordova, the Alaska SeaLife Center (ASLC) in Seward, the Kachemak Bay Research Reserve (KBRR) in Homer, and Alaska Sea Grant. This group will provide input on how to maximize community involvement in the oil spill region and will provide guidance on other outreach products as needed.

Program Science Coordinating Committee consisting of leads for the monitoring projects comprising the GWA Program will assist the Program Science Lead. As the guiding science body for the GWA Program, the Science Coordinating Committee will provide overall scientific leadership for program integration, data exchange and synthesis, dispute resolution, and assessing the need for any program revisions during the 5-year program. The Committee will help ensure coordinated planning of field and lab work to be performed in line with the approved statements of work and the goals of the overall program. The committee will help ensure the program is truly integrated, informs the management of injured resources, and is contributing to the restoration of the spill-impacted region and resources. They will also plan annual principal investigator meetings, help organize any special issue publications, represent the GWA Program at outside scientific and public meetings, proactively promote scientific partnerships with other programs as applicable, and finally help facilitate outreach opportunities. This committee will include data management services, Lingering Oil program, and Herring Research and Monitoring (HRM) program as needed. Terms of Reference for this committee will be adopted which includes staggered, 2-year terms for membership. The Science Coordinating Committee and the Program Management Team will meet together at least quarterly.

Program Science Review Panel. The Program Management Team and the Science Coordinating Committee select four members for this panel representing external scientific expertise in each of the Science Projects, to provide periodic external advice to the program. This panel meets during the annual PI meeting to assist the science lead and Science Coordinating Committee. They ensure proper design, objective evaluation, identify possible revisions and anticipate future needs for the GWA program. Recommendations from this panel may be incorporated into revisions to the annual work plans.

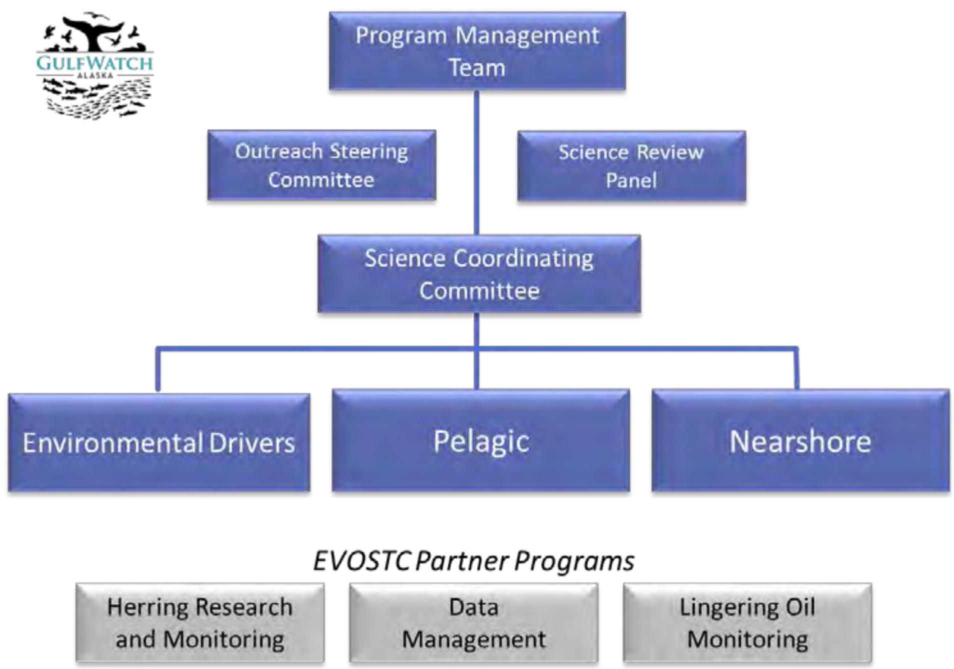

Figure A.1. GWA organizational chart.

2. Program Coordination

Coordination among project investigators. Program coordination among principal investigators (PIs) on the research team will be accomplished primarily through e-mail and quarterly audio and/or video teleconferences or webinars. PIs will meet quarterly with the Program Management Team and Science Coordinating Committee to ensure continuous communication and collaboration between program projects and monitoring components and to resolve any issues as they arise.

Annual investigator meetings are planned, tentatively in November, for all investigators to share information among themselves and potentially with investigators in other related programs, especially the EVOSTC'S HRM program and any other larger efforts underway in the Gulf of Alaska. The meetings will provide an opportunity to update the Program Science Review Panel and, as appropriate, the EVOSTC Science Panel, improve coordination among projects, and provide outreach and public input opportunities. The in-person meetings will also ensure proper communication among the individual monitoring components and provide an opportunity to informally review results of field activities and develop initial work plans for the following year.

Coordination with Herring Program. In order to meet EVOSTC goals for the combined Long-Term Monitoring (GWA) and HRM programs, the GWA program will be coordinated with the EVOSTC HRM Program. The GWA Program Science Lead and HRM Program Lead have identified specific areas of common interest such as oceanographic conditions, juvenile herring feeding on zooplankton, and herring predation by whales, fish, and birds. All of these factors have the potential to inhibit or enhance recovery of herring populations. The forage fish component of the GWA Pelagic Monitoring Project will be coordinated with work on herring populations, as well as other forage fish, in the Herring Program. The GWA and HRM Program teams will work together to identify historic data that both programs would benefit from as part of their coordinated data management efforts. In addition, representatives of the HRM Program will be invited to the GWA PI meeting, and representatives of the GWA Program will be invited to the HRM PI meeting.

Coordination with other programs. The GWA Program will be coordinated with other scientific programs in the region as appropriate and as opportunities arise. Ideas for collaboration and coordination are encouraged and should be forwarded to the Program Management Team. Coordination should include contingency planning if collaborative efforts are not funded. GWA Program Lead and the Science Coordinator will assist with this effort.

3. Planning field seasons

PIs will review field season plans at annual PI meetings and identify potential collaborations. Participation of media, teachers, and other non-scientists should be coordinated with the Outreach and Community Involvement Committee. Field sampling and scheduling will be integrated among PIs and with other organizations whenever possible.

4. Internal communications

A list of lead principal investigators for each Monitoring Project of the overall program, along with their full statements of work, contact information and pictures, will be posted on a special web page that has been established for this program by AOOS. This public page will also be used as a primary tool for public outreach.

An internal communications folder will be developed on the GWA Ocean Workspace site, with the goal of fostering communication among all program PIs and components. Summaries of internal meetings will be posted on this site. This site will provide a secure workspace for use by all PIs including sharing of data and project files.

5. Coordination of outreach and community involvement

The audiences for EVOSTC research and monitoring efforts are multiple and include, among others: local communities in the spill-impacted region, the scientific research community, management agencies, policy makers and congressional representatives and staff, commercial and subsistence users, teachers and students, the general public, media and non-governmental organizations. The Outreach Steering Committee will guide outreach and community involvement efforts.

If possible, space on research cruises and at research camps will be made available to community residents, teachers and students, and media representatives to interact with the PIs and provide first-hand insight into the monitoring program and Gulf of Alaska ecosystems. All such volunteers will meet applicable medical and training requirements. The GWA Program team will strive to create opportunities for community representatives and scientists to exchange views and knowledge. Principal investigators will be expected to be responsive to needs of journalists and other communicators, and to involve science team members in communication within the bounds of completing research tasks. AOOS staff will provide principal investigators with general guidance on working with the media.

Principal investigators are encouraged to coordinate with the Outreach Steering Committee in developing outreach products. If principal investigators have their own websites, they will recognize the EVOSTC for work funded under this program and link their website to the GWA Program website. The GWA Program website will also recognize funding partners and collaborating institutions.

6. Information and data sharing protocols

The EVOSTC and GWA require data sharing in its agreements among all principal investigators and program components. For this Program, all PIs adhere to these policies (unless individual agency or legal requirements require restrictions contrary to these policies). The GWA Program Workspace account on the AOOS Ocean Workspace is password protected to ensure confidentiality among PIs.

- All data are posted on the GWA Program Workspace as they become available following collection in order to promote internal integration and sharing within the project.
- These data are replaced with QA/QC'd data when available.
- Comprehensive metadata using FGDC (or ISO) standards accompany each dataset.
- Monitoring data are made available to the public as soon as it has been QA/QC'd or within 1 year following collection, whichever is sooner.
- Anyone making public use of another team's data contacts the data collector and provides appropriate attribution and credit.
- The Science Coordinating Committee must agree to any deviations from these policies in advance.

7. Data and document retention

As a program of the EVOSTC, all PIs and project managers are expected to adhere to EVOSTC policies regarding retention of all documents, correspondence (electronic and paper), samples and data per the terms of the EVOSTC court settlement.

8. Annual PI meetings

The Program Management Team will establish (and publish on the website), a schedule of meetings for the program. Representation by each project is expected at annual PI meetings. It is envisioned that the following meetings (or e-meetings) will be needed in the coming years: annual PI meetings in November, annual participation in the Alaska Marine Science Symposiums, and the Synthesis Workshop in Year 3 (2014). Additional meetings or special sessions at national meetings may also be planned as opportunities arise.

9. Progress reports

All GWA PIs will be required to submit annual progress reports in order to facilitate overall program management and to promote communication between program projects and monitoring components. Program approved templates must be used, and they must be submitted on time, or the investigator may jeopardize annual transfer of project fund allocation. The Program Team and the EVOSTC office are coordinating reporting and review requirements to streamline the process and minimize duplication. A schedule of all report due dates will be posted on the GWA Program's internal administration website and reminders will be sent to all PIs.

At this time, program and PI reports are expected to be due to the EVOSTC office on March 1 of each year. The Program Management Team will coordinate collection and submission of all PI annual reports. In addition, the Program Management Team will work with PIs to annually develop and submit by September 1 a work plan and budget for the next year of the program (February 1 – January 31), as well as a GWA Program Status Report to supplement the March annual report, for review by EVOSTC staff and science and public advisory panels, and EVOS Trustee Council action in August/September. Annual financial reports will be due March 1. Individual PI progress and financial reports and annual component work plans and budgets will be due to the contracting entity (agency or PWSSC) at least two weeks in advance of these dates, as specified in the annual contracts.

10. Reporting of research results and synthesis

The Science Coordinating Committee will work with the Program Lead and Science Coordinator to organize a schedule for the third year (Year 8) science synthesis and special issue consideration.

Publishing of research results in primary peer-reviewed literature is critical for the success of the program and the Science Coordinating Committee will work with PIs to promote collaborative publications. Scientists may publish in journals of their choice, or special issues organized by the Program team and the Science Coordinating Committee. Results also may be disseminated to EVOSTC communities and at scientific and management meetings including the Alaska Marine Science Symposium, the American Fisheries Society, PISCES, etc. Principal investigators will forward titles and publication information for accepted manuscripts to the GWA science lead, who will maintain a web-based list of GWA publications. The Science Coordinating Committee with EVOSTC staff will coordinate any special journal issues or syntheses of the program results.

11. Sampling Standard Operating Procedures (SOPs)

Each PI has documented the key sampling standard operating procedures (SOPs) employed by their monitoring component on the Program website. If the PI of that component changes, the agreed upon sampling procedures will continue to be used by any new PI. The Science Coordinating Committee must agree upon any changes to standard protocols desired by the PI. Any changes must be noted at the annual PI meeting.

12. Program review, corrective action and succession

Program review: The GWA Program Management Team and the Science Coordinating Committee will assess the status and success of the program with the EVOSTC staff following review of progress reports and the PI meetings on an annual basis and make any program revisions as needed. In addition to the annual review, in-season and between-season reviews of operations may be convened as necessary to assess the success of field seasons and identify possible improvements that may be incorporated into revised annual work plans.

Corrective action: Participants in the GWA Program are encouraged to resolve disputes at the lowest internal level possible. Disputes that cannot be resolved through negotiation and compromise will be elevated for resolution either by the Program Management Team or the Science Coordinating Committee as appropriate. If corrective action is deemed advisable for any specific monitoring component, the GWA Program Management Team will take the following escalating steps as they deem necessary and appropriate:

1. Inform the Science Coordinating Committee of the need for corrective action and receive a signed acknowledgement from the investigator in question that the action will be taken;
2. Negotiate corrective action directly with the principal investigator(s) and receive a signed acknowledgement from that investigator that the action will be taken; and
3. If corrective action is not taken, consider withholding additional funds for that investigator's work until the problem is resolved.

If resolution is not practical, respective agencies and organizations involved will be consulted to determine an appropriate solution. The Program Management Team may withhold funds as necessary and allowable until disputes are resolved.

Leadership and PI succession: The term of all PIs and leadership team members is the length of this proposal - five years. For the Program Management Team, any changes to the Program Lead or Science Coordinator must be agreed to by the remaining members of the Program Management Team and the Science Coordinating Committee. The Program Administrative and Outreach Lead remains the President of the PWSSC, even if the person holding that office changes.

If a Principal Investigator departs the program before it concludes, the PI's institution is responsible for ensuring that the activities described in that component are accomplished. If the PI's institution is not able to find a suitable replacement or if the PI is not affiliated with a formal institution, the Program Management Team and Science Coordinating Committee will be responsible for replacing the PI for that component.

Any changes to program leadership or investigators must be forwarded to the EVOS Trustee Council office and the NOAA contracting office for their approval.

GWA Data Management Plan Signature Pages

All GWA PIs and collaborators must sign the following signature page.

This is a requirement of participation in the Gulf Watch Alaska Program.

Name	Email	Signature	Date
Arimitsu, Mayumi	marimitsu@usgs.gov		
Ballachey, Brenda	bballachey@shaw.ca		
Batten, Sonia	sonia.batten@sahfos.ac.uk		
Bishop, Mary Anne	mbishop@pwssc.org		
Bodkin, James	jbodkin@usgs.gov		
Campbell, Rob	rcampbell@pwssc.org		
Coletti, Heather	heather_coletti@nps.gov		
Danielson, Seth	sldanielson@alaska.edu		
Dean, Thomas	tomdean@coastalresources.us		
Doroff, Angela	angela.doroff@alaska.gov		
Esler, Dan	desler@usgs.gov		
Esslinger, George	gesslinger@usgs.gov		
Hatch, Scott	shatch.isrc@gmail.com		
Hoffman, Katrina	khoffman@pwssc.org		
Holderied, Kris	kris.holderied@noaa.gov		
Hollmen, Tuula	tuulah@alaskasealife.org		

Hopcroft, Russell	rrhopcroft@alaska.edu	______________	______
Iken, Katrin	kbiken@alaska.edu	______________	______
Kaler, Robb	robert_kaler@fws.gov	______________	______
Kloecker, Kim	kkloecker@usgs.gov	______________	______
Konar, Brenda	bhkonar@alaska.edu	______________	______
Kuletz, Kathy	Kathy_kuletz@fws.gov	______________	______
Lindeberg, Mandy	mandy.lindeberg@noaa.gov	______________	______
Matkin, Craig	comatkin@gmail.com	______________	______
Miller, Amy	amy_e_miller@nps.gov	______________	______
Monson, Dan	dmonson@usgs.gov	______________	______
Moran, John	John.Moran@noaa.gov	______________	______
Piatt, John	jpiatt@usgs.gov	______________	______
Straley, Jan	jan.straley@uas.alaska.edu	______________	______
Weitzman, Ben	bweitzman@usgs.gov	______________	______

Budget Category:	Proposed FY 17	Proposed FY 18	Proposed FY 19	Proposed FY 20	Proposed FY 21	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$117.0	$120.0	$123.0	$126.0	$130.0	$616.0	
Travel	$13.1	$13.1	$13.1	$13.1	$15.3	$67.7	
Contractual	$67.0	$70.0	$72.0	$77.0	$82.0	$368.0	
Commodities	$3.0	$5.7	$2.0	$2.0	$1.5	$14.2	
Equipment	$8.0	$0.0	$0.0	$0.0	$0.0	$8.0	
SUBTOTAL	$208.1	$208.8	$210.1	$218.1	$228.8	$1,073.9	
General Administration (9% of subtotal)	$18.7	$18.8	$18.9	$19.6	$20.6	$96.6	N/A
PROJECT TOTAL	$226.8	$227.6	$229.0	$237.7	$249.3	$1,170.5	
Other Resources (Cost Share Funds)	$69.0	$69.0	$69.0	$69.0	$69.0	$345.0	

COMMENTS:
Over the life of this project, NOAA will make contributions for salary support: program lead, Lindeberg (6 mos/year; $345 K).

FY17-21

Project Title: Program Science and Synthesis
Primary Investigator: Mandy Lindeberg
Agency: NMFS

TRUSTEE AGENCY SUMMARY PAGE

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Mandy Lindeberg	Program Lead	6.0	0.0	0.0	0.0
TBD	Science Coordinator	12.0	9.8		117.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	9.8	0.0	
				Personnel Total	$117.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Marine Science Symposium (3 people for 5 days)	0.5	3	15	0.2	4.5
Coordination mtgs w/EVOSTC and LTM team (3 people/ 2 days @1/yr)	0.5	7	6	0.2	4.7
Principal Investigator Meeting - Anchorage (3 people for 4 days)	0.5	3	12	0.2	3.9
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$13.1

FY17

Project Title: Program Science and Synthesis
Primary Investigator: Mandy Lindeberg
Agency: NMFS

FORM 4B
PERSONNEL & TRAVEL
DETAIL

Contractual Costs: Description	Contract Sum
Program Coordinator	64.0
Program Coordinator office space	3.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$67.0

Commodities Costs: Description	Commodities Sum
Supplies	3.0
Commodities Total	$3.0

FY17

Project Title: Program Science and Synthesis
Primary Investigator: Mandy Lindeberg
Agency: NMFS

FORM 4B CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
Laptops for Science Coordinator and Program Coordinator	2.0	4.0	8.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$8.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY17

Project Title: Program Science and Synthesis
Primary Investigator: Mandy Lindeberg
Agency: NMFS

FORM 4B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Mandy Lindeberg	Program Lead	6.0	0.0	0.0	0.0
TBD	Science Coordinator	12.0	10.0		120.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	10.0	0.0	
				Personnel Total	$120.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Marine Science Symposium (3 people for 5 days)	0.5	3	15	0.2	4.5
Coordination mtgs w/EVOSTC and LTM team (3 people/ 2 days @1/yr)	0.5	7	6	0.2	4.7
Principal Investigator Meeting - Anchorage (3 people for 4 days)	0.5	3	12	0.2	3.9
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$13.1

FY18

Project Title: Program Science and Synthesis
Primary Investigator: Mandy Lindeberg
Agency: NMFS

FORM 4B
PERSONNEL & TRAVEL
DETAIL

Contractual Costs: Description	Contract Sum
Program Coordinator	67.0
Program Coordinator office space	3.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$70.0

Commodities Costs: Description	Commodities Sum
Supplies	2.0
Software (data analysis and visualization)	3.7
Commodities Total	$5.7

FY18

Project Title: Program Science and Synthesis
Primary Investigator: Mandy Lindeberg
Agency: NMFS

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY18

Project Title: Program Science and Synthesis
Primary Investigator: Mandy Lindeberg
Agency: NMFS

FORM 4B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Mandy Lindeberg	Program Lead	6.0	0.0	0.0	0.0
TBD	Science Coordinator	12.0	10.3		123.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	10.3	0.0	
				Personnel Total	$123.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Marine Science Symposium (3 people for 5 days)	0.5	3	15	0.2	4.5
Coordination mtgs w/EVOSTC and LTM team (3 people/ 2 days @1/yr)	0.5	7	6	0.2	4.7
Principal Investigator Meeting - Anchorage (3 people for 4 days)	0.5	3	12	0.2	3.9
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$13.1

FY19

Project Title: Program Science and Synthesis
Primary Investigator: Mandy Lindeberg
Agency: NMFS

FORM 4B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Program Coordinator	69.0
Program Coordinator office space	3.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$72.0

Commodities Costs: Description	Commodities Sum
Supplies	2.0
Commodities Total	$2.0

FY19

Project Title: Program Science and Synthesis
Primary Investigator: Mandy Lindeberg
Agency: NMFS

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY19

Project Title: Program Science and Synthesis
Primary Investigator: Mandy Lindeberg
Agency: NMFS

FORM 4B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Mandy Lindeberg	Program Lead	6.0	0.0	0.0	0.0
TBD	Science Coordinator	12.0	10.5		126.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	10.5	0.0	
				Personnel Total	$126.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Marine Science Symposium (3 people for 5 days)	0.5	3	15	0.2	4.5
Coordination mtgs w/EVOSTC and LTM team (3 people/ 2 days @1/yr)	0.5	7	6	0.2	4.7
Principal Investigator Meeting - Anchorage (3 people for 4 days)	0.5	3	12	0.2	3.9
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$13.1

FY20

Project Title: Program Science and Synthesis
Primary Investigator: Mandy Lindeberg
Agency: NMFS

FORM 4B
PERSONNEL & TRAVEL
DETAIL

Contractual Costs: Description	Contract Sum
Program Coordinator	74.0
Program Coordinator office space	3.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$77.0

Commodities Costs: Description	Commodities Sum
Supplies	2.0
Commodities Total	$2.0

FY20

Project Title: Program Science and Synthesis
Primary Investigator: Mandy Lindeberg
Agency: NMFS

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY20

Project Title: Program Science and Synthesis
Primary Investigator: Mandy Lindeberg
Agency: NMFS

FORM 4B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Mandy Lindeberg	Program Lead	6.0	0.0	0.0	0.0
TBD	Science Coordinator	12.0	10.8		130.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	10.8	0.0	
				Personnel Total	$130.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Marine Science Symposium (3 people for 5 days)	0.5	3	15	0.2	4.5
Coordination mtgs w/EVOSTC and LTM team (3 people/ 2 days @1/yr)	0.5	7	6	0.2	4.7
Principal Investigator Meeting - Anchorage (3 people for 4 days)	0.5	3	12	0.2	3.9
Joint Science Workshop (2 people 3 days)	0.5	2	6	0.2	2.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$15.3

FY21

Project Title: Program Science and Synthesis
Primary Investigator: Mandy Lindeberg
Agency: NMFS

FORM 4B
PERSONNEL & TRAVEL
DETAIL

Contractual Costs: Description	Contract Sum
Program Coordinator	79.0
Program Coordinator office space	3.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$82.0

Commodities Costs: Description	Commodities Sum
Supplies	1.5
Commodities Total	$1.5

FY21	**Project Title: Program Science and Synthesis** **Primary Investigator: Mandy Lindeberg** **Agency: NMFS**	**FORM 4B** **CONTRACTUAL &** **COMMODITIES DETAIL**

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY21

Project Title: Program Science and Synthesis
Primary Investigator: Mandy Lindeberg
Agency: NMFS

FORM 4B
EQUIPMENT DETAIL

August 24, 2016

Elise Hsieh, Executive Director
Exxon Valdez Oil Spill Trustee Council
4210 University Drive
Anchorage, AK 99508-4626

Dear Elise:

Final FY 2017-2021 Proposal Submittal for Long-term Monitoring

17120114-B. Program Management II – Administration, Science Review Panel, PI Meeting Logistics, Outreach, and Community Involvement

Gulf Watch Alaska, the long-term monitoring program of the *Exxon Valdez* Oil Spill Trustee Council (EVOSTC), has finalized our program and project proposals for fiscal years 2017-2021 funding based on comments received from EVOSTC's Science Panel on May 19, 2016. Below is the final budget summary and response to Science Panel comments for the Program Management II project.

EVOSTC Funding Requested *(including 9% GA)*

FY17	FY18	FY19	FY20	FY21	TOTAL
$277,100	$282,400	$303,900	$307,200	$312,900	$1,483,500

Non-EVOSTC Funding Available

FY17	FY18	FY19	FY20	FY21	TOTAL
$0	$0	$0	$0	$0	$0

Science Panel comment: *The administrative budget is substantial and the Program should be cautious with regard to such costs.*

PI Response:

- In order to enable most efficient management of the long term monitoring program, the Prince William Sound Science Center (PWSSC) serves as the fiscal agent to all non-Trustee agencies to which funds are extended through Gulf Watch Alaska.
- In an effort to address Science Panel concerns, PWSSC has reduced the Program Management II budget by $44K.

- PWSSC waived our 30% negotiated indirect cost rate for this program. However, in lieu of indirect cost recovery, we request fixed funding comparable to the 9% general administration rate obtained by Trustee Agencies. This extremely reasonable fixed funding request makes it feasible for PWSSC to fiscally administer all Gulf Watch Alaska non-Trustee Agency contracts across the five-year period of time.
- PWSSC has taken on additional responsibility in the Program Management II proposal. With the departure of Molly McCammon of the Alaska Ocean Observing System as Outreach Lead (Years 1-5), PWSSC is absorbing the Outreach Lead responsibilities, including oversight of Outreach Coordinator Stacey Buckelew and engagement of an Outreach Steering Committee comprised of representatives from multiple organizations.
- PWSSC supports all travel by Science Review Panel members Hal Batchelder, Leslie Holland-Bartels, Jeep Rice, Rich Brenner, and Terrie Klinger in support of their input and review of program synthesis and cross-program publications as well as attendance at annual PI meetings.
- PWSSC supports all PI and Program Management Team meeting expenses.
- The EVOSTC FY17-21 Invitation for Proposals requires respondents to have an administrative structure to manage funds and projects. With five years of demonstrated Gulf Watch Alaska fiscal administration and program management experience, PWSSC is well-poised to ensure continued cost-effective administrative activities.

Sincerely,

Mandy Lindeberg
Gulf Watch Alaska Program Lead designate

Attachment: Gulf Watch Alaska: Environmental Drivers Component Project Proposal: 17120114-B—Program Management II—Administration, Science Review Panel, PI Meeting Logistics, Outreach, and Community Involvement

EVOSTC FY17-FY21 INVITATION FOR PROPOSALS
PROGRAM PROJECT PROPOSAL SUMMARY PAGE

Project Title

Gulf Watch Alaska:

17120114-B—Program Management II – Administration, Science Review Panel, PI Meeting Logistics, Outreach, and Community Involvement

Primary Investigator(s) and Affiliation(s)

Katrina Hoffman, Prince William Sound Science Center (PWSSC)

Date Proposal Submitted

24 August 2016

Project Abstract

This project is the administrative and outreach component of the integrated Long-term Monitoring of Marine Conditions and Injured Resources and Services proposal submitted by Lindeberg et al., referred to as Gulf Watch Alaska (GWA). This proposal includes: fiscal management of non-Trustee Agency subawards; convening and management of the Outreach Steering Committee; engagement with *Exxon Valdez* Oil Spill Trustee Council (EVOSTC) staff, Trustees, and Public Advisory Committee members; and travel and logistics support of the Science Review Panel, PI meetings, plus outreach and community involvement activities. The Prince William Sound Science Center (PWSSC) will serve as the fiscal agent for GWA with Hoffman as Administrative Lead. This continues our role as with GWA during FY12–16. Hoffman is also picking up the role of Outreach and Community Involvement Lead for FY17-21. As a member of the Program Management Team, PWSSC contributes to the coordination and management of over two dozen scientists generating monitoring data and synthetic information about the ecosystems and marine conditions within the spill area. PWSSC has extensive fiscal experience with NOAA, through which all non-Trustee Agency funds are distributed; with the various fiscal agents for the non-Trustee Agencies participating in GWA; and with GWA's Trustee Agency principal investigators, for whom we coordinate semi-annual reporting to the National Oceanic and Atmospheric Administration and EVOSTC. We have previously and will continue to support travel and logistics for all Science Review Panel members. PWSSC is also the proposed administrative lead agency for the HRM program proposal. This arrangement allows for efficient fiscal management of both programs. PWSSC has relationships with members of the Outreach Steering Committee, who will guide the development of products to inform the public and managers about changes in the environment and the impact of said changes on injured resources and services.

EVOSTC Funding Requested *(must include 9% GA)*

FY17	FY18	FY19	FY20	FY21	TOTAL
$277.1	$282.4	$303.9	$307.2	$312.9	$1,483.5

Non-EVOSTC Funding Available

FY17	FY18	FY19	FY20	FY21	TOTAL
$0	$0	$0	$0	$0	$0

1. Executive Summary

The proposed FY 17-21 Gulf Watch Alaska (GWA) program encompasses a large interdisciplinary group of scientists representing a diverse suite of both Trustee and non-Trustee Agencies. They pursue over a dozen projects to monitor the recovery of injured resources from the *Exxon Valdez* oil spill (EVOS), as well as how factors other than oil may negatively affect recovering resources. Long-term observations enable us to monitor the recovery of resources from the initial injury as well as describe ecosystem dynamics and shifts that could negatively impact recovering resources.

Managing the administration of such a large effort is complex. Prince William Sound Science Center (PWSSC) ably accomplished this task during GWA Years FY12-16 and is poised to deliver another five years of successful program administration. We effectively manage this group of highly performing marine scientists from universities, federal and state agencies, and non-profit organizations in a manner that demonstrates our ability to cross institutional boundaries and help maintain the generation of long term monitoring data sets in Alaska. By managing non-Trustee Agency awards, the administrative burden on EVOSTC staff is reduced. PWSSC is fully integrated into the Program Management Team (PMT), has strong relationships with GWA principal investigators (PIs), Science Review Panel (SRP) members, and lingering oil and data management entities, as well as the Herring Research and Monitoring (HRM) program lead (Scott Pegau is on the PWSSC staff). Our consortium includes individuals who have worked in the spill area since the Exxon Valdez oil spill occurred. Collectively, our group's knowledge and understanding of the environmental drivers, pelagic, and nearshore ecosystems of the spill-affected region is unsurpassed.

In the first five years of GWA, we were responsive to the EVOSTC's data publication requirements. Indeed, the rapidity and degree to which data was made public represents a significant culture shift for participating Principal Investigators. The program developed an Ocean Workspace as an internal sharing portal, as well as the Gulf of Alaska Data Portal (http://portal.aoos.org/gulf-of-alaska.php), wherein the public and resource managers can access and utilize the data and information products delivered by GWA scientists. These assets and practices will be used and leveraged again in GWA FY17-21. PIs conducted outreach and public engagement activities that collectively reached thousands of audience members, from members of academe attending national conferences, to members of spill-affected communities. Equally if not more importantly, GWA has proven its capability to meet management agency objectives while simultaneously investigating hypotheses about the impacts of environmental change on injured resources and services.

Program Management II (PM II) has several overall goals. The overall goals of PM II are to:

- Award contracts, distribute, and manage funds to all non-Trustee Agency members of the consortium;
- Demonstrate reliable fiscal management through the completion of an annual audit;
- Convene a SRP to review work by the program PIs;
- Provide guidance to the PMT on the program's design and implementation; and
- Oversee the completion of outreach activities and products, especially as they pertain to the natural resource management objectives of agencies that provide services in the spill area and the interests of spill-affected communities, including Alaska Native communities.

2. Relevance to the Invitation for Proposals

The 1994 Restoration Plan identifies the continuing need for a sustained and interdisciplinary monitoring system to inform restoration needs and activities for injured resources and services. The highly collaborative, interdisciplinary nature of GWA enables integrative studies and an ecosystem-based approach to understanding factors that continue to affect recovery in the spill area. This approach is consistent with the 1994 Restoration Plan. The consortium has and will continue to generate science-based products regarding the impacts of environmental change on injured resources and services. Successful implementation requires strong science and business accountability. This PM II proposal is an essential part of GWA's strategy to meet this requirement. We actively address any concerns of the EVOSTC Science Panel and EVOSTC staff, have a regular practice of interacting with the PAC and EVOSTC at their meetings, and have excellent working relationships with the herring and data management program leads.

The EVOSTC FY17-21 Invitation for Proposals requires respondents to have an existing administrative structure to manage funds and projects. GWA meets this requirement and, with almost five years of demonstrated GWA PMT experience, PWSSC is well-poised to ensure continued efficient and cost-effective administrative activities. See the organizational diagram in Figure 1 for a schematic of the program and this project's key areas of responsibility.

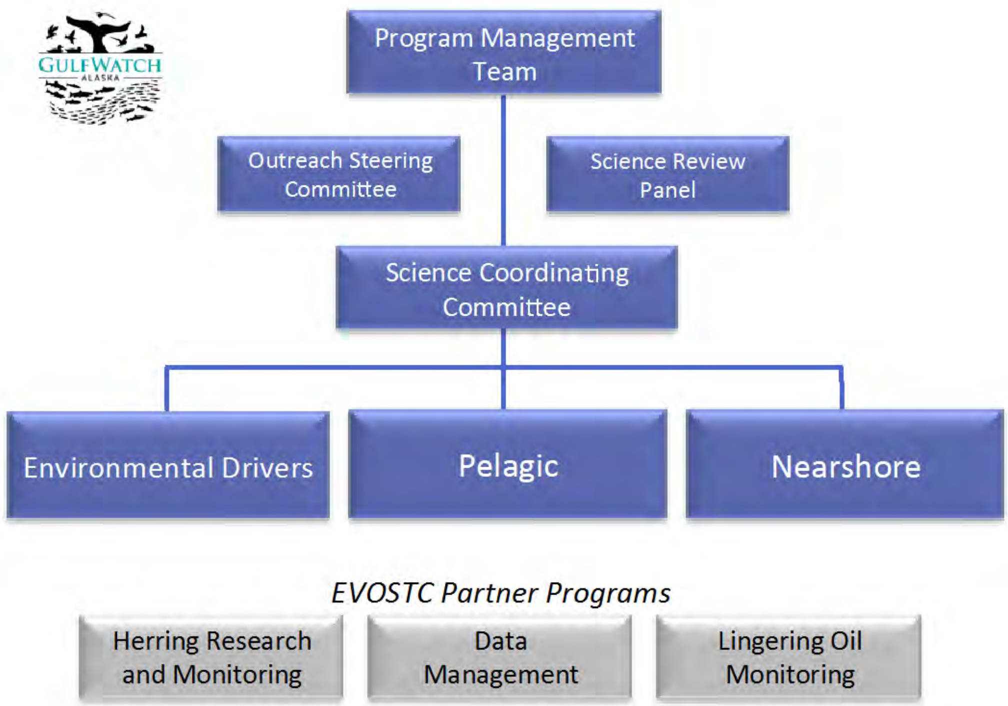

Figure 1. Gulf Watch Alaska organizational chart.

PWSSC has managed EVOSTC funds through a cooperative agreement with NOAA for the last five years and will continue to do so under the GWA FY17-21 proposal. Given our success managing the first five years of the program, we feel we can meet the Council's request to minimize administrative costs in two ways: 1) by waiving PWSSC's 30% overhead rate and accepting a fixed amount of funding (reduced in comparison to our negotiated indirect cost rate), in lieu of indirect cost recovery, comparable to the 9% general administration rate obtained by Trustee Agencies; 2) by downsizing the PMT; and 3) decreasing the outreach costs in FY17-21 compared to FY12-16 of GWA (per Invitation guidance). Katrina Hoffman will serve as PM II Administrative & Outreach Lead, reducing the PMT size by one individual (the outreach lead role was formerly held by Molly McCammon of AOOS with assistance from Marilyn Sigman of Alaska Sea Grant). As stated in the PM I proposal, Mandy Lindeberg will serve as overall Program Lead as well as Science Program Lead under whom a Science Coordinator and Program Coordinator will work. Lindeberg and Hoffman will lead the PMT and will ensure compliance with Trustee Council policies and procedures. To date, we have a 100% success rate in ensuring individual project compliance with reporting requirements. Our data management collaborator and Science Coordinating Committee ensure data quality control and timeliness of data publication. The addition of Outreach Coordinator Stacey Buckelew and integration of an Outreach Steering Committee will ensure completion of public outreach plan activities.

The Outreach Steering Committee is a continuation of the group that was formed in the first five years of the GWA program. The Outreach Steering Committee will include staff from the following organizations:

Alaska Ocean Observing System (Program Manager Holly Kent at AOOS), the Prince William Sound Science Center in Cordova (CEO Hoffman at PWSSC), the Alaska SeaLife Center in Seward (Education Director Laurie Morrow at Alaska SeaLife Center), the Kachemak Bay Research Reserve in Homer (Acting Director Jessica Ryan at KBRR), and Alaska Sea Grant (Marilyn Sigman). This group will provide input on how to maximize community involvement in the oil spill region and will provide guidance, as needed, on outreach products relevant to Trustee Agencies. We will closely coordinate our outreach efforts with the Herring Research and Monitoring program.

We will maintain and expand upon the web site that exists for the program and ensure that outreach products are relevant and available to spill-affected communities and members of the PAC. Opportunities for community engagement and involvement will enable two-way communication between interested parties in the spill area and the Principal Investigators across all three areas of interest: environmental drivers, pelagic monitoring, and nearshore monitoring. We will engage Trustee Agency public relations and outreach experts in Year 6 and beyond to ensure that our program's outreach products and content are aligned with their agency outreach priorities. We will hold listening sessions in Alaska Native communities in Years 7 & 9 to provide an avenue for traditional ecological knowledge to be shared with GWA PIs.

The Science Review Panel will be comprised of Hal Batchelder (PICES), Leslie Holland-Bartels (retired USGS), Jeep Rice (retired NOAA), Rich Brenner (ADF&G), and Terrie Klinger (University of Washington). This team will provide scientific peer review of reports and will be invited to participate in the Joint Science Program Workshop in Year 8. They will be available to provide input on data syntheses as well as cross-program publication proposals that may arise during the next five years. They will attend PI meetings so as to stay current on issues and developments in the GWA research arena.

3. Project Personnel

CVs, including full contact information, for Katrina Hoffman, Administrative Lead, and Stacey Buckelew, Outreach Coordinator, are provided at the end of this project proposal.

Katrina Hoffman will serve as PM II Administrative and Outreach Lead. She has served as Administrative Lead for the first five years of GWA; the Outreach Lead position was formerly held by Molly McCammon. Along with the rest of the PMT, Hoffman is committed to ensuring effective and efficient uses of funds and leveraging the right relationships to improve the impact and relevance of GWA data to Trustee Agencies and spill affected communities. Stacey Buckelew is the data coordinator for Axiom Data Science and has many years of experience in project management, scientific research, and science outreach. She has established an excellent rapport with PIs from the GWA and Herring research programs by supporting their use of data portals and data management tools, and is perfectly suited to fulfill the responsibilities of the Outreach Coordinator.

4. Project Design

A. Objectives

In Years 6-10 of GWA, we remain focused on the following program management-related objectives:

Objective 1 **Fiscal management and reporting**

a. Award and management of all contracts and subawards for non-Trustee Agency organizations involved in this program[1];
b. Timely submission of financial reports such as SF-424A to NOAA;
c. Timely submission of all narrative reports to both EVOSTC and NOAA;
d. Completion of an annual federal single audit and statement of financial position of PWSSC; and
e. Monitoring of project spending.

Objective 2 **Generate SRP input and oversight**

All five members from the GWA Year 5 SRP are willing participants in Years 6-10. The program management budget maintains funds to support logistics and administration of this panel, such as travel and meeting expenses. The Science Review Panel is comprised of retired federal scientists/agency managers, a current state agency manager, and members of academe.

Objective 3 **Host GWA PI meetings**

The administrative budget will support an annual meeting of GWA PIs. The location for the meeting will rotate among communities in the spill area and Anchorage. In addition to the annual PI meeting, we will also provide for engagement and collaboration between and among GWA, Herring, Outreach and Data Management personnel at the Alaska Marine Science Symposium, a second opportunity to advance program goals in person. PI teleconferences will round out the quarterly meeting schedule. Component meetings, Science Coordinating Committee meetings, and Program Management Team meetings will primarily be held by teleconference, but on occasion, in-person meetings may be necessary.

Objective 4 **Conduct GWA Outreach and Community Involvement activities**

We will engage Trustee Agency managers and community members with interests in the spill area, including those who can provide a perspective on traditional ecological knowledge, to learn how data and information products can best serve them. We will generate products to meet those needs and improve understanding of ecosystem processes affecting variation in spill-affected resources. We will work with the Herring program lead to coordinate some community involvement opportunities within the spill area. Listening to the input of community members and managers will be a key feature of these activities, as well as providing information and products that are easily accessible on the program web site. Outreach Coordinator Stacey Buckelew will organize these efforts in a manner responsive to direction from PM II lead Katrina Hoffman as well as the Outreach Steering Committee.

[1] Contracts will be awarded to the Univ. of Alaska Fairbanks (Hopcroft, Danielson, Konar, Iken), SAHFOS (Batten), North Gulf Oceanic Society (Matkin), Alaska Ocean Observing System/Axiom Consulting (McCammon/Bochenek/Buckelew).

Annual Administrative Lead Activities

- Be responsive to the EVOSTC and PAC each autumn and engage with them to report on program activities and answer program questions.
- Coordinate and participate in annual PI meeting – planned to be held at time convenient to both GWA and HRM.
- Update written and web-based materials describing overall 5-year program and individual components: project profiles and project updates.
- Hold GWA PI meeting concurrent with Alaska Marine Science Symposium in Anchorage.

Year 7 additions

- Host community involvement event in an Alaska Native village.

Year 8 additions

- Develop additional data products, visualizations, or materials for website, agencies, and communities.
- Participate in the Joint Science Program Workshop for both the GWA and Herring Research programs.

Year 9 additions

- Host community involvement event in an Alaska Native village.

Year 10 additions

- Develop written and web-based materials summarizing current state of knowledge from program.

B. Procedural and Scientific Methods

Objective 1 **Fiscal Management and Reporting**

PWSSC will continue to extend funding to non-Trustee Agency entities involved in the program with exceptions for two co-PIs who are working with Trustee agency projects (Straley from University of Alaska Southeast and Dean from Coastal Resources Associates). Straley and Dean's participation is included as contracts within, respectively, the Moran (NOAA) and Coletti (NPS) Trustee agency project DPDs and budgets. The budget assumes that funding to Trustee Agencies will be provided directly to that agency and not through PWSSC.

Objective 2 **Generate SRP input and oversight**

Staff from both PM I and PM II will engage with the SRP. PM II's responsibilities are oriented around logistics while PM I is oriented towards science content. As the logistics lead, PWSSC will ensure the SRP members have the opportunity to attend in-person meetings of PIs as well as participate in teleconferences and webinars as needed to improve connections between programs, provide scientific oversight, and ensure program priorities are met. We will support travel expenses and provide logistical support to make this possible.

Objective 3 **Host GWA PI meetings**

We will coordinate all meeting logistics including location, food, and hotel arrangements, as well as webinar and teleconference capabilities for remotely hosted meetings and presentations. Our intention is that the annual PI meeting will be inclusive of both GWA and HRM PIs to ensure transfer of information between programs. Complementary to logistics coordination, the Program Coordinator in the PM I project defines the meeting agenda; communicates all meeting content issues to the principal investigators; and, along with the Science Coordinator and Science Lead, ensures that program goals are being met.

Objective 4 **Conduct GWA Outreach and Community Involvement activities**

We plan to implement the following opportunities for GWA to receive input from key individuals and agencies by:

- Holding a meeting or meetings with Trustee Agency and management agency staff in Year 6 to learn about their priorities for data, data products, visualizations, and outreach products. We will query their preferences for additional engagement with the research programs
- Holding PI meetings in at least three different spill-affected communities across the five years (e.g. from among Cordova, Seward, Homer, Valdez, Kodiak) and having open time for input each day on the agenda; and
- Having a local and TEK roundtable-type symposium in spill-affected native communities in Years 7 & 9 where both scientists and native community members exchange information about different ways of knowing, as well as changes they have observed in the systems. Ideally, the program will engage with communities in both PWS and the Kachemak Bay/Kenai Peninsula area; for example, Chenega Bay or Tatitlek in one year and Nanwalek in the alternate year, should those communities be open to such an experience. Residents of Port Graham will be invited to attend any events held in Nanwalek in order to strengthen the opportunity for information exchange.
- Take advantage of opportunities to attend board meetings of organizations that are interested in program information and data, especially environmental drivers data (such as Cordova District Fishermen United, Prince William Sound Aquaculture Corporation; Valdez Fisheries Development Association; and Kodiak Regional Aquaculture Association).

C. Data Analysis and Statistical Methods

Not applicable.

D. Description of Study Area

All activities are within the spill area or relevant to it (such as in Anchorage, where Trustee Agency offices are located). Administrative services will be led from the offices of the Prince William Sound Science Center in Cordova. Program Management Team meetings, Principal Investigator meetings, Science Review Panel meetings, and Outreach Steering Committee meetings will be held in the EVOS region or in Anchorage. Outreach and community involvement activities and materials will be conducted or disseminated throughout the EVOS region, including within Alaska Native communities.

5. Coordination and Collaboration

WITHIN THE PROGRAM
The Administrative Lead will work closely with all other members of the PMT on a regular basis. The PMT will ensure within program coordination and collaboration through use of tools such as the Ocean Workspace as well as by email and teleconference. In-person PI meetings twice per year (typically at an annual meeting in the fall and then at AMSS if most PIs attend) facilitate communication about scientific results, environmental discoveries, equipment issues, and methodological and analytical approaches. We will coordinate with PIs around outreach needs, reporting requirements, and fiscal management of the program.

WITH OTHER EVOSTC-FUNDED PROGRAMS AND PROJECTS
Katrina Hoffman and Scott Pegau, the program leader for HRM, are co-located in Cordova. This supports cross-program information exchange. The GWA PMT copies Pegau on most communications about procedural activities and planning communications to ensure tight coordination. We also have a strong connection to Data Management through our established working relationship with the Alaska Ocean Observing System and Axiom Data Sciences, as well as Lingering Oil PIs from our leadership role in GWA FY12-16.

WITH TRUSTEE OR MANAGEMENT AGENCIES
PMT members represent GWA at an EVOSTC meeting every year. Additionally, this program intends to gather input in Year 6 from agency managers who can use information or data products generated by the program. The input we gather will guide development of the most useful outreach products and content.

WITH NATIVE AND LOCAL COMMUNITIES
As the Outreach Lead for GWA, the project will reach out to the boards of local, community-based organizations in the spill-affected region such as: Prince William Sound Aquaculture Corporation (PWSAC); Cordova District Fishermen United (CDFU); Valdez Fisheries Development Association (VFDA); Kodiak Regional Aquaculture Association (KRAA), and offer to present results of environmental drivers monitoring, as the information pertains to the activities and interests of these groups.

Thanks to youth engagement workshops hosted by GWA in its first five years, there is heightened familiarity in native communities about GWA. We will build on the goodwill generated by the youth engagement events and set up opportunities for representatives of GWA to have listening sessions in the villages, share information that native community members feel is especially pertinent, and learn about information that native community members have to share or request that we gather.

6. Schedule

PROGRAM MILESTONES
Objective 1 **Fiscal Management and Reporting**

This is ongoing throughout FY17-21 including sub-award administration, reporting, and annual audit.

Objective 2 **Generate SRP input and oversight**

This is ongoing throughout FY17-21 via attendance at all PI meetings, the Joint Science Workshop, and as reviewers of report content and synthesis activities.

Objective 3 **Host GWA PI meetings**

This is ongoing throughout FY17-21, approximately quarterly, with some meetings occurring by teleconference and others occurring in person.

Objective 4 **Conduct GWA Outreach and Community Involvement activities**

This is ongoing throughout FY17-21 through generation of program content for web, engagement of Trustee Agency outreach staff, involvement of Alaska Native and other communities.

MEASURABLE PROGRAM TASKS

Measurable program tasks to meet the above objectives are presented in Table 1 and described in more detail below.

Table 1. Schedule of Measurable Program Tasks.

	FY17				FY18				FY19				FY20				FY21			
	EVOSTC FY Quarter (beginning Feb. 1)																			
Task	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Task 1 Fiscal Admin																				
Issue subaward contracts	X				X				X				X				X			
Annual audit				X				X				X				X				X
Task 2 Meetings																				
PI meetings	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Trustee Council/PAC			X				X				X				X				X	
AMSS				X				X				X				X				X
Yr. 3 Joint Workshop													X							
Input from Trustee & mgt. agencies		X								X										
Community Involvement: Local entities and/or TEK			X				X				X				X				X	
Task 3 Reporting																				
Annual Reports					X				X				X				X			
FY Work Plan (DPD)			X				X				X				X					
Yr. 3 Synthesis Report												X								
Yr. 17-21 Final Report																				X

FY 2017 (Year 6)

FY 17, 1st quarter	(February 1, 2017 - April 31, 2017)
February:	*Compile/edit program status summary*
	Issue fiscal year subaward contracts
April:	*Submit 5-year program status summary*
	Plan and facilitate PI meeting
	Plan and facilitate Outreach Steering Committee meeting

FY 17, 2nd quarter	(May 1, 2017-July 30, 2017)
May:	*Complete updates to program website and outreach materials*
June-July:	*Plan and facilitate PI meeting*

FY 17, 3rd quarter	(August 1, 2017 – October 31, 2017)
August:	*Compile and submit semi-annual report for NOAA*
September:	*Submit annual program work plans*
	Plan and facilitate community involvement/TEK engagement
October:	*Plan and facilitate PI meeting*
	Review EVOSTC work plan comments

FY 17, 4th quarter	(November 1, 2017- January 31, 2018)
November:	*Annual PI meeting and workshops*
	Present to EVOSTC and PAC
December-January:	*Preparation for and attendance at AMSS*
	Plan and facilitate quarterly program teleconference

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FY 2018 (Year 7)

FY 18, 1st quarter	(February 1, 2018 - April 31, 2018)
February:	*Compile/edit FY17 annual report for EVOSTC and semi-annual NOAA rpt*
	Issue fiscal year subaward contracts
March:	*Submit Year FY17 annual report for EVOSTC and semi-annual NOAA rpt*
April:	*Plan and coordinate quarterly program teleconference*

FY 18, 2nd quarter	(May 1, 2018-July 30, 2018)
May:	*Complete updates to program website and outreach materials*
June-July:	*Review and respond to comments on proposal*
	Plan and facilitate quarterly program teleconference

FY 18, 3rd quarter	(August 1, 2018 – October 31, 2018)
August:	*Compile and edit semi-annual report for NOAA*
September:	*Prepare and submit annual work plans*
	Plan and facilitate community involvement/TEK engagement
October:	*Plan annual PI meeting and workshops*
	Review EVOSTC work plan comments

FY 18, 4th quarter	(November 1, 2018- January 31, 2019)
November:	*Annual PI meeting and workshops*
	Present to EVOSTC and PAC

December-January:	*Preparation for and attendance at AMSS* *Plan and facilitate quarterly program meeting* *Annual audit*

FY 2019 (Year 8)

FY 19, 1st quarter	(February 1, 2019 - April 31, 2019)
February:	*Compile/edit FY18 annual report for EVOSTC and semi-annual NOAA rpt* *Issue fiscal year subaward contracts*
March:	*Submit FY18 annual report for EVOSTC and semi-annual NOAA rpt*
April:	*Plan and coordinate quarterly program teleconference*

FY 19, 2nd quarter	(May 1, 2019-July 30, 2019)
May:	*Complete updates to program website and outreach materials*
June-July:	*Plan and facilitate quarterly program teleconference*

FY 19, 3rd quarter	(August 1, 2019 – October 31, 2019)
August:	*Compile and edit semi-annual report for NOAA*
September:	*Prepare and submit FY20 program work plans* *Coordinate compilation of special journal issue or program synthesis manuscripts* *Plan and facilitate community involvement/TEK engagement*
October:	*Plan annual PI meeting and workshops* *Review EVOSTC work plan comments*

FY 19, 4th quarter	(November 1, 2019- January 31, 2020)
November:	*Annual PI meeting and workshops* *Present to EVOSTC and PAC*
December-January:	*Facilitate Joint Science workshop, develop and present program content* *Annual audit*

FY2020 (Year 9)

FY 20, 1st quarter	(February 1, 2020 - April 31, 2020)
February:	*Participate in Joint Science Workshop with Herring & Data Mgt.* *Issue fiscal year subaward contracts* *Compile, edit, annual reports for FY19 EVOSTC and annual NOAA report*
March:	*Submit annual reports for EVOSTC FY19 and annual NOAA report*
April:	*Plan and coordinate quarterly program teleconference*

FY 20, 2nd quarter	(May 1, 2020-July 30, 2020)
May:	*Prepare and disseminate work plan templates to group*
June-July:	*Plan and facilitate quarterly program teleconference*

FY 20, 3rd quarter	(August 1, 2020 – October 31, 2020)
August:	*Compile/edit program work plans for FY21 and mid-year report for NOAA*
September:	*Annual work plans submitted to EVOSTC and mid-year report to NOAA* *Plan and facilitate community involvement/TEK engagement*
October:	*Plan annual PI meeting and workshops* *Review EVOSTC work plan comments*

FY 20, 4th quarter (November 1, 2020- January 31, 2021)

November: *Annual PI meeting and workshops*
Present to EVOSTC and PAC

December-January: *Preparation for and attendance at AMSS*
Plan and facilitate quarterly program PI mtg.
Begin compilation of FY20 annual report
Annual audit

FY2021 (Year 10)

FY 21, 1st quarter (February 1, 2021 - April 31, 2021)

February: *Compile/edit FY20 annual report for EVOSTC and semi-annual NOAA rpt*
Issue fiscal year subaward contracts
March: *Submit FY20 annual report for EVOSTC and semi-annual NOAA rpt*
April: *Plan and coordinate quarterly PI teleconference*
Submit FY22-26 program proposal

FY 21, 2nd quarter (May 1, 2021-July 30, 2021)

May: *Complete updates to program website and outreach materials*
June-July: *Coordinate review and response to comments from proposal*
Plan and facilitate quarterly PI teleconference

FY 21, 3rd quarter (August 1, 2020 – October 31, 2020)

August: *Compile and edit semi-annual report for NOAA*
September: *Submit revised program proposal for FY22-26 invitation (pending EVOSTC invitation to propose)*
October: *Plan annual PI meeting*
Review EVOSTC work plan comments

FY 21, 4th quarter (November 1, 2021- January 31, 2022)

November: *Annual PI meeting and workshops*
Present to EVOSTC and PAC
December-January: *Preparation for and attendance at AMSS*
Plan and facilitate PI program teleconference
Annual audit
Coordinate preparation and submission date of 5-year status summary or joint special issue with HRM program and EVOSTC staff

7. Budget

BUDGET FORMS (ATTACHED)

Please see PM II project in the program budget workbook for details.

SOURCES OF ADDITIONAL FUNDING

PWSSC is funded through soft money, so for program administration, no sources of additional funding are leveraged.

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Prince William Sound Science Center; President and CEO and
Oil Spill Recovery Institute; Executive Director (November 2011-present)
Manage a large staff dedicated to improving understanding and sustainable use of the northern Gulf of Alaska. Lead Administrative PI of EVOSTC-funded Gulf Watch Alaska and the ADF&G-funded Interactions of Hatchery and Wild Pink and Chum Salmon. Facilitate collaborations to improve the quality and impact of research and education programs relevant to the bioregion. Allocate funds to improve response to and recovery from oil spills and knowledge about Arctic and sub-Arctic ecosystems where oil spills may occur.

Washington Sea Grant, Coastal Resources Specialist (2007-2011)
Secured $777K federal grant to coordinate an international sustainable shoreline development initiative. Chaired Sustainable Coastal Communities Action Team for West Coast Governors' Alliance on Ocean Health; created tri-state work plan focused on economic development, sustainable aquaculture, sustainable fisheries, non-consumptive tourism and recreation, green ports, and clean marinas. Created science-based seminars for ~350 member Shoreline and Coastal Planners Group. Co-developed nationally recognized climate adaptation training with the NERR Coastal Training Program.

Regional Scale Nodes, **Grant Writer/Research Assistant, University of Washington** (**2006-2007)**
Wrote education component of the largest (to date) federal grant awarded to UW ($126 million) from NSF/JOI to build a seafloor cabled observatory for the Ocean Observatory. Graduate thesis assessing the education potential of observatory-related engineering software.

University of Washington, Lead Instructor and Teaching Assistant (2006)
Lead instructor for marine resources unit in Program on the Environment course. Developed and taught lecture materials and fieldwork to 35 students from Japan and China in an intensive sustainable development institute. Managed 25 visiting scholars in graduate seminar at UW School of Marine and Environmental Affairs; co-designed syllabus, maintained course web site, grades and communications.

Occidental College, Grant Administrator, Program Coordinator, Resource Teacher (2003-2005)
Lead instructor and administrator of $990,000 HHMI grant to train middle school and high school teachers and students about the nature of scientific research using oceanography and marine ecology (the Teachers + Occidental = Partnership in Science: Marine Science Experience). Led multi-week professional development courses for ~90 teachers; led ~180 research cruises on Santa Monica Bay. Directed students in fieldwork; guided research projects based on student-gathered long-term data sets.

Mira Costa High School, Science Teacher (February 2001-June 2003)
Instructor of Marine Science and College Preparatory Biology to 9th-l2th graders. Quadrupled enrollment in marine science course and served as sole curriculum developer. Developed and coordinated annual 8-month long field-based marine ecology research projects. Arranged student service-learning experiences at numerous marine facilities. Raised over $18,000 to facilitate four multi-day tall ship-based oceanographic field trips. Directed $10,000 grant for purchase of classroom aquarium system.

Monterey Bay Aquarium Research Institute, Assistant Researcher (2000)

Conducted biological and chemical oceanography research aboard a month-long NOAA Tropical Atmosphere Ocean monitoring cruise in the Equatorial Pacific. Collected data to: monitor plankton productivity; determine the effect of phenomena such as El Nino on biological processes in the Pacific Ocean; measure oxygen isotopes for Princeton University; measure dissolved organic nutrients for University of Washington. Research methods include ^{14}C incubations, nutrient and chlorophyll analysis.

Catalina Island Marine Institute, Marine Science Instructor (1998-2000)
Taught interactive marine science and oceanography classes to students from five Southwestern states. Classes taught: ichthyology, phycology, invertebrate biology, plankton biology, oceanography, island biogeography, astronomy. Co-developed laboratory spaces and program curriculum. Coordinated non-native plant removal campaign. Led kayaking, hiking, snorkeling and outrigger canoeing youth trips. Primary rock climbing and rappelling instructor. Vessel skipper.

University of California Berkeley, Research Technician (1997-1998)
Conducted algae genomics and protein biochemistry research using molecular techniques to determine the structure and function of uncharacterized proteins in the photosynthetic pathway. Maintained sizable algal culture library using sterile technique and harvesting methods. Supervised and trained student employees. Methods used include gel electrophoresis, DNA sequencing and recombinant DNA.

Monterey Bay Aquarium Research Institute, Research Intern (1997)
Conducted ship- and lab-based research on primary productivity of Monterey Bay with Drs. Raphael Kudela and Francisco Chavez. Used ^{14}C photosynthesis vs. irradiance curves, Pulsed Amplitude Modulation fluorometry, diode array spectrophotometry, chlorophyll and nutrient analysis methods. Maintained *Pseudo-nitzschia* cell cultures and chemostats.

PUBLICATIONS, ACTIVITIES & AFFILIATIONS

Daniel M, N. Faghin, **K. Hoffman.** 2009. Green Shores: LEED-style Rating System. *The Washington Planner*, Vol. 20, issue 4, 12-13.

Klinger, T., R.M. Gregg, K. Herrmann, **K. Hoffman**, J. Kershner, J. Coyle, and D. Fluharty. 2007. Assessment of Coastal Water Resources and Watershed Conditions at Olympic National Park, Washington. Natural Resource Technical Report NPS/NRPC/WRD/NRTR—2008/068.zNational Park Service, Fort Collins, Colorado.

Hoffman K.C., R.M. Kudela and F.P. Chavez. February 1998. Variable Fluorescence as a Biological Indicator of Primary Productivity. *Eos* abstracts.

- Advisory Board member, Alaska Ocean Observing System (2011-present)
- North Pacific Research Board member (2011-present)
- Presenter at international, national, regional, state and local science & policy conferences

EDUCATION

University of Washington, School of Marine and Environmental Affairs; M.M.A. (2007)
Chapman University: California Clear Teaching Credential, Biological Sciences (2004)
Oberlin College: B.A. Biology and B.A. Environmental Studies (1997)

Collaborators: Anderson, Emily (WSC); Baker, Matthew (NPRB); Beaudreau, Anne (UAF); Bochenek, Rob, (Axiom); Holderied, Kris (NOAA); Josephson, Ron (ret. ADFG); Knudsen, Eric; McCammon, Molly (AOOS); Morse, Kate (CRWP); Morton, Kes (OTN-Dalhousie); Neher, Tammy (NOAA); O'Connell, Victoria (SSSC); Rabung, Samuel (ADFG); Sigman, Marilyn (Alaska Sea Grant); Skorkowski, Robert (USFS—Cordova Ranger District); Walker, Seth (GreatBig.org)

Stacey Buckelew
Data Coordinator
Axiom Data Science, LLC.
95 Sterling Highway, Homer, AK 99603
Phone: 907.717.4583
Email: stacey@axiomdatascience.com

Professional Preparation

University of California, Santa Cruz; Marine Biology; B.S., 2000
University of California, Santa Cruz; Ecology and Evolutionary Biology; M.S., 2007

Appointments

2015 – Present	Data Coordinator, Axiom Data Science, Anchorage, AK
2012 – 2015	Coastal Training Program Coordinator, Kachemak Bay Research Reserve, Homer, AK
2011 – 2012	Program Manager, Saltwater Inc, Anchorage, AK
2010 – 2011	Alaska Dept of Fish & Game, Div of Commercial Fisheries, Anchorage, AK
2005 – 2010	Project Manager, Island Conservation, Santa Cruz, CA
2002 - 2005	Field Biologist, US Antarctic Marine Living Resources Program
2000 – 2002	Research Technician, University of California Santa Cruz

Synergistic Activities

2015 – Present	As Axiom Data Coordinator, outreach scientific data products at meetings and peer-reviewed conferences to scientific and resource management audiences; conduct informational webinars and training on use of data management tools.
2012 – 2015	As Coastal Training Program Coordinator, delivered science-based information to coastal decision-makers to promote informed decisions about coastal resources through meetings, workshops, and training events. Develop and maintain KBRR's website via Alaska Department of Fish and Game web-host and Community Council blog. Establish and maintain effective working relationships with government agencies, partners, and the public.
2010 – 2011	Maintain cooperative relationships with management agencies, including National Marine Fisheries Service (NMFS) and AK Dept of Fish and Game, to coordinate research program and collect scientific information about marine mammal interactions needed for fisheries management purposes. Communicate research findings to local stakeholders, including federal and state agencies, researchers, private organizations, and fishing industry, using oral and written communications.
2010 – 2011	Participate in interagency working groups to provide and receive resource management information and address specific resource harvest issues, including: Board of Fisheries, Regional Advisory Committee, Federal Subsistence Council, U.S.-Canada International Joint Technical Committee, and other public fishermen meetings. Interact with federal, state, and private groups, including tribal councils, to present or discuss status of Yukon fishery resources and management strategies. Regularly interact with residents of Alaska Native villages in the lower Yukon delta to address issues concerning subsistence resource harvest managed by a field office
2005 – 2010	Interact with media and public-interest groups to address sensitive wildlife issues. Coordinate and develop media communication strategies, including media interviews,

website development, and informational pamphlets, across partnered organizations, including federal agencies and private environmental groups.

Peer-Reviewed Publications

Croll, D.A., M. MacKown, K. Newton, N. Holmes, J. Williams, H. Young, S. Buckelew, C. Wolf, M. Bock, B. Tershy. 2016. Passive recovery of an island bird community after rodent eradication. *Biological Invasions 18:703-715.*

Doroff, A, Baird, S., Freymueller, J., Buckelew, S., Murphy, M. Assessing coastal habitat changes in a glacially influenced estuary system: Kachemak Bay, Alaska. *In review*.

Buckelew, S**.** 2014**.** Bivalves in Kachemak Bay: Applying Lessons Learned from Restoration along the Pacific Coast. Kachemak Bay Research Reserve, *Workshop Proceedings.*

Buckelew, S**.** 2013**.** Oyster Population Resiliency: Situation Assessment Report. Kachemak Bay Research Reserve, Homer, Alaska.

Buckelew, S., V. Byrd, G. Howald, S. MacLean, and J. Sheppard. 2011. Preliminary ecosystem response following invasive Norway rat eradication on Rat Island, Aleutian Islands, Alaska. *Island invasives: eradication and management. IUCN, Gland, Switzerland.*

Buckelew, S., G. Howald, S. Maclean, G. Siekaniec. 2009. Conservation in action: restoring habitat and protecting seabirds in the Aleutian Islands. *Oryx. 43(2).*

Trivelpiece, W.Z., S. Buckelew, C. Reiss, and S.G. Trivelpiece. 2007. The winter distribution of chinstrap penguins from two breeding sites in the South Shetland Islands of Antarctica. *Polar Biology. 30(10).*

Maron, J. L., J. A. Estes, D. A. Croll, E. M. Danner, S. C. Elmendorf, & S. L. Buckelew**.** 2006. An introduced predator transforms Aleutian Island plant communities by disrupting spatial subsidies. *Ecological Monographs. 76*.

Collaborators

Bailey, Kathleen	Integrated Ocean Observing System, Silver Spring, MD
Baker, Matthew	North Pacific Research Board, Anchorage, AK
Dickson, Danielle	North Pacific Research Board, Anchorage, AK
Doroff, Angela	Kachemak Bay Research Reserve, Homer, AK
Dugan, Darcy	Alaska Ocean Observing System, Anchorage, AK
Hoem-Neher, Tammy	NOAA Kasitsna Bay Laboratory, Homer, AK
Hoffman, Katrina	Prince William Sound Science Center, Cordova, AK
Holderied, Kris	NOAA Kasitsna Bay Laboratory, Homer, AK
Holman, Amy	NOAA National Ocean Service, Anchorage, AK
Iken, Karin	University of Alaska Fairbanks
Kent, Holly	Alaska Ocean Observing System, Anchorage, AK
Mellish, Joann	North Pacific Research Board, Anchorage, AK
McCammon, Molly	Alaska Ocean Observing System, Anchorage, AK
Pegau, Scott	Oil Spill Recovery Institute, Cordova, AK
Ryan, Jessica	Kachemak Bay Research Reserve, Homer, AK
Saupe, Susan	Cook Inlet Citizen’s Advisory Council, Anchorage, AK
Seiden, Erika	NOAA National Estuarine Research Reserve, Silver Spring, MD
Snowden, Derrick	Integrated Ocean Observing System, Silver Spring, MD
Thompson, Terry	Alaska Dept. of Fish and Game, Anchorage, AK
Trowbridge, Beth	Center for Alaskan Coastal Studies, Homer, AK

Budget Category:	Proposed FY 17	Proposed FY 18	Proposed FY 19	Proposed FY 20	Proposed FY 21	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$128.4	$134.4	$135.7	$139.7	$144.1	$682.3	
Travel	$32.3	$31.8	$27.6	$33.4	$30.1	$155.0	
Contractual	$87.1	$87.1	$108.6	$101.2	$102.9	$486.9	
Commodities	$6.4	$5.9	$7.0	$1.5	$10.0	$30.8	
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
Indirect Costs (*waived*)							
SUBTOTAL	$254.2	$259.1	$278.9	$275.8	$287.1	$1,355.0	
General Administration (9% of	$22.9	$23.3	$25.1	$24.8	$25.8	$121.9	N/A
PROJECT TOTAL	$277.1	$282.4	$303.9	$300.6	$312.9	$1,476.9	
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	

COMMENTS:
PWSSC proposes a flat rate in lieu of its federal recognized IDC rate. This itemized budget includes expenses that would normally be charged to IDC, and ALSO INCLUDES $30K per year in Outreach expenses AS WELL AS travel and meeting logistics expenses that are direct program charges, such as those expenses for Science Review Panel activities.

FY17-21

Project Title: Program Management II – Administration, Science Review Panel, PI Meeting Logistics, Outreach, and Community Involvement
Primary Investigator: Hoffman

NON-TRUSTEE AGENCY SUMMARY PAGE

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
TBN	Administrative Assistant	3.0	6.7		20.1
Ginger Drake	Bookkeeper	7.0	5.2		36.4
Signe Fritsch	Development & Communications Asst.	2.0	7.8		15.6
Katrina Hoffman	CEO	2.0	14.8		29.6
Penelope Oswalt	Finance Director	3.0	8.9		26.7
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	43.4	0.0	
				Personnel Total	$128.4

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Science Review Panel to fall PI meeting (4 days x 5 people = 20 days)	0.7	5	20	0.3	9.3
Science Review Panel to AMSS PI meeting (5 days x 5 people = 25 days)	0.7	5	25	0.3	11.0
Admin travel to Anchorage for PAC & TC meetings	0.4	2	4	0.3	2.0
Admin travel to Program Management Team meeting	0.5	1	2	0.3	1.1
Outreach Coordinator travel to Trustee Agencies	0.6	3	5	0.3	3.3
Synthesis, data management, and research collaboration	0.5	6	7	0.3	5.0
Admin travel to Juneau for PMT planning meeting	0.3	1	1	0.3	0.6
					0.0
					0.0
					0.0
					0.0
				Travel Total	$32.3

FY17

Project Title: Program Management II – Administration, Science Review Panel, PI Meeting Logistics, Outreach, and Community Involvement
Primary Investigator: Hoffman

FORM 3B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Printing; graphic design	2.0
Information Technology Provider	2.1
Webmaster (subcontract with Axiom)	5.0
Outreach Coordinator (subcontract with Axiom)	19.2
Meeting space rental & catering	1.3
Editing	2.0
Electricity (12 mo. @ $475)	5.7
Rent	12.0
Audit (portion of annual fee)	8.0
Postage	1.0
Communications (phone, fax, internet) (12 mo. @ $650)	7.8
Insurance	11.4
Maintenance	9.1
Vehicle travel & maintenance (local in Cordova)	0.5
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$87.1

Commodities Costs: Description	Commodities Sum
Miscellaneous office supplies	1.0
Computer hardware / software	3.0
Lumber/hardware	2.4
Commodities Total	$6.6

FY17

Project Title: Program Management II – Administration, Science Review Panel, PI Meeting Logistics, Outreach, and Community Involvement
Primary Investigator: Hoffman

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY17

Project Title: Program Management II – Administration, Science Review Panel, PI Meeting Logistics, Outreach, and Community Involvement
Primary Investigator: Hoffman

FORM 3B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
TBN	Administrative Assistant	3.0	6.9		20.7
Ginger Drake	Bookkeeper	7.0	5.4		37.8
Signe Fritsch	Development & Communications Asst.	2.0	8.9		17.8
Katrina Hoffman	CEO	2.0	15.4		30.8
Penelope Oswalt	Finance Director	3.0	9.1		27.3
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	45.7	0.0	
				Personnel Total	$134.4

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Science Review Panel to fall PI meeting (4 days x 5 people = 20 days)	0.7	5	20	0.3	9.3
Science Review Panel to AMSS PI meeting (5 days x 5 people = 25 days)	0.7	5	25	0.3	11.0
Admin travel to Anchorage for PAC & TC meetings	0.4	2	4	0.3	2.0
Admin travel to Program Management Team meeting	0.5	1	2	0.3	1.1
Outreach Coordinator & PI travel to TEK mtg. in native village	0.7	4	8	0.2	4.4
Synthesis, data management, and research collaboration	0.5	5	5	0.3	4.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$31.8

FY18

Project Title: Program Management II – Admin, Science Review Panel, PI Meeting Logistics, Outreach, and Community Involvement
Primary Investigator: Hoffman

FORM 3B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Printing; graphic design	2.4
Information Technology Provider	2.1
Webmaster (subcontract with Axiom)	5.1
Outreach Coordinator (subcontract with Axiom)	19.8
Meeting space rental & catering	1.2
Editing	2.0
Electricity (12 mo. @ $475)	5.7
Rent	10.0
Audit (portion of annual fee)	8.5
Postage	1.0
Communications (phone, fax, internet) (12 mo. @ $650)	7.8
Insurance	12.0
Maintenance	9.0
Vehicle travel & maintenance (local in Cordova)	0.5
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$87.1

Commodities Costs: Description	Commodities Sum
Miscellaneous office supplies	1.0
Computer hardware / software	2.0
Lumber/hardware	2.9
Commodities Total	$5.9

FY18	**Project Title: Program Management II – Administration, Science Review Panel, PI Meeting Logistics, Outreach, and Community Involvement** **Primary Investigator: Hoffman**	**FORM 3B** **CONTRACTUAL &** **COMMODITIES DETAIL**

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY18

Project Title: Program Management II – Administration, Science Review Panel, PI Meeting Logistics, Outreach, and Community Involvement
Primary Investigator: Hoffman

FORM 3B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
TBN	Administrative Assistant	3.0	7.1		21.3
Ginger Drake	Bookkeeper	7.0	5.5		38.5
Signe Fritsch	Development & Communications Asst.	2.0	8.2		16.4
Katrina Hoffman	CEO	2.0	15.8		31.6
Penelope Oswalt	Finance Director	3.0	9.3		27.9
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	45.9	0.0	
				Personnel Total	$135.7

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Outreach travel for vizualization products generation; local org. engageme	0.5	1	1	0.2	0.7
Science Review Panel to fall PI meeting (4 days x 5 members = 20 days)	0.7	5	20	0.3	9.3
Science Review Panel to AMSS PI meeting (5 days x 5 members = 25 da	0.7	5	25	0.3	11.0
Admin travel to Anchorage for PAC & TC meetings	0.4	2	4	0.3	2.0
Synthesis, data management, and research collaboration	0.5	5	7	0.3	4.6
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$27.6

FY19

Project Title: Program Management II – Administration, Science Review Panel, PI Meeting Logistics, Outreach, and Community Involvement
Primary Investigator: Hoffman

FORM 3B PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description		Contract Sum
Printing; graphic design		5.6
Information Technology Provider		2.3
Webmaster (subcontract with Axiom)		5.3
Outreach Coordinator (subcontract with Axiom)		20.4
Meeting space rental & catering		2.0
Editing		4.0
Electricity (12 mo. @ $625)		7.5
Rent		11.0
Audit (portion of annual fee)		10.0
Postage		1.0
Communications (phone, fax, internet) (12 mo. @ $850)		10.2
Insurance		16.0
Maintenance		12.0
Vehicle travel & maintenance (local in Cordova)		1.3
If a component of the project will be performed under contract, the 4A and 4B forms are required.	**Contractual Total**	$108.6

Commodities Costs: Description	Commodities Sum
Miscellaneous office supplies	1.0
Computer hardware / software	2.5
Lumber/hardware	3.5
Commodities Total	$7.0

FY19

Project Title: Program Management II – Administration, Science Review Panel, PI Meeting Logistics, Outreach, and Community Involvement
Primary Investigator: Hoffman

FORM 3B CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY19

Project Title: Program Management II – Administration, Science Review Panel, PI Meeting Logistics, Outreach, and Community Involvement
Primary Investigator: Hoffman

FORM 3B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
TBN	Administrative Assistant	3.0	7.2		21.6
Ginger Drake	Bookkeeper	7.0	5.7		39.9
Signe Fritsch	Development & Communications Asst.	2.0	8.4		16.8
Katrina Hoffman	CEO	2.0	16.3		32.6
Penelope Oswalt	Finance Director	3.0	9.6		28.8
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	47.2	0.0	
				Personnel Total	$139.7

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Outreach Coordinator & PI travel to TEK mtg. in native village	0.3	7	8	0.3	5.1
Science Review Panel to fall PI meeting (4 days x 5 members = 20 days)	0.7	5	20	0.3	9.3
Science Review Panel to AMSS PI meeting (5 days x 5 members = 25 da	0.7	5	25	0.3	11.0
Admin travel to Anchorage for PAC & TC meetings	0.4	2	4	0.3	2.0
Admin travel to Program Management Team meeting	0.5	1	2	0.3	1.1
Synthesis, data management, and research collaboration	0.5	6	7	0.3	5.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$33.4

FY20

Project Title: Program Management II – Administration, Science Review Panel, PI Meeting Logistics, Outreach, and Community Involvement
Primary Investigator: Hoffman

FORM 3B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Printing; graphic design	6.0
Information Technology Provider	2.3
Webmaster (subcontract with Axiom)	5.5
Outreach Coordinator (subcontract with Axiom)	21.0
Meeting space rental & catering	2.0
Editing	4.0
Electricity (12 mo. @ $625)	7.5
Rent	12.0
Audit (portion of annual fee)	10.0
Postage	1.4
Communications (phone, fax, internet) (12 mo. @ $850)	10.2
Insurance	14.3
Maintenance	10.0
Vehicle travel & maintenance	1.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$101.2

Commodities Costs: Description	Commodities Sum
Miscellaneous office supplies	1.5
Commodities Total	$1.5

FY20	Project Title: Program Management II – Administration, Science Review Panel, PI Meeting Logistics, Outreach, and Community Involvement Primary Investigator: Hoffman	FORM 3B CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
New Equipment Total			$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY20

Project Title: Program Management II – Administration, Science Review Panel, PI Meeting Logistics, Outreach, and Community Involvement
Primary Investigator: Hoffman

FORM 3B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
TBN	Administrative Assistant	3.0	7.5		22.5
Ginger Drake	Bookkeeper	7.0	5.9		41.3
Signe Fritsch	Development & Communications Asst.	2.0	8.6		17.2
Katrina Hoffman	CEO	2.0	16.7		33.4
Penelope Oswalt	Finance Director	3.0	9.9		29.7
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	48.6	0.0	
				Personnel Total	$144.1

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Outreach coordinator travel to local orgs & trustee agencies	0.5	3	6	0.2	2.7
Science Review Panel to fall PI meeting (4 days x 5 members = 20 days)	0.7	5	20	0.3	9.3
Science Review Panel to AMSS PI meeting (5 days x 5 members = 25 da	0.7	5	25	0.3	11.0
Admin travel to Anchorage for PAC & TC meetings	0.4	2	4	0.3	2.0
Admin travel to Program Management Team meeting	0.5	1	2	0.3	1.1
Synthesis, data, management, and research collaboration	0.5	5	5	0.3	4.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$30.1

FY21

Project Title: Program Management II – Administration, Science Review Panel, PI Meeting Logistics, Outreach, and Community Involvement
Primary Investigator: Hoffman

FORM 3B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Printing; graphic design	6.0
Information Technology Provider	2.3
Webmaster (subcontract with Axiom)	5.6
Outreach Coordinator (subcontract with Axiom)	21.6
Meeting space rental & catering	2.0
Editing	6.7
Electricity (12 mo. @ $625)	7.5
Rent	12.0
Audit (portion of annual fee)	10.0
Postage	2.0
Communications (phone, fax, internet) (12 mo. @ $850)	10.2
Insurance	16.0
Vehicle travel & maintenance	1.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$102.9

Commodities Costs: Description	Commodities Sum
Miscellaneous office supplies	5.0
Computer hardware / software	5.0
Commodities Total	$10.0

FY21

Project Title: Program Management II – Administration, Science Review Panel, PI Meeting Logistics, Outreach, and Community Involvement
Primary Investigator: Hoffman

FORM 3B CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY21

Project Title: Program Management II – Administration, Science Review Panel, PI Meeting Logistics, Outreach, and Community Involvement

FORM 3B EQUIPMENT DETAIL

	Logistics, Outreach, and Community Involvement Primary Investigator: Hoffman	EQUIPMENT DETAIL

August 24, 2016

Elise Hsieh, Executive Director
Exxon Valdez Oil Spill Trustee Council
4210 University Drive
Anchorage, AK 99508-4626

Dear Elise:

Final FY 2017-2021 Proposal Submittal for Long-term Monitoring

17120114-C. Monitoring Long-term Changes in Forage Fish in Prince William Sound

Gulf Watch Alaska, the long-term monitoring program of the *Exxon Valdez* Oil Spill Trustee Council (EVOSTC), has finalized our program and project proposals for fiscal years 2017-2021 funding based on comments received from EVOSTC's Science Panel on May 19, 2016. Below is the final budget summary and response to Science Panel comments for the forage fish project.

EVOSTC Funding Requested *(including 9% GA)*

FY17	FY18	FY19	FY20	FY21	TOTAL
$198,800	$229,800	$221,300	$224,700	$232,000	$1,106,600

Non-EVOSTC Funding Available

FY17	FY18	FY19	FY20	FY21	TOTAL
$256,000	$256,000	$256,000	$256,000	$256,000	$1,280,000

Science Panel comment: *While the Panel is supportive of continued forage fish work, there are concerns regarding the actual integration of the three projects. The proposal appears to be an integration of PIs collecting data at the same time and location through a shared vessel. It was unclear from any of the three proposals how the data would actually be integrated to address the hypotheses of the Integrated Predator-Prey Survey. If the intent is not a true integration, then the project should be renamed accordingly.*

PI Response:

- Clarified that the integrated pelagic component projects share a survey platform and explained how the data will be integrated across projects (see the Executive Summary, pages 3-6, and the end of Section 4C, page 15)

Science Panel comment: *Also, based on the focus on known seabird and marine mammal foraging areas, the proposal should note that it does not intend to scale-up results to the level of PWS.*

PI Response:

- Clarified that biomass estimates will be specific to sub-region and will not scale up to all of Prince William Sound (see top of page 9)

Science Panel comment: *Moreover, the Panel was unsure of how the seabird diet data from Middleton Island would be incorporated into the Survey, given its offshore GOA location, 130 km southwest of Cordova. The other projects are benefiting from data collected at the same time and location, but Middleton Island is not within any of the anticipated survey areas. The Panel acknowledges that inclusion of Middleton Island allows incorporation of a set of important seabirds not included elsewhere in the LTM Program, specifically an auklet, black-legged kittiwake, and puffins.*

PI Response:

- Added additional background on the importance of including Middleton Island in the study when it is outside of the spill-affected area (see page 6 "Long-term Data on Seabird Diets")

Science Panel comment: *The proposal is short on methodology. The Panel requests the proposers to expand the description of their methods as there is insufficient information for a thorough review.*

PI Response:

- Added additional project background to explain why the project is shifting directions for the upcoming funding cycle (see abstract and pages 4-5)
- Included the density of humpback whale observations to the survey design figure to demonstrate the rationale for sub-region study site selection (see Figure 1 on page 10)

- Recalculated the power analysis with new area totals and transect lengths; the reanalysis changed the anticipated coefficients of variation and lowered the effect size we could detect in 5 years (see pages 13-14)

- Explained more specifically how the forage fish data could help scientists understand predator-prey interactions while bringing the framework of hypotheses into the analytical methods (see the end of Section 4C, page 15)

Sincerely,

Mandy Lindeberg
Gulf Watch Alaska Program Lead designate

Attachment: Gulf Watch Alaska: Pelagic Component Project Proposal: 17120114-C—Monitoring Long-term Changes in Forage Fish Distribution, Relative Abundance, and Body Condition in Prince William Sound

EVOSTC FY17-FY21 INVITATION FOR PROPOSALS
PROGRAM PROJECT PROPOSAL SUMMARY PAGE

Project Title

Gulf Watch Alaska: Pelagic Component Project:

17120114-C—Monitoring long-term changes in forage fish distribution, relative abundance, and body condition in Prince William Sound

Primary Investigator(s) and Affiliation(s)

Mayumi Arimitsu and John Piatt, U.S. Geological Survey – Alaska Science Center

Date Proposal Submitted

24 August 2016

Project Abstract

New Direction for Forage Fish Studies: The forage fish proposal will change directions in 2017-2021: we will integrate directly with the humpback whale and marine bird predation studies and apply the methods we have learned in the previous 5 years to provide estimates of forage biomass in the immediate vicinity of predator aggregations. By integrating with these projects, we will sample forage fish in the same locations and times, thus providing valuable prey information for two pelagic predator groups of key value to EVOSTC, governmental and nongovernmental groups and the public while obtaining trend information for our forage fish monitoring program. Obtaining sound-wide forage fish population/biomass estimates is not feasible with the resources available; funds are insufficient to adequately sample the entire area, and the key forage species in PWS differ significantly in their life histories, habitats, and ease of detection (e.g., sand lance are shallow inshore, while euphausiids are usually deep and off shore), making defensible sound-wide holistic estimations impractical. For this reason, the proposed work focuses on smaller geographical areas within Prince William Sound (PWS) and takes advantage of known persistent predator aggregations to locate prey that can then be well monitored over time within reasonable financial resources. Additionally, using predators as samplers of forage fish can provide an important index of changes in prey species composition over time. Thus we will incorporate into the Gulf Watch Alaska (GWA) Pelagic Component a long-term seabird diet data collection program as a cost-effective means to monitor forage fish stocks in the northern Gulf of Alaska.

Integrated Predator-Prey Surveys 2017-2021: Humpback Whales, Marine Birds, Forage Fish
Under the next five year monitoring program, we will integrate two predator studies (Moran/Straley humpback whale and Bishop fall/winter marine birds) with the forage fish study, by operating at the same time and locations, and using the same vessels. In the past, the predator studies have attempted to opportunistically sample and identify the forage, but not quantify the forage biomass on an area/depth/volume basis. By combining logistic resources and expertise, we will identify and estimate the forage biomass at the same locations in which predators are feeding, which will provide comparable information on both predator density and prey availability (species composition, depth distribution, density and biomass). Collectively, we will use two platforms; a larger vessel to support the acoustic forage fish transects and marine bird surveys (see Bishop fall/winter marine bird proposal), and a smaller second

vessel to both scout ahead looking for the predator aggregations and to photo ID the whales (see Moran and Straley humpback whale proposal). The integrated survey would be conducted during the fall, providing insight into predator-prey interactions at a crucial time when forage fish energy is maximized and while marine birds and humpback whales are provisioning for the upcoming winter.

Forage fish component: This proposal covers the forage fish component of the integrated study. The forage fish survey will focus on prey availability, distribution relative to the predators and geography, energy density, and water column depth using primarily hydroacoustic methods developed in the previous 5-year study. Ground truthing (sampling by fishing) is an important secondary component to confirm species identity and size for acoustic estimates of biomass, provide samples for other analyses (e.g., diet, stable isotopes, energy content), and will provide critical information on the size distribution of the forage. Experience indicates that herring and euphausiids are the primary forage in the areas of predator aggregation, although capelin, juvenile pollock and other forage species are found there as well. Net sampling and other methods will allow us to collect samples of all these species.

Survey areas will encompass the known historical locations of the feeding aggregations of predators (Figure 1), and we will also conduct adaptive sampling if predators are found in unexpected locations. Marine bird observations (see Bishop marine bird project proposal) will be recorded concurrently with acoustic transects, while humpback whale distribution and abundance will be assessed from a smaller vessel concurrently in the same area (see Moran and Straley humpback whale project proposal). The simultaneous surveys of three component projects will reduce vessel cost for overall while combining sampling efforts with spatial and temporal consistency. Combined efforts by GWA's pelagic component humpback whale, marine bird and forage fish principal investigators (PIs) will provide a more comprehensive understanding of the pelagic ecosystem and provide an integrated dataset that facilitates analyses of predator prey relationships within the sampled regions. In addition to a planned research cruise in September/October, the proposed approach may also allow for in-kind contributions from National Oceanic and Atmospheric Administration (NOAA) for vessel charter and an additional survey in March, when humpback whales are returning from their migrations to feed and when we can assess the impact of severe winter conditions on forage fish. The NOAA funds will be applied for and awarded on an annual basis, and a March NOAA cruise, if awarded, would be an added value to the GWA Pelagic monitoring program.

Long-term Data on Predator Diets

Forage fish monitoring using predators as samplers is a proven and cost-effective approach in marine ecosystem research (Hatch & Sanger 1992, Roseneau & Byrd 1997, Thayer et al. 2008). Concordance in trends of key forage species have been observed between GWA studies in PWS and seabird diet sampling at Middleton. Long-term seabird diet data from Middleton Island can provide a useful index of long-term trends in PWS. Given Middleton Island's location near the continental shelf edge, the data obtained also reflect interannual variability in both pelagic (deep ocean) and neritic (continental shelf) habitats (Hatch 2013). Furthermore, the Middleton Island seabird diet dataset is the longest continuous dataset on forage fish in the region. Since the project is no longer directly supported by the U.S. Geological Survey after the retirement of the lead PI (i.e., Scott Hatch, Institute for Seabird Research and Conservation [ISRC]) future funding for the program is highly uncertain. Therefore, we propose to support the field effort required to continue this important dataset within the GWA forage fish monitoring program.

EVOSTC Funding Requested *(must include 9% GA)*					
FY17	**FY18**	**FY19**	**FY20**	**FY21**	**TOTAL**
$198.8	**$229.8**	**$221.3**	**$224.7**	**$232.0**	**$1,106.6**

Non-EVOSTC Funding Available					
FY17	**FY18**	**FY19**	**FY20**	**FY21**	**TOTAL**
$256.0	**$256.0**	**$256.0**	**$256.0**	**$256.0**	**$1,280.0**

1. Executive Summary

Pelagic Component

In the aftermath of the 1989 *Exxon Valdez* oil spill (EVOS) it was difficult to distinguish between the impacts of the spill and natural variability in affected animal populations. The main problem for assessing impacts on pelagic species was that long-term baseline data were largely absent. As a result, managers struggled to make informed decisions regarding estimation of damages and recommendations for recovery. Ten years after the spill it became widely recognized that climate change adds additional layers of uncertainty to a post spill recovery; there had been a major climatic regime shift (from colder to warmer than average) that altered the marine ecosystem prior to the spill, including marine birds, marine mammals, groundfish, and the shared forage species they all consumed. As we begin to close the second decade of the 2000s we are experiencing anomalous ocean warming events driven by changing atmospheric conditions at both inter-decadal (i.e., Pacific Decadal Oscillation) and shorter (e.g., El Niño Southern Oscillation) time scales. These changes may have profound effects on pelagic ecosystems such as unusual mortality events, harmful algal blooms, and fishery closures.

During the first five years of the Gulf Watch Alaska (GWA) program, the pelagic component research team addressed two main questions: 1) What are the population trends of key pelagic species groups in PWS, and, 2) How can forage fish population trends in Prince William Sound (PWS) be monitored most effectively? To answer these questions, pelagic component projects focused on species that play a pivotal role in the pelagic ecosystem as trophic indicators for short and long-term ecosystem change: forage fish, marine birds (both fall/winter distribution, and summer status and trends), humpback whales, and killer whales. Monitoring of killer whales and marine birds benefitted from having pre-existing long-term data sets as a result of the damage assessment process following the EVOS (>25-year time series).

Moving forward for the next five years, the pelagic research team re-evaluated their primary objectives. The group's primary objective — to determine the long-term population trends of key pelagic species groups in PWS — will remain the same. The second primary objective was fundamentally different: Develop a means to effectively monitor forage fish. Based on knowledge gained in the first five years of the forage fish project, we learned that the goal of moving to a sound wide forage fish assessment was too labor and vessel intensive, thus not feasible. During pilot work in September 2014 that used humpback whales as indicators of high-density prey aggregations we learned that it is more productive to use the predators to find the forage, and focus assessments based on and around predator feeding aggregations. In addition to providing a means to effectively monitor indices of prey availability (species, depth distribution, density and biomass) to predators, our integrated approach will also enhance our understanding of predator-prey relationships and help us identify some mechanisms of change in populations. Ultimately, the integrated surveys along with information from the GWA Environmental Drivers component will provide a way to evaluate perturbations on the PWS pelagic ecosystem.

Thus, the two over-arching questions for the pelagic component to answer in the next five years are:

1. What are the population trends of key upper trophic level pelagic species groups in PWS – killer whales, humpback whales, and marine birds?
2. How do predator-prey interactions, including interannual changes in prey availability, contribute to underlying changes in the populations of pelagic predators in PWS and Middleton Island?

The pelagic component research team is proposing to continue monitoring key pelagic species groups in PWS using the same component projects focused on killer whales, humpback whales, forage fish, and marine birds (fall/winter and summer). However, modifications have been made to some projects for greater integration, increased precision of information, and achieving new goals. Ultimately this will provide more information to the EVOS Trustee Council (EVOSTC), agency resource managers, non-governmental organizations, and the public.

Forage Fish Monitoring

Forage species are difficult and expensive to monitor because they are patchy in their distribution, comprised of species with different life histories and habitats, and their life history traits may predispose populations to large fluctuations in abundance. Examples of important forage taxa in PWS include capelin, Pacific sand lance, juvenile walleye pollock, eulachon, Pacific herring, juvenile salmon and euphausiids, all included hereafter under the label of "forage fish".

Many investigators have attempted to document forage fish distribution, abundance, and variability in PWS and Cook Inlet since the 1990s (Norcross et al. 1999, Stokesbury et al. 2000, Thedinga et al. 2000, Brown 2002, Ainley et al. 2003, Abookire & Piatt 2005, Speckman et al. 2005, Piatt et al. 2007), but for PWS, none have provided population estimates that can be tracked annually in a cost-effective and practical manner. Survey methods for estimating abundance and distribution of forage fish included hydroacoustic surveys coupled with trawl-sampling (Haldorson et al. 1998, Speckman et al. 2005) and Sound-wide aerial surveys for surface-schooling fish (Brown & Moreland 2000).

Predator diets can provide quantitative information on abundance, distribution, temporal variability, condition and community structure of local prey stocks (Hatch & Sanger 1992, Roseneau & Byrd 1997, Davoren & Montevecchi 2003, Litzow et al. 2004). Drawbacks of using predators as indicators of forage fish stocks are the potential for prey selectivity among generalist vs. specialist predators, non-random sampling of foraging areas, and restrictions on the depth of sampled prey because of predator limitations (Hunt et al. 1991). For example, tufted puffins (*Fratercula cirrhata*) bring a greater diversity of prey items to their nest than horned puffins (*F. corniculata*) (Hatch & Sanger 1992), suggested that the tufted puffin diets represent a more opportunistic sample of food availability than horned puffins. Some species, like surface-feeding kittiwakes, are limited in their diving depth and their diets are representative only of prey which make it to the surface at some point in their diurnal cycle of vertical migration (Hatch 2013). Nonetheless, the advantages of easy access and sampling can outweigh the known sampling biases or disadvantages, and in the absence of traditional fisheries surveys for forage fish in the region, the information gleaned from predator diets at seabird colonies provides the best continuous long-term information available on some forage fish species in the northern Gulf of Alaska. These time series reveal much about the availability of key forage species in the Gulf of Alaska.

Project Background

During the first 5-year funding period of GWA the forage fish component tested a variety of survey methods that could yield robust indices for monitoring forage fish in the spill-affected region. This started with a traditionally-designed systematic hydroacoustic-trawl survey in 2012-13 that included sampling of fish, seabird, zooplankton, oceanography and nutrients at 27 fixed stations (although one site was sampled in both years) using a stratified systematic design. With the exception of euphausiids near tidewater glaciers, midwater trawl composition at fixed stations throughout the Sound suggested our encounter rate with target species was not sufficient to assess abundance. Frequency of occurrence in trawls (FO) was low for capelin (3.7%), eulachon (3.7%), and euphausiids (11.1%), and catches were overwhelmingly dominated by non-target species (young of the year walleye pollock, FO = 100%, and jelly fish FO = 81.5%). Likewise, beach seines targeting Pacific sand lance had low and variable catches (mean CPUE ± SD = 3.5 ± 10.5 fish per set). Thus we began to look for ways to improve our ability to sample target fish species.

In 2013 we explored the use of adaptive cluster sampling, and tested combined aerial and acoustic surveys with validation ("aerial-acoustic surveys") as means to increase our encounter rate with target species. Adaptive cluster sampling (i.e., intensive sampling right over schools we found during surveys or by chance) generally involved a high degree of effort and did not facilitate a quantitative means of assessing abundance and distribution at the sound-wide scale because of the relatively infrequent and opportunistic nature of this sampling strategy. We devoted 3 days of ship time to validation of limited aerial surveys. An experienced spotting pilot directed the ship or a skiff to forage fish schools visible from the plane. Schools were captured with nets, jigs, video, and hydroacoustics whenever possible. The ground crew recorded, and relayed to the pilot, information about fish species, fish size, and depth of the schools. After the pilot left, we conducted hydroacoustic surveys of the area, and we used midwater trawls, gill nets, cast nets, dip nets, jigs, or video to confirm the species composition and fish size for conversion of acoustic backscatter to biomass. Although this work facilitated a better way to target near-surface forage fish schools available for observation from a plane, our sampling efforts still resulted in relatively low-encounter rate with forage schools below the depth visible to the spotter pilot (> 10-15 m).

We recognized that surveying all of PWS to locate scattered and relatively small aggregations of target forage species was inefficient, and would ultimately require a far greater investment of vessel time and expense than our budget allowed, or warranted. We know, however, that humpback whales are efficient predators of forage species (fish and euphausiids), and whale distribution may be a key indicator of high density prey patches at depths that are not visible to observers in a plane. In July and Sept 2014 we coordinated with the whale survey principal investigators (PIs) to estimate distribution and density of whale prey near Montague Strait, Green Island and Port Chalmers in July, and successfully quantified schools of krill and capelin in association with the whales. We observed considerable differences in whale prey density and depth distribution between July and September 2014. During daytime surveys in July there were few whales, and only a thin layer of krill and dispersed age-1 capelin at 100 m depth. By September humpback whale numbers increased, and whales there co-occurred with thick scattering layers of krill, adult herring and adult walleye pollock. We therefore considered using whales to effectively locate forage aggregations for us, and thus allow us to focus our offshore vessel sampling efforts. Because of the success of this pilot study, and the fact that annual sound-wide biomass estimates of forage fish populations aren't feasible or cost effective, we propose a survey design using systematic and adaptive sampling of persistent whale foraging areas in PWS that can provide us with long-term monitoring data on forage taxa in offshore waters of PWS.

Integrated Predator-Prey Surveys 2017-2021: Humpback Whales, Marine Birds, Forage Fish

In our initial GWA efforts, we have been able to identify several areas in PWS with seasonally predictable predator-prey aggregations. Given limited resources and patchy predator-prey distribution in PWS, we propose using a combination of systematic transects in conjunction with predator guided surveys to home in on important marine mammal and marine bird foraging areas with significant aggregations of prey. Our new proposed integrated predator-prey surveys will allow us to monitor the status and trends of individual pelagic ecosystem elements as a primary goal. Predator-prey indices will be measured concurrently, thus we will also be able to examine spatial and temporal covariance among indices to better understand the effects of perturbations in the environment. Our framework includes the following hypotheses:

1. *Predator distribution and abundance varies with prey availability (availability and quality)*
2. *Changes in prey availability and quality occur in response to changes in habitat quality (phytoplankton/zooplankton and environment/temperature)*
3. *Variation in prey availability occurs in response to predation pressure*

Long-term Data on Seabird Diets

Although avian, fish and marine mammal predator diets have previously been used to infer forage fish availability throughout Alaska (Best & St-Pierre 1986, Roseneau & Byrd 1997, Sinclair & Zeppelin 2002, Yang et al. 2005), the Middleton Island long-term seabird diet data (Hatch 2013) are of particular interest for several reasons. The Middleton forage fish index, which includes 26 years of frequency of occurrence and size data on capelin, sand lance, myctophids, Pacific herring, juvenile sablefish (reflecting nearby slope spawning habitat), and juvenile pink and chum salmon from PWS and southeast Alaska (as evidenced by thermally marked otoliths), represents the longest continuous time series of forage fish species composition and abundance index in the region. Additionally, forage fish data at Middleton Island appear to track climate signals in the Gulf of Alaska (Sydeman et al. *in review*, Hatch 2013) and are coherent with changes in forage fish abundance observed in PWS during our own studies in 2012-2015 (Arimitsu et al. in prep). Although Middleton Island is situated about 100 km from Hinchinbrook entrance, tagged kittiwakes from the Middleton Island colony regularly foraged at locations within and adjacent to PWS (Hatch 2015).

2. Relevance to the Invitation for Proposals

The proposed work meets the Trustee Council's goal to monitor the recovery of resources from the initial injury, and monitor how factors other than oil may inhibit full recovery or adversely impact recovering resources by collecting data on physical and biological environmental factors that drive ecosystem-level changes. In addition, this integrated multi-trophic level approach meets the core science mission of the U.S. Geological Survey (USGS) Ecosystems program. This monitoring provides an important baseline leading to our understanding of how climate change and other perturbations to the ecosystem affect these pelagic species in PWS. This program will also insure the continuation of the Middleton Island seabird diet monitoring, which is the longest continuous forage fish dataset in region.

3. Project Personnel

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Please see 2-page CVs at end of this document

4. Project Design

A. Objectives

Pelagic Component

The following lists the two over-arching questions for the pelagic component to address in the next five years:

1. *What are the population trends of key upper trophic level pelagic species groups in PWS – killer whales, humpback whales, and marine birds?*
2. *How do predator-prey interactions, including interannual changes in prey availability, contribute to underlying changes in the populations of pelagic predators in Prince William Sound and Middleton Island?*

Integrated Predator-Prey Surveys and Forage Fish Monitoring

Fundamental to ecosystem monitoring is a basic understanding of the status and trends of individual biological components within the system. It is increasingly clear, however, that an understanding of the mechanisms underlying change requires knowledge of interactions among predators, prey and habitat. The main objectives of the predator-prey and forage fish monitoring projects are to:

1. Monitor the status and trends of co-occurring pelagic marine ecosystem components during Fall/Winter in areas with known seasonally predictable aggregations of predators and prey

   a. Estimate humpback whale abundance, diet, and distribution (see Moran and Straley humpback whale proposal)

   b. Estimate marine bird abundance and distribution in areas with known seasonally predictable aggregations of predators and prey. (See Bishop marine bird proposal)

      i. relate marine bird presence to prey fields identified during hydroacoustic surveys.

      ii. characterize marine bird-humpback whale foraging dynamics

   c. Estimate an index of forage fish availability (this proposal)

i. species composition and biomass within persistent predator foraging areas

ii. density and depth distribution

d. Estimate an index of krill availability (this proposal)

i. species composition and biomass within persistent predator foraging areas

ii. density and depth distribution

e. Relate whale, marine bird and forage fish indices to marine habitat (all integrated project proposals)

Long-term Data on Seabird Diets

2. Support annual field and laboratory efforts to continue the long-term seabird diet index in April-August (this proposal)

B. PROCEDURAL AND SCIENTIFIC METHODS

Integrated Predator-Prey Surveys 2017-2021: Humpback Whales, Marine Birds, Forage Fish

As stated in all three integrated project proposals to meet the goals of the program we propose an integrated survey design that brings together predator and prey components of the pelagic ecosystem. We propose to conduct an annual hydroacoustic-trawl survey that targets persistent humpback whale feeding locations (hereafter, "sub-regions") in Montague Strait, Bainbridge Passage and Port Gravina (Figure 1). As proposed, the survey will be conducted during the fall of each year. However, potential in-kind contributions from NOAA may allow facilitate expansion of the survey into two time periods: fall and winter (Sept./Oct. and March). Proposed time periods will coincide with periods of peak whale abundance in PWS. The pending in-kind contributions would support the charter costs for the vessels. For the humpback whale component of the fall/winter survey the in-kind contributions would free up Trustee funds that would be applied towards the additional data management and processing the increased number samples resulting from an additional survey. For the acoustic survey component, USGS would contribute further in-kind support to ensure that the second survey was staffed and the acoustic data analyzed. The fall/winter marine bird component will ensure that observers are aboard all surveys, however funded.

The basic structure of the survey is for researchers working from the acoustic vessel to collect acoustic backscatter, trawl and marine habitat data (forage fish team) and concurrently conduct surveys for all marine birds and mammals (fall/winter marine bird team) along fixed transect lines within each sub-region (Figure 1). While the acoustic vessel is conducting transects, trawls and habitat sampling, a second smaller vessel will be used to assess whale abundance (humpback whale team). The smaller vessel will depart from the acoustic vessel and work independently in the sub-region where the acoustic data are being collected. This gives the whale vessel the ability to census and sample whales and scout for whales outside the sub-region as necessary.

Surveys of all three pelagic elements (humpback whales, marine birds and forage fish) will occur during daylight hours for coordinated analyses of predator-prey interactions within and among sub-regions (see also Table 2 in section 5 that details specific tasks and responsibilities by each PI). Our approach to quantifying daytime prey aggregations with hydroacoustics concurrent to predator densities is modeled after work on similar species elsewhere (Gende & Sigler 2006, Friedlaender et al. 2009, Hazen et al. 2009, Boswell et al. 2016). Sub-region-specific biomass estimates, species composition and depth distribution will be comparable within and among years, and thus meet our monitoring objectives of providing an index of prey availability in areas with seasonally predictable predator foraging aggregations. However, our survey design will not provide Sound-wide biomass estimates of forage species because we are unable to sample the entire Sound with existing program resources. Furthermore, although our analytical methods will compensate for changes in acoustical properties of herring with depth and density during daytime surveys (see data analysis and statistical methods section), our biomass estimates for herring by sub-region will not be directly comparable to nighttime hydroacoustic surveys designed specifically to estimate Sound-wide pre-spawning biomass (Thomas & Thorne 2003, Thorne & Thomas 2008).

Hydroacoustic-trawl. The fixed transect layout was chosen to sample areas of persistent humpback whale habitat use identified in surveys conducted in 2006-2014. To estimate depth distribution, density and biomass of prey in the water column a calibrated SIMRAD 38-120 kHz split beam EK60 system will be towed beside the boat along a zig-zag transect layout with a random starting point. Each transect will serve as a sample to estimate the abundance and variance of forage fish and krill biomass in each sub-region (Figure 1) using geostatistical methods (Petitgas 1993).

We will use a midwater trawl and other means as necessary to verify species and size (length in mm, weight to 0.01 g) of fish that contribute to hydroacoustic backscatter in each sub-region. The net has an approximately 154 m^2 mouth (14 m x 11 m) and is 22 m long. Mesh size diminishes from 38 mm at the mouth to 12 mm at the cod end (Innovative Net Systems, Inc.). The net is held open by two 0.4 m^2, series 2000 steel mid-water trawl doors (Nor 'Eastern, Inc.); each weighing approximately 76 lbs. The net will be towed at less than 3 kt, trawl duration will depend on the vertical and horizontal distribution of acoustic targets. Depth of the headrope will be managed with a TrawlMaster system. Although we will try to accomplish ground-truthing of acoustic sign on daytime transects, logistical constraints (daylight hours, trawl depth limitations, etc.) may require that trawls occur at night when the scattering layer ascends in the water column. We will also attempt to ground truth untrawlable (e.g., shallow nearshore areas) acoustic backscatter with other means as necessary (e.g., underwater video, jigs, dipnets, cast nets).

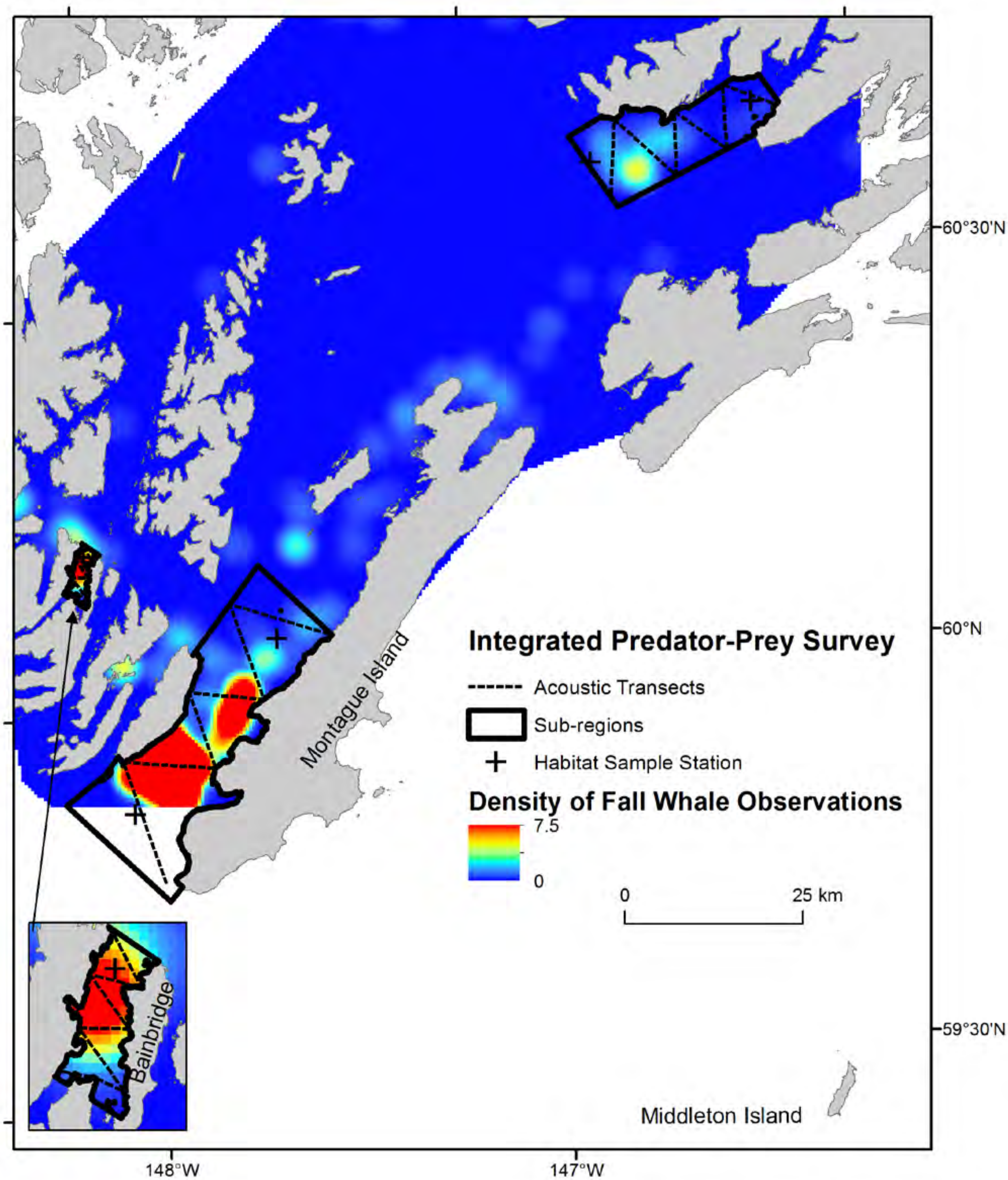


Figure 1. Map of the study area, including Prince William Sound and Middleton Island, and inset of Bainbridge sub-area (lower left). Kernel density of fall whale observations weighted by number of animals in each observation is shown in color (data courtesy of J. Moran and J. Straley, GWA humpback whale project). The GWA integrated predator-prey survey design will include concurrent hydroacoustic and predator transects as well as habitat sampling within each sub-region.

Trawl catches will be enumerated, measured (TL and FL, mm) and weighed (0.01 g) by species. Fish samples will be taken for age, sex, diet, energetics, and isotope analysis. A subsample of the euphausiid catch will be preserved in 3-5% formaldehyde solution for laboratory analysis of species proportion and weight.

In addition to fixed transects in persistent predator aggregation areas, we will also characterize prey density more closely associated with individual or groups of whales in each sub-region (Montague, Bainbridge and Port Gravina). This will involve focal follows of individual whales, and prey mapping near groups of feeding whales.

Marine habitat. Concurrent sampling of ocean and zooplankton indices will provide spatial and temporal overlap of environmental and predator-prey indices. At five fixed stations in the study area we will measure oceanographic variables with a SBE19 plus v2 conductivity-temperature depth profiler (CTD) equipped with a fluorometer, turbidity sensor, beam-transmissometer, PAR sensor, dissolved oxygen and pH sensor and water sampler. Water samples will be taken and analyzed at the University of Washington for nutrients (silica, nitrate, nitrite, ammonium, and phosphate), and chlorophyll *a* (to calibrate the *in situ* fluorometer). After each CTD cast we will also collect zooplankton samples with a 100 m vertical haul of a 150 μ-mesh zooplankton net. Zooplankton samples will be identified to species, enumerated and weighed (0.01 mg) at a laboratory in Fairbanks, AK.

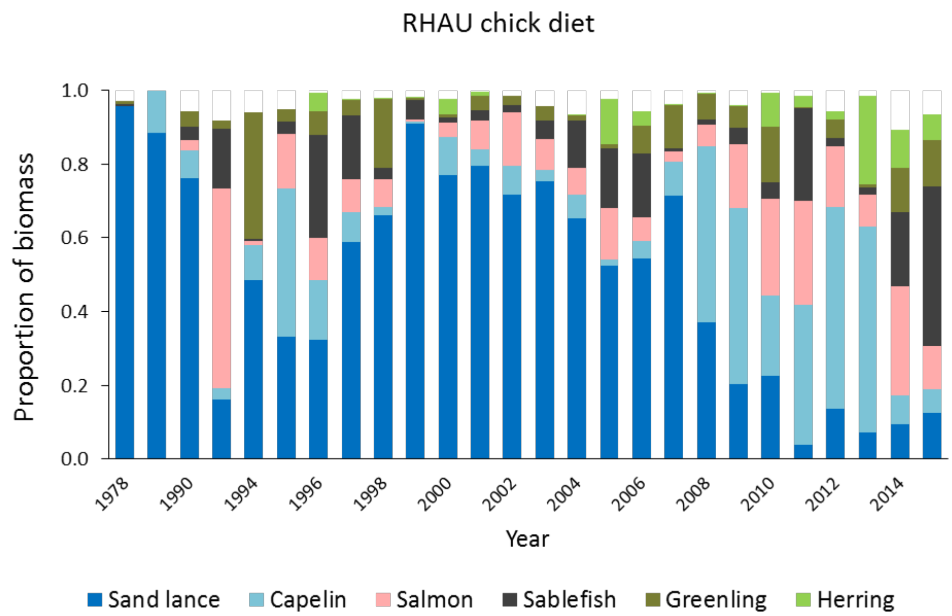
During each cruise we will sample approximately 150 km of transects, with associated trawls (max depth 100 m) for ground-truthing size and species of fish and krill, and 5 CTD/zooplankton stations. We anticipate a typical survey will occur as follows (subject to changes as necessary for logistics and weather conditions):

Day 1. load, travel, calibrate hydroacoustics, passive noise test
Day 2. Montague (82 km tx, 2 trawl, 2 CTD/zoop)
Day 3. Montague (82 km, 2 trawl, 2 CTD/zoop)
Day 4. Finish Montague, focal follows or adaptive tx. Transit.
Day 5. Bainbridge (18 km tx, 1 trawl, 1 CTD/zoop, 1-2 hour focal/adaptive). Transit.
Day 6. Knowles/Gravina (57 km tx , 1-2 trawls, 2 CTD/zoop)
Day 7. Knowles/Gravina (57 km tx, 1-2 trawls, 2 CTD/zoop, 2-3 hour focal/adaptive)
Day 8. Weather or focal/adaptive effort
Day 9. Weather or focal/adaptive effort
Day 10. Transit. Unload.

Long-term Seabird Diet Index

Work planned for GWA at the Middleton Island field station will build upon a 26-year time series that effectively documents forage fish occurrence in seabird diets (Figure 2). Prime samplers are black-legged kittiwakes and rhinoceros auklets, representing an obligate surface feeder and a diving species, respectively. In most years since 2000, regurgitated food samples have been collected from adult and/or nestling kittiwakes during all months April through August. Kittiwake food samples are collected when the adults regurgitate whole fish and other prey soon after capture for morphometrics and/or tagging. Nestling diets of rhinoceros auklets are monitored by collecting bill-loads from chick-provisioning adults, usually once or twice per week from early July through early or mid-August— historically; auklet diet monitoring provides the single best indicator of forage fish availability in the region (Figure 2). Bill loads are collected by placing a screen over the nest entrance, waiting 2-3 hours until the adult returns with whole fish for the chicks, collecting the discarded prey left at the screen and removing the screen from the next entrance.

Both time series will be continued annually during this study using established methods (Hatch & Sanger 1992, Thayer et al. 2008, Hatch 2013). Middleton Island forage fish data will provide an index of forage fish availability during the breeding season (April – Aug), and although not directly comparable to other planned work in the fall, it will provide a prey index for the region that will be useful for relating to the survey for marine bird population and trends conducted biannually in PWS during July (PIs: Kuletz and Kaler).



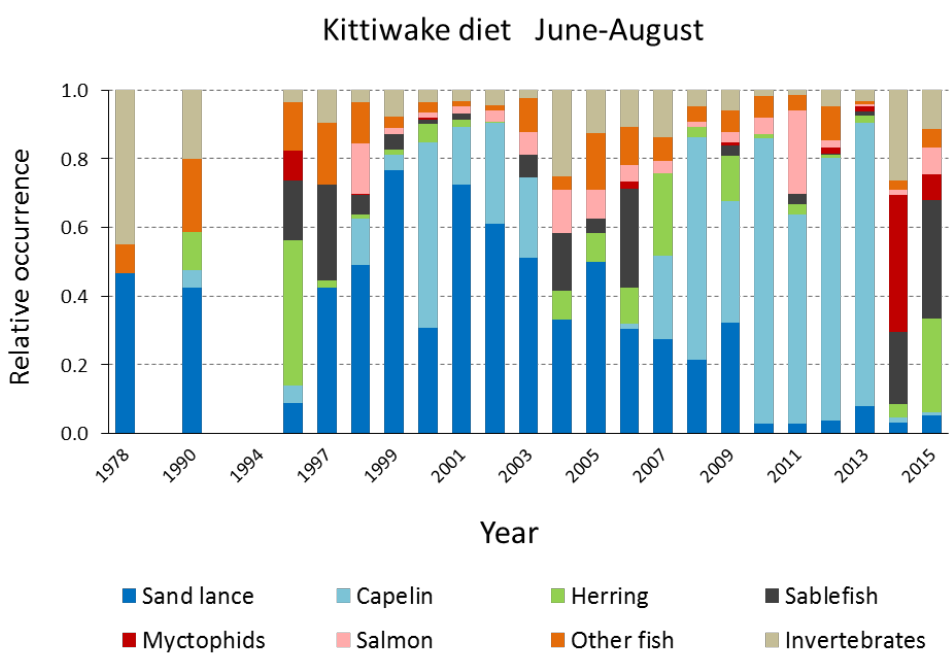


Figure 2. Interannual variation in diet composition of chick-rearing rhinoceros auklets (RHAU) on Middleton Island, 1978 to 2015, with a similar time series for black-legged kittiwakes (lower panel) for comparison. Data are courtesy of Scott Hatch (ISRC).

C. DATA ANALYSIS AND STATISTICAL METHOD

We will calculate the echo integral over a given area (mean Nautical Area Scattering Coefficient, NASC, m^2nm^{-2}) using EchoView software (Hobart, Tasmania, Australia). Because acoustic properties of fish are species specific, the target strengths (TS) for captured species will be estimated using the relationships in Table 1 (Thomas et al. 2002, Gauthier & Horne 2004, Boswell et al. 2016). Note that depth effect on TS of herring (Ona 2003) for herring at 38 kHz is specified following Boswell et al. (2016).

Table 1. Theoretical target strength (TS) relationships by species for 2 frequencies.

Species	120 kHz	38 kHz
Capelin	TS = 28.4Log(L)-81.8	TS=20Log(L)-69.3
Pacific herring	TS = 20Log(L)-67.6	TS = 20Log(L)-2.3Log(1+z/10)-65.4
Eulachon	TS = 15.3Log(L)-77.6	TS = 27.3Log(L)-94.0
Walleye pollock	TS=21.1Log(L)-70.5	TS=20Log(L)-67.2
Pacific sand lance	TS=20Log(L)-80	TS=20Log(L)-93.7
Euphausiid	TS = 34.8Log(L) – 127.5	NA

Due to dense aggregative behavior of herring schools during the day, we will compensate for the effects of acoustic shadowing and extinction on the estimates of density and biomass using established methods for Pacific herring (Zhao 2003, Sigler & Csepp 2007, Boswell et al. 2016). Density of fish per unit surface area (ρ_a) will be assessed using the following equation (MacLennan et al. 2002):

$$\rho_a = s_A/\{4\pi\langle\sigma_{bs}\rangle\}$$

where s_A is the echo integral (NASC) and $\sigma_{bs}$is the backscattering cross section (m^2), abundance within each sub-region is calculated as the product of density in the sub-region and the area of the sub-region. Biomass in each sub-region is calculated as the product of the abundance in each sub-region and the average weight of a fish within each sub-region.

Euphausiid biomass will be analyzed by using the difference of mean volume backscattering strengths (ΔMVBS) between 38 and 120 kHz frequencies (Kang 2002, De Robertis et al. 2010). Where ΔMVBS > 10 dB, s_A will be converted to biomass by species using the proportional allocation of euphausiid species identified in trawl catches (Simmonds & MacLennan 2005).

We used the following equations to estimate the effect size we may detect (Gerrodette 1987) given the empirical coefficient of variation (CV), which depends on the degree of hydroacoustic transect coverage Λ (Simmonds and MacLennen 2005):

$$\Lambda = \frac{D}{\sqrt{A}}$$

$$\mathrm{CV} = \frac{0.5}{\sqrt{\Lambda}}$$

$$r^2n^3 = 12CV^2\left(z\alpha_{/2} + z_\beta\right)$$

where D = distance in km of hydroacoustics transects within each sub-area, A = surface area of the water covered by each sub-area, and n = number of years and r = the fractional rate of change of relative biomass over time. During the initial 5 years of this study, at $\alpha = \beta = 0.05$, we expect to detect an effect size of 0.18 for all sub-areas combined (n = 5, CV = 0.21), 0.23 in Montague (n = 5, CV = 0.27), 0.22 in Port Gravina (n = 5, CV = 0.26) and 0.20 in Bainbridge (n = 5, CV = 0.24), (Figure 3).

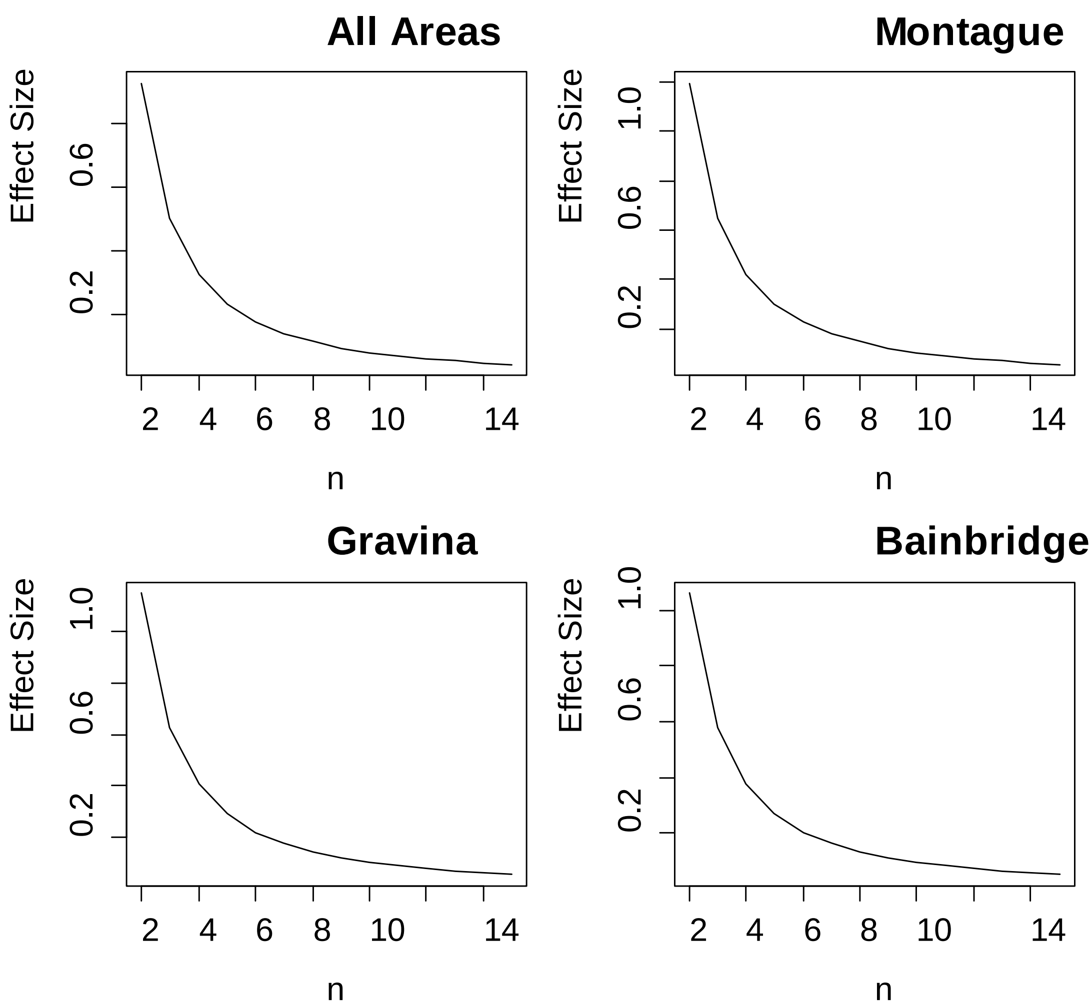


Figure 3. Estimated fractional rate of change (effect size) relative to number of years (n) for all areas and for each sub-region during the Prince William Sound integrated predator-prey surveys.

Forage fish abundance indices will be summarized using simple univariate statistics, and changes among years and subareas tested with ANOVA. We will employ a variety of statistical approaches to examine predator-prey interactions and distributional patterns with respect to bio-physical features. For example, we will use geostatistical models to graphically represent spatial patterns of distribution of predators and prey, Principal Components Analysis (PCA) to identify gradients in physical properties, Generalized Linear Models (GLM) and non-linear methods (e.g., GAMM, gradient boosted regression trees) to assess the relative contributions of different biophysical features in predicting the relative abundance of key forage fish and apex predators. Where appropriate, we will use Detrended Correspondence Analysis (DCA) or Non-metric multidimensional scaling (MDS) to characterize community structure and patterns of community response to physical gradients.

Specifically, with enough years of predator-prey monitoring data we can begin to address our framework hypotheses as follows:

1. *Predator distribution and abundance varies with prey availability (availability and quality)*
    a. *Multiple regression to examine the responses of predators (humpback whales and marine birds) to forage fish (capelin, herring, sand lance, pollock, euphausiid) biomass, species composition, depth distribution over time*
    b. *Multivariate community analysis of predators and prey in each sub-region and all sub-regions combined*
2. *Changes in prey availability and quality occur in response to changes in habitat quality (phytoplankton/zooplankton and environment/temperature)*
    a. *Multiple regression to examine the response of forage fish abundance indices and energy density to changes in habitat (zooplankton biomass, bottom depth, temperature, salinity, beam transmission, dissolved oxygen, chlorophyll a, photic depth, nutrients)*
3. *Variation in prey availability occurs in response to predation pressure*
    a. *Correlation to relate indices of prey availability to predator density within and among sub-areas over time*

D. Description of Study Area

This work will be conducted in spill-affected regions including PWS (bounding coordinates: 61.292, -148.74; 61.168, -146.057; 60.273, -145.677; 59.662, -148.238), and Middleton Island (59.4414, -146.3382).

5. Coordination and Collaboration

Within the Program

The proposed integrated predator-prey surveys will require close coordination with the humpback whale and winter bird component team leads to conduct the work. This collaboration will afford efficiencies in field work, as well as facilitate greater understanding of predator-prey interactions in the Sound (Table 2).

Table 2. Integrated predator-prey collaborations by objective.

Objective	Index	Task	PI
a. Estimate humpback whale abundance, diet, and distribution			
	Whale counts by sub-region	Integrated Surveys: whale counts, biopsies	Moran (NOAA)/ Straley (UAS)
	Whale Identification	Integrated Surveys: Photo ID	Moran (NOAA)/ Straley (UAS)
	Whale Diet	Integrated Surveys: scales, scat, biopsies, visual observations, hydroacoustics	Moran (NOAA)/ Straley (UAS)/ Arimitsu & Piatt (USGS)
b. Estimate marine bird abundance and distribution in seasonally predictable predator aggregation areas			
	Georeferenced marine bird counts, group size, behavior by species	Integrated Surveys: marine bird transects	Bishop (PWSSC)
b.i. Relate marine bird presence to prey fields identified during hydroacoustic surveys.			

Objective	Index	Task	PI
	Spatial coherence of bird presence/ absence, acoustic estimates of forage fish and euphausiid biomass	Integrated Surveys: hydroacoustic and marine bird transects	Arimitsu & Piatt (USGS)/ Bishop (PWSSC)
b.ii. Characterize marine bird-humpback whale foraging dynamics			
	Georeferenced marine bird and whale counts, group size, behavior by species	Data Collection Integrated Surveys: marine bird transects; whale focal follows	Bishop (PWSSC)/ Moran (NOAA)/ Straley (UAS)/ Arimitsu & Piatt (USGS)
c. Estimate index of forage fish availability in seasonally predictable predator foraging areas			
	Species composition and biomass within persistent predator foraging areas	Integrated Surveys: hydroacoustic-trawl data	Arimitsu & Piatt (USGS)
	Density and depth distribution	Integrated Surveys: hydroacoustic-trawl data	Arimitsu & Piatt (USGS)
	Diet, energy density	Sample Analysis: forage fish	Moran (NOAA)
d. Estimate an index of euphausiid availability in seasonally predictable predator foraging areas			
	Species composition and biomass within persistent predator foraging areas	Integrated Surveys: hydroacoustic-trawl data	Arimitsu & Piatt (USGS)
	Density and depth distribution	Integrated Surveys: hydroacoustic-trawl data	Arimitsu & Piatt (USGS)
e. Relate whale, marine bird and forage fish indices to marine habitat			
	Oceanographic metrics and zooplankton biomass	Integrated Surveys: CTD and zooplankton samples	Arimitsu & Piatt (USGS)/ Moran (NOAA)/ Straley (UAS)/ Bishop (PWSSC)

WITH OTHER EVOSTC-FUNDED PROGRAMS AND PROJECTS

We propose to continue collaborative work with Scott Pegau and the Herring Research and Monitoring Program's proposed aerial surveys for juvenile herring and other forage fish, should they occur in the future. This will include in-kind USGS logistical support (equipment, design modifications support) and survey data analysis. Given the existing long-term dataset and recent validation efforts that indicate a reasonably high species identification rate by experienced aerial observers, we believe the continuation of the long-term aerial schools index is important, particularly with respect to understanding changes in nearsurface prey availability for breeding seabirds in the Sound. When NOAA-funded March integrated herring surveys occur we will also coordinate closely with ADF&G and the HRM program to share real-time information relevant to their pre-spawning herring biomass surveys.

WITH TRUSTEE AND MANAGEMENT AGENCIES

We will collaborate closely with Scott Hatch (Institute for Seabird Research and Conservation [ISRC]), who conducted seabird and forage fish work at Middleton under as a Department of Interior research program since 1978. Dr. Hatch now supervises research on Middleton under the auspices of the ISRC, a non-profit research organization. A contract to ISRC will support costs for this long-term monitoring program that is leveraged by addition support from other ISRC partners (e.g., University of Alaska Fairbanks, University of Manitoba, Alaska Sealife Center, and Farallon Institute).

6. Schedule

PROGRAM MILESTONES

Objective 1: Monitor the status and trends of co-occurring pelagic marine ecosystem components during Fall/Winter in areas with known persistent aggregations of predators and prey

Integrated survey data collection, data analysis, and workspace upload will occur each year of the project.

Objective 2. Support annual field and laboratory efforts to continue the Middleton Island long-term seabird diet index in April-August

Ongoing throughout the project in collaboration with Scott Hatch (ISRC)

MEASURABLE PROGRAM TASKS

Measurable program tasks for the forage fish monitoring program include tasks involving administration and logistics, data acquisition and processing, dedicated data management, analysis and reporting (Table 3).

Table 3. Forage fish monitoring task schedule.

Task	FY17				FY18				FY19				FY20				FY21			
	EVOSTC FY Quarter (beginning Feb. 1)																			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Task 1 admin & logistics																				
Contracting	X	X		X	X	X		X	X	X		X	X	X		X	X	X		X
Permitting			X				X				X				X				X	
Equipment calibration		X				X				X				X				X		
Task 2 data acquisition & processing																				
Middleton Island support	X	X	X		X	X	X		X	X	X		X	X	X		X	X	X	
Integrated predator-prey surveys (EVOSTC)			X				X				X				X				X	
Alternate survey schedule (with added NOAA funds)	X		X		X		X		X		X		X		X		X		X	
Acoustic data processing	X	X	X		X	X	X		X	X	X		X	X	X		X	X	X	
CTD data processing	X				X				X				X				X			
Chlorophyll *a* fluorometry	X				X				X				X				X			
Task 3 data management																				
Database mgmt./QAQC	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Metadata	X				X				X				X				X			
Workspace upload		X				X				X				X				X		
Task 4 analysis & reporting																				
Analysis and summary	X				X								X				X			
Annual Reports	X				X				X				X				X			
Annual PI meeting				X				X				X				X				X
FY Work Plan (DPD)			X				X				X				X					
Permit reports				X				X				X				X				X

FY 2017 (Year 6)

FY 17, 1st quarter (February 1, 2017 - April 30, 2017)
February: *Middleton Island Contract*
March: *2016 Annual Report*

FY 17, 2nd quarter (May 1, 2017 - July 31, 2017)
May: *FY17 Fish Resource Permit Application*
June: *Contracting, shipping for equipment calibration*
April-August: *Middleton Island field work*

FY 17, 3rd quarter (August 1, 2017 - October 31, 2017)
August: *FY18 project proposal*
September: *Integrated predator-prey survey cruise*

FY 17, 4th quarter (November 1, 2017 - January 31, 2018)
November: *PI Meeting in Anchorage*
December: *FY17 Fish Resource Permit Reporting*
January: *Contract, prep, ship zooplankton (Fairbanks AK) and nutrients (Seattle WA) samples*

FY 2018 (Year 7)

FY 18, 1st quarter (February 1, 2018 - April 30, 2018)
February: *Middleton Island Contract*
March: *FY17 Annual Report*
March: *NOAA Integrated predator-prey survey cruise (TBD)*
February-April: *FY17 Data processing*

FY 18, 2nd quarter (May 1, 2018 - July 31, 2018)
May: *FY18 Fish Resource Permit Application*
June: *Contracting, shipping for equipment calibration*
May-July: *FY17 Data processing/QAQC*
April-August: *Middleton Island support*

FY 18, 3rd quarter (August 1, 2018 - October 31, 2018)
August: *FY19 project proposal*
August: *Upload FY17 data to workspace*
September: *Integrated predator-prey survey Fall cruise*

FY 18, 4th quarter (November 1, 2018 - January 31, 2019)
November: *PI Meeting in Anchorage*
December: *FY18 Fish Resource Permit Reporting*
January: *Contract, prep, ship zooplankton (Fairbanks AK) and nutrients (Seattle WA) samples*

FY 2019 (Year 8)

FY 19, 1st quarter (February 1, 2019 - April 30, 2019)
February: *Middleton Island Contract*
February: *FY18 Annual Report*
March: *NOAA Integrated predator-prey survey cruise (TBD)*
February-April: *FY18 Data processing*

FY 19, 2nd quarter (May 1, 2019 - July 31, 2019)
May: *FY19 Fish Resource Permit Application*
June: *Contracting, shipping for equipment calibration*
May-July: *FY18 Data processing/QAQC*
April-August: *Middleton Island field work*

FY 19, 3rd quarter (August 1, 2019 - October 31, 2019)
August: *FY20 project proposal*
August: *Upload FY19 data to workspace*
September: *Integrated predator-prey survey Fall cruise*

FY 19, 4th quarter (November 1, 2019 - January 31, 2020)
November: *PI Meeting in Anchorage*
December: *FY19 Fish Resource Permit Reporting*
January: *Contract, prep, ship zooplankton (Fairbanks AK) and nutrients (Seattle WA) samples*

FY 2020 (Year 9)

FY 20, 1st quarter (February 1, 2020 - April 30, 2020)
February: *Middleton Island Contract*
February: *FY19 Annual Report*
March: *NOAA Integrated predator-prey survey cruise (TBD)*
February-April: *FY19 Data processing*

FY 20, 2nd quarter (May 1, 2020 - July 31, 2020)
May: *FY20 Fish Resource Permit Application*
June: *Contracting, shipping for equipment calibration*
May-July: *FY19 Data processing/QAQC*
April-August: *Middleton Island field work*

FY 20, 3rd quarter (August 1, 2020 - October 31, 2020)
August: *FY21 project proposal*
August: *Upload FY20 data to workspace*
September: *Integrated predator-prey survey Fall cruise*

FY 20, 4th quarter (November 1, 2020 - January 31, 2021)
November: *PI Meeting in Anchorage*
December: *FY20 Fish Resource Permit Reporting*
January: *Contract, prep, ship zooplankton (Fairbanks AK) and nutrients (Seattle WA) samples*

FY 2021 (Year 10)

FY 21, 1st quarter (February 1, 2021 - April 30, 2021)
February: *Middleton Island Contract*
February: *FY20 Annual Report*
March: *NOAA Integrated predator-prey survey cruise (TBD)*
February-April: *FY20 Data processing*

FY 21, 2nd quarter (May 1, 2021 - July 31, 2021)
May: *FY21 Fish Resource Permit Application*
June: *Contracting, shipping for equipment calibration*
May-July: *FY20 Data processing/QAQC*
April-August: *Middleton Island field work*

FY 21, 3rd quarter (August 1, 2021 - October 31, 2021)
August: *FY22 project proposal*
August: *Upload FY21 data to workspace*
September: *Integrated predator-prey survey Fall cruise*

FY 21, 4th quarter (November 1, 2021 - January 31, 2022)
November: *PI Meeting in Anchorage*
December: *FY21 Fish Resource Permit Reporting*
January: *Contract, prep, ship zooplankton (Fairbanks AK) and nutrients (Seattle WA) samples*

7. Budget

BUDGET FORMS (ATTACHED)

Completed budget forms are attached.

SOURCES OF ADDITIONAL FUNDING

Over the life of the project, USGS will make a substantial in-kind contribution of salary (446.8K) for PIs (6 mo. Arimitsu GS-12, 2 mo. Piatt GS-15), and in each year all the field equipment required (6K; nets, underwater cameras, field computers), SIMRAD split beam dual frequency hydroacoustic equipment (141K), Marel Marine Lab Scale (10K), CTD and EcoSampler (40K), and small boats (20K). We will also support aerial survey design and data analysis in conjunction with the HRM program lead.

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Speckman SG, Piatt JF, Mintevera C, Parrish J (2005) Parallel structure among environmental gradients and three trophic levels in a subarctic estuary. Prog Oceanogr 66:25–65

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Sydeman WJ, Piatt JF, Thompson SA, García-Reyes M, Hatch SA, Arimitsu ML, Slater L, Williams JC, Rojek NA, Zador SG, Renner HM Puffins reveal contrasting relationships between forage fish and ocean climate in the N. Pacific. Fish Oceanogr

Thayer J a., Bertram DF, Hatch SA, Hipfner MJ, Slater L, Sydeman WJ, Watanuki Y (2008) Forage fish of the Pacific Rim as revealed by diet of a piscivorous seabird: synchrony and relationships with sea surface temperature. Can J Fish Aquat Sci 65:1610–1622

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Zhao X (2003) Estimation and compensation models for the shadowing effect in dense fish aggregations. ICES J Mar Sci 60:155–163

PROJECT DATA ONLINE

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Mayumi L. Arimitsu, Ph.D.
Curriculum Vitae
Research Ecologist, USGS-Alaska Science Center
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EDUCATION

University of California, Santa Cruz CA	B.S. Biology (1998)
University of Alaska Fairbanks, Juneau AK	M.S. Fisheries (2009)
University of Alaska Fairbanks, Juneau AK	Ph.D Fisheries (2016)

TECHNICAL TRAINING

Secondary Education Credential Program, Humboldt State University, 2000
Wildlife and Fisheries Survey Design and Analysis, Oz Garton, 2008
Experimental Design, University of Alaska Fairbanks, 2008
Physical Oceanography, University of Alaska Fairbanks, 2008
Fish Population Dynamics, University of Alaska Fairbanks, Terry Quinn, 2008
Community Ecology, University of Alaska Fairbanks, 2011
Spatial Statistics, University of Alaska Fairbanks, 2012
Advanced R programming for Fisheries Statistics, University of Washington, 2013
Fisheries Acoustics, John Horne University of Washington, 2013

RELEVANT RESERACH EXPERIENCE

Monitoring Strategies to Improve Detection of Change in Forage Fish Stocks (2011- present). Co-Principal Investigator on the GWA long-term monitoring program in Prince William Sound. Designed surveys that include broad-scale aerial surveys coupled with hydroacoustic-trawl surveys to assess status and trends of prey species such as capelin, sand lance, juvenile herring, and krill.

Glacial-marine Ecosystem Studies (2004 – present). Principal Investigator on a program to investigate the influence of freshwater runoff from melting glaciers on seabirds and forage fish in the Gulf of Alaska. Work includes field measurements of oceanography, nutrient, zooplankton, fish and seabirds to model trophic interactions, and stable isotopes and radiocarbon to estimate the contribution of terrestrial subsidies to marine food webs.

Seabirds as Indicators of Forage Fish Stocks in Alaska (2012 – present). Collaborator on project that compiled historical data and collected new data on the feeding ecology of Puffins throughout coastal Alaska. Field work involved visiting colonies to collect prey samples, measure chick health, conduct at-sea surveys of marine bird density, hydroacoustic surveys for forage fish and other indices of marine habitat. These data along with historical data from more than 30 sites over 30 years contributed to analyses of geographic structure, temporal variability and marine habitat of key forage fish from southeast Alaska to the western Aleutians.

Kittlitz's Murrelet Distribution, Marine Habitat Use and Seasonal Movements (2008 – present). Co-Principal Investigator on a range-wide study of the breeding ecology of murrelets, which are seabird species of conservation concern. Used line transect methods to estimate abundance at sea, conducted hydroacoustic-trawl and oceanography surveys to identify characteristics of prey availability and marine habitat, used satellite tags to document post-breeding movement.

Forage Fish Ecology in the Aleutian Islands (2005 – 2010). Co-Principal Investigator during a large-scale forage fish and oceanography study that sampled 1500 km along the Alaska Peninsula and Aleutian Archipelago. I oversaw fishing, plankton and oceanography data collection efforts, data analysis and reporting.

Inventory and Monitoring in Southeast Alaska National Parks (2002 – 2006). Lead biologist during two inventory and monitoring projects in Alaska's national parks. I conducted a marine and estuarine fish inventory in Glacier Bay, Sitka, Klondike Gold, and Wrangell St. Elias National Parks, and was in charge of bottom and midwater trawl fishing operations, voucher specimen identification and curating, data analysis, interpretation, and reporting. I also led a ground-nesting marine bird inventory in Glacier Bay, and was responsible for all aspects of the work, including permitting, staffing, data collection, analysis and reporting.

SELECTED PUBLICATIONS

Arimitsu, M.L. 2016. Influence of Glaciers on Coastal Marine Ecosystems in the Gulf of Alaska. Dissertation. University of Alaska Fairbanks. 160 pp.

O'Neel, S., Hood, E., Bidlack, A., Fleming, S., Arimitsu, M., Arendt, A., Burgess, E., Sergeant, S. Beaudreau, A., Timm, K., Hayward, G., Reynolds, J. and Pyare, S. 2015. Icefield-to-Ocean Linkages across the Northern Pacific Coastal Temperate Rainforest Ecosystem. BioScience 65:499-512.

Fellman, J., Hood, E., Raymond, P., Hudson, J., Bozeman, M. and Arimitsu, M. 2015. Evidence for the assimilation of ancient glacier organic carbon in a proglacial stream food web. Limnology and Oceanography 60:1118-1128.

Arimitsu, M. and Piatt, J. 2015. Forage fish populations in Prince William Sound: Designing efficient monitoring techniques to detect change. In: Quantifying temporal and spatial variability across the Northern Gulf of Alaska to understand mechanisms of change (Hoem Neher et al., eds). Science Synthesis Report for the Gulf Watch Alaska Program, Anchorage AK. 247 pp.

Renner, M., M.L. Arimitsu, and J.F. Piatt. 2012. Structure of marine predator and prey communities along environmental gradients in a glaciated fjord. Canadian Journal of Fisheries and Aquatic Sciences. 69:2029-2045

Arimitsu, M.L., J.F. Piatt, E.N. Madison, J.S. Conaway, and N. Hillgruber. 2012. Oceanographic gradients and seabird prey community dynamics in glacial fjords. Fisheries Oceanography 21:148-169.

Arimitsu, M.L., J.F. Piatt, M.A. Litzow, A.A. Abookire, M.D. Romano, and M.D. Robards. 2008. Distribution and spawning dynamics of capelin (*Mallotus villosus*) in Glacier Bay, Alaska: A cold water refugium. Fisheries Oceanography 17:137-146.

Arimitsu, M. L., J. F. Piatt, M. D. Romano, and D. C. Douglas. 2007. Distribution of Forage Fishes in Relation to the Oceanography of Glacier Bay National Park. Pages 102–106 *in* J. F. Piatt and S. M. Gende, editors. Proceedings of the Fourth Glacier Bay Science Symposium. USGS Scientific Investigations Report 2007 – 5047.

COLLABORATIONS: Anne Beaudreau (UAF), Allison Bidlack (ACRC), Mary Anne Bishop (PWSSC), Gary Drew (USGS), Jason Fellman (UAS), Keith Hobson (University of Ottowa), Brielle Heflin (USGS), Eran Hood (UAS), Erica Madison (USGS), John Moran (NOAA), Franz Mueter (UAF), Shad O'Neel (USGS), Scott Pegau (PWSSC), John Piatt (USGS), Martin Renner (Tern Again Consulting), Sarah Schoen (USGS), Jan Straley (UAS), Bill Sydamen (Farralon's Institute), Darcy Webber (Quantifish, New Zealand)

John F. Piatt

Curriculum Vitae

Research Biologist (GS-15), Marine Ecology Project Leader, Alaska Science Center, U.S. Geological Survey, 4210 University Drive, Anchorage, Alaska, U.S.A. 99508.

E-mail: john_piatt@usgs.gov

Web: http://www.absc.usgs.gov/research/seabird_foragefish/index.html

ACADEMICS:

Affiliate Professor, School of Aquatic and Fisheries Sciences, University of Washington, Seattle.

Ph.D., Marine Biology, 1987, Department of Biology, Memorial University of Newfoundland, St. John's, Canada. Thesis: Behavioural Ecology of Common Murre and Atlantic Puffin Predation on Capelin: Implications for Population Biology.

B.Sc. (Hons.) Biochemistry, 1977, Memorial University of Newfoundland, St. John's, Canada.

RELEVANT RESEARCH EXPERIENCE

Functional Response of Seabirds to their Prey (1995-2015). Principal Investigator of integrated studies of oceanography, forage fish (seining, trawling, hydroacoustics), and seabirds (e.g., diets, breeding, foraging behavior, genetics, etc.) in and around seabird colonies in Prince William Sound, Cook Inlet, Gulf of Alaska, Aleutians and Bering Sea. Work with an international group of scientists to examine the global responses of seabirds to fluctuations in prey abundance.

Endangered Species Studies (2001-2015). Principal Investigator for studies on rare and threatened seabirds in Alaska, including Kittlitz's Murrelet, Marbled Murrelet and Short-tailed Albatross. Studies include detailed investigations of marine ecology, forage fish and habitat use, radio and satellite telemetry, physiology, surveys for distribution and abundance in Alaska, etc.

North Pacific Pelagic Seabird Database (2002-2015). Principal Investigator responsible for the compilation of ca. 350,000 transects that document the distribution of seabirds at sea in the North Pacific Ocean. Work is proceeding to map seabird distribution at different spatial scales, and relate distribution to currents, sea temperature, productivity and prey abundance.

Studies (1991- 1999, 2012-2015) on Tufted and Horned Puffin population and feeding ecology at 40 colonies in the Aleutian Archipelago and Gulf of Alaska (chick diets and growth, adult diets, seabird distribution at sea, hydroacoustic surveys).

Participated in 43 research cruises in 1977-2014 to study oceanography, plankton, forage fish and seabirds in the North Atlantic, Labrador Sea, eastern Canadian Arctic, North Central Pacific, Gulf of Alaska, Aleutians, Bering Sea and Chukchi Sea.

OTHER ACTIVITIES

Contributing Editor, Marine Ecology Progress Series (2007- current)

Science Panel, North Pacific Research Board, Anchorage, Alaska (2005-2011)

Past or Current advisor and/or graduate committee member for: A. Agness *U. Washington*; S. Speckman, *U. Washington*.; M. Romano, *Oregon State U.*; M. Robards, *Memorial U. Newfoundland*; T. Van Pelt, *U. Glasgow*; M. Litzow, *U. California, Santa Cruz*; A. Kitaysky, *U. Washington*; Ann Harding, *Sheffield U.;* K. Kuletz*, U. Victoria,* S. Zador*, U. Washington,* M. Renner*, U. Washington,* Mayumi Arimitsu, *U. Alaska, Fairbanks*, J. Lawonn, *Oregon State U.*, J. Cragg, *U. Victoria*.

SELECTED PUBLICATIONS:

Drew, G.S., Piatt J.F., and M. Renner. 2015. User's Guide to the North Pacific Pelagic Seabird Database 2.0; U.S. Geological Survey Open-File Report 2015-1123, 52pp.

Piatt, John F., Mayumi Arimitsu, William Sydeman, et al. 2015. Geographic structure of coastal marine food webs in the Alaskan North Pacific. Marine Ecology Progress Series. (*In review*)

Renner, M., J.K. Parrish, J.F. Piatt, K.J. Kuletz, A.E. Edwards, and G.L. Hunt, Jr. 2013. Modeled distribution and abundance of a pelagic seabird reveal trends in relation to fisheries. Marine Ecology Progress Series 484: 259-277.

Drew, G.S., J.F. Piatt, and D.F. Hill. 2012. Effects of currents and tides in fine-scale use of marine bird habitats in a Southeast Alaska hotspot. Marine Ecology Progress Series 487: 275-286.

Renner, M., M.L. Arimitsu, and J.F. Piatt. 2012. Structure of marine predator and prey communities along environmental gradients in a glaciated fjord. Canadian Journal of Fisheries and Aquatic Sciences 69: 2029-2045.

Arimitsu, M.L, J.F. Piatt, E.N. Madison, J.S. Conaway, N. Hillgruber. 2012. Oceanographic gradients and seabird prey community dynamics in a glacial fjord. Fisheries Oceanography. 21: 148-169.

Cury, P.M., I.L. Boyd, S. Bonhommeau, T. Anker-Nilssen, R.J.M. Crawford, R.W. Furness, J.A. Mills, E. Murphy, H. Osterblom, M. Paleczny, J.F. Piatt, J.P. Roux, L. Shannon, W.J. Sydeman. 2011. Global seabird responses to forage fish depletion – one-third for the birds. Science 334: 1703-1706.

Kitaysky, A.S., J. F. Piatt, S. A. Hatch, E.V. Kitaiskaia, Z. M. Benowitz-Fredericks, M.T. Shultz, and J.C. Wingfield. 2010. Food availability and population processes: severity of nutritional stress during reproduction predicts survival of long-lived seabirds. Functional Ecology. 24:625-637.

Shultz, M.T., J.F. Piatt, A.M. A. Harding, A.B. Kettle, T.I. Van Pelt. 2009. Timing of breeding and reproductive performance in murres and kittiwakes reflect mismatched seasonal prey dynamics. Marine Ecology Progress Series 393: 247-258.

Piatt, J.F., A.M.A. Harding, M. Shultz, S.G. Speckman, T. I. van Pelt, G.S. Drew, A.B. Kettle. 2007. Seabirds as indicators of marine food supplies: Cairns revisited. Marine Ecology Progress Series 352: 221-234.

Harding, A.M.A., Piatt, J.F., Schmutz, J.A., Shultz, M.T., Van Pelt, T.I., Kettle, A.B., and Speckman, S.G. 2007. Prey density and the behavioral flexibility of a marine predator: the Common Murre (*Uria aalge*). Ecology 88: 2024-2033.

Piatt, J.F., and A.M.A. Harding. 2007. Population Ecology of Seabirds in Cook Inlet. Pp. 335-352 *in*: Robert Spies (ed.), Long-term Ecological Change in the Northern Gulf of Alaska. Elsevier, Amsterdam.

Speckman, S., J.F. Piatt, C. Minte-Vera and J. Parrish. 2005. Parallel structure among environmental gradients and three trophic levels in a subarctic estuary. Progress in Oceanography 66: 25-65.

Litzow, M.A., J.F. Piatt, A.A. Abookire, and M. Robards. 2004. Energy density and variability in abundance of pigeon guillemot prey: support for the quality-variability tradeoff hypothesis. Journal of Animal Ecology 73: 1149-1156.

Abookire, A.A. and J.F. Piatt. 2005. Oceanographic conditions structure forage fishes into lipid-rich and lipid-poor communities in lower Cook Inlet, Alaska, USA. Marine Ecology Progress Series 287: 229-240.

COLLABORATORS Josh Adams (USGS), Mayumi Arimitsu (USGS), Alan Burger (U. Victoria, Canada), Robin Corcoran (USFWS), Philippe Cury (Ctr. Tropical Fish. Res., France), Vicki Friesen (Queen's U., Canada), Bob Furness (U. Glasgow, UK), Keith Hobson (U. Saskatchewan, Canada), David Irons (USFWS), Alexander Kitaysky (U. Alaska, Fairbanks), Kathy Kuletz (USFWS), Ellen Lance (USFWS), Bill Montevecchi (Memorial U., Canada), John Moran (NMFS), Scott Pegau (PWSSC), Bill Pyle (USFWS), Heather Renner (USFWS), Martin Renner (U. Wash.), Dan Roby (Oregon State U.), Jan Straly (UAS), Rob Suryan (OSU), William Sydeman (Farallon Inst.), Stephani Zador (NOAA).

Budget Category:	Proposed FY 17	Proposed FY 18	Proposed FY 19	Proposed FY 20	Proposed FY 21	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$122.0	$127.7	$135.5	$139.8	$146.7	$671.7	
Travel	$8.6	$7.3	$8.6	$7.3	$7.3	$39.0	
Contractual	$47.5	$47.5	$47.5	$47.5	$47.5	$237.5	
Commodities	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
Equipment	$4.3	$28.4	$11.4	$11.4	$11.4	$66.9	
SUBTOTAL	$182.4	$210.8	$203.0	$206.0	$212.8	$1,015.1	
General Administration (9% of subtotal)	$16.4	$19.0	$18.3	$18.5	$19.2	$91.4	N/A
PROJECT TOTAL	$198.8	$229.8	$221.3	$224.5	$232.0	$1,106.4	
Other Resources (Cost Share Funds)	$256.0	$256.0	$256.0	$256.0	$256.0	$1,280.0	

COMMENTS:
Over life of the project, USGS will make a substantial contribution of salary (446.8K) for PIs (6 mo. GS-12, 2 mo. GS-15), and in each year all the field equipment required including sampling nets (6K; purse seine, beach seine, cast nets), SIMRAD split beam dual frequency hydroacoustic equipment (141K), and small boats (20K). We will also support aerial survey design, vaildation and data analysis in conjunction with the HRM program.

FY17-21

Project Title: Forage Fish Monitoring
Primary Investigator: John Piatt & Mayumi Arimitsu
Agency: USGS

TRUSTEE AGENCY SUMMARY PAGE

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Piatt GS-15 (in-kind)	Team Leader	2.0	0.0	0.0	0.0
Arimitsu GS-12 (in-kind)	Project Leader	6.0	0.0	0.0	0.0
GS-9	Biologist & Data Manager	11.0	7.2	5.0	84.6
GS-7	Biologist	6.5	5.1	4.0	37.4
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	12.4	9.0	
				Personnel Total	$122.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Piatt Meeting: Airfare, hotel, M&IE	1.0	1	5	0.2	2.0
Arimitsu Meeting: Airfare, M&IE	0.6	1	4	0.2	1.4
Arimitsu Field: Airfare, hotel, M&IE	0.6	2	15	0.1	2.0
GS 9 Field Site: Airfare, M&IE	0.5	1	10	0.0	0.7
GS 9 Field Site: Airfare, M&IE	0.5	1	15	0.1	1.3
GS 7 Field Site: Airfare, M&IE	0.6	1	15	0.1	1.4
					0.0
					0.0
					0.0
					0.0
				Travel Total	$8.6

FY17

Project Title: Forage Fish Monitoring
Primary Investigator: John Piatt & Mayumi Arimitsu
Agency: USGS

FORM 4B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Stark - Zooplankton/euphausiid ID, enumeration and weights	6.3
UW Marine Chemisty Lab - nutrients	1.3
ISRC - Middleton Island	40.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$47.5

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY17

Project Title: Forage Fish Monitoring
Primary Investigator: John Piatt & Mayumi Arimitsu
Agency: USGS

FORM 4B CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
CTD calibration	1.0	3.3	3.3
other field supplies	1.0	1.0	1.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$4.3

Existing Equipment Usage: Description	Number of Units	Inventory Agency
SIMRAD 38-120 kHz split beam hydroacoustics system	1	USGS
RECON handheld data loggers, cameras	4	USGS
CastAway CTD	1	USGS
SBE19plus V2 + fluorometer/turb + PAR + Beam transmissometer + pH + DO + SBE55 autofire water sampler	1	USGS
Trawlmaster Net Sounder	1	USGS
Zooplankton sampling gear	1	USGS

FY17

Project Title: Forage Fish Monitoring
Primary Investigator: John Piatt & Mayumi Arimitsu
Agency: USGS

FORM 4B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Piatt GS-15 (in-kind)	Team Leader	2.0	0.0	0.0	0.0
Arimitsu GS-12 (in-kind)	Project Leader	6.0	0.0	0.0	0.0
GS-9	Biologist & Data Manager	11.0	7.6	5.0	88.6
GS-7	Biologist	6.5	5.4	4.0	39.1
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	13.0	9.0	
				Personnel Total	$127.7

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Piatt Meeting: Airfare, hotel, M&IE	1.0	1	5	0.2	2.0
Arimitsu Meeting: Airfare, M&IE	0.6	1	4	0.2	1.4
Arimitsu Field: Airfare, hotel, M&IE	0.6	2	15	0.1	2.0
Biologist Field (Middleton)	0.5	1	10	0.0	0.7
Biologist Field (Cordova)	0.5	1	15	0.1	1.3
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$7.3

FY18

Project Title: Forage Fish Monitoring
Primary Investigator: John Piatt & Mayumi Arimitsu
Agency: USGS

FORM 4B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
ISRC - Middleton Island	40.0
Stark - Zooplankton/euphausiid ID, enumeration and weights	6.3
UW marine chemistry dept - nutrients	1.3
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$47.5

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY18

Project Title: Forage Fish Monitoring
Primary Investigator: John Piatt & Mayumi Arimitsu
Agency: USGS

FORM 4B CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
EchoView Data Processing Software upgrade	1.0	24.1	24.1
CTD calibration			3.3
other field supplies			1.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$28.4

Existing Equipment Usage: Description	Number of Units	Inventory Agency
SIMRAD 38-120 kHz split beam hydroacoustics system	1	USGS
RECON handheld data loggers, cameras	4	USGS
CastAway CTD	1	USGS
SBE19plus V2 + fluorometer/turb + PAR + Beam transmissometer + pH + DO + SBE55 autofire water sampler	1	USGS
Trawlmaster Net Sounder	1	USGS
Zooplankton sampling gear	1	USGS

FY18

Project Title: Forage Fish Monitoring
Primary Investigator: John Piatt & Mayumi Arimitsu
Agency: USGS

FORM 4B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Piatt GS-15 (in-kind)	Team Leader	1.0	0.0	0.0	0.0
Arimitsu GS-12 (in-kind)	Project Leader	6.0	0.0	0.0	0.0
GS-9	Biologist & Data Manager	11.0	8.0	5.0	92.9
GS-7	Biologist	6.5	5.9	4.0	42.6
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	13.9	9.0	
				Personnel Total	$135.5

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Piatt Meeting: Airfare, hotel, M&IE	1.0	1	5	0.2	2.0
Arimitsu Meeting: Airfare, M&IE	0.6	1	4	0.2	1.4
Arimitsu Field: Airfare, hotel, M&IE	0.6	2	15	0.1	2.0
Biologist Field (Middleton)	0.5	1	10	0.0	0.7
Biologist Field (Cordova)	0.5	1	15	0.1	1.3
Biologist Field (Cordova)	0.6	1	15	0.1	1.4
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$8.6

FY19

Project Title: Forage Fish Monitoring
Primary Investigator: John Piatt & Mayumi Arimitsu
Agency: USGS

FORM 4B
PERSONNEL & TRAVEL
DETAIL

Contractual Costs: Description	Contract Sum
ISRC - Middleton Island	40.0
Stark - Zooplankton/euphausiid ID, enumeration and weights	6.3
UW Marine Chemistry Lab - nutrients	1.3
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$47.5

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY19

Project Title: Forage Fish Monitoring
Primary Investigator: John Piatt & Mayumi Arimitsu
Agency: USGS

FORM 4B CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
EchoView Data Processing Software annual upgrade			7.1
CTD calibration			3.3
other field supplies			1.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$11.4

Existing Equipment Usage: Description	Number of Units	Inventory Agency
SIMRAD 38-120 kHz split beam hydroacoustics system	1	USGS
Small boats (Naiad RIB, Zodiac)	2	USGS
RECON handheld data loggers	4	USGS
Inshore fish sampling gear (beach seine, cast-nets, purse seine)	4	USGS
CastAway CTD	1	USGS
SBE19plus V2 + fluorometer/turb + PAR + Beam transmissometer + pH + DO + SBE55 autofire water sampler	1	USGS
Trawlmaster Net Sounder	1	USGS
Zooplankton sampling gear	1	USGS

FY19

Project Title: Forage Fish Monitoring
Primary Investigator: John Piatt & Mayumi Arimitsu
Agency: USGS

FORM 4B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Piatt GS-15 (in-kind)	Team Leader	2.0	0.0	0.0	0.0
Arimitsu GS-12 (in-kind)	Project Leader	6.0	0.0	0.0	0.0
GS-9	Biologist & Data Manager	11.0	8.4	5.0	97.2
GS-7	Biologist	6.5	5.9	4.0	42.6
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	14.3	9.0	
				Personnel Total	$139.8

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Piatt Meeting: Airfare, hotel, M&IE	1.0	1	5	0.2	2.0
Arimitsu Meeting: Airfare, M&IE	0.6	1	4	0.2	1.4
Arimitsu Field: Airfare, hotel, M&IE	0.6	2	15	0.1	2.0
Biologist Field (Middleton)	0.5	1	10	0.0	0.7
Biologist Field (Cordova)	0.5	1	15	0.1	1.3
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$7.3

FY20

Project Title: Forage Fish Monitoring
Primary Investigator: John Piatt & Mayumi Arimitsu
Agency: USGS

FORM 4B
PERSONNEL & TRAVEL
DETAIL

Contractual Costs: Description	Contract Sum
ISRC - Middleton Island	40.0
Stark - Zooplankton/euphausiid ID, enumeration and weights	6.3
UW Marine Chemistry Lab - nutrients	1.3
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$47.5

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY20

Project Title: Forage Fish Monitoring
Primary Investigator: John Piatt & Mayumi Arimitsu
Agency: USGS

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
EchoView Data Processing Software annual upgrade			7.1
CTD calibration			3.3
other field supplies			1.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$11.4

Existing Equipment Usage: Description	Number of Units	Inventory Agency
SIMRAD 38-120 kHz split beam hydroacoustics system	1	USGS
Small boats (Naiad RIB, Zodiac)	2	USGS
RECON handheld data loggers	4	USGS
Inshore fish sampling gear (beach seine, cast-nets, purse seine)	4	USGS
CastAway CTD	1	USGS
SBE19plus V2 + fluorometer/turb + PAR + Beam transmissometer + pH + DO + SBE55 autofire water sampler	1	USGS
Trawlmaster Net Sounder	1	USGS
Zooplankton sampling gear	1	USGS

FY20

Project Title: Forage Fish Monitoring
Primary Investigator: John Piatt & Mayumi Arimitsu
Agency: USGS

FORM 4B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Piatt GS-15 (in-kind)	Team Leader	2.0	0.0	0.0	0.0
Arimitsu GS-12 (in-kind)	Project Leader	6.0	0.0	0.0	0.0
GS-9	Biologist & Data Manager	11.0	8.8	5.0	101.8
GS-7	Biologist	6.5	6.2	4.3	44.9
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	15.0	9.3	
				Personnel Total	$146.7

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Piatt Meeting: Airfare, hotel, M&IE	1.0	1	5	0.2	2.0
Arimitsu Meeting: Airfare, M&IE	0.6	1	4	0.2	1.4
Arimitsu Field: Airfare, hotel, M&IE	0.6	2	15	0.1	2.0
GS 9 Field Site: Airfare, M&IE	0.5	1	10	0.0	0.7
GS 9 Field Site: Airfare, M&IE	0.5	1	15	0.1	1.3
GS 7 Field Site: Airfare, M&IE	0.6	0	15	0.0	0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$7.3

FY21

Project Title: Forage Fish Monitoring
Primary Investigator: John Piatt & Mayumi Arimitsu
Agency: USGS

FORM 4B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
ISRC - Middleton Island	40.0
Stark - Zooplankton/euphausiid ID, enumeration and weights	6.3
UW Marine Chemistry Lab - nutrients	1.3
capelin sandlance otolith	0.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$47.5

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY21	Project Title: Forage Fish Monitoring Primary Investigator: John Piatt & Mayumi Arimitsu Agency: USGS	FORM 4B CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
EchoView Data Processing Software annual upgrade			7.1
CTD calibration			3.3
other field supplies			1.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$11.4

Existing Equipment Usage: Description	Number of Units	Inventory Agency
SIMRAD 38-120 kHz split beam hydroacoustics system	1	USGS
Small boats (Naiad RIB, Zodiac)	2	USGS
RECON handheld data loggers, cameras	4	USGS
Inshore fish sampling gear (beach seine, cast-nets, purse seine)	4	USGS
CastAway CTD	1	USGS
SBE19plus V2 + fluorometer/turb + PAR + Beam transmissometer + pH + DO + SBE55 autofire water sampler	1	USGS
Trawlmaster Net Sounder	1	USGS
Zooplankton sampling gear	1	USGS

FY21

Project Title: Forage Fish Monitoring
Primary Investigator: John Piatt & Mayumi Arimitsu
Agency: USGS

FORM 4B
EQUIPMENT DETAIL

August 24, 2016

Elise Hsieh, Executive Director
Exxon Valdez Oil Spill Trustee Council
4210 University Drive
Anchorage, AK 99508-4626

Dear Elise:

Final FY 2017-2021 Proposal Submittal for Long-term Monitoring

17120114-D. Continuous Plankton Recorder Monitoring of Plankton populations on the Alaskan Shelf

Gulf Watch Alaska, the long-term monitoring program of the *Exxon Valdez* Oil Spill Trustee Council (EVOSTC), has finalized our program and project proposals for fiscal years 2017-2021 funding based on comments received from EVOSTC's Science Panel on May 19, 2016. Below is the final budget summary and response to Science Panel comments for the Continuous Plankton Recorders project.

EVOSTC Funding Requested *(including 9% GA)*

FY17	FY18	FY19	FY20	FY21	TOTAL
$76,500	$78,800	$81,200	$78,200	$86,100	$400,800

Non-EVOSTC Funding Available

FY17	FY18	FY19	FY20	FY21	TOTAL
$183,700	$183,900	$186,300	$188,300	$190,300	$932,500

Science Panel comment: *The Panel notes this is a continuing time series of zooplankton information useful to a variety of other projects. The proposer (Batten) has a solid record of producing timely results, including a consistent dataset.*

PI Response:

- Thank you for the comment. The proposal was not revised.

Sincerely,

Mandy Lindeberg
Gulf Watch Alaska Program Lead designate

Attachment: Gulf Watch Alaska: Environmental Drivers Component Project Proposal: 17120114-D—Continuous Plankton Recorder monitoring of plankton populations on the Alaskan Shelf

EVOSTC FY17-FY21 INVITATION FOR PROPOSALS
PROGRAM PROJECT PROPOSAL SUMMARY PAGE

Project Title

Gulf Watch Alaska: Environmental Drivers Component Project:

17120114-D—Continuous Plankton Recorder monitoring of plankton populations on the Alaskan Shelf

Primary Investigator(s) and Affiliation(s)

Sonia Batten, Sir Alister Hardy Foundation for Ocean Science

Robin Brown, North Pacific Marine Science Organisation

Date Proposal Submitted

24 August 2016

Project Abstract

The Continuous Plankton Recorder (CPR) transect samples the Alaskan shelf from lower Cook Inlet across the slope into the open Gulf of Alaska, providing a record of taxonomically resolved, seasonal, near-surface zooplankton and large phytoplankton abundance over a wide spatial scale. Sampling takes place approximately monthly, six times per year, usually between April and September. Outputs from the project include indices of plankton abundance (e.g., large diatom abundances, estimated zooplankton biomass), seasonal cycles (phenology of key groups) and community composition (e.g., appearance of warm water species, change in dominance by some groups). Variability in any, or all, of these indices might be expected to flow-through to higher trophic levels such as herring, salmon, birds and mammals that forage across the region. Recent results show that interannual variability in plankton dynamics is high and plankton responded clearly and rapidly to the recent warm conditions, with changes evident in abundance, composition and timing.

EVOSTC Funding Requested *(must include 9% GA)*

FY17	FY18	FY19	FY20	FY21	TOTAL
$76.5	$78.8	$81.2	$78.2	$86.1	$400.8

Non-EVOSTC Funding Available

FY17	FY18	FY19	FY20	FY21	TOTAL
$183.7	$183.9	$186.3	$188.3	$190.3	$932.5

1. Executive Summary

The Continuous Plankton Recorder (CPR) transect samples the Alaskan shelf across the slope into the open Gulf of Alaska (GOA), providing a record of taxonomically resolved, seasonal, near-surface zooplankton and large phytoplankton abundance over a wide spatial scale (Figure 1). Many important species, including herring, salmon, birds and marine mammals forage in these regions of the shelf and GOA for at least some of their life history so an understanding of the productivity of these areas is important to understanding and predicting fluctuations in resource abundance. CPR sampling began in 2000 so there is now an adequate time series available to assess the impacts of climate variability. Natural, as well as human-related, processes known to influence this region are numerous. For example, on seasonal and interannual time scales the strength of the Alaskan shelf and Alaskan Coastal currents are mediated by freshwater run-off and winds (Royer 1979, Stabeno et al. 2004, Weingartner et al. 2005), persistent coastal down-welling in contrast to most eastern Pacific boundary regions, and eddy-mediated cross-shelf transport of organisms and nutrients (Okkonen et al. 2003, Ladd et al. 2005). Moderate to strong El Niño and La Niña events are also felt on the Alaskan Shelf (Weingartner et al. 2002). Regime shifts, which may be triggered by the climate processes described above, have periodically occurred with lower frequency, such as the 1976/77 shift which changed Alaskan fisheries from shrimp to fish dominated (Francis and Hare 1994). The sudden and unusual warming in the North Pacific in 2014-2015 has also caused widespread impacts on Alaskan marine ecosystems which are still being noted and assessed.

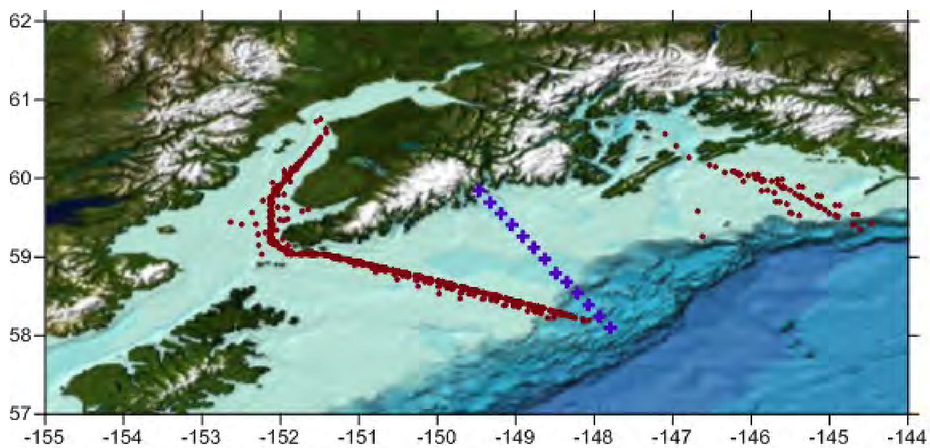

Figure 1. Location of historic CPR samples on the shelf (red dots) from 2000 to 2015 and the Seward Line stations (blue +). Since 2004 the transect has sampled into Cook Inlet and has a very consistent location.

With short generation times, limited mobility and lack of a commercial harvest, plankton often respond to changes in their environment more rapidly and less ambiguously than higher trophic levels, so that a relatively short time series of plankton information can provide insights into the responses of the shelf ecosystem to some of the processes described above. Any of, or a combination of, the physical processes described above can influence water column stability and nutrient availability which in turn affects plankton timing, composition and productivity. During the most recent period of funding the transition from cool conditions to unusually warm conditions occurred and changes in the plankton were quite dramatic. There was a change in the diatom community to species more favored by low nutrients, and cell counts were low. The zooplankton community was dominated by small species very early in the year in 2015, to levels not seen before in the time series (Figure 2) and the presence of jellyfish appears to be increasing. Strong relationships between plankton indices from the CPR and first year Prince William Sound (PWS) herring growth have recently been documented as a product of collaboration between the

Gulf Watch Alaska (GWA) and Herring Research and Monitoring programs (Batten et al. 2016). It is likely that the conditions in 2015 will not have been favorable for young herring.

Continued sampling of the CPR transect over the next 5 years will test the hypothesis that plankton communities have changed in response to several years of warming, and will additionally determine whether any returns to cool conditions also see a return to more typical sub-arctic plankton communities. The CPR will sample the same transect approximately monthly, 6 times per year, between about April and September providing sufficient temporal resolution to detect seasonal shifts as well as community composition changes. The transect links two of the other plankton sampling regions within the Environmental Drivers group, that of the Seward Line (Figure 1) and in Kachemak Bay, to provide a larger-scale context for these more intensive regional projects. With similar sampling frequency to the PWS oceanographic and zooplankton sampling, comparisons of lower trophic level fluctuations across the wider region will be made to examine responses to local and regional forcing.

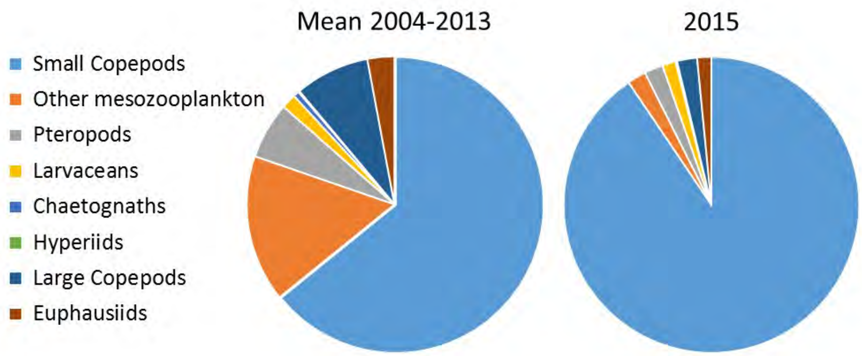

Figure 2. Zooplankton community composition in spring 2015 compared to the mean for 2004-2013, as a %. Before 2014 small copepods comprised 25-75%, but reached 82 and 91 % in 2014 and 2015, respectively.

The funding requested for CPR sampling is modest because of the consortium approach (the North Pacific CPR program is funded through a consortium managed by the North Pacific Marine Science Organization, PICES) and is less than half the actual cost of the data collection. The project has a proven track record with a high sampling success rate, all past deliverables have been fully met and there is a strong record of primary publications resulting from the program (see the list of publications in Batten's resume below).

2. Relevance to the Invitation for Proposals

This project specifically addresses the *Exxon Valdez* Oil Spill Trustee Council's (EVOSTC's) goal to determine "how factors other than oil may inhibit full recovery or adversely impact recovering resources" since the results will demonstrate how ocean climate variability, mediated through physical processes, causes variability in lower trophic levels. Plankton support the recovering resources either directly as a food source, as in the case of juvenile herring, or indirectly with intermediate trophic levels, but an assessment of plankton variability is essential to understanding fluctuations in resources of concern. This study contributes to the project of interest "An assessment of the transport of nutrients between the GOA and PWS and the effects on biological production over time". The addition of a further 5 years of data will extend the dataset to almost 20 years, a duration where relationships with longer lived higher trophic levels can start to be determined. CPR data are already provided as an annual summery to the National Oceanographic and Atmospheric Administration Ecosystems Considerations Report, a synthesis report used by fisheries managers, and this contribution will be continued. See http://access.afsc.noaa.gov/reem/ecoweb/index.cfm for previous reports.

3. Project Personnel

Dr. Sonia Batten
Scientific PI
Sir Alister Hardy Foundation for Ocean Science (SAHFOS)
C/o 4737 Vista View Crescent
Nanaimo, British Columbia, V9V 1N8, Canada
(250) 756-7747 (office)
soba@sahfos.ac.uk

Robin Brown
Administrative Lead
Executive Director
North Pacific Marine Science Organisation
P.O. Box 6000
9860 West Saanich Rd.
Sidney, British Columbia, V8L 4B2, Canada
(250) 363-6364 (office)
(250) 363-6827
Robin.Brown@pices.int
(CPR Funding Consortium administrator)

Please see 2 page CVs at end of this document

4. Project Design

A. Objectives

Objectives are unchanged from the previously funded project. The fundamental goal of this program is to provide consistent large spatial scale data on plankton populations of the Alaskan Shelf to extend the existing time series and integrate the data with other regional sampling. More specifically, we will provide monthly (spring to fall – typically April to September) sampling of zooplankton and large phytoplankton along the transect from the oceanic GOA to Cook Inlet, analyzing every 4th oceanic and every shelf sample to provide taxonomically resolved abundances.

B. Procedural and Scientific Methods

We do not propose to make any changes to the sampling regime that has been operating so successfully. The cargo vessel Matson (formerly Horizon) Kodiak will tow a CPR northbound towards Cook Inlet approximately once per month between about April and September each year to provide 6 samplings per year. The samples will be unloaded and the gear serviced each time by Alaskan technicians who have been trained by SAHFOS. SAHFOS is the world authority on CPR sampling. Sample processing will be carried out at the Canadian Department of Fisheries and Oceans (DFO) laboratory in Sidney, BC and at the SAHFOS laboratory in the UK, as before. Briefly, the CPR is deployed from the stern of the volunteer vessel once it has cleared port and is underway (or when the Captain deems it is safe to do so) and is towed behind the vessel on a fixed length cable so that it samples the surface mixed layer at a depth of about 7m. Water enters the front of the CPR, passes along a tunnel and through a silk filtering mesh (with a mesh size of 270μm) which retains the plankton and allows the water to exit at the back of the machine. The movement of the CPR through the water turns an external propeller which, via a drive shaft and gear-box, moves the filtering mesh across the tunnel. As the filtering mesh leaves the tunnel it is covered by a second band of mesh so that the plankton are sandwiched between these two layers, which then wind on into a storage chamber containing preservative. The CPR is normally deployed in Juan de Fuca Strait and recovered in Cook Inlet at around 60°N or at the Captain's discretion. The ship's officers record launch and recovery times and positions and all course changes. At the end of the tow the machine is returned to the laboratory and using the information from the ship's log the transect is reconstructed and the mesh is marked into separate samples, each representing 18.5 km of tow and about 3m3 of seawater filtered.

The first step is the assessment of phytoplankton colour (the greenness of the sample) which is a representation of the total phytoplankton biomass and includes the organisms that are too fragile to survive the sampling process intact but which leave an impression on the mesh (see Raitsos et al. 2013 for more information on this index). The assessment is made against a standard colour chart, into one of 4 colour categories. The mesh is then cut into separate samples which are randomly distributed amongst a team of analysts for taxonomic assessment. Hard-shelled phytoplankton are semi-quantitatively determined under a microscope by viewing 20 fields of view and recording the presence of all the different taxa in each field. Small zooplankton are identified and counted from a subsample (1/49 of the sample) whilst all zooplankton larger than about 2 mm are counted with no subsampling, unless numbers are very large. Identification is carried out to the highest practicable taxonomic level and is a compromise between speed of analysis and scientific interest. Since copepods make up the majority of the zooplankton most copepods are identified to species level whilst other groups are generally identified to a lower level. Although CPR sampling is continuous, the midpoint of the sample is used to label it with latitude, longitude, time and date. Quality Control of analysis also follows SAHFOS standard protocols; briefly, results from adjacent samples are compared and inconsistencies checked, and if necessary corrected, before the sample data are finalised and released. All of the samples are archived after analysis so that they can be re-examined at any time, or used for additional analyses (molecular studies and stable isotope analyses are now possible, for example).

Summary indices such as 'mesozooplankton biomass' and 'total diatom abundance' are routinely calculated from the abundance data. Temperature loggers have been fitted to the CPRs since 2011 and we are endeavoring to maintain in situ temperature data collection on this transect.

C. Data Analysis and Statistical Methods

The sampling frequency and spacing is suitable to characterize seasonal, interannual and spatial variability in the plankton at the mesoscale. Large scale patchiness (on the order of 10s to 100s of kms) needs to be considered as a factor that may contribute to observed variability in the plankton data. The greatest resolution possible from CPR data is 18.5 km, however, to maximise coverage with the resources available we process samples spaced 74 km in the open ocean (every fourth sample being processed) but all samples on the shelf. An individual sample will pass through small patches of plankton and so provide an 'average' of the small-scale patchiness. We have established the decorrelation length-scales for common taxa from data collected early in the survey (2000) and determined that samples that are spaced well apart, such as every 74 km, are likely to be representative and not likely to be within or outside of a patch.

Our methodology has remained unchanged since the survey's inception so comparisons with previously collected CPR data are straightforward. Comparisons with other plankton sampling are more problematic as each sampling system has a bias of some sort caused by, for example, mesh size, depth of sampling, taxonomic resolution. However, by using indices such as anomalies and pooling taxa to create functional groups useful comparisons can be made. The Environmental Drivers group has made some progress in this regard and as the individual time series lengthen such comparisons will be more robust and informative.

D. Study Area

The project will sample waters on a transect leaving from the Straits of Juan de Fuca outside of Puget Sound (48.45°N, 125°W, Captain's discretion) across the GOA to Cook Inlet and Anchorage. Sampling will end at about 60ºN, 151.9°W (at Captain's discretion). See Figure 1 above for a map of the northern end of the transect. It intersects with the outermost Seward line stations and also samples outside of Kachemak Bay in Cook Inlet, thereby linking with two other Environmental Drivers sampling locations. Ship tracks vary minimally from month to month.

5. Coordination and Collaboration

Within the Program

This project provides a spatial link between the locally more intensive (but less seasonally resolved) sampling of lower trophic levels from the Seward line and Kachemak Bay within the Environmental Drivers Component. Although there are differences in sampling design in each place, necessitated by the different sampling conditions, there are techniques available to facilitate integration, as mentioned above. The CPR data can also provide information on seasonal timing changes which will help with interpretation. The time series in PWS offers a chance to compare variability across the wider region and examine the degree to which the outer shelf may influence the Sound. There is thus strong collaboration within the Environmental Drivers group. Productivity of the plankton populations directly influences the organisms monitored by the Pelagic Component, and will be a necessary contribution to their studies. Nearshore studies are perhaps harder to link directly, but many benthic invertebrates have a planktonic phase. We have already provided a subset of CPR data to other GWA PIs summarising the meroplankton to examine the long-term variability in larvae, and we expect such collaboration to continue.

With Other EVOSTC-funded Programs and Projects

We have actively collaborated with the Herring Research and Monitoring program in the most recent funding period, and a publication has been produced (Batten et al. 2016). These time series will be updated during this project, and as they lengthen we expect further insights, especially in light of the unusually warm conditions currently being experienced.

With Trustee or Management Agencies

There are no planned or required collaborations with other management agencies at this time.

With Native and Local Communities

Servicing is provided in Anchorage by Kinnetic Laboratories, the volunteer vessel officers and crew are strong supporters of the project and pleased to be participating, providing some local involvement.

6. Schedule

Program Milestones

Objective 1. Sample collection on the transect from Cook Inlet to Puget Sound will begin in spring 2017 and continue approximately monthly through to August/September 2017 (6 transects will be sampled). This schedule will be repeated each year to 2021. All shelf samples will be processed and every 4th oceanic sample.

Objective 2. A subset of samples (25%) will be processed within 3 months of collection at the Institute of Ocean Sciences (DFO, Canada) and results from this processing (e.g., estimated mesozooplankton biomass and comparisons with data from previous years) will be available in progress reports and on the project website as soon as practicable. Full, quality controlled data from 2017 will be available by July 2018, and in a similar fashion in subsequent years (e.g. July 2019 for data collected within 2018). Data will be publicly available through the GWA data portal:

http://portal.aoos.org/gulf-of-alaska.php#metadata/87f56b09-2c7d-4373-944e-94de748b6d4b/project/files

and also directly from S. Batten on request.

MEASURABLE PROGRAM TASKS

Measurable project tasks are presented by fiscal year and quarter graphically in Table 1 and descriptively below.

Table 1. Project tasks and activities by fiscal year and quarter, beginning February 1, 2017.

	FY17				FY18				FY19				FY20				FY21			
Task	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Sample Collection																				
CPR shipment	X				X				X				X				X			
Transect sampling	X	X	X		X	X	X		X	X	X		X	X	X		X	X	X	
CPR winter overhaul			X				X				X				X				X	
Sample Processing																				
Sampling results		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Reporting																				
Progress reports			X				X				X				X				X	
Annual reports					X				X				X				X			
Annual PI meeting				X				X				X				X				X
FY work plan (DPD)			X				X				X				X					

FY 2017 (Year 6)

FY 17, 1st quarter (February 1, 2017 - April 30, 2017)
February: *Shipping of serviced CPR from UK to Matson Kodiak*
Mar/April: *First transect sampled*

FY 17, 2nd quarter (May 1, 2017 - July 31, 2017)
May-July: *Three transects sampled*
June: *First results from 2017 sampling, ongoing hereafter*
July: *Finalised data from previous year completed*

FY 17, 3rd quarter (August 1, 2017 - October 31, 2017)
Aug-Sept: *Two transects sampled, CPR shipped back to UK for winter overhaul*
August: *Submit progress report*

FY 17, 4th quarter (November 1, 2017 - January 31, 2018)
November: *Attend PI meeting*

December: *Processing and initial analysis of samples collected in summer/fall 2017 will be completed*
January: *Attend Alaska Marine Science Symposium and PI meeting.*
Prepare annual report

FY 2018 (Year 7)

FY 18, 1st quarter (Feb 1, 2018 - April 30, 2018)
February: *Shipping of serviced CPR from UK to Matson Kodiak*
Mar/April: *First transect sampled*

FY 18, 2nd quarter (May 1, 2018 - July 31, 2018)
May-July: *Three transects sampled*
June: *First results from 2018 sampling, ongoing hereafter*
July: *Finalised data from previous year completed*

FY 18, 3rd quarter (August 1, 2018 - October 31, 2018)
Aug-Sept: *Two transects sampled, CPR shipped back to UK for winter overhaul*
August: *Submit progress report*

FY 18, 4th quarter (November 1, 2018 -January 31, 2019)
November: *Attend PI meeting*
December: *Processing and initial analysis of samples collected in summer/fall 2018 will be completed*
January: *Attend Alaska Marine Science Symposium and PI meeting*
Prepare annual report

FY 2019 (Year 8)

FY 19, 1st quarter (Feb 1, 2019 - April 30, 2019)
February: *Shipping of serviced CPR from UK to Matson Kodiak*
Mar/April: *First transect sampled*

FY 19, 2nd quarter (May 1, 2019 - July 31, 2019)
May-July: *Three transects sampled*
June: *First results from 2019 sampling, ongoing hereafter*
July: *Finalised data from previous year completed*

FY 19, 3rd quarter (August 1, 2019 - October 31, 2019)
Aug-Sept: *Two transects sampled, CPR shipped back to UK for winter overhaul*
August: *Submit progress report*

FY 19, 4th quarter (November 1, 2019 -January 31, 2020)
November: *Attend PI meeting*
December: *Processing and initial analysis of samples collected in summer/fall 2019 will be completed*
January: *Attend Alaska Marine Science Symposium and PI meeting*
Prepare annual report

FY 2020 (Year 9)

FY 20, 1st quarter	(Feb 1, 2020 - April 30, 2020)
February:	*Shipping of serviced CPR from UK to Matson Kodiak*
Mar/April:	*First transect sampled*
FY 20, 2nd quarter	(May 1, 2020 - July 31, 2020)
May-July:	*Three transects sampled*
June:	*First results from 2020 sampling, ongoing hereafter*
July:	*Finalised data from previous year completed*
FY 20, 3rd quarter	(August 1, 2020 - October 31, 2020)
Aug-Sept:	*Two transects sampled, CPR shipped back to UK for winter overhaul*
August:	*Submit progress report*
FY 20, 4th quarter	(November 1, 2020 -January 31, 2021)
November:	*Attend PI meeting*
December:	*Processing and initial analysis of samples collected in summer/fall 2020 will be completed*
January:	*Attend Alaska Marine Science Symposium and PI meeting*
	Prepare annual report

FY 2021 (Year 10)

FY 21, 1st quarter	(Feb 1, 2020 - April 30, 2021)
February:	*Shipping of serviced CPR from UK to Matson Kodiak*
Mar/April:	*First transect sampled*
FY 21, 2nd quarter	(May 1, 2021 - July 31, 2021)
May-July:	*Three transects sampled*
June:	*First results from 2021 sampling, ongoing hereafter*
July:	*Finalised data from previous year completed*
FY 21, 3rd quarter	(August 1, 2021 - October 31, 2021)
Aug-Sept:	*Two transects sampled, CPR shipped back to UK for winter overhaul*
August:	*Submit progress report*
FY 21, 4th quarter	(November 1, 2021 -January 31, 2022)
November:	*Attend PI meeting*
December:	*Processing and initial analysis of samples collected in summer/fall 2021 will be completed*
January:	*Attend Alaska Marine Science Symposium and PI meeting*
	Prepare annual report

7. Budget

BUDGET FORMS (ATTACHED)

Completed budget forms are attached.

SOURCES OF ADDITIONAL FUNDING

The North Pacific CPR survey is supported by a Consortium managed by PICES, of which the EVOSTC is a member. There are two CPR transects in the survey, one of which is not in the *Exxon Valdez* oil spill affected area and which is supported by the other Consortium members. Costs included in the budget are estimated at 40% of the full costs of acquiring data along the north-south transect shown in Figure 1. Other members of the Consortium which contribute to this transects costs are:

The North Pacific Research Board (NPRB) contributes funding at a similar annual level to that requested here, through the NPRBs Long Term Monitoring Program. We are currently in Year 2 of a 20-year commitment.

The DFO contributes $50k annually as well as in-kind support by providing laboratory facilities at the DFO lab in Sidney, BC.

The CPR parent organization, SAHFOS, is also providing salary support for some of the UK-based personnel, and in-kind support through sample archiving and curation.

Owing to the differing financial year cycles of each organisation, contributing funds per EVOSTC fiscal year from each source have been estimated as best we can.

LITERATURE CITED

Batten, S.D., Moffitt, S., Pegau, W.S., and Campbell, R. 2016. Plankton indices explain interannual variability in Prince William Sound herring first year growth. Fish. Oceanogr. 25:420-432.

Batten, S.D., Clarke, R.A., Flinkman, J., Hays, G.C., John, E.H., John, A.W.G., Jonas, T.J., Lindley, J.A., Stevens, D.P., Walne, A.W. 2003. CPR sampling – The technical background, materials and methods, consistency and comparability. Progress in Oceanography 58:193-215.

Francis, R. C. and Hare, S.R. 1994. Decadal-scale regime shifts in the large marine ecosystems of the Northeast Pacific: a case for historical science. Fish. Oceanogr. 3:279-291.

Ladd, C., N. B. Kachel, C. W. Mordy, and P. J. Stabeno. 2005. Observations from a Yakutat eddy in the northern Gulf of Alaska, Journal of Geophysical Research – Oceans, 110, C03003, doi: 03010.01029/02004JC002710.

Okkonen, S.R., Weingartner, T.J., Danielson, S.L., and Musgrave, D.L. (2003) Satellite and hydrographic observations of eddy-induced shelf-slope exchange in the northwestern Gulf of Alaska. Journal of Geophysical Research, 108 (C2), 3033, doi:10.1029/2002JC001342.

Raitsos, D.E., Walne, A., Lavender, S.J., Licandro, P., Reid, P.C., and Edwards, M. 2013. A 60-year ocean colour data set from the Continuous Plankton Recorder. Journal of Plankton Research, 35(1):158–164

Royer, T.C. 1979. On the effect of precipitation and runoff on coastal circulation in the Gulf of Alaska. J. Phys. Oceanogr. 9:555–563.

Stabeno, P.J., Bond, N.A., Hermann, A.J., Kachel, N.B., Mordy, C.W. and Overland, J.E. 2004. Meteorology and oceanography of the Northern Gulf of Alaska, Continental Shelf Research 24:859-897.

Weingartner, T.J., Danielson, S.L. and Royer, T.C. 2005. Freshwater variability and predictability in the Alaska Coastal Current, Deep Sea Research Part II: Topical Studies in Oceanography, Volume 52, Pages 169-191.

Weingartner, T. J., K. O. Coyle, B. Finney, R. Hopcroft, T. Whitledge, R. D. Brodeur, M. Dagg, E. Farley, D. Haidvogel, L. Haldorson, A. Herman, S. Hinckley, J. M. Napp, P. J. Stabeno, T. Kline, C. Lee, E. Lessard, T. Royer, S. Strom. 2002. The Northeast Pacific GLOBEC Program: Coastal Gulf of Alaska. Oceanography 15:48-63

Resume: Sonia Dawn Batten Ph.D.

Sir Alister Hardy Foundation for Ocean Science (SAHFOS)
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Nanaimo, British Columbia, V9V 1N8, Canada

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Qualifications

1990–1994. PhD. Marine Biology. 'Correlative studies of the ecophysiology and community structure of benthic macrofauna' Southampton University, UK.

1987–1990. BSc. Honours Degree in Oceanography with Biology, 2(i). Southampton Uni., UK

Career History

2000 to present. Part-time Research Fellow. SAHFOS.

2003 and 2004. Temporary Instructor, Malaspina University College, Fisheries and Aquaculture program.

1996–2000. Assistant Director. SAHFOS, UK

1994–1996. Postdoctoral Research Fellow. SAHFOS, UK

Current Activities

During the past 23 years I have been working with the Continuous Plankton Recorder Survey through the Sir Alister Hardy Foundation for Ocean Science. Since 2000 I have been based in western Canada, co-ordinating the north Pacific CPR survey which in 2008 became the N. Pacific CPR Consortium under PICES. My main research focus has been the mesozooplankton; their distribution, ecology and role in the upper pelagic ecosystem. Since Sept 2015 I have also been the Chair of the Global Alliance of CPR Surveys.

Five Recent Publications

Batten, S.D., Moffitt, S., Pegau, W.S., and Campbell, R. (2016) Plankton indices explain interannual variability in Prince William Sound herring first year growth. Fisheries Oceanography 25, 420-432.

Batten, S.D., and Gower, J.F.R. (2014). Did the iron fertilization near Haida Gwaii in 2012 affect the pelagic lower trophic level ecosystem? J. Plankton Res., 39, 925-932.

Rooper, C.N., J.L. Boldt, S.D. Batten & C. Gburski. (2012). Growth and production of Pacific ocean perch (Sebastes alutus) in nursery habitats of the Gulf of Alaska. Fisheries Oceanography 21, 415-429.

Batten, S.D and Walne, A.W. (2011) Variability in northwards extension of warm water copepods in the NE Pacific. Journal of Plankton Research 33, 1643-1653.

Batten, S.D., and Mackas, D.L. (2009) Shortened duration of the annual Neocalanus plumchrus biomass peak in the Northeast Pacific. Marine Ecology Progress Series. 393, 189-198.

Relevant Other Publications

Chiba, S., Batten, S., Sasaoka, K., Sasai, Y., and Sugisaki, H. (2012). Influence of the Pacific Decadal Oscillation on phytoplankton phenology and community structure in the western North Pacific. Geophysical Research Letters 39, L15603, doi:10.1029/2012GL052912

Batten, S.D and Burkill, P.H. (2010) The Continuous Plankton Recorder: towards a global perspective. Journal of Plankton Research 2010 32: 1619-1621

Mackas, D.L., Batten, S.D., and Trudel, M., (2007) Effects on zooplankton of a warming ocean: recent evidence from the Northeast Pacific. Progress in Oceanography, 75, 223-252

Batten, S.D. and Freeland, H.J. (2007). Plankton populations at the bifurcation of the North Pacific Current. Fisheries Oceanography, 16, 536-646.

Batten, S.D and Crawford, W.R. (2005). The influence of coastal origin eddies on oceanic plankton distributions in the eastern Gulf of Alaska. Deep Sea Research II, 52, 991-1009.

Collaborators during the last 4 years (excludes Gulf watch PIs not published with)

Boldt, Jennifer, DFO Canada
Campbell, Robert, PWSSC
Chiba, Sanae JAMSTEC, Japan
Gower, John, DFO Canada
Moffit, Steve, ADF&G
Pegau, Scott, PWSSC
Rooper, Christopher, NOAA
Sugisaki, Hiroya, FRA, Japan
Walne, Anthony, SAHFOS
Yoshiki, Tomoko, JAMSTEC, Japan

Curriculum Vitae
Robin M. Brown

Personal Information

Full Name: Robin Middleton Brown
Date of Birth: July 18, 1954
Work Address: North Pacific Marine Science Organization (PICES)
P.O. Box 6000
9860 West Saanich Rd.
Sidney, British Columbia
V8L 4B2
ph: (250) 363-6364
fax: (250) 363-6827
email: Robin.Brown@pices.int

1976 Graduated from the University of British Columbia with a Bachelor of Science (Marine Biology) degree.

Employment:

February, 2015 – present	Executive Secretary, North Pacific Marine Science Organization (PICES)
August, 1999 to February, 2015	Division/Research Manager - Ocean Sciences Division at the Institute of Ocean Sciences Department of Fisheries and Oceans – Science Branch).
February, 1992 to August, 1999	Oceanographic Data Manager at the Institute of Ocean Sciences (Department of Fisheries and Oceans).
June, 1985 to January, 1991	Multidisciplinary Oceanographer with the Ocean Ecology Group at the Institute of Ocean Sciences (Department of Fisheries and Oceans).
May 1979-June 1985	Oceanographer with Seakem Oceanography Ltd., Sidney, B.C. (now AXYS Environmental Consulting Ltd.)
1976-1979:	Research Assistant - University of British Columbia

Awards and Recognition:

2012 - Deputy Minister's Commendation for efforts in support of the Cohen Commission of Inquiry into the Decline of Sockeye Salmon in the Fraser River.
2010 - Assistant Deputy Minister's Distinction Award for contributions to / coordination of the visit of the Emperor and Empress of Japan to the Institute of Ocean Sciences.
2009 - DFO Prix d'Excellence for contributions to the team that worked to have Bowie Seamount designated as a Marine Protected Area
1993 - Deputy Minister's Commendation for contributions to the Fisheries Management Information Study Team

International Experience:

North Pacific Marine Science Organization (PICES):

- Canadian delegate to the Governing Council (appointed in 2013)
- Member of the Finance and Administration Committee (appointed in 2012)
- Chair of the Advisory Panel on Status, Outlooks, Forecasts and Engagement (AP-SOFE) from 2009-2012. Continuing appointment as a member of this Advisory Panel since 2012.
- Chair of the Technical Committee on Data Exchange (TCODE) from 1995 – 2001. Continuing appointment as a member of this Committee since 2001.
- Chair of the Study Group on Ecosystem Status Reporting (2006-2007)
- Member of Science Board (1995-2001; 2009; 2012)
- Attended every PICES Annual Meeting since 1995 (PICES IV) and several other intersessional meetings and special PICES symposia
- Chairman of Local Organizing Committee for PICES-2007 in Victoria, B.C.

North Pacific Anadromous Fish Commission (NPAFC)

- Appointed as Lead Commissioner for Canada in 2013
- Lead Canadian representative on the Finance and Administration Committee.
- Elected as Vice- Chairman in May 2014

Coordinator – Visit of the Emperor and Empress of Japan to the Institute of Ocean Sciences (2007):
Canadian Representative – APEC Marine Resource Conservation Task Team (1995-1997)
Advisor – International GLOBEC Program – data management policy and practices (1994-1996)

Teamwork and Interagency Coordination:

Member of the Science Team providing analysis and advice to Fisheries and Oceans Canada for the Cohen Commission of Inquiry.

Co-chair of the Science and Monitoring Committee of the Federal-Provincial Japan Tsunami Debris Coordinating Committee (2012 – present).

Selected Publications and Reports

- Smith, J.N., **R.M. Brown**, W.J. Williams, M. Robert, R. Nelson and S.B. Moran. 2014. Arrival of the Fukushima radioactivity plume in North American continental waters. PNAS February 3, 2015 vol. 112 no. 5 pp. 1310-1315
- Chen, J., M.W. Cooke, J. Mercier, B. Ahier, M. Trudel, G. Workman, M. Wyeth and **R. Brown**. 2014. A report on radioactivity measurements of fish samples from the west coast of Canada. Radiat. Prot. Dosimetry .doi:10.1093/rpd/ncu150
- Lucas, B.G., Verrin, S., and **Brown, R**. (Editors). 2007. Ecosystem overview: Pacific North Coast Integrated Management Area (PNCIMA). Can. Tech. Rep. Fish. Aquat. Sci. 2667: xii + 105 p

Collaborators:
N/A

Budget Category:	Proposed FY 17	Proposed FY 18	Proposed FY 19	Proposed FY 20	Proposed FY 21	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$35.82	$36.89	$38.00	$39.1	$40.3	$190.2	
Travel	$1.11	$1.15	$1.18	$1.22	$1.25	$5.9	
Contractual	$9.97	$10.26	$10.57	$10.89	$11.22	$52.9	
Commodities	$3.24	$3.34	$3.44	$0.0	$3.65	$13.7	
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
Indirect Costs (*40%*)	$ 20	$ 21	$ 21	$ 20	$ 23	$105.1	
SUBTOTAL	$70.2	$72.3	$74.5	$71.7	$79.0	$367.7	
General Administration (9% of subtotal)	$6.3	$6.5	$6.7	$6.5	$7.1	$33.1	N/A
PROJECT TOTAL	$76.5	$78.8	$81.2	$78.2	$86.1	$400.8	
Other Resources (Cost Share Funds)	$183.7	$183.9	$186.3	$188.3	$190.3	$801.6	

COMMENTS:
The North Pacific CPR survey is supported by a Consortium managed by the North Pacific Marine Science Organisation, of which the EVOS TC is a member. Costs included here are estimated at 40% of the full costs of acquiring data along the north-south transect. The remining funds will come from the consortium which currently includes the NPRB, Canadian Dept Fisheries and Oceans and SAHFOS.

FY17-21

Project Title: CPR sampling of the GoA
Primary Investigator: Sonia Batten

NON-TRUSTEE AGENCY SUMMARY PAGE

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
S Batten	Long term monitoring of zooplankton	1.2	8.4		10.1
Doug Moore	populations on the Alaskan Shelf and Gulf	1.4	6.2		8.7
Technicians - workshop	of Alaska using Continuous Plankton recorders	0.3	6.1		1.8
Technicians - analysts		2.0	5.7		11.4
D Stevens		0.3	6.4		2.1
D. Wilson		0.2	8.4		1.7
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	41.3	0.0	
				Personnel Total	$35.8

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
Portion of PI's travel to PI meetings					1.1
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$1.1

FY17

Project Title: CPR sampling of the GoA
Primary Investigator: Sonia Batten

FORM 3B
PERSONNEL & TRAVEL
DETAIL

Contractual Costs: Description	Contract Sum
Portion of local CPR servicing in Anchorage	2.8
Portion of CPR leasing	3.8
Portion of computing services	0.2
Portion of website maintenance by PICES	0.5
Portion of tow payment to ship	0.8
Shipping of gear	1.5
Shipping of samples	0.4
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$10.0

Commodities Costs: Description	Commodities Sum
lab consumables	0.9
Filtering mesh	1.9
Tow wires	0.5
Commodities Total	$3.2

FY17	Project Title: CPR sampling of the GoA Primary Investigator: Sonia Batten	FORM 3B CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
existing CPRs will be used. Lease costs charged above cover replacement/repair	1	SAHFOS
external bodies	1	SAHFOS
internal mechanisms	3	SAHFOS
Temperature recorder	1	SAHFOS
Existing microscopes will also be used, (including one purchased in FY03)	7	SAHFOS

FY17

Project Title: CPR sampling of the GoA
Primary Investigator: Sonia Batten

FORM 3B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
S Batten	Long term monitoring of zooplankton	1.2	8.7		10.4
Doug Moore	populations on the Alaskan Shelf and Gulf	1.4	6.4		9.0
Technicians - workshop	of Alaska using Continuous Plankton recorders	0.3	6.2		1.9
Technicians - analysts		2.0	5.9		11.8
D Stevens		0.3	6.6		2.1
D. Wilson		0.2	8.7		1.7
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	42.5	0.0	
				Personnel Total	$36.9

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
Portion of PI's travel to PI meetings					1.1
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$1.1

FY18

Project Title: CPR sampling of the GoA
Primary Investigator: Sonia Batten

FORM 3B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Portion of local CPR servicing in Anchorage	2.9
Portion of CPR leasing	3.9
Portion of computing services	0.2
Portion of website maintenance by PICES	0.5
Portion of tow payment to ship	0.8
Shipping of gear	1.5
Shipping of samples	0.4
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$10.3

Commodities Costs: Description	Commodities Sum
lab consumables	0.9
filtering mesh	2.0
Tow wires	0.5
Commodities Total	$3.3

FY18	Project Title: CPR sampling of the GoA Primary Investigator: Sonia Batten	FORM 3B CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
existing CPRs will be used. Lease costs charged above cover replacement/repair	1	
external bodies	1	
internal mechanisms	3	
Temperature recorder	1	
Existing microscopes will also be used, (including one purchased in FY03)	7	

FY18

Project Title: CPR sampling of the GoA
Primary Investigator: Sonia Batten

FORM 3B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
S Batten	Long term monitoring of zooplankton	1.2	8.9		10.7
Doug Moore	populations on the Alaskan Shelf and Gulf	1.4	6.6		9.3
Technicians - workshop	of Alaska using Continuous Plankton recorders	0.3	6.4		1.9
Technicians - analysts		2.0	6.1		12.1
D Stevens		0.3	6.8		2.2
D. Wilson		0.2	8.9		1.8
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	43.8	0.0	
				Personnel Total	$38.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
Portion of PI's travel to PI meetings					1.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$1.2

FY19

Project Title: CPR sampling of the GoA
Primary Investigator: Sonia Batten

FORM 3B
PERSONNEL & TRAVEL
DETAIL

Contractual Costs: Description	Contract Sum
Portion of local CPR servicing in Anchorage	3.0
Portion of CPR leasing	4.0
Portion of computing services	0.2
Portion of website maintenance by PICES	0.5
Portion of tow payment to ship	0.8
Shipping of gear	1.6
Shipping of samples	0.4
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$10.6

Commodities Costs: Description	Commodities Sum
lab consumables	0.9
filtering mesh	2.0
Tow wires	0.5
Commodities Total	$3.4

FY19

Project Title: CPR sampling of the GoA
Primary Investigator: Sonia Batten

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
existing CPRs will be used. Lease costs charged above cover replacement/repair	1	
external bodies	1	
internal mechanisms	3	
Temperature recorder	1	
Existing microscopes will also be used, (including one purchased in FY03)	7	

FY19

Project Title: CPR sampling of the GoA
Primary Investigator: Sonia Batten

FORM 3B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
S Batten	Long term monitoring of zooplankton	1.2	9.2		11.0
Doug Moore	populations on the Alaskan Shelf and Gulf	1.4	6.8		9.5
Technicians - workshop	of Alaska using Continuous Plankton recorders	0.3	6.6		2.0
Technicians - analysts		2.0	6.2		12.5
D Stevens		0.3	7.0		2.3
D. Wilson		0.2	9.2		1.8
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	45.1	0.0	
				Personnel Total	$39.1

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
Portion of PI's travel to PI meetings					1.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$1.2

FY20

Project Title: CPR sampling of the GoA
Primary Investigator: Sonia Batten

FORM 3B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Portion of local CPR servicing in Anchorage	3.0
Portion of CPR leasing	4.1
Portion of computing services	0.3
Portion of website maintenance by PICES	0.5
Portion of tow payment to ship	0.9
Shipping of gear	1.6
Shipping of samples	0.4
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$10.9

Commodities Costs: Description	Commodities Sum
lab consumables	0.9
filtering mesh	2.1
Tow wires	0.5
Commodities Total	$3.5

FY20

Project Title: CPR sampling of the GoA
Primary Investigator: Sonia Batten

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
existing CPRs will be used. Lease costs charged above cover replacement/repair	1	
external bodies	1	
internal mechanisms	3	
Temperature recorder	1	
Existing microscopes will also be used, (including one purchased in FY03)	7	

FY20

Project Title: CPR sampling of the GoA
Primary Investigator: Sonia Batten

FORM 3B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
S Batten	Long term monitoring of zooplankton	1.2	9.5		11.3
Doug Moore	populations on the Alaskan Shelf and Gulf	1.4	7.0		9.8
Technicians - workshop	of Alaska using Continuous Plankton recorders	0.3	6.8		2.0
Technicians - analysts		2.0	6.4		12.9
D Stevens		0.3	7.2		2.3
D. Wilson		0.2	9.5		1.9
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	46.4	0.0	
				Personnel Total	$40.3

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
Portion of PI's travel to PI meetings					1.3
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$1.3

FY21

Project Title: CPR sampling of the GoA
Primary Investigator: Sonia Batten

FORM 3B
PERSONNEL & TRAVEL
DETAIL

Contractual Costs: Description	Contract Sum
Portion of local CPR servicing in Anchorage	3.1
Portion of CPR leasing	4.3
Portion of computing services	0.3
Portion of website maintenance by PICES	0.5
Portion of tow payment to ship	0.9
Shipping of gear	1.7
Shipping of samples	0.5
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$11.2

Commodities Costs: Description	Commodities Sum
lab consumables	1.0
filtering mesh	2.1
Tow wires	0.5
Commodities Total	$3.6

FY21

Project Title: CPR sampling of the GoA
Primary Investigator: Sonia Batten

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
existing CPRs will be used. Lease costs charged above cover replacement/repair	1	
external bodies	1	
internal mechanisms	3	
Temperature recorder	1	
Existing microscopes will also be used, (including one purchased in FY03)	7	

FY21

Project Title: CPR sampling of the GoA
Primary Investigator: Sonia Batten

FORM 3B
EQUIPMENT DETAIL

August 24, 2016

Elise Hsieh, Executive Director
Exxon Valdez Oil Spill Trustee Council
4210 University Drive
Anchorage, AK 99508-4626

Dear Elise:

Final FY 2017-2021 Proposal Submittal for Long-term Monitoring

17120114-E. Long-term Monitoring of Marine Birds during Fall and Winter in Prince William Sound

Gulf Watch Alaska, the long-term monitoring program of the *Exxon Valdez* Oil Spill Trustee Council (EVOSTC), has finalized our program and project proposals for fiscal years 2017-2021 funding based on comments received from EVOSTC's Science Panel on May 19, 2016. Below is the final budget summary and response to Science Panel comments for the marine birds during fall and winter project.

EVOSTC Funding Requested *(including 9% GA)*

FY17	FY18	FY19	FY20	FY21	TOTAL
$90,100	$92,700	$95,700	$98,600	$101,300	$478,500

Non-EVOSTC Funding Available

FY17	FY18	FY19	FY20	FY21	TOTAL
$53,000	$53,000	$53,000	$53,000	$53,000	$265,000

Science Panel comment: *The Panel noted that the proposal was difficult to review as a majority of the text was copied from the other Predator-Prey Survey proposal. It was challenging to find information within the text specific to this project. The Panel requests a revised proposal that focuses on the details of this specific project and how its data will be integrated into a wider cross-project set of analyses of interacting forage "fish", and piscivorous seabirds, and whales (humpback whales explicitly).*

PI Response:

- Revised and clarified text throughout the proposal to be specific to the marine bird project while referencing the integrated predator-prey surveys
- Clarified marine bird data collection and analysis methods in conjunction with the forage fish and humpback whale surveys (see pages 7-9)

Sincerely,

Mandy Lindeberg
Gulf Watch Alaska Program Lead designate

Attachment: Gulf Watch Alaska: Pelagic Component Project Proposal: 17120114-E—Long-term Monitoring of Marine Bird Abundance and Habitat Associations during Fall and Winter in Prince William Sound

EVOSTC FY17-FY21 INVITATION FOR PROPOSALS
PROGRAM PROJECT PROPOSAL SUMMARY PAGE

Project Title

Gulf Watch Alaska: Pelagic Component Project:

17120114-E—Long-term Monitoring of Marine Bird Abundance and Habitat Associations during Fall and Winter in Prince William Sound

Primary Investigator(s) and Affiliation(s)

Mary Anne Bishop, Ph.D., Prince William Sound Science Center

Date Proposal Submitted

24 August 2016

Project Abstract

The fall-winter marine bird surveys will continue to build upon the previous years of monitoring marine bird abundance and habitat associations (2007-2016), but will be upgraded by means of further integration with companion studies of humpback monitoring and forage fish assessments of prey availability. All three components will share logistics, sample timing, and location of sampling and monitoring. Of the marine birds that overwinter in Prince William Sound (PWS), nine species were initially injured by the *Exxon Valdez* oil spill, including three species that have not yet recovered or their recovery is unknown (pigeon guillemot, marbled murrelet, and Kittlitz's murrelet). Fall through winter are critical periods for survival as food tends to be relatively scarce or inaccessible, the climate more extreme, light levels and day length reduced, and water temperatures colder. By monitoring marine birds during fall and winter we will improve our predictive models of species abundance and distribution across PWS in relation to biological and physical environmental factors. Furthermore, continued monitoring will help determine marine bird vulnerability to future perturbations and environmental change, including oil spills. Our long-term monitoring has shown that the nonbreeding season cannot be characterized as a single time period when describing marine bird distribution and suggests that multiple surveys are required to quantify wintering populations and understand changes in marine bird distribution. The project utilizes established U.S. Fish and Wildlife Service survey protocols adapted for GPS-integrated data entry. Surveys are conducted onboard research vessels already conducting oceanographic, fisheries, or marine mammal surveys, thereby increasing opportunities for cross-project collaboration and reducing project costs. For 2017-2021 we have identified four cruises a year for marine bird surveys: Gulf Watch Alaska Pelagic Integrated Predator Prey Surveys (September/October, March- funding dependent), Alaska Department of Fish and Game spot shrimp survey (October), and PWS Science Center Ocean Tracking Network maintenance cruise (February). Our participation in the Gulf Watch Alaska Pelagic Integrated Predator Prey Surveys will allow us to identify and estimate the forage biomass at the same locations in which marine birds and humpback whales are feeding, which will provide comparable information on both predator density and prey availability.

EVOSTC Funding Requested (must include 9% GA)					
FY17	**FY18**	**FY19**	**FY20**	**FY21**	**TOTAL**
$90.1	**$92.7**	**$95.7**	**$98.6**	**$101.3**	**$478.5**

Non-EVOSTC Funding Available					
FY17	**FY18**	**FY19**	**FY20**	**FY21**	**TOTAL**
$53.0 in-kind	**$53.0 in-kind**	**$53.0 in-kind**	**$53.0 in-kind**	**$53.0 in-kind**	**$265.0 in-kind**

1. Executive Summary

Background & History

Of the marine birds that overwinter in Prince William Sound (PWS), nine species were initially injured by the *Exxon Valdez* oil spill (EVOS). As of 2014, two species that overwinter in PWS have not yet recovered (marbled murrelet and pigeon guillemot) and a third species, Kittlitz's murrelet, has an unknown recovery status. The vast majority of marine bird monitoring in areas affected by EVOS has taken place around breeding colonies during the reproductive season, a time when food is generally at its most plentiful. Long-term monitoring of marine birds in PWS during fall and winter is needed to understand how post-spill ecosystem recovery and changing physical and biological factors are affecting marine bird abundance and species composition, as well as marine bird distribution and habitat use.

Systematic fall and winter marine bird surveys began in 2007 under the direction of co-principal investigators (PI) Bishop and Kuletz. In 2012 this research project became part of the Gulf Watch Alaska (GWA) Pelagic Component under the direction of PI Bishop. Over the past nine winters (2007-2008 through 2015-2016) a total of 36 marine bird surveys, typically 6-9 d in duration, have been conducted across PWS. Observers are placed on "ships of opportunity" that include research vessels already conducting oceanographic, fisheries, or marine mammal surveys, thereby enabling integration of data across projects. Collaborators have included the EVOS funded GWA Pelagic- Humpback Whale Project and the Herring and Research Monitoring-Juvenile Herring Hydroacoustic Surveys, as well as Alaska Department of Fish and Game (ADF&G) spot shrimp surveys, and the PWS Science Center Ocean Tracking Network maintenance cruises.

We have documented consistent temporal patterns in density and distribution from fall through winter for the most abundant marine bird species, including common murre, marbled murrelet, black-legged kittiwake, and large gulls (primarily glaucous-winged gull) (Zuur et al. 2012, Dawson et al. 2015, Bishop and Kuletz, unpubl. data). Common murres and marbled murrelets both tend to increase in density from early to midwinter, with murrelets decreasing as winter progresses. Black-legged kittiwakes decrease to extremely low numbers during midwinter surveys and increase again in late-winter. Our surveys have established that marine bird communities in the bays and fjords show significant differences in species composition between early (November) and late (March) winter, driven primarily by higher common murres and lower marbled murrelet densities in late winter compared to early winter (Bishop and Kuletz in prep).

Our surveys have also identified patterns in the spatial distribution of marine birds in the Sound. Habitat association modeling has indicated that winter climate conditions may drive distribution patterns in PWS (Dawson et al. 2015). Our models revealed that common murre favor relatively protected waters while marbled murrelet favor inside bays and passages (which make up 45% of semi-protected waters) and areas of higher sea surface temperatures (Dawson et al. 2015).

Most recently, our surveys detected changes in common murre densities and distribution in the months leading up to a prolonged die-off event occurring along the Gulf of Alaska. During our February 2015 surveys, which immediately preceded the onset of the die-off (March 2015), we recorded a dramatic increase in the number of common murres using the southwest passages of PWS. Immediately prior to the peak of the die-off in December 2015, we again recorded significantly higher murre densities in PWS (November 2015 surveys; Bishop unpubl. data).

Based on surveys conducted between November 2007 and March 2016 (nine winters) we have identified areas of persistent, high marine bird concentrations including northeast PWS, Montague Strait, and the southwest passages. These are also areas in which humpback whales concentrate. Similarly, Montague Strait is a known hotspot for killer whales. This suggests that in these areas environmental drivers such as currents and nutrients are creating dependable, favorable foraging conditions for marine birds and marine mammals.

Finally, we developed a bioenergetics model for marine birds in winter. Our model results highlight the importance of herring to marine birds in PWS during winter and suggest that predation by marine birds may have an important top-down effect on the PWS herring population. Our model shows that in winters with relatively high numbers of marine birds or with relatively low adult herring biomass, as much as 10% (1864 t) of the adult biomass can be removed by avian predators (Bishop et al. 2015).

2017-2021 Project Summary

Over the next five-year cycle, our project will: a) continue to conduct systematic, marine bird surveys to document the abundance and distribution in PWS using regularly-scheduled vessels of opportunity; and, b) investigate the trophic linkages in areas with high marine bird concentrations by expanding and integrating our efforts with two other components in the Pelagic Program -the forage fish and humpback whale projects. Predator-prey surveys that combine the marine bird, humpback whale, and forage fish (including euphausiids) projects will be conducted each fall (September/October) and late winter (March, funding-dependent). Using the same vessel platforms in time and space, concurrent surveys will provide quantitative measures of the density and distribution of marine bird and humpback whale predators relative to forage fish availability and will facilitate an integrated analysis of how predator communities respond to changes in prey availability (quantity and quality).

2017-2021 Hypotheses

There are two primary research questions for the overall GWA Pelagic Component of which this proposal is a component:

1) What are the population trends of key upper trophic level pelagic species groups in PWS (marine birds, humpback whale, killer whale)?
2) How do predator-prey interactions, including interannual changes in prey availability, contribute to underlying changes in the populations of pelagic predators in PWS and Middleton Island?

The pelagic component research team is proposing to continue monitoring key pelagic species groups in PWS using the same five projects focused on 1) killer whales, 2) humpback whales, 3) forage fish, and 4) marine birds (this proposal). However, modifications have been made to the forage fish, humpback whale, and fall/winter marine bird (this proposal) projects for greater integration, increased precision of information, and achievement of new goals. Ultimately this will provide more information to the EVOS Trustee Council, agency resource managers, non-governmental organizations, and the public.

Our marine bird study will gather data to improve our ability to monitor status and trends of marine bird populations during fall and winter. Additionally, this research will address the following hypotheses:

1) *Marine bird distribution and abundance varies with physical and biological habitat characteristics within the fall/winter season.*
2) *Marine bird distribution and abundance varies with prey availability (quantity and/or quality).*
    a. *Marine bird forage flocks signal the presence of prey aggregation to humpback whales.*

To address the first hypothesis, our project will continue to conduct marine bird surveys in collaboration with three to four marine research cruises every winter, including the ADF&G spot shrimp survey, the PWS Science Center Ocean Tracking Network maintenance cruise, and the Pelagic Component's Integrated Predator-Prey Surveys. The second hypothesis will be addressed during marine bird surveys conducted as part of the Pelagic Component's Integrated Predator-Prey Surveys.

2. Relevance to the Invitation for Proposals

This study is focused within the EVOS spill area and is a continuation of a long-term data set initiated in 2007 monitoring several injured marine bird species that overwinter in PWS. As of the most recent 2014 list of injured species (EVOS 2014), marbled murrelet and pigeon guillemot are both species that occur in PWS during fall and winter that have not yet recovered. Kittlitz's murrelet, a species frequenting PWS during some winters, is considered an injured species with an unknown recovery status. Other marine bird species initially injured by the spill and wintering in PWS include common loon, cormorants (pelagic, red-faced, and double-crested), common murre, and bald eagle (EVOS 2014). In addition, our project will provide information on the impact of these marine bird species on Pacific herring, a species that has not recovered since the spill (EVOS 2014).

This marine bird research is also relevant to the invitation as it ties in a key upper trophic level predator (marine birds) to the pelagic component as described in the Invitation. These data will provide a baseline to interpret changes due to long-term oceanographic or climatic change or sudden perturbations. The project continues to develop and use other techniques that include Integrated Predator-Prey surveys that combine forage fish, krill, humpback whale, and marine bird surveys. Finally, this research will provide valued and requested information to the general public and resource managers regarding the basic ecology of marine bird species in PWS.

3. Project Personnel

MARY ANNE BISHOP, Ph.D.
Research Ecologist,
Prince William Sound Science Center
300 Breakwater, PO Box 705
Cordova, Alaska 99574
907-424-5800 x 228; mbishop@pwssc.org

Please see 2-page CV at the end of this document.

4. Project Design

A. OBJECTIVES

Our long-term monitoring has shown that the nonbreeding season cannot be characterized as a single time period when describing marine bird distribution and suggests that multiple surveys are required to quantify wintering populations and understand changes in marine bird distribution (Zuur et al. 2012, Bishop 2014, Dawson et al. 2015). For 2017-2022 this project will continue to conduct marine bird surveys in conjunction with marine research cruises, including the Integrated Predator-Prey Surveys, the ADF&G spot shrimp survey cruise, and the PWS Science Center Ocean Tracking Network maintenance cruise.

Objectives of this study are to:

1. Characterize the spatial and temporal distribution of marine birds in Prince William Sound during fall and winter.
2. Estimate marine bird abundance and distribution in areas with known seasonally predictable aggregations of predators and prey.
   a. relate marine bird presence to prey fields identified during concurrent hydroacoustic surveys.
   b. characterize marine bird-humpback whale foraging dynamics.
3. Model species abundance in relation to physical and biological variables across time and space.

Based on our long-term monitoring surveys, this project will provide information on fall and winter ecology of marine bird species injured by the oil spill that can be used to help restore and/or conserve their populations. In addition, the monitoring of top down forcing by marine birds and whales, which are important predators on herring and potentially other forage fish and krill, will also complement the suite of *PWS Herring Research & Monitoring* studies, including insertion of key data into the population modeling of herring.

B. PROCEDURAL AND SCIENTIFIC METHODS

Fall/Winter Marine Bird Surveys (Objectives 1-3)

This project will be a continuation of systematic, annual late fall and winter marine bird surveys begun in 2007 by M.A. Bishop and K. Kuletz and continued since 2012 by M.A. Bishop as a project in the GWA Pelagic component. Surveys will be conducted during the months of September, October, February, and March (funding dependent). Depending on the vessel of opportunity used, surveys will be coupled with the GWA Pelagic Integrated Predator-Prey surveys in September and March, and with vessels associated with the ADF&G Spot Shrimp survey (October), or the PWS Science Center Ocean Tracking Network annual maintenance survey (February).

All surveys will employ established U.S. Fish and Wildlife Service (USFWS) protocols that have been adapted for GPS-integrated data entry programs (USFWS 2007). One observer will record the number and behavior of birds and marine mammals occurring along a strip transect width of 300 m (150 m both sides and ahead of the vessel, in distance bins of 50 m). Additionally, any noteworthy observations (e.g. marine mammals, forage flocks) will be recorded out to 1 km on either side. A forage flock will be defined as an aggregation of >10 individuals of one or more species that is either sitting on the water or flying, but showing a clear interest in the water surface. Observations of flying birds will be recorded as instantaneous scans of the entire survey window (1 scan/minute). Observations will be recorded into a GPS-integrated laptop computer using the program Dlog (Ford Consulting, Inc., Portland, OR). This GPS-integrated program provides location data at 15 sec intervals and for every entered observation. In addition, sea and weather conditions will be tracked on site by the observer.

Integrated Predator-Prey Surveys (Objective 2). We propose to combine surveys for marine bird, humpback whale, and forage fish (including euphausiids) projects into one (September/October) or two (September/October and March) integrated predator-prey surveys to provide a better understanding of interspecies foraging dynamics and forage fish availability in PWS. The September/October integrated survey will provide quantitative measures of predator density and distribution relative to prey availability to better understand predator-prey interactions at a crucial time when forage fish energy is maximized and while marine birds and humpback whales are provisioning for the upcoming winter. Because predators (marine birds and humpback whales) and prey will be surveyed together in the same location at the same time, this coordinated effort will facilitate an integrated analysis of how predator communities respond to changes in prey availability (quantity and quality). In addition to a planned research cruise in September/October, the proposed approach may also allow for in-kind contributions from National Oceanic and Atmospheric Administration (NOAA) for vessel charter and an additional survey in March, when humpback whales are returning from their migrations to feed and when we can assess the winter severity on forage fish.

While standard marine bird surveys will be conducted en route to fish and humpback whale sampling locations, the following modified methods will be used during hydroacoustic surveys and whale focal follows:

<u>Hydroacoustic/Marine Bird Transects</u>*.* Marine bird observations will be recorded using the same methods described above and concurrent with hydroacoustic fish and krill surveys along fixed transect lines (Figure 1). These transects were designed to sample areas of persistent humpback whale feeding locations in Montague Strait, Bainbridge Passage, and Port Gravina. Surveys will occur during daylight hours for coordinated analyses of predator-prey interactions within and among sub-regions.

<u>Forage Flock/Humpback Whale Foraging Dynamics</u>. When a forage flock is encountered during surveys, the observer will note if there are any marine mammals associated with the flock. For this study, a forage flock will be defined as an aggregation of >10 individuals of one or more species either sitting on the water or flying, but showing a clear interest in the water surface by either circling or hovering, and separated spatially from other such groups (Anderwald et al. 2011). A marine mammal will be considered associated with a forage flock if it surfaces within 150 m of the aggregation. Following Anderwald et al. (2011), the observer will record the time and position of the encounter, species composition, and number of individuals per species in the forage flock.

Focal follows of individual whales will be conducted opportunistically, during which hydroacoustic surveys for fish and zooplankton will occur simultaneously. During focal follows, the marine bird observer will go off of formal survey effort and will only record encounters between the focal whales and marine bird aggregations. Encounter time and position, species composition, and the number of individuals in the forage flock will be recorded, as well as the surfacing behavior and feeding events of the whales associated with each flock.

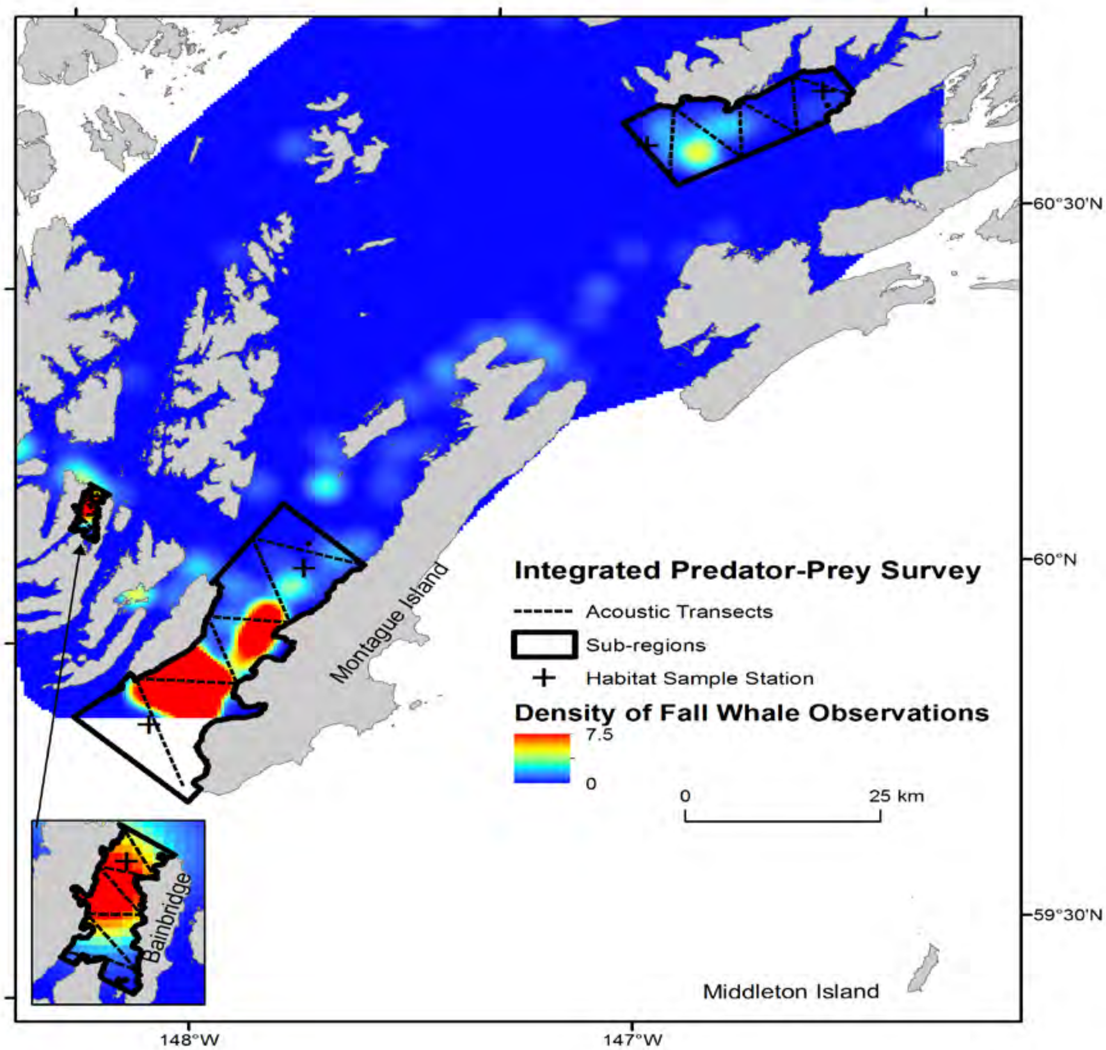

Figure 1. Proposed survey design for the Integrated Predator-Prey Surveys (September and March) in Prince William Sound. Marine bird density and whale counts will be assessed in conjunction with hydroacoustic transect for fish and krill. Habitat sampling will also take place within each sub-region. Kernel density of fall whale observations weighted by number of animals in each observation is shown in color.

C. Data Analysis and Statistical Method

Density (birds/km^2) of each marine bird species will be calculated for each 3 km segment of survey trackline. We will use data from all surveys conducted since 2007 to describe temporal and spatial variation of marine bird distribution and abundance within and across years. We will map all marine bird observations using ArcGIS.

Objectives 1 & 3: Using data from all surveys, we will model marine bird abundance and distribution in relation to physical and environmental factors and will identify marine bird habitat characteristics in PWS within and across years. For each 3 km of survey trackline, we will use GIS to spatially match explanatory variables and bird density values to the midpoint of each transect. Covariates will include physical, spatial, temporal, and environmental variables expected to influence detection and marine bird distribution (e.g. observer, distance bin, winter, time period, glare, sea and weather condition, sea surface temperature, bathymetry, slope, distance to land, marine habitat type).

We previously analyzed marine bird habitat associations using a two-stage hurdle model (Dawson et al. 2015, Zuur et al. 2012). However, a major assumption of the hurdle model is that all zeros are instances of absence, i.e. they are "true zeros". Failure to account for false zeros (birds present but not detected) can cause bias in estimates of parameter effects and their associated uncertainties (Mackenzie et al. 2002). Detection is not a perfect process, particularly in the case of sampling animals; therefore, the probability of detection given presence is nearly always <1 (see Dorazio et al. 2006). This detection probability can be estimated for a survey using repeated counts in a closed time interval, and the influence of detection-level explanatory variables examined. In cases of ships of opportunity, however, repeated surveys at a location are not possible, and a detection function cannot be directly estimated from the data.

This leads us to seek an analysis strategy for incorporating imperfect detection into our estimates of occupancy and relative abundance. For this analysis of marine bird distribution, we will transition to a modeling framework that allows us to incorporate some detection-level covariates into an explanation of a portion of the zero values. We will therefore use Zero-inflated Poisson (ZIP) models to incorporate zeros that we suspect are due to lack of detection of birds that were present (Ross et al. 2012, Arab 2015). ZIP models assume there are two zero generating processes: the first is governed by a binary distribution that generates structural zeros ("true" absence of birds), while the second is governed by a Poisson distribution that generates counts, some of which may be zero (marine birds were present but not detected). Unlike two-stage hurdle models (in which the presence-absence and count components of the data are fit separately), ZIP models estimate the parameters for the zero and non-zero parts of the model simultaneously. We will implement the ZIP models using a Bayesian hierarchical modeling approach, which will allow us to account for data sampling variability, parameter uncertainty, and potential dependence structures (e.g. spatial or temporal) in the data. Models will be fit in program R (R Core Team 2012) using integrated nested Laplace approximation (INLA). From these results, we will be able to create maps predicting marine bird distribution across PWS given spatial and environmental covariates.

Objective 2a: The September and March (funding-dependent) marine bird observations collected as part of the Pelagic Integrated Predator-Prey Surveys will be conducted concurrently with hydroacoustic fish surveys. This will allow us to directly relate marine bird presence and abundance to their prey and enable us to improve our estimates of herring consumption by marine bird predators. We will use two-step hurdle models (Zuur et al. 2012) to model marine bird occupancy and abundance in relation to fish school characteristics (e.g., fish biomass by depth, school density, school area, species composition, size structure, school depth) and habitat characteristics (e.g., SST, distance to shore, bathymetry, slope) known or expected to influence marine bird predation (Benoit-Bird et al. 2013, Ostrand et al. 2004, Speckman 2004, Day and Nigro 2000). First, logistic regression will be used to model the relative importance of covariates on marine bird presence or absence near fish schools. Marine birds will be considered present if they are within 150 m of the fish school. We will then evaluate the relative contribution of these covariates on the abundance of marine birds, only including data from bird-associated fish schools.

Additionally, the increased temporal resolution of sampling in the current proposal will enable us to include direct observations of marine bird presence from fall through winter in our herring consumption model (Bishop et al. 2015). In its current state, the consumption model uses the best available data about marine bird residency times and estimated marine bird consumption based on a daily energy budget projected over each species' assumed winter residency period. Refined data for each species will be used to update the residence time parameter in our current consumption model, thereby improving estimates of marine bird consumption of herring during winter.

Objective 2b: The September and March marine bird surveys also will be conducted simultaneously with humpback whale surveys, enabling us to characterize interspecies foraging dynamics. We will use a generalized linear model (GLM) with a binomial error structure to model whale presence and absence near a forage flock in relation to forage flock characteristics. Additionally, we will use the same model framework to evaluate the influence of forage flock characteristics on whale foraging behavior (whether a surface lunge by the whale was observed or not). Forage flock covariates may include the number of species present in the flock, the number of individuals, foraging mode (eg. surface seizing, pursuit diving), flock diversity, or the dominant guild or species present (Anderwald et al. 2011). Model selection will be guided using Akaike's Information Criterion (AIC; Akaike 1973).

Statistical rationale

At the end of 5 years of continued funding (September 2022), this study will have produced a long-term fall through winter data set that includes broad-scale coverage of PWS for each month up to 11 winters (Table 1). One goal of our research is to use our estimates of density as an index to track marine bird use of surveyed areas of PWS during fall and winter. However, our density estimates are quite variable over time and space, so reliably discerning trends is challenging (p-value = 0.061; Figure 2). To better understand how many years of data are required to achieve an acceptable level of precision of marine bird density over time (coefficient of variation of <20%), we simulated 3, 5, 9, 15, 20, and 25 years of density estimates using the average density, standard deviation, and trend (density ~ time) from 9 years of previously collected survey data. From this exercise we found that, given the current level of variation in winter marine bird densities, we need a minimum of 15-20 years of winter densities estimates to reach a coefficient of variation of <20% (5-10 additional years of survey effort).

Table 1. Total years of broad-scale PWS marine bird surveys by month, March 2007 – March 2022 (n = 56).

Month	Total Survey Years
September	7
October	11
November	10
December	4
January	2
February	9
March	13

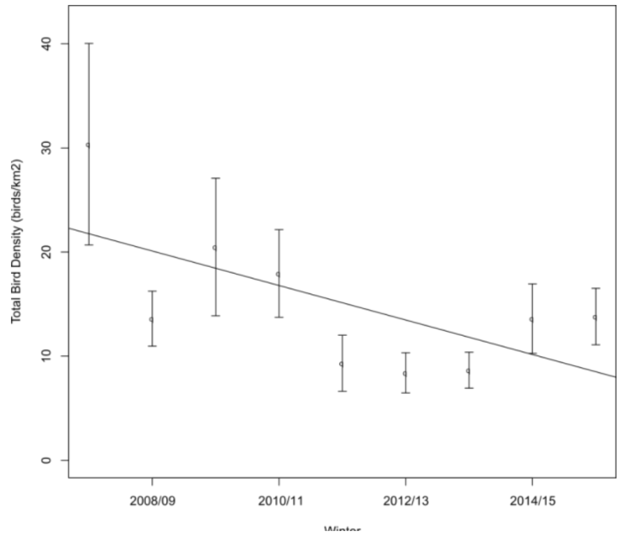

Figure 2. Average total marine bird densities, standard errors, and trend (slope = -1.66, *p*-value = 0.061) for 9 survey winters (2007/08-2015/16) in Prince William Sound, AK.

D. Description of Study Area

This study is part of an ongoing, long-term project investigating marine bird abundance and habitat associations during fall and winter in PWS (bounding coord: 61.292, -148.74; 61.168, -146.057; 60.273, -145.677; 59.662, -148.238). Our surveys will continue to take place in the inside waters of PWS (Figure 3).

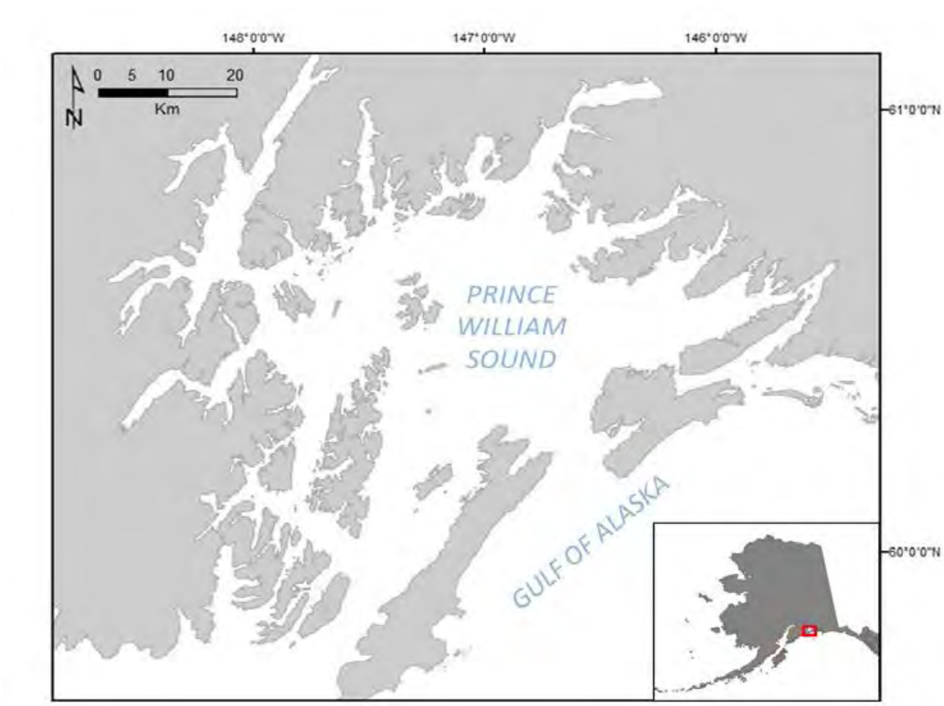

Figure 3. Marine bird surveys will take place in Prince William Sound in collaboration with cruises conducted by: ADF&G, PWS Science Center & the Gulf Watch Pelagic Integrated Predator-Prey surveys.

5. Coordination and Collaboration

WITHIN THE PROGRAM

This project is a component of the integrated GWA Long-term Monitoring of Marine Conditions and Injured Resources and Services. This long-term monitoring program is composed of several components (Environmental Drivers, Pelagic, and Nearshore Monitoring) with a series of projects in each component led by principal investigators from a number of institutions.

The fall and winter marine bird project is headed by Dr. Mary Anne Bishop, and is part of the Pelagic monitoring component. This projects shares research vessels associated with the Integrated Predator-Prey Surveys (Table 2). Marine bird observations from this project are integrated into the whale surveys (PIs Moran and Straley) and forage fish surveys (PIs Piatt and Arimitsu) through the Integrated Predator-Prey Surveys. This collaboration will afford efficiencies in field work, as well as facilitate greater understanding of predator-prey interactions in the Sound. Our program also complements the Pelagic Component's PWS Marine Bird Summer surveys conducted by US Fish & Wildlife Service (Kuletz & Kaler).

Table 2. Integrated predator-prey collaborations by objective. Objectives related to marine birds are bolded.

Objective	Index	Task	PI
a. Estimate humpback whale abundance, diet, and distribution			
	Whale counts by subregion	Integrated Surveys: whale counts, biopsies	Moran (NOAA)/ Straley (UAS)
	Whale Identification	Integrated Surveys: Photo ID	Moran (NOAA)/ Straley (UAS)
	Whale Diet	Integrated Surveys: scales, scat, biopsies, visual observations, hydroacoustics	Moran (NOAA)/ Straley (UAS)/ Arimitsu-Piatt (USGS)
b. Estimate marine bird abundance and distribution in seasonally predictable predator aggregation areas			
	Georeferenced marine bird counts, group size, behavior by species	**Integrated Surveys: marine bird transects**	**Bishop (PWSSC)**
b.i. Relate marine bird presence to prey fields identified during hydroacoustic surveys.			
	Spatial coherence of bird presence/ absence, acoustic estimates of forage fish and euphausiid biomass	**Integrated Surveys: hydroacoustic and marine bird transects**	**Arimitsu-Piatt (USGS)/ Bishop (PWSSC)**
b.ii. Characterize marine bird-humpback whale foraging dynamics			
	Georeferenced marine bird and whale counts, group size, behavior by species	**Data Collection Integrated Surveys: marine bird transects; whale focal follows**	**Bishop (PWSSC)/ Moran (NOAA)/ Straley (UAS)/ Arimitsu-Piatt (USGS)**
c. Estimate index of forage fish availability in seasonally predictable predator foraging areas			
	Species composition and biomass within persistent predator foraging areas	Integrated Surveys: hydroacoustic-trawl data	Arimitsu-Piatt (USGS)
	Density and depth distribution	Integrated Surveys: hydroacoustic-trawl data	Arimitsu-Piatt (USGS)
	Diet, energy density	Sample Analysis: forage fish	Moran (NOAA)
d. Estimate an index of euphausiid availability in seasonally predictable predator foraging areas			

Objective	Index	Task	PI
	Species composition and biomass within persistent predator foraging areas	Integrated Surveys: hydroacoustic-trawl data	Arimitsu-Piatt (USGS)
	Density and depth distribution	Integrated Surveys: hydroacoustic-trawl data	Arimitsu-Piatt (USGS)
e. Relate whales, marine birds and forage fish indices to marine habitat			
	Oceanographic parameters and zooplankton biomass	**Integrated Surveys: CTD and zooplankton samples**	**Arimitsu-Piatt (USGS)/ Moran (NOAA)/ Straley (UAS)/ Bishop (PWSSC)**

WITH OTHER EVOSTC-FUNDED PROGRAMS AND PROJECTS

In the past we have had observers onboard vessels associated with the PWS Herring Research and Monitoring Program. As currently designed, during this 5-year period the fall/winter marine bird project will not be working directly with the PWS Herring Research and Monitoring Program. However, our data will complement the suite of data being collected in this program, including insertion of key predator data into the population modeling of herring. And, as part of the Integrated Predator-Prey Surveys we will collect forage fish for P.I. Kristin Gorman's Herring Age at Maturity project.

WITH TRUSTEE AND MANAGEMENT AGENCIES

This long-term marine bird monitoring project uses as observing platforms vessels associated with other agencies. We have arrangements with the following agencies and organizations to place a marine bird observer onboard during these regularly scheduled annual surveys.

Alaska Department of Fish and Game: Jan Rumble. ADF&G provides a berth for a marine bird observer during the October shrimp surveys.

Prince William Sound Science Center: Mary Anne Bishop. PWS Science Center provides a berth for a marine bird observer during the February cruise to upload data from the Ocean Tracking Network arrays.

Finally, information from this project will feed into the *North Pacific Pelagic Seabird Database,* a database that is maintained by USFWS and U.S. Geological Survey (USGS).

6. Schedule

PROGRAM MILESTONES

1) Characterize the spatial and temporal distribution of marine birds in PWS during fall and winter.

   Data analyses incorporating data collected through October 2021 will be completed by January 2022 and incorporated into LTM program report by Mar 2022.

2) Estimate marine bird abundance and distribution in areas with known seasonally predictable aggregations of predators and prey.
   a. relate marine bird presence to prey fields identified during concurrent hydroacoustic surveys.
      Data analyses incorporating data collected through October 2021 will be completed by January 2022 and incorporated into LTM program report by Mar 2022.
   b. characterize marine bird- humpback whale foraging dynamics.

Data analyses incorporating data collected through October 2021 will be completed by January 2022 and incorporated into LTM program report by Mar 2022.

3) Model species abundance in relation to physical and environmental variables across time and space.

Data analyses incorporating data collected through October 2021 will be completed by January 2022 and incorporated into LTM program report by Mar 2022.

MEASURABLE PROGRAM TASKS

Measureable project tasks are presented by fiscal year and quarterly graphically in Table 3 and descriptively below.

Table 3. Schedule of Measurable Program Tasks

	FY17				FY18				FY19				FY20				FY21				FY22
Task	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1
Task 1 Data Collection																					
Field cruises (Feb OTN, Oct ADF&G, Sep Integrated predator-Prey)	X		X		X		X		X		X		X		X		X		X		
Alternative Survey Schedule (w additional NOAA funds)	X				X				X				X				X				
Task 2 Data Processing/Mgmt																					
Data summary/analysis	X	X		X	X	X		X	X			X	X			X	X			X	
Upload data workspace	X				X				X				X				X				X
Metadata/data published	X				X				X				X				X				X
Task 3 Reporting																					
Annual Rpts	X				X				X				X				X				
Annual PI meeting				X				X				X				X				X	
FY Work Plan (DPD)			X				X				X				X						
5-Year Final Report																					X

FY 2017 (Year 6)

FY 17, 1st quarter (February 1, 2017 - April 30, 2017)
February: *Marine bird survey: PWS Science Center Ocean Tracking Network cruise*
March: *Publish metadata/database from winter 2015/16*
March: *Marine bird survey: Integrated Predator Prey Survey (funding dependent)*
April: *Upload winter 2016/17 data to workspace*
February-April: *Data analyses*

FY 17, 2nd quarter (May 1, 2017 - July 31, 2017)
May-July: *Data analyses*

FY 17, 3rd quarter (August 1, 2017 - October 31, 2017)
August: *Annual work plan*
September: *Marine bird survey: Integrated Predator-Prey Survey cruise*
October: *Marine bird survey: ADF&G spot shrimp cruise*

FY 17, 4th quarter (November 1, 2017 - January 31, 2018)
November: *GWA PI meeting*
December: *Marine bird survey: Integrated Predator-Prey Survey cruise*
January: *Data analyses*
January: *Alaska Marine Science Symposium*

FY 2018 (Year 7)

FY 18, 1st quarter (February 1, 2018 - April 30, 2018)
February: *Annual report*
February: *Marine bird survey: PWS Science Center Ocean Tracking Network cruise*
March: *Marine bird survey: Integrated Predator Prey Survey (funding dependent)*
March: *Publish metadata/database from winter 16/17*
April: *Upload winter 2017/18 monitoring data to workspace;*
February-April: *Data analyses*

FY 18, 2nd quarter (May 1, 2018 - July 31, 2018)
May-July: *Data analyses*

FY 18, 3rd quarter (August 1, 2018 - October 31, 2018)
August: *Annual work plan*
September: *Marine bird survey: Integrated Predator-Prey Survey cruise*
October: *Marine bird survey: ADF&G spot shrimp cruise*

FY 18, 4th quarter (November 1, 2018 - January 31, 2019)
November: *GWA PI meeting*
December: *Marine bird survey: Integrated Predator-Prey Survey cruise*
January: *Data analyses*

FY 2019 (Year 8)

FY 19, 1st quarter (February 1, 2019 - April 30, 2019)
February: *Annual report*
February: *Marine bird survey: PWS Science Center Ocean Tracking Network cruise*
March: *Publish metadata/database from winter 17/18*
March: *Marine bird survey: Integrated Predator Prey Survey (funding dependent)*
April: *Upload winter 2018/19 monitoring data to workspace;*
February-April: *Data analyses*

FY 19, 2nd quarter (May 1, 2019 - July 31, 2019)
May-July: *Data analyses*

FY 19, 3rd quarter (August 1, 2019 - October 31, 2019)
August: *Annual work plan*
September: *Marine bird survey: Integrated Predator-Prey Survey cruise*
October: *Marine bird survey: ADF&G spot shrimp cruise*

FY 19, 4th quarter (November 1, 2019 - January 31, 2020)
November: *GWA PI meeting*

December: *Marine bird survey: Integrated Predator-Prey Survey cruise*
January: *Data analyses*

FY 2020 (Year 9)

FY 20, 1st quarter (February 1, 2020 - April 30, 2020)
February: *Annual report*
February: *Marine bird survey: PWS Science Center Ocean Tracking Network cruise*
March: *Publish metadata/database from winter 2018/19*
March: *Marine bird survey: Integrated Predator Prey Survey (funding dependent)*
April: *Upload winter 2019/20 monitoring data to workspace;*
February-April: *Data analyses*

FY 20, 2nd quarter (May 1, 2020 - July 31, 2020)
May-July: *Data analyses*

FY 20, 3rd quarter (August 1, 2020 - October 31, 2020)
August: *Annual work plan*
September: *Marine bird survey: Integrated Predator-Prey Survey cruise*
October: *Marine bird survey: ADF&G spot shrimp cruise*

FY 20, 4th quarter (November 1, 2020 - January 31, 2021)
November: *GWA PI meeting*
December: *Marine bird survey: Integrated Predator-Prey Survey cruise*
January: *Data analyses*

FY 2021 (Year 10)

FY 21, 1st quarter (February 1, 2021 - April 30, 2021)
February: *Annual report*
February: *Marine bird survey: PWS Science Center Ocean Tracking Network cruise*
March: *Publish metadata/database from winter 2019/20*
March: *Marine bird survey: Integrated Predator Prey Survey (funding dependent)*
March: *Publish metadata/database from FY 19*
March: *Submit Proposal - GWA 2022-2026*
April: *Upload winter 2020/21 monitoring data to workspace*
February-April: *Data analyses*

FY 21, 2nd quarter (May 1, 2021 - July 31, 2021)
May-July: *Data analyses*

FY 21, 3rd quarter (August 1, 2021 - October 31, 2021)
August: *Annual work plan*
September: *Marine bird survey: Integrated Predator-Prey Survey cruise*
October: *Marine bird survey: ADF&G spot shrimp cruise*

FY 21, 4th quarter (November 1, 2021 - January 31, 2022)
November: *GWA PI meeting*
December: *Marine bird survey: Integrated Predator-Prey Survey cruise*
January: *Data analyses*

FY 2022 (Year 11)

FY 22, 1st quarter	(February 1, 2022 - April 30, 2022)
February-March:	*If third, 5-year period approved, prepare & conduct field work*
February-March:	*Preparation of final report and/or other publications for 2nd five-year funding period*
March:	*Publish metadata/database from winter 2020/21*
April:	*Upload winter 2021/22 monitoring data to workspace*

7. Budget

This project is part of the Long-Term Monitoring of Marine Conditions and Injured Resources and Services, Pelagic Monitoring Component. Vessel costs are in the GWA long-term monitoring project humpback whale monitoring for the Integrated Predator-Prey cruises and additional NOAA funding is being sought for March cruises. An observer also will be onboard two other cruises: 1) annual ADF&G PWS shrimp survey and 2) the annual PWS Science Center maintenance cruise for the Ocean Tracking Network (funded by Alaska Ocean Observing System beginning in FY17).

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ONLINE RESOURCES

http://portal.aoos.org/gulf-of-alaska.php#metadata/771492cd-94b6-47ab-952a-02b152a535cf/project/files

March 2007 PWS Seabird Observations.csv
Winter 2007-2008 PWS Seabird Observerations.csv
Winter 2008-2009 PWS Seabird Observerations.csv
Winter 2009-2010 PWS Seabird Observerations.csv
Winter 2010-2011 PWS Seabird Observerations.csv
PWS Fall and Winter 2011-2012 Seabird Observations.csv
PWS Fall and Winter 2012-2013 Seabird Observations.csv
PWS Fall and Winter 2013-2014 Seabird Observations.csv
PWS Fall and Winter 2014-2015 Seabird Observations.csv

PROJECT PERSONNEL CURRICULUM VITAE

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EDUCATION

Ph.D.	Wildlife Ecology, 1988	University of Florida, Gainesville
M.S.	Wildlife and Fisheries Sciences, 1984	Texas A & M University, College Station
B.B.A.	Real Estate and Urban Land Economics, 1974	University of Wisconsin, Madison

RECENT PROFESSIONAL EXPERIENCE

6/99-present	Research Ecologist, Prince William Sound Science Center, Cordova, Alaska
4/90-3/94& 4/97-5/99	Research Wildlife Biologist, Copper River Delta Institute, Pacific Northwest Research Station, U.S. Forest Service, Cordova, Alaska
4/94-3/97	Research Wildlife Biologist, Center for Streamside Studies & Dept. Fisheries, University Washington, assigned to Copper River Delta Institute, Cordova, Alaska

SELECTED SCIENTIFIC PUBLICATIONS (10 of 53 publications)

Bishop, M.A., J.B. Buchanan, B. McCaffery, J.A. Johnson. 2016. Spring stopover sites used by the Red Knot *Calidris canutus roselaari* in Alaska, USA: connectivity between Copper River Delta and the Yukon-Kuskokwim River Delta. *Wader Study* 123 (2): i*n press.*

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Professional Collaborations

M. Armistisu (USGS), A Arab (Quanticipate Consulting), J. Buchanan (WDFG), K. Carpenter (CRWP), N. Dawson (PWSSC), J. Eiler (NOAA), N. Hill (MIT), E.N. Ieno (Highland Statistics), J. Johnson (USFWS) K. Kuletz (USFWS), S. Lewandoski (PWSSC), F. Li (Intl. Crane Foundation), B. McCaffrey (USFWS), M. McKinzie (PWSSC/Auburn University), J. Moran (NOAA), T. Morgan (PWSSC/ABR), E. Nol (Trent Univ.), J. Piatt (USGS), S. Powers (U. S. Alabama), R. Porter, B. Reynolds (PWSSC), D. Roby (OSU), J. Runstadler (MIT), A Saveliev (Highland Statistics), A. Schaefer (PWSSC), K. Sowl (USFWS), J. Stocking (PWSSC/UNC-Raleigh), J. Straley (UAS), Y. Suzuki (OSU), A. Taylor (UAA), D. Tsamchu (Tibet Plateau Institute of Biology), E. Weiser (U. Kansas), J. Watson (PWSSC), A. Zuur (Highland Statistics)

Budget Category:	Proposed FY 17	Proposed FY 18	Proposed FY 19	Proposed FY 20	Proposed FY 21	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$80.8	$83.2	$86.0	$88.7	$91.5	$430.1	
Travel	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
Contractual	$1.7	$1.7	$1.7	$1.7	$1.7	$8.5	
Commodities	$0.2	$0.2	$0.1	$0.1	$0.1	$0.7	
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
Indirect Costs (*waived*)							
SUBTOTAL	$82.7	$85.1	$87.8	$90.5	$93.3	$439.3	
General Administration (9% of subtotal)	$7.4	$7.7	$7.9	$8.1	$8.4	$39.5	N/A
PROJECT TOTAL	$90.1	$92.7	$95.7	$98.6	$101.7	$478.8	
Other Resources (Cost Share Funds)	$53.0	$53.0	$53.0	$53.0	$53.0	$265.0	

COMMENTS:
PWSSC waives the indirect cost on this proposal due to its administration of the overall proposal. This project is part of the Long-Term Monitoring of Marine Conditions and Injured Resources and Services (LTM), Pelagic Monitoring Component. We are using vessels of opportunity for the seabird observers. Vessel costs are in the Gulfwatch LTM project Humpback whale monitoring for 2 cruises; observers will also be onboard the annual ADFG Prince William Sound shrimp survey ($53K/yr) and the annual maintenance cruise for the Ocean Tracking Network (paid for by Alaska Ocean Observering System).

FY17-21

Project Title: Seabird abundance & habitat associations during fall & winter in PWS
Primary Investigator: M.A. Bishop

NON-TRUSTEE AGENCY SUMMARY PAGE

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
A. Schaefer	Research Assistant	5.0	5.9		29.5
M.A. Bishop	Principal Investigator	4.5	11.4		51.3
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	17.3	0.0	
				Personnel Total	$80.8

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY17

Project Title: Seabird abundance & habitat associations during fall & winter in PWS
Primary Investigator: M.A. Bishop

FORM 3B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
network & software subscriptions $100/staff mo	1.0
communications (phone & fax) $50/staff mo	0.5
printing & copying $25/staff mo	0.2
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$1.7

Commodities Costs: Description	Commodities Sum
supplies	0.2
Commodities Total	$0.2

FY17

Project Title: Seabird abundance & habitat associations during fall & winter in PWS
Primary Investigator: M.A. Bishop

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY17

Project Title: Seabird abundance & habitat associations during fall & winter in PWS
Primary Investigator: M.A. Bishop

FORM 3B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
A. Schaefer	Research Assistant	5.0	6.1		30.5
M.A. Bishop	Principal Investigator	4.5	11.7		52.7
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	17.8	0.0	
				Personnel Total	$83.2

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY18

Project Title: Seabird abundance & habitat associations during fall & winter in PWS
Primary Investigator: M.A. Bishop

FORM 3B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
network & softward subscriptions $100/staff mo	1.0
communications (phone & fax) $50/staff mo	0.5
printing & copying $25/staff mo	0.2
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$1.7

Commodities Costs: Description	Commodities Sum
Supllies	0.2
Commodities Total	$0.2

FY18

Project Title: Seabird abundance & habitat associations during fall & winter in PWS
Primary Investigator: M.A. Bishop

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY18

Project Title: Seabird abundance & habitat associations during fall & winter in PWS
Primary Investigator: M.A. Bishop

FORM 3B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
A. Schaefer	Research Assistant	5.0	6.4		32.0
M.A. Bishop	Principal Investigator	4.5	12.0		54.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	18.4	0.0	
				Personnel Total	$86.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY19

Project Title: Seabird abundance & habitat associations during fall & winter in PWS
Primary Investigator: M.A. Bishop

FORM 3B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
network & software subscriptions $100/staff mo	1.0
communications (phone & fax) $50/staff mo	0.5
printing & copying $25/staff mo	0.2
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$1.7

Commodities Costs: Description	Commodities Sum
supplies	0.1
Commodities Total	$0.1

FY19

Project Title: Seabird abundance & habitat associations during fall & winter in PWS
Primary Investigator: M.A. Bishop

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY19

Project Title: Seabird abundance & habitat associations during fall & winter in PWS
Primary Investigator: M.A. Bishop

FORM 3B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
A. Schaefer	Research Assistant	5.0	6.6		33.0
M.A. Bishop	Principal Investigator	4.6	12.1		55.7
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	18.7	0.0	
				Personnel Total	$88.7

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY20

Project Title: Seabird abundance & habitat associations during fall & winter in PWS
Primary Investigator: M.A. Bishop

FORM 3B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
network & software subscriptions $100/staff mo	1.0
communications (phone & fax) $50/staff mo	0.5
printing &copying $25/staff mo	0.2
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$1.7

Commodities Costs: Description	Commodities Sum
supplies	0.1
Commodities Total	$0.1

FY20

Project Title: Seabird abundance & habitat associations during fall & winter in PWS
Primary Investigator: M.A. Bishop

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY20

Project Title: Seabird abundance & habitat associations during fall & winter in PWS
Primary Investigator: M.A. Bishop

FORM 3B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
A. Schaefer	Research Assistant	5.1	7.0		35.7
M.A. Bishop	Principal Investigator	4.5	12.4		55.8
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	19.4	0.0	
				Personnel Total	$91.5

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY21

Project Title: Seabird abundance & habitat associations during fall & winter in PWS
Primary Investigator: M.A. Bishop

FORM 3B PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
network & software subscriptions $100/staff mo	1.0
communications (phone & fax) $50/staff mo	0.5
printing & copying $25/staff mo	0.2
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$1.7

Commodities Costs: Description	Commodities Sum
supplies	0.1
Commodities Total	$0.1

FY21

Project Title: Seabird abundance & habitat associations during fall & winter in PWS
Primary Investigator: M.A. Bishop

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY21

Project Title: Seabird abundance & habitat associations during fall & winter in PWS
Primary Investigator: M.A. Bishop

FORM 3B
EQUIPMENT DETAIL

August 24, 2016

Elise Hsieh, Executive Director
Exxon Valdez Oil Spill Trustee Council
4210 University Drive
Anchorage, AK 99508-4626

Dear Elise:

Final FY 2017-2021 Proposal Submittal for Long-term Monitoring

17120114-G. Long-term Monitoring of Oceanographic Conditions in Prince William Sound

Gulf Watch Alaska, the long-term monitoring program of the *Exxon Valdez* Oil Spill Trustee Council (EVOSTC), has finalized our program and project proposals for fiscal years 2017-2021 funding based on comments received from EVOSTC's Science Panel on May 19, 2016. Below is the final budget summary and response to Science Panel comments for the Oceanographic Conditions in Prince William Sound project.

EVOSTC Funding Requested *(including 9% GA)*

FY17	FY18	FY19	FY20	FY21	TOTAL
$218,700	$223,430	$228,310	$233,330	$238,530	$1,142,300

Non-EVOSTC Funding Available

FY17	FY18	FY19	FY20	FY21	TOTAL
$300,000	$300,000	$275,000	$275,000	$275,000	$1,425,000

Science Panel comment: *The Panel acknowledges the value of continued time series of physical, chemical, and biological primary production data to provide the basis for analyses of how changing environmental conditions are affecting the higher trophic level animals of the PWS and other spill-affected regions of the Northern Gulf of Alaska.*

PI Response:

- Thank you for the comment. The proposal was not revised.

Sincerely,

Mandy Lindeberg
Gulf Watch Alaska Program Lead designate

Attachment: Gulf Watch Alaska: Environmental Drivers Component Project Proposal: 17120114-G—Long-term Monitoring of Oceanographic Conditions in Prince William Sound

EVOSTC FY17-FY21 INVITATION FOR PROPOSALS
PROGRAM PROJECT PROPOSAL SUMMARY PAGE

Project Title

Gulf Watch Alaska: Environmental Drivers Component Project:

17120114-G—Long-term monitoring of oceanographic conditions in Prince William Sound

Primary Investigator(s) and Affiliation(s)

Robert W. Campbell

Date Proposal Submitted

24 August 2016

Project Abstract

This project will continue physical and biological measurements that may be used to assess trends in the marine environment and bottom-up impacts on the marine ecosystems of Prince William Sound (PWS). Regular (~6 per year) vessel surveys of PWS will be conducted to maintain ongoing time series observations of physical (temperature, salinity, turbidity), biogeochemical (nitrate, phosphate, silicate, dissolved oxygen) and biological (chlorophyll-a concentration, zooplankton abundance and composition) parameters in several parts of PWS: in central PWS, at the entrances (Hinchinbrook Entrance and Montague Strait), and at four priority bays that were part of the *Exxon Valdez* Oil Spill Trustee Council-funded Sound Ecosystem Assessment project in the 1990s and the ongoing Herring Research and Monitoring program.

Additionally, an autonomous profiling mooring will be deployed each year in central PWS to provide high frequency (at least daily) depth-specific measurements of the surface layer that will be telemetered out in near real-time. The profiler will include measurements that complement the survey activities (temperature, salinity, oxygen, nitrate, chlorophyll-a, turbidity). An in-development *in situ* plankton camera will also enumerate zooplankton, large phytoplankton and other particles, with some taxonomic discrimination.

EVOSTC Funding Requested *(must include 9% GA)*

FY17	FY18	FY19	FY20	FY21	TOTAL
$218.7	**$223.4**	**$228.3**	**$233.3**	**$238.5**	**$1,142.3**

Non-EVOSTC Funding Available

FY17	FY18	FY19	FY20	FY21	TOTAL
$300	**$300**	**$275**	**$275**	**$275**	**$1,425**

1. Executive Summary

The Ecosystem Drivers component of the Gulf Watch Alaska (GWA) program provides the spatial and temporal context for understanding change in the physical and chemical environment. Abiotic environmental changes will mediate lower trophic level (phytoplankton and zooplankton) productivity changes and subsequently propagate upwards to the mid and upper trophic level consumers. As in the first 5 years of GWA, this observation network consists of 5 separate, but often interconnected components distributed across the spill-impacted Gulf of Alaska (GOA):

- Oceanographic station GAK-1 at the mouth of Resurrection Bay that has over 45 years of nominally monthly repeat observations (Danielson)
- The multidisciplinary Seward Line surveys stretching 250 km from GAK-1 into offshore waters, and covering the deep passages of PWS for nearly 2 decades (Hopcroft)
- The Lower Cook Inlet Oceanographic surveys of the past decade (Doroff/Holderied)
- The oceanographic surveys of PWS bays and entrances that builds upon 4 decades of prior work (Campbell)
- The Continuous Plankton Recorder surveys that connect several of these surveys with the broader domain of GOA for the past 15 years (Batten)

Combined with measurements and analyses that incorporate other broad-scale ocean, atmosphere and cryosphere datasets, the Ecosystem Drivers component positions itself to understand the ramifications of environmental perturbations such as El Nino, the recent North Pacific warm water anomalies, longer-term trends of a warming climate, and altered species distributions and interactions.

The goal of this project is to continue the time series of oceanographic observations in PWS that began in 2009 under the GWA program and to continue to put that new data into context with a 40-year conductivity-temperature-depth (CTD) database that has been assembled (Figure 1). These data will be used to observe and describe how the region changes in response to the 2013-2016 warm anomaly and very strong 2016 El Niño event over the next few years, and to begin to address the many hypotheses for the mechanisms that are driving productivity in the region. As well as the more traditional vessel-based surveys that will return information on spatial variability, a state of the art autonomous profiling mooring will be used to observe the evolution of the annual cycle in physical, biogeochemical, and biological parameters in central PWS at very high frequency.

A marine pelagic ecosystem is a complicated network of constantly changing trophic and biogeochemical pathways, embedded within a 3-dimensional moving fluid that evolves in both space and time. The GOA ecosystem is of medium complexity (Fautin et al. 2010) but large spatial extent (order of 1.5×10^6 km^2) and is connected to PWS through the several large entrances, providing an upstream influence that is then modified within PWS in numerous ways (Cooney et al. 2001). In the Prince William Sound (PWS) region, there is a ~40-year time series of hydrographic, biogeochemical and biological observations, with the bulk of the data collected since the 1989 *Exxon Valdez* oil spill (EVOS); there is ongoing ecosystem monitoring work being done in the region, from ocean climate through top predators.

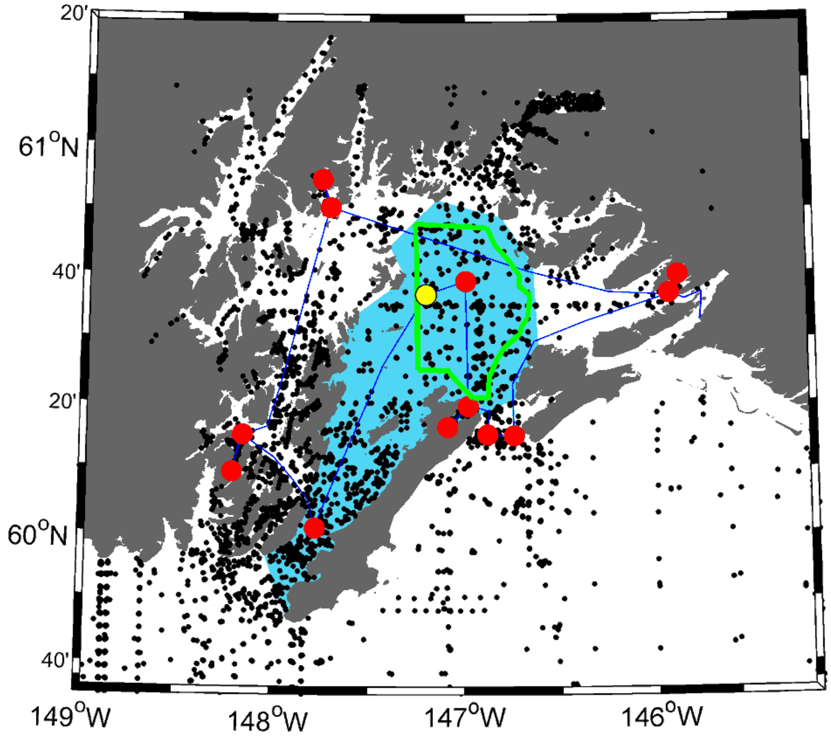

Figure 1: Prince William Sound. Black dots indicate the position of CTD casts done 1974-2016. Red dots indicate the stations visited during vessel surveys (this study), and the blue line indicates the standard vessel track. The yellow dot indicates the position of the autonomous profiling mooring. The blue area is the "central PWS" region, and was used for the determination of anomalies (see Figure 2). The green polygon is the area within which MODIS chlorophyll pixels were averaged (see Figure 3).

A great deal of research has been done on the relative importance of various forcing factors, such as "top down" vs "bottom up" (e.g., Megrey et al. 2009) or climate (Francis et al. 1998). Forcings are moving targets (Jochum et al. 2012) and it is not instructive to pick a single one (Rice 2001). That said, given the conservation of mass and energy, one can expect that the amount of material and energy entering at the bottom of a food web will constrain overall ecosystem productivity. Long term observations of biogeochemical cycling and lower trophic level dynamics are thus of considerable value to the understanding of the long term dynamics of the pelagic ecosystem in PWS.

Primary productivity in the GOA and PWS is highly seasonal, and thought to be mediated by the availability of light and water column stability (Henson, 2007). There is usually a large bloom each spring that depletes surface nutrients, a period of relatively low productivity through the summer months, and potentially a smaller autumn bloom as stability breaks down. The canonical mechanism for spring bloom formation is the Critical Depth Hypothesis (CDH; Sverdrup 1953), whereby bloom initiation occurs after stability reaches a critical depth and growth exceeds losses. Recent work elsewhere has suggested that the CDH does not necessarily hold, and that bloom formation may occur in winter, leading to the Dilution-Recoupling Hypothesis of Behrenfeld (2010), which explicitly includes zooplankton grazing. Neither hypothesis has been tested empirically in the GOA, likely due to lack of the necessary data.

Within PWS, variations in annual productivity have been posited to vary based on the variations in upwelling/downwelling and the track of the Alaska Coastal Current (ACC; the River-Lake hypothesis of Cooney 2001). Some support was found for the hypothesis for some years (1981-1991), but not in others (Eslinger et al. 2001). The hypothesis has not been revisited since 2001. In the greater GOA, it has been suggested that salmon returns are mechanistically linked to zooplankton and phytoplankton productivity via large scale atmospheric and oceanographic processes (the Optimal Stability Window hypothesis of Gargett 1997). It has been suggested that retrospective data is lacking to test the hypothesis, but that long time series of hydrographic profiles and biological observations are one way to move forward (Gargett et al. 1998).

There are any number of additional hypotheses for mechanisms structuring annual productivity that are more specific to the region that might be put forward, given appropriate observations. For instance, there is the role of turbidity: the waters of the margin of the GOA are quite turbid, the result of freshwater runoff containing particulates of glacial origin. The southern coast of Alaska is currently losing ice mass at some of the highest rates on earth (Jacob et al. 2012), which may be accompanied by increases in surface layer turbidity, which could then retard phytoplankton growth rates. Similarly, increases in freshwater inputs can be expected to have an impact on the timing of springtime stability, and the depth of the annual mixed layer where productivity occurs.

Identifying interannual trends in a system that is strongly seasonal is challenging: as well as absolute differences (e.g., warmer vs. colder, less vs. more), there can be changes in timing (i.e., earlier vs later). For a system with irregular and infrequent sampling instances, it is often difficult to tell the difference. The PWS region has arguably one of the better time series in the GOA, particularly since EVOS. However, work

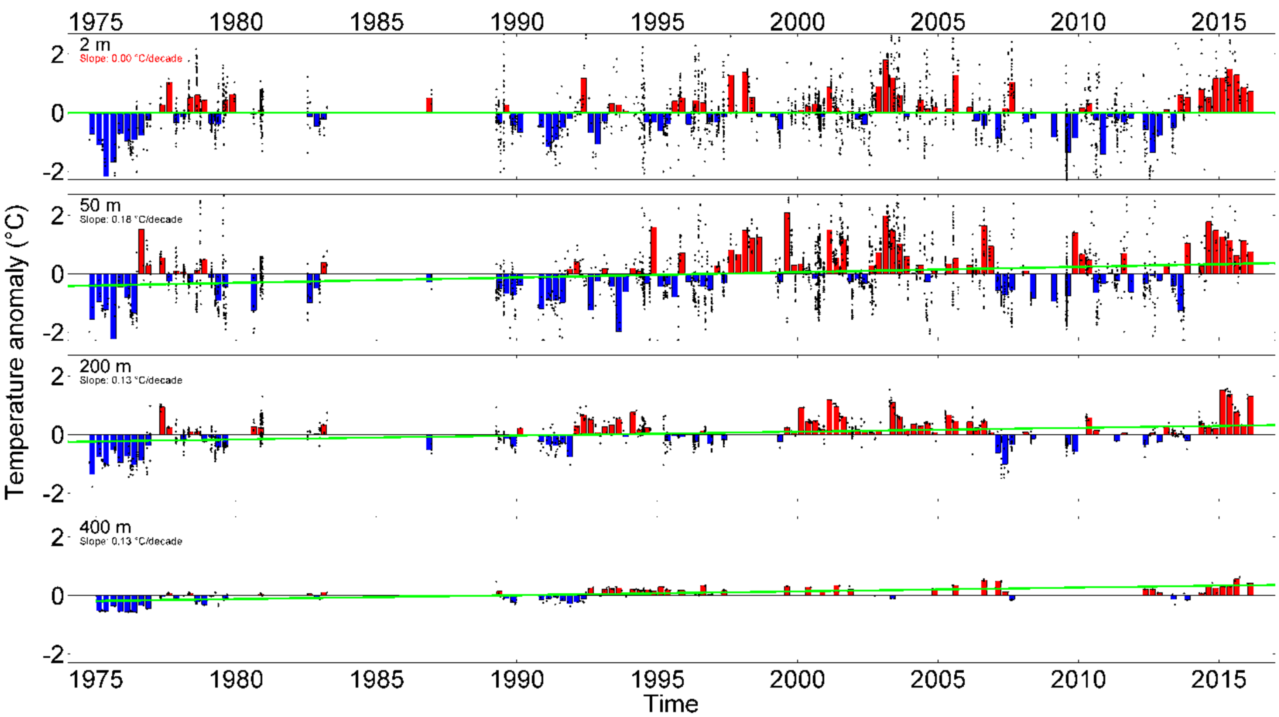

Figure 2: Temperature anomalies at four selected depths in central PWS (the blue-shaded area in Figure 1). Anomalies were calculated as the residual to a second order cosine curve fit to all years data (to remove seasonality). Black points are observations, bars are quarterly averages, and the green line indicates the linear trend. Slopes with text in black are significantly different from zero ($p<0.05$).

in the area has been done by several different projects, often with differing priorities, and inter- and even intra-annual coverage can be limited.

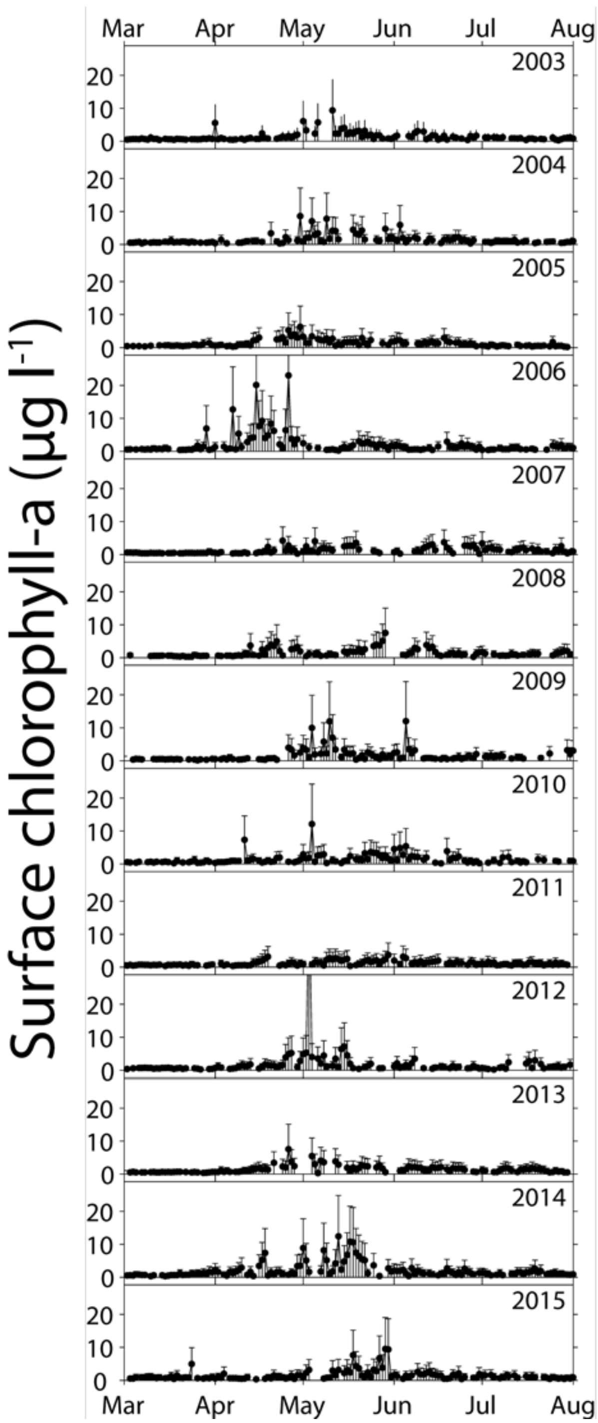

Figure 3: Annual time series of chlorophyll-a concentration in central PWS. Time series were produced from MODIS L3SMI composites (NOAA ERDDAP product erdMH1chla1day); daily averages (± SD) were calculated for all non cloud-masked pixels within the polygon in Figure 1.

As part of the ongoing GWA project (project 12120114-E) that precedes this proposal, an exhaustive effort to compile all historical CTD casts in the region has been conducted. Those efforts produced a database of casts dating back to 1974. That database has been continually combined with the data collected by the GWA program and as of January 2016 contains 23150 unique profiles throughout the region (Figure 1). The resulting dataset is temporally patchy and spatially variable: projects have come and gone over time, and the station locations have also varied. Some spatial aggregation is necessary to make use of the dataset (e.g., looking at "central PWS" as a single area). Analysis of the anomalies in temperature shows a warming trend over the last 40 years at most depths (Figure 2). The temperature trend at the surface is flat (and not significantly different from zero), presumably due to enhanced inputs of cold meltwater at the surface along the margin of the GOA. In the northwestern portion of PWS (not shown), the trend at the surface is one of cooling and freshening.

In late 2013, temperature anomalies shifted to primarily positive (Figure 2), which echoes a pattern of warm anomalies observed GOA-wide (Bond et al., 2015). That anomaly (colloquially referred to as "The Blob") is hypothesized to have arisen as a result of a strong atmospheric ridge creating a persistent high pressure of the GOA, which in turn altered storm tracks and resulted in less than average winter cooling (Bond et al. 2015). Estimates of heat flux at buoys in PWS suggest that the same mechanism occurred within the PWS region (Campbell, 2016). Anomalies within PWS in 2015 were as much as 4 °C above average, which appears to be causing numerous changes in the marine ecosystem, including observations of rare southern species; mortality events in birds, mammals and starfish; and larger than average blooms of toxin producing phytoplankton. The winter of 2015/2016 is also reported to be one of the strongest El Niños on record. At the time this proposal was submitted (August 2016) sea surface temperatures measured by buoys in PWS remained ~1-1.5 °C above average.

Biological and biogeochemical observations in PWS are much sparser than temperature and salinity, and it is difficult to describe trends without a long time series. The best record currently is satellite chlorophyll (which is confounded by the high degree of cloudiness in the region, as well as by turbidity artifacts). Examination of satellite chlorophyll records from central PWS (Figure 3) shows that phytoplankton abundance varies considerably over the course of each year, with many episodic blooms (both during the major spring bloom, and earlier and later in the year). The spring bloom in 2014 ("Blob" year #1) was much earlier and stronger than average, while in 2015 it was comparatively small and late. Observations made by ongoing GWA projects also support that idea. Preliminary analysis of observations made in 2016 by the central PWS profiler suggest that this year's spring bloom was also smaller and earlier than average.

2. Relevance to the Invitation for Proposals

This project addresses both of the areas of interest under the Environmental Drivers component. It proposes to continue the monitoring of oceanographic conditions, including water temperature, salinity, and turbidity (as well as oxygen, chlorophyll-a fluorescence and zooplankton concentrations) throughout the spill-affected area, and in the area most heavily impacted by the spill. As well as the biological studies done by this project, the data collected is of use and interest to several of the other sub-components of the project, including other Environmental Drivers projects, as well as Nearshore and Pelagic projects, and the Herring Research and Monitoring program (Campbell is already actively collaborating with several members of those projects).

This project also includes numerous measurements of macronutrients (nitrate, phosphate and silicate) both from water samples collected during vessel surveys, and from the profiling mooring (which has a nitrate sensor on board) that may in part be used to assess the transport of nutrients into PWS. Estimates of inflows/outflows to the system are required to estimate nutrient budgets, but were not included in this proposal to keep costs reasonable; interannual changes in nutrient concentrations in deep waters may provide clues about the year to year changes in inputs attributable to deepwater renewal.

3. Project Personnel

Dr. Robert William Campbell
Prince William Sound Science Center
P.O. Box 705, Cordova, AK, 99574
(907)424-5800 x241(office)
rcampbell@pwssc.org

Please see 2-page CV at end of this document

4. Project Design

A. Objectives

The goal of this program is to deliver a monitoring program that will return useful information on temporal and spatial changes in the marine environment in PWS, at a reasonable cost. The data will be depth-specific (because water column stability is important to ecosystem productivity), of sufficient frequency to capture timing changes (changes that occur on order of weeks), and give an idea of spatial variability in the region. As well, given that PWS herring will remain a funding priority of the *Exxon Valdez* Oil Spill Trustee Council

(EVOSTC) in the next 20 years, any long term monitoring efforts will be integrated with future herring studies as well as building upon ongoing work funded by the EVOSTC. Specific objectives include:

1. Conduct regular surveys in PWS and its entrances to continue the ongoing time series of physical, biogeochemical, and biological parameters while also supporting continued herring research by maintaining the existing time series (hydrography, plankton and nutrients) at the four Sound Ecosystem Assessment project bays.
2. Install and maintain an autonomous profiling mooring in PWS that will conduct frequent (at least daily) profiles of the same physical, biogeochemical and biological parameters as the surveys, plus in situ observations of zooplankton, large phytoplankton and other particles.

B. Procedural and Scientific Methods

Vessel surveys will be conducted 6 times per year, and will visit the four Sound Ecosystem Assessment project bays (Eaglek, Simpson, Whale, and Zaikof) that have been a focus of prior EVOSTC funded research, as well as Hinchinbrook Entrance, Montague Strait, and central PWS (Figure 1). Each station will include a CTD cast, water samples for nutrient and chlorophyll-a analysis, and a zooplankton tow (a 202 μm mesh, 60 cm diameter bongo net). Two stations will be sampled in each of the bays, one near the head where juvenile herring are more frequently encountered, and one in more open waters at the mouth of the bay where older age classes are more common. The timing of the surveys will be structured around the "productivity season" to attempt to capture the spring and autumn blooms (i.e., pre-bloom, bloom and post-bloom). The data collected during the surveys (particularly phytoplankton abundance and nutrient concentrations) will be compared to the high frequency record in the central sound, in order to assess how the timing and magnitude of production events in the bays differs from the open waters of PWS. Stage composition of the copepod species collected by the plankton net will also give information on annual changes in phenology.

The Seabird SBE25plus CTD used in the surveys has in initial accuracy of ±0.001 °C and ±0.0003 S/m for temperature and salinity; and drift between annual calibrations has been on order of 0.0002 °C/year and 0.0003 PSU/month, respectively. The Wetlabs FLNTU fluorometer/turbidometer has a resolution of 0.01 μg l^{-1} chl-a and 0.01 NTU, and the Seabird SBE43 oxygen sensor has an accuracy of ±2% of saturation and a drift of ~3% per year. Extracted chlorophyll-a has a detection limit of 0.05μg/l. Nutrients will be measured on a Seal Analytical AA3 autoanalyzer, and detection limits for nitrate, phosphate and silicate are 0.015 μM, 0.03 μM, and 0.29 μg/l, respectively.

The autonomous profiling mooring is deployed in central PWS near Naked Island (Figure 1). The site is the same location occupied by a surface buoy deployed during the SEA project (Eslinger et al. 2001) and co-located with a sampling site occupied during Seward Line cruises (see Hopcroft's Seward Line proposal). The mooring is an Autonomous Moored Profiler (AMP; WetLabs, Inc.). The AMP is a self-contained positively buoyant float that is capable of profiling from ~60 m to the surface, via an onboard winch that pays out and retrieves a thin (4mm UHMWPE) tether. The system is powered by an onboard 1.5 kWh battery, which allows ~45 profiles from 60 m to the surface per charge (i.e. 6 weeks of daily profiles). The instrument payload on the AMP includes a Seabird SBE16 CTD (0.01 °C, 0.001 S/m resolution), a Wetlabs FLNTU fluorometer/turbidometer (0.01 μg l-1 chl-a and 0.01 NTU resolution), and a UV nitrate analyzer (a Satlantic SUNA: 2 μM resolution). The profiler underwent significant upgrades in early 2016, including new controller electronics and new communications hardware. An in situ camera system was developed in collaboration with researchers at the Scripps Institution of Oceanography, it is expected to sample ~700 ml of water at 4 Hz, with a pixel resolution of ~15 µm. As of mid-July 2016, the camera had taken over one million images of individual plankters, totaling over 26 gigabytes.

C. Data analysis and statistical methods

The patchiness of the long term dataset in space and time (e.g., see Figures 1 & 2) confounds standard time series analysis, and some spatial binning is required to produce time series that are dense enough to analyze. At present, spatially binned data (such as the blue area in Figure 1) are seasonally detrended with a second order cosine function, anomalies determined from the residuals, and used to detect long term trends (Figure 2). Trends have been examined with standard linear regression and more complicated nonlinear models to incorporate cyclical variations (such as the 18.6-year nodal tidal signal that arises in many geophysical datasets). Power analysis has not yet been conducted on this series of methods, and will likely require a Monte Carlo simulation approach to be developed.

Plankton distributions will be analyzed with a set of common multivariate approaches. Species-by- station matrices will be assigned into clusters by various similarity metrics (Bray-Curtis being the most common). Following clustering, indicator species analysis (ISA) applied to the clusters returns information on the species that define the cluster groups (Legendre and Gallagher 2001). The impact of environmental parameters on species assemblages will be analyzed with Canonical Correlation Analysis, which permits reducing dimensionality and determining which environmental axes most closely relate to different zooplankton taxa. Multivariate approaches such as these are better described as descriptive (versus inferential), and power analysis is not usually applied.

The data collected by the profiling mooring results in an impressive record of the seasonal cycle of all of the parameters being measured. The onset of seasonal stratification is captured in the temperature and salinity records, and the effect of wind events on stratification is evident. The uptake of nutrients and increased fluorescence that accompanies the growth of phytoplankton is also apparent. To better understand how the physical environment is forcing lower trophic level productivity in that area, the one-dimensional physical-biological model developed by Allen and Wolfe (2013) will be adapted to Prince William Sound (the model code is available online from Susan Allen). The model framework allows the impacts of various physical and biogeochemical variables to be parsed out and examined separately.

D. Description of study area

This study will be conducted throughout PWS; the stations occupied are shown in Figure 1 and Table 1.

Table 1: Station locations

Station	Latitude	Longitude
Simpson Bay head	60.67	-145.87
Simpson Bay mouth	60.61	-145.93
Hinchinbrook Entrance East	60.25	-146.73
Hinchinbrook Entrance West	60.25	-146.89
Zaikof Bay head	60.27	-147.09
Zaikof Bay mouth	60.34	-146.96
Montague Strait	60.01	-147.77
Whale Bay head	60.15	-148.21
Whale Bay mouth	60.23	-148.17
Eaglek Bay head	60.93	-147.74
Eaglek Bay mouth	60.85	-147.71
Central PWS	60.58	-146.93
Profiling Mooring	60.61	-147.20

5. Coordination and Collaboration

WITHIN THE PROGRAM

This project links materially with the Lower Cook Inlet/Kachemak Bay long term monitoring effort: plankton samples collected under that program will be analyzed at the Prince William Sound Science Center by this project. The data collected will also be of use to projects under the Nearshore component (particularly in areas of overlap, such as Whale Bay) and the Pelagic component by providing climatic context to their studies. During the predecessor project to this proposal, Campbell has collaborated with the other GWA program team members on publications, by providing data, and by making room on cruises for other researchers. In collaboration with the Matkin group (long-term monitoring of killer whales in PWS/Kenai Fjords), a pilot hydrophone was deployed on the profiling mooring in 2016 to listen for marine mammal vocalizations (early results show several good detections of vocalizations). Pending results of the pilot study, it is expected that it will continue be deployed for the duration of this project.

WITH OTHER EVOSTC-FUNDED PROGRAMS AND PROJECTS

This project links directly with the Herring Research and Monitoring program submitted separately to the EVOSTC. This project provides a bottom up context for the proposed work on herring in PWS. Plankton samples have been sent to Hershberger group for herring disease studies for several years, and those activities will continue.

WITH TRUSTEE OR MANAGEMENT ACTIVITIES

Plankton samples have been regularly sent to the U.S. Geological Survey Marrowstone group for tests for the presence of Ichthyophonus life stages, and that sampling will continue under this project. Discussions with John Crusius (U.S. Geological Survey, University of Washington) began in 2016 about adding a low drift oxygen sensor to the moored profiler, which may be used to infer primary productivity from oxygen generation.

WITH NATIVE AND LOCAL COMMUNITIES

Water samples for measurement of carbonate chemistry will be taken during the vessel surveys and sent to the analysis facility at the Alutiiq Pride Shellfish Hatchery in Seward (owned and operated by the Chugach

Regional Resource Division, a coalition of several Native villages in the Chugach region). Their observations will assist other researchers in tracking the impacts of Ocean Acidification in PWS. This collaboration began in 2016 on the predecessor project to this proposal.

Campbell has given several public lectures in the region on the “State of the Sound” to local residents, and will continue to do so, and to participate in media outreach (radio, TV, podcasts).

6. Schedule

PROJECT MILESTONES

Objective 1: 6 vessel-based surveys will be conducted each year between March and November. Samples will for the most part be analyzed as they come in. Nutrient samples (which are filtered and frozen) will be stockpiled and analyzed en mass at the end of each year. Data will be made available via the online workspace and publically-available GWA data portal within one year of collection.

Objective 2: The autonomous profiling mooring will be installed during the first survey of the year (late March, as weather allows), and will remain in place operationally until the final cruise of the year (~November). In the event of breakdowns, the profiler will be repaired as soon as possible and returned to service.

MEASUREABLE PROGRAM TASKS

Measurable project tasks are presented by fiscal year and quarter graphically in Table 2 and descriptively below.

Table 2. Schedule of Measurable Project Tasks

Task	FY17				FY18				FY19				FY20				FY21			
	Quarter (EVOSTC FY beginning Feb. 1)																			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Task 1 Surveys																				
Vessel surveys	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sample analysis	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Data available online					X				X				X				X			
Task 2 Profiling mooring																				
Mooring deployed	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Service/calibration				X	X			X	X			X	X			X	X			
Task 3 Reporting																				
Annual Reports					X				X				X				X			
Annual PI meeting				X				X				X				X				X
FY Work Plan (DPD)			X				X				X				X					

FY 2017 (Year 6)

FY 17, 1st quarter (February 1, 2017 - April 30, 2017)
March: *PWS survey, install mooring*

FY 17, 2nd quarter (May 1, 2017 - July 31, 2017)
May: *PWS Survey, service mooring*
June: *PWS Survey, service mooring*
July: *Service mooring*

FY 17, 3rd quarter (August 1, 2017 - October 31, 2018)
August: *PWS Survey, service mooring*
October: *PWS Survey, service mooring*

FY 17, 4th quarter (November 1, 2017 - January 31, 2018)
November: *PWS survey, remove mooring*
January: *Sample analysis completed*

FY 18 (Year 7)

FY 18, 1st quarter (February 1, 2018 - April 30, 2018)
March *PWS survey, install mooring, submit annual report*

FY 18, 2nd quarter (May 1, 2018 - July 31, 2018)
May: *PWS survey, service mooring*
June: *PWS survey, service mooring*
July: *Service mooring*

FY 18, 3rd quarter (August 1, 2018 - October 31, 2019)
August: *PWS survey, service mooring*
October: *PWS survey, service mooring*

FY 18, 4th quarter (November 1, 2018 - January 31, 2019)
November: *PWS survey, remove mooring*
January: *Sample analysis completed*

FY 19 (Year 8)

FY 19, 1st quarter (February 1, 2019 - April 30, 2019)
March: *PWS survey, install mooring, submit annual report*
February-April : *Analysis ongoing*

FY 19, 2nd quarter (May 1, 2019 - July 31, 2019)
May: *PWS survey, service mooring*
June: *PWS survey, service mooring*
July: *Service mooring*

FY 19, 3rd quarter (August 1, 2019 - October 31, 2019)
August: *PWS survey, service mooring*
October: *PWS survey, service mooring*

FY 19, 4th quarter (November 1, 2019 - January 31, 2020)
November: *PWS survey, remove mooring*

January: *Sample analysis completed*

FY 20 (Year 9)

FY 20, 1st quarter (February 1, 2020 - April 30, 2020)
March: *PWS survey, install mooring, submit annual report*

FY 20, 2nd quarter (May 1, 2020 - July 31, 2020)
May: *PWS survey, service mooring*
June: *PWS survey, service mooring*
July: *Service mooring*

FY 19, 3rd quarter (August 1, 2020 - October 31, 2020)
August: *PWS survey, service mooring*
October: *PWS survey, service mooring*

FY 20, 4th quarter (November 1, 2020 - January 31, 2021)
November: *PWS survey, remove mooring*
January: *Sample analysis completed*

FY 21 (Year 10)

FY 21, 1st quarter (February 1, 2021 - April 30, 2021)
March: *PWS survey, install mooring, submit annual report*

FY 21, 2nd quarter (May 1, 2021 - July 31, 2021)
May: *PWS survey, service mooring*
June: *PWS survey, service mooring*
July: *Service mooring*

FY 19, 3rd quarter (August 1, 2020 - October 31, 2020)
August: *PWS survey, service mooring*
October: *PWS survey, service mooring*

FY 21, 4th quarter (November 1, 2021 - January 31, 2022)
November: *PWS survey, remove mooring*
January: *Sample analysis completed, submit manuscript*

7. Budget

BUDGET FORMS (ATTACHED)
Completed budget forms are attached.

SOURCES OF ADDITIONAL FUNDING:
A major refit of the profiling mooring (new communications and electronics, development of an in situ plankton camera) began in 2016 with support from the North Pacific Research Board ($400K from 2015-2018), and that project will also support higher than average frequency sampling and maintenance visits.

As well, a surface weather buoy that will be deployed adjacent to the mooring site is in development with support from the PWS Regional Citizen's Advisory Council ($125K from 2015-2018), and will allow additional opportunities for service visits at the mooring (as well as expanding the suite of measurements available at the site).

In-kind contributions include the instruments used on the vessel surveys (~$100K), mooring equipment used for the profiling mooring (releases, floats, ADCP current meters and CT recorders: ~$100K), laboratory equipment used for the nutrient, extracted chlorophyll-a, and zooplankton analyses (nutrient autoanalyzer, fluorometer and microscopes: ~$75K). The vessel used for the surveys is owned by PWSSC, which allows the timing of the cruises to be very flexible, and to avoid the standby and mobilization/demobilization fees that are standard with a charter vessel.

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Bond, N.A., Cronin, M.F., Freeland, H. and N. Mantua. 2015. Causes and impacts of the 2014 warm anomaly in the NE Pacific. Geophys. Res. Lett. 42:3414-3420, doi:10.1002/2015GL063306.

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Henson SA. 2007. Water column stability and spring bloom dynamics in the Gulf of Alaska. J. Mar. Res. 65:715-736.

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PROJECT DATA ONLINE

http://portal.aoos.org/gulf-of-alaska.php#metadata/fc5b0956-ef7c-49df-b261-c8e2713887fc/project

http://portal.aoos.org/gulf-of-alaska.php#metadata/fc5b0956-ef7c-49df-b261-c8e2713887fc/project/files

Robert William Campbell
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EDUCATION

Doctor of Philosophy, University of Victoria, School of Earth and Ocean Sciences (1999-2003)
Thesis: "Overwintering ecology of Neocalanus plumchrus"
Master of Science, Biology, Dalhousie University (1996-1998)
Thesis: "Reproduction of Calanus finmarchicus in the western North Atlantic: fecundity and hatching success"
Bachelor of Science (Hons), Biology, University of Toronto (1991-1996)
Thesis: "Simulation and bioenergetic modeling of Walleye (Stizostedion v. vitreum) populations"

APPOINTMENTS

2007 – present Oceanographer, Prince William Sound Science Center
2010 – present Affiliate faculty, University of Alaska Anchorage
2004-2006 Post-doctoral researcher, University of Hamburg, Germany

PROFESSIONAL SOCIETY MEMBERSHIP/PROFESSIONAL SERVICE

Member, American Society of Limnology and Oceanography (1998-present)
2007: Member-at-large, Education and Human Resource Image Library Subcommittee
Member, International Council for the Exploration of the Sea
Member, Exxon Valdez Trustee Council Integrated Herring Restoration Plan Working Group.
Proposal Reviewer: NPRB, National Science Foundation, Deutsche Forschungsgemeinschaft.
Report Reviewer: Exxon Valdez Trustee Council
Manuscript Reviewer: Canadian Journal of Fisheries and Aquatic Sciences, ICES Journal of Marine Science, Journal of Marine Systems, Journal of Plankton Research, Marine Biology, Marine Ecology Progress Series, Progress in Oceanography

RECENT RELEVANT PUBLICATIONS

Batten, S.D., Moffitt, S., Pegau, W.S. and R. Campbell. 2016. Plankton indices explain interannual variability in Prince William Sound herring first year growth. Fisheries Oceanography. 25:420-432.
Schroth, A.W., Crusius, J., Hoyer, I. and R. Campbell. 2013. Estuarine removal of glacial iron and implications for iron fluxes to the ocean. Geophysical Research Letters.
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Mackas, D., et. al. 2013. Zooplankton time series from the Strait of Georgia: Results from
year-round sampling at deep water locations, 1990–2010. Progress in Oceanography. 115:129-159.
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OTHER PUBLICATIONS

Campbell, R.W. and J.F. Dower. 2003. The role of lipids in the regulation of buoyancy by zooplankton. Mar. Ecol. Prog. Ser. 263:93-99.
Campbell, R.W. 2008. Overwintering habitat of Calanus finmarchicus in the North Atlantic inferred from autonomous profiling floats. Deep Sea Res. 55:630-645.
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Pond, D., Saito, H., Stübing, D., and P. Virtue. 2007. Perspectives on zooplankton lipids. Can. J. Fish. Aquat. Sci. 64:1628-1639.

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RECENT COLLABORATORS (EXCLUSIVE OF CO-AUTHORS ABOVE)

Batten, Sonia; Bishop, Mary Anne; Causey, Doug; Doroff, Angela; Gassó , Santiago; Gorman, Kristin; Heintz, Ron; Holderied, Kris; Hopcroft, Russ; Matkin, Craig; Mayumi, Arimitzu; Moran, John; Pegau, Scott; Rand, Pete; Sewall, Fletcher; Sorum, Alan; Thomas, Andrew; Welker, Jeff.

Budget Category:	Proposed FY 17	Proposed FY 18	Proposed FY 19	Proposed FY 20	Proposed FY 21	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$145.0	$149.3	$153.8	$158.4	$163.2	$769.7	
Travel	$1.0	$1.0	$1.0	$1.0	$1.0	$5.0	
Contractual	$43.7	$43.7	$43.7	$43.7	$43.7	$218.3	
Commodities	$11.0	$11.0	$11.0	$11.0	$11.0	$55.0	
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
Indirect Costs (*waived*)							
SUBTOTAL	$200.6	$205.0	$209.5	$214.1	$218.8	$1,048.0	
General Administration (9% of subtotal)	$18.1	$18.4	$18.9	$19.3	$19.7	$94.3	N/A
PROJECT TOTAL	$218.7	$223.4	$228.3	$233.3	$238.5	$1,142.3	
Other Resources (Cost Share Funds)	$300.0	$300.0	$275.0	$275.0	$275.0	$1,425.0	

COMMENTS:
PWSSC waives the indirect cost on this proposal due to its administration of the overall proposal. This project is part of the Long-Term Monitoring of Marine Conditions and Injured Resources and Services (LTM), Environmental Drivers Monitoring Component.

FY17-21

Project Title: Long-term monitoring of oceanographic conditions in PWS
Primary Investigator: Robert W. Campbell

NON-TRUSTEE AGENCY SUMMARY PAGE

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Robert Campbell	Principal Investigator	5.0	10.3		51.7
Robert Campbell - at sea rate	Principal Investigator	0.5	11.4		5.7
Caitlin McKinstry	Technician	12.0	7.3		87.6
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	29.0	0.0	
				Personnel Total	$145.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
PI Meeting	0.4	1	3	0.2	1.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$1.0

FY17

Project Title: Long-term monitoring of oceanographic conditions in PWS
Primary Investigator: Robert W. Campbell

FORM 3B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Instrument calibration	3.0
Vessel Charter	37.8
Network and Telephone	2.6
Printing	0.3
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$43.7

Commodities Costs: Description	Commodities Sum
Reagents and Lab Supplies	5.0
Mooring supplies	5.0
Sampling harware	1.0
Commodities Total	$11.0

FY17

Project Title: Long-term monitoring of oceanographic conditions in PWS
Primary Investigator: Robert W. Campbell

FORM 3B CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
Seabird Conductivity Temperature Depth (CTD) meter	2	PWSSC
WETlabs fluorometer	2	PWSSC
Satlantic SUNA	2	PWSSC
Mooring releases	2	PWSSC
Mooring flotation	4	PWSSC
Seal AA3 nutrient autoanalyzer	1	PWSSC
Turner Designs fluorometer	1	PWSSC

FY17

Project Title: Long-term monitoring of the oceanographic conditions of PWS
Primary Investigator: Robert W. Campbell

FORM 3B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Robert Campbell	Principal Investigator	5.0	10.7		53.3
Robert Campbell - at sea rate	Principal Investigator	0.5	11.7		5.9
Caitlin McKinstry	Technician	12.0	7.5		90.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	29.9	0.0	
				Personnel Total	$149.3

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
PI Meeting	0.4	1	3	0.2	1.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$1.0

FY18

Project Title: Long-term monitoring of oceanographic conditions of PWS
Primary Investigator: Robert W. Campbell

FORM 3B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Instrument calibration	3.0
Vessel Charter	37.8
Network and Telephone	2.6
Printing	0.3
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$43.7

Commodities Costs: Description	Commodities Sum
Reagents and Lab Supplies	5.0
Mooring supplies	5.0
Sampling harware	1.0
Commodities Total	$11.0

FY18	Project Title: Long-term monitoring of oceanographic conditions in PWS Primary Investigator: Robert W. Campbell	FORM 3B CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
Seabird Conductivity Temperature Depth (CTD) meter	2	PWSSC
WETlabs fluorometer	2	PWSSC
Satlantic SUNA	2	PWSSC
Mooring releases	2	PWSSC
Mooring flotation	4	PWSSC
Seal AA3 nutrient autoanalyzer	1	PWSSC
Turner Designs fluorometer	1	PWSSC

FY18

Project Title: Long-term monitoring of oceanographic conditions in PWS
Primary Investigator: Robert W. Campbell

FORM 3B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Robert Campbell	Principal Investigator	5.0	11.0		54.8
Robert Campbell - at sea rate	Principal Investigator	0.5	12.1		6.0
Caitlin McKinstry	Technician	12.0	7.7		92.9
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	30.8	0.0	
				Personnel Total	$153.8

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
PI Meeting	0.4	1	3	0.2	1.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$1.0

FY19

Project Title: Long-term monitoring of oceanographic conditions in PWS
Primary Investigator: Robert W. Campbell

FORM 3B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Instrument calibration	3.0
Vessel Charter	37.8
Network and Telephone	2.6
Printing	0.3
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$43.7

Commodities Costs: Description	Commodities Sum
Reagents and Lab Supplies	5.0
Mooring supplies	5.0
Sampling harware	1.0
Commodities Total	$11.0

FY19

Project Title: Long-term monitoring of oceanographic conditions in PWS
Primary Investigator: Robert W. Campbell

FORM 3B CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
Seabird Conductivity Temperature Depth (CTD) meter	2	PWSSC
WETlabs fluorometer	2	PWSSC
Satlantic SUNA	2	PWSSC
Mooring releases	2	PWSSC
Mooring flotation	4	PWSSC
Seal AA3 nutrient autoanalyzer	1	PWSSC
Turner Designs fluorometer	1	PWSSC

FY19

Project Title: Long-term monitoring of oceanographic conditions in PWS
Primary Investigator: Robert W. Campbell

FORM 3B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Robert Campbell	Principal Investigator	5.0	11.3		56.5
Robert Campbell - at sea rate	Principal Investigator	0.5	12.4		6.2
Caitlin McKinstry	Technician	12.0	8.0		95.7
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	31.7	0.0	
				Personnel Total	$158.4

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
PI Meeting	0.4	1	3	0.2	1.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$1.0

FY20

Project Title: Long-term monitoring of oceanographic conditions in PWS
Primary Investigator: Robert W. Campbell

FORM 3B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Instrument calibration	3.0
Vessel Charter	37.8
Network and Telephone	2.6
Printing	0.3
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$43.7

Commodities Costs: Description	Commodities Sum
Reagents and Lab Supplies	5.0
Mooring supplies	5.0
Sampling harware	1.0
Commodities Total	$11.0

FY20

Project Title: Long-term monitoring of oceanographic conditions in PWS
Primary Investigator: Robert W. Campbell

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
Seabird Conductivity Temperature Depth (CTD) meter	2	PWSSC
WETlabs fluorometer	2	PWSSC
Satlantic SUNA	2	PWSSC
Mooring releases	2	PWSSC
Mooring flotation	4	PWSSC
Seal AA3 nutrient autoanalyzer	1	PWSSC
Turner Designs fluorometer	1	PWSSC

FY20

Project Title: Long-term monitoring of oceanographic conditions in PWS
Primary Investigator: Robert W. Campbell

FORM 3B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Robert Campbell	Principal Investigator	5.0	11.6		58.2
Robert Campbell - at sea rate	Principal Investigator	0.5	12.8		6.4
Caitlin McKinstry	Technician	12.0	8.2		98.6
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	32.7	0.0	
				Personnel Total	$163.2

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
PI Meeting	0.4	1	3	0.2	1.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$1.0

FY21

Project Title: Long-term monitoring of oceanographic conditions in PWS
Primary Investigator: Robert W. Campbell

FORM 3B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Instrument calibration	3.0
Vessel Charter	37.8
Network and Telephone	2.6
Printing	0.3
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$43.7

Commodities Costs: Description	Commodities Sum
Reagents and Lab Supplies	5.0
Mooring supplies	5.0
Sampling harware	1.0
Commodities Total	$11.0

FY21

Project Title: Long-term monitoring of oceanographic conditions in PWS
Primary Investigator: Robert W. Campbell

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
Seabird Conductivity Temperature Depth (CTD) meter	2	PWSSC
WETlabs fluorometer	2	PWSSC
Satlantic SUNA	2	PWSSC
Mooring releases	2	PWSSC
Mooring flotation	4	PWSSC
Seal AA3 nutrient autoanalyzer	1	PWSSC
Turner Designs fluorometer	1	PWSSC

FY21

Project Title: Long-term monitoring of oceanographic conditions in PWS
Primary Investigator: Robert W. Campbell

FORM 3B
EQUIPMENT DETAIL

August 24, 2016

Elise Hsieh, Executive Director
Exxon Valdez Oil Spill Trustee Council
4210 University Drive
Anchorage, AK 99508-4626

Dear Elise:

Final FY 2017-2021 Proposal Submittal for Long-term Monitoring

17120114-H. Nearshore Ecosystems in the Gulf of Alaska

Gulf Watch Alaska, the long-term monitoring program of the *Exxon Valdez* Oil Spill Trustee Council (EVOSTC), has finalized our program and project proposals for fiscal years 2017-2021 funding based on comments received from EVOSTC's Science Panel on May 19, 2016. Below is the final budget summary and response to Science Panel comments for the Nearshore project.

EVOSTC Funding Requested *(including 9% GA)*

FY17	FY18	FY19	FY20	FY21	TOTAL
$401,900	$452,700	$411,400	$402,200	$402,800	$2,071,000

Non-EVOSTC Funding Available

FY17	FY18	FY19	FY20	FY21	TOTAL
$410,000	$410,000	$410,000	$392,000	$392,000	$2,014,000

Science Panel comment: *The Panel has no project specific comments.*

PI Response:

- The proposal was not revised.

Sincerely,

Mandy Lindeberg
Gulf Watch Alaska Program Lead designate

Attachment: Gulf Watch Alaska: Nearshore Component Project Proposal: 17120114-H—Nearshore Ecosystems in the Gulf of Alaska

EVOSTC FY17-FY21 INVITATION FOR PROPOSALS
PROGRAM PROJECT PROPOSAL SUMMARY PAGE

Project Title

Gulf Watch Alaska: Nearshore Component Project:

17120114-H—Nearshore ecosystems in the Gulf of Alaska

Primary Investigator(s) and Affiliation(s)

Heather Coletti, National Park Service

Dan Esler, U.S. Geological Survey, Alaska Science Center

Brenda Konar, University of Alaska Fairbanks

Katrin Iken, University of Alaska Fairbanks

Kim Kloecker, U.S. Geological Survey, Alaska Science Center

Dan Monson, U.S. Geological Survey, Alaska Science Center

Ben Weitzman, U.S. Geological Survey, Alaska Science Center

Date Proposal Submitted

24 August 2016

Project Abstract

Nearshore monitoring in the Gulf of Alaska (GOA) provides ongoing evaluation of the status and trend of more than 200 species, including many of those recovering from the 1989 *Exxon Valdez* oil spill (EVOS). The monitoring design includes spatial, temporal and ecological features that support inference regarding drivers of change through testing of alternative hypotheses. Examples of the application of the monitoring design include assessment of change in sea otter populations related to EVOS recovery and density dependent factors; and assessment of the relative roles of static versus dynamic drivers in structuring benthic communities. Continued monitoring will allow for a better understanding of variation in the nearshore ecosystems across the GOA and a more thorough evaluation of the status of spill injured resources. This information will be critical for anticipating and responding to ongoing and future perturbations in the region, as well as providing for global contrast.

EVOSTC Funding Requested (must include 9% GA)

FY17	FY18	FY19	FY20	FY21	TOTAL
$401.9	**$452.7**	**$411.4**	**$402.2**	**$402.8**	**$2,071.0**

Non-EVOSTC Funding Available

FY17	FY18	FY19	FY20	FY21	TOTAL
$410.0	**$410.0**	**$410.0**	**$392.0**	**$392.0**	**$2,014.0**

1. Executive Summary

Nearshore marine ecosystems face significant challenges at global and regional scales, with threats arising from both the adjacent lands and oceans. An example of such threats was the 1989 grounding of the T/V *Exxon Valdez* in Prince William Sound (PWS). An important lesson arising from this event, as well as similar events around the world, was that understanding the structure and function of the ecosystem and the composition and abundance of species is essential when responding to and managing present and anticipated threats.

The nearshore is broadly recognized as highly susceptible and sensitive to a variety of natural and human disturbances on a variety of temporal and spatial scales (reviewed in Valiela 2006, Bennett et al. 2006, Dean and Bodkin 2006). For example, observed changes in nearshore systems have been attributed to such diverse causes as global climate change (e.g., Barry et al. 1995, Sagarin et al. 1999, Hawkins et al. 2008, Hoegh-Guldberg and Bruno 2010, Doney et al. 2012), earthquakes (e.g., Baxter 1971, Noda et al., 2015), oil spills (e.g., Peterson 2001, Peterson et al. 2003, Bodkin et al. 2014), human disturbance and removals (e.g., Schiel and Taylor 1999, Crain et al. 2009, Fenberg and Roy 2012), and influences of invasive species (e.g., Jamieson et al. 1998, O'Connor 2014). Nearshore systems are especially good indicators of change because organisms in the nearshore are relatively sedentary, accessible, and manipulable (e.g., Dayton 1971, Sousa 1979, Peterson 1993, Lewis 1996). In contrast to other marine habitats, there is a comparatively thorough understanding of mechanistic links between species and their physical environment (e.g., Connell 1972, Paine 1974, 1977, Estes et al. 1998, Menge and Menge 2013, Menge et al. 2015) that facilitates understanding causes for change. Many of the organisms in the nearshore are sessile or have relatively limited home ranges, providing a geographic link to sources of change. Nearshore habitats will likely have detectable levels of change in the future, and we will continue to be able to detect relatively localized sources of change, tease apart human induced from naturally induced changes, and, provide suggestions for management actions to reduce human induced impacts.

The Nearshore Component of the Gulf Watch Alaska (GWA) long-term monitoring project investigates and monitors the nearshore environment of the greater *Exxon Valdez* oil spill (EVOS) area, with focus on selected elements of the nearshore food web. Our overarching goal is to understand drivers of variation in the Gulf of Alaska (GOA) nearshore ecosystem. The foundational hypotheses of the Nearshore Project include: (1) What are the spatial and temporal scales over which change in nearshore ecosystems is observed? (2) Are observed changes related to broad-scale environmental variation, or local perturbations? (3) Does the magnitude and timing of changes in nearshore ecosystems correspond to those measured in pelagic ecosystems? The design features of the nearshore monitoring program include a rigorous site selection process that allows statistical inference over various spatial scales (e.g., GOA and regions within the GOA) as well as the capacity to evaluate potential impacts from more localized sources, and especially those resulting from human activities, including lingering effects of EVOS. In addition to detecting change at various spatial scales, design features incorporate both static (e.g., substrate, exposure, bathymetry) and dynamic (e.g., variation in oceanographic conditions, productivity, and predation) drivers as potential mechanisms responsible for change. More than 200 species dependent on nearshore habitats, many with well recognized ecological roles in the nearshore food web, are monitored annually within four regional blocks in the GOA. Evaluation of change in those species over time in relation to well defined static and dynamic drivers will allow accurate and defensible measures of change and support management and policy needs addressing nearshore resources both within the GOA and globally.

Harnessing the power of long-term datasets, the first years of the GWA Nearshore Component, were combined with preceding time series, totaling over 50 years. Building on this legacy has resulted in many important insights and management-relevant findings. As an example, data on sea otter population dynamics have revealed that patterns of changes in abundance differ among regions. Changes in sea otters are driven largely by local conditions, although drivers may vary (e.g., recovery from the EVOS in PWS, recolonization following fur harvest in Katmai and Kachemak Bay, and prey availability in Kenai Fjords). As another example, data on rocky intertidal communities indicate that static physical attributes do not differ markedly across regions, neither do intertidal biota; this indicates that our design is well-suited to document temporal variation and whether it is synchronous across regions. Many additional examples are provided by the reports and publications listed in Section 2 of this proposal.

Our goals for the second phase of the long-term nearshore monitoring program are to continue to document the status of the nearshore system by continuing time series, some of which date more than five decades, and many that were initiated after the 1989 spill. This information will be synthesized with other components of GWA in order to identify potential causes of change, including those related to EVOS and climate change. We will continue to use existing and new information from this second phase to address our overarching hypotheses in communities across the GOA and to communicate those findings to the public and resource managers.

2. Relevance to the Invitation for Proposals

This project proposal addresses the EVOS Trustee Council's (EVOSTC's) request for long-term monitoring plans for the nearshore benthic ecosystem directly impacted by EVOS. It is a continuation of the first 5-year phase of the GWA program, which is built on previous projects: 15120114-R Nearshore Benthic Systems in the Gulf of Alaska and 12120114-L, Ecological Trends in Kachemak Bay.

A restoration and ecosystem monitoring plan for the nearshore marine ecosystems affected by the EVOS in the GOA (Dean and Bodkin 2006) recognized that (1) restoration efforts for resources injured by the spill will benefit from information on the status and trends of those resources on a variety of spatial scales within the Gulf, and (2) changes independent of the oil spill are likely to occur in the GOA during the 21st century, and are likely to result from a number of different agents (e.g. normal environmental stochasticity, global climate change, and shoreline development and associated inputs of pollutants). Further, to restore injured resources it is essential to separate EVOS-related effects from other sources of change. The long-term GWA monitoring program initiated in 2011 supports the accomplishment of these goals.

We anticipate that global climate change may result in a gradual transition in the nearshore community that occurs over decades and has impacts over the entire GOA. Conversely, it is possible that climate change will lead to tipping points in the community where sudden changes or collapses can be observed over large spatial scales (Alley et al. 2003, Lenton et al. 2008). In contrast, impacts from shoreline development or other human activities will likely be more episodic and localized. Thus, a suitable monitoring program needs to be designed to detect ecological impacts on these various spatial and temporal scales. To this end, the conceptual framework for monitoring in the nearshore that was implemented over the last decade was designed with the following elements:

1. Synoptic sampling of specified physical parameters (e.g., temperature and salinity) over the entire GOA. This synoptic nearshore sampling is complemented by offshore measurements in the GOA through the Environmental Drivers component of the GWA program.

2. Sampling of a variety of specified biological parameters (e.g. abundance and growth of intertidal organisms, abundance of selected birds and marine mammals) within select areas spread throughout the GOA. Monitoring includes many resources that were injured by the EVOS, allowing perspective on natural variation relative to oil-spill injury.
3. The hierarchical sampling design allows us to test patterns on various spatial scales. For example, rocky intertidal communities are sampled with replicates along various tidal strata at multiple sites within a region, and across four regions (western PWS [WPWS], Katmai National Park [KATM], Kenai Fjords National Park [KEFJ], and Kachemak Bay [KBAY]).
4. The components of the design are centered around the nearshore food web, where primary productivity originates largely in the kelps, other macroalgae and seagrass, is transferred to benthic invertebrates, and then to higher trophic levels (Figure 1).
5. Coordination with externally-funded, short-term (2-5 years) studies aimed at identifying important processes regulating or causing changes within a given system or subsystem. For example, a National Park Service (NPS) funded study examining the reliance of sea otters on a variable prey resource, *Mytilus trossulus*, and how that variability may affect sea otter population status.

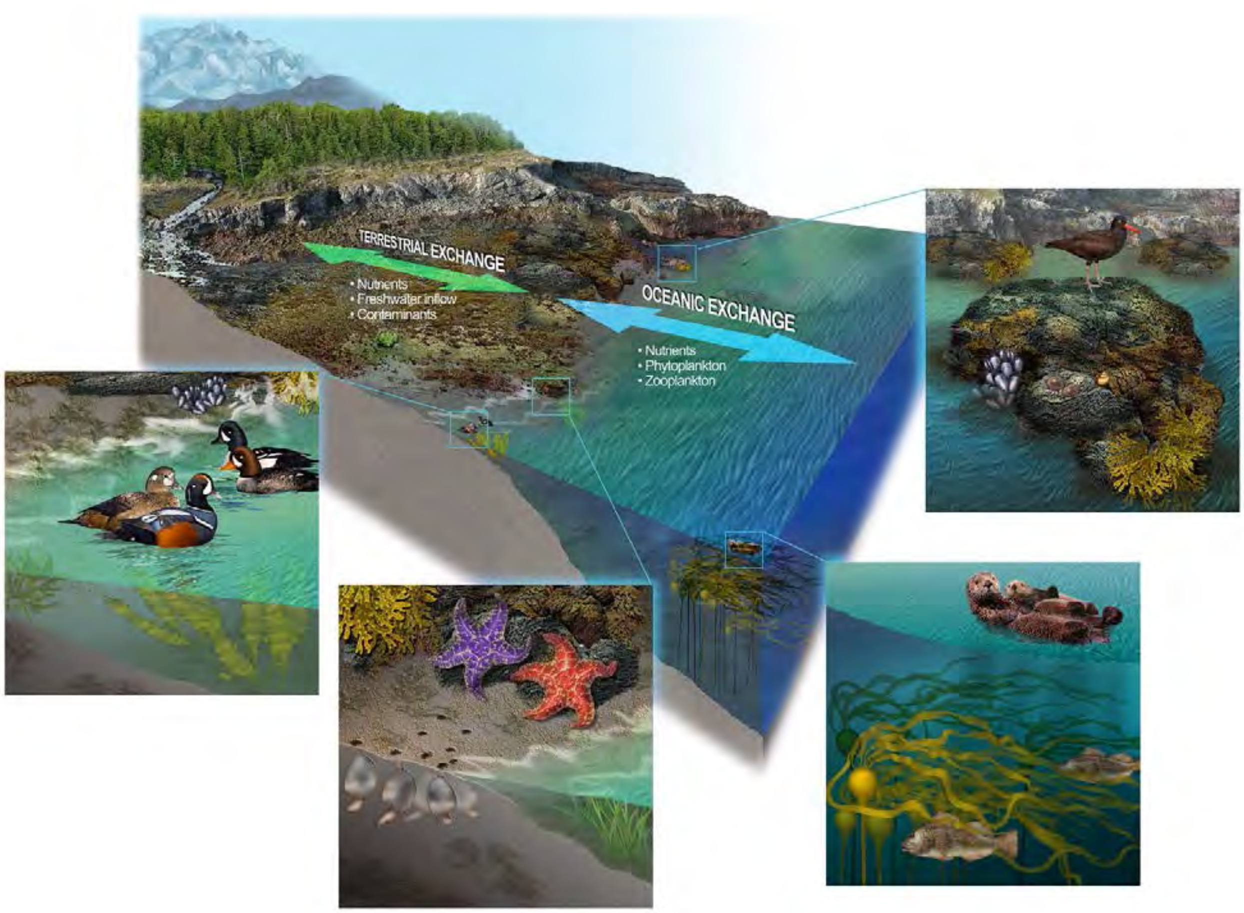

Figure 1. Conceptual model of the nearshore food web with terrestrial and oceanic influences illustrated. In this model, sea otters, black oystercatchers, sea ducks and sea stars act as the top level consumers in a system where primary productivity originates mostly from the macroalgae and sea grass and moves through to the benthic invertebrates to the top level consumers.

Potential Benefits and Recipients of GWA Nearshore Project: We expect our existing monitoring design will continue to have the capacity to track the status and trend of select EVOS injured resources (Monson et al. 2011, Ballachey et al. 2014a, b, Bodkin et al. 2014, Esler 2013, Bowen et al. 2015). We also expect that our monitoring will continue to contribute to detection of differences in status and trend among nearshore populations, and to differentiate potential causes for those differences (Miles et al. 2012, Newsome et al. 2015, Tinker 2015, von Biela et al. in press, Coletti et al. in review). Similarly, our monitoring of static and dynamic drivers is helping to elucidate what controls biological communities in the GOA (Konar et al. submitted). The work cited above demonstrates the value of the nearshore monitoring program to date and exemplifies, in the peer reviewed literature, the contributions to restoration, conservation, and management of nearshore resources in the GOA and across the north Pacific.

The nearshore program also continues to provide valuable data and recommendations to management of nearshore resources in near real time. For example, monitoring data on sea otter abundance and diet has been transmitted to the Department of Interior, U.S. Fish and Wildlife Service (USFWS) related to the status and trend of the southwest Alaska stock of sea otters listed under the Endangered Species Act. The nearshore program has provided distribution and abundance data on nearshore species to state and federal resource managers responding to environmental threats from contaminant spills and potential resource extraction proposals. In several instances, the nearshore program provided some of the only recent reference points available in the region when environmental perturbations seemed imminent. The KATM coast has experienced at least two vessel groundings since the implementation in 2006 of long-term monitoring, both of which our data was used as baseline prior to contamination. In 2009, the KATM and Lake Clark coastlines were threatened by a potential large oil spill from the Drift River terminal during the eruption of Mt. Redoubt. Nearshore monitoring data was used to highlight particularly sensitive areas and help plan spill response. In 2014 and 2015 we adopted additional sampling protocols to contribute to the understanding on the spatial and temporal magnitude of the west coast sea star decline. Below we provide two examples of additional monitoring results with broad scale relevance to resource managers, policy makers and the public.

Since 2006 we have documented Gulf wide declines in mussel (*Mytilus trossulus*) abundance (Figure 2). These declines, and subsequent recovery in some regions, have varied in both extent and magnitude. This variation in a prey resource has likely impacted top level predators, such as sea otters and shorebirds. Long-term impacts of this decline are still unknown. However, complementary data indicate that recovery of mussels is likely driven by local factors affecting survival and not exclusively recruitment. Associated high-intensity studies are proposed to improve our understanding of causes of population change in this keystone intertidal species.

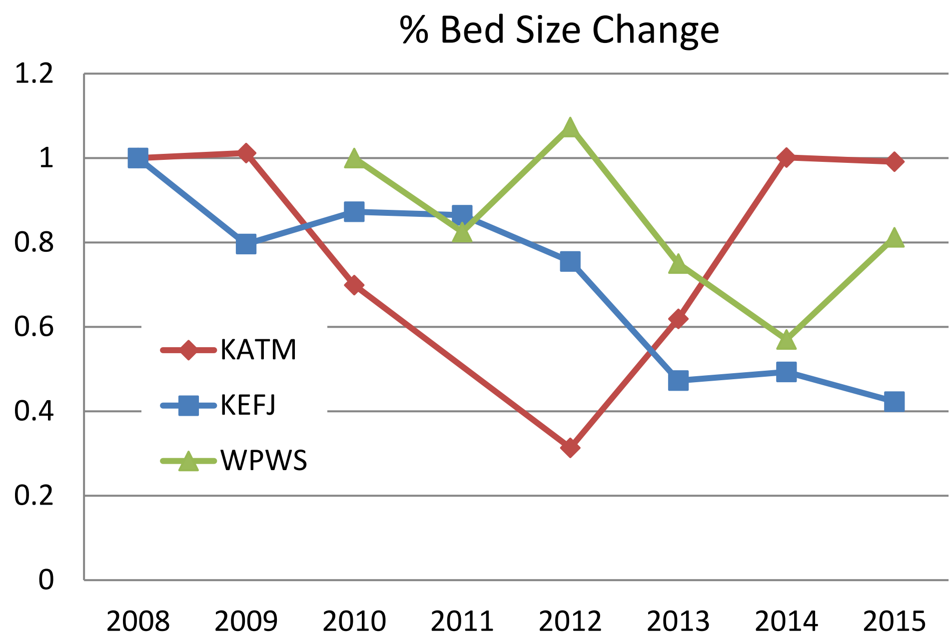

Figure 2. Percent change in mussel bed from size when sampling was initiated. Error bars were omitted for clarity of divergent trends.

We have documented anomalous events in collaboration with the pelagic component such as the sea bird die-off in 2015. We observed large increases in common murres during the summer of 2015 relative to previous years (Figures 3 and 4). This increase was particularly evident in KATM where there are no murre colonies and densities of murres are generally low. This increase in numbers is most likely a function of changed distribution. In poor nutritional conditions, these long-lived birds will readily defer breeding, therefore they are not tied to colonies and thus ended up nearshore, likely searching for food. KEFJ does have common murre colonies, however we still have evidence of an increase of these birds moving into coastal areas not associated with colonies. Our documentation of unusual murre distributions correspond to observations of large die-offs of murres throughout the north Pacific in winter 2015-2016. We speculate that high water temperature may have disrupted prey abundance or availability, leading to changes in murre distribution, behavior, condition, and mortality rates. Our results contribute to observations across GWA components that demonstrate that 2015 was an anomalous year.

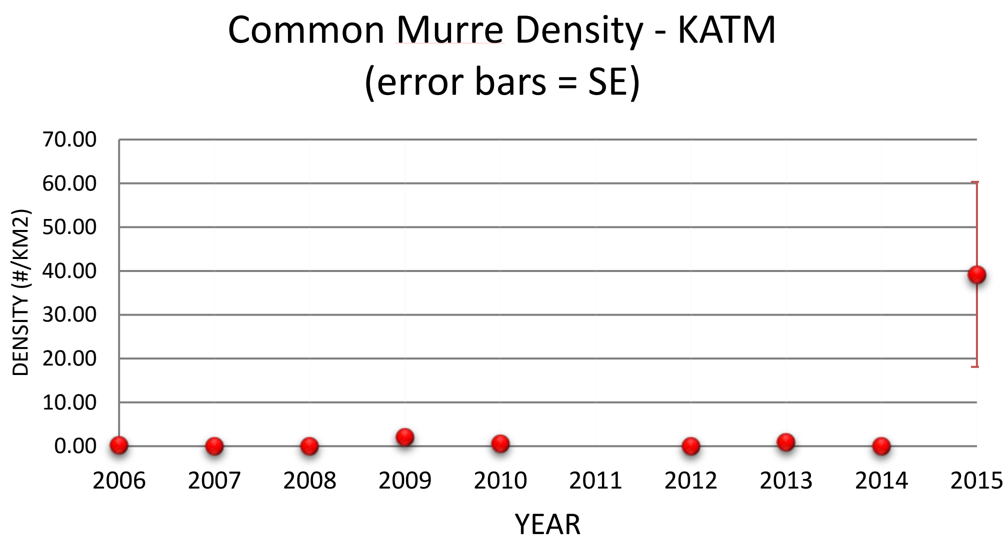

Figure 3. Common murre density estimates in KATM from 2006-2015. 2011 was not surveyed.

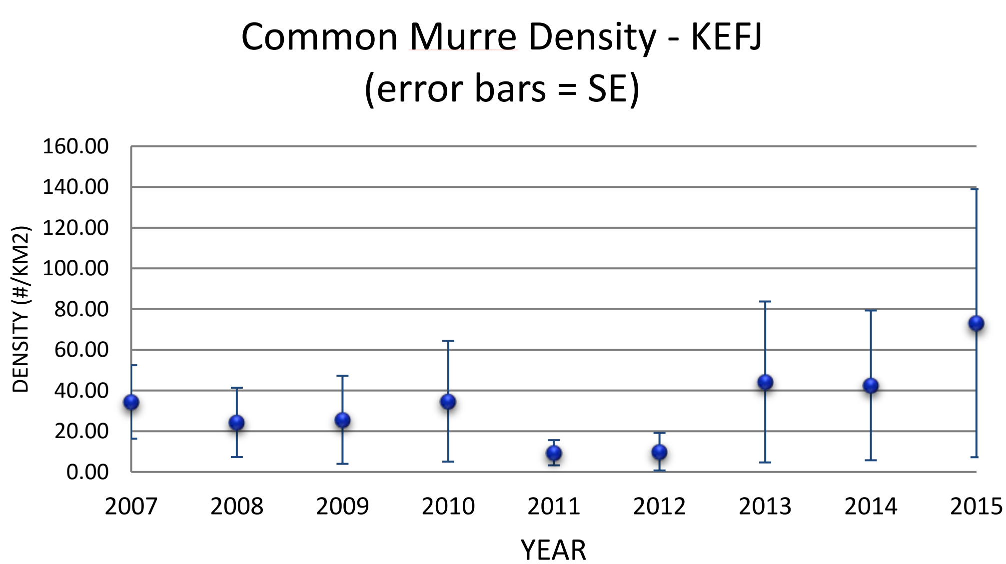

Figure 4. Common murre density estimates in KEFJ from 2007-2015.

The nearshore program continues to benefit from the spatial and ecological linkages explicit in the monitoring design. We anticipate, over time, our understanding of those linkages will increase and allow us to provide increasingly relevant and valuable data and insight.

3. Project Personnel

Overall project management will be the responsibility of H. Coletti, D. Esler, B. Konar and K. Iken. CVs for each of these principal (PIs) are included at the end of this proposal, including full contact information.

We anticipate that T. Dean, J. Bodkin, B. Ballachey, D. Monson, K. Kloecker, G. Esslinger and B. Weitzman with support from M. Lindeberg, A. Miller and additional U.S. Geological Survey (USGS) and NPS scientific staff, will continue the data collection and sampling (all components) in PWS, Kenai and Katmai, and that B. Konar and K. Iken will have responsibility for the Kachemak Bay site, with support from A. Doroff for sea otter foraging observations and additional support from the USFWS for sea otter surveys and carcass collections. This team of scientists has an extensive background of research efforts in coastal marine areas of Alaska. H. Coletti has worked in the GOA since 2000, and has been dedicated to the NPS nearshore monitoring program since 2006. D. Esler leads the Nearshore Marine Ecosystem Research Program at USGS, Alaska Science Center, and has decades of experience working in coastal systems of the north Pacific, including extensive work addressing effects of EVOS. B. Konar and K. Iken both have extensive experience working in various coastal areas of Alaska, and are currently conducting the nearshore monitoring in Kachemak Bay. They both have been PIs on previous EVOS studies and the Census of Marine Life with ecological work in Kachemak Bay. B. Ballachey and T. Dean have both been PIs on previous EVOS studies, with a primary focus on PWS studies, since 1989, and currently are conducting the monitoring of nearshore areas in PWS. J. Bodkin and T. Dean have been central in development and implementation of both the NPS and the USGS/EVOS nearshore monitoring programs. D. Monson of the USGS joined the project in the summer of 2012, and brings over two decades of experience working in PWS and other areas of coastal Alaska. B. Weitzman joined the project in 2012, with seven years of working and managing field efforts in the GOA, and has worked in all four regions to measure and ensure consistency within GWA data streams. A. Miller of the NPS is in charge of the long-term monitoring program in the Kenai and Katmai parks. We anticipate a team approach to the overall field work effort, with shared personnel across areas wherever possible, to ensure consistency of data collection and enhance our understanding of comparisons and contrasts across areas. We will attend an annual meeting of the larger group of scientists involved in the overall long-term monitoring; but also expect that we will continue to work closely together as a sub-group and to meet less formally as required throughout each year.

4. Project Design

The monitoring protocols implemented in 2012 at the onset of the GWA program are based on past work of the PIs and collaborators, allowing the continuation of valuable time series information about critical nearshore habitats in the GOA. Sampling protocols originally developed for the nearshore environment that included sea otters, nearshore marine birds, intertidal kelps, seagrasses and invertebrates in PWS in 2003 were adopted by the NPS's Vital Signs Long-Term Monitoring Plan, and implemented in KATM in 2006 and in KEFJ in 2007. In 2010, EVOS Project 10100750 (J. Bodkin and T. Dean, PIs) was funded to implement the long-term nearshore monitoring plan in WPWS. Nearshore monitoring of rocky intertidal and seagrass habitats in KBAY was initiated in 2003 through the Census of Marine Life program (K. Iken and B. Konar, PIs). In 2011, the GWA program was initiated to continue and expand these long-term nearshore monitoring programs, in combination with studies of pelagic systems and environmental drivers; the work described and proposed herein is a continuation of the nearshore benthic monitoring effort of the GWA project.

We propose to continue long-term restoration and ecosystem monitoring program at four locations across the GOA. Much of the effort to be funded by the EVOSTC program is concentrated in WPWS, but we will integrate with existing monitoring efforts on the Katmai coast and the Kenai Peninsula to cost-effectively monitor other areas of the spill-affected region and provide better information and reference for recovery and restoration of injured resources. The sampling design follows that initially put forward in the first GWA phase in 2010, and consists of four primary sampling locations in nearshore habitats in the central GOA region: KATM, WPWS, KEFJ and KBAY. We propose to continue sampling these regions on an annual basis through 2021. Monitoring includes physical measurements, and abundance estimates of kelps, other macroalgae, seagrasses, marine invertebrates, birds, and mammals, with a focus on species that were injured as a result of the EVOS (EVOSTC 2006). In addition to taxon-specific resources, monitoring includes recognized important ecological relations that include predator-prey interactions, measures of nearshore ecosystem productivity, and stable isotope and contaminant analyses. The nearshore monitoring program will also continue to utilize physical data collected in PWS, along the GOA shelf and in Cook Inlet, by the Environmental Drivers component of the proposed long-term monitoring program. Contrasts between the Nearshore and Pelagic components of Gulf Watch will facilitate understanding how various drivers influence these two important food webs.

A. Objectives

1. To determine status and detect patterns of change in a suite of nearshore species and communities.
2. Identify temporal and spatial extent of observed changes.
3. Identify potential causes of change in biological communities, including those related to climate change.
4. Communicate these to the public and to resource managers to preserve nearshore resources.
5. Continue restoration monitoring in the nearshore in order to evaluate the current status of injured resources in oiled areas and identify factors potentially affecting present and future trends in population status.

B. Procedural and Scientific Method

The *Nearshore Restoration and Ecosystem Monitoring Program* (Dean and Bodkin 2006) and the *National Park Service SWAN Nearshore Monitoring Program* (Dean et al. 2014) include protocols that provide justification, background, objectives, goals, an overview of the monitoring and sample design, the fundamental analytical approach, and description of operational requirements. The Protocol Narrative for Nearshore Monitoring in the Gulf of Alaska (Dean et al.2014) is located at https://workspace.aoos.org/group/4601/project/4650/folder/26475/protocol-narrative and is summarized briefly below.

Standard operating procedures (SOPs) for all data collection have been fully developed and reviewed as part of the preparation and implementation of nearshore monitoring in KATM, KEFJ, and WPWS and are located on the GWA Workspace at https://workspace.aoos.org/group/4601/project/4650/folder/26476/sops. The SOPs provide the details of each data collection procedure, their relations to one another, and how they can be integrated to provide understanding of causes of change that will be detected. The sites in KBAY have been using Census of Marine Life protocols (Konar 2007, Rigby et al. 2007) since 2002 but have revised these to be more comparable with the entire nearshore program. These revisions include increasing the quadrat replicate size from five to ten and extending the transect lengths from 30 m to 50 m. We will continue to evaluate and assess data streams to ensure consistency and comparability, within and between programs.

Nearshore Monitoring Design

The Nearshore Monitoring protocol focuses on sampling of several key components of the nearshore system in the GOA that are both numerically and functionally important to the system's health and on several key environmental drivers. These are termed "vital signs" and include kelps (and other marine algae) and seagrasses, marine intertidal invertebrates, marine birds, black oystercatchers *(Haematopus* *bachmani*), sea otters (*Enhydra lutris)*, and marine water chemistry and quality. The rationale for focusing on these vital signs is given in Bennett et al. 2006 and is summarized here.

Kelp, other seaweeds, and seagrass are "living habitats" that serve as a nutrient filter, provide understory and habitat for planktivorous fish, clams, urchins, and a physical substrate for other invertebrates and algae. Kelps and other seaweeds are the major primary producers in the marine nearshore and because they are located in shallow water they could be significantly impacted by human activities. These include spills of oil or other contaminants, dredging and disturbance from anchoring of vessels, and increased turbidity caused by runoff of sediments or nutrients.

Marine Intertidal Invertebrates provide critical food resources for shorebirds, ducks, fish, bears, sea otters, and other marine invertebrate predators, as well as spawning and nursery habitats for forage fish and juvenile crustaceans. Benthic invertebrates and algae are ecologically diverse in terms of habitat and trophic requirements; have a wide range of physiological tolerances; are relatively sedentary, and have varied life-histories. As a result, they are good biological indicators of both short-term (e.g., annual) and long-term (e.g., decadal scale) changes in environmental conditions.

Marine Birds are predators near the top of marine nearshore food webs. Marine birds are long-lived, conspicuous, abundant, widespread members of the marine ecosystem and are sensitive to change. Because of these characteristics marine birds are good indicators of change in the marine ecosystem. Many studies have documented that their behavior, diets, productivity, and survival changed when conditions change. Public concern exists for the welfare of seabirds because they are affected by human activities like oil pollution and commercial fishing.

Black Oystercatchers are well suited for inclusion into a long-term monitoring program of nearshore habitats because they are long-lived; reside and rely on intertidal habitats; consume a diet dominated by mussels, limpets, and chitons; and provision chicks near nest sites for extended periods. Additionally, as a conspicuous species sensitive to disturbance, the black oystercatcher would likely serve as a sentinel species in detecting change in nearshore community resulting from human or other disturbances.

Sea Otters are keystone species that can dramatically affect the structure and complexity of their nearshore ecological community. They cause well described top-down cascading effects on community structure by altering abundance of prey (e.g., sea urchins) which can in turn alter abundance of lower trophic levels (e.g., kelps)**.** Sea otters generally have smaller home ranges than other marine mammals; eat large amounts of food; are susceptible to contaminants such as those related to oil spills; and have broad appeal to the public. Recent declines in sea otters have been observed in the Aleutian Islands. Currently declines are documented in areas to the western edge of our study area. As a result of these declines, the Western Alaska stock of sea otters (which includes populations in Katmai National Park and Preserve as well as Aniakchak National Monument and Preserve), was federally listed as threatened on September 2005 under the Endangered Species Act.

Marine Water Chemistry and Water Quality including temperature and salinity, are critical to intertidal fauna and flora and are likely to be important determinants of both long-term and short-term fluctuations in the intertidal biotic community. Basic water chemistry parameters provide a record of environmental conditions at the time of sampling and are used in assessing the condition of biological assemblages. Water quality (including water temperature, salinity, and levels of contaminants such as heavy metals and organic pollutants) are also critical in structuring nearshore marine ecosystems and can cause both acute and chronic changes in nearshore populations and communities.

Specific questions and objectives for each of the vital signs are:

Kelp, other seaweeds, and seagrass

Objective:

- Estimate short-term and long-term trends in abundance and distribution of kelp, other seaweeds, and eelgrass at various spatial scales.

Question:

- What are the large-scale (GOA-wide, over decades) trends in the relative abundance and distribution of canopy forming kelps, other seaweeds, and eelgrass?
- What are annual trends in the abundance of canopy forming kelps, intertidal algae, and eelgrass?
- How do inter-annual changes in relative abundance of eelgrass, algae and kelp communities differ among locations?
- What environmental and biological variables are driving the observed temporal and spatial trends and patterns?

Marine Intertidal Invertebrates

Objectives:

- Monitor short-term and long-term trends in species composition and abundance of invertebrate species at various locations.
- Document how the size distributions of limpets (*Lottia persona*), mussels (*Mytilus trossulus*), and clams are changing annually at various locations.

Questions:

- How are the composition and relative abundance of intertidal algae and invertebrates changing annually?
- How do inter-annual changes in relative abundance of intertidal algae and invertebrates differ among locations?
- What environmental and biological variables are driving the observed temporal and spatial trends and patterns?

Marine Birds

Objective:

- Estimate long-term trends in the seasonal abundance of seabirds and seaducks at various locations.

Questions:

- How is the species composition and abundance of birds (and especially those closely linked to the nearshore, such as harlequin ducks and Barrow's goldeneye) changing annually during summer and winter?

- How do inter-annual changes in the number of bird species present and the relative abundance of birds differ among locations?

Black Oystercatcher

Objectives:

- Estimate long-term trends in relative density and nest site productivity of black oystercatchers at various locations.
- Estimate long-term trends in black oystercatcher diet through collection of prey remains at various locations.

Questions:

- How are the relative density (pairs per linear kilometer of shoreline) of black oystercatcher nests and the nest site productivity (number of chicks or eggs per nest) changing annually?
- How is the composition of prey provisioned to black oystercatcher chicks changing over time?
- How do inter-annual changes in density of black oystercatchers and composition of prey provisioned to chicks differ among locations?

Sea Otter

Objectives:

- Estimate long-term trends in sea otter abundance and spatial distribution.
- Estimate and compare age-specific survival rates of sea otters among regions within the GOA.
- Estimate diet composition of sea otters at various locations.

Questions:

- How is abundance and spatial distribution of sea otters changing over time?
- How is age-specific survival of sea otters changing annually?
- How is the diet of sea otters changing annually?
- How do inter-annual changes in abundance, survival, and diet differ among areas?

Marine Water Chemistry and Quality

Objectives:

- Document daily, seasonal, and annual variability in temperature and salinity at various intertidal sampling sites.
- Monitor status and trends in the concentration of metals, polycyclic aromatic hydrocarbons (PAHs; polycyclic aromatic hydrocarbons often associated with petroleum contamination), polychlorinated biphenyls (PCBs), pesticides, and metals in the tissues of mussels collected from various intertidal sampling sites over time.
- Explore other water quality parameters (such as turbidity, dissolved oxygen, carbon system variables, etc.) and disturbance events to help understand changes at intertidal sampling sites over time.

Questions:

- What is the daily, seasonal, and annual variation in intertidal water temperature (including variation in the duration of minimum and maximum temperatures) and salinity and how are these changing over time?
- How is the concentration of contaminants in mussel tissue (an integrated index of contaminant concentrations in water) changing over time?
- How do inter-annual changes in water chemistry and contaminant levels differ among locations?

Sampling Areas

The design focuses on examining these vital signs in KATM, KEFJ, WPWS, and KBAY (Figure 2). Due to logistical constraints, not all vital signs are collected in all regions (see below).

Most vital sign metrics are evaluated on an annual basis, for some metrics less frequent sampling occurs. Sampling frequency was determined based on the expected extent of inter-annual variation for a given metric as well as cost and logistical constraints. For example, the species distribution and abundance of intertidal invertebrates that are known to exhibit high inter-annual variation are sampled either annually or bi-annually whereas less variable contaminant levels in mussel tissue are monitored every 7 to 10 years.

The number and location of sampling units differ among metrics, but in general the design calls for sampling at multiple sites within each region. The number of sampling locations and the rationale for this are specified in vital sign specific SOPs, but in general were guided by preliminary estimates of effort required to detect ecologically meaningful levels of change (Dean and Bodkin 2006). Sampling sites were selected to provide a random, spatially balanced distribution. The design allows for detection of large temporal or spatial-scale changes (e.g., changes that may occur over the entire region over time or among blocks). For some metrics (e.g. contaminants in mussels) the design will also allow for detection of changes that may occur on a more localized scale (e.g., at a site of heavy human influence).

Sampling method overview

Sampling in the core sampling regions (KATM, KEFJ, and WPWS; and except where noted in KBAY) will consist of:

- <u>Surveys of eelgrass and kelp canopy</u> – The area covered by canopy forming kelps and eelgrass will be evaluated based on region-wide aerial surveys (Harper and Morris 2004), expected to be repeated on a ten to twelve-year frequency. Changes in percent cover by eelgrass will also be evaluated in randomly selected eelgrass beds on an annual basis. Sites (5 in KATM KEFJ and WPWS, 4 in KBAY) will be areas of historical eelgrass cover (as documented by previous ShoreZone mapping conducted by Harper and Morris 2004) that are nearest to sites where intertidal algae and invertebrates are sampled. Metrics will include the percent cover, density and, bed size. The boundaries of each bed will be located (either visually or using a fathometer and underwater camera) and positions recorded using a global positioning system (GPS).
- <u>Sampling of intertidal algae and invertebrates on sheltered rocky shores</u> - Randomly selected sites on sheltered rocky shores will be sampled annually to estimate the abundance and distribution of intertidal invertebrates and algae. Five sites will be sampled within each block (6 within KBAY because of historical sampling). Metrics will include number of kelp and mobile invertebrate species identified to the lowest possible taxa, percent cover of algal and sessile invertebrate taxa and size distributions of limpets (*Lottia persona*).

- Sampling of bivalves in gravel / mixed-sand gravel shores - Sampling of bivalves will be conducted every other year at five gravel/mixed sand-gravel sites in each block. Sampling will focus on bivalves that are relatively large, long-lived, and common (Lees and Driskell 2006). Metrics obtained will include abundances of selected bivalve species and size distributions of several dominant species. Sediment samples will be obtained from gravel / sand-gravel site for determination of grain size distribution.
- Sampling of Pacific blue mussels in mussel beds – The density and size distribution of mussels will be measured annually in 5 mussel beds in each region. Metrics of mussel bed size, density, and size structure are obtained using a combined sampling technique (Bodkin et al. 2016). While the focus is on larger mussels that are important prey for sea otters, sea ducks, and black oystercatchers, mussels are also sampled in such a way that all sizes are targeted in order to get an accurate view of their entire size frequency distribution. The selected mussel beds will be the nearest beds to sheltered rocky intertidal sampling sites.
- Sampling marine bird and mammal abundance – Marine bird and mammal abundance will be estimated via boat annually in summer in KATM and KEFJ. Sampling in PWS will be done under a separate contract to the USFWS. In addition, winter sampling will be conducted in KATM and KEFJ every two to three years, funded by NPS. There are no current marine bird and mammal surveys in KBAY. Counts will be made along shoreline transects using the methods of Irons et al. (2000). The focus will be on estimating the abundance of birds closely linked to the nearshore including harlequin ducks, Barrow's goldeneyes, and black oystercatchers (Webster 1941, Goudie and Ankney 1986, Andres 1998). Surveys will be conducted in summer and winter so that abundance estimates can be obtained for birds with different seasonal patterns (e.g., harlequin ducks that are more abundant in winter and black oystercatchers that are more abundant in summer).
- Sampling of black oystercatcher nest site density and oystercatcher chick provisioning - The number of black oystercatcher nest sites will be surveyed annually along shoreline transects in KATM, KEFJ and WPWS. The number of eggs and/or chicks present will be counted as an index of nest productivity. The species composition and relative abundance of oystercatcher prey provided to chicks will be evaluated by sampling prey remains at oystercatcher nesting sites (Webster 1941, Andres 1998).
- Aerial surveys of sea otter abundance - Sea otter abundance will be estimated within each region (KATM, KEFJ or WPWS) in the summer of every third year using aerial survey methods described by Bodkin and Udevitz (1999). These methods have been used to conduct annual surveys to estimate the abundance of sea otters in PWS since 1993 (Bodkin et al. 2002), and on a less frequent basis elsewhere in the GOA. The metric obtained will be numbers of sea otters per block.
- Sampling of sea otter diets - The species composition and relative abundance of sea otter prey will be estimated annually using direct observation of sea otter feeding (Calkins 1978, Estes et al. 1981, Dean et. al 2002). These observations will provide an assessment of foraging efficiency (energy obtained per hour of feeding) as well as the composition of prey being consumed by sea otters (Tinker 2015). The latter will provide an indirect measure of the composition and relative abundance of representative intertidal and subtidal invertebrates that are difficult to sample directly.
- Coastline surveys for collection of sea otter carcasses - Specified beach segments will be walked annually for collection of sea otter skulls in KATM, KEFJ and WPWS. The segments will be in areas

where sea otter carcasses accumulate and will be based on preliminary surveys. KBAY carcasses are collected opportunistically year-round. A tooth will be extracted from each skull and sectioned to estimate the age of the sea otter (Bodkin et al. 1997). The data on the age distribution of dead sea otters will be used to evaluate changes in age-specific survival and to develop age-specific survival estimates based on an age-structured demographic model (Monson et al. 2000, 2011; Bodkin et al. 2002).

- Sampling of water/air temperature, salinity, and contaminants in mussels- Intertidal water/air temperature will be measured at each of the sheltered rocky intertidal sites. Temperature recording devices will be fixed at the 0.5 m tidal elevation in the intertidal zone and will record temperature every hour on a year round basis. Initially, salinity will be measured at one to two sites in KBAY. It is anticipated that more sites will be added if instruments prove reliable. The concentration of contaminants will be measured in mussels collected from rocky intertidal sites once every seven to ten years in KATM, KEFJ and WPWS. KBAY mussels are collected and analyzed for contaminants under the National Oceanographic and Atmospheric Administration (NOAA) Mussel Watch Program. When feasible, we will explore other water quality and disturbance variables (ice scour, storm surges) that may also be contributing to site variation and changes over time.

Design Considerations

In the process of developing the NPS Southwest Alaska Network (SWAN) and EVOS nearshore monitoring programs we investigated most, if not all of the active nearshore monitoring programs along the west coast of North America (e.g., PISCO, MARINe, LIMPET, NAGISA, PSP, NOAA mussel watch). Where feasible we adopted and designed species and location specific procedures that would facilitate comparison of common metrics among existing and prior programs. For example, we employ point contact methods to estimate percent cover of intertidal invertebrates and algae that are similar to PISCO and MARINe methods and will facilitate comparison. We also estimate densities of large motile invertebrates (e.g., stars), that will be comparable to estimates from PISCO, MARINe, and other programs employing comparable techniques. In many instances species differences existed between existing nearshore monitoring programs in the contiguous US and Alaska requiring modification to available procedures. Where appropriate we adopted widely used and published methods to estimate marine bird densities (Irons et al. 2000) black oystercatcher abundance and diet (Andres 1998, Webster 1941) and sea otter abundance (Bodkin and Udevitz 1999), diet (Calkins 1978, Estes et al. 1981), and survival (Monson et al. 2000).

There are, however, fundamental differences between some of the objectives of the GOA nearshore monitoring program described here and other nearshore monitoring programs. These include a GOA program objective to allow statistical inference to the entire region and therefore required a random component to site selection, rather than focusing on specific selected sites. An exception to this random site selection occurred in KBAY. Here, four of the initial sites that were chosen to be monitored (starting in 2002 with another program) were chosen on the south side of the bay because of their large spatial extent and high species diversity. When KBAY joined the GOA monitoring team, we added two addition sites on the north side of the bay to better represent the region. Compared to other existing programs, many GOA sites are remotely located and access is difficult and costly. As a result, our sampling frequency is generally equal to or greater than one year (with a few exceptions such as water quality), with limited ability to detect within year variation or trends. Furthermore, there are additional location-specific factors (e.g. a large tidal prism and high degree of disturbance due to ice and storms) that led us to different sampling designs than employed by other programs. Perhaps most importantly, the GOA program attempts to encompass all major elements of the nearshore trophic web: kelps and seagrasses as primary producers, benthic invertebrates as primary consumers, and the birds and mammals as apex predators (i.e., black oystercatchers, sea ducks and the sea otter). We know of no other nearshore monitoring program that incorporates this breadth of trophic interaction that will allow both “bottom-up” and “top-down” perspectives on causes of change in the nearshore marine ecosystem. This approach required adapting existing procedures where available and appropriate, and developing new ones as needed.

Selection of sampling regions

As indicated above, sampling will be largely restricted to the Katmai, Kenai Peninsula and Prince William Sound coastlines, and will be concentrated in four regions (KATM, KEFJ, WPWS, and KBAY) (Figure 5). There are a wide variety of habitats within these regions. For the purpose of the GWA monitoring program, we intend to restrict sampling of intertidal invertebrates and algae to sheltered-rocky shores and to gravel and mixed sand-gravel beaches. We selected these habitats because they represent over half (about 58%) of the shorelines within the region (Ford et al. 1996); are biologically diverse; harbor both hard bottom (epibenthic) and soft bottom (infaunal) organisms; are tractable to sample, and have a wealth of historical data relative to other habitats. Thus, they provide excellent indicators of change. Sampling of nearshore birds and mammals will include the full range of nearshore habitats.

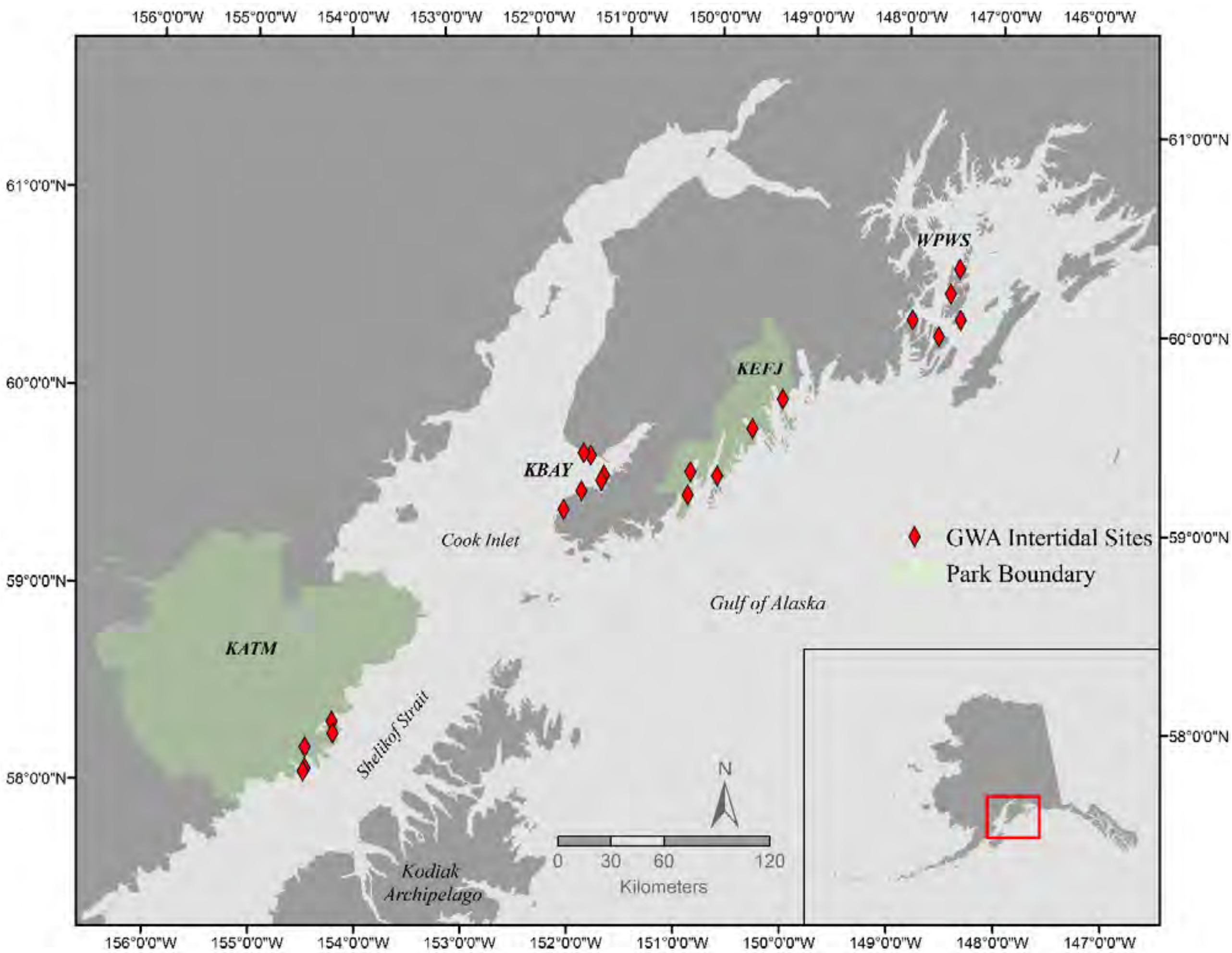

Figure 5. Map showing study sites within KATM, KEFJ, KBAY and WPWS. The red diamonds represent rocky intertidal sites that act as a central point to establish monitoring sites or transects of several other marine nearshore vital signs.

Sampling Site Locations

In KBAY, sites were selected based on location of historical data (from the Census of Marine Life Project and others) or to ensure good representation of the bay. For the rocky sheltered/mixed gravel cobble sites, four were historical sites and two were chosen to better represent the area). For the seagrass sites, two had historical data and two were chosen to ensure better spatial coverage. For all but the KBAY sites, discrete sampling sites used to sample intertidal invertebrates and algae on sheltered rocky shorelines were selected using a generalized random tessellation stratified (GRTS) sampling scheme (Stevens and Olsen, 2004). This design provided a random yet spatially balanced distribution of sites within region. A GRTS design also allows for expansion or contraction of the number of sites to be sampled over time by pre-selecting a large number of sites that were ordered with respect to priority. Thus, sampling sites could be added or deleted without compromising the statistical or spatial integrity of the design.

Rocky intertidal sampling sites were selected using S-Draw, a windows-based GRTS sampling software program (GRTS for the Average Joe: A GRTS Sampler for Windows; http:// http://west-inc.com/reports/grts.pdf). Potential shorelines representing sheltered rocky or gravel/mixed sand gravel geomorphologic types were identified using Geographic Information System (GIS) software from Environmentally Sensitive Index (ESI) maps produced for each region (RPI, 1983a, 1983b, 1985, 1986). The S-Draw software was then used to produce an ordered list of 100 potential sampling sites within each block. Water quality metrics (contaminants in mussels, temperature, and salinity) are to be measured at sites identified for sampling of intertidal invertebrates on rocky shores. Subsequent site selection for other vital signs were based on proximity to the location of the stratified random sample of sheltered rocky sites within each region.

Selection of the size and number of sampling units

The size and number of sampling units to be included for evaluation of each metric within a given sampling period are described in detail in specific SOPs. A sampling unit is defined as the smallest unit for which a particular metric is measured and expressed. For example, the number of sea stars will be counted within a 200 m^2 area and expressed as number per 100 m^2. For each metric, the size of the sampling unit and number of sampling units varies dependent largely on the behavior of the species of interest. In estimating abundance of larger, more motile species that have large and variable home ranges that can cover large portions of a region (e.g. sea otters), sampling will be conducted along relatively large random or systematically placed transects of several hundred meters or more that cover the entire region. For sessile species or ones with a limited home range (e.g., many invertebrates) sampling will be conducted at discrete, permanently established sites within each region. A site is defined as an approximately 50 to 100-m section of coastline and the water directly adjacent to it. For these smaller, less motile species, sampling will be conducted within quadrats or transects ranging in size from approximately 0.10 to 200 m^2 at each site. The number of transects or quadrats sampled per site will range from one (for larger invertebrates like sea stars) to 24 (divided equally between two vertical strata (or 4 vertical strata as in KBAY)) for smaller invertebrates and algae. The intent is to sample a number of units that will provide sufficient statistical power to detect changes ranging from 20% to 80% (dependent on the metric, see section below). These criteria were selected as ones that were both biologically meaningful and achievable given budgetary and logistical constraints.

Transects used for estimating black oystercatcher density were centered on sites used to sample intertidal invertebrates on rocky shores. Nest productivity is estimated at each nest site located within these transects and prey composition is measured at any nest site where prey are observed.

Sea otter abundance (aerial surveys) is estimated using counts of sea otters along transects within defined sea otter habitat throughout each region that were selected systematically with a random start point.

Sea otter foraging observations are to be made at sites wherever sea otters are seen foraging within a 5 km radius of intertidal sampling sites. This radius roughly corresponds to the annual home range for sea otters. Sampling will be focused as close to the invertebrate sites as possible but will be dependent on the presence of sea otters required to obtain the minimum sample of 50 forage bouts per year.

Carcasses of sea otter skulls are collected from wherever skulls are found within each region, but will focus on specific locations where large numbers of sea otter carcasses have been found in the past.

C. Data Analysis and Statistical Methods

Power and the levels of detectable change

As indicated above, the objective of the sampling program is to assess how various metrics change over time and how those changes vary with respect to location and one another. The levels of change that we can expect to detect and the time and spatial scales over which they are to be detected vary with metric. The spatial scales over which trends will be examined range from a region (for large motile species like sea otters) to a site (for smaller, less motile species like mussels). In general, the goal for most biological metrics (e.g., abundance of sea otters, harlequin ducks, or dominant intertidal invertebrates like mussels) is to detect levels of change that are deemed to be of ecological importance (see Protocol Narrative for a discussion of determination of levels of change that are deemed ecologically important for each metric). In general, we intend to detect changes ranging from 20 to 80% (depending on the metric) at a given region (e.g., KATM or PWS). The ability to detect change can be expressed as power, the probability that a given level of change could be detected given the sampling design employed. Power analyses can also be used as a planning tool, to determine the sampling effort required to detect a given level of change with a prescribed power. It is anticipated that one of the primary methods used to detect change will conceptually take the form of mixed-model analyses (McCulloch et al. 2008) that examine, at a minimum, time (year) and location as the primary factors. The location factor consists of blocks (and in some cases sites nested within each block) with replicate samples within the block. Various mixed models would examine the extent of variation for a particular metric that could be attributed to location (e.g., region or sites within a block), time, and the interaction between these factors.

It is reasonable to assume that the power to detect a given level of change will increase over time as the number of surveys increases. This stresses the need for conducting periodic power analyses to suggest modifications to sampling designs over time and to ensure efficiency in the sampling. The power to detect a given level of change also depends on biases associated with a particular sampling regime (Tyre et al. 2003, Earnst et al. 2005). For example, these might include biases introduced by using different observers in aerial surveys of sea otters or birds or those associated with the inability to detect all individuals present. When possible, we will account for these biases in our analyses.

Data analyses and statistical methods that will be used to evaluate changes in the nearshore environment are detailed in Dean and Bodkin (2006) and Dean et al. (2014). In general, we will examine trends in each metric over time within each location, differences among locations over time, and interactions between time and locations (i.e., the extent to which changes within each location track changes across locations over time) through regression and information-theoretic (IT) criteria (Burnham and Anderson 2002, 2004). Competing hypotheses (models) will be selected a priori and those models will be ranked based on their relative support (AIC values). These analyses will help to sort out effects of small scale sources of change (e.g., effects of oil in PWS or other location specific impacts such as logging activities) from larger scale sources of change (e.g., those due to climate change that are occurring over the entire GOA).

To illustrate that the current nearshore design is capable of assessing how various metrics change over time and how those changes vary with respect to location and one another, here we provide a brief overview of two publications that utilize data collected through the integrated design. A recent submission to an Ecosphere special issue (Coletti et al. in review) analyzed sea otter abundance, energy recovery rates and age at death data across KATM, KEFJ and WPWS. Because the monitoring design allows broad spatial inference and has direct food web linkages, we demonstrated the ability of our data to simultaneously detect change and examine potential mechanisms underlying that change. Specifically, our analysis of recent sea otter abundance at these three locations in the GOA indicates populations with divergent trajectories, including growth (WPWS), stability (KEFJ) and perhaps most recently, decline (KATM), although additional surveys will be required to verify findings. This spatial contrast among locations, one of the key design features of our monitoring program, suggests that mechanisms influencing sea otter abundance and trend can differ at relatively small scales. Further, these data suggest that sea otter abundance in the GOA currently is not being driven by Gulf-wide factors. The divergent trends in sea otter abundance allow us to evaluate those regional trends independently, using the diet and mortality data collected concurrently within each region.

In another example, a paper recently accepted by Estuaries and Coasts (Konar et al. submitted) tested hypotheses that rocky intertidal community structure is less similar at the local scale compared with the regional scale, coinciding with static drivers being less similar on smaller scales (sites within regions) than larger scales (across larger geographic regions). It also was hypothesized that static attributes mainly drive local biological community structure. For this, we examined multiple static variables (distance to freshwater, tidewater glacial presence, exposure to wave energy, fetch, beach slope, and substrate composition) to determine their importance in influencing biological communities at specific sites and across regions. Our results suggest that generally, biological communities in the northern GOA are not strongly influenced by the local static attributes measured in this analysis. An alternative is that the static attributes among our regions are not different enough to manifest a change in the biological communities. This lack of evidence for a strong driver associated with static attributes may be a result of the site selection process, which targeted sheltered rocky habitats, and may not have varied greatly in their static characteristics. If true, this suggests that our rocky sheltered sites may be well positioned to examine the influence of dynamic drivers, including those resulting from climate change (i.e., temperature, salinity). We have concluded that a longer term study at our monitoring sites should be able to tease apart the interactions of static and dynamic drivers. Hence, continuing data collection and analyses will focus on drivers of these communities.

These analyses enhance our understanding of system dynamics and illustrate the ability of the integrated design to detect change and infer cause. Because of this, we expect our results to promote conservation and improve management of natural resources.

D. DESCRIPTION OF STUDY AREA

Locations (see Figure 5)**:**

Western PWS (5 intensive sites): This study area was funded by EVOSTC (Projects 10100750 and 12120114-R, covering data collection during 2010-2016. We are requesting funds to continue monitoring the study sites long-term, including 2017–2021.

Katmai and Kenai National Parks (5 intensive sites each park): These study areas have been funded primarily by NPS, with data collection at Katmai ongoing since 2006, and at Kenai since 2007. We request funding for support of sea otter aerial surveys at KATM, KEFJ and WPWS areas (alternate years each location), for the charter vessel to Katmai for annual sampling, and for continuing support of personnel who will be involved in data collection, analysis and management across all study locations, 2017-2021.

Kachemak Bay (6 intensive sites): Monitoring of intertidal invertebrates, algae and seagrass beds in nearshore areas of Kachemak Bay has been ongoing for over a decade, along with extensive sea otter surveys, shellfish surveys, and oceanographic measurements. Intertidal survey methods have followed slightly different but overall comparable protocols to those used in the other proposed nearshore study areas. We implemented modified sampling protocols in 2012 that made sampling more consistent with other areas. We also conducted a comparison of protocols between KBAY and the other regions in 2015 and found them to be similar (in Konar et al. submitted). We request support for continued work in 2017-2021.

5. Coordination and Collaboration

WITHIN THE PROGRAM

The nearshore component of GWA is a highly coordinated effort involving multiple PIs with expertise on various aspects of nearshore ecosystems; the overall design and coordination are critical for drawing inference about factors affecting the nearshore. Since 2012 under GWA, there have been two nearshore projects (15120114-R Nearshore Benthic Systems in the GOA and 12120114-L, Ecological Trends in Kachemak Bay). The two projects have worked closely in the past five years to ensure that data collected in Kachemak Bay are comparable with those from other nearshore sites across the GOA and provide another window into the causative factors and spatial extent of changes in nearshore systems. For example, we collaborated with Drs. Konar and Iken to combine data sets for analyses presented in the 2014 GWA Science Synthesis report, which is in prep to be submitted to a peer reviewed journal. In addition, for 2017-2021, we have proposed to integrate the two nearshore projects into a single program to further our collaboration.

An educational collaboration also exists within this project There are two University of Alaska field courses that are taught by Konar and Iken at the Kasitsna Bay Lab that assist with the data collection used in this program. Students will get valuable experience and training from participating in this project and the project will benefit from having these students. In addition, the KBAY portion of this project provides summer funding for one graduate student who can then dedicate more time to assist in the sampling and sample processing.

We have worked closely with the other GWA components (Environmental Drivers and Pelagic) over the previous five years to identify data sets that can be shared. For example, Environmental Drivers data were used extensively in our analysis of mussel trends across the Gulf of Alaska, presented in the GWA Science

Synthesis report (Monson et al. 2015). For the next five years, we hypothesize that productivity in the nearshore is strongly influenced by physical oceanographic processes. It will be a priority to evaluate whether or not changes that may be noted in the nearshore systems are reflected in either oceanographic conditions or in synchronous changes in pelagic species and conditions. The geographic scale of our study (GOA-wide) will provide greater ability to discern both potential linkages across these diverse components, as well as among the study areas within the nearshore, allowing us to evaluate relations and changes in the nearshore resources. We will incorporate data on annual and seasonal patterns measured in the Environmental Drivers component of the overall study as well as data from the Pelagic study components.

In July 2015, during our fieldwork in KATM, we coordinated with the GWA Environmental Drivers component (Doroff and Holderied) to collect phytoplankton and mussel samples in light of the harmful algal bloom documented in 2015. These samples are still being analyzed. With oceanographic conditions continuing to change, we anticipate further collaboration with the Environmental Drivers group to collect relevant physical and biological data.

As productivity in the nearshore is strongly influenced by physical oceanographic processes, it will be a priority to evaluate whether or not changes that may be noted in the nearshore systems are reflected in either oceanographic conditions or in synchronous changes in pelagic species and conditions. The geographic scale of our study (GOA-wide) will provide greater ability to discern both potential linkages across these diverse components, as well as among the study areas within the nearshore, allowing us to evaluate relations and changes in the nearshore resources. We will incorporate data on annual and seasonal patterns measured in the Environmental Drivers component of the overall study as well as data from the Pelagic study components. For example, we have documented synchronicity at various time and spatial scales in the abundance of mussels in the Gulf of Alaska with cascading effects to upper trophic levels (Monson et al. 2015). Continued monitoring focused on identifying mechanisms of change (e.g., recruitment versus adult survival) may be needed to identify the ultimate driver of the observed synchrony. One component of the overall LTM of particular importance to the nearshore is surveys of nearshore marine birds, which will be accomplished in PWS through the Marine Bird Population Trends monitoring component (representing a further long-term data set; see Irons et al. 2000) and at Kenai Fjords and Katmai by the NPS SWAN program. Contrasting the changes occurring in the pelagic and nearshore environments during the recent years when GOA waters have warmed by several degrees in 2014 and 2015 (https://alaskapacificblob.wordpress.com/2016/02/09/subsurface-warmth-persists/) may be particularly illuminating.

We have been working with Tuula Hollmen and Lisa Sztukowski of the Alaska SeaLife Center (ASLC) on a nearshore conceptual model, leading from variation in prey to variation in behavioral and demographic responses in consumers such as sea otters and sea ducks.

Finally, data collected by the nearshore component are relevant for understanding ecosystem recovery with respect to the Lingering Oil component (e.g., sea otter abundance, energy recovery rate, and age-at-death data) have all been used to evaluate population recovery to this point (Ballachey et al. 2014b).

WITH OTHER EVOSTC-FUNDED PROGRAMS AND PROJECTS

The Nearshore Component of GWA historically has been closely linked with the Lingering Oil component, given that lingering oil occurs in nearshore habitats and affects nearshore species. Although the EVOSTC has indicated that Lingering Oil will be treated as a separate program in the upcoming 5 years, those conceptual and collaborative linkages remain. In 2016, a Lingering Oil proposal will be submitted by L. Bowen, K. Miles, B. Ballachey, J. Bodkin and colleagues to address exposure and effects of hydrocarbons in mussels. If funded, extensive collaboration and synergies will occur between programs, including sample collection, logistical support, conceptual considerations, and shared analysis of relevant data streams.

Also, an associated “above-ceiling” proposal is being submitted, which would (1) establish high-intensity sites for asking critical directed questions that inform ongoing monitoring and (2) address factors leading to variability in population dynamics of mussels. As indicated above, mussels are a key element of nearshore communities. While we have the ability to accurately describe variation in mussels at a number of spatial and temporal scales, our annual monitoring cannot elucidate the underlying mechanisms leading to observed changes. Therefore, the proposed work will look closely at the relative importance of bottom-up and top-down effects on mussels, and how that changes over time and space. This work would be done with a high degree of collaboration with Nearshore and Environmental Drivers Components of GWA. It also would provide insights on processes that affect results of mussel monitoring, which in turn make the findings most useful for managers as they anticipate change in marine ecosystems.

With Trustee or Management Agencies

In addition to the logistical, administrative, and in-kind support that the NPS, USGS, NOAA and University of Alaska Fairbanks (UAF) has provided to ensure the success of the GWA Nearshore component, there are several additional projects with trustee and management agencies that the nearshore component of GWA has collaborated with. Below are several recent examples. We expect to continue these projects.

NPS sea otters in KEFJ

In 2013, building on GWA findings indicating that sea otters in KEFJ consume mussels at much higher frequencies than at other areas, we initiated a study of annual patterns in mussel energetics and sea otter foraging at KEFJ, funded by NPS and USGS. That study is to be completed in 2016. Initial results indicate that mussel energy density varies seasonally, likely corresponding to spawning condition. Further, we found that mussel consumption by otters varied slightly seasonally in association with varying mussel energy density, but overall mussel consumption was high in KEFJ across seasons.

NPRB sea otter study

Our GWA nearshore data from KATM contributed to USGS and North Pacific Research Board (NPRB) studies of the status of the southwest Alaska stock of sea otters, which is listed as threatened under the Marine Mammal Protection Act. These data are shared with the USFWS, Marine Mammals Management, who is responsible for sea otter management. NPRB Project 717 Final Report, Estes, Bodkin and Tinker 2010.

NPS Changing Tides

Nearshore GWA PIs (Ballachey, Bodkin, Coletti, and Esler) worked with NPS on the ‘Changing Tides’ Project. This study examines the linkages between terrestrial and marine ecosystems and is funded by the National Park Foundation. Field work was initiated in July 2015 with in-kind support from our KATM vessel charter. National Parks in Southwest Alaska are facing a myriad of management concerns that were previously unknown for these remote coasts, including increasing visitation, expanded commercial and industrial development, and environmental changes due to natural and anthropogenic forces. These are concerns because of their potential to significantly degrade and potentially impair resources in coastal systems. The project has three key components: (1) brown bear fitness and use of marine resources, (2) health of bivalves (clams and mussels), and (3) an integrated outreach program. We (GWA nearshore component) assisted with the collection of a variety of bivalve species from the coast of Katmai National Park and Preserve. Several specimens were kept live in small aquarium-like containers, and condition and performance metrics were assessed in the laboratory by ASLC collaborators Tuula Hollmen and Katrina Counihan. Others are being used to perform genetic transcription diagnostics (gene expression) to measure the physiologic responses of individuals to stressors, in collaboration with Liz Bowen and Keith Miles of USGS. This project will increase our understanding of how various stressors may affect both marine intertidal invertebrates and bear populations at multiple spatial and temporal scales.

BOEM Nearshore community assessments

Nearshore component PIs (Coletti, Iken, Konar and Lindeberg) have been working on development of recommendations to the Bureau of Ocean Energy Management (BOEM) for nearshore community assessment and long-term monitoring. The BOEM Proposed Final Outer Continental Shelf (OCS) Oil and Gas Leasing Program 2012-2017 includes proposed Lease Sale 244 in the Cook Inlet Planning Area in 2017. An OCS Cook Inlet Lease Sale National Environmental Policy Act (NEPA) analysis has not been undertaken since 2003. Updated information is needed to support an analysis associated with the planned lease sale. The overall objective of this study is to provide data on habitats and sensitive species to support environmental analyses for NEPA documents, potential future Exploration Plans, and Development and Production Plans. The goal was to utilize existing protocols already developed thorough GWA when possible to ensure data comparability. The project will be ongoing through 2019 and all data are being provided to the Alaska Ocean Observing System data portal.

WITH NATIVE AND LOCAL COMMUNITIES

We have no plans for local or native community involvement at this time.

6. Schedule

PROGRAM MILESTONES

Deliverable/Milestone	***Status***
Field Work (multiple trips, multiple tasks per trip to collect data on series of nearshore metrics); KATM, KEFJ, WPWS, KBAY	Completed, April - July, Annually
Upload Data To Project Website	To be Completed 1 Year After Collection
PI's Attend Annual Program Meeting	To be Completed Annually
Meet All Program Reporting Requirements	To be Completed Annually

MEASURABLE PROGRAM TASKS

The projected schedule of tasks for the nearshore benthic component is outlined in Table 1.

1. Annual Collection of sea otter skulls for determination of age-at-death.
2. Annual collection of sea otter diet and energy recovery rate data.
3. Aerial surveys of sea otter abundance.
4. Sampling of intertidal invertebrates and algae.
5. Sampling of sea grasses.
6. Sampling diet and productivity of black oystercatchers.
7. Sampling marine bird and mammal density (summer).
8. Sampling marine bird and mammal density (winter).
9. Stable isotope analysis of selected nearshore species.
10. Contaminants analysis
11. All reporting

Table 1. Schedule of Measurable Program Tasks

Task	FY17				FY18				FY19				FY20				FY21			
	Quarter (EVOSTC FY beginning Feb. 1)																			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Task 1 - Collection of sea otter skulls for determination of age-at-death	X	X			X	X			X	X			X	X			X	X		
Task 2 - Annual collection of sea otter diet and energy recovery rate data		X				X				X				X				X		
Task 3 - Aerial surveys of sea otter abundance (alternating between KATM, KEFJ and WPWS)		X				X				X				X				X		
Task 4 - Sampling of intertidal invertebrates and algae		X				X				X				X				X		
Task 5 - Sampling of sea grasses and subtidal kelps		X				X				X				X				X		
Task 6 - Diet and productivity of black oystercatchers		X				X				X				X				X		
Task 7 – Marine bird and mammal surveys (summer KATM and KEFJ)		X				X				X				X				X		
Task 8 - Marine bird and mammal surveys (winter KATM or KEFJ, alternate years)	X				X				X											
Task 9 - Stable isotope analysis of selected nearshore species		X				X				X				X				X		
Task 10 - Contaminant analysis						X														
Task 11 - Reporting																				

Task	FY17				FY18				FY19				FY20				FY21			
	Quarter (EVOSTC FY beginning Feb. 1)																			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Published data sets available			X				X				X				X				X	
Annual Rpts	X				X				X				X				X			
Annual PI meeting				X				X				X				X				X
FY Work Plan (DPD)			X				X				X				X					

FY 17 (Year 6)

FY17, 1st quarter (February 1, 2017 - April 30, 2017)
Submit year 5 (2016) annual reports (Feb. 1)

PI data compliance – prior year available to public

Field work includes collection of sea otter skulls for age-at-death determination during April in PWS (task 1) and winter (March) marine bird and mammal surveys in either KATM or KEFJ, depending on NPS priority (NPS funded)

Continue to prepare for upcoming field season (all logistics including staff, timing, equipment, vessel contracts and travel)

FY17, 2nd quarter (May 1, 2017 - July 31, 2017)
All field tasks initiated and completed in all three regions (KBAY, KATM, KEFJ and WPWS) (May, June and July)

WPWS sea otter aerial survey (June)

Open submissions for GWA Special Issue (July 1, 2016)

FY17, 3rd quarter (August 1 2017 - October 31, 2017)
Annual workplan completed

Datasets from current year posted on the internal Ocean Workspace

End Special Issue submission period (Sept. 30, 2016)

FY17, 4th quarter (November 1, 2017 - January 31, 2018)
Analysis continues along with preparation for annual GWA meeting in November and for Alaska Marine Science Symposium in January

Begin annual report, summarize annual results including outreach as well as publications

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FY 2018 (Year 7)

FY18, 1st quarter (February 1, 2018 - April 30, 2018)
Submit year 1 annual reports (Feb. 1)

PI data compliance – prior year available to public

Field work includes collection of sea otter skulls for age-at-death determination during April in PWS (task 1) and winter (March) marine bird and mammal surveys in either KATM or KEFJ, depending on NPS priority (NPS funded)

Continue to prepare for upcoming field season (all logistics including staff, timing, equipment, vessel contracts and travel)

FY18, 2nd quarter (May 1, 2018 - July 31, 2018)
All field tasks initiated and completed in all three regions (KBAY, KATM, KEFJ and WPWS) (May, June and July)

KATM sea otter aerial survey (July)

Samples collected for contaminant analyses in all regions

FY18, 3rd quarter (August 1, 2018 - October 31, 2018)
Annual workplan completed

Datasets from current year posted on the internal Ocean Workspace

FY18, 4th quarter (November 1, 2018 - January 31, 2019)
Analysis continues along with preparation for annual GWA meeting in November and for Alaska Marine Science Symposium in January

Begin annual report, summarize annual results including outreach as well as publications

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FY 2019 (Year 8)

FY19, 1st quarter (February 1, 2019 - April 30, 2019)
Submit year 2 annual reports (Feb. 1)

PI data compliance – prior year available to public

Field work includes collection of sea otter skulls for age-at-death determination during April in PWS (task 1) and winter (March) marine bird and mammal surveys in either KATM or KEFJ, depending on NPS priority (NPS funded)

Continue to prepare for upcoming field season (all logistics including staff, timing, equipment, vessel contracts and travel)

FY19, 2nd quarter (May 1, 2019 - July 31, 2019)
All field tasks initiated and completed in all three regions (KBAY, KATM, KEFJ and WPWS) (May, June and July)

KEFJ sea otter aerial survey (June)

FY19, 3rd quarter (August 1, 2019 - October 31, 2019)
Annual workplan completed

Datasets from current year posted on the internal Ocean Workspace

FY19, 4th quarter (November 1, 2019 - January 31, 2020)

Analysis continues along with preparation for annual GWA meeting in November and for Alaska Marine Science Symposium in January

Begin annual report, summarize annual results including outreach as well as publications

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FY 2020 (Year 9)

FY20, 1st quarter (February 1, 2020 - April 30, 2020)
Submit year 3 annual reports (Feb. 1)

PI data compliance – prior year available to public

Field work includes collection of sea otter skulls for age-at-death determination during April in PWS (task 1) and winter (March) marine bird and mammal surveys in either KATM or KEFJ, depending on NPS priority (NPS funded)

Continue to prepare for upcoming field season (all logistics including staff, timing, equipment, vessel contracts and travel)

FY20, 2nd quarter (May 1, 2020 - July 31, 2020)
All field tasks initiated and completed in all three regions (KBAY, KATM, KEFJ and WPWS) (May, June and July)

WPWS sea otter aerial survey (June)

FY20, 3rd quarter (August 1, 2020 - October 31, 2020)
Annual workplan completed

Datasets from current year posted on the internal Ocean Workspace

FY20, 4th quarter (November 1, 2020 - January 31, 2021)
Analysis continues along with preparation for annual GWA meeting in November and for Alaska Marine Science Symposium in January

Begin annual report, summarize annual results including outreach as well as publications

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FY 2021 (Year 10)

FY21, 1st quarter (February 1, 2021 - April 30, 2021)
Submit year 4 annual reports (Feb. 1)

PI data compliance – prior year available to public

Field work includes collection of sea otter skulls for age-at-death determination during April in PWS (task 1) and winter (March) marine bird and mammal surveys in either KATM or KEFJ, depending on NPS priority (NPS funded)

FY21, 2nd quarter (May 1, 2021 - July 31, 2021)

All field tasks initiated and completed in all three regions (KBAY, KATM, KEFJ and WPWS) (May, June and July)

KATM sea otter aerial survey (July)

FY21, 3rd quarter (August 1, 2021 - October 31, 2021)
Annual workplan completed

Datasets from current year posted on the internal Ocean Workspace

FY21, 4th quarter (November 1, 2021 - January 31, 2022)
Analysis continues along with preparation for annual GWA meeting in November and for Alaska Marine Science Symposium in January

Begin annual report, summarize annual results including outreach as well as publications

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FY 2022 (Year 11)

FY22, 1st quarter (February 1, 2022 - April 30, 2022)
Submit year 5 final reports (Feb. 1)

7. Budget

Budget forms (Attached)

Completed budget forms are attached.

Sources of additional funding

Annual in-kind contributions consist of staff time (USGS = $92K; NPS = $130k; NOAA = $10k), reduced charter costs (USGS = $45K; NPS= $25K), winter bird surveys (NPS=$18K through 2019), use of equipment such as rigid-hull inflatable, inflatables/outboards, GPSs, spotting scopes, field laptops, sounding equipment (USGS = $40K; NPS = $40K) and commodities (USGS = $5k; NPS = $5K). NPS budgets are projected to decline over time based on agency 5-year planning.

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Project Data Online

http://portal.aoos.org/gulf-of-alaska.php#metadata/a51209ad-e2fd-4292-b9ef-4e6f45b5f15a/project/files

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Current activities related to the proposed project: Monitoring resources that are explicitly linked to the marine nearshore along regions within the Gulf of Alaska through the NPS SWAN I&M program and Gulf Watch Alaska.

Selected Publications

Ballachey, B.E., J.L. Bodkin, K.A. Kloecker, T.A. Dean, and **H.A. Coletti**. 2015. Monitoring for Evaluation of Recovery and Restoration of Injured Nearshore Resources. *Exxon Valdez* Oil Spill Restoration Project Final Report (Restoration Project 10100750), U.S. Geological Survey, Alaska Science Center, Anchorage, Alaska.

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Education:

2000 Ph.D. Wildlife Science. Oregon State University, Corvallis, Oregon, USA.
1988 M.Sc. Wildlife Ecology. Texas A&M University, College Station, Texas, USA.
1985 B.Sc. Biology/Outdoor Education. Northland College, Ashland, Wisconsin, USA.

Recent Professional Experience:

August 2013 – present

Project Leader and Research Wildlife Biologist, Nearshore Marine Ecosystem Research Program, Alaska Science Center, U.S. Geological Survey, Anchorage, Alaska. I lead the Nearshore Marine Ecosystems Research Program (NMERP) of the Alaska Science Center, USGS. My program conducts studies to document and understand underlying causes of change in nearshore marine systems.

February 2001 – May 2013

University Research Associate and Adjunct Professor, Centre for Wildlife Ecology, Department of Biological Sciences, Simon Fraser University, British Columbia
Responsibilities: I led a research team conducting a broad suite of studies related to wildlife conservation in western North America, particularly marine birds and their prey. This research was designed to generate findings relevant for management of populations and habitats at regional or continental scales.

Relevant Peer-reviewed Publications:

Esler, D., P. L. Flint, D. V. Derksen, J.-P.L. Savard, and J. Eadie. 2015. Conclusions, synthesis, and future directions: understanding sources of population change. *in* J.-P.L. Savard, D. Derksen, D. Esler, and J. Eadie, editors. Ecology and Conservation of North American Sea Ducks. Studies in Avian Biology.

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Kirk, M., **D. Esler**, and W. S. Boyd. 2007. Morphology and density of mussels on natural and aquaculture structure habitats: implications for sea duck predators. Marine Ecology Progress Series 346:179-187.

Lewis, T. L., **D. Esler**, and W. S. Boyd. 2007. Effects of predation by sea ducks on clam abundance in soft-bottom intertidal habitats. Marine Ecology Progress Series 329:131-144.

Žydelis, R., **D. Esler**, W. S. Boyd, D. Lacroix, and M. Kirk. 2006. Habitat use by wintering surf and white-winged scoters: effects of environmental attributes and shellfish aquaculture. Journal of Wildlife Management 70:1754-1762.

Peterson, C. H., S. D. Rice, J. W. Short, **D. Esler**, J. L. Bodkin, B. A. Ballachey, and D. B. Irons. 2003. Long-term ecosystem response to the *Exxon Valdez* oil spill. Science 302:2082-2086.

Esler, D., T. D. Bowman, K. Trust, B. E. Ballachey, T. A. Dean, S. C. Jewett, and C. E. O'Clair. 2002. Harlequin duck population recovery following the Exxon Valdez oil spill: progress, process, and constraints. Marine Ecology Progress Series 241:271-286.

<u>Recent Collaborators:</u>

Anderson, Eric (British Columbia Institute of Technology), Ballachey, Brenda (USGS retired), Bodkin, James (USGS retired), Bowen, Liz (USGS), Bowman, Tim (USFWS), Boyd, W. Sean (Environment Canada), Coletti, Heather (NPS), Derksen, Dirk (USGS retired), Eadie, John (University of California Davis) Flint, Paul (USGS), Gorman, Kristen (PWSSC), Hogan, Danica (Environment Canada), Hollmen, Tuula (UAF/ASLC), Hupp, Jerry (USGS), Lok, Erika (Environment Canada), Matkin, Craig (North Gulf Oceanic Society), Lindeberg, Mandy (NOAA), Palm, Eric (Ducks Unlimited), Rice, Jeep (NOAA retired), Schmutz, Joel (USGS), Thompson, Jonathan (Golder), Tinker, Tim (USGS/University of California Santa Cruz), Uher-Koch, Brian (USGS), Ward, David (USGS), Willie, Megan (Simon Fraser University), and Ydenberg, Ron (Simon Fraser University)

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Ms. Kloecker is a marine ecologist who has taken on project and data management tasks. She has over 10 years managing cross-project budgets, logistics, and data and more than 20 years' experience working with agency, university, and private researchers, volunteers, students, and resource managers. Her goals include mentoring the next generation of scientists in data stewardship and rescuing historic or orphaned data sets relevant to the long-term monitoring program.

Education

MS, Marine Sciences, University of California, Santa Cruz, CA, 1993
BS, Biological Science, Michigan State University, E. Lansing, MI, 1989

Professional Experience

USGS Anchorage, AK, *Biologist* 2002 – Present
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Relevant Publications and Technical Reports

Ballachey, B. E., D. H. Monson, G. G. Esslinger, K. A. Kloecker, J. L. Bodkin, L. Bowen, and A. K. Miles. 2014. 2013 update on sea otter studies to assess recovery from the 1989 *Exxon Valdez* oil spill, Prince William Sound, Alaska. USGS Open-File Report 2014-1030, 40 p. doi:10.3133/ofr20141030.

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Bodkin, J. L. K. A. Kloecker, G. G. Esslinger, D. H. Monson, H. A. Coletti and J. Doherty. 2003. Sea Otter Studies in Glacier Bay. Annual Report 2002. USGS Alaska Science Center, Anchorage AK.

Bodkin, J. L. K. A. Kloecker, G. G. Esslinger, D. H. Monson, J. D. DeGroot and J. Doherty. 2002. Sea Otter Studies in Glacier Bay. Annual Report 2001. USGS Alaska Science Center, Anchorage AK.

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- Hydrocarbon Residues in Tissues of Sea Otters Collected from southeast Alaska.
- Hydrocarbon Residues in Tissues of Sea Otters Collected Following the EVOS.
- Hydrocarbons in Hair, Liver, and Intestine of Sea Otters Found Dead Along the Path of the EVOS.

Rebar, A. H., B. E. Ballachey, D. L. Bruden, and K. A. Kloecker. 1996. Hematology and Clinical Chemistry of Sea Otters Captured Following the *Exxon Valdez* Oil Spill. EVOS State/Federal NRDA Final Reports, USFWS, Anchorage, AK.

Collaborators

- USGS: Daniel Esler, Brenda Ballachey, Jim Bodkin, Daniel Monson, George Esslinger, Ben Weitzman, John Paszalek, Vanessa von Biela, Yvette Gillies, Anthony Fischbach, Rose Cunningham, Durelle Smith, Viv Hutchinson, Keith Miles, Shaylyn Storms
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- FWS: Marine Mammals Management: Joel Garlich-Miller, Brad Benter; Migratory Bird Management: Rob Kaler, Kathy Kuletz
- NOAA: Auke Bay Lab: Mandy Lindeberg; Emergency Response Division: Gary Shigenaka; Kasitsna Bay Lab: Chris Holderied; National Estuarine Research Reserve: Angela Doroff
- Academic: UCSC: Tim Tinker, Sarah Espinosa; UAA: Jennifer Burns; UC Davis: Liz Bowen
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Research Wildlife Biologist, Alaska Science Center, 1996-present
Biological Technician and Statistical Assistant, Alaska Science Center, 1987-1996
2009 – Ph.D., University of California Santa Cruz, Santa Cruz, CA. (Ecol. & Evol. Biology)
1995 – M.S., University of California Santa Cruz, Santa Cruz, CA. (Marine Science)
1983 – B.A., Luther College, Decorah, Iowa (Biology)

Dan has been involved in the Coastal Ecosystems research program for the Alaska Science Center since 1987. Beginning in 2012, Dan became a PI for the Nearshore component within the GulfWatch Program where his role is to conduct high quality research focused on understanding natural and anthropogenic factors affecting nearshore ecosystems that will be critical for ecosystem-based management of these resources. In particular, the status of sea otter populations provides important insights into the health and function of nearshore systems, and Dan brings more than two decades of experience conducting multi-disciplinary research on sea otters and their environment with collaborators from more than a dozen different agencies, academic and private institutions.

Relevant Publications

Monson, D.H., J. A. Estes, J.L. Bodkin, and D.B. Siniff. 2000. Life history plasticity and population regulation in sea otters. Oikos 90:457-468.

Monson, D.H., D.F. Doak, B.E. Ballachey, A. Johnson, and J.L. Bodkin. 2000. Long-term impacts of the *Exxon Valdez* oil spill on sea otters, assessed through age-dependent mortality patterns. Proceedings of the National Academy of Sciences. 97:6562-6567.

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Newsome, S.D., M.T. Tinker, D. Monson, O.T. Oftedal, K. Ralls, M.M. Staedler, M.L. Fogel, and J.A. Estes. 2009. Using stable isotopes to investigate individual diet specialization in California sea otters (*Enhydra lutris nereis*). Ecology 90:961-974.

Monson, D.H., Daniel F. Doak, Brenda E. Ballachey, and James L. Bodkin. 2011. Effect of the *Exxon Valdez* oil spill on the sea otter population of Prince William Sound, Alaska: Do lingering oil and *source-sink* dynamics explain the long-term population trajectory? Ecological Applications 21(8):2917-2932.

Bodkin, J.L B.E. Ballachey, H.A. Coletti, G. G. Esslinger, K.A. Kloecker, S.D. Rice, J. A. Reed, and D. H. Monson. 2012. Long-term effects of the *Exxon Valdez* oil spill: Sea otter foraging in the intertidal as a pathway of exposure to lingering oil. Marine Ecology Progress Series 447:273-287.

Ballachey, B.E., J.L. Bodkin and D.H. Monson. 2013. Quantifying long-term risks to sea otters from the 1989 'Exxon Valdez' oil spill: Reply to Harwell & Gentile (2013). Marine Ecology Progress Series 488: 297–301.

Ballachey, B.E., D.H. Monson, G.G. Esslinger, K. Kloecker, J. Bodkin, L. Bowen, and A.K. Miles. 2014. 2013 update on sea otter studies to assess recovery from the 1989 *Exxon Valdez* oil spill, Prince William Sound, Alaska: U.S. Geological Survey Open-File Report 2014-1030, 40 p., http://dx.doi.org/10.3133/ofr20141030.

Esslinger, G.G., J.L. Bodkin, A. Brenton, J.M. Burns, and D.H. Monson. 2014. Temporal patterns in the foraging behavior of sea otters in Alaska. Journal of Wildlife Management 78:689-700.

Monson, D.H. and L. Bowen. 2015. Evaluating the Status of Individuals and Populations: Advantages of Multiple Approaches and Time Scales. In: *Sea Otter Conservation,* S.E. Larson, J.L. Bodkin and G.R. VanBlaricom (eds). Elsevier, London. Pp. 63-88.

Monson, D.H., T.A. Dean, M.R. Lindeberg, J.L. Bodkin, H.A. Coletti, D. Esler, K.A. Kloecker, B.P. Weitzman and B.E. Ballachey. 2015 Pacific blue mussel (*Mytilus trossulus*) abundance in the Gulf of Alaska: synthesis of gulf watch data (2006-2013) and a consideration of major recruitment events (1989-2013). Report to the EVOS Trustee Council, Anchorage, AK 39 pp.

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Education

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2010-2013 M.A. Ecology & Evolutionary Biology ***University of California, Santa Cruz***
Advisors: Dr. M. Tim Tinker, Dr. James A. Estes, James L. Bodkin, Dr. Laurel Fox, & Dr. Pete Raimondi
2004-2008 B.Sc. Marine Biology. ***University of California, Santa Cruz***
Advisor: Dr. Terrie M. Williams

Professional Experience

February 2013 – Present *Wildlife Biologist*: US Geological Survey: Western Ecological Resource Center, Santa Cruz, CA & Alaska Science Center, Anchorage, AK

- Duties include conducting variety of specialized surveys of nearshore organisms in the North Pacific, responsible for data management and analysis in contribution to summaries, reports, and publication. Extensive experience in coordinating field logistics, leading dynamic projects, compilation and synthesis of large data sets, public speaking/outreach on natural history and nearshore ecology (see presentations), and coordination of collaborative intra- and inter-agency projects.
- Supervisors: Dr. Tim Tinker (current, WERC), Dr. Daniel Esler (current, ASC), Dr. Brenda Ballachey (previous, ASC), & George Esslinger (previous, ASC).

April 2010 – February 2013 *Graduate Student Researcher/Biologist.* US Geological Survey: Western Ecological Resource Center & Alaska Science Center

- Similar to current position, Supervisor: Dr. Tim Tinker (current, WERC) & George Esslinger (ASC)

March 2008 – April 2010 *Scientific Aide.* California Dept. Fish & Game, Santa Cruz, CA

- Contributed to field data collections, necropsies, environmental sampling, data management, and laboratory experiments relating to sea otters and nearshore ecosystems. Supervisor: Jack Ames (retired) & Dr. Dave Jessup (retired))

Publications, Reports, & Outreach

- Presented at over 20 conferences, workshop, public lecture, and outreach events between 2010-2015
- Weitzman, B.P., Esslinger, G.G., Bodkin, J.L., Kloecker, K.K., Tinker, M.T., Monson, D.H., Estes, J.A., Esler, D. (*in progress) Changes in unconsolidated benthic ecosystems following the recolonization and growth of sea otters in Glacier Bay, Alaska.*
- Esslinger, G.G., Weitzman, B.P., Bodkin, J.L., Monson, D.H., Tinker, M.T., Kloecker, K.K., Estes, J.A., Esler, D. (*in progress) Dietary patterns associated with the recolonization and growth of sea otters in a soft-sediment*

ecosystem.

- Tinker, M. T., *et al.* (2015, *in progress*) *Sea Otter Population Biology at Big Sur and Monterey California: Investigating the Consequences of Resource Abundance and Anthropogenic Stressors for Sea Otter Recovery.* Open File Report. pp. 1-246.
- Weitzman, B.P., Esslinger, G.G. (2015) *Aerial Sea Otter Abundance Surveys – Prince William Sound, Alaska, Summer 2014*. Administrative report for USFWS Region 7, pp 1-9.
- Tinker, M.T., *et al.* (2014) *Southern Sea Otters in Elkhorn Slough and Sea Otter Recovery Outreach and Education Program, Year-End Report, June 2014*. Annual report to California Coastal Conservancy. pp 1-16.
- Weitzman, B.P., Esslinger, G.G., Bodkin, J.L., (2013) *Using a Diver-operated Suction Dredge to Evaluate the Effects of a Top-predator on Subtidal Soft-sediment Infaunal Bivalve Communities*, in Stellar, D., Lobel, L., eds., Proceedings of the American Academy of Underwater Sciences 31st Symposium, September 24-29, 2012. Monterey, CA: Diving for Science 2012. pp. 103-109.
- Tomoleoni, J.A., Weitzman, B.P., Young, C., Harris, M., Hatfield, B.E., Kenner, M. (2013) *Closed-Circuit Diving Techniques for Wild Sea Otter Capture*, in Stellar, D., Lobel, L., eds., Proceedings of the American Academy of Underwater Sciences 31st Symposium, September 24-29, 2012. Monterey, CA: Diving for Science 2012. pp. 193-199.
- Esslinger, G.G., Bodkin, J.L., Weitzman, B.P. (2013) *Sea otter Population Abundance and Distribution in Glacier Bay, Alaska*. Administrative Report for USFWS Region 7, pp. 1-11.
- Coletti, H. A., Esslinger G.G., and Weitzman, B.P. (2013) *Sea Otter Abundance in Katmai National Park and Preserve: Results from the 2012 Aerial Survey,* Southwest Alaska Network Inventory and Monitoring Program. Natural Resource Technical Report. National Park Service, Fort Collins, Colorado.

Collaborators:

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Academic Preparation

San Jose State University, San Jose, CA	Zoology	B.A. 1986
Moss Landing Marine Laboratories, CA	Marine Sciences	M.S. 1991
University of California, Santa Cruz	Biology	Ph.D. 1998

Appointments

2014-Present	Associate Dean, School of Fisheries and Ocean Sciences (SFOS), University of Alaska Fairbanks (UAF)
2014-present	Director, Coastal Marine Institute, SFOS, UAF
2012-2014	Academic Program Head, Graduate Program in Marine Sciences and Limnology, UAF
2009-Present	Professor, SFOS, UAF
2006-Present	Science Director. Kasitsna Bay Laboratory
2004-2009	Associate Professor. SFOS, UAF
2000-2004	Assistant Professor, SFOS, UAF
1999-2000	Research Assistant Professor, SFOS, UAF

Example of Recent Publications (* denotes students)

*Ravelo AM, B Konar and BA Bluhm. 2015. Spatial variability of epibenthic communities on the Alaska Beaufort Shelf. Polar Biology DOI 10.1007/s00300-015-1741-9

*Stewart N, B Konar. MT Tinker. 2015. Testing the nutritional-limitation, predator-avoidance, and storm-avoidance hypotheses for restricted sea otter habitat use in the Aleutian Islands, Alaska. Oecologia 177:645-655

Konar B, M Edwards, *T Efird. 2015. Local habitat and regional oceanographic influence on fish distribution patterns in the diminishing kelp forests across the Aleutian Archipelago. Environmental Biology of Fishes. DOI: 10.1007/s10641-015-0412-6.

* Stewart N, B Konar, A Doroff. 2014. Sea otter (*Enhydra lutris*) foraging habitat use in a heterogeneous environment in Kachemak Bay off Alaska. Bulletin of Marine Science. 90:921-939.

*Schuster M, B Konar. 2014. Foliose algal assemblages and deforested barren areas: Phlorotannin content, sea urchin grazing and holdfast community structure in the Aleutian dragon kelp, *Eualaria fistulosa*. Marine Biology 161:2319-2332.

Konar B, M Edwards, JA Estes. 2014. Biological interactions maintain the boundaries between kelp forests and urchin barrens in the Aleutian Archipelago. Hydrobiologia 724:91-107.

*Efird T, B Konar. 2013. Habitat characteristics can influence fish assemblages in high latitude kelp forests. Environmental Biology of Fishes 97:1253-1263.

Konar B. 2013. Lack of recovery from disturbance in high-Arctic boulder communities. Polar Biology 36:1205-1214.

*Deiman M, K Iken, B Konar. 2012. Susceptibility of *Nereocystis luetkeana* (Laminariales, Ochrophyta) and *Eualaria fistulosa* (Laminariales, Ochrophyta) spores to sedimentation. Algae 27:115-123

Konar B, K Iken, JJ Cruz-Motta, L Benedetti-Cecchi, A Knowlton, G Pohle, P Miloslavich, M Edwards, T Trott, E Kimani, R Riosmena-Rodriguez, M Wong, S Jenkins, A Silva, I Sousa Pinto, Y Shirayama. 2010. Current patterns of macroalgal diversity and biomass in northern hemisphere rocky shores. PLoS ONE 5:e13195.

Synergistic Activities

Development of Curricular Materials (courses not previously taught at UAF):

Field Topics in Marine Biology, Kelp Forest Ecology, Scientific Diving, and several seminars including Macroalgae, Controversies in Science, and Professional Development

Development of Curricular Materials (Book Chapter and teaching publication):

Pearse JS, MH Carr, CH Baxter, JM Watanabe, MS Foster, DL Steller, JA Coyer, **B Konar,** DO Duggin and PK Dayton. 2013: Kelpbeds as classrooms: Perspectives and lessons learned. *In*: Research and Discoveries: The revolution of science through scuba, Lang M (ed). Smithsonian Contributions to the Marine Science 39.

Konar B, K Iken, G Pohle, P Miloslavich, JJ Cruz-Motta, L Benedetti-Cecchi, E Kimani, A Knowlton, T Trott, T Iseto and Y Shirayama. 2010. Surveying nearshore biodiversity. In: AD McIntyre (ed) Life in the World's Oceans: Diversity, Distribution, and Abundance Blackwell Publishing Ltd. (Oxford). pp 27-41.

Committee examples:

International: Natural Geography Inshore Areas (NaGISA) Steering Committee (past co-PI)
National: National Research Council Study Committee for the North Pacific Research Board (past)
State: Kachemak Bay National Research Reserve Advisory Council (current)

Examples of Outreach:

K-12 presentations at 16 different schools, Alaska native community presentations at 10 different communities in Alaska, multiple media interactions.
Worked with PolarTREK teachers in the Arctic and Antarctic.

Collaborators

Dr. Brenda Ballachey (USGS), Dr. Lisandro Benedetti-Cecchi (University of Pisa, Italy), James Bodkin (USGS), Dr. J Byrnes (University of Massachusetts Boston), Dr. Mark Carr (University of California Santa Cruz), Heather Coletti (National Park Service), Dr. Lee Cooper (University of Tennessee), Dr. Juan J. Cruz (Simon Bolivar University, Venezuela), Dr. Ken Dunton (University of Texas), Dr. Matt Edwards (San Diego State University), Dr. Dan Esler (USGS), Dr. James Estes (University of California Santa Cruz), Dr. Jackie Grebmeier (University of Tennessee), Dr. Kris Holderied, (NOAA), Dr. Katrin Iken (University of Alaska Fairbanks), Mandy Lindeberg (NOAA), Dr. Patricia Miloslavich (Simon Bolivar University, Venezuela), Dr. Brenda Norcross (UAF), Dr. John Pearse (University of California Santa Cruz), Dr. Gerhard Pohle (The Huntsman Marine Science Centre, Canada), Dr. Yoshihisa Shirayama (Seto Marine Biological Lab, Kyoto University, Japan), Dr. Tim Tinker (University of California Santa Cruz), Dr. John Trefry (Florida Institute of Technology)

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Professor in Marine Biology, University of Alaska Fairbanks, 2002-present
1999 - 2001 Postdoctoral Research Fellow, University of Alabama at Birmingham
1996 - 1999 Postdoctoral Research Fellow, Alfred Wegener Institute, Germany
1995 Ph.D. Alfred Wegener Institute for Polar and Marine Research, Germany
1991 M.S. University of Bayreuth, Germany
1987 B.S. University of Düsseldorf, Germany

Dr. Katrin Iken is a Professor in Marine Biology at UAF and a benthic ecologist with research interests in the Arctic and in nearshore regions of Alaska. Her main research focus is on community structure, biodiversity, and food web structure and energy flow through ecosystems. She spends considerable time every year in the field conducting intertidal, nearshore subtidal and ship-based work. She currently is the project lead or co-PI of 12 externally funded research projects. She also teaches at UAF and advises several graduate students involved in her research programs.

Relevant Peer-Reviewed Publications (out of 83 total)
(* denotes student author)

Duffy JE, Reynolds PL, Boström C, Coyer JA, Cusson M, Donadi, S, Douglass GJ, Eklöf JS, Engelen AH, Eriksson BK, Fredriksen S, Gamfeldt L, Gustafsson C, Hoarau G, Hori M, Hovel K, **Iken K,** and 11 others (2015) Biodiversity mediates top–down control in eelgrass ecosystems: a global comparative-experimental approach. Ecol Lett 18: 696-705

Divine LM*, **Iken K**, Bluhm B (2015) Regional benthic food web structure on the Alaska Beaufort Sea shelf. Mar Ecol Prog Ser 531: 15-32, doi: 10.3354/meps11340

Iken K, Bluhm BA, Søreide JE (2013) Arctic benthic communities. Arctic Report Card Update for 2013. http://www.arctic.noaa.gov/reportcard/benthic_communities.html

Miloslavich P, Cruz-Motta JJ, Klein E, **Iken K**, Weinberger V, Konar B, and 13 others (2013) Large-scale spatial distribution patterns of gastropod assemblages in rocky shores. PLoS One 8(8): e71396. doi:10.1371/journal.pone.0071396

Murphy M*, **Iken K** (2013) Larval brachyuran crab timing and distribution in relation to water properties and flow in a high-latitude estuary. *Estuaries and Coasts* 37: 177-190. DOI 10.1007/s12237-013-9668-2

Spurkland T*, **Iken K**. (2012) Seasonal growth patterns of *Saccharina latissima* in a glacially-influenced subarctic estuary. *Phycological Research* 60: 261-275. DOI 10.1111/j.1440-1835.2012.00657.x

Deiman M*, **Iken K**, Konar B (2012) Susceptibility of *Nereocystis luetkeana* (Laminariales, Ochrophyta) and *Eualaria fistulosa* (Laminariales, Ochrophyta) spores to sedimentation. *Algae* 27: 115-123

Iken K (2012) Grazers on benthic seaweeds. In: Wiencke C, Bischof K (eds) Seaweed Biology: Novel Insights into Ecophysiology, Ecology and Utilization. Ecological Studies, Springer Verlag, Berlin, pp 157-176.

Dubois A*, **Iken K** (2012) Seasonal variation in kelp phlorotannins in relation to grazer abundance and environmental variables in the Alaskan sublittoral zone. *Algae* 27: 9-19. DOI 10.4490/algae.2012.27.1.001

1987 Spurkland T*, **Iken K** (2011) Salinity and irradiance effects on growth and maximum quantum yield of photosynthesis of subarctic *Saccharina latissima* (Laminariales, Laminariaceae)*. Botanica Marina* 54: 355-365, doi:10.1515/BOT.2011.042

1988 Spurkland T*, **Iken K** (2011) Kelp bed dynamics in estuarine environments in subarctic Alaska. *Journal of Coastal Research* 27: 133-143. doi:10.2112/JCOASTRES-D-10-00194.

Pohle G, **Iken K**, Clarke KR, Trott T, Konar B, and 11 others (2011) Aspects of benthic decapod diversity and distribution from rocky nearshore habitat at geographically widely dispersed sites. *PLoS One* 6(4): e18606. doi:10.1371/journal.pone.0018606

Cruz-Motta JJ, Miloslavich P, Palomo G, **Iken K**, Konar B, Pohle G, and 15 others (2010) Patterns of spatial variation of assemblages associated with intertidal rocky shores: a global perspective. *PLoS One* 5(12): e14354

Iken K, Konar B, Benedetti-Cecchi L, Cruz-Motta JJ, and 14 pothers (2010) Large-scale spatial distribution patterns of echinoderms in nearshore rocky habitats. *PLoS One* 5(11): e13845

Konar B, **Iken K**, Cruz-Motta JJ, Benedetti-Cecchi L, and 13 others (2010) Global patterns of macroalgal diversity and biomass in rocky nearshore environments. *PLoS One* 5(10): e13195

Konar B, **Iken K**, Pohle G, Miloslavich P, Cruz-Motta JJ, and 6 others (2010) Surveying Nearshore Biodiversity. In: AD McIntyre (ed) Life in the World's Oceans: Diversity, Distribution, and Abundance. Blackwell Publishing Ltd. (Oxford), pp 27-41

Konar B, **Iken K,** Edwards M (2009) Depth-stratified community zonation patterns on Gulf of Alaska rocky shores. *Marine Ecology* 30: 63-73

Konar B, **Iken K** (2009) Influence of taxonomic resolution and morphological functional groups in multivariate analyses of macroalgal assemblages. *Phycologia* 48: 24-31

Hondolero DE*, Konar B, **Iken K,** Chenelot H (2007) Variation in low Intertidal Communities: Submerged vs. Emerged. In: Rigby P.R. and Shirayama Y. (eds) Selected Papers of the NaGISA World Congress 2006, Publications of the Seto Marine Biological Laboratory, Special Publication Series Vol. VIII. pp 29-36

Chenelot HA, **Iken K,** Konar B, Edwards M (2007) Spatial and Temporal Distribution of Echinoderms in Rocky Nearshore Areas of Alaska In Rigby P.R. and Shirayama Y. (eds) Selected Papers of the NaGISA World Congress 2006, Publications of the Seto Marine Biological Laboratory, Special Publication Series Vol. VIII. pp 11-28

Rigby R, **Iken K,** Shirayama, Y (2007) *Sampling biodiversity in coastal communities.* Kyoto University Press. pp. 145

Collaborators (other than co-PIs of this proposal and co-authors listed above)

C. Amsler (UAB), C. Ashjian (WHOI), P. Archambault (UQR, Canada), B. Baker (USFS), S. Budge (Dalhousie), M. Blicher (Greenland IMR), R.E. Collins (UAF), L. Cooper (UM), N. Denisenko (RAS, Russia), E. Duffy (VIMS), K. Dunton (UT Austin), N. Foster (UAF), R. Gradinger (UAF), J. Grebmeier (UM), M. Hoberg (UAF), K. Holderied (NOAA-NCCOS), K. Kuletz (USFWS), J. McClintock (UAB), S. Moore (NOAA), S. Saupe (CIRCAC), K. Stafford (UW-APL), C. Wiencke (AWI, Germany)

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EDUCATION

Oregon State University, Corvallis, Oregon - Ph.D., 1985
Colorado State University, Fort Collins, Colorado - M.S., 1980
Colorado State University, Fort Collins, Colorado - B.S. with distinction, 1974

PROFESSIONAL EXPERIENCE

USGS Emeritus, Alaska Biological Science Center, USGS, Anchorage, AK
December 2015, ongoing

Research Physiologist, Alaska Biological Science Center, USGS, Anchorage, AK,
(formerly U.S. National Biological Service; U.S. Fish & Wildlife Service)
July 1990 to November 2015 (retired November 2015): Research on marine nearshore ecosystems, with emphasis on studies of long-term effects of the *Exxon Valdez* oil spill on the sea otters and nearshore communities.

General Biologist, Alaska Fish and Wildlife Research Center, USFWS, Anchorage, AK,
November 1989 to July 1990: Research on sea otters, with emphasis on studies of acute effects of the *Exxon Valdez* oil spill on the sea otters.

Staff Officer, Board on Agriculture, National Research Council, Washington, DC, USA,
March 1987 to November 1989: Worked with the Committee on Managing Global Genetic Resources on conservation of genetic diversity in agricultural species, encompassing crops, livestock, forests and fisheries.

Research Associate, Department of Chemistry, South Dakota State University, Brookings.
January 1986 to March 1987: Post-doctoral appointment to conduct research on the relation between stability of DNA in spermatozoa and male fertility, using flow cytometry to evaluate DNA.

SELECTED PUBLICATIONS

Bowen, L., A.K. Miles, B. **Ballachey**, S. Waters and J. Bodkin. In review. Gene transcript profiling in sea otters post-*Exxon Valdez* oil spill: A tool for marine ecosystem health assessment. J. Mar. Sci. Eng.

Coletti, H.A., J.L. Bodkin, D.H. Monson, B.E. **Ballachey** and T.A. Dean. In review. Engaging form and function to detect and infer cause of change in an Alaska marine ecosystem. Ecosphere.

Ballachey, B.E., J.L. Bodkin, D. Esler and S.D. Rice. 2015. Lessons from the 1989 *Exxon Valdez* oil spill: a biological perspective. Chapter 9 in: J.B. Alford, M.S. Peterson and C.C. Green, Eds. Impacts of Oil Spill Disasters on Marine Habitats and Fisheries in North America. CRC Marine Biology Series.

Ballachey, B.E. and J.L. Bodkin. 2015. Challenges to sea otter recovery and conservation. Chapter 4 in J. Bodkin, S. Larson and G. VanBlaricom, Eds. Sea Otter Conservation Elsevier.

Ballachey, B.E., J.L. Bodkin, K.A. Kloecker, T.A. Dean, and H.A. Coletti. 2015. Monitoring for Evaluation of Recovery and Restoration of Injured Nearshore Resources. *Exxon Valdez* Oil Spill Restoration Project Final Report (Restoration Project 10100750), U.S. Geological Survey, Alaska Science Center, Anchorage, Alaska.

Bowen, L., Miles, A.K., **Ballachey**, B.E., Bodkin, J.L., and Esler, D. 2015. Gulf Watch Alaska Long-term Monitoring Program - Evaluating Chronic Exposure of Harlequin Ducks and Sea Otters to Lingering Exxon Valdez Oil in Western Prince William Sound. Exxon Valdez Oil Spill Restoration Project Final Report (Restoration Project 12120114-Q), Pacific Wildlife Foundation and Centre for Wildlife Ecology, Simon Fraser University, Delta, British Columbia, Canada. U.S. Geological Survey, Alaska Science Center, Anchorage, Alaska.

Ballachey, B.E., D.H. Monson, G.G. Esslinger, K. Kloecker, J. Bodkin, L. Bowen and A.K. Miles. 2014. 2013 update on sea otter studies to assess recovery from the 1989 *Exxon Valdez* oil spill, Prince William Sound, Alaska: US Geological Survey Open-File Report 2014-1030, 40p. http://dx.doi.org/10.3133/ofr20141030.

Bodkin, J.L., D. Esler, S.D. Rice, C.O. Matkin, and B.E. **Ballachey**. 2014. The effects of spilled oil on coastal ecosystems: lessons from the *Exxon Valdez* spill. In: B. Maslo and J.L. Lockwood, Eds. Coastal Conservation. Cambridge University Press. Pp. 311-346.

Ballachey, B.E., J.L. Bodkin and D.H. Monson. 2013. Quantifying long-term risks to sea otters from the 1989 'Exxon Valdez' oil spill: Reply to Harwell & Gentile (2013). Mar Ecol Prog Ser 488: 297-301.

Bodkin, J.L, B.E. **Ballachey**, H.A. Coletti, G.G. Esslinger, K.A. Kloecker, S.D. Rice, J.A. Reed, and D.H. Monson. 2012. Long-term effects of the *Exxon Valdez* oil spill: Sea otter foraging in the intertidal as a pathway of exposure to lingering oil. Mar Ecol Prog Ser 447:273-287.

Bowen, L. A.K. Miles, M. Murray, M. Haulena, J. Tuttle, W. Van Bonn, L. Adams, J.L. Bodkin, B.E. **Ballachey**, M. T. Tinker, R. Keister, and J.L. Stott. 2012. Gene Transcription in Sea Otters (*Enhydra lutris*); Development of a diagnostic tool for sea otter and ecosystem health. Molec Ecol Res 12: 67-74

Miles , A.K., L. Bowen, B E. **Ballachey**, J.L. Bodkin, M. Murray, J.A. Estes, R.A. Keister and J.L. Stott. 2012. Gene transcription in sea otters (*Enhydra lutris*) two decades post *Exxon Valdez*. Mar Ecol Prog Ser 451:201-212.

Monson, D.H., D.F. Doak, B.E. **Ballachey** and J.L. Bodkin. 2011. Could residual oil from the *Exxon Valdez* spill create a long-term population "sink" for sea otters in Alaska? Ecol Appl 21(8)2917–2932.

Esler, D., K.A. Trust, B.E. **Ballachey**, S.A. Iverson, T.L. Lewis, D.J. Rizzolo, D.M. Mulcahy, A.K. Miles, B.R. Woodin, J.J. Stegeman, J.D. Henderson, and B.W. Wilson. 2010. Cytochrome P4501A biomarker indication of oil exposure in harlequin ducks up to 20 years after the *Exxon Valdez* oil spill. Environ Toxicol Chem 29(5):1138-1145.

Peterson, C.H., S.D. Rice, J.W. Short, D. Esler, J.L. Bodkin, B.E. **Ballachey**, and D.B. Irons. 2003. Long-term ecosystem response to the Exxon Valdez oil spill. Science 302:2082-2086.

Bodkin, J.L., B.E. **Ballachey**, T.A. Dean, S. Jewett, L. McDonald, D. Monson, C. O'Clair, and G. VanBlaricom. 2002. Recovery of sea otters in Prince William Sound following the *Exxon Valdez* oil spill. Mar Ecol Prog Ser 241:237-253.

COLLABORATORS

Bodkin, J., USGS; Bowen, L., USGS/UC Davis; Coletti, H., NPS; Esslinger, G., USGS; Dean, T., Coastal Resources Associates; Doroff, A., ADF&G/UAA; Counihan, K., Alaska SeaLife Center; Esler, D., USGS; Holdried, K., NOAA Kasitsna Bay Lab; Hoffman, K., PWSSC, Cordova; Hollmen, T., Alaska SeaLife Center; Howlin, S., West Ecosystems Technology; Kloecker, K., USGS; Larson, S., Seattle Aquarium; Lipscomb, T., DVM. Diplomate ACVP; Lindeberg, M., NOAA; Matkin, C., North Gulf Oceanographic Society; McCammon, M., AOOS, Anchorage; Miles, A.K., USGS; Mohr, F.C., UC Davis; Monson, D., USGS; Murray, M., Monterey Bay Aquarium; Newsome, S., UNM; Rice, S., NOAA retired; Speckman, S., USFWS; Von Biela, V., USGS; Weitzman, Ben, USGS. (Note: full listing of Gulf Watch Alaska PI's not given here; available upon request).

James L. Bodkin,
Scientist Emeritus
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Research Wildlife Biologist, Alaska Science Center, 1991-2013
1985 - MS, California Polytechnic State University, San Luis Obispo, CA. (Wildlife Biology)
1976 - BS, Long Beach State University (Biology), Long Beach, CA

Jim led the Coastal Ecosystems research program for the Alaska Science Center, US Geological Survey from 1991 until his retirement in 2013. At that time he accepted an emeritus position and continues to pursue his research interests in coastal marine ecology and long term ecological monitoring. As project leader Jim supervised and managed all activities associated with a complex and diverse array of research projects internal to the Alaska Science Center and collaborated with at least 14 agencies, academic or private institutions on cooperative, multi-disciplinary projects.

Relevant Publications

Ricca, M.A., A.K.Miles, B.E. Ballachey, J.L. Bodkin, D.E. Esler, and K.A. Trust. 2010. PCB exposure in sea otters and harlequin ducks in relation to history of contamination by the *Exxon Valdez* oil spill. Marine Pollution Bulletin.

Monson, D.H., Daniel F. Doak, Brenda E. Ballachey, and James L. Bodkin. 2011. Effect of the *Exxon Valdez* oil spill on the sea otter population of Prince William Sound, Alaska: Do lingering oil and *source-sink* dynamics explain the long-term population trajectory? Ecological Applications 21(8):2917-2932.

Bodkin, J.L., B.E. Ballachey, and G.G. Esslinger. 2011, Trends in sea otter population abundance in western Prince William Sound, Alaska: Progress toward recovery following the 1989 *Exxon Valdez* oil spill: U.S. Geological Survey Scientific Investigations Report 2011-5213 14 p.

Bodkin, J.L B.E. Ballachey, H.A. Coletti, G. G. Esslinger, K.A. Kloecker, S.D. Rice, J. A. Reed, and D. H. Monson. 2012 Long-term effects of the Exxon Valdez oil spill: Sea otter foraging in the intertidal as a pathway of exposure to lingering oil. Marine Ecology Progress Series 447:273-287.

Bowen, L. A.K. Miles, M. Murray, M. Haulena, J. Tuttle, W. Van Bonn, L. Adams, J.L. Bodkin, B.E. Ballachey, M. T. Tinker, R. Keister, and J.L. Stott. 2012 Gene transcription in sea otters (*Enhydra lutris*); Development of a diagnostic tool for sea otter and ecosystem health. Molecular Ecology Resources 12: 67-74

Miles , A.K., L Bowen, B E. Ballachey, J.L. Bodkin, M. Murray, J.A. Estes, R.A. Keister and J.L. Stott. 2012. Variation in transcript profiles in sea otters (*Enhydra lutris*) from Prince William Sound, Alaska and clinically normal reference otters. Marine Ecology Progress Series 451:201-212.

Ballachey, B.E., J.L. Bodkin and D.H. Monson. 2013. Quantifying long-term risks to sea otters from the 1989 'Exxon Valdez' oil spill: Reply to Harwell & Gentile (2013). Marine Ecology Progress Series 488: 297–301.

Bodkin, J.L., D. Esler, S.D. Rice, C.O. Matkin, and B.E. Ballachey. 2014. The effects of spilled oil on coastal ecosystems: lessons from the Exxon Valdez spill. In Maslo, B. and J.L. Lockwood (eds), Coastal Conservation. Cambridge University Press, NY. Pp. 311-346.

L. Bowen, A. K. Miles, C. A. Kolden, J.A. Saarinen, J. L. Bodkin, M. Murray, M. T. Tinker. 2015. Effects of wildfire on sea otter (*Enhydra lutris*) gene transcript profiles Marine Mammal Science 31:1: 191-210.

Ballachey, B. E., J. L. Bodkin, D. Esler, and S. D. Rice. 2014. Lessons from the 1989 *Exxon Valdez* oil spill: A biological perspective. Pages 181-197 *in* Alford, J. B., M. S. Peterson, and C. C. Green (eds.), Impacts of Oil Spill Disasters on Marine Habitats and Fisheries in North America. CRC Press, 320 p.

Larson, S.E, J.L. Bodkin and G.R. VanBlaricom (eds). 2015. Sea Otter Conservation. Elsevier, London. 468 pages.

Larson, S.E and J.L. Bodkin. 2015. The conservation of sea otters: a prelude. In: *Sea Otter Conservation,* S.E. Larson, J.L. Bodkin and G.R. VanBlaricom (eds). Elsevier, London. Pp. 2-15.

Ballachey, B.E. and J.L. Bodkin. 2015. Challenges to sea otter recovery and conservation. In: *Sea Otter Conservation,* S.E. Larson, J.L. Bodkin and G.R. VanBlaricom (eds). Elsevier, London. Pp. 63-88.

Recent collaborators:
Dr. B.E. Ballachey, Alaska Science Center, US Geological Survey
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Dr. D. Doak, Univ. Colorado
Dr. C. Kolden, Univ. Idaho
Dr. S. Larson, Seattle Aquarium
C. Matkin, North Gulf Oceanic Society
Dr. K. Miles, Western Ecological Research Center, US Geological Survey
Dr. M. Murray, Monterey Bay Aquarium
Dr. S. Newsome, Univ. New Mexico
Dr. J.A. Saarinen, Univ. Michigan
Dr. S.D. Rice, Auke Bay Lab, NOAA
Dr. M.Tinker, Western Ecological Research Center, US Geological Survey
Dr. G. VanBlaricom, Washington Cooperative Fish and Wildlife Research Unit, USGS

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Education

2011 - Master of Science, Biological Sciences, University of Alaska, Anchorage, AK
1993 - Bachelor of Science, Wildlife, Humboldt State University, Arcata, CA

Work experience

11/98 – present	Zoologist, U.S. Geological Survey, Anchorage, AK
10/96 – 11/98	Fish and Wildlife Biologist, U.S. Geological Survey, Anchorage, AK
04/95 – 10/96	Fish and Wildlife Biologist, U.S. Fish and Wildlife Service, Anchorage, AK
04/93 – 04/95	Biological Science Technician, U.S. Fish and Wildlife Service, Anchorage, AK

Professional licenses and memberships

Member, USGS Diving Safety Board, 2010-present, Anchorage, AK
Research Vessel Manager, U.S. Geological Survey, 2006-present, Anchorage, AK
Oxygen Rebreather Diver, Aqua Lung, 2006, Vista, CA
Master 50-100 ton License, U.S. Coast Guard, 1999-present, Anchorage, AK
Motorboat Operator Instructor, Department of Interior, 1997, Lake Mead, NV
Divemaster, NOAA Dive Program, 1996, Seattle, WA
Working Diver, NOAA Dive Program, 1994, Seattle, WA

Publications

Monk, M. H., G.G. Esslinger, V. A. Gill, M. Mangel, and M.T. Tinker. In prep. Abundance and carrying capacity of the Southeast Alaska stock of northern sea otters. Ecological Applications.

Esslinger, G.G., B. P. Weitzman, J.L. Bodkin, D.H. Monson, K.A. Kloecker, M.T. Tinker, J.A. Estes, D. Esler. In prep. Dietary patterns associated with the colonization and growth of sea otters in a soft-sediment ecosystem. Marine Ecology Progress Series.

Weitzman, B.P. , Esslinger, G.G. , J.L. Bodkin, D.H. Monson, K.A. Kloecker, M.T. Tinker, J.A. Estes, and D. Esler. In prep. Changes in unconsolidated benthic ecosystems following the recolonization and growth of sea otters in Glacier Bay, Alaska.

Esslinger, G.G., B. Ballachey, D. Esler, S. Howlin, and L. Starcevich. 2015. Monitoring population status of sea otters (*Enhydra lutris*) in Glacier Bay National Park and Preserve—Options and considerations. U.S. Geological Survey Open-File Report 2015-1119, 42 p., http://dx.doi.org/10.3133/ofr20151119.

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Esslinger, G.G., J.L. Bodkin, A.R. Breton, J.M. Burns, D.M. Monson. 2014. Temporal patterns in the foraging behavior of sea otters in Alaska. Journal of Wildlife Management 78(4):689-700.

Bodkin, J.L., B.E. Ballachey, H.A. Coletti, G.G. Esslinger, K.A. Kloecker, S.D. Rice, J.A. Reed, and D.H. Monson. 2012. Long-term effects of the Exxon Valdez oil spill: Sea otter foraging in the intertidal as a pathway of exposure to lingering oil. Marine Ecology Progress Series 447:273-287.

Bodkin, J.L., B.E. Ballachey, and G.G. Esslinger. 2011. Trends in sea otter population abundance in western Prince William Sound, Alaska: Progress toward recovery following the 1989 *Exxon Valdez* oil spill. U.S. Geological Survey Scientific Investigations Report 2011–5182, 14 p.

Esslinger, G. G. 2011. Temporal patterns in the behavior and body temperature of sea otters in Alaska. M.S. Thesis, Department of Biological Sciences, University of Alaska, Anchorage. 74 pp.

Jewett, S. C., J. L. Bodkin, H. Chenelot, G. G. Esslinger, and M. K. Hoberg. 2010. The Nearshore Benthic Community of Kasatochi Island, One Year after the 2008 Volcanic Eruption. Arctic, Antarctic, and Alpine Research 42(3):315-324. DOI:10.1657/1938-4246-42.3.315

Esslinger, G.G., and J.L. Bodkin. 2009. Status and Trends of Sea Otter Populations in Southeast Alaska, 1969-2003. U.S. Geological Survey Scientific Investigations Report 2009–5045, 19 p.

Bodkin, J. L., D. H. Monson, and G. G. Esslinger. 2007. Activity budgets derived from time-depth recorders in a diving mammal. Journal of Wildlife Management 71(6):2034-2044.

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Bodkin, J. L., G. G. Esslinger, and D. H. Monson. 2004. Foraging depths of sea otters and implications to coastal marine communities. Marine Mammal Science 20(2):305-321.

Collaborators:

Dr. Brenda Ballachey (USGS), Mr. James Bodkin (USGS), Mr. Michael Bower (NPS), Dr. McCrea Cobb (USFWS), Ms. Heather Coletti (NPS), Dr. Dan Esler (USGS), Dr. James Estes (University of California Santa Cruz), Ms. Verena Gill (BOEM), Ms. Kim Kloecker (USGS), Dr. Daniel Monson (USGS) , Dr. Mevin Hooten (USGS), Dr. John Piatt (USGS), Dr. Tim Tinker (USGS), Dr. Perry Williams (Colorado State University), Mr. Ben Weitzman (USGS), Dr. Jamie Womble (NPS).

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Education

University of Delaware, Ph.D., Biology 1977
East Carolina University, M.A., Biology 1973
Gettysburg College, B.A., Biology 1970

Professional Experience

President 1988 to Present
Coastal Resources Associates, Inc.

Associate Research Biologist 1978 to 1987
University of California, Santa Barbara

Senior Staff Ecologist 1976 to 1978
E.H. Richardson Associates

Selected Publications

Bowyer, R.T., G.M. Blundell, M. Ben-David, S.C. Jewett, T.A. Dean, L.A. Duffy. 2003. Effects of the *Exxon Valdez* oil spill on river otters: injury and recovery of a sentinel species. Wildlife Monographs 67:1-53.

Dean, T.A., J.L. Bodkin, A. Fukuyama, S.C. Jewett, D.H. Monson, C.E. O'Clair, G.R. VanBlaricom. 2002. Food limitation and the recovery of sea otters following the *Exxon Valdez* oil spill. Marine Ecology Progress Series 241:255-270

Deysher, L.E., T.A. Dean, R. Grove, A. Jahn. 2002. Design considerations for an artificial reef to grow giant kelp (*Macrocystis pyrifera*) in Southern California. ICES J. Mar Sci. 217:17-24

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Esler, D., T.D. Bowman, K.A. Trust, B.E. Ballachey, T.A. Dean, S.C. Jewett, C.E. O'Clair. 2002. Harlequin duck population recovery following the *Exxon Valdez* oil spill: Progress, process, and constraints. Marine Ecology Progress Series 241: 271-286

Jewett, S.C., T.A. Dean, B.R. Woodin, M.K. Hoberg, and J.L. Stegeman. 2002. Exposure to hydrocarbons ten years after the *Exxon Valdez* oil spill: evidence from cytochrome P4501A expression and biliary FACs in nearshore demersal fishes. Marine Environmental Research. 54:21-48.

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Dean T.A., J.L. Bodkin, S.C. Jewett, D.H. Monson, D. Jung. 2000. Changes in sea urchins and kelp following reduction in sea otter density as a result of the *Exxon Valdez* oil spill. Marine Ecology Progress Series 199:281-291

Dean T.A., L. Haldorson, D.R. Laur, S.C. Jewett, A. Blanchard. 2000. The distribution of nearshore fishes in kelp and eelgrass communities in Prince William Sound, Alaska: associations with vegetation and physical habitat characteristics. Environmental Biology of Fishes 57: 271-287

Jewett, S.C., T.A. Dean, R.O. Smith, A. Blanchard. 1999. The *Exxon Valdez* oil spill: Impacts and recovery in the soft-bottom benthic community in and adjacent to eelgrass beds. Mar Ecol Prog Ser 185:59-83

Dean, T.A., K. Thies, S. Lagos. 1989. Survival of juvenile giant kelp: The effects of demographic factors, competitors, and grazers. Ecology 70:483-495

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Dean, T.A., F. R. Jacobsen. 1986. Nutrient-limited growth of juvenile kelp, *Macrocystis pyrifera* during the 1982-1984 "El Nino" in southern California. Mar. Biol. 90:597-601

Dean, T.A. 1985. The temporal and spatial distribution of underwater quantum irradiation in a southern California kelp forest. Estuar. Coast. Shelf Sci. 21:835-601

Dean, T.A., S. Schroeter, J. Dixon. 1984. Effects of grazing by two species of sea urchins (*Strongylocentrotus franciscanus* and *Lytechinus anamesus*) on recruitment and survival of two species of kelp (*Macrocystis pyrifera* and *Pterygophora californica*). Mar. Biol. 78: 301-313

Collaborators:
Dr. B. Ballachey, (emeritus) Alaska Science Center, USGS, Anchorage, AK, Mr. J. Bodkin, (emeritus) Alaska Science Center, USGS, Anchorage, AK, Ms. H. Coletti, National Park Service, Fairbanks, AK, Dr. D. Esler, Alaska Science Center, USGS, Anchorage, AK, Dr. B. Konar, Univ. of Alaska, Fairbanks, AK, Dr. T. Klinger, Univ. of Washington, Seattle, WA, Ms. M. Lindeberg, Auke Bay Laboratory, NOAA/NMFS, Juneau, AK

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Professional Experience

Leadership

- GWA Pelagic Component Lead (since 2013).
- Research Coordinator for Recruitment, Energetics, and Coastal Assessment Program (2011-current) - NMFS Auke Bay Laboratories (ABL).
- Acting Deputy Director for NMFS Auke Bay Laboratories, half a year (2013).
- Core team member of Habitat and Ecological Processes Program, Alaska Fisheries Science Center (AFSC) - developing RFPs, reviewing proposals for scientific merit, and recommendation for funding.
- Chair for Auke Bay Laboratories Data Coordination Committee and member of AFSC Public Access and Research Results (PARR) workgroup.
- Coordinator for Division FOIA responses – NMFS, Auke Bay Laboratories.

Research

1990 - Present: Mandy has been involved in oil spill research and nearshore habitat studies throughout Alaska's coastline, particularly Prince William Sound, for over 25 years. Her research includes damage assessment and long term monitoring of nearshore flora, fauna, and persistence of oil in the EVOS spill region. Mandy has been an integral part of the Gulf Watch Alaska Program serving as Pelagic Component Lead (2013-16), co-Principle Investigator for the Nearshore component (2011-16), and co-Principle Investigator for the Lingering oil component (2011-16). She has been a core steering committee member and a participant in the Alaska *ShoreZone* habitat mapping project for over 12 years. Mandy has also conducted research on essential fish habitat under the Magnuson-Stevens Act, focusing on nearshore forage fish throughout the state. Her specific scientific expertise lies with coastal ecology and specializes in the taxonomy and ecology of seaweeds. All of these studies have enabled her to not only develop a unique knowledge of Alaskan marine ecosystems but also manage all activities associated with a diverse array of research projects and collaborators.

Education: BS 1989, Marine Biology, Western Washington University, Bellingham, Washington.

Publications:

Research Highlights:

Lindeberg, M.R. and S.C. Lindstrom. 2016 re-print. Field Guide to Seaweeds of Alaska. Alaska Sea Grant College Program, University of Alaska Fairbanks, 192 p.

Lindeberg and Johnson, 2015. Alaska Chapter. Our living oceans: Habitat. Status of the habitat of U.S. living marine resources, 1st edition. U.S. Dep. Commer. NOAA Tech. Memo. NMFS-F/SPO-75.

Lindstrom, S. C., M. R. Lindeberg, and D. A. Guthrie. 2015. Marine Macroalgae of the Aleutian Islands: I. Bangiales. Algae, 30(4): 1-17.

Johnson, S. W., A. D. Neff, and M. R. Lindeberg. 2015. A handy field guide to the nearshore fishes of Alaska. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-293, 211 p.
Kawai, H., T. Hanyuda, M.R. Lindeberg, and S.C. Lindstrom. 2008. Morphology and molecular phylogeny of *Aureophycus aleuticus* gen. *et* sp. Nov. (Laminariales, Phaeophyceae) from the Aleutian Islands. J. of Phycol. 44:1013-1021.

EVOS Research Highlights:

Lindeberg, M. R. et al. 2014. Variability within pelagic ecosystems of Prince William Sound: introduction to pelagic ecosystem monitoring. Gulf Watch Alaska Program 3 year synthesis Report, *Exxon Valdez* Trustee Council.
Short, J. W., K. R. Springman, M. R. Lindeberg, L. G. Holland, M. L. Larsen, C. A. Sloan, C. Khan, P. V. Hodson, and S. D. Rice. 2008. Semipermeable membrane devices link site-specific contaminants to effects: Part II – A comparison of lingering *Exxon Valdez* oil with other potential sources of CYP1A inducers in Prince William Sound, Alaska. Mar. Environ. Res. 66:487-498.
Springman, K. R., J. W. Short, M. Lindeberg, and S. D. Rice. 2008. Evaluation of bioavailable hydrocarbon sources and their induction potential in Prince William Sound, Alaska. Mar. Environ. Res. 66:218-220.
Springman, K. R., J. W. Short, M. R. Lindeberg, J. M. Maselko, C. Khan, P. V. Hodson, and S. D. Rice. 2008. Semipermeable membrane devices link site-specific contaminants to effects: Part 1 – Induction of CYP1A in rainbow trout from contaminants in Prince William Sound, Alaska. Mar. Environ. Res. 66:477-486.
Thomas, R.E., M. R. Lindeberg, Patricia M. Harris, and Stanley D. Rice. 2007. Induction of DNA Strand Breaks in the Mussel (*Mytilus trossulus*) and Clam (*Protothaca staminea*) Following Chronic Field Exposure to Polycyclic Aromatic Hydrocarbons from the *Exxon Valdez* Spill. Marine Pollution Bulletin. 54: 726-732.
Short J.W., G. V. Irvine, D. H. Mann, J. M. Maselko, J. J. Pella, M. R. Lindeberg, J. R. Payne, W. B. Driskell, and S. D. Rice. 2007. Slightly weathered *Exxon Valdez* oil persists in Gulf of Alaska beach sediments after 16 years. Environ. Sci. Technol. 41:1245-1250.
Short, J.W., J.M. Maselko, M.R. Lindeberg, P.M Harris, and S.D. Rice. 2006. Vertical distribution and probability of encountering intertidal *Exxon Valdez* oil on shorelines of three embayments within Prince William Sound, Alaska. Environ. Sci. and Technol. Vol. 40, 3723-3729.
Short, J.W., M. R. Lindeberg, Patricia M. Harris, J. Maselko, Jerome J. Pella, and S.D. Rice. 2004. An estimate of oil persisting on beaches of Prince William Sound, 12 years after the *Exxon Valdez* oil spill. Environ. Sci. and Technol. Vol 38: 19-25.
O'Clair, Charles E., M. R. Lindeberg, and Joshua Millstein. 2001. "Mesoscale differences in mussel, *Mytilus trossulus*, population structure in Prince William Sound, Alaska in relation to oiling history and predation intensity." Journal of Experimental Marine Biology and Ecology. 262:155-176.
Highsmith, Raymond C., Rucker, T.L., Stekoll, M.S., Saupe, S.M., Lindeberg, M.R., Jenne, R.N., Erickson, W.P. 1996. Impact of the *Exxon Valdez* Oil Spill on Intertidal Biota. American Fisheries Society Symposium 18:212-237.

Collaborators:
Coon, Catherine (BOEM); Eagleton, Mathew (Alaska Regional Office, NMFS); Iken, Katrin (UAF); Hoffman, Christopher (USACOE); Jones, Tahzay (NPS); Konar, Brenda (UAF); Lewis, Steve (Alaska Regional Office, NMFS); Lindstrom, Sandra (UBC); Lauenstein, Gunnar (NOAA); Robertson, Tim (Nuka Research, Inc.);

Saupe, Sue (Cook Inlet RCAC); Schock, Carl (Coastal and Oceans Research, Inc.); Stickle, William (LSU).

ANGELA M. DOROFF
Kachemak Bay National Estuarine Research Reserve, 2181 Kachemak Drive Homer AK 99603, Day Phone: 907-235-4795; Email: adoroff@uaa.alaska.edu

EDUCATION: M.Sc. in Wildlife Ecology (1988) University of Wisconsin, Madison; B.S. in Biology (1984) University of Minnesota, St. Paul

CURRENT POSITION: Kachemak Bay National Estuarine Research Reserve (Reserve), Research Coordinator since11/2008. I supervise the national monitoring program development for water quality, weather, and salt marsh habitats for the Reserve and specialize in the nearshore marine ecology and biological oceanography. The Reserve is a unique organization composed of research, education, and coastal training sectors that collectively benefit the State of Alaska, National Oceans and Atmospheric Administration (NOAA), and the coastal communities in Southcentral Alaska. We conduct locally and nationally relevant research and communicate the science to the public, coastal decision-makers, and other scientists. I serve as the sea otter representative to the Otter Specialist Group of the International Union for the Conservation of Nature (IUCN). I am an Affiliate Faculty at the University of Alaska, Fairbanks School of Fisheries and Ocean Sciences (2015-2018).

RECENT JOURNAL PUBLICATIONS:

Carrasco, S. E., B. B. Chomel, V. A. Gill, A. M. Doroff, M. A. Miller, K. A. Burek, R. W. Kasten, B. A. Byrne, T. G. Goldstein, J. A. K. Mazet. 2014. Exposure to *Bartonella spp*. is common in Alaskan sea otters. Vector-borne and Zoonotic Diseases. Vol. 14(12) 831.

Stewart, N.L., B. Konar, A. Doroff. 2014. Sea Otter (*Enhydra lutris*) foraging in a heterogeneous environment in Kachemak Bay, Alaska. Bulletin of Marine Science 90:921-939.

Newsome, S. D., M. T. Tinker, V.A. Gill, A.M. Doroff, L. Nichol, and J.L. Bodkin. 2015. The interaction of intraspecific competition and habitat on individual diet specialization. Oecologia
DOI 10.1007/s00442-015-3223-8.

Traiger, S., B. Konar, A. Doroff, and L. McCaslin. In review. Sea otters versus sea stars as major clam predators: evidence from foraging pits and shell litter. Submitted: Marine Ecological Progress Series.

Doroff, A., S. Baird, J. Freymeuller, M. Murphy, and S. Buckelew. In review. Assessing coastal habitat changes in a glacially influenced estuary system, Kachemak Bay, Alaska. Submitted: Estuaries and Coasts special issue journal.

RECENT GRANTS AWARDED:

State Wildlife Grants annually 2009-2016: Principal Investigator /Project Manager (145K)University of New Hampshire, Science Collaborative (2010-2013): Principal Investigator (915K)Exxon Valdez Trustee Council, Long-term monitoring (2011-2016): Principal Investigator (700K) NOAA Habitat Focus Area: Kachemak Bay: Principal Investigator (385K)

RECENT COLLABORATORS (EXCLUSIVE OF CO-AUTHORS ABOVE):

Sonia Batten; Rob Campbell; Kris Holderied; Russ Hopcroft; Tom Weingartner; Mark Johnson, Georgina Gibson; Katrin Iken; Jeff Hatrick; Michael Opheim; E. Jamie Trammel; Marcus Geist; Dom Hondelaro; Pat Tester; Wayne Litker; Catie Bursch; Jessica Shepard; Deb Tobin; Kathy Kuletz; Elizabeth Labunski.

Amy E. Miller
Supervisory Ecologist
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2015-present – Supervisory Ecologist, National Park Service, Anchorage, AK
2004-2015 – Ecologist, National Park Service, Anchorage, AK
2002-2004 – Research Associate, Univesity of California, Santa Barbara, CA
2004 - Ph.D., University of Colorado, Boulder, CO (Biology)
1993 – B.S., Oregon State University, Corvallis, OR (Botany)

Amy leads the Inventory and Monitoring Program for the Southwest Alaska Network (SWAN), a network of five National Park Service units consisting of Kenai Fjords National Park, Lake Clark National Park and Preserve, Katmai National Park and Preserve, Alagnak Wild River, and Aniakchak National Monument and Preserve. She oversees all activities associated with the five program areas of the SWAN: climate, water, terrestrial wildlife, nearshore marine environments, and vegetation. Previously, she served as the terrestrial ecologist for the network, in which she managed a long-term monitoring program examining vegetation and landcover change, and collaborated with more than a dozen university and agency partners. She serves as Affiliate Faculty with the University of Alaska and is a member of the Steering Committee for the Western Alaska Landscape Conservation Cooperative.

RECENT PUBLICATIONS

Csank AZ, Miller AE, Sherriff RL, Berg EE, Welker JM. Tree-ring isotope chronologies reveal drought sensitivity in trees killed by insect outbreaks in Alaska. *Ecological Applications* (in press).
Lindsay C, Zhu J, Miller AE, Kirchner P, Wilson TL. 2015. Deriving snow cover metrics for Alaska from MODIS. *Remote Sensing* 7:12961-12985..
Homyak PM, Sickman JO, Miller AE, Melack JM, Meixner T, Schimel JP. 2014. Assessing nitrogen- saturation in a seasonally dry chaparral watershed: Limitations of traditional indicators of N-saturation. *Ecosystems* 17:1286-1305.
Carlson ML, Lipkin R, Roland C, Miller AE. 2013. New and important vascular plant collections from south-central and southwestern Alaska: a region of floristic convergence. *Rhodora* 115:61-95.
Sherriff RL, Berg EE, Miller AE. 2011. Climate variability and spruce beetle (*Dendroctonus rufipennis*) outbreaks in south-central and southwest Alaska. *Ecology* 92:1459-1470.
Thompson WL, Miller AE, Mortenson DC, Woodward A. 2011. Developing effective sampling designs for monitoring natural resources in Alaskan national parks. *Biological Conservation* 144:1270-1277.
Ashton IW, Miller AE, Bowman WD, Suding KN. 2010. Niche complementarity due to plasticity in resource use: plant partitioning of chemical N forms. *Ecology* 91:3252-3260.
Reed B, Budde M, Spencer P, Miller AE. 2009. Integration of MODIS-derived metrics to assess interannual variability in snowpack, lake ice, and NDVI in southwest Alaska. *Remote Sensing of Environment* 113:1443-1452.
Miller AE, Schimel JP, Sickman JO, Skeen K, Meixner T, Melack JM. 2009. Seasonal variation in nitrogen uptake and turnover in two high-elevation soils: mineralization response is site-dependent. *Biogeochemistry* 93:253-270.

Ashton IW, Miller AE, Bowman WD, Suding KN. 2008. Nitrogen preferences and plant-soil feedbacks as influenced by neighbors in the alpine tundra. *Oecologia* 156:625-636.
Miller AE, Bowman WD, Suding KN. 2007. Plant uptake of inorganic and organic nitrogen: neighbor identity matters. *Ecology* 88:1832-1840.
Miller AE, Schimel JP, Sickman JO, Meixner T, Doyle AP, Melack JM. 2007. Mineralization responses at near-zero temperatures in three alpine soils. *Biogeochemistry* 84:233-245.
Nemergut DR, Anderson SP, Cleveland CC, Martin AP, Miller AE, Seimon A, Schmidt SK. 2007. Microbial community succession in an unvegetated, recently deglaciated soil. *Microbial Ecology* 53:110-122.
Gende SM, Miller AE, Hood E. 2007. The effects of salmon carcasses on soil nutrient pools in a riparian forest of southeast Alaska. *Canadian Journal of Forest Research* 37:1194-1202.

RECENT COLLABORATORS

Rosemary Sherriff, Humboldt State University, Arcata, CA
Edward Berg, U.S. Fish and Wildlife Service, Soldotna, AK (emeritus)
Adam Csank, University of Nevada, Reno/Nipissing University, Ontario, Canada
Jeffrey Welker, University of Alaska, Anchorage, AK
Bruce McCune, Oregon State University, Corvallis, OR
Steffi Ickert-Bond, University of Alaska, Fairbanks, AK
Jiang Zhu, University of Alaska Fairbanks, Fairbanks, AK
Tom Heinrichs, University of Alaska, Fairbanks, AK
Matthew Carlson, University of Alaska, Anchorage, AK
Bradley Reed, U.S. Geological Survey, Reston, VA
Michael Budde, U.S. Geological Survey, Sioux Falls, SD
Andrew Richardson, Harvard University, Cambridge, MA
Robert Kennedy, Boston University, Boston, MA
Andrew Robertson, Saint Mary's University of Minnesota, Winona, MN

Budget Category:	Proposed FY 17	Proposed FY 18	Proposed FY 19	Proposed FY 20	Proposed FY 21	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$228.8	$229.1	$229.4	$229.8	$230.1	$1,147.2	
Travel	$17.4	$17.5	$17.6	$17.7	$17.8	$88.0	
Contractual	$83.1	$120.6	$83.1	$83.1	$83.1	$453.0	
Commodities	$23.9	$23.0	$23.0	$23.0	$23.0	$115.9	
Equipment	$5.0	$15.0	$14.0	$5.0	$5.0	$44.0	
Indirect Costs (*will vary by proposer*)	$10.5	$10.2	$10.3	$10.4	$10.5	$51.9	
SUBTOTAL	$368.7	$415.4	$377.4	$369.0	$369.6	$1,900.0	
General Administration (9% of subtotal)	$33.2	$37.4	$34.0	$33.2	$33.3	$171.0	N/A
PROJECT TOTAL	$401.9	$452.7	$411.4	$402.2	$402.8	$2,071.0	
Other Resources (Cost Share Funds)	$410.0	$410.0	$410.0	$392.0	$392.0	$2,014.0	

COMMENTS:
This is the combined budget for the individual Coletti/Esler and Iken/Konar budgets that follow. Coletti is affliated with the National Park Service, A Trustee Agency, Esler is affiliated with the U.S. Geological Survey, a Trustee Agency, and Iken and Konar are affiliated with the University of Alaska Fairbanks, a Non-Trustee Agency. The budgets have been combined by using a Non-Trustee Agency budget reporting form. This form contains the summary information only. Detail by year for each of the Trustee and Non-Trustee Agency PIs can be found in the following two worksheets.

FY17-21

Project Title: Nearshore
Primary Investigators: H. Coletti, D. Esler, K. Iken, & B. Konar

NON-TRUSTEE AGENCY SUMMARY PAGE

Budget Category:	Proposed FY 17	Proposed FY 18	Proposed FY 19	Proposed FY 20	Proposed FY 21	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$194.1	$194.1	$194.1	$194.1	$194.1	$970.5	
Travel	$15.5	$15.5	$15.5	$15.5	$15.5	$77.5	
Contractual	$80.9	$118.4	$80.9	$80.9	$80.9	$442.0	
Commodities	$20.7	$21.5	$21.5	$21.5	$21.5	$106.7	
Equipment	$5.0	$15.0	$14.0	$5.0	$5.0	$44.0	
SUBTOTAL	$316.2	$364.5	$326.0	$317.0	$317.0	$1,640.7	
General Administration (9% of subtotal)	$28.5	$32.8	$29.3	$28.5	$28.5	$147.7	N/A
PROJECT TOTAL	$344.7	$397.3	$355.3	$345.5	$345.5	$1,788.4	
Other Resources (Cost Share Funds)	$410.0	$410.0	$410.0	$392.0	$392.0	$2,014.0	

COMMENTS:
Annual in-kind contributions consist of staff time (USGS = $92K; NPS = $130k; NOAA = $10k), reduced charter costs (USGS = $45K; NPS= $25K), winter bird surveys (NPS=$18K), use of equipment such as rigid-hull inflatable, inflatables/outboards, GPSs, spotting scopes, field laptops, sounding equipment (USGS = $40K; NPS = $40K) and commodities (USGS = $5k; NPS = $5K). NPS budgets are projected to decline over time based on agency 5-year planning.

FY17-21

Project Title: Nearshore
Primary Investigator: Coletti & Esler
Agency: NPS & USGS

TRUSTEE AGENCY SUMMARY PAGE

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
D. Esler (USGS)		1.0	10.5		10.5
G. Esslinger (USGS)		1.0	9.5		9.5
K. Kloecker (USGS)		4.0	9.9		39.6
D. Monson (USGS)		4.0	10.4		41.6
B. Weitzman (USGS)		6.0	6.7		40.2
Tech (USGS or NPS)		6.0	6.7		40.2
Overtime (estimated)		1.0	12.5		12.5
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	66.2	0.0	
				Personnel Total	$194.1

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Field Travel (NOAA)					2.5
AMSS and LTM PI meetings (Coletti)	0.5	3	15	0.2	4.5
Field travel (NPS)					2.5
Field travel (USGS)					6.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$15.5

FY17

Project Title: Nearshore
Primary Investigator: Coletti & Esler
Agency: NPS & USGS

FORM 4B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Vessel Charter (Katmai)	20.0
Aerial Surveys for sea otters - WPWS	17.5
Sea otter carcass tooth cementum age analysis	1.4
Stable Isotope analyses, mussels and POM	6.0
Senior Scientist (T. Dean, J. Bodkin, B. Ballachey)	36.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$80.9

Commodities Costs: Description	Commodities Sum
fuel for skiffs	3.0
field & safety gear	3.0
software	3.0
sampling gear (NOAA)	7.5
equipment maintenance	4.2
Commodities Total	$20.7

FY17

Project Title: Nearshore
Primary Investigator: Coletti & Esler
Agency: NPS & USGS

FORM 4B CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
data logging instruments			5.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$5.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
Questar spotting scopes & high-power binocs for sea otter forage data collection	5	USGS/NPS
Existing small skiffs for charters (3 skiffs/nearshore trip are needed, more if trips are concurrent)	3	USGS/NPS
Field computers	4	USGS/NPS
Cameras	4	USGS/NPS
GPS units	5	USGS/NPS
Radio units	8	USGS/NPS
25 ft Boston Whaler, if needed for carcass surveys, monitoring work	1	USGS
airplane GPS unit for sea otter surveys	1	USGS

FY17

Project Title: Nearshore
Primary Investigator: Coletti & Esler
Agency: NPS & USGS

FORM 4B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
D. Esler (USGS)		1.0	10.5		10.5
G. Esslinger (USGS)		1.0	9.5		9.5
K. Kloecker (USGS)		4.0	9.9		39.6
D. Monson (USGS)		4.0	10.4		41.6
B. Weitzman (USGS)		6.0	6.7		40.2
Tech (USGS or NPS)		6.0	6.7		40.2
Overtime (estimated)		1.0	12.5		12.5
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	66.2	0.0	
				Personnel Total	$194.1

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Field Travel (NOAA)					2.5
AMSS and LTM PI meetings (Coletti)	0.5	3	15	0.2	4.5
Field travel (NPS)					2.5
Field travel (USGS)					6.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$15.5

FY18

Project Title: Nearshore
Primary Investigator: Coletti & Esler
Agency: NPS & USGS

FORM 4B
PERSONNEL & TRAVEL
DETAIL

Contractual Costs: Description	Contract Sum
Vessel Charter (Katmai)	20.0
Aerial Surveys for sea otters - KATM	17.5
Sea otter carcass tooth cementum age analysis	1.4
Stable Isotope analyses, mussels and POM	6.0
Senior Scientist (T. Dean, J. Bodkin, B. Ballachey)	36.0
Contaminant analyses, Mussel Watch, 15 sites * 2.5/site	37.5
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$118.4

Commodities Costs: Description	Commodities Sum
fuel for skiffs	3.0
field & safety gear	3.0
software	3.0
sampling gear (NOAA)	7.5
equipment maintenance	5.0
Commodities Total	$21.5

FY18

Project Title: Nearshore
Primary Investigator: Coletti & Esler
Agency: NPS & USGS

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
data logging instruments	1.0	5.0	5.0
field laptops	2.0	5.0	10.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$15.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
Questar spotting scopes & high-power binocs for sea otter forage data collection	5	USGS/NPS
Existing small skiffs for charters (3 skiffs/nearshore trip are needed, more if trips are concurrent)	3	USGS/NPS
Field computers	4	USGS/NPS
Cameras	4	USGS/NPS
GPS units	5	USGS/NPS
Radio units	8	USGS/NPS
25 ft Boston Whaler, if needed for carcass surveys, monitoring work	1	USGS
airplane GPS unit for sea otter surveys	1	USGS

FY18

Project Title: Nearshore
Primary Investigator: Coletti & Esler
Agency: NPS & USGS

FORM 4B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
D. Esler (USGS)		1.0	10.5		10.5
G. Esslinger (USGS)		1.0	9.5		9.5
K. Kloecker (USGS)		4.0	9.9		39.6
D. Monson (USGS)		4.0	10.4		41.6
B. Weitzman (USGS)		6.0	6.7		40.2
Tech (USGS or NPS)		6.0	6.7		40.2
Overtime (estimated)		1.0	12.5		12.5
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	66.2	0.0	
				Personnel Total	$194.1

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Field Travel (NOAA)					2.5
AMSS and LTM PI meetings (Coletti)	0.5	3	15	0.2	4.5
Field travel (NPS)					2.5
Field travel (USGS)					6.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$15.5

FY19

Project Title: Nearshore
Primary Investigator: Coletti & Esler
Agency: NPS & USGS

FORM 4B
PERSONNEL & TRAVEL
DETAIL

Contractual Costs: Description	Contract Sum
Vessel Charter (Katmai)	20.0
Aerial Surveys for sea otters - KEFJ	17.5
Sea otter carcass tooth cementum age analysis	1.4
Stable Isotope analyses, mussels and POM	6.0
Senior Scientist (T. Dean, J. Bodkin, B. Ballachey)	36.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$80.9

Commodities Costs: Description	Commodities Sum
fuel for skiffs	3.0
field & safety gear	3.0
software	3.0
sampling gear (NOAA)	7.5
equipment maintenance	5.0
Commodities Total	$21.5

FY19

Project Title: Nearshore
Primary Investigator: Coletti & Esler
Agency: NPS & USGS

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
data logging instruments	1.0	5.0	5.0
inflatable skiff for field work w outboard and accessories (Mark II w/ 20hp)	1.0	9.0	9.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$14.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
Questar spotting scopes & high-power binocs for sea otter forage data collection	5	USGS/NPS
Existing small skiffs for charters (3 skiffs/nearshore trip are needed, more if trips are concurrent)	3	USGS/NPS
Field computers	4	USGS/NPS
Cameras	4	USGS/NPS
GPS units	5	USGS/NPS
Radio units	8	USGS/NPS
25 ft Boston Whaler, if needed for carcass surveys, monitoring work	1	USGS
airplane GPS unit for sea otter surveys	1	USGS

FY19

Project Title: Nearshore
Primary Investigator: Coletti & Esler
Agency: NPS & USGS

FORM 4B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
D. Esler (USGS)		1.0	10.5		10.5
G. Esslinger (USGS)		1.0	9.5		9.5
K. Kloecker (USGS)		4.0	9.9		39.6
D. Monson (USGS)		4.0	10.4		41.6
B. Weitzman (USGS)		6.0	6.7		40.2
Tech (USGS or NPS)		6.0	6.7		40.2
Overtime (estimated)		1.0	12.5		12.5
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	66.2	0.0	
				Personnel Total	$194.1

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Field Travel (NOAA)					2.5
AMSS and LTM PI meetings (Coletti)	0.5	3	15	0.2	4.5
Field travel (NPS)					2.5
Field travel (USGS)					6.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$15.5

FY20

Project Title: Nearshore
Primary Investigator: Coletti & Esler
Agency: NPS & USGS

FORM 4B PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Vessel Charter (Katmai)	20.0
Aerial Surveys for sea otters - WPWS	17.5
Sea otter carcass tooth cementum age analysis	1.4
Stable Isotope analyses, mussels and POM	6.0
Senior Scientist (T. Dean, J. Bodkin, B. Ballachey)	36.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$80.9

Commodities Costs: Description	Commodities Sum
fuel for skiffs	3.0
field & safety gear	3.0
software	3.0
sampling gear (NOAA)	7.5
equipment maintenance	5.0
Commodities Total	$21.5

FY20

Project Title: Nearshore
Primary Investigator: Coletti & Esler
Agency: NPS & USGS

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
data logging instruments	1.0	5.0	5.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
New Equipment Total			$5.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
Questar spotting scopes & high-power binocs for sea otter forage data collection	5	USGS/NPS
Existing small skiffs for charters (3 skiffs/nearshore trip are needed, more if trips are concurrent)	3	USGS/NPS
Field computers	4	USGS/NPS
Cameras	4	USGS/NPS
GPS units	5	USGS/NPS
Radio units	8	USGS/NPS
25 ft Boston Whaler, if needed for carcass surveys, monitoring work	1	USGS
airplane GPS unit for sea otter surveys	1	USGS

FY20

Project Title: Nearshore
Primary Investigator: Coletti & Esler
Agency: NPS & USGS

FORM 4B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
D. Esler (USGS)		1.0	10.5		10.5
G. Esslinger (USGS)		1.0	9.5		9.5
K. Kloecker (USGS)		4.0	9.9		39.6
D. Monson (USGS)		4.0	10.4		41.6
B. Weitzman (USGS)		6.0	6.7		40.2
Tech (USGS or NPS)		6.0	6.7		40.2
Overtime (estimated)		1.0	12.5		12.5
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	66.2	0.0	
				Personnel Total	$194.1

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Field Travel (NOAA)					2.5
AMSS and LTM PI meetings (Coletti)	0.5	3	15	0.2	4.5
Field travel (NPS)					2.5
Field travel (USGS)					6.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$15.5

FY21

Project Title: Nearshore
Primary Investigator: Coletti & Esler
Agency: NPS & USGS

FORM 4B
PERSONNEL & TRAVEL
DETAIL

Contractual Costs: Description	Contract Sum
Vessel Charter (Katmai)	20.0
Aerial Surveys for sea otters - KATM	17.5
Sea otter carcass tooth cementum age analysis	1.4
Stable Isotope analyses, mussels and POM	6.0
Senior Scientist (T. Dean, J. Bodkin, B. Ballachey)	36.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$80.9

Commodities Costs: Description	Commodities Sum
fuel for skiffs	3.0
field & safety gear	3.0
software	3.0
sampling gear (NOAA)	7.5
equipment maintenance	5.0
Commodities Total	$21.5

FY21

Project Title: Nearshore
Primary Investigator: Coletti & Esler
Agency: NPS & USGS

**FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL**

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
data logging instruments	1.0	5.0	5.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$5.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
Questar spotting scopes & high-power binocs for sea otter forage data collection	5	USGS/NPS
Existing small skiffs for charters (3 skiffs/nearshore trip are needed, more if trips are concurrent)	3	USGS/NPS
Field computers	4	USGS/NPS
Cameras	4	USGS/NPS
GPS units	5	USGS/NPS
Radio units	8	USGS/NPS
25 ft Boston Whaler, if needed for carcass surveys, monitoring work	1	USGS
airplane GPS unit for sea otter surveys	1	USGS

FY21

Project Title: Nearshore
Primary Investigator: Coletti & Esler
Agency: NPS & USGS

FORM 4B
EQUIPMENT DETAIL

Budget Category:	Proposed FY 17	Proposed FY 18	Proposed FY 19	Proposed FY 20	Proposed FY 21	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$34.7	$35.0	$35.3	$35.7	$36.0	$176.7	
Travel	$1.9	$2.0	$2.1	$2.2	$2.3	$10.5	
Contractual	$2.2	$2.2	$2.2	$2.2	$2.2	$11.0	
Commodities	$3.2	$1.5	$1.5	$1.5	$1.5	$9.2	
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
Indirect Costs (25%)	$10.50	$10.17	$10.28	$10.40	$10.52	$ 51.87	
SUBTOTAL	$52.50	$50.9	$51.4	$52.0	$52.6	$259.3	
General Administration (9% of subtotal)	$4.7	$4.6	$4.6	$4.7	$4.7	$23.3	N/A
PROJECT TOTAL	$57.2	$55.4	$56.0	$56.7	$57.3	$282.7	
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	

COMMENTS:
-Year 1 will have greater amount of budget for equipment and supplies and travel
-Tuition has a 5-10% yearly increase for student employees.

FY17-21

Project Title: Kachemak Bay Ecology
Primary Investigator: Brenda Konar and Katrin Iken

NON-TRUSTEE AGENCY SUMMARY PAGE

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Konar		0.6	15.7		9.9
Iken		0.6	18.5		11.7
Doroff		0.5	12.0		5.5
Student		2.0	3.7		7.5
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	50.0	0.0	
				Personnel Total	$34.7

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
RT Fairbanks-Kachemak Bay	0.4	2	4	0.3	1.8
Ground transportation	0.1	2			0.1
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$1.9

FY17

Project Title: Kachemak Bay Ecology
Primary Investigator: Brenda Konar and Katrin Iken

FORM 3B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Laboratory analyses	2.2
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$2.2

Commodities Costs: Description	Commodities Sum
Supplies	0.5
Data loggers	2.7
Commodities Total	$3.2

FY17

Project Title: Kachemak Bay Ecology
Primary Investigator: Brenda Konar and Katrin Iken

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY17

Project Title: Kachemak Bay Ecology
Primary Investigator: Brenda Konar and Katrin Iken

FORM 3B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Konar		0.6	16.0		10.1
Iken		0.6	18.5		11.7
Doroff		0.5	12.3		5.7
Student		2.0	3.7		7.5
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	50.6	0.0	
				Personnel Total	$35.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
RT Fairbanks to Kachemak Bay	0.4	2	4	0.3	1.9
Ground transportation	0.1	2			0.1
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2.0

FY18

Project Title: Kachemak Bay Ecology
Primary Investigator: Brenda Konar and Katrin Iken

FORM 3B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Lab services	2.2
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$2.2

Commodities Costs: Description	Commodities Sum
Supplies	0.5
Data loggers	1.0
Commodities Total	$1.5

FY18

Project Title: Kachemak Bay Ecology
Primary Investigator: Brenda Konar and Katrin Iken

FORM 3B CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY18

Project Title: Kachemak Bay Ecology
Primary Investigator: Brenda Konar and Katrin Iken

FORM 3B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Konar		0.6	16.3		10.3
Iken		0.6	18.5		11.7
Doroff		0.5	12.7		5.8
Student		2.0	3.7		7.5
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	51.2	0.0	
				Personnel Total	$35.3

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Travel RT-Fairbanks to Kachemak Bay	0.5	2	4	0.3	2.0
Ground transportation	0.1	2			0.1
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2.1

FY19

Project Title: Kachemak Bay Ecology
Primary Investigator: Brenda Konar and Katrin Iken

FORM 3B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Lab services	2.2
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$2.2

Commodities Costs: Description	Commodities Sum
Supplies	0.5
Data loggers	1.0
Commodities Total	$1.5

FY19

Project Title: Kachemak Bay Ecology
Primary Investigator: Brenda Konar and Katrin Iken

FORM 3B CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY19

Project Title: Kachemak Bay Ecology
Primary Investigator: Brenda Konar and Katrin Iken

FORM 3B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Konar		0.6	16.6		10.5
Iken		0.6	18.5		11.7
Doroff		0.5	13.0		6.0
Student		2.0	3.7		7.5
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	51.9	0.0	
				Personnel Total	$35.7

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
RT-Fairbanks to Kachemak Bay	0.5	2	4	0.3	2.1
Ground transportation	0.1	2			0.1
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2.2

FY20

Project Title: Kachemak Bay Ecology
Primary Investigator: Brenda Konar and Katrin Iken

FORM 3B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Lab services	2.2
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$2.2

Commodities Costs: Description	Commodities Sum
Supplies	0.5
Data loggers	1.0
Commodities Total	$1.5

FY20

Project Title: Kachemak Bay Ecology
Primary Investigator: Brenda Konar and Katrin Iken

FORM 3B
CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY20

Project Title: Kachemak Bay Ecology
Primary Investigator: Brenda Konar and Katrin Iken

FORM 3B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Konar		0.6	17.0		10.7
Iken		0.6	18.5		11.7
Doroff		0.5	13.3		6.1
Student		2.0	3.7		7.5
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	52.5	0.0	
				Personnel Total	$36.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
RT=Fairbanks to Kachemak Bay	0.6	2	4	0.3	2.2
Ground transportation	0.1	2			0.1
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2.3

FY21

Project Title: Kachemak Bay Ecology
Primary Investigator: Brenda Konar and Katrin Iken

FORM 3B PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Lab services	2.2
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$2.2

Commodities Costs: Description	Commodities Sum
Supplies	0.5
Data loggers	1.0
Commodities Total	$1.5

FY21

Project Title: Kachemak Bay Ecology
Primary Investigator: Brenda Konar and Katrin Iken

FORM 3B
CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY21

Project Title: Kachemak Bay Ecology
Primary Investigator: Brenda Konar and Katrin Iken

FORM 3B
EQUIPMENT DETAIL

August 24, 2016

Elise Hsieh, Executive Director
Exxon Valdez Oil Spill Trustee Council
4210 University Drive
Anchorage, AK 99508-4626

Dear Elise:

Final FY 2017-2021 Proposal Submittal for Long-term Monitoring

17120114-I. Long-term Monitoring of Oceanographic Conditions in the Alaska Coastal Current from Hydrographic Station GAK-1

Gulf Watch Alaska, the long-term monitoring program of the *Exxon Valdez* Oil Spill Trustee Council (EVOSTC), has finalized our program and project proposals for fiscal years 2017-2021 funding based on comments received from EVOSTC's Science Panel on May 19, 2016. Below is the final budget summary and response to Science Panel comments for the Oceanographic Conditions at GAK-1 project.

EVOSTC Funding Requested *(including 9% GA)*

FY17	FY18	FY19	FY20	FY21	TOTAL
$146,800	$148,400	$132,600	$125,600	$127,400	$680,800

Non-EVOSTC Funding Available

FY17	FY18	FY19	FY20	FY21	TOTAL
$0	$0	$0	$0	$0	$0

Science Panel comment: *This long-term data set provides critical information to both Programs and to researchers beyond the Programs. The resultant data are heavily used. The Panel supports the continued funding of this work. The Panel also awaits seeing new analyses that integrate these environmental variables into the changing abundances of members of the food webs of importance.*

PI Response:

- Thank you for the comment. The proposal was not revised.

Sincerely,

Mandy Lindeberg
Gulf Watch Alaska Program Lead designate

Attachment: Gulf Watch Alaska: Environmental Drivers Component Project Proposal: 17120114-I—Long-term Monitoring of Oceanographic Conditions in the Alaska Coastal Current from Hydrographic Station GAK-1

EVOSTC FY17-FY21 INVITATION FOR PROPOSALS
PROGRAM PROJECT PROPOSAL SUMMARY PAGE

Project Title

Gulf Watch Alaska: Environmental Drivers Component Project:

17120114-I—Long-term Monitoring of Oceanographic Conditions in the Alaska Coastal Current from Hydrographic Station GAK-1

Primary Investigator(s) and Affiliation(s)

Seth L. Danielson, Principal Investigator, University of Alaska Fairbanks

Thomas J. Weingartner, Co-Investigator, University of Alaska Fairbanks

Date Proposal Submitted

24 August 2016

Project Abstract

This program continues a 45-year time-series of temperature and salinity measurements at hydrographic station GAK-1. The data set, which began in 1970, now consists of quasi-monthly conductivity-temperature versus depth (CTD) casts and a mooring outfitted with seven temperature/conductivity recorders distributed throughout the water column and a fluorometer at 20 m depth. The project monitors five important Alaska Coastal Current (ACC) ecosystem parameters that quantify and help us understand hourly to seasonal, interannual and multi-decadal period variability in:

1. Temperature and salinity throughout the 250 m deep water column
2. Near surface stratification
3. Surface pressure fluctuations
4. Fluorescence as an index of phytoplankton biomass
5. Along-shelf transport in the ACC

All of these parameters are basic descriptors that characterize the workings of the inner shelf and the ACC, an important habitat and migratory corridor for organisms inhabiting the northern Gulf of Alaska (GOA), including Prince William Sound (PWS). We are aware of 69 publications utilizing data collected at station GAK-1 and since 2000 the citation list has grown by nearly three publications per year. GAK-1 data are cited within at least eight student Masters theses and Doctoral dissertations, peer-reviewed papers, and both State of Alaska and federal agency reports. The topics covered by these publications range from physical oceanography and climate through lower- and upper-trophic (including commercial fisheries) level components and ecosystem analyses.

EVOSTC Funding Requested *(must include 9% GA)*

FY17	FY18	FY19	FY20	FY21	TOTAL
$146.8	$148.4	$132.6	$125.6	$127.4	$680.8

Non-EVOSTC Funding Available

FY17	FY18	FY19	FY20	FY21	TOTAL
0	0	0	0	0	0

1. Executive Summary

The goal of the GAK-1 project is to provide a long-term high-quality reference dataset for the coastal northern GOA that enables scientists, students, commercial and subsistence fishers and resource managers to better understand climatic and ecological conditions, their changes, and ramifications of change (Figure 1). Understanding, anticipating, and responding to change requires a stationary frame of reference in the form of long-term in situ observations. Such datasets are the best means to guide our assessments and interpretations of system variability. Untangling the relations between climatic and other drivers of change (e.g., oil spills or fishing regulations) similarly requires long reference time-series. Environmental time-series data can provide information valuable to the management of fish and shellfish populations and fisheries (Anderson and Piatt 1999, Munro and Tide 2014).

There exist no other full water column temperature and salinity time-series in the northern GOA with comparable data quality, temporal extent, and frequency of sampling. Hence, the GAK-1 dataset is the premier reference dataset for evaluating hypotheses that seek mechanistic descriptions of the regional ocean environment and ecosystem. As shown by an ever-increasing number of publications that utilize the GAK-1 dataset, the value of this unique time-series continues to grow and even accelerate with the passing years and decades.

The GAK-1 dataset is collected under the fundamental hypothesis that oceanic conditions are important to the physical and biological functioning of the PWS and GOA ecosystems. To that end, dozens of papers have examined this hypothesis from numerous perspectives (for a comprehensive listing, see the GAK-1 home page at http://www.ims.uaf.edu/gak1/). As the chemical and biological datasets begin to catch up (via quality of resolution, duration and frequency) to the physical measurements we expect that the insights gleaned through interdisciplinary analyses will grow in kind. To date, the 45-year GAK-1 time-series has helped show:

1. Large interannual differences associated with El Nino and La Nina events, including substantial differences in the spring bloom between these phenomena (Weingartner et al., 2003, Childers et al., 2005).
2. The intimate connection between coastal freshwater discharge and the depth-varying evolution of winter and spring temperatures over the shelf (Janout, 2009; Janout et al. 2010).
3. GAK-1 provides a reliable index of ACC transports of mass, heat, and freshwater (Weingartner et al., 2005).
4. That GAK-1 near-surface salinities are correlated with coastal freshwater discharge from around the GOA (Weingartner et al., 2005).

5. Variations in mixed-layer depth in the northern GOA, which affects primary production (Sakar et al., 2006).
6. Decadal scale trends in salinity and temperature, (Royer 2005; Royer and Grosch 2006, Weingartner et al. 2005, Janout et al. 2010, Kelley 2015).
7. The relationships between temperature and salinity variations and the Pacific Decadal Oscillation and the strength and position of the Aleutian Low (Royer 2005, Weingartner et al. 2005, and Janout et al. 2010).
8. That the record can guide understanding the variability in iron concentrations, a potentially limiting micro-nutrient required by many phytoplankton. Preliminary efforts indicate that iron and surface salinity are correlated at least in certain seasons (Wu et al. 2008).
9. Between about 1000 and 1500 years before present the northern GOA likely experienced a cooler, more sluggish and higher salinity ACC, whereas between 600 and 1000 years before present a stronger Aleutian Low may have driven a stronger and fresher ACC (Hallmann et al. 2011)
10. Ocean acidification (carbonate) system variability can be described using multiple linear regression models to predict dissolved inorganic carbon and total alkalinity using observations of nitrate, temperature, salinity, and pressure (Evans et al. 2013).
11. A decoupling of near-surface and near-bottom waters through increased stratification (Kelley, 2015) with implications for nutrient resupply to the euphotic zone and long-term changes in shelf productivity.

As shown and discussed by Mueter et al. (1994), Mueter (2004), and Spies (2009), these factors affect and relate to many ecosystem processes on both the shelf and within PWS and Lower Cook Inlet/Kachemak Bay.

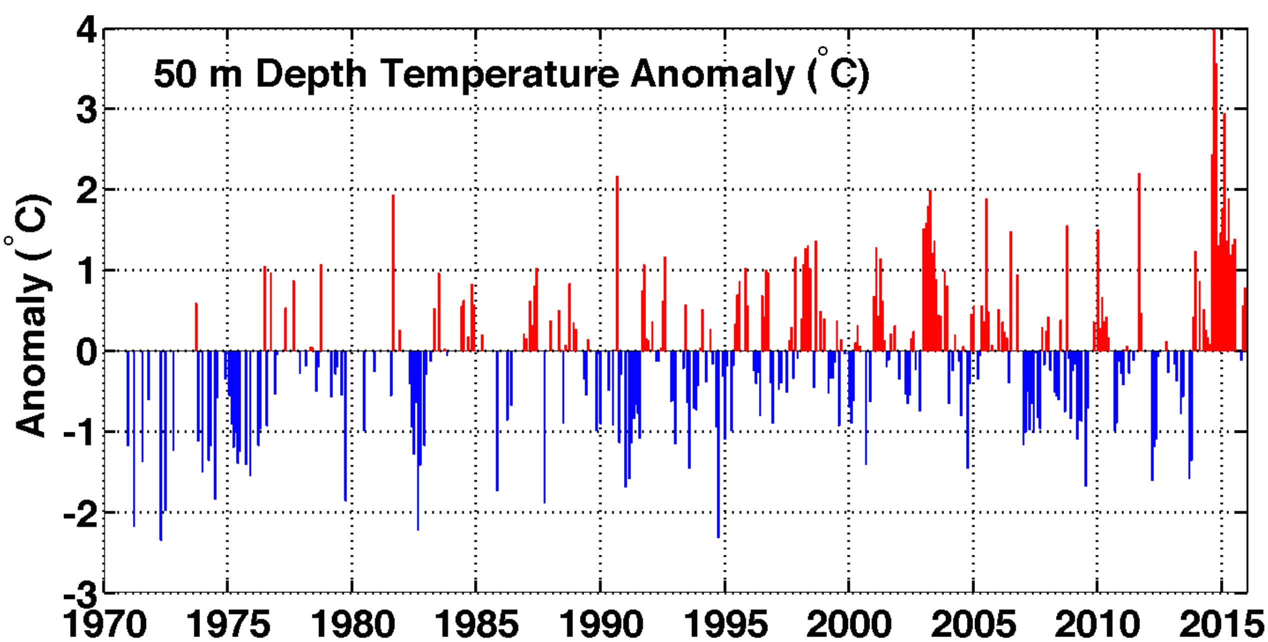

Figure 1. Temperature anomalies from the GAK-1 dataset at 50 m depth exhibit a long-term trend in warming along with signals associated with the cycles of El Nino and other phenomena.

2. Relevance to the Invitation for Proposals

The purpose of this proposal is to provide long-term monitoring data on the physical oceanography of ACC and the northern GOA shelf. The ACC is the most prominent feature of the GOA shelf circulation. It is a narrow (~40 km), swift, year-round flow maintained by the integrated forcing of winds and coastal freshwater discharge. That forcing is variable and reflected in ACC properties. The current originates on the British Columbian shelf and leaves the GOA for the Bering Sea through Unimak Pass. Substantial portions of the ACC circulate through PWS and feed lower Cook Inlet and Kachemak Bay before flowing southwestward through Shelikof Strait; another significant fraction bypasses Shelikof Strait to flow along the southeastern coast of Kodiak Island. The current controls water exchange and transmits its properties into the fjords and bays between PWS and the Alaska Peninsula. The monitoring proposed herein quantifies variability of the GOA's shelf environment. ACC monitoring provides the broader-scale context for understanding variability in adjacent marine ecosystems and its effect on particular species (e.g., herring, salmon, forage fish). The ACC's variability is transmitted to nearshore habitats around the GOA.

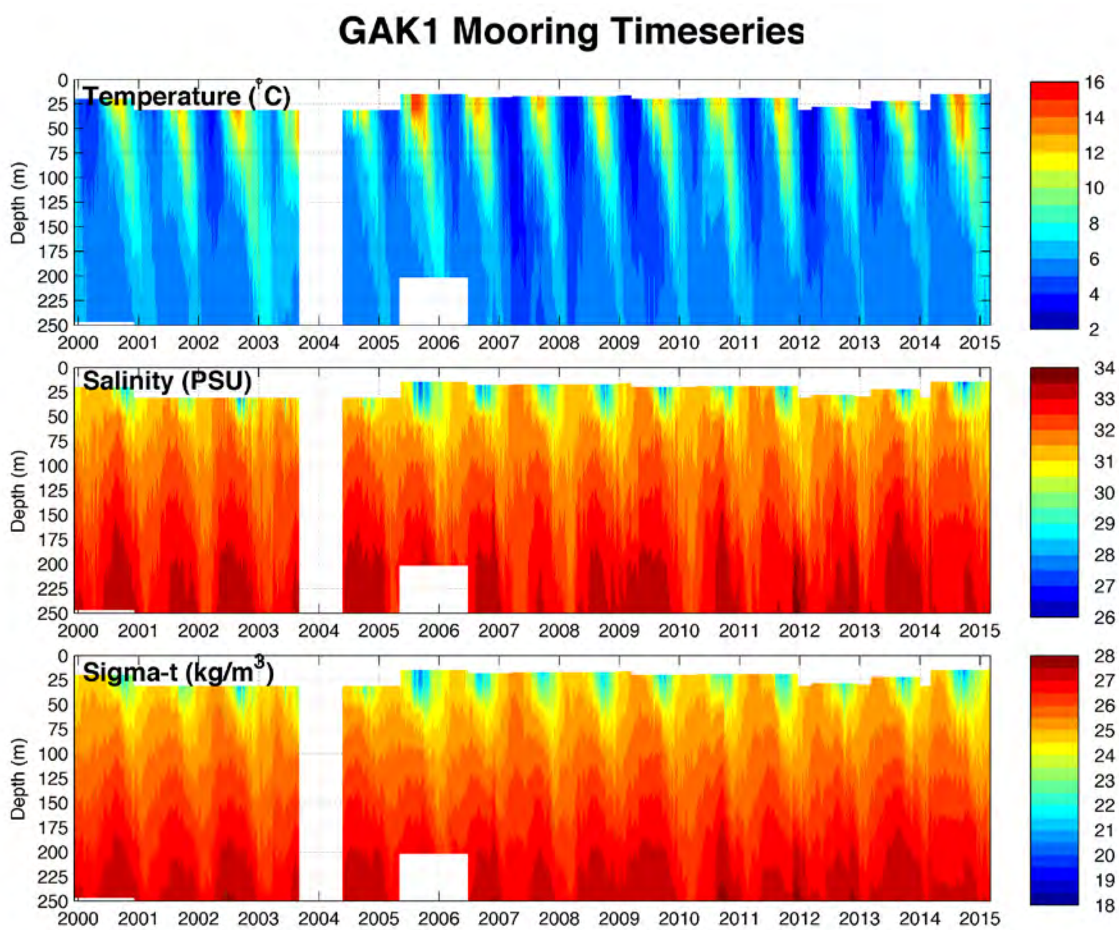

Figure 2. Time-series over 2000 to 2015 of temperature, salinity, and density (sigma-t) from the GAK-1 mooring.

Table 1. Relation between the along-shelf baroclinic transport and GAK-1 measurements of salinity and dynamic height integrated from the surface to 200 m depth (dynamic height is derived from the CTD temperature, salinity and pressure data). From left to right, the columns show the observed parameters, months that the regression holds for, fraction of variance explained by the regression, regression slope, and the 95% confidence bound on the slope. Reproduced from Weingartner et al. (2005).

GAK-1 Parameter	Months	r^2	Slope	CI
30 m Salinity	Nov-May	0.47	0.69	-0.28
50 m Salinity	Jun-Aug	0.72	0.85	-0.43
200 m Dynamic Height	Jun-Aug	0.86	0.93	-0.3

Measurements (Figures 1 and 2) at GAK-1, at the mouth of Resurrection Bay, began in 1970. Initially the sampling was opportunistic, became more regular in the 1980s and 1990s, and fully systematic beginning in 1997 with National Science Foundation Global Ocean Ecosystem Dynamics (GLOBEC) program support of Seward Line sampling that occupied station GAK-1 with multidisciplinary sampling up to 7 times per year from 1997 to 2004 and *Exxon Valdez* Oil Spill Trustee Council (EVOSTC) support of moorings and monthly CTDs. Since then it involves monthly CTD casts and from 2000 hourly temperature and salinity measurements at 6-7 depths distributed over the water column from the GAK-1 subsurface mooring (Figure 2). GAK-1 is the only station over the GOA shelf that measures both salinity and temperature over the 250 m deep water column. As shown in Table 1, the GAK-1 measurements also provide a proxy for the along-shelf transport of the ACC. With this metric we are able to assess fluctuations in the advection of passively drifting organisms, fresh water and heat in the coastal zone (Weingartner et al. 2005).

3. Project Personnel

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Please see 2 page CVs at end of this document

4. Project Design

A. OBJECTIVES

The fundamental goal of this program is to provide high quality, long-term data to quantify and understand variations that occur over short (hours to days) to long (inter-annual to multi-decadal) period variability of the GOA shelf. This measurement provides the broader temporal and spatial perspective important to our ecosystem-level understanding and management of the northern GOA. Specifically, we will measure:

1. Temperature and salinity throughout the water column,
2. Near-surface pressure fluctuations,
3. Water column stratification since this affects phytoplankton bloom dynamics
4. Fluorescence at 20 m depth as a measure of phytoplankton standing crop.

B. PROCEDURAL AND SCIENTIFIC METHODS

Following past protocols, we propose nominally monthly CTD measurements and year-long, continuous measurements from a subsurface mooring with temperature and conductivity (T/C) recorders placed at depths of 20, 30, 60, 100, 150, 200, and 250 m. A fluorometer (Wetlabs, Inc.) is included at 20 m, to determine timing and duration of the spring, summer, and fall blooms. The fluorometer emits an illuminated beam of light (at 470 nm) that stimulates chlorophyll in the beam path. The absorbed light excites the chlorophyll molecules, which emit light (fluoresce) at a 695 nm. The emitted light is detected by the fluorometer and the intensity of the fluorescence is proportional to chlorophyll biomass. Note that fluorescence is only a relative measure of chlorophyll concentration and the signal has dependencies on temperature, phytoplankton species composition, and health of the algae cells.

The moored instruments and monthly CTD sampling schemes are complementary; the CTD provides high vertical resolution at monthly time scales and the mooring provides high temporal resolution, but at coarser vertical spacing. The monthly CTDs provide redundancy in the event an instrument fails on the mooring. The GAK-1 monthly temperature and salinity are statistically significant predictors of monthly anomalies of the alongshelf baroclinic transport in the ACC (Table 1) so ACC transport anomalies are monitored indirectly from the GAK-1 data (Weingartner et al. 2005).

The moored T/C recorders are Microcats (at depths greater than 20 m) and a SeaCat (at 20 m depth, to incorporate the fluorometer). Both are manufactured by Seabird, Inc. Seabird performs pre- and post-deployment calibrations upon which we determine sensor drift (typically ~0.01°C yr-1 and ~0.03, or better, Practical Salinity Unit yr-1). The monthly CTD casts are collected from a chartered fishing vessel resident in Seward using a portable CTD (Seabird SBE-25) or the UAF Seward Marine Center vessel the R/V Little Dipper. The SBE 25 has an accuracy ~0.01 or better for salinity and .005 °C for temperature. The mooring is recovered and re-deployed annually. Bio-fouling gradually degrades the signal quality of the fluorometer so we strive to deploy the mooring in March or early April (depending upon weather) in order to minimize fouling potential prior to the spring bloom in April or May. Temperature and salinity data are sampled at 15-minute intervals except at 20 m depth where power supply considerations for the fluorometer dictate hourly sampling.

ALTERNATIVE METHODOLOGIES

Autonomous underwater vehicles (AUVs) could provide higher vertical resolution than the mooring sensors and higher temporal resolution than the ship-based CTDs. AUVs have the ability to move along tracklines (e.g., along the Seward Line) or remain near one point and conduct repeat vertical profiles. They can operate for 3-4 months on a single battery charge and have the ability to fly themselves from and then back to the dock in Seward at the start and end of a mission, respectively. AUVs can also incorporate additional biological and geochemical measurement parameters. However, the AUV spin-up equipment cost (~$200k) is significant and additional technician time is needed to run the AUV. We determined that the proposed ship and mooring-based sampling methods still represent the most cost-effective balance for temporal and spatial resolution in the data collection.

C. DATA ANALYSIS AND STATISTICAL METHODS

The temperature and salinity data analyses are straightforward. We will compute standard statistical estimates for each month and depth and compare these with historical data since the thrust of this effort is to quantify seasonal to interannual and longer variability. We continue to incorporate an integrated discharge time-series and air-sea heat fluxes derived from National Center for Environmental Prediction (NCEP) in our analyses of salinity and temperature variability, however the National Weather Service has changed their reporting divisions for temperature and precipitation and we will need to generate a new set of regressive relations in order to make new updates. Heat flux calculations that show winter heat losses (from the ocean to the atmosphere) are more variable both interannually and at longer periods than summer heat gains. For example, winter heat loss has decreased by nearly 20% since the mid-1970s and this change was reflected in the warming at GAK-1 through 2005. Since that time winter heat loss has increased substantially and returned to values that occurred in the early 1970s. Winter heat loss, in conjunction, with runoff, affects the ocean temperature distribution through spring when many young larvae are emerging to feed (Janout et al. 2010). On the other hand, summer heat gains appear to be relatively consistent from year to year because this is primarily a function of cloud cover. Royer et al. (2006) contend that summer surface temperatures over the shelf and in PWS are primarily a function of the stratification. They suggest that stronger stratification traps heat in the surface layer and elevates surface temperatures, whereas weaker stratification allows the heat to mix to greater depths. Within the ACC, stratification is primarily a function of the vertical salinity gradients that we are measuring at GAK-1.

We will also quantify spring and summer phytoplankton blooms in relation to changes in stratification, runoff, and winds. Stratification estimates will be made from the 3 uppermost instruments and the monthly CTD surveys. The fluorescence data will provide an estimate of the number of blooms and bloom duration observed in spring and summer. This approach is necessarily subjective since a bloom event is defined with reference to a base line, which may drift over time because of bio-fouling, and because phytoplankton species composition affects fluorometer signals. However, when present, biofouling develops after the spring bloom, so our qualitative descriptions are primarily valuable in describing year-to-year variability of the spring bloom. GLOBEC measurements, as well as those by Eslinger et al. (2001) from PWS, indicate that the timing of the spring bloom varies considerably from year-to-year perhaps by as much as several weeks or more. Weingartner et al. (2003) show that the onset of the spring bloom on the GOA shelf is tied to the quantity and phasing of winter and early spring runoff because freshwater is the principal stratifying agent in the ACC in both seasons. For example, the spring bloom in the ACC was delayed until May in 2007 and 2008 because of the weak stratification; in contrast it occurred between early to mid-April during the GLOBEC years when winters were wetter and warmer, and stratification stronger and earlier.

CTD data represents the fundamental physical hydrographic measurements and data are fully comparable to all other high-quality CTD profile and time-series data from around the globe, including profile data from the ARGOS program in the deep North Pacific. The chosen SeaBird Electronics instruments represent this manufacturer's industry-leading CTD sensors that are well known for their accuracy, stability, and low sensor drift. With a sample rate of one month for the CTD profiles we well capture seasonal-scale hydrographic anomalies and with the 15-minute MicroCat sampling we resolve the fluctuations associated with storms, tides and other high frequency motions.

D. Description of Study Area

The fieldwork will be conducted at oceanographic station GAK-1 at the mouth of Resurrection Bay. GAK-1 is located at 59° 51'N, 149° 28'W, and is located on the inner edge of the ACC midway between PWS and Cook Inlet in approximately 265 m water depth.

5. Coordination and Collaboration

Data availability

GAK-1 data provides high-resolution long-term contextual environmental data for the Gulf Watch Alaska scientific team, other researchers and agency personnel and the public at large. Data are available online at the GAK-1 website home page (http://www.ims.uaf.edu/gak1/) and through the Alaska Ocean Observing System (AOOS) Gulf of Alaska Data Portal served by Axiom. After processing, the data are posted to the GAK-1 website, submitted to the Gulf Watch Alaska data management team for archiving, and published to the AOOS-Axiom Gulf of Alaska Data Portal.

Coordination with other EVOSTC and Non-EVOSTC research

The Gulf Watch Alaska framework for integration with other principal investigators and components of the environmental drivers monitoring, and Herring Research and Monitoring and Lingering Oil programs were outlined separately in the project management proposals. In addition, we note that the GAK-1 effort has assisted many others with their research over the years both within EVOSTC funded projects and external projects. For example, in 2001-02 it provided a test bed for prototype halibut tags (developed by USGS-BRD scientists), which were then used to study halibut migrations in the GOA and the Bering Sea. The data were used by herring biologists to assess energetic costs of overwintering herring (Heintz, pers. comm), and it has been used studies of king crab (Bechtol, 2009), spiny dogfish Tribuzio (2009), the community structure of rocky coasts (Ingolfsson, 2005), rock sole (Fedewa et al., 2015) and salmon (Boldt and Haldorson, 2002). We have had requests from Steve Moffitt (Alaska Department of Fish and Game salmon biologist) to use this data as an aid in salmon forecasts (see Eggers et al., 2013; Munro and Tide, 2014) and we are aware of several GOA fishermen who routinely access this data set. The GAK-1 data are also used by the AOOS-supported ocean acidification (OA) monitoring study on the surface buoy nearby to GAK-1, which is known as mooring GAK-OA (Evans et al., 2013). Many other similar examples can be found in the publication list at the GAK-1 website (http://www.ims.uaf.edu/gak1/).

We have assisted the National Park Service (NPS) in establishing a similar monthly sampling and data processing protocol in Glacier Bay National Park and Preserve through the Inventory and Monitoring program (http://science.nature.nps.gov/im/units/sean/default.aspx), which also serves their data online. The sampling in Glacier Bay therefore provides a complementary data set that is made upstream in terms of the general circulation characteristics of the GOA shelf. Collectively, the Glacier Bay, PWS, Cook

Inlet, and GAK-1 data sets provide a broad-scale perspective of the GOA shelf environment. We are collaborating at no cost to this proposal with NPS scientists using CTD sampling and analysis protocols identical to those at GAK-1. Since southeast Alaska waters contribute to the ACC, the 24-year Glacier Bay time-series provides the opportunity to assess variability in the northeast and northwest GOA and to understand how these regions co-vary and how the ACC evolves as if flows westward toward PWS.

6. Schedule

Project Milestones

- **Task 1**
  Collect monthly CTD profiles; process profile data and upload to the GAK-1 and AOOS websites.
- **Task 2**
  Annually deploy and recover GAK1 mooring; process mooring data and upload to the GAK-1 and AOOS websites.
- **Task 3**
  Determine seasonal changes in the water column stratification since this affects phytoplankton bloom dynamics. Updated annually in accordance with the processing of the mooring data.

Measurable Project Tasks

Measureable project tasks are presented by fiscal year and quarterly graphically in Table 2 and descriptively below.

Table 2. Schedule of Measurable Program Tasks

Task	FY17				FY18				FY19				FY20				FY21			
	Quarter (EVOSTC FY beginning Feb. 1)																			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Data collection & processing																				
Monthly CTD Cruises	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
CTD Data Processing	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
CTD Data Upload to Web	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Mooring Turnaround	X				X				X				X				X			
Moored Data Processing				X				X				X				X				X
Mooring Data Upload to Web				X				X				X				X				X
Reporting																				
Annual Reports	X				X				X				X				X			
Annual PI meeting				X				X				X				X				X
FY Work Plan (DPD)			X				X				X				X					

FY 2017 (Year 6)

FY17, 1st quarter (February 1, 2017 - April 30, 2017)
February: Project funding approved by EVOSTC
February, March, and April monthly CTD profile cruise
March mooring recovery and redeployment cruise
Process prior quarter's CTD profile data and update webpage

FY17, 2nd quarter (May 1, 2017 - July 31, 2017)
Ship recovered mooring instrumentation to SeaBird, Inc. for post-deployment calibrations
June and July monthly CTD profile cruise (May survey on Seward Line cruise)
Process prior quarter's CTD profile data and update webpage

FY17, 3rd quarter (August 1, 2017 - October 31, 2017)
August and October monthly CTD profile cruise (September profile on Seward Line cruise)
Process prior quarter's CTD profile data and update webpage

FY17, 4th quarter (November 1, 2017 - January 31, 2018)
Update webpage with prior year's mooring data
November, December and January monthly CTD profile cruise
Process prior quarter's CTD profile data and update webpage
Process prior year's recovered mooring data when all instruments are returned from calibration facility
Begin annual analysis and report writing

FY 2018 (Year 7)

FY18, 1st quarter (February 1, 2018 - April 30, 2018)
February, March, and April monthly CTD profile cruise
March mooring recovery and redeployment cruise
Process prior quarter's CTD profile data and update webpage

FY18, 2nd quarter (May 1, 2018 - July 31, 2018)
Ship recovered mooring instrumentation to SeaBird, Inc. for post-deployment calibrations
June and July monthly CTD profile cruise (May survey on Seward Line cruise)
Process prior quarter's CTD profile data and update webpage

FY18, 3rd quarter (August 1, 2018 - October 31, 2018)
August and October monthly CTD profile cruise (September profile on Seward Line cruise)
Process prior quarter's CTD profile data and update webpage

FY18, 4th quarter (November 1, 2018 - January 31, 2019)
Update webpage with prior year's mooring data
November, December and January monthly CTD profile cruise
Process prior quarter's CTD profile data and update webpage
Process prior year's recovered mooring data when all instruments are returned from calibration facility
Begin annual analysis and report writing

FY 2019 (Year 8)

FY19, 1st quarter (February 1, 2019 - April 30, 2019)
February, March, and April monthly CTD profile cruise
March mooring recovery and redeployment cruise
Process prior quarter's CTD profile data and update webpage

FY19, 2nd quarter (May 1, 2019 - July 31, 2019)
Ship recovered mooring instrumentation to SeaBird, Inc. for post-deployment calibrations
June and July monthly CTD profile cruise (May survey on Seward Line cruise)
Process prior quarter's CTD profile data and update webpage

FY19, 3rd quarter (August 1, 2019 - October 31, 2019)
August and October monthly CTD profile cruise (September profile on Seward Line cruise)
Process prior quarter's CTD profile data and update webpage

FY19, 4th quarter (November 1, 2019 - January 31, 2020)
Update webpage with prior year's mooring data
November, December and January monthly CTD profile cruise
Process prior quarter's CTD profile data and update webpage
Process prior year's recovered mooring data when all instruments are returned from calibration facility
Begin annual analysis and report writing

FY 2020 (Year 9)

FY20, 1st quarter (February 1, 2020 - April 30, 2020)
February, March, and April monthly CTD profile cruise
March mooring recovery and redeployment cruise
Process prior quarter's CTD profile data and update webpage

FY20, 2nd quarter (May 1, 2020 - July 31, 2020)
Ship recovered mooring instrumentation to SeaBird, Inc. for post-deployment calibrations
June and July monthly CTD profile cruise (May survey on Seward Line cruise)
Process prior quarter's CTD profile data and update webpage

FY20, 3rd quarter (August 1, 2020 - October 31, 2020)
August and October monthly CTD profile cruise (September profile on Seward Line cruise)
Process prior quarter's CTD profile data and update webpage

FY20, 4th quarter (November 1, 2020 - January 31, 2021)
Update webpage with prior year's mooring data
November, December and January monthly CTD profile cruise
Process prior quarter's CTD profile data and update webpage
Process prior year's recovered mooring data when all instruments are returned from calibration facility
Begin annual analysis and report writing

FY 2021 (Year 10)

FY21, 1st quarter (February 1, 2021 - April 30, 2021)
February, March, and April monthly CTD profile cruise
March mooring recovery and redeployment cruise

Process prior quarter's CTD profile data and update webpage

FY21, 2nd quarter (May 1, 2021 - July 31, 2021)

Ship recovered mooring instrumentation to SeaBird, Inc. for post-deployment calibrations
June and July monthly CTD profile cruise (May survey on Seward Line cruise)
Process prior quarter's CTD profile data and update webpage

FY21, 3rd quarter (August 1, 2021 - October 31, 2021)

August and October monthly CTD profile cruise (September profile on Seward Line cruise)
Process prior quarter's CTD profile data and update webpage

FY21, 4th quarter (November 1, 2021 - January 31, 2022)

Update webpage with prior year's mooring data
November, December and January monthly CTD profile cruise
Process prior quarter's CTD profile data and update webpage
Process prior year's recovered mooring data when all instruments are returned from calibration facility
Begin annual analysis and report writing

7. Budget

BUDGET FORMS (ATTACHED)

Completed budget forms are attached.

SOURCES OF ADDITIONAL FUNDING

None.

LITERATURE CITED

Anderson, P. J., and J. F. Piatt. 1999. Community reorganization in the Gulf of Alaska following ocean climate regime shift.pdf. Marine Ecology Progress Series 189:117–123.

Bechtol, W.R. 2009. Abundance, recruitment, and environmental forcing of Kodiak red king crab. University of Alaska Fairbanks, Doctoral dissertation, 205 p

Boldt, J. L. and L. J. Haldorson. 2002. A Bioenergetics Approach to Estimating Consumption of Zooplankton by Juvenile Pink Salmon in Prince William Sound, Alaska, Alaska Fishery Research Bulletin, V9 No. 2, Winter 2002

Childers, A. R., T. E. Whitledge, and D. A. Stockwell. 2005. Seasonal and interannual variability in the distirubtion of nutrients and chlorophyll a across the Gulf of Alaska shelf: 1998 – 2000. Deep Se Res., Pt. II 52(1-2):193-216.

Eggers, D. M., C. Tide, and A. M. Carroll, editors. 2013. Run forecasts and harvest projections for 2013 Alaska salmon fisheries and review of the 2012 season. Alaska Department of Fish and Game, Special Publication No. 13-03, Anchorage.

Eslinger DL, Cooney RT, McRoy CP, Ward A, Kline T, et al. 2001. Plankton dynamics: observed and modeled responses to physical conditions in Prince William Sound, Alaska. Fish. Oceanogr. 10(Suppl. 1):81-96.

Evans, W., J. T. Mathis, P. Winsor, H. Statscewich, and T. E. Whitledge. 2013. A regression modeling approach for studying carbonate system variability in the northern Gulf of Alaska, J. Geophys. Res. Oceans 118:476–489, doi:10.1029/2012JC008246.

Fedewa, E.J., J. A. Miller and T.P. Hurst. 2015. Pre-settlement processes of northern rock sole (*Lepidopsetta polyxystra*) in relation to interannual variability in the Gulf of Alaska., J. Sea Res., http://dx.doi.org/10.1016/j.seares.2015.11.008

Hallmann, N., Schöne, B.R., Irvine, G.V., Burchell, M., Cockelet, E.D., Hilton, M.R. 2011. An improved understanding of the Alaska coastal current: the application of a bivalve growth temperature model to reconstruct freshwater-influenced paleoenvironments. Palaios 26, 346e363

Ingolfsson, A. 2005. Community structure and zonation patterns of rocky shores at high latitudes: an interocean comparison, Journal of Biogeography, 32(1):169-182, doi:10.1111/j.1365-2699.2004.01150.x

Janout, M. A., T. Weingartner, P. Stabeno. 2013. Air-sea and oceanic heat flux contributions to the heat budget of the northern Gulf of Alaska shelf. 2013. J. Geophys. Res., 118, doi:10.1002/jgrc.20095.

Janout, M.A, T. J. Weingartner, T. Royer, and S. Danielson. 2010. On the nature of winter cooling and the recent temperature shift on the northern Gulf of Alaska shelf, J. Geophys. Res., 115, C05023, doi:10.1029/2009JC005774.

Kelley, J. 2015. An Examination of Hydrography and Sea Level in the Gulf of Alaska. M.S. Thesis, University of Alaska Fairbanks.

Mueter, F.J., B.L. Norcross and T.C. Royer. 1994. Do cyclic temperatures cause cyclic fisheries? Can. Spec. Publ. Fish. Aquat. Sci. 121:119-129.

Mueter, F.J. 2004. Gulf of Alaska. In: Marine Ecosystems of the North Pacific. PICES Special Publication 1, pp.153-175.

Munro, A. R., and C. Tide, editors. 2014. Run forecasts and harvest projections for 2014 Alaska salmon fisheries and review of the 2013 season. Alaska Department of Fish and Game, Special Publication No. 14-10, Anchorage.

Royer, T.C. 2005. Hydrographic responses at a coastal site in the northern Gulf of Alaska to seasonal and interannual forcing, Deep-Sea Research Part II-Topical Studies in Oceanography 52(1-2):267-288.

Royer, T. C. and C. E. Grosch. 2006. Ocean warming and freshening in the northern Gulf of Alaska, Geophysical Research Letters, 33 (16), L16605,doi:10.1029/2006GL026767

Sarkar, N, T. C. Royer and C. E. Grosch. 2005. Hydrographic and mixed layer depth variability on the shelf in the northern Gulf of Alaska, 1974-1998. Cont. Shelf. Res. 25:2147-2162.

Spies, R. B., editor. 2007. Long-Term Ecological Change in the Northern Gulf of Alaska, Elsevier B.V., Amsterdam, 589 pp.

Tribuzio, C.A. 2009. Life history, demography and ecology of the spiny dogfish (*Squalus acanthias*) in the Gulf of Alaska: Critical information for aiding management, Doctoral dissertation, University of Alaska Fairbanks

Weingartner, T.J. 2007. The Physical Environment of the Gulf of Alaska (Section 2.2, p 12 – 47), IN: Long Term Ecological Change in the Northern Gulf of Alaska, edited by R. B. Spies, Elsevier B.V., Amsterdam, 589 p.

Weingartner, T.J., S. Danielson, and T. C. Royer. 2005. Freshwater Variability and Predictability in the Alaska Coastal Current Deep-Sea Res., 52:169-192.

Weingartner, T.J., K. Coyle, B. Finney, R. Hopcroft, T. Whitledge, R. Brodeur, M. Dagg, E. Farley, D. Haidvogel, L. Haldorson, A. Hermann, S. Hinckley, J. Napp, P. Stabeno, T. Kline C. Lee, E. Lessard, T. Royer, S. Strom. 2002. The Northeast Pacific GLOBEC Program: Coastal Gulf of Alaska, Oceanogr. 15:48-63

Wu, J., A. Aguilar-Islas, R. Rember, T. Weingartner, S. L. Danielson, and T. Whitledge. 2009. Size-fractionated iron distribution on the northern Gulf of Alaska, Geophys. Res. Lett., 36, L11606, doi:10.1029/2009GL038304.

PROJECT DATA ONLINE

Publicly available data from this project are available online at the following internet links:

UAF GAK-1 HOMEPAGE
http://www.ims.uaf.edu/gak1/data/

AOOS GULF WATCH ALASKA DATA PORTAL
http://portal.aoos.org/gulf-of-alaska.php#metadata/3c4ecb88-6436-4312-8281-ed584e020b0e/project/files

Project Personnel Curriculum Vitae

Seth Lombard Danielson

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Professional Preparation

University of Alaska Fairbanks, Ph.D. Oceanography, 2012
University of Alaska Fairbanks; M.S. Oceanography, 1996
Lehigh University; B.S. Electrical Engineering, 1990, with honors

Appointments

Research Assistant Professor of Oceanography, IMS-UAF, Fairbanks, AK, 2013-present
Research Professional, IMS-UAF, UAF, Fairbanks, AK, 1997–2013
Driller, Polar Ice Coring Office, IMS-UAF, Fairbanks AK, 1993-1994 and UNL, Lincoln, NB, 1996-1997
Research Assistant, Institute of Marine Science, UAF, Fairbanks, AK, 1994-1996
Junior Engineer, Allen Organ Company, Macungie, PA, 1990-1992

Memberships

American Geophysical Union
The Oceanography Society

5 Publications Related to GAK-1

Stabeno, P. J. S. Bell, W. Cheng, **S. L. Danielson**, N. B. Kachel, C. W. Mordy (in press) Long-term observations of Alaska Coastal Current in the northern Gulf of Alaska, *Deep-Sea Res. II*

Janout, M. A., T. J. Weingartner, T. C. Royer, **S. L. Danielson** (2010), On the nature of winter cooling and the recent temperature shift on the northern Gulf of Alaska shelf, JGR Oceans, 2009JC005774R, DOI: 10.1029/2009JC005774

Wu, J., A. Aguilar-Islas, R. Rember, T. Weingartner, **S. L. Danielson**, and T. Whitledge (2009), Size-fractionated iron distribution on the northern Gulf of Alaska, *Geophys. Res. Lett.*, 36, L11606, doi:10.1029/2009GL038304.

Weingartner, T. J., L. Eisner, G. L. Eckert, **S. L. Danielson** (2008), Southeast Alaska: oceanographic habitats and linkages (p 387-400), *J. of Biogeography*, DOI: 10.1111/j.1365-2699.2008.01994.x.

Weingartner, T. J., **S. L. Danielson**, T.C. Royer (2005), Fresh Water Variability in the Gulf of Alaska: Seasonal, Interannual and Decadal Variability, Deep-Sea Res. II, 52 (1-2): 169-191

5 Selected Peer-Reviewed Publications

Danielson. S. L., L. Eisner, C. Ladd, C. Mordy, L. de Sousa, and T. J. Weingartner (in press) A comparison between late summer 2012 and 2013 water masses, macronutrients, and phytoplankton standing crops in the northern Bering and Chukchi Seas, Arctic Eis DSR-II Special Issue

Danielson, S. L., T. W. Weingartner, K. Hedstrom, K. Aagaard, R. Woodgate, E. Curchitser, and P. Stabeno, (2014), Coupled wind-forced controls of the Bering–Chukchi shelf circulation and the Bering Strait through- flow: Ekman transport, continental shelf waves, and variations of the Pacific–Arctic sea surface height gradient. Prog. Oceanogr. http://dx.doi.org/ 10.1016/j.pocean.2014.04.006

Grebmeier, J. M., B. A. Bluhm, L. W. Cooper, **S. L. Danielson**, K. R. Arrigo, A. L. Blanchard, J. T. Clarke, R. H. Day, K. E. Frey, R. R. Gradinger, M. Kedra, B. Konar, K. J. Kuletz, S. H. Lee, J. R. Lovvorn, B. L. Norcross, S. R. Okkonen. (2015) Ecosystem Characteristics and Processes Facilitating Persistent Macrobenthic Biomass Hotspots and Associated Benthivory in the Pacific Arctic, *Prog. Oceanogr.*,

V136, August 2015, pp. 92-114, doi:10.1016/j.pocean.2015.05.006

Danielson, S. L., K. Hedstrom, K. Aagaard, T. Weingartner, and E. Curchitser (2012), Wind-induced reorganization of the Bering shelf circulation, *Geophys. Res. Lett.*, 39, L08601, doi:10.1029/2012GL051231.

Danielson, S. L., E. N. Curchitser, K. Hedstrom, T. J. Weingartner, and P. Stabeno (2011) On ocean and sea ice modes of variability in the Bering Sea, *J. Geophys. Res.*, doi:10.1029/2011JC007389

RELATED ACTIVITIES

1997-2004: Global Ocean Ecosystem Dynamics (GLOBEC) program in the Gulf of Alaska (NSF)
2008-2014: Bering Sea Ecosystem Study (BEST) moorings and larval transport modeling (NSF)
2008-2014: Chukchi Sea Environmental Studies Program (CSESP, Shell/Conoco Phillips/Statoil)
2009-present: PI, Advisor and analyst for Glacier Bay National Park and Preserve oceanographic monitoring and associated process studies (NPS)
2012-2015: co-PI, Arctic Ecosystem Integrated Survey (Arctic Eis, BOEM)
2013-present: PI, Cook Inlet Model Computations (BOEM)
2014-present: PI, Ecosystem monitoring and detection of wind and ice-mediated changes through a year-round physical and biogeochemical mooring in the Northeast Chukchi Sea (NPRB, AOOS, Olgoonik-Fairweather, UAF)
2014-present: co-PI Measuring the pulse of the Gulf of Alaska: Oceanographic observations along the Seward Line (NPRB)
2015-present: co-PI, Arctic Marine Biodiversity Observing Network (AMBON; NOPP)

THESIS TITLES

Variability in the circulation, temperature, and salinity fields of the eastern Bering Sea shelf in response to atmospheric forcing, 2012 Ph.D. Thesis
Chukchi Sea Tidal Currents: Model and Observations, 1996 Masters Thesis.

COLLABORATORS (OUTSIDE OF UAF AND OVER LAST 48 MONTHS)

Aagaard, Knut, UW; Bluhm, Bodil, AUN; Bond, Nick, NOAA; Carmack, Eddy DFO-IOS Canada; Cross, Jessica, JISAO; Curchitser, Enrique, Rutgers; Day, Robert, ABR, Inc.; De Robertis, Alex, NOAA; Drinkwater, Kenneth, IMR; Eisner, Lisa, NOAA; Evans, Wiley, NOAA; Frey, Karen, Clark U; Gradinger, Rolf, AUN; Heintz, Ron, NOAA; Hunt, George, UW; Jakobsson, Martin, Stockholm U; Kuletz, Kathy, USFWS; Ladd, Carol, NOAA; Lauth, Robert, NOAA; Logerwell, Elizabeth, NOAA; Lovvorn, James, SIU; Martini, Kim, NOAA; Mathis, Jeremy, NOAA/UAF; Mordy, Calvin, NOAA; Overland, James, NOAA; Pickart, Robert, WHOI; Sigler, Michael, NOAA; Sousa, Leandra, NSB; Stabeno, Phyllis, NOAA; Whitehouse, Andrew, NOAA; Williams, William, DFO-IOS Canada; Wood, Kevin, NOAA; Woodgate, Rebecca, UW; Zarayskaya, Yulia, GI RAS

THOMAS J. WEINGARTNER

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EDUCATION

Ph.D. Physical Oceanography, 1990, North Carolina State University
M.S. Physical Oceanography, 1980, University of Alaska
B.S. Biology, 1974, Cornell University

SYNERGISTIC ACTIVITIES

National

Workshop Organizer, Physical Oceanography Studies Needs for the Alaskan Beaufort Sea (sponsored by MMS, 2004)
Past Member, GLOBEC Northeast Pacific Executive Committee, 2000 - 2003
Past Member, Science Steering Committee, NSF - Arctic System Science-Ocean Atmosphere Ice Interaction (OAII) Shelf-Basin Interaction Project (2/98 - 2/03).
Past Member, Science Steering Committee, NSF - ARCSS-OAII Shelf-Basin Interactions (1995 -2002)
Past Member, UNOLS Fleet Improvement Committee (1994 – 1998)
Member, Science Advisory Committee, Synthesis Of Arctic Research, BOEM-NOAA (2012-2015)
Member, National Research Council Committee on "The Arctic in the Anthropocene: Emerging Research Questions" (2013 - 2014)

State of Alaska

Member, Science Advisory Council, Alaska Sea Life Center,
Member, Science Advisory Committee, Shell-North Slope Borough Baseline Studies Program, Barrow, Alaska (2011-2015).

University of Alaska

Chair IMS Ship Committee (1994 – present)
Chair (Academic Coordinator), Graduate Program in Marine Science and Limnology, SFOS (2005-07)
Chair, Unit (Oceanography) Promotion and Tenure Committee (2010, 2012)
Member, Unit (Oceanography) Promotion and Tenure Committee

AWARDS

Emil Usibelli Distinguished Research Award at University of Alaska, Fairbanks
2014 Alaska Marine Research Award

PROFESSIONAL EXPERIENCE

Professor; Institute of Marine Science, School of Fisheries and Ocean Sciences, U. of Alaska Fairbanks, Alaska; 6/07 – present
Associate Professor; Institute of Marine Science, School of Fisheries and Ocean Sciences, U. of Alaska Fairbanks, Alaska; 6/99 – 6/07
Assistant Professor; Institute of Marine Science, School of Fisheries and Ocean Sciences, U. of Alaska Fairbanks, Alaska; 11/93 - 1999
Research Associate; Institute of Marine Science, School of Fisheries and Ocean Sciences, U. of Alaska Fairbanks, Alaska; 9/91 - 10/93
Postdoctoral Student; Institute of Marine Science, School of Fisheries and Ocean Sciences, U. of Alaska Fairbanks, Alaska; 7/88 - 8/91

Graduate Research Assistant; Department of Marine, Earth and Atmospheric Sciences, North Carolina State U.; Raleigh, North Carolina; and Department of Marine Science, U. of South Florida; St. Petersburg, Florida; 8/84 - 10/88

ADDITIONAL APPOINTMENTS

Affiliate Senior Oceanographer, Applied Physics Laboratory, University of Washington, (2000 – 2014)
Affiliate Professor, College Natural Science and Mathematics, University of Alaska Fairbanks

REFEREED PUBLICATIONS (PUBLISHED, IN PRESS OR SUBMITTED)

1) Kasper, J. and T. Weingartner. 2015. The spreading of a buoyant plume beneath a landfast ice cover. *Journal of Physical Oceanography* 45: 478 – 494.
2) Lu, K., T. Weingartner, S. Danielson, P. Winsor, E. Dobbins, K. Martini, and H. Statscewich, 2015. Lateral mixing across ice meltwater fronts of the Chukchi Sea shelf. *Geophys. Res. Lett.*, 42, 6754–6761, doi:10.1002/2015GL064967.
3) Fang, Y-C., T. J. Weingartner, R. A. Potter, H. Statscewich, P. R. Winsor. Quality Assessment of HF Radar Derived Surface Currents Using Optimal Interpolation. 2015. *Journal of Atmospheric and Oceanic Technology,* 32:282-296. doi: 10.1175/JTECH-D-14-00109.1
4) Day, R. H., T. J. Weingartner, R. R. Hopcroft, L. A. M. Aerts, A. L. Blanchard, *A. E. Gall, B. J. Gallaway, D. E. Hannay, B. A. Holladay, J. T. Mathis, B. L. Norcross, and S. S. Wisdom. 2013. The offshore northeastern Chukchi Sea: a complex high-latitude system. *Continental Shelf Research*. http://dx.doi.org/10.1016/j.csr.2013.02.002.
5) Weingartner, T., E. Dobbins, S. Danielson, R. Potter, H. Statscewich, and P. Winsor. 2013 Hydrographic variability over the northeastern Chukchi Sea shelf in summer-fall 2008–2010, *Continental Shelf Research*. http://dx.doi.org/10.1016/j.csr.2013.03.012.

PUBLICATIONS USING OR INSPIRED BY GAK 1 DATA

1) Janout, M. A., T. Weingartner, P. Stabeno, Air-sea and oceanic heat flux contributions to the heat budget of the northern Gulf of Alaska shelf. 2013. *Journal of Geophysical Research*, 118, doi:10.1002/jgrc.20095.
2) Janout, M.A, T. J. Weingartner, T. Royer, and S. Danielson, 2010. On the nature of winter cooling and the recent temperature shift on the northern Gulf of Alaska shelf, *Journal of Geophysical Research*, 115, C05023, doi:10.1029/2009JC005774
3) Yankovsky, A. E., G. M. Maze, and T. J. Weingartner, 2010. Offshore transport of the Alaska Coastal Current water induced by a cyclonic wind field, *Geophysical Research Letters,* 37, L03604, doi:10.1029/2009GL041939
4) Williams, W. J., T. J. Weingartner, A. J. Hermann, 2010. Idealized 2-dimensional modeling of a coastal buoyancy front, or river front, under downwelling-favourable wind-forcing with application to the Alaska Coastal Current, *Journal of Physical Oceanography,* 40: 279-294.
5) Weingartner, T.J., S. Danielson, and T. C. Royer. 2005. Freshwater Variability and Predictability in the Alaska Coastal Current *Deep-Sea Research*, 52: 169 – 192.

COLLABORATORS

Aagaard, Knut, University of Washington
Brugler, Eric, WHOI
Curcuitser, Enrique, Rutgers
Day, Robert, ABR, Inc.
De Sousa, Leandra, North Slope Borough
Hannay, David JASCO
Pickart, Robert WHOI
Stabeno, Phyllis, NOAA
Williams, William, DFO-Canada
Woodgate, Rebecca, University of Washington

Budget Category:	Proposed FY 17	Proposed FY 18	Proposed FY 19	Proposed FY 20	Proposed FY 21	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$47.1	$48.2	$49.3	$50.4	$51.6	$246.6	
Travel	$4.4	$4.4	$4.4	$4.4	$4.4	$21.9	
Contractual	$18.7	$18.7	$18.7	$18.7	$18.7	$93.3	
Commodities	$6.1	$6.1	$6.1	$6.1	$6.1	$30.5	
Equipment	$39.3	$39.5	$23.7	$15.8	$16.0	$134.3	
Indirect Costs (*25% of non-equip.*)	$ 19	$ 19	$ 20	$ 20	$ 20	$ 98	
SUBTOTAL	$134.6	$136.2	$121.7	$115.2	$116.8	$624.6	
General Administration (9% of	$12.1	$12.3	$11.0	$10.4	$10.5	$56.2	N/A
PROJECT TOTAL	$146.8	$148.4	$132.6	$125.6	$127.4	$680.8	
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	

COMMENTS:

FY17-21

Project Title: Oceanographic Conditions in the Alaska Coastal Current from GAK-1.
Primary Investigator: Seth Danielson

NON-TRUSTEE AGENCY SUMMARY PAGE

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Seth Danielson	Principal Investigator	1.0	12.8		12.8
Tom Weingartner	Co-Investigator	0.4	17.3		7.6
Peter Shipton	Mooring and field technician	1.5	7.7	5.6	16.9
Elizabeth Dobbins	Analyst	1.0	9.8		9.8
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	47.6	5.6	
				Personnel Total	$47.1

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
GulfWatch PI Meeting	0.4	1	5	0.1	0.7
GulfWatch PI Meeting:lodging			4	0.1	0.4
GulfWatch PI Meeting: ground transportation			1	0.1	0.1
GAK1 Team Meeting	0.4	5	5	0.1	2.3
GAK1 Team Meeting:lodging			4	0.2	0.7
GAK1 Team Meeting: car rental			5	0.1	0.3
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$4.4

FY17

Project Title: Oceanographic Conditions in the Alaska Coastal Current from GAK-1.
Primary Investigator: Seth Danielson

FORM 3B PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Vessel Charter for CTDs - 8 1-day trips, $1500/day	12.0
Vessel Charter for Moorings - 2 1-day trips, $2000/day	4.0
Instrument Calibrations and refurbishments	1.9
Shipping	0.8
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$18.7

Commodities Costs: Description	Commodities Sum
Project supplies	0.5
Instrument batteries and hardware	0.9
Mooring floats, cages, line, etc	4.8
Commodities Total	$6.1

FY17

Project Title: Oceanographic Conditions in the Alaska Coastal Current from GAK-1.
Primary Investigator: Seth Danielson

FORM 3B CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
SBE37	1.0	7.5	7.5
SBE16	1.0	24.1	24.1
Mooring fabrication & construction	1.0	7.7	7.7
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$39.3

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency
SBE37	12	UAF
SBE16	2	UAF
Floats, cages, line	2	UAF

FY17

Project Title: Oceanographic Conditions in the Alaska Coastal Current from GAK-1.
Primary Investigator: Seth Danielson

FORM 3B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Seth Danielson	Principal Investigator	1.0	13.0		13.0
Tom Weingartner	Co-Investigator	0.4	17.6		7.8
Peter Shipton	Mooring and field technician	1.5	7.9	5.7	17.3
Elizabeth Dobbins	Analyst	1.0	10.1		10.1
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	48.6	5.7	
				Personnel Total	$48.2

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
GulfWatch PI Meeting	0.4	1	5	0.1	0.7
GulfWatch PI Meeting:lodging			4	0.1	0.4
GulfWatch PI Meeting: ground transportation			1	0.1	0.1
GAK1 Team Meeting	0.4	5	5	0.1	2.3
GAK1 Team Meeting:lodging			4	0.2	0.7
GAK1 Team Meeting: car rental			5	0.1	0.3
					0.0
					0.0
					0.0
				Travel Total	$4.4

FY18

Project Title: Oceanographic Conditions in the Alaska Coastal Current from GAK-1.
Primary Investigator: Seth Danielson

FORM 3B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Vessel Charter for CTDs - 8 1-day trips, $1500/day	12.0
Vessel Charter for Moorings - 2 1-day trips, $2000/day	4.0
Instrument Calibrations and refurbishments	1.9
Shipping	0.8
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$18.7

Commodities Costs: Description	Commodities Sum
Project supplies	0.5
Instrument batteries and hardware	0.9
Mooring floats, cages, line, etc	4.8
Commodities Total	$6.1

FY18

Project Title: Oceanographic Conditions in the Alaska Coastal Current from GAK-1.
Primary Investigator: Seth Danielson

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
SBE37	1.0	7.5	7.5
SBE16	1.0	24.1	24.1
Mooring fabrication & construction	1.0	7.9	7.9
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$39.5

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency
SBE37	12	UAF
SBE16	2	UAF
Floats, cages, line	2	UAF

FY18

Project Title: Oceanographic Conditions in the Alaska Coastal Current from GAK-1.
Primary Investigator: Seth Danielson

FORM 3B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Seth Danielson	Principal Investigator	1.0	13.3		13.3
Tom Weingartner	Co-Investigator	0.4	18.0		7.9
Peter Shipton	Mooring and field technician	1.5	8.1	5.8	17.8
Elizabeth Dobbins	Analyst	1.0	10.3		10.3
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	49.7	5.8	
				Personnel Total	$49.3

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
GulfWatch PI Meeting	0.4	1	5	0.1	0.7
GulfWatch PI Meeting:lodging			4	0.1	0.4
GulfWatch PI Meeting: ground transportation			1	0.1	0.1
GAK1 Team Meeting	0.4	5	5	0.1	2.3
GAK1 Team Meeting:lodging			4	0.2	0.7
GAK1 Team Meeting: car rental			5	0.1	0.3
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$4.4

FY19

Project Title: Oceanographic Conditions in the Alaska Coastal Current from GAK-1.
Primary Investigator: Seth Danielson

FORM 3B PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Vessel Charter for CTDs - 8 1-day trips, $1500/day	12.0
Vessel Charter for Moorings - 2 1-day trips, $2000/day	4.0
Instrument Calibrations and refurbishments	1.9
Shipping	0.8
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$18.7

Commodities Costs: Description	Commodities Sum
Project supplies	0.5
Instrument batteries and hardware	0.9
Mooring floats, cages, line, etc	4.8
Commodities Total	$6.1

FY19

Project Title: Oceanographic Conditions in the Alaska Coastal Current from GAK-1.
Primary Investigator: Seth Danielson

FORM 3B CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
SBE37 temperature-conductivity-pressure datalogger	1.0	7.5	7.5
Mooring fabrication & construction	1.0	8.1	8.1
Mooring fabrication & construction	1.0	8.1	8.1
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$23.7

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency
SBE37	12	UAF
SBE16	2	UAF
Floats, cages, line	2	UAF

FY19

Project Title: Oceanographic Conditions in the Alaska Coastal Current from GAK-1.
Primary Investigator: Seth Danielson

FORM 3B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Seth Danielson	Principal Investigator	1.0	13.6		13.6
Tom Weingartner	Co-Investigator	0.4	18.4		8.1
Peter Shipton	Mooring and field technician	1.5	8.3	6.0	18.2
Elizabeth Dobbins	Analyst	1.0	10.6		10.6
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	50.8	6.0	
				Personnel Total	$50.4

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
GulfWatch PI Meeting	0.4	1	5	0.1	0.7
GulfWatch PI Meeting:lodging			4	0.1	0.4
GulfWatch PI Meeting: ground transportation			1	0.1	0.1
GAK1 Team Meeting	0.4	5	5	0.1	2.3
GAK1 Team Meeting:lodging			4	0.2	0.7
GAK1 Team Meeting: car rental			5	0.1	0.3
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$4.4

FY20

Project Title: Oceanographic Conditions in the Alaska Coastal Current from GAK-1.
Primary Investigator: Seth Danielson

FORM 3B PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Vessel Charter for CTDs - 8 1-day trips, $1500/day	12.0
Vessel Charter for Moorings - 2 1-day trips, $2000/day	4.0
Instrument Calibrations and refurbishments	1.9
Shipping	0.8
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$18.7

Commodities Costs: Description	Commodities Sum
Project supplies	0.5
Instrument batteries and hardware	0.9
Mooring floats, cages, line, etc	4.8
Commodities Total	$6.1

FY20

Project Title: Oceanographic Conditions in the Alaska Coastal Current from GAK-1.
Primary Investigator: Seth Danielson

FORM 3B CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
SBE37 temperature-conductivity-pressure datalogger	1.0	7.5	7.5
Mooring fabrication & construction	1.0	8.3	8.3
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
New Equipment Total			$15.8

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency
SBE37	12	UAF
SBE16	2	UAF
Floats, cages, line	2	UAF

FY20

Project Title: Oceanographic Conditions in the Alaska Coastal Current from GAK-1.
Primary Investigator: Seth Danielson

FORM 3B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Seth Danielson	Principal Investigator	1.0	13.8		13.8
Tom Weingartner	Co-Investigator	0.4	18.7		8.2
Peter Shipton	Mooring and field technician	1.5	8.5	6.1	18.7
Elizabeth Dobbins	Analyst	1.0	10.8		10.8
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	51.9	6.1	
				Personnel Total	$51.6

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
GulfWatch PI Meeting	0.4	1	5	0.1	0.7
GulfWatch PI Meeting:lodging			4	0.1	0.4
GulfWatch PI Meeting: ground transportation			1	0.1	0.1
GAK1 Team Meeting	0.4	5	5	0.1	2.3
GAK1 Team Meeting:lodging			4	0.2	0.7
GAK1 Team Meeting: car rental			5	0.1	0.3
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$4.4

FY21

Project Title: Oceanographic Conditions in the Alaska Coastal Current from GAK-1.
Primary Investigator: Seth Danielson

FORM 3B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Vessel Charter for CTDs - 8 1-day trips, $1500/day	12.0
Vessel Charter for Moorings - 2 1-day trips, $2000/day	4.0
Instrument Calibrations and refurbishments	1.9
Shipping	0.8
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$18.7

Commodities Costs: Description	Commodities Sum
Project supplies	0.5
Instrument batteries and hardware	0.9
Mooring floats, cages, line, etc	4.8
Commodities Total	$6.1

FY21

Project Title: Oceanographic Conditions in the Alaska Coastal Current from GAK-1.
Primary Investigator: Seth Danielson

FORM 3B CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
SBE37 temperature-conductivity-pressure datalogger	1.0	7.5	7.5
Mooring fabrication & construction	1.0	8.5	8.5
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$16.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency
SBE37	12	UAF
SBE16	2	UAF
Floats, cages, line	2	UAF

FY21

Project Title: Oceanographic Conditions in the Alaska Coastal Current from GAK-1.
Primary Investigator: Seth Danielson

FORM 3B
EQUIPMENT DETAIL

August 24, 2016

Elise Hsieh, Executive Director
Exxon Valdez Oil Spill Trustee Council
4210 University Drive
Anchorage, AK 99508-4626

Dear Elise:

Final FY 2017-2021 Proposal Submittal for Long-term Monitoring

17120114-J. Oceanographic Monitoring in Cook Inlet and Kachemak Bay

Gulf Watch Alaska, the long-term monitoring program of the *Exxon Valdez* Oil Spill Trustee Council (EVOSTC), has finalized our program and project proposals for fiscal years 2017-2021 funding based on comments received from EVOSTC's Science Panel on May 19, 2016. Below is the final budget summary and response to Science Panel comments for the Oceanographic Monitoring in Cook Inlet and Kachemak Bay project.

EVOSTC Funding Requested *(including 9% GA)*

FY17	FY18	FY19	FY20	FY21	TOTAL
$169,700	$174,400	$183,400	$135,700	$133,300	$796,500

Non-EVOSTC Funding Available

FY17	FY18	FY19	FY20	FY21	TOTAL
$205,000	$213,000	$215,000	$217,000	$194,000	$1,044,000

Science Panel comment: *The investigators propose to modify sampling conducted in 2012-2016 to profile oceanographic variables (water temperature, salinity, nutrients) and plankton from ship and shore in lower Cook Inlet and Kachemak Bay in response to the anomalously warm waters in 2014-2015*.

PI Response:

- Clarified that the purposes for modifying the study design are to 1) maintain core oceanographic and plankton time-series from FY12-16, 2) increase sampling frequency in Kachemak Bay and southeast Cook Inlet to better characterize estuary-shelf gradients in oceanographic and nutrient conditions for an area of high biological productivity, and 3) reduce the spatial coverage of shipboard sampling in northern and western Cook Inlet to limit overall project costs. Also clarified that spatial variability in marine conditions across Cook Inlet was characterized throughout the FY12-16 sampling period, but only by leveraging additional non-EVOSTC funding sources.

- Revised text to clarify that both the continued time-series data collections and increased temporal sampling in a portion of the study area are intended to strengthen our monitoring of climate driven variability in general rather than for the recent Pacific warm water anomaly specifically; higher frequency sampling in areas where marine conditions support high biological productivity will improve the utility of these coastal time-series data for other proposed monitoring efforts in the GWA Nearshore Component, as well as for state and federal Trustee Agency pelagic species management in the area.

Science Panel comment: *The Panel does not feel that the proposed research is a priority, given the cost and the relative lack of connection to the larger program.*

PI Response:

- Clarified the connections between the lower Cook Inlet and Kachemak Bay oceanographic sampling to the other Environmental Drivers (ED) projects and the Nearshore project, as well as project support for pelagic species monitoring efforts of the GWA program (by hosting a seabird/marine mammal observer from the Pelagic component) and for Trustee Agency management efforts in the area outside of the long-term monitoring program
- Revised project methodology to reduce costs by sampling as much as possible with a smaller vessel and focusing sampling of the entire Cook Inlet entrance (which requires a larger charter vessel) on the spring phytoplankton bloom time period. Clarified that this sampling is coordinated with the spring sampling by the ED Seward Line and Continuous Plankton Recorder (CPR) projects.

Science Panel comment: *Answers to the proposed hypotheses are largely self-evident as stated and seemingly could be tested with data already in hand. A more compelling justification for the proposed research would have been helpful. For instance, hypothesis 1 that lower Cook Inlet is mostly synchronous with PWS suggests that continued oceanographic measurements in Cook Inlet may be redundant.*

PI Response:

- Agree that the project hypotheses could be more clearly stated and have revised them to frame four distinct scientific issues that the long-term data from the Cook Inlet/Kachemak Bay oceanography project will help address (see page 8).
- Revised the hypothesis statement about similarity in temporal changes across the region to clarify that we expect to continue to observe synchronous variations at longer (seasonal/interannual) time scales, but asynchronous patterns at shorter time scales. The differences in the spatial correlation of marine condition response at different time scales have implications for biological responses of different species, depending on species life histories (see page 8).

Science Panel comment: *The proposal also would have benefitted from a robust statement of how the expected outcomes of the proposed research would be integrated with those from the rest of the program.*

PI Response:

- Significantly revised the statement of expected project outcomes and integration with other GWA projects throughout the proposal. Clarified that the Cook Inlet/Kachemak Bay project contributes nearshore marine condition and estuary/shelf oceanographic gradient information to the GWA program with sufficient temporal and spatial resolution to assess seasonal and annual variability in primary and secondary productivity (as measured by sampling in the Cook Inlet, Seward Line and CPR projects). Included more examples of results from the FY12-16 sampling period to help illustrate the benefits gained by the higher frequency sampling. Clarified that the data products provided for the Nearshore component programs and Trustee Agency pelagic species management include temperature/salinity anomalies, water column stratification changes, an index of freshwater content, and time-series of dissolved oxygen, fluorescence, turbidity, chlorophyll and nutrient conditions. Clarified that sampling in both the Prince William Sound and Cook Inlet estuaries strengthens the ability of the GWA program to evaluate local (within estuary) and remote (shelf, North Pacific Ocean) climate forcing effects on nearshore and pelagic food webs.

Science Panel comment: *It is not clear that extending a modified version of the previous five years of research via monitoring would significantly advance our understanding of productivity and links to nearshore species, seabirds and marine mammals in the study area, especially given the expense of the project.*

PI Response:

- Clarified that lower Cook Inlet and Kachemak Bay oceanographic and plankton monitoring is key to understanding the estuary-shelf water mass exchange and nutrient dynamics that drive high biological production in this area.
- Clarified how the oceanographic and plankton data collected by the Cook Inlet/Kachemak Bay project inform understanding of how climate variability affects seabirds, marine mammals and nearshore species through "bottom-up" food web dynamics in the study area.
- Clarified that the higher frequency, year-round sampling of the Cook Inlet/Kachemak Bay project fills a data gap not met by the Seward Line (spring/fall only) or the CPR (April to October only) project sampling.
- The Cook Inlet/Kachemak Bay project cost has been reduced by $100K to provide additional funds to the Seward Line project for increased plankton and nutrient sampling and analyses during the monthly CTD surveys in Resurrection Bay and at the GAK-1 location. This additional sampling in Resurrection Bay will support the ED component's goal to improve temporal resolution of marine conditions and characterization of estuary/shelf gradients.

Science Panel comment: *The methods appear to be appropriate; though including a fluorometer with the CTDs to profile chlorophyll fluorescence throughout the water column would have been beneficial.*

PI Response:

- Clarified that the project's CTD has a fluorometer and provided examples of time-series data collected in the first five-year period (see Figure 4 on page 6 and Figure 7 on page 12).

Sincerely,

Mandy Lindeberg
Gulf Watch Alaska Program Lead designate

Attachment: Gulf Watch Alaska: Environmental Drivers Component Project Proposal: 17120114-J—Long-term Monitoring of Oceanographic Conditions in Cook Inlet/Kachemak Bay, Alaska

EVOSTC FY17-FY21 INVITATION FOR PROPOSALS
PROGRAM PROJECT PROPOSAL SUMMARY PAGE

Project Title

Gulf Watch Alaska: Environmental Drivers Component Project:

17120114-J—Long-term Monitoring of Oceanographic Conditions in Cook Inlet/Kachemak Bay, Alaska

Primary Investigator(s) and Affiliation(s)

Angela Doroff, Kachemak Bay National Estuarine Research Reserve/Alaska Center for Conservation Science/ University of Alaska Anchorage

Kris Holderied, NOAA/National Ocean Service/National Centers for Coastal Ocean Science/Kasitsna Bay Laboratory

Date Proposal Submitted

24 August 2016

Project Abstract

The lower Cook Inlet/Kachemak Bay (CIKB) oceanographic monitoring project, in conjunction with other Gulf Watch Alaska (GWA) Environmental Drivers (ED) projects, assesses the effects of oceanographic variability on nearshore and pelagic species injured by the Exxon Valdez Oil Spill. We currently have oceanographic data from a 6-year time-series within CIKB and 15-year record of continuous nearshore water quality station observations in Kachemak Bay. Oceanographic monitoring in this area is important because variables important to biological production change at different time and space scales, including water temperature, stratification, fresh water runoff, the strength and position of the Alaska Coastal Current, regional modes of climate variability and nutrient conditions (changes within season, seasonally, and inter-annually). During the first five years of cross-program synthesis in the ED group, we began to quantify the spatial and temporal trends and variability in oceanographic conditions for CIKB, Prince William Sound (PWS) and the Gulf of Alaska shelf; we found that temporal patterns are quasi-synchronous at longer time scales overall but asynchronous at shorter times and finer space scales in the estuary.

Based on FY12-16 observations (and to refine coordination with other GWA projects) we propose to increase sampling frequency along the estuary gradient and add nutrient monitoring in the eastern portion of our study area, with an associated reduction in spatial coverage across Cook Inlet. Ship-based oceanographic surveys are proposed monthly, seasonally, and annually in CIKB, with conductivity-temperature-depth casts (including fluorescence, turbidity, and dissolved oxygen), phytoplankton, and zooplankton collected along repeated transects. These data will be augmented with continuous oceanographic measurements recorded at Kachemak Bay National Estuarine Research Reserve oceanographic stations in Seldovia harbor, Homer harbor, and at a Bear Cove mooring. This proposal fills data gaps in the monitoring not currently being met by ED monitoring of the Seward Line (spring/fall only) or the Continuous Plankton Recorder (April-October) in the northern part of the Gulf of Alaska and will provide context for shorter time scales of variability relevant to ecosystem-level monitoring in GWA. By sampling in both estuaries (PWS and CIKB), we strengthen the ability of the GWA program to evaluate local (within estuary) and remote (shelf, North Pacific) climate forcing effects on nearshore ecosystems.

EVOSTC Funding Requested *(must include 9% GA)*

FY17	**FY18**	**FY19**	**FY20**	**FY21**	**TOTAL**
$169.7	**$174.4**	**$183.4**	**$135.7**	**$133.3**	**$796.5**

Non-EVOSTC Funding Available

FY17	**FY18**	**FY19**	**FY20**	**FY21**	**TOTAL**
$205.0	**$213.0**	**$215.0**	**$217.0**	**$194.0**	**$1,044.0**

1. Executive Summary

The Cook Inlet/Kachemak Bay (KIKB) oceanography project extends oceanographic data collection—including physical, chemical, and biological variables—from a 6-year time-series of shipboard oceanographic observations and a 15-year record of continuous nearshore water quality observations. The proposed FY17-21 sampling maintains long-term oceanographic time-series that provides detailed temporal resolution of nearshore gradients in oceanography and nutrient conditions between estuary and shelf waters to better support region-wide assessment of the impact of climate variability on the northern Gulf of Alaska marine ecosystem (Figure 1). This project also supports the Gulf Watch Alaska (GWA) Nearshore component intertidal monitoring project and ongoing pelagic seabird and marine mammal monitoring efforts in Kachemak Bay. Important fish, shellfish, seabird, shorebird and marine mammal species forage in CIKB for some or all of their life history and long-term data on environmental conditions and plankton are required to understand how climate variability and change can affect upper trophic species through "bottom-up" ecosystem processes. Water temperature, stratification, fresh water runoff, the strength and position of the Alaska Coastal Current, and nutrient conditions have been observed to change seasonally and inter-annually with regional climate variations (e.g. El Nino/La Nina, Pacific Decadal Oscillation, and the recent 2014-2016 Pacific Warm Anomaly), and these changes can have significant impacts on marine species in the region (e.g., Speckman et al., 2005). However, we still lack an adequate understanding of how nearshore and pelagic food webs respond to these climate-driven variations in physical processes, particularly for inshore regions (Mundy and Spies, 2005).

Long-term data on variability and change in both nearshore and shelf water column conditions are required to evaluate several hypotheses that have been put forward to explain climate-driven changes in Gulf of Alaska biological production (summarized in Mundy and Spies, 2005), including the match-mismatch hypothesis (Mackas et al., 2007; Anderson and Piatt, 1999), pelagic-benthic split hypothesis (Eslinger et al., 2001), and optimum stability window hypothesis (Gargett, 1997). The GWA Environmental Drivers (ED) component projects provide the long-term, high quality time-series needed for these regional evaluations of ecosystem dynamics, as well as for distinguishing between natural and human-caused (e.g., oil spills, fishing, aquaculture, nutrient runoff, climate change) changes in species populations. The CIKB oceanographic monitoring project provides critical information on nearshore and estuarine oceanographic patterns, as well as estuary-to-shelf oceanographic gradients and nutrient exchange to the GWA program's regional assessment.

Results from the first years of coordinated monitoring in the GWA ED were used in the GWA science synthesis report to assess oceanographic variability across the EVOS spill-affected region. The initial assessment showed spatial differences in monthly mean oceanographic conditions between CIKB (this project), PWS (Campbell GWA project) and the Gulf of Alaska shelf (GAK-1 and Seward Line projects); indicating that oceanographic changes over time are quasi-synchronous at longer time scales and asynchronous at shorter time scales across the region (Holderied and Weingartner, in review). Based on the FY12-16 monitoring results, input from the Joint GWA/Herring Research and Monitoring Programs Science Workshop, and coordination with researchers from the ED and Nearshore components, for the FY17-21 period we propose to maintain core oceanography and plankton time-series in Kachemak Bay and southeast Cook Inlet and increase the frequency and spatial resolution of along-estuary oceanography and nutrient sampling, to best characterize seasonal and interannual variability in marine conditions and how those conditions affect plankton abundance and community composition. To constrain project costs we propose to reduce the spatial coverage of ship-based sampling in northern and western Cook Inlet, having characterized spatial and seasonal variability across the Inlet in FY12-16. This will allow us to focus on estuary-shelf linkages and on areas where water mass and nutrient exchange from shelf waters drive relatively high biological production and concentrations of fish, seabirds and marine mammals in Kachemak Bay and southeastern Cook Inlet. *Our overall project goal is to continue and enhance time-series of oceanographic data from shipboard surveys and shore-based stations in lower CIKB that provide information on seasonal, inter-annual, and spatial trends and variability of marine conditions, to help understand of variations in nearshore and pelagic food webs.*

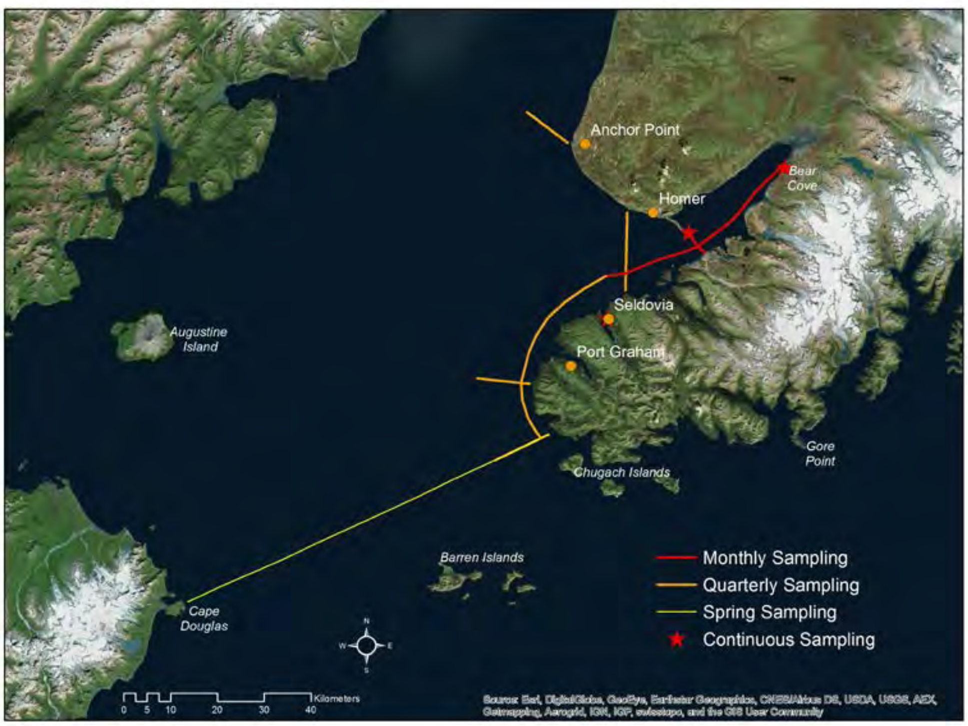

Figure 1. Proposed CIKB sampling locations. Red stars indicate sites of continuous sampling stations. Monthly CTD and plankton sampling (red lines) in mid-Kachemak Bay (Transect 9, T9) expands with along-bay stations. Quarterly sampling (orange lines) adds sampling in high productivity areas in outer Kachemak Bay (T4), near Anchor Point (east part of T3) and southeast Cook Inlet entrance (east parts of T6 and T7, plus along-estuary stations). Spring survey (dashed yellow line) adds stations across the Cook Inlet entrance (T6).

The importance of characterizing and understanding how lower trophic levels change in response to climate-driven variability in marine conditions is underscored both by past events, such as the 1976/1977 North Pacific marine ecosystem regime shift that was associated with a shift in the Pacific Decadal Oscillation (Mantua et al., 1997; Anderson and Piatt, 1999), as well as by the recent biological responses (still being evaluated) to the recent Pacific Warm Anomaly that has affected most of the northeast Pacific Ocean. The FY12-16 GWA monitoring efforts captured the transition in the Gulf of Alaska from relatively cold conditions in 2012 to anomalously warm marine conditions starting in 2014 and continuing to present, with dramatic biological responses observed across the region in 2015, including seabird and marine mammal mortalities, increased toxic algal bloom events, and changing marine species distributions. The interannual variations in the timing and degree of biological response to the unprecedented Pacific warming event provide an example of ecosystem response to changing marine conditions that the GWA program was designed to capture. We are using the CIKB oceanographic data, in collaboration with researchers from other GWA projects, NOAA, U.S. Fish and Wildlife Service (USFWS), U.S. Geological Survey and Alaska Department of Fish and Game (ADF&G), to help explain how bottom-up forcing associated with this climate perturbation may have driven observed changes in upper trophic species. We expect to monitor the ecosystem response to an expected return to cooler ocean conditions during the FY17-21 period, as well as continuing to monitor the response of nearshore water to shorter-term (El Nino) and longer-term (PDO) modes of climate variability.

The CIKB project provides nearshore and estuary/shelf oceanographic gradient information to the GWA program with sufficient temporal and spatial resolution to assess seasonal and interannual variability, as shown in the following examples. Figure 2 shows results from long-term temperature observations from the Homer water quality monitoring station. Measured against the climatological monthly means for 2001-2015, conditions in 2014-2015 were persistently warmer than those of the relatively cooler water period that persisted from 2006 until late 2013. While the biological effects of the warm anomaly on upper trophic species were more severe in 2015 than in 2014, the influence of warmer conditions was already reflected in 2014 by sharp changes in abundance of the small copepod *Pseudocalanus* in lower CIKB (Figure 3), as well in samples from the Seward Line and CPR (not shown).

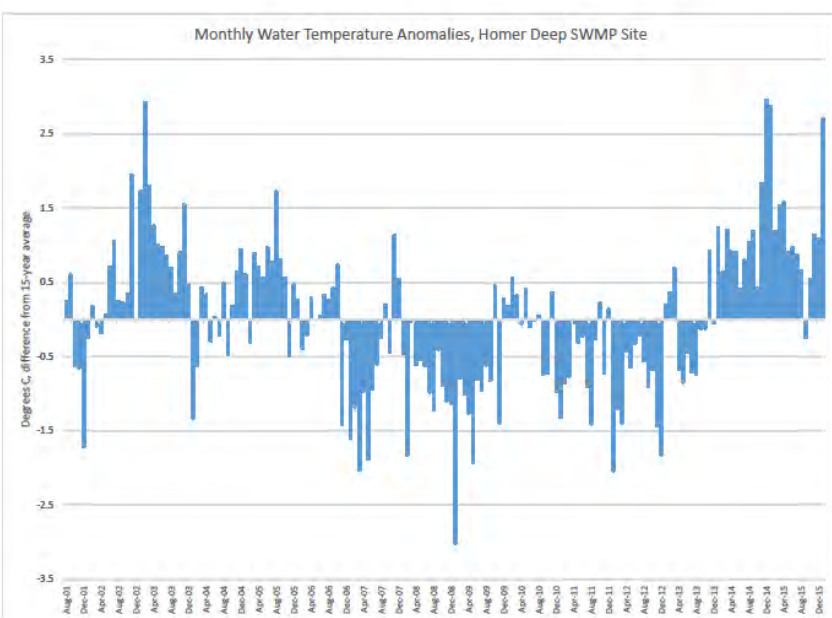

Figure 2. Monthly temperature anomalies based on water temperatures recorded 1m above bottom at the Kachemak Bay National Estuarine Research Reserve long-term water quality monitoring site in Homer harbor from Aug 2001- Dec 2015.

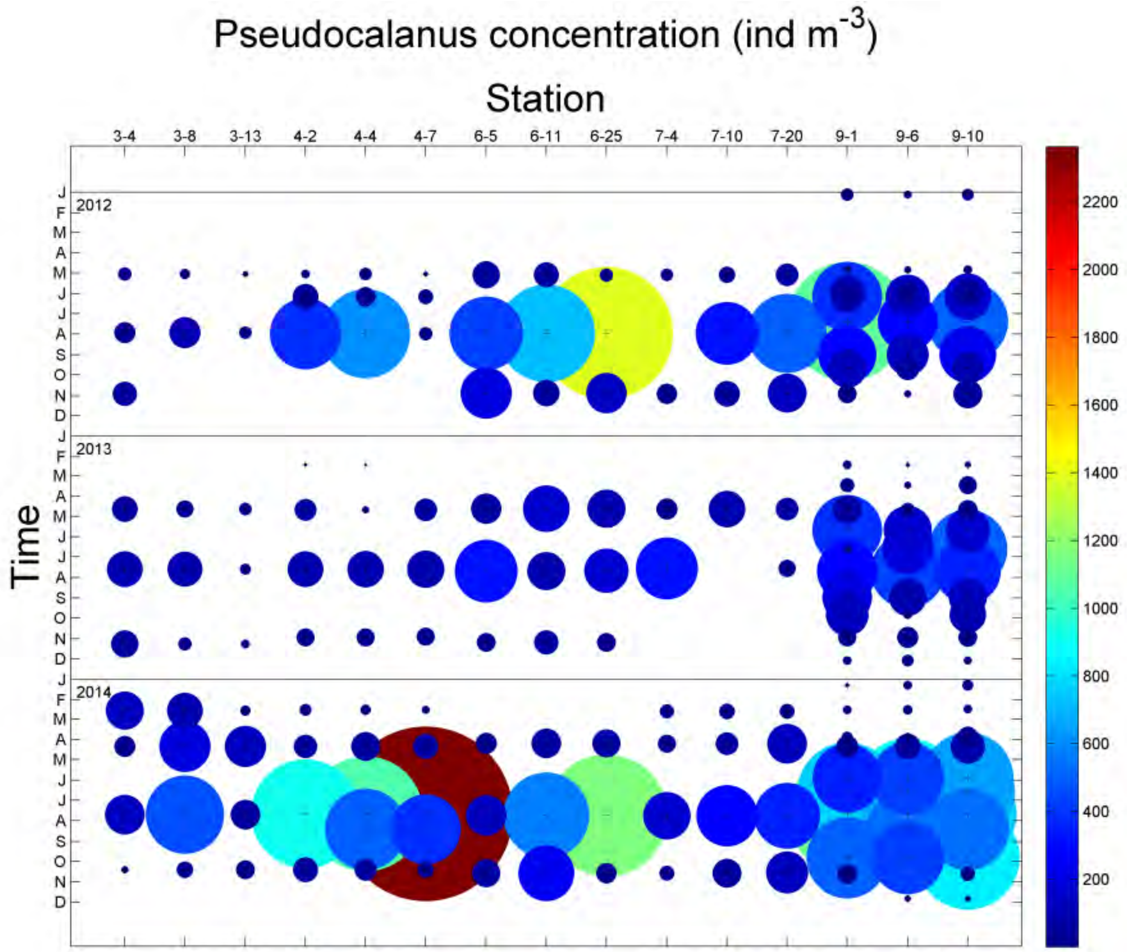

Figure 3. Pseudocalanus concentrations (individuals m-3) observed during 2012-2014 at stations (numbers on x-axis) across the study area. Both the size and color of the dots are proportional to copepod abundance. Station numbers identify transects in Kachemak Bay (T4, T9) and lower Cook Inlet (T3, T6, T7), with plankton sampled at three stations on each transect. Mid-Kachemak Bay stations (T9) are sampled monthly, while other transects are sampled quarterly.

Monthly shipboard sampling in Kachemak Bay provides temporal resolution of changing water column properties, as shown in the 2015 time-series of vertical profiles of temperature and fluorescence (Figure 4), which can help explain lower trophic level changes. An initial, cross-region ocean temperature climatology has been calculated from long-term measurements made across the ED components and is being used to help evaluate changes in intertidal species and habitats observed at GWA Nearshore component monitoring sites. Figure 5 shows an example of monthly climatology calculated from continuous temperature measurements at the Seldovia water quality station, by near-surface sensors on the GAK-1 mooring and at the NOAA tide gauge station at Cordova in PWS. Figure 6 provides a comparison of monthly mean salinity time-series between Seldovia and near surface sensors at the GAK-1 mooring. Interestingly, the near-surface conditions in outer Kachemak Bay are colder and saltier than for shelf waters at GAK-1 for most months of the year, with estuary and shelf conditions being most similar in the spring.

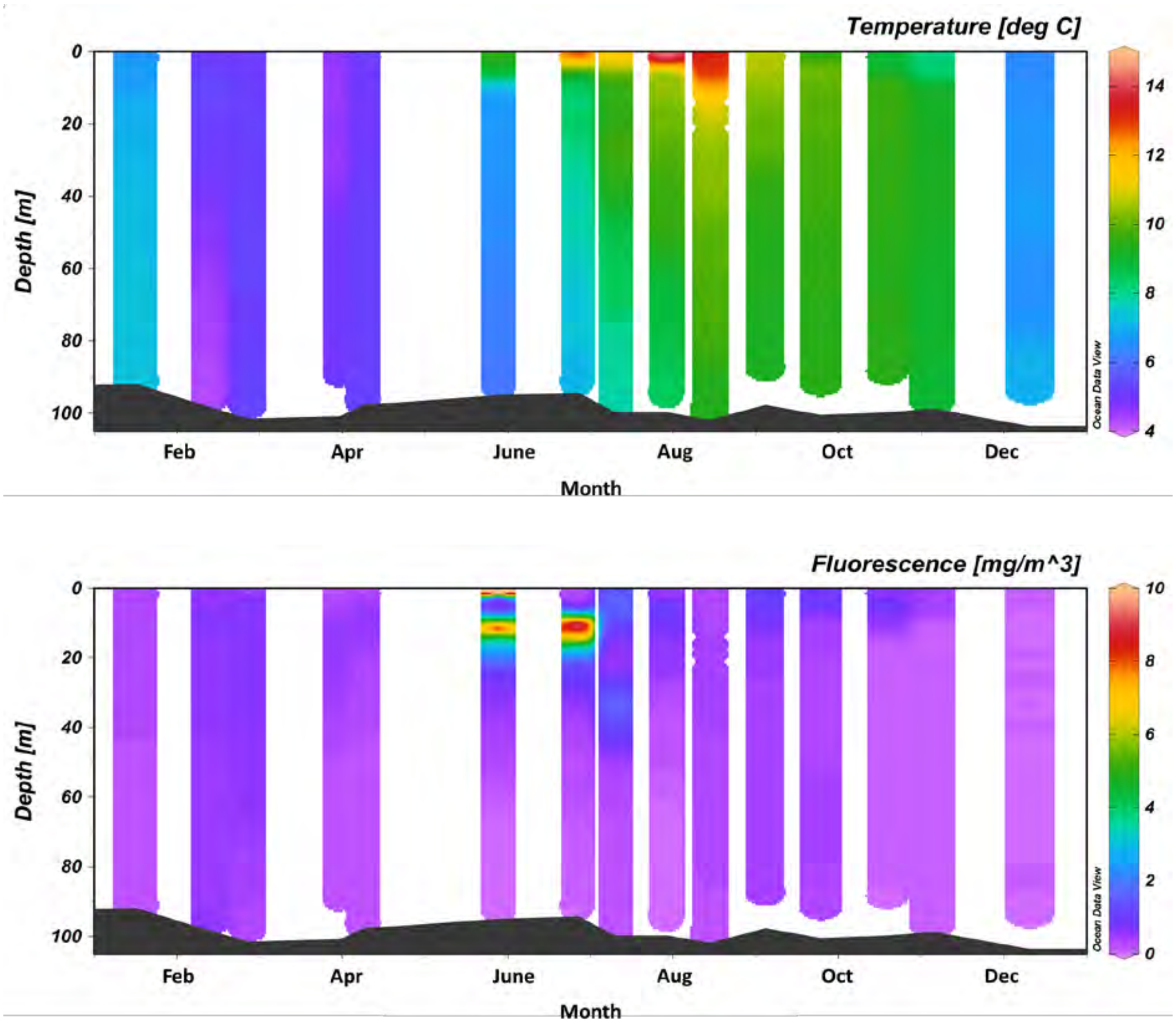

Figure 4. Water column temperature (top) and fluorescence (bottom) time-series for 2015 from repeated CTD casts at a station along the mid-Kachemak Bay transect (Transect 9).

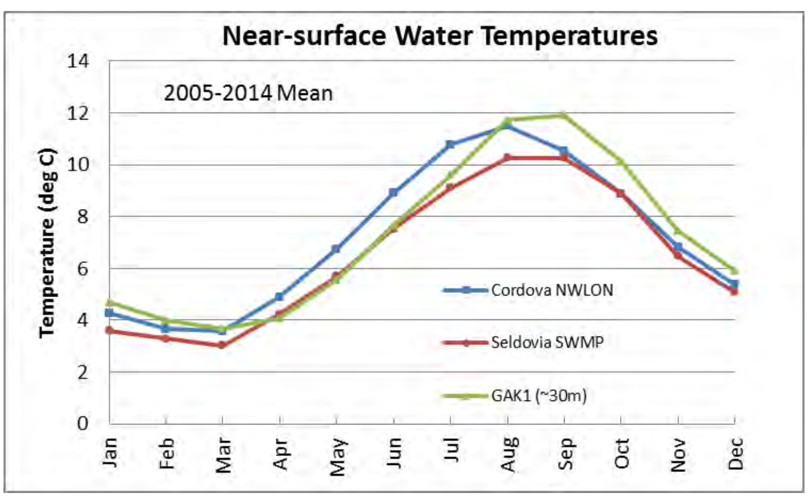

Figure 5. Monthly water temperature climatology for PWS, shelf and Kachemak Bay waters, calculated from continuous observations at Cordova, GAK-1 mooring and Seldovia, from 2005-2014.

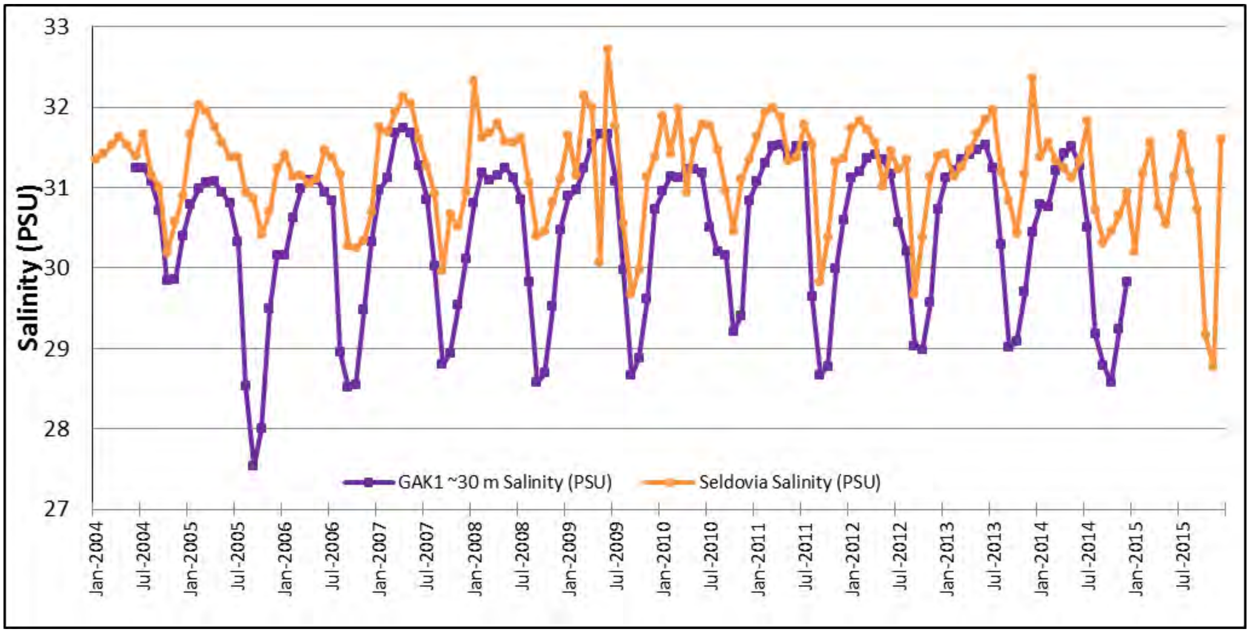

Figure 6. Monthly mean near-surface salinity from 2004-2015 at continuous oceanographic monitoring stations in the northern Gulf of Alaska (in practical salinity units, PSU). GAK-1 mooring observations are at ~30m depth on the shelf and Seldovia water quality station observations are at ~8m depth in the Kachemak Bay estuary.

With five years of integrated monitoring results from the GWA program, we are starting to be able to assess the biological implications of these spatial and temporal trends and associated variability marine conditions across the region, for both nearshore and pelagic species. The recent climate perturbation of the unprecedented Pacific warming also provides a preview of future changes that Trustee agencies could expect and need to manage for under a warmer Gulf of Alaska climate change scenario. How these longer-term climate changes will impact nearshore and pelagic ecosystems are still not well understood; continuing the established time-series of GWA oceanography and marine plankton monitoring will provide the data needed to better understand the consequences of changes in economically important marine resources and populations within EVOS-affected areas.

Project hypotheses:

H1. Climate variability in the Gulf of Alaska region drives measureable changes in oceanographic conditions in both Cook Inlet and Kachemak Bay, which in turn affect the abundance, composition and phenology of phytoplankton and zooplankton communities within the region.

H2. Gradients in oceanographic conditions and nutrient distributions between the Kachemak Bay estuary and Gulf of Alaska shelf waters are altered by climate variations, and changes in these gradients influence the distribution of plankton and upper trophic species.

H3. Time-series of relative freshwater content, derived from repeated oceanographic sections across Kachemak Bay, provide a useful, integrated index of seasonal and interannual variability in freshwater input for the estuary and lower Cook Inlet region.

H4. Longer-term regional observations will show that the temporal response of oceanographic conditions across estuarine (Prince William Sound; lower Cook Inlet) and shelf waters of the northern Gulf of Alaska remains quasi-synchronous at seasonal and longer time scales, but asynchronous at shorter time scales.

Please see Section 4. A. below for the specific project objectives that address these hypotheses.

2. Relevance to the Invitation for Proposals

The proposed CIKB project addresses the EVOSTC goal to determine "how factors other than oil may inhibit full recovery or adversely impact recovering resources" by providing oceanographic data at the time and space scales required to characterize ocean variability and the impact of that variability on lower trophic levels. The project responds directly to the EVOSTC FY17-21 Invitation for Proposals for "monitoring of oceanographic conditions, including water temperature, salinity and turbidity, … particularly in support of biological studies conducted by the Programs" and for "an evaluation of the possible effects of climate change on the pelagic and nearshore ecosystems." The CIKB project provides information on seasonal and interannual patterns in water temperature, stratification, freshwater content and nutrients needed by the GWA Nearshore monitoring component to assess marine drivers of intertidal ecosystem changes. The CIKB project also contributes information on nearshore oceanographic patterns, as well as estuary-shelf oceanographic gradients and nutrient exchange to the GWA ED component, providing part of the long-term data needed to distinguish between natural and human-caused (e.g., oil spill) changes in marine populations. By collecting oceanographic data with high temporal resolution and year-round coverage, we can evaluate interannual variability in conditions that influence regional ecosystems, as well as changes in seasonal conditions and timing. This higher temporal resolution of sampling fills a data gap in the monitoring not met by the Seward Line (spring/fall only) or the Continuous Plankton Recorder (April-October) for oceanographic and marine plankton data; monthly and quarterly plankton sampling conducted in CIKB provides context for the results obtained in the other ED projects for this region. By sampling in both estuaries, PWS and CIKB, we strengthen the ability of the GWA program to evaluate local (within estuary) and remote (shelf, North Pacific) climate forcing effects on nearshore ecosystems. In addition, the oceanographic time-series collected in CIKB support state (ADFG, ADEC) and federal (NOAA, USFWS) Trustee Agency resource management in the region, including understanding distribution and changes in shellfish, fish, marine birds, sea ducks, and marine mammal populations, as well as identifying triggers for harmful algal bloom events.

Specifically, the lower CIKB oceanographic project addresses EVOSTC goals by providing temperature, salinity, nutrient, and plankton data at the temporal and spatial scales required to:

- Characterize seasonal and interannual trends and changes in marine conditions for GWA Nearshore component monitoring sites in Kachemak Bay,
- Quantify long-term marine trends and anomalies and identify the response of plankton communities to those physical changes, in order to assess climatic forcings on biological production,
- Improve characterization of estuary-shelf linkages and how changes in estuary-shelf exchange affect changes in nearshore and pelagic species,
- Provide information on changing marine conditions needed to assess the effect of climate variations on harmful algal blooms, marine invertebrates, pelagic seabirds, and marine mammals in lower Cook Inlet and Kachemak Bay,
- Assess spatial and temporal variability in oceanographic conditions and marine plankton communities across the northern Gulf of Alaska, including PWS, shelf waters and lower Cook Inlet, in collaboration with other GWA ED projects.

3. Project Personnel

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Please see CVs provided at the end of this document.

4. Project Design

A. Objectives

The overall project goal is to continue and enhance time-series of oceanographic data from shipboard surveys and shore-based stations in lower CIKB that provide information on seasonal, inter-annual, and spatial trends and variability of marine conditions, to help understand of variations in nearshore and pelagic food webs. We also put these observations in the context of other ongoing physical and biological oceanographic studies occurring in PWS, the outer Kenai Peninsula, and the Gulf of Alaska under the Gulf Watch Alaska program, as well as other ongoing state and federal agency studies in the region. Our data will be used to better understand how the coastal region responds to climate variability and change.

Specific project objectives include (with links to project hypotheses in parentheses):

1. Determine the thermohaline structure of Kachemak Bay and the southeastern Cook Inlet entrance at seasonal and longer time scales.(H1, H2, H3)
2. Determine long-term trends and variability from daily to interannual time scales in Kachemak Bay oceanography. (H1, H4)
3. Determine seasonal patterns of phytoplankton and zooplankton species abundance and community composition within Kachemak Bay and southeastern Cook Inlet. (H1, H2)
4. Assess interannual changes in oceanographic structure and phytoplankton/zooplankton species composition across the Cook Inlet entrance. (H1, H2)
5. Assess seasonal patterns in oceanography, macronutrients, and plankton between Kachemak Bay, southeastern Cook Inlet and the adjacent shelf (collaboration with Seward Line and CPR projects). (H1, H4)
6. Determine temporal patterns and linkages in oceanographic conditions and plankton communities between CIKB and the Gulf of Alaska continental shelf (GAK-1, Seward Line, CPR GWA ED projects), and PWS (PWS and Seward Line GWA ED projects). (H4)
7. Provide environmental forcing data for correlation with biological data sets in the nearshore benthic project component and pelagic components of GWA. (H1, H2, H3)
8. Provide ADF&G, NOAA and USFWS resource managers with assessment of oceanographic trends and seasonal conditions. (H1, H2, H3)

B. Procedural and Scientific Methods

Ship-based oceanographic sampling and nearshore water quality station sampling, including instrument calibration, data collection, sample processing, quality control, and quality assurance, will continue to be conducted in accordance with the project sampling protocols used in FY12-16 (available on the GWA program Ocean Workspace operated by the Alaska Ocean Observing System/Axiom data management team).

Ship-based oceanographic surveys will be conducted monthly, seasonally and annually in Kachemak Bay and lower Cook Inlet, with vertical oceanographic profiles, phytoplankton and zooplankton data collected along repeated transects (see Figure 1 for transect locations). Oceanographic data are collected from near-surface to just above the sea floor at vertical stations with CTD profilers, using KBL and KBNERR Seabird Electronics 19plus CTD profilers. For consistency among sampling efforts within the ED and historic data collections, zooplankton are sampled with vertical tows of 150 and 333 µm bongo nets equipped with a flowmeter, to depths of 50 meters depth or 5 meters from the sea floor if bottom depths are shallower than 50 meters. Phytoplankton species are sampled with collection of a measured quantity of surface water (amount varies by season) and filtered through 20 µm mesh nets. During FY17-21 we will increase sampling and analyses for nutrients (nitrate, ammonium, orthophosphate, silicate) on ship-based surveys by leveraging funding to NOAA Kasitsna Bay Laboratory from the Alaska Ocean Observing System, through the NOAA Integrated Ocean Observing System program.

Monthly oceanographic surveys will be conducted in Kachemak Bay along mid-bay (Transect 9) and along-bay transects (red lines in Figure 1) with Kasitsna Bay Laboratory small boats. Quarterly, additional sampling locations will be added to the monthly small boat surveys to assess seasonal conditions (in February, April, July, October) with stations along transects in outer Kachemak Bay (Transect 4), near Anchor Point (eastern stations on Transect 3), and the southeastern part of Cook Inlet entrance (eastern portions of Transects 6 and 7 and along-estuary stations). The additional quarterly sampling transects are indicated with orange lines in Figure 1. In spring (April/May), a larger vessel will be chartered to conduct a survey across the Cook Inlet entrance (Transect 6, yellow line on Figure 1), in addition to the monthly and quarterly sampling locations in Kachemak Bay and eastern Cook Inlet. Plankton sampling will be conducted at the same three stations on the cross-Kachemak Bay transects (Transects 9 and 4), at the same eastern Cook Inlet stations (quarterly on Transects 3, 6 and 7) and at the same Cook Inlet entrance stations (spring on Transect 6) that were sampled for plankton in FY12-16, to maintain consistent time-series in FY17-21.

In order to increase temporal sampling of estuary-shelf gradients consistently throughout the FY17-21 study period (which required us to find other funding sources in the first five-year period), we propose to reduce the spatial extent of seasonal sampling along transects 3, 6 and 7 (compared to FY12-16), and only sample across the entire Cook Inlet entrance (Transect 6) once a year during spring. This modification will significantly reduce large vessel charter costs. We are prioritizing a spring survey of Cook Inlet entrance based on results from GWA FY12-16 monitoring in Cook Inlet and to coordinate with spring Seward Line and Continuous Plankton Recorder sampling. The modified sampling design allows us to maintain core oceanographic time-series, while maintaining high temporal resolution in areas where shelf waters enter Cook Inlet and Kachemak Bay (southeast Cook Inlet) and in spatial locations with relatively high fish, seabird and marine mammal populations (outer Kachemak Bay, Anchor Point and southeast Cook Inlet). More frequent along-estuary small-boat sampling in Kachemak Bay will also improve information on the timing and spatial patterns of spring and fall oceanographic transitions and on marine plankton blooms to support the GWA Nearshore Component as well as NOAA and ADFG resource management.

Continuous oceanographic measurements will be made year-round at KBNERR SWMP water quality stations at the Seldovia and Homer harbors as well as in ice-free months (March to November) from a buoy in Bear Cove at the head of Kachemak Bay (see locations in Figure 1). The National Estuarine Research Reserve SWMP program is transitioning the sensor package used for water quality monitoring stations from the YSI 6660 model to the YSI EXOII model and we expect the new sondes to be installed at the Homer and Seldovia stations in 2016. The new sensors will collect the same data as the previous sensors and the NERR program has conducted cross-calibrations between the two sonde models to ensure consistency. Otherwise the procedures for the nearshore water quality station measurements are the same as in the FY12-16 sampling period. Oceanographic data collected continuously and recorded every 15 minutes includes temperature, salinity, pressure, dissolved oxygen, turbidity and chlorophyll. Water samples are collected monthly at each station to measure nutrients (nitrate, nitrite, silicate, phosphate) and chlorophyll.

C. Data analysis and statistical methods

Data analysis and statistical methods will be consistent with methods used during the first five-year period.

All KBNERR long-term water quality and meteorological data are subjected to primary data quality assurance-quality control (QAQC) at the National Estuarine Research Reserve System Central Data Management Office (CDMO). Provisional data are ingested into the CDMO database within one week of data retrieval. The data are then returned to KBNERR, where Reserve staff use tools (Excel macros) provided by the CDMO to perform secondary QAQC on the data. Data that have been through secondary QAQC are submitted back to the CDMO quarterly and again annually and these data are posted as provisional plus. After annual submission to the CDMO is complete, the data undergo final tertiary QAQC by the CDMO. The data and accompanying metadata documentation are checked for completeness before dissemination as authenticated historical data via the CDMO Online Data Information Server (http://cdmo.baruch.sc.edu) and on the GWA program Ocean Workspace and public data portal http://portal.aoos.org/gulf-of-alaska.php#metadata/4e28304c-22a1-4976-8881-7289776e4173/project/files.

Seabird Electronics (SBE) 19Plus CTD profiler data from all transects are processed with standard SBE Seasoft software algorithms and averaged into 1 meter depth bins. Subsequent data processing uses Matlab and Ocean Data Viewer software algorithms to compute density and construct along-transect distance versus depth contour plots of temperature, salinity, density, fluorescence and other parameters (e.g. Figure 7). Water density fields are used to estimate vertical stratification at each station. Lateral variability across the transect and temporal variability between sampling periods are assessed by calculating means and standard deviations for temperature, salinity and density fields. The relative amount of freshwater at each station is calculated using a reference salinity (32 psu) consistent with earlier studies. Freshwater content is also derived for each cross-bay section, to provide an integrated index of freshwater input to the bay over time.

We will provide CTD and data in a format and with metadata compatible with the data management protocols of the integrated monitoring program. CTD data will be provided to other integrated program investigators and publicly through the program website as soon as practical, no later than a year after initial data collection. We will also assist the integrated program data management team to synthesize past oceanographic data from the existing water quality station time-series and CTD surveys in lower Cook Inlet. Methods for integrating these data across study areas in the GWA project will build on initial analyses in the GWA synthesis report by Holderied and Weingartner (in review).

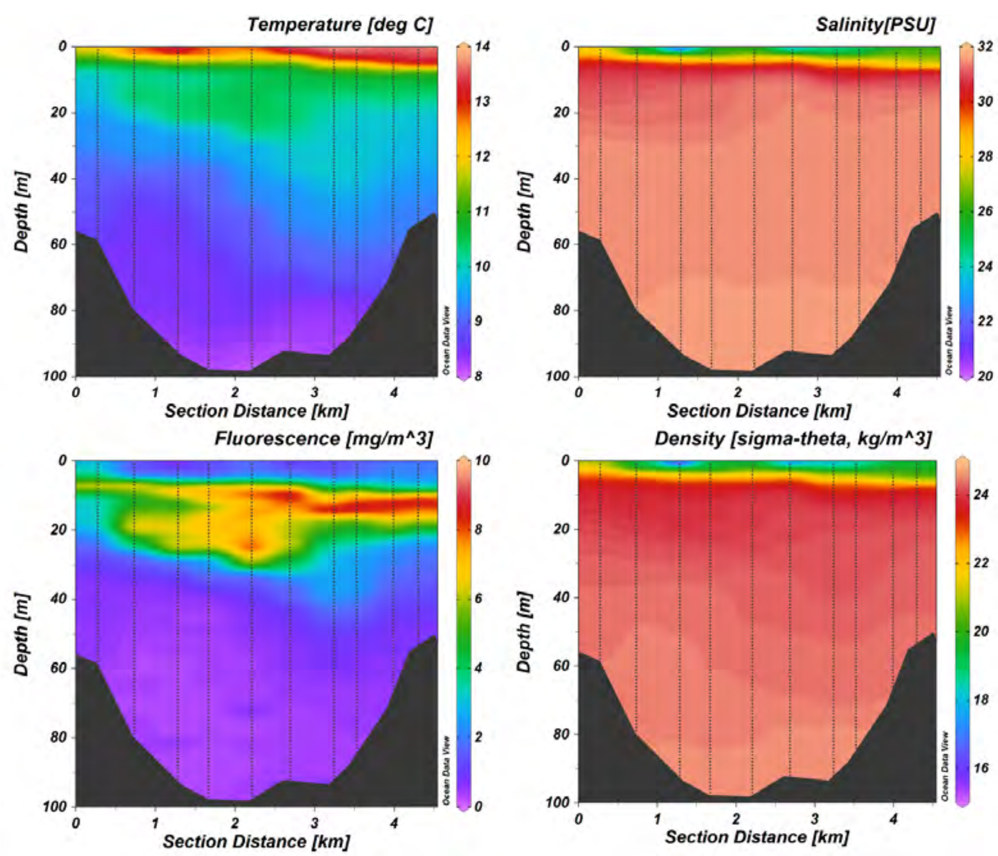

Figure 7. Contours of water column properties from CTD profiler casts (shown as dashed vertical lines) taken along the mid-Kachemak Bay transect (Transect 9) on 21 July 2014. The perspective is looking west or out of the bay, with the end of the Homer Spit on the right side.

Zooplankton data identification and analyses will be provided by Rob Campbell at the PWSSC and we will coordinate with Campbell to correlate temporal and spatial patterns between zooplankton and physical oceanographic data and to compare patterns between Cook Inlet and PWS. In collaboration with Campbell, we are analyzing our zooplankton samples with a set of common multivariate approaches. Species by station matrices will be assigned into clusters by various similarity metrics (Bray-Curtis being the most common). Following clustering, Indicator species analysis (ISA) applied to the clusters returns information on the species that define the cluster groups (Legendre and Gallager, 2001). The impact of environmental parameters on species assemblages will be analyzed with Canonical Correlation Analysis, which permits reducing dimensionality and determining which environmental axes most closely relate to different zooplankton taxa. Multivariate approaches are descriptive analyses (versus inferential), and power analysis is not usually applied. Marine plankton will be linked across study areas within the GWA program following methods described in Batten et al. (in review).

D. Description of Study Area

Our study area includes waters in eastern portions of lower Cook Inlet, the Cook Inlet entrance, and Kachemak Bay, Alaska (60.056, -154.365; 60.02, -150.9; 58.573, -154.349; 58.539, -151.033). See Figure 1 for proposed FY17-21 shipboard and shore station sampling locations. Transect numbers and locations for shipboard surveys are consistent with the FY12-16 sampling design, but additional along-estuary stations have been added to improve characterization of estuary-shelf gradients in water column properties. Stations in northern and western portions of lower Cook Inlet will not be sampled in FY17-21, except along the Cook Inlet entrance. In the next five years we will: 1) maintain monthly shipboard oceanographic and plankton sampling in mid-Kachemak Bay (Transect 9) and add along-bay oceanographic sampling stations; 2) maintain quarterly shipboard oceanographic and plankton sampling at stations in outer Kachemak Bay (Transect 4), near Anchor Point (Transect 3) and in southeast Cook Inlet (Transects 6 and 7); and 3) add spring (April/May) sampling across the Cook Inlet entrance from Point Adam to Cape Douglas (Transect 6). Continuous oceanographic and monthly nutrient measurements will be made year-round at KBNERR water quality monitoring stations at the Seldovia and Homer harbors and a mooring will be deployed to make continuous oceanographic measurements from March-November each year in Bear Cove near the head of Kachemak Bay. The sampling locations cover estuarine-shelf gradients in marine conditions from the head of Kachemak Bay to the Cook Inlet entrance, capture estuary waters influenced by glacial (inner Kachemak Bay) and non-glacial (outer Kachemak Bay) watersheds, and provide time-series information on estuarine conditions at a location “downstream” in the Alaska Coastal Current from the shelf water observations at the GAK-1 mooring and along the Seward Line.

5. Coordination and Collaboration

The Kachemak Bay National Estuarine Research Reserve (KBNERR), a State of Alaska and NOAA partnership, and the NOAA Kasitsna Bay Laboratory (KBL) collaborate on this oceanographic monitoring project to cost-effectively leverage organization resources as well as historical data sets. The KBNERR has 15 years of water quality and meteorological data at two System-Wide Monitoring Program (SWMP) sites in Homer and Seldovia harbors, as well as from two meteorological stations (Homer harbor and Anchor Point). We also leverage historical oceanographic data collected with from several CTD profiler surveys in Kachemak Bay and lower Cook Inlet, including during recent studies by Speckman et al. (2005), Okkonen et al. (2009), and Murphy (2010). Our sampling design includes transects sampled routinely by Okkonen (2009) and Murphy (2010), which extends the project time-series. Temperature and water level data from 1964 to present are also available from the NOAA tide station at Seldovia (https://tidesandcurrents.noaa.gov/physocean.html?id=9455500), which provides an even longer climate change context for the current program. Complementing the physical data, annual intertidal invertebrate and macroalgae monitoring has been conducted at sites near KBL for 15 years, which are included in the GWA nearshore component (PIs Iken/Konar).

Specific collaborations include the following:

WITHIN THE PROGRAM

1) *Environmental Drivers component*: We coordinate on oceanographic and zooplankton sampling protocols and synthesis of monitoring results with other Environmental Drivers component PIs (Weingartner, Hopcroft, Batten, Campbell) through teleconferences, joint field work and in breakout discussions at the annual principal investigators (PI) meeting.
2) *Nearshore component*: The CIKB project provides information on seasonal and interannual patterns in water temperature, stratification, freshwater content and nutrients needed by the GWA Nearshore team to assess drivers of intertidal ecosystem changes at their Kachemak Bay sites.
3) *Pelagic component*: We coordinate with Kathy Kuletz (GWA Pelagic component, USFWS Migratory Bird Management office) to opportunistically host a seabird/marine mammal observer on our shipboard surveys, with the goal of improving understanding of relationships between marine conditions, primary productivity, and seabird and marine mammal populations.

WITH OTHER EVOSTC-FUNDED PROGRAMS AND PROJECTS

1) *Herring Research and Monitoring Program*: We coordinate informally with Scott Pegau (HRM program lead) and Rob Campbell (PWS oceanography project under GWA program) to compare PWS and Cook Inlet oceanographic patterns and changes in plankton, herring and other forage fish populations. These discussions helped us decide to modify our project sampling design to enhance measurement of estuary-shelf gradients in oceanography and nutrient conditions.
2) *FY17-21 Data Management Program*: We worked closely with the AOOS/Axiom data management team in the FY12-16 program and expect to continue those collaborations in the future, including providing data to the Ocean Workspace and AOOS Gulf of Alaska public data portal.

WITH TRUSTEE OR MANAGEMENT AGENCIES

1) *NOAA/National Ocean Service:* We collaborate with researchers at our NOS/NCCOS Beaufort Laboratory (North Carolina) to use the project oceanography and phytoplankton sampling data to identify environmental triggers for increases in the phytoplankton species (*Alexandrium* spp.) that cause paralytic shellfish poisoning events.
2) *State of Alaska agencies – ADFG and ADEC:* We provide real-time and historical trends for water temperature data to shellfish managers with the Alaska Department of Fish and Game (Commercial and Sportfish) in Homer and Kenai and with the Alaska Department of Environmental Conservation in Anchorage. We use project data to help inform management for shellfish harvest, mariculture operations, harmful algal bloom event response and marine invasive species monitoring.
3) *U.S. Fish and Wildlife Service*: As described above, we collaborate with Kathy Kuletz to host shipboard seabird/marine mammal observers. Doroff also works on sea otter mortality response efforts in Kachemak Bay and project data is provided to USFWS and NOAA to help understand potential ecosystem causes of seabird, sea otter and whale mortality events.
4) *North Pacific Research Board*: Holderied is participating in the NPRB-funded FY16-18 synthesis effort for the Gulf of Alaska Integrated Ecosystem Research Program with researchers from NOAA,

USFWS, ADFG and other organizations. Project data is being used to help understand how linkages between nearshore and shelf waters affect groundfish recruitment.

WITH NATIVE AND LOCAL COMMUNITIES

1) *Alutiiq Pride Shellfish Hatchery*: We collaborate with the hatchery on a regional project to monitor ocean acidification in coastal waters. Water samples for measurement of carbonate chemistry will be taken during our shipboard surveys and sent to the analysis facility at the Alutiiq Pride Shellfish Hatchery in Seward (owned and operated by the Chugach Regional Resource Division, a coalition of several native villages in the Chugach region).
2) *KBNERR Community Council and other local venues*: Doroff and Holderied present information from this study quarterly to the KBNERR Community Council, routinely provide public talks on project results in Homer and Seldovia, and participate in public education "Discovery Labs". To inform Kachemak Bay communities about changing marine conditions, we provide information on monitoring results via local radio and newspaper media. We also provide information on oceanographic monitoring techniques and results to K-12 students in in Homer, Seldovia, Port Graham and Nanwalek. We will continue these local community collaborations in FY17-21.

6. Schedule

PROJECT MILESTONES

Project Milestones (Table 1) include monthly, seasonal and annual ship-based oceanographic surveys, data delivery, reports, publications and annual GWA PI meeting attendance. Doroff and Holderied will also present monitoring results annually at the Alaska Marine Science Symposium.

Table 1. Schedule of Measurable Project Tasks

Task	FY17				FY18				FY19				FY20				FY21			
	Quarter (EVOSTC FY beginning Feb. 1)																			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Field Sampling																				
Monthly Surveys	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Spring Surveys (all)	x				x				x				x				x			
Summer Surveys		x				x				x				x				x		
Fall Surveys			x				x				x				x				x	
Winter Surveys	x				x				x				x				x			
SWMP Water quality	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
SWMP Nutrients	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
SWMP Meteorological	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Data Delivery	x			x	x			x	x			x	x			x	x			x
Reporting																				
Annual Reports	x				x				x				x				x			
Annual PI meeting				x				x				x				x				x
Annual Work Plan			x				x				x				x				x	

MEASUREABLE PROJECT TASKS

Tasks include repeated monthly, quarterly and annual oceanographic survey tasks, listed below by fiscal quarter. Data delivery occurs within no more than 1 year of collection. Other annual tasks include Doroff and Holderied attending the annual principal investigators meeting and presenting of project results at the Alaska Marine Science Symposium. We also plan to produce peer-reviewed science manuscripts for the year 3 program synthesis and at the end of the FY17-21 period.

FY 2017 (Year 6)

FY17, 1st quarter (February 1, 2017 - April 30, 2017)

February: *Project funding approved by Trustee Council; Monthly survey Kachemak Bay; Quarterly survey of transects in Kachemak Bay and eastern Cook Inlet*

March: *Monthly survey Kachemak Bay; Deploy seasonal Bear Cove water quality mooring*

April: *Monthly survey Kachemak Bay; Annual survey of all transects in Kachemak Bay and lower Cook Inlet, including across Cook Inlet entrance*

FY17, 2nd quarter (May 1, 2017 - July 31, 2017)

May: *Monthly survey Kachemak Bay*

June: *Monthly survey Kachemak Bay*

July: *Monthly survey Kachemak Bay; Quarterly survey of transects in Kachemak Bay and eastern Cook Inlet*

FY17, 3rd quarter (Aug. 1 2017 - Oct. 31 2017)

August: *Monthly survey Kachemak Bay; Submit annual project workplan*

September: *Monthly survey Kachemak Bay*

October: *Monthly survey Kachemak Bay; Quarterly survey of transects in Kachemak Bay and eastern Cook Inlet*

FY17, 4th quarter (Nov. 1 2017 - Jan. 31 2017)

November: *Monthly survey Kachemak Bay; Annual GWA PI Meeting; Remove Bear Cove mooring*

December: *Monthly survey Kachemak Bay*

January: *Monthly survey Kachemak Bay; Alaska Marine Science Symposium & PI meeting*

FY 2018 (Year 7)

FY18, 1st quarter (February 1, 2018 - April 30, 2018)

February: *Project funding approved by Trustee Council; Monthly survey Kachemak Bay; Quarterly survey of transects in Kachemak Bay and eastern Cook Inlet; Submit annual project report*

March: *Monthly survey Kachemak Bay; Deploy seasonal Bear Cove water quality mooring*

April: *Monthly survey Kachemak Bay; Annual survey of all transects in Kachemak Bay and lower Cook Inlet, including across Cook Inlet entrance*

FY18, 2nd quarter (May 1, 2018 - July 31, 2018)

May: *Monthly survey Kachemak Bay*

June: *Monthly survey Kachemak Bay*

July: *Monthly survey Kachemak Bay; Quarterly survey of transects in Kachemak Bay and eastern Cook Inlet*

FY18, 3rd quarter (August 1, 2018 - October 31, 2018)
August: *Monthly survey Kachemak Bay; Submit annual project workplan*
September: *Monthly survey Kachemak Bay*
October: *Monthly survey Kachemak Bay; Quarterly survey of transects in Kachemak Bay and eastern Cook Inlet;*

FY18, 4th quarter (November 1, 2018 - January 31, 2019)
November: *Monthly survey Kachemak Bay; Annual GWA PI Meeting; Remove Bear Cove mooring*
December: *Monthly survey Kachemak Bay;*
January: *Monthly survey Kachemak Bay; Alaska Marine Science Symposium & PI meeting*

FY 2019 (Year 8)

FY19, 1st quarter (February 1, 2019 - April 30, 2019)
February: *Project funding approved by Trustee Council; monthly survey Kachemak Bay; Quarterly survey of transects in Kachemak Bay and eastern Cook Inlet; Submit annual project report*
March: *Monthly survey Kachemak Bay; Deploy seasonal Bear Cove water quality mooring*
April: *Monthly survey Kachemak Bay; Annual survey of all transects in Kachemak Bay and lower Cook Inlet, including across Cook Inlet entrance*

FY19, 2nd quarter (May 1, 2019 - July 31, 2019)
May: *Monthly survey Kachemak Bay*
June: *Monthly survey Kachemak Bay*
July: *Monthly survey Kachemak Bay; Quarterly survey of transects in Kachemak Bay and eastern Cook Inlet*

FY19, 3rd quarter (August 1, 2019 - October 31, 2019)
August: *Monthly survey Kachemak Bay; Submit annual project workplan*
September: *Monthly survey Kachemak Bay*
October: *Monthly survey Kachemak Bay; Quarterly survey of transects in Kachemak Bay and eastern Cook Inlet; Submit draft manuscript for year 3 science synthesis.*

FY19, 4th quarter (November 1, 2019 - January 31, 2020)
November: *Monthly survey Kachemak Bay; Annual GWA PI Meeting; Remove Bear Cove mooring*
December: *Monthly survey Kachemak Bay; Submit final manuscript for science synthesis*
January: *Monthly survey Kachemak Bay; Alaska Marine Science Symposium & PI meeting*

FY 2020 (Year 9)

FY20, 1st quarter (February 1, 2020 - April 30, 2020)
February: *Project funding approved by Trustee Council; Monthly survey Kachemak Bay; Quarterly survey of transects in Kachemak Bay and eastern Cook Inlet; Submit annual project report*
March: *Monthly survey Kachemak Bay; Deploy seasonal Bear Cove water quality mooring*
April: *Monthly survey Kachemak Bay; Annual survey of all transects in Kachemak Bay and lower Cook Inlet, including across Cook Inlet entrance*

FY20, 2nd quarter (May 1, 2020 - July 31, 2020)
May: *Monthly survey Kachemak Bay*
June: *Monthly survey Kachemak Bay*
July: *Monthly survey Kachemak Bay; Quarterly survey of transects in Kachemak Bay and eastern Cook Inlet*

FY20, 3rd quarter (August 1, 2020 - October 31, 2020)
August: *Monthly survey Kachemak Bay; Submit annual project workplan*
September: *Monthly survey Kachemak Bay*
October: *Monthly survey Kachemak Bay; Quarterly survey of transects in Kachemak Bay and eastern Cook Inlet*

FY20, 4th quarter (November 1, 2020 - January 31, 2021)
November: *Monthly survey Kachemak Bay; Annual GWA PI Meeting; Remove Bear Cove mooring*
December: *Monthly survey Kachemak Bay*
January: *Monthly survey Kachemak Bay; Alaska Marine Science Symposium & PI meeting*

FY 2021 (Year 10)

FY21, 1st quarter (February 1, 2021 - April 30, 2021)
February: *Project funding approved by Trustee Council; monthly survey Kachemak Bay; Quarterly survey of transects in Kachemak Bay and eastern Cook Inlet; Submit annual project report*
March: *Monthly survey Kachemak Bay; Deploy seasonal Bear Cove water quality mooring*
April: *Monthly survey Kachemak Bay; Annual survey of all transects in Kachemak Bay and lower Cook Inlet, including across Cook Inlet entrance*

FY21, 2nd quarter (May 1, 2021 - July 31, 2021)
May: *Monthly survey Kachemak Bay*
June: *Monthly survey Kachemak Bay*
July: *Monthly survey Kachemak Bay; Quarterly survey of transects in Kachemak Bay and eastern Cook Inlet*

FY21, 3rd quarter (August 1, 2021 - October 31, 2021)
August: *Monthly survey Kachemak Bay; Submit annual project workplan*
September: *Monthly survey Kachemak Bay*

October: *Monthly survey Kachemak Bay; Quarterly survey of transects in Kachemak Bay and eastern Cook Inlet*

FY21, 4th quarter (November 1, 2021 - January 31, 2022)
November: *Monthly survey Kachemak Bay; Annual GWA PI Meeting; Remove Bear Cove mooring*
December: *Monthly survey Kachemak Bay; Submit manuscript for peer reviewed science journal publication*
January: *Monthly survey Kachemak Bay; Alaska Marine Science Symposium & PI meeting;*

7. Budget

BUDGET FORMS (ATTACHED)

Please see the attached project budget forms included in the program budget workbook, with a Non-trustee Agency form for Doroff, a Trustee Agency form for Holderied and a summary form for the entire project.

SOURCES OF ADDITIONAL FUNDING:

We expect to continue significant leveraging for this project in FY17-21.

1) *KBNERR System-wide monitoring program*: this long-term monitoring program provides the continuous measures in Kachemak Bay for temp/conductivity, DO, pressure (depth), pH, turbidity and fluorescence (a measure of phytoplankton biomass); nutrients (Nitrite + Nitrate, Ammonium, Orthophosphate, and Silicate) are analyzed at the Virginia Institute of Marine Science (VIMS) Lab. Chlorophyll-a and Phaeophytin pigments are analyzed using standard methods at the KBNERR from water samples collected at five sites throughout the ice-free periods in the Bay. The Reserve also provides real-time and archival meteorological data from two sites for this program which include measures of: air temperature, relative humidity, barometric pressure, wind speed, wind direction, and total solar radiation, precipitation, and PAR. Collectively, these data provide a longer term perspective for our point-sample oceanographic data. This monitoring contributes $120K/year.
2) *KBNERR/ADF&G community-based monitoring for harmful species*: this project contributes an extensive volunteer network for monitoring phytoplankton in the event of a harmful algal bloom in Kachemak Bay. We hosted stakeholder engagement workshops to identify and fill data gaps in understanding harmful algal blooms and improve communications during bloom events (Cooney 2014). This project has supplemented our monitoring with SST at all mariculture sites located in sub-bays of Kachemak Bay since 2006.
3) *NOAA Kasitsna Bay Laboratory and AOOS:* NOAA KBL and AOOS have an ongoing collaboration to assess oceanography, ocean acidification and harmful algal bloom conditions in Kachemak Bay, and to develop risk assessment tools for paralytic shellfish poisoning and other harmful algal bloom events. AOOS plans to provide $25K annually from FY17-20 to support these efforts. The AOOS-funded monitoring will both expand and benefit from the oceanographic monitoring in our EVOSTC project and will help support additional nutrient analyses.
4) *USFWS Migratory Bird Management and Marine Mammals Management*: We coordinate with Kathy Kuletz of the USFWS Migratory Bird Management office to host a seabird/marine mammal observer on our Cook Inlet surveys, with the goal of improving understanding of relationships between marine conditions, primary productivity, and seabird and marine mammal populations. We

coordinate with Joel Garlic Miller in the USFWS Marine Mammals Office on sea otter stranding and sampling programs.

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Batten, S., R. Campbell, A. Doroff, K. Holderied, R. Hopcroft and T. Weingartner. ***In review***. Chapter 2: Environmental Drivers: Regional Variability in Oceanographic Patterns across the Gulf of Alaska. In Quantifying temporal and spatial variability across the northern Gulf of Alaska to understand mechanisms of change. Gulf Watch Alaska program science synthesis report. In review and finalization for the *Exxon Valdez* Oil Spill Trustee Council.

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Holderied, K. and T. Weingartner. ***In review***. Linking Variability in Oceanographic Patterns Between Nearshore and Shelf Waters Across the Gulf of Alaska. In Quantifying temporal and spatial variability across the northern Gulf of Alaska to understand mechanisms of change. Gulf Watch Alaska program science synthesis report. In review and finalization for the *Exxon Valdez* Oil Spill Trustee Council.

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Okkonen S. R. (2005) Observations of hydrography and currents in central Cook Inlet, Alaska during diurnal and semidiurnal tidal cycles. Final Report OCS Study MMS 2004-058, University of Alaska Coastal Marine Institute, University of Alaska Fairbanks and USDOI, MMS, Alaska OCS Region, pp 1-24.

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Project data online

Publicly available data from this project are available online at the following link:

http://portal.aoos.org/gulf-of-alaska.php#metadata/4e28304c-22a1-4976-8881-7289776e4173/project/files

CURRICULUM VITAE

ANGELA M. DOROFF

Kachemak Bay National Estuarine Research Reserve, 2181 Kachemak Drive Homer AK 99603, Day Phone: 907-235-4795; Email: adoroff@alaska.edu

EDUCATION: M.Sc. in Wildlife Ecology (1988) University of Wisconsin, Madison; B.S. in Biology (1984) University of Minnesota, St. Paul

CURRENT POSITION: Kachemak Bay National Estuarine Research Reserve (Reserve), Research Coordinator since 11/2008.

Affiliate Faculty at the University of Alaska, Fairbanks School of Fisheries and Ocean Sciences (2015-2018).

RECENT JOURNAL PUBLICATIONS:

Carrasco, S. E., B. B. Chomel, V. A. Gill, A. M. Doroff, M. A. Miller, K. A. Burek, R. W. Kasten, B. A. Byrne, T. G. Goldstein, J. A. K. Mazet. 2014. Exposure to *Bartonella spp*. is common in Alaskan sea otters. Vector-borne and Zoonotic Diseases. Vol. 14(12) 831.

Stewart, N.L., B. Konar, A. Doroff. 2014. Sea Otter (*Enhydra lutris*) foraging in a heterogeneous environment in Kachemak Bay, Alaska. Bulletin of Marine Science 90:921-939.

Newsome, S. D., M. T. Tinker, V.A. Gill, A.M. Doroff, L. Nichol, and J.L. Bodkin. 2015. The interaction of intraspecific competition and habitat on individual diet specialization. OecologiaDOI 10.1007/s00442-015-3223-8.

Traiger, S., B. Konar, A. Doroff, and L. McCaslin. In review. Sea otters versus sea stars as major clam predators: evidence from foraging pits and shell litter. Submitted: Marine Ecological Progress Series.

Doroff, A., S. Baird, J. Freymeuller, M. Murphy, and S. Buckelew. In review. Assessing coastal habitat changes in a glacially influenced estuary system, Kachemak Bay, Alaska. Submitted: Estuaries and Coasts special issue journal.

T.L. Burgess, C. Kreuder Johnson, A.Burdin, V.A. Gill, A. M. Doroff, P.Tuomi, W. A. Smith, and T. Goldstein. In prep. *Brucella* infection in common sea otters (*Enhydra lutris lutris*) at Bering Island, Russia. Short Communications. Journal of Wildlife Diseases.

RECENT GRANTS AWARDED:

State Wildlife Grants annually 2009-2016: Principal Investigator /Project Manager (145K); University of New Hampshire, Science Collaborative (2010-2013): Principal Investigator (915K); *Exxon Valdez* Trustee Council, Long-term monitoring (2011-2016): Principal Investigator (700K); NOAA Habitat Focus Area Kachemak Bay (2016-2017): Principal Investigator (385K).

RECENT COLLABORATORS (EXCLUSIVE OF CO-AUTHORS ABOVE):

Brenda Ballachey (USGS/ retired); Sonia Batten (SAHFOS); Tim Blackmon (ADF&G); James Bodkin (USGS/ retired); Mike Booz (ADF&G); Catie Bursch (UAA/KBNERR); Rob Campbell (PWSSC); Nicole Duplaix (IUCN OSG); Dan Esler(USGS); Joel GarlicMiller (USFWS); Marcus Geist (UAA); Georgina Gibson (UAF); Verena Gill (BOEM); Jeff Hetrick (Alutiiq Pride Shellfish Hatchery); Kris Holderied (NOAA KBL); Dominic Hondolero (NOAA); Russ Hopcroft (UAF); Katrin Iken (UAF); Mark Johnson (UAF); Carol Kervilet (ADF&G); Kim Kloecker(USGS); Kathy Kuletz (USFWS); Elizabeth Labunski (USFWS); Wayne Litaker (NOAA); Caitlin McKinstry (PWSSC); Dan Monson (USGS); Michael Opheim (Seldovia Tribes Environmental Coordinator); Heather Renner(USFWS); Jessica Shepard (UAA/KBNERR); Pat Tester (NOAA/OceanTester); Deb Tobin (UAA); E. Jamie Trammel (UAA); Marc Webber (USFWS); Tom Weingartner (UAF); Jeff Williams (USFWS).

Curriculum Vitae

Kristine (Kris) Holderied
National Oceanic and Atmospheric Administration (NOAA) Kasitsna Bay Laboratory
95 Sterling Highway, Suite 2, Homer, Alaska 99603 907-235-4004 *kris.holderied@noaa.gov*

EDUCATION

Massachusetts Institute of Technology-Woods Hole Oceanographic Institution Joint Program,
M.S. 1988, Physical Oceanography, Cambridge MA. (Satellite scatterometer wind study)
U.S. Naval Academy, B.S. 1984, Oceanography, Annapolis MD. Valedictorian.

WORK EXPERIENCE

Director/Supervisory Physical Oceanographer: 09/2005- present
NOAA, National Centers for Coastal Ocean Science (NCCOS), Kasitsna Bay Laboratory. Homer, AK

Physical Scientist: 06/2000-09/2005
NOAA, NCCOS, Center for Coastal Monitoring and Assessment. Silver Spring, MD

Graduate Research Assistant: 11/1996-06/2000
Old Dominion University, Center for Coastal Physical Oceanography. Norfolk, VA

Oceanographer: 01/1992-11/1996
U.S. Army Corps of Engineers, Norfolk District. Norfolk, VA

Systems Engineer (acoustics): 11/1991-01/1992
GE Government Services. Norfolk, VA

Naval Officer (Oceanographer): 05/1984-09/1991
U.S. Navy active duty - Rota, Spain; Cambridge, MA; Norfolk, VA; Bay St Louis, MS

RELEVANT PUBLICATIONS

- Hoem Neher, T. et al. In Review. Quantifying Temporal and Spatial Ecosystem Variability Across the Northern Gulf of Alaska to Understand Mechanisms of Change. Science Synthesis report to the *Exxon Valdez* Oil Spill Trustee Council. 256 pp.
- Holderied K. and T. Weingartner. In review. Linking Variability in Oceanographic Patterns Between Nearshore and Shelf Waters Across the Gulf of Alaska. In Quantifying Temporal and Spatial Ecosystem Variability Across the Northern Gulf of Alaska to Understand Mechanisms of Change. Science Synthesis report to the *Exxon Valdez* Oil Spill Trustee Council. Chapter 2, pp. 26-36.
- Sigler M.F, R. J. Foy, M. Carls, M. Dalton, L. B. Eisner, K. Holderied, T. P. Hurst, J. F. Morado, P. Stabeno, and R. P. Stone. 2010. NOAA Alaska Region Ocean Acidification Research Plan. Chapter 2 in: NOAA Ocean Acidification Steering Committee. NOAA Ocean and Great Lakes Acidification Research Plan. NOAA Special Report. 143pp.
- Valle-Levinson, A., K. Holderied, C. Li, and R. J. Chant. 2007. Subtidal flow structure at the turning region of a wide outflow plume. J. Geophys. Res. 112. C04004, doi:10.1029/2006JC003746.
- Stumpf, R., S. Dunham, L. Ojanen, A. Richardson, T. Wynne, K. Holderied. 2005. Characterization and Monitoring of Temperature, Chlorophyll, and Light Availability Patterns in National Marine Sanctuary Waters: Final Report. NOAA NCCOS Technical Memorandum 13. Silver Spring, MD. 56 pp.
- National Oceanic and Atmospheric Administration. 2003. Atlas of the Shallow-Water Benthic Habitats of the Northwestern Hawaiian Islands. 160 pp.

- Stumpf, R.P., K. Holderied, and M. Sinclair. 2003. Determination of water depth with high-resolution satellite imagery over variable bottom types. *Limnology and Oceanography*, v. 48(1, part 2), pp. 547-556.
- Caceres, M., A. Valle-Levinson, H.H. Sepulveda, and K. Holderied. 2002. Transverse variability of flow and density in a Chilean fjord. Continental Shelf Research, v. 22(11-13), pp. 1683-1698.

COLLABORATORS IN PAST FOUR YEARS

Apeti, Dennis (NOAA/NOS/NCCOS), Arimitsu, Mayumi (USGS), Ballachey, Brenda (USGS), Bochenek, Rob (Axiom Consulting), Bodkin, Jim (USGS), Batten, Sonia (Sir Alister Hardy Foundation for Ocean Science), Bishop, Mary Ann (PWSSC), Brainard, Starr (NOAA Hollings Scholar), Buckelew, Stacey (Axiom Data Science), Cammarata, Charlayna (NOAA Hollings Scholar), Campbell, Rob (PWSSC), Claar, Danielle (NOAA Hollings Scholar), Coletti, Heather (USNPS), Dean, Tom (Coastal Resources Associates, Inc), Delmaine, Avery (University of North Carolina Wilmington intern), Doroff, Angela (Kachemak Bay National Estuarine Research Reserve), Dugan, Darcy (Alaska Ocean Observing System), Field, Don (NOAA/NOS/NCCOS), Hartwell, Ian (NOAA/NOS/NCCOS), He, Jing (Middlebury College intern), Hoffman, Katrina (PWSSC), Hollmann, Rebecca (NOAA Hollings Scholar), Holman, Amy (NOAA), Hollmen, Tuula (Alaska Sea Life Center), Hondolero, Dominic (NOAA/NOS/NCCOS), Hopcroft, Russ (University of Alaska Fairbanks), Iken, Katrin (UAF), Irons, David (USFWS), Ko, Stanley (NOAA Hollings Scholar), Konar, Brenda (UAF), Lanerolle, Lyon (NOAA/NOS/Office of Coast Survey), Litaker, Wayne (NOAA/NOS/NCCOS), Mathis, Jeremy (UAF), Matkin, Craig (North Gulf Oceanic Society), McCammon, Molly (AOOS), Moran, John (NOAA/NMFS/AFSC), Neher, Tammy (NOAA/NOS/NCCOS), Opheim, Michael (Seldovia Village Tribe), Patchen, Rich (NOAA/NOS/Office of Coast Survey), Paternostro, Chris ((NOAA/NOS/CO-OPS), Pegau, Scott (Oil Spill Recovery Institute), Piatt, John (USGS), Pickens, Chris (NOAA Hollings Scholar), Rear-McLaughlin, Laura (NOAA/NOS/CO-OPS), Rice, Jeep (NOAA/NMFS/AFSC), Rosenberg, Lily (Mt Holyoke College intern), Roy, Emily (University of Massachusetts Amherst intern), Seaman, Glenn (consultant), Sethi, Suresh (USFWS), Tester, Pat (NOAA/NOS/NCCOS), Thompson, Terry (KBNERR), Weingartner, Tom (UAF)

Budget Category:	Proposed FY 17	Proposed FY 18	Proposed FY 19	Proposed FY 20	Proposed FY 21	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$47.2	$49.3	$50.8	$49.6	$53.3	$250.3	
Travel	$7.9	$7.6	$10.5	$8.6	$9.1	$43.7	
Contractual	$74.8	$76.8	$80.3	$38.9	$31.4	$302.2	
Commodities	$11.0	$11.5	$11.5	$12.5	$12.5	$59.0	
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
Indirect Costs (*will vary by proposer*)	$14.8	$14.8	$15.2	$14.9	$16.0	$75.6	
SUBTOTAL	$155.7	$160.0	$168.2	$124.5	$122.3	$730.8	
General Administration (9% of subtotal)	$14.0	$14.4	$15.1	$11.2	$11.0	$65.8	N/A
PROJECT TOTAL	$169.7	$174.4	$183.4	$135.7	$133.3	$796.5	
Other Resources (Cost Share Funds)	$205.0	$213.0	$215.0	$217.0	$194.0	$1,044.0	

COMMENTS:
This is the combined budget for the individual Doroff and Holderied budgets that follow. Doroff is affiliated with the University of Alaska Anchorage, a Non-Trustee Agency, and Holderied is affiliated with NOAA, a Trustee Agency. The budgets have been combined by using a Non-Trustee Agency budget reporting form. This form contains the summary information only. Detail by year for each PI can be found in the following two worksheets.
Cost Share Funds, Doroff: $120K for KBNERR water quality and meteorology long-term monitoring and $5K for CTD uses for a total of $125K/year
Cost Share Funds, Holderied: Annual in-kind support of $50K in NOAA salary (increased annually), $5K for CTD use, $6K for small boat use (~$61K/yr).
Leveraged Funds, Holderied: $25K/yr from AOOS (FY17-20), subject to availability of federal funding.

FY17-21

Project Title: Lower Cook Inlet Oceanographic
Primary Investigators: Angela Doroff (UAA, KBNERR) & Kris Holderied (NOAA)

NON-TRUSTEE AGENCY SUMMARY PAGE

Budget Category:	Proposed FY 17	Proposed FY 18	Proposed FY 19	Proposed FY 20	Proposed FY 21	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$47.2	$49.3	$50.8	$49.6	$53.3	$250.3	
Travel	$2.4	$2.0	$2.0	$2.0	$2.5	$10.8	
Contractual	$5.5	$4.0	$4.0	$4.0	$4.0	$21.5	
Commodities	$4.0	$4.0	$4.0	$4.0	$4.0	$20.0	
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
Indirect Costs (*25%*)	$14.8	$14.8	$15.2	$14.9	$16.0	$75.6	
SUBTOTAL	$73.8	$74.1	$75.9	$74.5	$79.8	$378.2	
General Administration (9% of subtotal)	$6.6	$6.7	$6.8	$6.7	$7.2	$34.0	N/A
PROJECT TOTAL	$80.5	$80.8	$82.8	$81.2	$87.0	$412.3	
Other Resources (Cost Share Funds)	$125.0	$125.0	$125.0	$125.0	$125.0	$625.0	

COMMENTS:
Cost Share Funds: $120K for KBNERR water quality and meteorology long-term monitoring and $5K for CTD uses for a total of $125K/year

FY17-21

Project Title:Lower Cook Inlet Oceanographic
Primary Investigator: Angela Doroff

NON-TRUSTEE AGENCY SUMMARY PAGE

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Angela Doroff	Research Coordinator	2.8	12.0	0.0	33.6
Jame Schlomer	Biological Technician	2.3	4.7	0.0	10.8
Steve Baird	Research Analyst	0.3	11.2	0.0	2.8
Dana Nelson	Education Coordinator	0.0	4.7	0.0	0.0
Rosie Robinson	Biological Technician	0.0	4.7	0.0	0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	37.3	0.0	
				Personnel Total	$47.2

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
EVOS PI Meeting	0.3	1	4	0.1	0.7
AMSS	0.3	1	5	0.1	0.8
lodging			9	0.1	0.9
Taxi			2	0.0	0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2.4

FY17

Project Title:Lower Cook Inlet Oceanographic
Primary Investigator: Angela Doroff

FORM 3B
PERSONNEL & TRAVEL
DETAIL

Contractual Costs: Description	Contract Sum
CTD Calibration	3.0
YSI Bear Cove Sonde Calibration	1.0
Bear Cove Nutrient Analyses	1.5
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$5.5

Commodities Costs: Description	Commodities Sum
Zooplankton supplies(jars, shipping, nets)	1.7
SBE tools and upgrades	0.5
Rite-in-Rain paper/labels, notebooks, pens	0.3
ship/boat safety gear	0.5
Boat fuel	1.0
Commodities Total	$4.0

FY17

Project Title:Lower Cook Inlet Oceanographic
Primary Investigator: Angela Doroff

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
None	0.0	0.0	0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
SBE19+ CTD	1	KBNERR
60cm dia 333mircron mesh bongo nets	1	KBNERR
Davet/lines/weights	multiple	KBNERR
YSI Buoy	1	KBNERR
EXO II water quality data sondes	2	KBNERR
Phytoplankton Nets, bottles, & preservation supplies	multiple	KBNERR
25ft Boston Whaler	1	KBNERR

FY17

Project Title:Lower Cook Inlet Oceanographic
Primary Investigator: Angela Doroff

FORM 3B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Angela Doroff	Research Coordinator	2.8	12.3	0.0	34.4
James Schlomer	Biological Technician	2.5	4.8	0.0	12.0
Steve Baird	Research Analyst	0.3	11.5	0.0	2.9
Dana Nelson	Education Coordinator	0.0	4.8	0.0	0.0
Rosie Robinson	Biological Technician	0.0	4.8	0.0	0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	38.2	0.0	
				Personnel Total	$49.3

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
EVOS PI Meeting	0.3	1	4	0.1	0.5
AMSS	0.3	1	5	0.1	0.6
lodging			9	0.1	0.9
Taxi			2	0.0	0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2.0

FY18

Project Title:Lower Cook Inlet Oceanographic
Primary Investigator: Angela Doroff

FORM 3B
PERSONNEL & TRAVEL
DETAIL

Contractual Costs: Description	Contract Sum
CTD Calibration	2.5
YSI Bear Cove Sonde Calibration	0.7
Bear Cove Nutrient Analyses	0.8
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$4.0

Commodities Costs: Description	Commodities Sum
Zooplankton supplies (jars, shipping, nets)	1.7
SBE tools and upgrades	0.5
Rite-in-Rain paper/labels, notebooks, pens	0.3
ship/boat safety gear	0.5
Boat fuel	1.0
Commodities Total	$4.0

FY18

Project Title:Lower Cook Inlet Oceanographic
Primary Investigator: Angela Doroff

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
None	0.0	0.0	0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
New Equipment Total			$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
SBE19+ CTD	1	KBNERR
60cm dia 333mircron mesh bongo nets	1	KBNERR
Davet/lines/weights	multiple	KBNERR
YSI Buoy	1	KBNERR
EXO II water quality data sondes	2	KBNERR
Phytoplankton Nets, bottles, & preservation supplies	multiple	KBNERR
25ft Boston Whaler	1	KBNERR

FY18

Project Title:Lower Cook Inlet Oceanographic
Primary Investigator: Angela Doroff

FORM 3B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Angela Doroff	Research Coordinator	2.8	12.7	0.0	35.6
James Schlomer	Biological Technician	2.5	4.9	0.0	12.3
Steve Baird	Research Analyst	0.3	11.8	0.0	3.0
Dana Nelson	Education Coordinator	0.0	4.9	0.0	0.0
Rosie Robinson	Biological Technician	0.0	4.9	0.0	0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	39.2	0.0	
				Personnel Total	$50.8

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
EVOS PI Meeting	0.3	1	4	0.1	0.5
AMSS	0.3	1	5	0.1	0.6
lodging			9	0.1	0.9
Taxi			2	0.0	0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2.0

FY19

Project Title:Lower Cook Inlet Oceanographic
Primary Investigator: Angela Doroff

FORM 3B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
CTD Calibration	2.5
YSI Bear Cove Sonde Calibration	0.5
Bear Cove Nutrient Analyses	1.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$4.0

Commodities Costs: Description	Commodities Sum
Zooplankton supplies (jars, shipping, nets)	1.7
SBE tools and upgrades	0.5
Rite-in-Rain paper/labels, notebooks, pens	0.3
ship/boat safety gear	0.5
Boat fuel	1.0
Commodities Total	$4.0

FY19

Project Title:Lower Cook Inlet Oceanographic
Primary Investigator: Angela Doroff

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
SBE19+ CTD	1	KBNERR
60cm dia 333mircron mesh bongo nets	1	KBNERR
Davet/lines/weights	multiple	KBNERR
YSI Buoy	1	KBNERR
EXO II water quality data sondes	2	KBNERR
Phytoplankton Nets, bottles, & preservation supplies	multiple	KBNERR
25ft Boston Whaler	1	KBNERR

FY19

Project Title:Lower Cook Inlet Oceanographic
Primary Investigator: Angela Doroff

FORM 3B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Angela Doroff	Research Coordinator	2.8	13.0	0.0	36.4
James Schlomer	Biological Technician	2.0	5.1	0.0	10.2
Steve Baird	Research Analyst	0.3	12.1	0.0	3.0
Dana Nelson	Education Coordinator	0.0	5.1	0.0	0.0
Rosie Robinson	Biological Technician	0.0	5.1	0.0	0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	40.4	0.0	
				Personnel Total	$49.6

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
EVOS PI Meeting	0.3	1	4	0.1	0.5
AMSS	0.3	1	5	0.1	0.6
lodging			9	0.1	0.9
Taxi			2	0.0	0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2.0

FY20

Project Title:Lower Cook Inlet Oceanographic
Primary Investigator: Angela Doroff

FORM 3B
PERSONNEL & TRAVEL
DETAIL

Contractual Costs: Description	Contract Sum
CTD Calibration	2.7
YSI Bear Cove Sonde Calibration	0.5
Bear Cove Nutrient Analyses	0.8
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$4.0

Commodities Costs: Description	Commodities Sum
Zooplankton supplies (jars, shipping, nets)	1.7
SBE tools and upgrades	0.5
Rite-in-Rain paper/labels, notebooks, pens	0.3
ship/boat safety gear	0.5
Boat fuel	1.0
Commodities Total	$4.0

FY20

Project Title:Lower Cook Inlet Oceanographic
Primary Investigator: Angela Doroff

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
SBE19+ CTD	1	KBNERR
60cm dia 333mircron mesh bongo nets	1	KBNERR
Davet/lines/weights	multiple	KBNERR
YSI Buoy	1	KBNERR
EXO II water quality data sondes	2	KBNERR
Phytoplankton Nets, bottles, & preservation supplies	multiple	KBNERR
25ft Boston Whaler	1	KBNERR

FY20

Project Title:Lower Cook Inlet Oceanographic
Primary Investigator: Angela Doroff

FORM 3B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Angela Doroff	Research Coordinator	2.8	13.3	0.0	37.2
James Schlomer	Biological Technician	2.0	5.2	0.0	10.4
Steve Baird	Research Analyst	0.3	12.4	0.0	3.1
Dana Nelson	Education Coordinator	0.1	5.2	0.0	0.5
Rosie Robinson	Biological Technician	0.4	5.2	0.0	2.1
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	41.3	0.0	
				Personnel Total	$53.3

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
EVOS PI Meeting	0.3	1	4	0.1	0.5
AMSS	0.3	1	5	0.1	0.6
lodging			9	0.1	0.9
Taxi			1	0.0	0.0
one additional conference TBD	0.3	1	4	0.1	0.5
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2.5

FY21

Project Title:Lower Cook Inlet Oceanographic
Primary Investigator: Angela Doroff

FORM 3B
PERSONNEL & TRAVEL
DETAIL

Contractual Costs: Description	Contract Sum
CTD Calibration	2.7
YSI Bear Cove Sonde Calibration	0.5
Bear Cove Nutrient Analyses	0.8
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$4.0

Commodities Costs: Description	Commodities Sum
Zooplankton supplies (jars, shipping, nets)	1.7
SBE tools and upgrades	0.5
Rite-in-Rain paper/labels, notebooks, pens	0.3
ship/boat safety gear	0.5
Boat fuel	1.0
Commodities Total	$4.0

FY21

Project Title:Lower Cook Inlet Oceanographic
Primary Investigator: Angela Doroff

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
None	0.0	0.0	0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
SBE19+ CTD	1	KBNERR
60cm dia 333mircron mesh bongo nets	1	KBNERR
Davet/lines/weights	multiple	KBNERR
YSI Buoy	1	KBNERR
EXO II water quality data sondes	2	KBNERR
Phytoplankton Nets, bottles, & preservation supplies	multiple	KBNERR
25ft Boston Whaler	1	KBNERR

FY21

Project Title:Lower Cook Inlet Oceanographic
Primary Investigator: Angela Doroff

FORM 3B
EQUIPMENT DETAIL

Budget Category:	Proposed FY 17	Proposed FY 18	Proposed FY 19	Proposed FY 20	Proposed FY 21	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
Travel	$5.6	$5.6	$8.5	$6.6	$6.6	$32.8	
Contractual	$69.3	$72.8	$76.3	$34.9	$27.4	$280.7	
Commodities	$7.0	$7.5	$7.5	$8.5	$8.5	$39.0	
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
SUBTOTAL	$81.9	$85.9	$92.3	$50.0	$42.5	$352.5	
General Administration (9% of subtotal)	$7.4	$7.7	$8.3	$4.5	$3.8	$31.7	N/A
PROJECT TOTAL	$89.2	$93.6	$100.6	$54.5	$46.3	$384.2	
Other Resources (Cost Share Funds)	$80.0	$88.0	$90.0	$92.0	$69.0	$419.0	

COMMENTS:
Cost Share Funds:
In-kind: Annual NOAA Kasitsna Bay Laboratory in-kind contributions of $50K in NOAA salary support (increased annually), $5K for CTD use, and $6K for small boat use.
Leveraged Funds: $25K/yr from AOOS (FY17-20), subject to availability of federal funding.
Contractual costs include personnel support for KBL contractor staff in FY17-19.

FY17-21

Project Title: Cook Inlet/Kachemak Bay Oceanography
Primary Investigator: Kris Holderied
Agency: NOAA

TRUSTEE AGENCY SUMMARY PAGE

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	0.0	0.0	
				Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Gulf Watch Alaska annual PI Meeting, 1 person	0.4	1	4	0.3	1.4
Alaska Marine Science Symposium, 2 people	0.4	2	10	0.3	3.2
Water taxi	0.1	12			1.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$5.6

FY17

Project Title: Cook Inlet/Kachemak Bay Oceanography
Primary Investigator: Kris Holderied
Agency: NOAA

FORM 4B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Vessel charter contracts for Cook Inlet surveys	20.5
Data analysis and field sampling support (KBL contractor, Kim Powell)	46.0
CTD calibration	2.8
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$69.3

Commodities Costs: Description	Commodities Sum
Field and boat supplies	1.5
Office supplies	0.5
Boat fuel for KBL small boats	5.0
Commodities Total	$7.0

FY17

Project Title: Cook Inlet/Kachemak Bay Oceanography
Primary Investigator: Kris Holderied
Agency: NOAA

FORM 4B CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
NOAA Kasitsna Bay Lab 19plus CTD profiler	1	1

FY17

Project Title: Cook Inlet/Kachemak Bay Oceanography
Primary Investigator: Kris Holderied
Agency: NOAA

FORM 4B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	0.0	0.0	
				Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Gulf Watch Alaska annual PI Meeting, 1 person	0.4	1	4	0.3	1.4
Alaska Marine Science Symposium, 2 people	0.4	2	10	0.3	3.2
Water taxi	0.1	12			1.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$5.6

FY18

Project Title: Cook Inlet/Kachemak Bay Oceanography
Primary Investigator: Kris Holderied
Agency: NOAA

FORM 4B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Vessel charter contracts for Cook Inlet surveys	22.0
Data analysis and field sampling support (KBL contractor, Kim Powell)	48.0
CTD calibration	2.8
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$72.8

Commodities Costs: Description	Commodities Sum
Field and boat supplies	1.0
Office supplies	1.0
Boat fuel for KBL small boats	5.5
Commodities Total	$7.5

FY18

Project Title: Cook Inlet/Kachemak Bay Oceanography
Primary Investigator: Kris Holderied
Agency: NOAA

FORM 4B CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
NOAA Kasitsna Bay Lab 19plus CTD profiler	1	1

FY18

Project Title: Cook Inlet/Kachemak Bay Oceanography
Primary Investigator: Kris Holderied
Agency: NOAA

FORM 4B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	0.0	0.0	
				Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Gulf Watch Alaska annual PI Meeting, 1 person	0.4	1	4	0.3	1.6
Alaska Marine Science Symposium, 2 people	0.4	2	10	0.3	3.8
Water taxi	0.1	12			1.1
Joint field work (PWS, Campbell project) to refine sampling protocols	0.5	1	6	0.3	2.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$8.5

FY19

Project Title: Cook Inlet/Kachemak Bay Oceanography
Primary Investigator: Kris Holderied
Agency: NOAA

FORM 4B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Vessel charter contracts for Cook Inlet surveys	23.5
Data analysis and field sampling support (KBL contractor, Kim Powell)	50.0
CTD calibration	2.8
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$76.3

Commodities Costs: Description	Commodities Sum
Field and boat supplies	1.0
Office/poster supplies	0.5
Boat fuel for KBL small boats	6.0
Commodities Total	$7.5

FY19

Project Title: Cook Inlet/Kachemak Bay Oceanography
Primary Investigator: Kris Holderied
Agency: NOAA

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
NOAA Kasitsna Bay Lab 19plus CTD profiler	1	1

FY19

Project Title: Cook Inlet/Kachemak Bay Oceanography
Primary Investigator: Kris Holderied
Agency: NOAA

FORM 4B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	0.0	0.0	
				Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Gulf Watch Alaska annual PI Meeting, 1 person	0.4	1	4	0.3	1.6
Alaska Marine Science Symposium, 2 people	0.4	2	10	0.3	3.8
Water taxi	0.1	12			1.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$6.6

FY20

Project Title: Cook Inlet/Kachemak Bay Oceanography
Primary Investigator: Kris Holderied
Agency: NOAA

FORM 4B PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Vessel charter contracts for Cook Inlet surveys	22.0
Data analysis and field sampling support (KBL contractor)	10.0
CTD calibration	2.9
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$34.9

Commodities Costs: Description	Commodities Sum
Field and boat supplies	1.5
Office supplies	0.5
Boat fuel for KBL small boats	6.5
Commodities Total	$8.5

FY20

Project Title: Cook Inlet/Kachemak Bay Oceanography
Primary Investigator: Kris Holderied
Agency: NOAA

FORM 4B CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
NOAA Kasitsna Bay Lab 19plus CTD profiler	1	1

FY20

Project Title: Cook Inlet/Kachemak Bay Oceanography
Primary Investigator: Kris Holderied
Agency: NOAA

FORM 4B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
				0.0	0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	0.0	0.0	
				Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Gulf Watch Alaska annual PI Meeting, 1 person	0.4	1	4	0.3	1.6
Alaska Marine Science Symposium, 2 people	0.4	2	10	0.3	3.8
Water taxi	0.1	12			1.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$6.6

FY21

Project Title: Cook Inlet/Kachemak Bay Oceanography
Primary Investigator: Kris Holderied
Agency: NOAA

FORM 4B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Vessel charter contracts for Cook Inlet surveys	24.5
Data analysis and field sampling support (KBL contractor)	0.0
CTD calibration	2.9
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$27.4

Commodities Costs: Description	Commodities Sum
Field and boat supplies	1.5
Office supplies	0.5
Boat fuel for KBL small boats	6.5
Commodities Total	$8.5

FY21

Project Title: Cook Inlet/Kachemak Bay Oceanography
Primary Investigator: Kris Holderied
Agency: NOAA

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
NOAA Kasitsna Bay Lab 19plus CTD profiler	1	1

FY21

Project Title: Cook Inlet/Kachemak Bay Oceanography
Primary Investigator: Kris Holderied
Agency: NOAA

FORM 4B
EQUIPMENT DETAIL

August 24, 2016

Elise Hsieh, Executive Director
Exxon Valdez Oil Spill Trustee Council
4210 University Drive
Anchorage, AK 99508-4626

Dear Elise:

Final FY 2017-2021 Proposal Submittal for Long-term Monitoring

17120114-L. The Seward Line – Marine Ecosystem monitoring in the Northern Gulf of Alaska

Gulf Watch Alaska, the long-term monitoring program of the *Exxon Valdez* Oil Spill Trustee Council (EVOSTC), has finalized our program and project proposals for fiscal years 2017-2021 funding based on comments received from EVOSTC's Science Panel on May 19, 2016. Below is the final budget summary and response to Science Panel comments for the Seward Line project.

EVOSTC Funding Requested *(including 9% GA)*

FY17	FY18	FY19	FY20	FY21	TOTAL
$132,700	$136,100	$139,500	$143,000	$146,600	$697,900

Non-EVOSTC Funding Available

FY17	FY18	FY19	FY20	FY21	TOTAL
$297,000	$311,000	$314,800	$319,000	$323,500	$1,565,300

Science Panel comments: *The Science Panel notes that this transect of moorings has value as professed in the proposal for purposes of assessing long-term environmental forcing of the base of the pelagic food chains.*

PI Response:

- Thank you for the comment.

  Based on two Science Panel comments: 1) Project costs for 17120114-J Oceanographic Monitoring in Cook Inlet and Kachemak Bay seemed high and 2) the value of additional nutrient monitoring within the Alaska Coastal Current (2014 Science Synthesis Workshop), we have revised this project's proposal to include additional sampling at GAK-1, RES2.5 on the Seward Line, and a more nearshore location to be determined. We proposed to take advantage of day-cruises already proposed by the GAK-1 project, adding a few hours of additional sampling to those cruises to collect nutrients, chlorophyll, and zooplankton. This will result in the Seward Line's end-members (GAK-1 and RES2.5) being sampled with more similar temporal coverage to that now occurring within Kachemak Bay and Prince William Sound, and with a comparable spectrum of chemical and biological measurements accompanying its current physical oceanographic profiles. Funds have been moved laterally within the Environmental Drivers component, from Project 17120114-J Oceanographic Monitoring in Cook Inlet and Kachemak Bay to 17120114-L Seward Line, to support these changes.

Sincerely,

Mandy Lindeberg
Gulf Watch Alaska Program Lead designate

Attachment: Gulf Watch Alaska: Environmental Drivers Component Project Proposal: 17120114-I—The Seward Line – Marine Ecosystem monitoring in the Northern Gulf of Alaska

EVOSTC FY17-FY21 INVITATION FOR PROPOSALS
PROGRAM PROJECT PROPOSAL SUMMARY PAGE

Project Title

Gulf Watch Alaska: Environmental Drivers Project:

17120114-L—The Seward Line – Marine Ecosystem monitoring in the Northern Gulf of Alaska

Primary Investigator(s) and Affiliation(s)

Russell R Hopcroft, Principal Investigator, University of Alaska Fairbanks

Seth L Danielson, University of Alaska Fairbanks

Kenneth O. Coyle, University of Alaska Fairbanks

Date Proposal Submitted

24 August 2016

Project Abstract

Long times-series are required for scientists to tease out pattern and causation in the presence of substantial year-to-year variability. For the 5-year period beginning in 2017, we propose continued multi-disciplinary oceanographic observations begun in fall 1997 in the northern Gulf of Alaska. Cruises occur in early May and early September to capture the typical spring bloom and summer conditions, respectively, along a 150-mile cross shelf transect to the south of Seward, Alaska. The line is augmented by stations in the entrances and deep passages of Prince William Sound. We determine the physical-chemical structure, the distribution and abundance of phytoplankton, microzooplankton, and mesozooplankton, and survey seabirds and marine mammals. These observations enable descriptions of the seasonal and inter-annual variations of this ecosystem. Our goal is to characterize and understand how different climatic conditions influence the biological conditions across these domains within each year, and what may be anticipated under future climate scenarios.

EVOSTC Funding Requested *(must include 9% GA)*

FY17	FY18	FY19	FY20	FY21	TOTAL
$132.7	**$136.1**	**$139.5**	**$143.0**	**$146.6**	**$697.9**

Non-EVOSTC Funding Available

FY17	FY18	FY19	FY20	FY21	TOTAL
$297.0	**$311.0**	**$314.8**	***$319.0****	***$323.5****	**$1,565.3**

* anticipated funding following current 5-year grant

1. Executive Summary

We live in a constantly changing world, influenced by a combination of stochastic events, natural cycles, longer-term oscillations, and the accelerating impact of human activities. Once thought to house relatively stable ecosystems, the oceans are now known to fluctuate between multiple states or "regimes" apparently coupled to major climatic shifts such as the Pacific Decadal Oscillation (PDO). This knowledge derived initially from long-term and global views of physical changes in the ocean and atmosphere, but most importantly from long-term biological observations that demonstrate the impact of "regime shifts" (Francis & Hare 1994, Manuta *et al.* 1997). Such regime shifts may be common (Hare & Mantua 2000), and we are beginning to identify the mechanisms by which these physical changes impact ecosystems (McGowan *et al.* 1998, Beaugrand 2004).

Our understanding of community level changes would not be possible without long-term observation programs (LTOPs), whose value is becoming increasingly apparent as our understanding of ecosystem change and its drivers becomes more sophisticated. Biological time-series such as the North Atlantic CPR (Beaugrand 2004), the North Pacific CalCOFI (McGowan *et al.* 1998), Station/Line P (Mackas *et al.* 2004), and the younger CPR program (Batten & Freeland 2007) in the subarctic Pacific are proving invaluable at documenting regime shift-related changes in species distributions (Beaugrand & Reid 2003) and timing of life histories (Mackas *et al.* 1998). The 1976 Pacific Decadal Oscillation (PDO; Mantua et al. 1997) triggered an ecological regime shift by pushing the Northern Gulf of Alaska (GOA) over a tipping point, resulting in a change from a shrimp-dominated fishery to one dominated by pollock, salmon and halibut (Anderson & Piatt 1999). The PDO and the second mode of North Pacific variability as expressed by the North Pacific Gyre Oscillation (NPGO; Di Lorenzo et al. 2008) are dominant extremes among a continuum of Pacific-wide patterns of oceanic variability. Dominated by a strong seasonal cycle (Waite & Mueter 2013), the GOA ecosystem does not respond in a currently predictable way to intermittent basin-scale events such as El Niño or to longer-term regime shifts such as the PDO (Stabeno et al. 2004), perhaps because the ecosystem is highly adapted to great variability. Nonetheless, it is profoundly affected by warmer years, fresher years, and light conditions in spring, that influence the timing of planktonic processes, but not necessarily their ultimate abundance or biomass (Figure 1). In contrast, temperature is much less variable during late summer, although biological communities continue to show high variability, including increased prevalence of southern species during warmer years. Furthermore, our observations suggest that the recent North Pacific warm-water anomalies impacted rates of *Neocalanus* lipid accumulation and their overwintering health. Understanding how complex pelagic ecosystems work, and how they might be affected by climate change, was the fundamental goal of the Global Ocean Ecosystems Dynamics (GLOBEC) program that occupied the Seward Line from 1997 to 2004. The core questions and related hypotheses can only be addressed by an observational program of sufficient length to encompass long-term (decadal-scale) change and repeated observations of disturbance at different temporal and spatial scales. These observations will allow us to elucidate

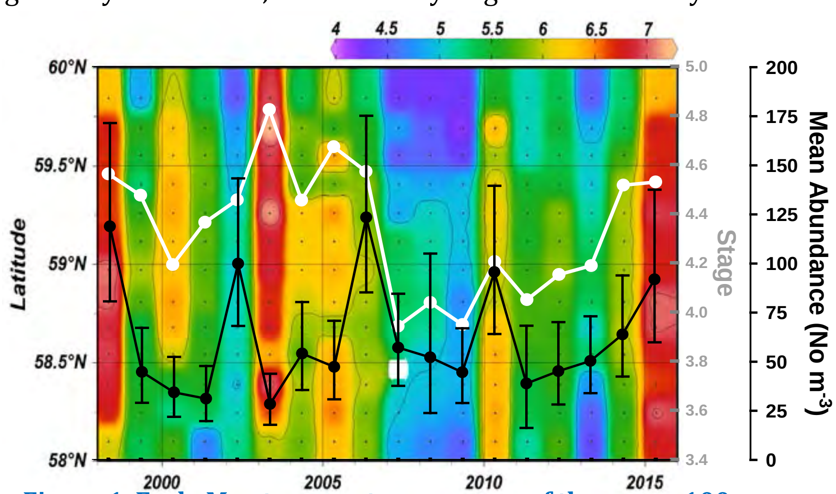

Figure 1. Early May temperature average of the upper 100m along the Seward Line, with abundance (black) and mean stage (white) of *Neocalanus* spp.

the mechanisms underlying adaptation, resilience, diversity and potential tipping points (e.g., Beaugrand et al. 2010, Wiltshire et al. 2008).

Our proposed research will continue long-term multi-disciplinary oceanographic sampling in the GOA, to provide insights into ongoing ecosystem changes in the North Pacific.

Specifically, cruises:

1. Determine thermohaline, velocity, and nutrient structure of the GOA shelf, emphasizing the Seward Line, and Prince William Sound (PWS).
2. Determine the state of carbonate chemistry (i.e., Ocean acidification – Alaska Ocean Observing System [AOOS] funded)
3. Determine the patterns of macronutrient availability across the sampling domain
4. Determine phytoplankton biomass distribution (as chlorophyll)
5. Determine composition and biomass of phytoplankton and microzooplankton (North Pacific Research Board [NPRB] funded).
6. Determine the distribution, abundance and taxonomic composition of zooplankton.
7. Determine the distribution and abundance of seabirds and marine mammals (NPRB funded).

Hypotheses

- ***Climate variations propagate through changes in physical and chemical oceanography, impacting the biological communities in the Gulf of Alaska in terms of composition, magnitude and phenology***
- ***Cross-shelf zonation arises from gradients in the availability of nutrients as well as mixing energy, and is associated with significant gradients in the composition and biomass of phyto-, micro- and mesozooplankton; these in turn result in cross-shelf gradients in seabird communities.***
- ***Standing stocks of plankton communities along the Seward Line, and within PWS, provide useful indices of favorable conditions for higher trophic levels such as fish and seabirds.***

2. Relevance to the Invitation for Proposals

Our proposed research will continue the long-term multi-disciplinary oceanographic sampling program in the Gulf of Alaska. Given the potential for profound climatic impact, the Seward Line Long-term Observation Program (http://www.sfos.uaf.edu/sewardline/) provides these critical observations on the current state of the Northern Gulf of Alaska ecosystem. The work seeks to build a clearer understanding of the dynamics of the North Pacific ecosystems that enables effective long-term management and sustainable use of marine resources through the long-term multidisciplinary monitoring of marine environment.

The Seward Line represents the most comprehensive long-term multidisciplinary sampling program in the coastal GOA; it provides observation of changes in the oceanography of this region that is critical to Alaska's fisheries, subsistence and tourist economies. Seward Line observations over the past 18 years have fundamentally revised our understanding of the coastal GOA ecosystem and allow us an appreciation of not only its major properties, but also their inter-annual variability. It is also essential that time-series are already in place when unforeseen events occur, either due to human activities (e.g., oil spills) or natural events such as the recent North Pacific Warming and current El Niño. Recent warm years have shown an influx of California Current System zooplankton, several of which have not been previously observed in these waters; these may be previews of changes that will occur in a future warmer Gulf of Alaska.

To date, the Seward Line has shown that the quantity and composition of both late spring and summer zooplankton, appear to be significantly correlated with PWS hatchery pink salmon survival in this region (Mundy et al. 2010, Doubleday & Hopcroft 2015). Thus, springtime abundance of zooplankton along the Seward Line appears to be an index of generally favorable years for higher trophic levels throughout the GOA. The recent Gulf of Alaska Integrated Ecosystem Research Program, for which the Seward Line provides an oceanographic foundation, is exploring broader regional patterns as well as looking for relationships between oceanography and other species of forage and commercial fish.

3. Project Personnel

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Please see 2 page CVs at end of this document

4. Project Design

A. Objectives

The scientific purpose of this project is to develop an understanding of the response of this marine ecosystem to climate variability, and provide baselines against which to access any other anthropogenic influences on the GOA ecosystem. Toward this end, the Seward Line cruises on the GOA shelf determine the physical-chemical structure, primary production and the distribution and abundance of zooplankton, along with their seasonal and inter-annual variations. Some of the data are compared with historical data sets whereas other data sets are a product of this continuing systematic sampling effort on this shelf.

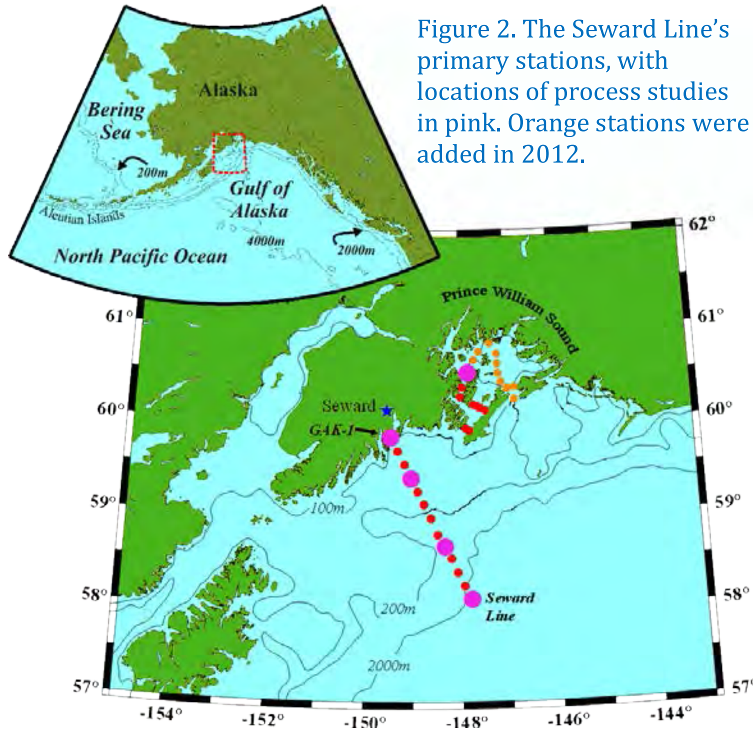

Figure 2. The Seward Line's primary stations, with locations of process studies in pink. Orange stations were added in 2012.

Specifically, cruises:

1. Determine thermohaline, velocity, and nutrient structure of the GOA shelf, emphasizing the Seward Line, and PWS stations (Figure 2).

2. Determine the state of carbonate chemistry (i.e., Ocean acidification – AOOS funded)

3. Determine the patterns of macronutrient availability across the sampling domain

4. Determine phytoplankton biomass distribution (as chlorophyll)

5. Determine composition and biomass of phytoplankton and microzooplankton (NPRB funded).

6. Determine the distribution, abundance and taxonomic composition of zooplankton.

7. Determine the distribution and abundance of seabirds and marine mammals (NPRB funded).

B. Procedural and Scientific Methods

The Seward Line stretches across the GOA Shelf approximately 150 miles, and is augmented by over a dozen stations in PWS. Our cruises capture the major spring-late summer gradient in this seasonality, while retaining a focus on important periods for the life cycles of various zooplankton species. It consists of two cruises each year. The early May period was selected to capture the peak productivity associated with the spring bloom. The consistent timing of the May cruise has allowed us to look at phenological shifts in the large *Neocalanus* copepods that dominate the spring. The September cruise coincides with the end of the low productivity oceanographic summer, when smaller phyto- and zooplankton dominate, and precedes the stormy fall overturn. Using the U.S. Fish and Wildlife Service (USFWS) vessel *Tiglax*, these cruises collect data on the physical-chemical structure, algal biomass, and the distribution, abundance, biomass and productivity of micro- and mesozooplankton. Together, the spring and fall cruises enable us to explore seasonal and inter-annual variations, as we seek to understand how different climatic conditions influence the biological conditions in each year. It provides a reference dataset against which other Gulf Watch Alaska components can index basic environmental conditions.

Methods remain as employed for the past 5-20 years, with details provided on the Gulf Watch Alaska Ocean Workspace (Program Management > Sampling Protocols > Revise Protocols). In brief, physical parameters are measured with a Seabird CTD (Janout et al. 2010). Water samples are collected at up to 12 depths per station with a CTD rosette, then analyzed for nutrient (Childers et al. 2005) and carbonate chemistry (Evans & Mathis 2013). Samples for chlorophyll, phytoplankton and microzooplankton are removed from a subset of the same bottles (Strom et al 2007a,b). Zooplankton are collected to 100 m depth with two types of plankton nets: a vertically-hauled 150-μm net CalVet during daytime that targets the smaller and most numerous animals, and an obliquely-towed 505-μm Multinet during nightime that targets larger and more mobile animals (Coyle & Pinchuk 2003, 2005). Seabird and marine mammal observations are made from the flying bridge using strip-transect methodology (USFWS 2008) on all daytime transits between stations.

Beginning this 5-year cycle, we propose to add additional chemical and biological observations to 6 of the monthly day-trip CTD casts presently ongoing at GAK-1, as well as to the RES2.5 station (centrally located in Resurrection Bay and sampled during Seward Line cruises) and a third station selected by the Nearshore component project. Sampling with be conducted with an SBE-25 CTD and 12-bottle SBE-32SC rosette at depth. Macronutrients and chlorophyll with be collected from the bottles at depths consistent with the Seward Line cruises, filtered and frozen for later analysis. Zooplankton will be sampled at these stations with the same 150 μm nets employed by Seward Line cruises, and analyzed following established protocols.

C. Data Analysis and Statistical Methods

Physical and chemical datasets are examined for trends, often after reducing them to anomalies and variances calculated over the observation period. Biological data sets are also examined for species trends, while community analyses often consider similarity coefficients and use nonparametric multi-dimensional scaling (nMDS) to look for patterns across space and time, and relate these to associated meteorological, physical and biological parameters (Clarke et al. 2014).

D. Description of Study Area

The main Seward Line (Figure 2) consists of 15 stations stretched from Resurrection Bay (~60°N 149.5°W) 150 nm across the shelf to deep offshore waters (to 57.8°N 147.5°W), and includes an equal number of stations within the main passages and entrances to PWS, plus 2 tidewater glaciers (59.9-61°N 146.75-148.25°W).

5. Coordination and Collaboration

Within the Program

This project links tightly with the GAK-1 mooring, providing a cross shelf context for its observations. It complements the continuous plankton recorder, PWS, and Lower Cook Inlet/Kachemak Bay long-term monitoring efforts by providing more detailed oceanographic evaluation of the Gulf of Alaska shelf and the major passages in PWS than is provided by the other programs. These components overlap relatively little in their sampling locations — enough to ensure comparability between datasets, but not enough to be duplicative and wasteful of resources. The addition of monthly sampling in Resurrection Bay aligns sampling periodicity with other Environmental Driver component projects.

Hopcroft has served on the Gulf Watch Alaska Science Coordinating Committee since its inception, with Danielson now also involved, ensuring all components are linked to environmental drivers that assess oceanographic change in the region. The additional monthly sampling in Resurrection Bay and at GAK-1 provide oceanographic context for Nearshore component project activities underway within Resurrection Bay.

With other EVOSTC-funded Programs and Projects

The Seward Line makes physical and biological data available to the Herring Research and Monitoring program.

With Trustee and Management Agencies

Like other Environmental Driver components, Seward Line data is available to the Alaska Department of Fish and Game for salmon forecasting, and provided to the National Oceanographic and Atmospheric Administration for their GOA Ecosystem Status reports.

With Native and Local Communities

Seward Line status is presented annually at the Alaska Marine Science Symposium which is well-attended by residents of the coastal GOA. A seminar will be presented annually at a selected coastal community in the GOA.

6. Schedule

Project Milestones

Project Milestones (Table 1) essentially revolve around the execution of cruises each May and September and the delivery of data. Dependent on the type of data, delivery occurs within 6 months to 1 year of collection. Other milestones include the annual principal investigators meeting and presentation of results at the Alaska Marine Science Symposium.

Table 1. Schedule of Measurable Program Tasks

Task	FY17				FY18				FY19				FY20				FY21			
	Quarter (EVOSTC FY beginning Feb. 1)																			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Cruises																				
May survey		X				X				X				X				X		
Sept survey			X				X				X				X				X	
Data delivery	X			X	X			X	X			X	X			X	X			X
Task 3 Reporting																				
Annual reports	X				X				X				X				X			
Annual PI meeting				X				X				X				X				X
FY work plan (DPD)			X				X				X				X					

MEASURABLE PROJECT TASKS

FY 2017 (Year 6)

FY17, 1st quarter (February 1, 2017 - April 30, 2017)
February: *Annual reports submitted (first 5-year program)*
April: *Daytrip-cruise (Little Dipper)*

FY17, 2nd quarter (May 1, 2017 - July 31, 2017)
May: *Sampling cruise (R/V Tiglax)*
June and July: *Daytrip-cruise (Little Dipper)*

FY17, 3rd quarter (August 1 2017 - October 31, 2017)
August: *Daytrip-cruise (Little Dipper)*
September: *Sampling cruise (R/V Tiglax)*
October: *Daytrip-cruise (Little Dipper)*

FY17, 4th quarter (November 1, 2017 - January 31, 2018)
November: *Annual PI meeting*
December: *Daytrip-cruise (Little Dipper); most sample processing completed for cruises through May, preliminary data available for summer and fall cruises*
January: *Results presented at AMSS*

FY 2018 (Year 7)

FY18, 1st quarter (February 1, 2018 - April 30, 2018)
February: *Annual reports submitted*
April: *Daytrip-cruise (Little Dipper)*

FY18, 2nd quarter (May 1, 2018 - July 31, 2018)
May: *Sampling cruise (R/V Tiglax)*
June and July: *Daytrip-cruise (Little Dipper)*

FY17, 3rd quarter (August 1 2018 - October 31, 2019)
August: *Daytrip-cruise (Little Dipper)*
September: *Sampling cruise (R/V Tiglax)*
October: *Daytrip-cruise (Little Dipper)*

FY18, 4th quarter (November 1, 2018 - January 31, 2019)
November: *Annual PI meeting*
December: *Daytrip-cruise (Little Dipper); most sample processing completed for cruises through May, preliminary data available for summer and fall cruises*
January: *Results presented at AMSS*

FY 2019 (Year 8)

FY19, 1st quarter (February 1, 2019 - April 30, 2019)
February: *Annual reports submitted*
April: *Daytrip-cruise (Little Dipper)*

FY19, 2nd quarter (May 1, 2019 - July 31, 2019)
May: *Sampling cruise (R/V Tiglax)*
June and July: *Daytrip-cruise (Little Dipper)*

FY19, 3rd quarter (August 1, 2019 - October 31, 2019)
August: *Daytrip-cruise (Little Dipper)*
September: *Sampling cruise (R/V Tiglax)*
October: *Daytrip-cruise (Little Dipper)*

FY19, 4th quarter (November 1, 2019 - January 31, 2020)
November: *Annual PI meeting*
December: *Daytrip-cruise (Little Dipper); most sample processing completed for cruises through May, preliminary data available for summer and fall cruises*
January: *Results presented at AMSS*

FY 2020 (Year 9)

FY20, 1st quarter (February 1, 2020 - April 30, 2020)
February: *Annual reports submitted*
April: *Daytrip-cruise (Little Dipper)*

FY20, 2nd quarter (May 1, 2020 - July 31, 2020)
May: *Sampling cruise (R/V Tiglax)*
June and July: *Daytrip-cruise (Little Dipper)*

FY20, 3rd quarter (August 1, 2020 - October 31, 2020)
August: *Daytrip-cruise (Little Dipper)*
September: *Sampling cruise (R/V Tiglax)*

October: *Daytrip-cruise (Little Dipper)*

FY20, 4th quarter (November 1, 2020 - January 31, 2021)
November: *Annual PI meeting*
December: *Daytrip-cruise (Little Dipper); most sample processing completed for cruises through May, preliminary data available for summer and fall cruises*
January: *Results presented at AMSS*

FY 2021 (Year 10)

FY21, 1st quarter (February 1, 2021 - April 30, 2021)
February: *Annual reports submitted*
April: *Daytrip-cruise (Little Dipper)*

FY21, 2nd quarter (May 1, 2021 - July 31, 2021)
May: *Sampling cruise (R/V Tiglax)*
June and July: *Daytrip-cruise (Little Dipper)*

FY21, 3rd quarter (August 1, 2021 - October 31, 2021)
August: *Daytrip-cruise (Little Dipper)*
September: *Sampling cruise (R/V Tiglax)*
October: *Daytrip-cruise (Little Dipper)*

FY21, 4th quarter (November 1, 2021 - January 31, 2022)
November: *Annual PI meeting*
December: *Daytrip-cruise (Little Dipper); most sample processing completed for cruises through May, preliminary data available for summer and fall cruises*
January: *Results presented at AMSS*

7. Budget

BUDGET FORMS (ATTACHED)
Please see the attached project budget form included in the program budget workbook.

SOURCES OF ADDITIONAL FUNDING
This proposal seeks the Exxon Valdez Oil Spill Trustee Council's continuation in a consortium with NPRB and AOOS that currently funds the Seward Line. Full annual costs are ~$400K, with ~$200K coming from NPRB and $100K from AOOS. Half of these costs are associated with vessel charter. Additional ancillary data come from National Science Foundation and National Oceanic and Atmospheric Administration-funded projects that participate on cruises. The proposal also leverages on existing equipment provided by the PIs as well as the consolidation of historical and contemporary information in the GOA through associated activities.

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University of Guelph	Marine Ecology	M.Sc. 1988
University of Guelph	Marine Biology	Ph.D. 1997
Monterey Bay Aquarium Research Institute (MBARI)	Zooplankton Ecology	1997-1999
University of Massachusetts Dartmouth	Zooplankton Ecology	1999-2000

APPOINTMENTS:

Professor, Institute of Marine Science, University of Alaska Fairbanks, 2010-present
Associate Professor, IMS/UAF, 2005-2010
Assistant Professor, IMS/UAF, 2000-2005

MOST RELEVANT PUBLICATIONS: (out of 95)

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Coyle, K.O., G.A. Gibson, K. Hedstrom, A. Hermann, & **R.R. Hopcroft.** 2013. Zooplankton biomass, advection and production on the northern Gulf of Alaska shelf from simulations and field observations. *J. Mar. Sys.* **128**: 185-207.

OTHER SIGNIFICANT PUBLICATIONS:

Mundy, P., D. Allen, J.L. Boldt, N.A. Bond, S. Dressel, E. Farley Jr., D. Hanselman, J. Heifetz, **R.R. Hopcroft**, M.A. Janout, C. Ladd, R. Lam, P. Livingston, C. Lunsford, J.T. Mathis, F. Mueter, C. Rooper, N. Sarkar, K. Shotwell, M. Sturdevant, A.C. Thomas, T.J. Weingartner & D. Woodby. 2010. Status and trends of the Gulf of Alaska Coastal region, 2003-2008. pp. 142-195. *In:* S.M. McKinnell & M. Dagg (ed.) Marine Ecosystems of the North Pacific Ocean; 2003-2008. *PICES Spec. Pub. 4. 393p.*

Pinchuk, A.I., K.O. Coyle & **R.R. Hopcroft**. 2008. Climate-related variability in abundance and reproduction of euphausiids in the northern Gulf of Alaska in 1998-2003. *Prog. Oceanogr.* **77**:203-216.

Liu, H. & **R.R. Hopcroft**. 2008. Growth and development of *Pseudocalanus* spp. in the northern Gulf of Alaska. *J. Plankton Res.* **30**: 923-935.

Pinchuk, A.I. & **R.R. Hopcroft**. 2007. Seasonal variations in the growth rate of euphausiids (*Thysanoessa inermis*, *T. spinifera*, and *Euphausia pacifica*) from the northern Gulf of Alaska. *Mar. Biol.* **151**: 257-269

Liu, H. & **R.R. Hopcroft**. 2006. Growth and development of *Neocalanus flemingeri/plumchrus* in the northern Gulf of Alaska: validation of the artificial cohort method in cold waters. *J. Plankton Res.* **28**: 87-101.

SYNERGISTIC ACTIVITIES:

Public outreach through contributions to magazines (National Geographic, Current: the Journal of Marine Education), radio, newspaper, and television on Arctic ecosystems

Educational web-pages:
http://www.arcodiv.org
http://www.sfos.uaf.edu/sewardline/

Steering Group – Gulf Watch Alaska, Gulf of Alaska Integrated Research Program, Census of Marine Life's (CoML) Arctic Ocean Biodiversity (ArcOD) & Census of Marine Zooplankton (CMarZ), Executive Committee member - Northeast Pacific GLOBEC, US member – Plankton Experts Lead, Circumpolar Biodiversity Monitoring Program

Editorial Board – Marine Biodiversity (Springer), Plankton and Benthic Research (Japan)

Reviewer: manuscripts reviewed for ~15 primary journals, proposals for 6 funding agencies, NSF OPP & BO panel member.

SUBMERSIBLE AND ROV EXPERIENCE:

Johnson-Sea-Link, Ventana, Tiburon, Global Explorer (~100 dives total)

RESEARCH CRUISE EXPERIENCE:

~1000 at-sea days on cruises up to 45 days duration aboard vessels ranging in size from 15-120 m.

COLLABORATORS & OTHER AFFILIATIONS

Collaborators (outside UAF): Bodil Bluhm (UiT), Ann Bucklin (UConn), Lee Cooper (UMCES), Lisa Eisner (NOAA), Jackie Grebmeier (UMCES), Hans-Jurgen Hirche (AWI), Petra Lenz (UH), Ksenia Kosobokova (RAS), Kathy Kuletz (USFWS), Carol Ladd (NOAA), Dhugal Lindsay (JAMSTEC), Jeremy Mathis (NOAA), Calvin Mordy (JISAO), John Nelson (UVic), Torkel Nielsen (DMU), Robert Pickart (WHOI), Phyllis Stabeno (NOAA), Suzanne Strom (WWU)

Graduate advisor: John C. Roff (Acadia U)

Postdoctoral advisors: Bruce Robison & Francisco Chavez (MBARI), Brian Rothchild (UMass)

Graduate Students: Imme Rutzen, Jennifer Questel, Elizaveta Ershova (all Ph.D. *in progress*); Caitlin Smoot (M.Sc. 2015), Ayla Doubleday (M.Sc. 2013), Jenefer Bell (M.Sc.2009), Hui Liu (Ph.D. 2006), Alexei Pinchuk (Ph.D. 2006), Laura Slater (M.Sc. 2004).

SETH LOMBARD DANIELSON

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PROFESSIONAL PREPARATION

University of Alaska Fairbanks, Ph.D. Oceanography, 2012
University of Alaska Fairbanks; M.S. Oceanography, 1996
Lehigh University; B.S. Electrical Engineering, 1990, with honors

APPOINTMENTS

Research Assistant Professor of Oceanography, IMS-UAF, Fairbanks, AK, 2013-present
Research Professional, IMS-UAF, UAF, Fairbanks, AK, 1997–2013
Driller, Polar Ice Coring Office, IMS-UAF, Fairbanks AK, 1993-1994 and UNL, Lincoln, NB, 1996-1997
Research Assistant, Institute of Marine Science, UAF, Fairbanks, AK, 1994-1996
Junior Engineer, Allen Organ Company, Macungie, PA, 1990-1992

MEMBERSHIPS

American Geophysical Union
The Oceanography Society

5 SELECTED PEER-REVIEWED PUBLICATIONS

Danielson. S. L., L. Eisner, C. Ladd, C. Mordy, L. de Sousa, and T. J. Weingartner (in press) A comparison between late summer 2012 and 2013 water masses, macronutrients, and phytoplankton standing crops in the northern Bering and Chukchi Seas, Arctic Eis DSR-II Special Issue

Danielson, S. L., T. W. Weingartner, K. Hedstrom, K. Aagaard, R. Woodgate, E. Curchitser, and P. Stabeno, (2014), Coupled wind-forced controls of the Bering–Chukchi shelf circulation and the Bering Strait through- flow: Ekman transport, continental shelf waves, and variations of the Pacific–Arctic sea surface height gradient. Prog. Oceanogr. http://dx.doi.org/ 10.1016/j.pocean.2014.04.006

Grebmeier, J. M., B. A. Bluhm, L. W. Cooper, **S. L. Danielson**, K. R. Arrigo, A. L. Blanchard, J. T. Clarke, R. H. Day, K. E. Frey, R. R. Gradinger, M. Kedra, B. Konar, K. J. Kuletz, S. H. Lee, J. R. Lovvorn, B. L. Norcross, S. R. Okkonen. (2015) Ecosystem Characteristics and Processes Facilitating Persistent Macrobenthic Biomass Hotspots and Associated Benthivory in the Pacific Arctic, *Prog. Oceanogr*., V136, August 2015, pp. 92-114, doi:10.1016/j.pocean.2015.05.006

Danielson, S. L., K. Hedstrom, K. Aagaard, T. Weingartner, and E. Curchitser (2012), Wind-induced reorganization of the Bering shelf circulation, *Geophys. Res. Lett*., 39, L08601, doi:10.1029/2012GL051231.

Danielson, S. L., E. N. Curchitser, K. Hedstrom, T. J. Weingartner, and P. Stabeno (2011) On ocean and sea ice modes of variability in the Bering Sea, *J. Geophys. Res.*, doi:10.1029/2011JC007389

OTHER PUBLICATIONS RELATED TO THE SEWARD LINE

Stabeno, P. J. S. Bell, W. Cheng, **S. L. Danielson**, N. B. Kachel, C. W. Mordy (in press) Long-term observations of Alaska Coastal Current in the northern Gulf of Alaska, *Deep-Sea Res. II*

Janout, M. A., T. J. Weingartner, T. C. Royer, **S. L. Danielson** (2010), On the nature of winter cooling and the recent temperature shift on the northern Gulf of Alaska shelf, JGR Oceans, 2009JC005774R, DOI: 10.1029/2009JC005774

Wu, J., A. Aguilar-Islas, R. Rember, T. Weingartner, **S. L. Danielson**, and T. Whitledge (2009), Size-fractionated iron distribution on the northern Gulf of Alaska, *Geophys. Res. Lett*., 36, L11606, doi:10.1029/2009GL038304.

Weingartner, T. J., L. Eisner, G. L. Eckert, **S. L. Danielson** (2008), Southeast Alaska: oceanographic

habitats and linkages (p 387-400), *J. of Biogeography*, DOI: 10.1111/j.1365-2699.2008.01994.x.
Weingartner, T. J., **S. L. Danielson**, T.C. Royer (2005), Fresh Water Variability in the Gulf of Alaska: Seasonal, Interannual and Decadal Variability, Deep-Sea Res. II, 52 (1-2): 169-191
Okkonen, S. R., T. J. Weingartner, **S. L. Danielson**, D. L. Musgrave and G. M. Schmidt (2003), Satellite and Hydrographic Observations of Eddy-Induced Shelf-Slope Exchange in the Northwestern Gulf of Alaska, JGR Oceans, 108 (C2): Art. No. 3033

SYNERGISTIC ACTIVITIES

Participant and presenter at the Pribilof Island *Bering Sea Days* week of ocean exploration for St. Paul Island and St. George Island students and community members 2011-present.
October 2010 BEST/BSIERP Professional Development Workshop in Anchorage, AK
October 2009 Center for Ocean Science Education Excellence (COSEE) "Salmon in the Classroom" teacher workshops in Fairbanks AK.
Reviewer for: *Geophysical Research Letters*, *Journal of Geophysical Research*, *Continental Shelf Research*, *Deep-Sea Research*, *Climate Dynamics;* EPSCOR, NOAA, NSF, NPRB
Creator of numerous outreach-directed marine science web pages, including:

- Retrospective analysis of Norton Sound benthic communities (www.ims.uaf.edu/NS/)
- GAK-1 long-term oceanographic monitoring timeseries (www.ims.uaf.edu/gak1/)
- GLOBEC NEP monitoring program (www.ims.uaf.edu/GLOBEC/)
- community-based satellite drifters in the Bering & Chukchi Seas (www.ims.uaf.edu/drifters/)

THESIS TITLES

Variability in the circulation, temperature, and salinity fields of the eastern Bering Sea shelf in response to atmospheric forcing, 2012 Ph.D. Thesis
Chukchi Sea Tidal Currents: Model and Observations, 1996 Masters Thesis.

RELATED ACTIVITIES

1997-2004: Global Ocean Ecosystem Dynamics (GLOBEC) program in the Gulf of Alaska (NSF)
2008-2014: Bering Sea Ecosystem Study (BEST) moorings and larval transport modeling (NSF)
2008-2014: Chukchi Sea Environmental Studies Program (CSESP, Shell/Conoco Phillips/Statoil)
2009-present: PI, Advisor and analyst for Glacier Bay National Park and Preserve oceanographic monitoring and associated process studies (NPS)
2012-2015: co-PI, Arctic Ecosystem Integrated Survey (Arctic Eis, BOEM)
2013-present: PI, Cook Inlet Model Computations (BOEM)
2014-present: PI, Ecosystem monitoring and detection of wind and ice-mediated changes through a year-round physical and biogeochemical mooring in the Northeast Chukchi Sea (NPRB, AOOS, Olgoonik-Fairweather, UAF)
2014-present: co-PI Measuring the pulse of the Gulf of Alaska: Oceanographic observations along the Seward Line (NPRB)
2015-present: co-PI, Arctic Marine Biodiversity Observing Network (AMBON; NOPP)

COLLABORATORS (OUTSIDE UAF)

Aagaard, Knut, UW; Arrigo, Kevin, Stanford; Bates, Nicholas, BIOS; Berge, Jorgen, AUN; Bluhm, Bodil, AUN; Bond, Nick, NOAA; Buckley, Troy, NOAA; Busby, Morgan NOAA; Carmack, Eddy DFO-IOS Canada; Cheng, Wei, NOAA; Clarke, Janet, Leidos; Cokelet, Edward, NOAA; Cosca, Catherine, NOAA; Cross, Jessica, JISAO; Curchitser, Enrique, Rutgers; Daase, Malin, AUN; Daly, Kendra, USF; Day, Robert, ABR, Inc.; De Robertis, Alex, NOAA; Drinkwater, Kenneth, IMR; Eisner, Lisa, NOAA; Evans, Wiley, NOAA; Feely, Richard, NOAA; Frey, Karen, Clark U; Gradinger, Rolf, AUN; Heintz, Ron, NOAA; Hop, Hakkon, NPI; Hunt, George, UW; Isla, Enrique, ICR; Jakobsson, Martin, Stockholm U; Karnovsky, Nina, Pomona College; Kedra, Monika, PAS; Kuletz, Kathy, USFWS; Ladd, Carol, NOAA; Laidre, Kristin, UW; Lauth, Robert, NOAA; Lee, Sang, PNU; Logerwell, Elizabeth, NOAA; Lovvorn, James, SIU; Martini, Kim, NOAA; Mathis, Jeremy, NOAA/UAF; Mordy, Calvin, NOAA; Murphy, Eugene, BAS; Overland, James, NOAA; Pickart, Robert, WHOI; Renaud, Paul, Akvaplanniva, Fram Centre; Salo, Sigrid, NOAA; Sigler, Michael, NOAA; Smith, Walker, VIMS; Sousa, Leandra, NSB; Stabeno, Phyllis, NOAA; Takahashi, Taro, Lamont-Doherty Earth Observatory; Trathan, Philip, BAS; Whitehouse, Andrew, NOAA; Williams, William, DFO-IOS Canada; Wolf-Gladrow, Dieter, AWI; Wood, Kevin, NOAA; Woodgate, Rebecca, UW; Zarayskaya, Yulia, GI RAS

KENNETH O. COYLE
Institute of Marine Science
University of Alaska Fairbanks
Fairbanks, AK 99775-7220
907-474-7705, 907-474-7204 (fax)
coyle@ims.alaska.edu

Education:
University of Alaska Fairbanks, Ph.D. Oceanography, 1997
University of Alaska Fairbanks; M.S. Oceanography, 1974
University of Washington; B.S. Oceanography, 1972

Positions Held:
Research Associate, Institute of Marine Science, University of Alaska Fairbanks, 1988–present
Oceanographic Technician, University of Alaska, 1974–1988
Graduate Research Assistant, IMS, University of Alaska, January 1972–June 1973
Graduate Teaching Assistant, Microbiology, University of Alaska, September 1971–December 1971

Experience:
Zooplankton studies, Bering Sea and Gulf of Alaska (GLOBEC), 1997 - present
Scientific exchange: Murmansk Marine Biological Institute, November 1989; Marine Biological Institute, Vladivostok, June–July 1990
Amphipod energetics, sample collection and processing, data processing, publications, 1986–1994
Seabird studies with G. Hunt, U.C. Irvine: Zooplankton collections, hydroacoustic data collection and processing, northern Bering Sea and Pribilof Islands, Aleutian Islands, Bristol Bay, 1985–2005
Zooplankton collections, sample processing, data processing, publications, APPRISE project, 1985–1992
Bering Sea Ice Edge Ecosystem, sample collection, sample processing, data processing, publications, 1976–1978 (BLM, NOAA, OCS), 1981–1982 (Polar Programs)
Zooplankton and microplankton studies in the Bering, Chukchi and Beaufort Seas (BLM/NOAA, OCS), 1975–1977
Phytoplankton studies, sea ice and marginal ice zone, Beaufort and Chukchi Seas, 1972–1974

Translator: Russian-English translations:
Russian-English translation of articles from Voprosy Ikhtiologii, Gidrobiologicheskii Zhurnal and Okeanologiya for Scripta Publishing Co., 1985–1995

Thesis:
Coyle, K. O. 1974. The ecology of the phytoplankton of Prudhoe Bay, Alaska, and the surrounding waters.

Dissertation
Coyle, K. O. 1997. Distribution of large calanoid copepods in relation to physical oceanographic conditions and foraging auklets in the western Aleutian Islands.

Relevant Publications:
Coyle, K. O., Gibson, G. A., Hedstrom, K., Hermann, A. J., Hopcroft, R. R. 2013. Zooplankton biomass, advection and production on the northern Gulf of Alaska shelf from simulations and field observations. Journal of Marine Systems, 128: 185-207.

Coyle, K. O., Cheng, W., Hinckley, S. L., Lessard, E. J., Whitledge, T., Hermann, A. H, Hedstrom, K. 2012. Model and field observations of effects of circulation on the timing and magnitude of nitrate utilization and production on the northern Gulf of Alaska shelf. Prog. Oceanogr. 103: 16-41.
Coyle, K. O., Eisner, L. B., Mueter, F. J., Pinchuk, A. I., Janout, M. A., Cieciel, K. D., Farley, E. V., Andrews, A. G. 2011. Climate change in the southeastern Bering Sea: impacts on pollock stocks and implications for the Oscillating Control Hypothesis. Fisheries Oceanography, 20(2): 139-156.
Coyle, K. O. 2005. Zooplankton distribution, abundance and biomass relative to water masses in eastern and central Aleutian Island passes. Fish. Oceanogr. 14(Suppl. 1): 77 – 92.
Coyle, K. O. and P. I. Pinchuk. 2005 Seasonal cross-shelf distribution of major zooplankton taxa on the northern Gulf of Alaska shelf relative to water mass properties, species depth preferences and vertical migration behavior. Deep Sea Res. II. 52: 217 – 245.

Recent Publications:

Coyle, K. O., Pinchuk, A. I., Eisner, L. B., Napp, J. M. 2008. Zooplankton species composition, abundance and biomass on the eastern Bering Sea shelf during summer: the potential role of water column stability and nutrients in structuring the zooplankton community. Deep Sea Res. II. (in press)
Coyle, K. O., Konar, B., Blanchard, A., Highsmith, R. C., Carroll, J., Carroll, M., Denisenko, S. G., Sirenko, B. I. 2007. Potential effects of temperature on the benthic infaunal community on the southeastern Bering Sea shelf: Possible impacts of climate change. Deep-Sea Research II, doi:10.1016/j.dsr2.2007.08.025
Coyle, K. O., Bluhm, B., Konar, B., Blanchard, A., Highsmith, R. C. 2007. Amphipod prey of gray whales in the northern Bering Sea: comparison of biomass and distribution between the 1980s and 2002 - 2003. Deep Sea Res. II doi:10.1016/j.dsr2.2007.08.026
Coyle, K. O. and P. I. Pinchuk. 2002. Climate-related differences in zooplankton density and growth on the inner shelf of the southeastern Bering Sea. Prog. Oceanogr. 55: 177-194.
Coyle, K. O. and G. L. Hunt. 2000. Seasonal differences in the distribution, density and scale of zooplankton patches in the upper mixed layer near the western Aleutian Islands. *Plankton. Biol. Ecol.*, 47: 31-42.

Synergistic Activities: Translation of Russian scientific articles and books into English; Development of database of software for analysis of BASIS Bering Sea fisheries and oceanographic data.

Collaborators:
Bodil Bluhm, University of Alaska, Fairbanks
George Hunt, School of Aquatic and Fishery Sciences, University of Washington
Evelyn Lessard, Dept of Oceanography, University of Washington
Sue Moore, National Marine Mammal Laboratory, NOAA, Seattle
Jeff Napp, National Marine Fisheries Service, Seattle
Phyllis Stabeno, Pacific Marine Environmental Lab, NOAA, Seattle
Suzanne Strom, Western Washington State University, Bellingham, Washington
Tom Weingartner, University of Alaska, Fairbanks
Steve Zeeman, University of New England, Biddeform, Maine

Graduate Advisors: Rita Horner, M.S., R. T. Cooney, Ph.D.
Graduate Student Advisor: C. Adams (PhD 2007), L. DeSousa (PhD, 2010)

Budget Category:	Proposed FY 17	Proposed FY 18	Proposed FY 19	Proposed FY 20	Proposed FY 21	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$83.2	$85.2	$87.2	$89.3	$91.4	$436.3	
Travel	$3.9	$4.0	$4.1	$4.3	$4.4	$20.7	
Contractual	$8.0	$8.3	$8.6	$8.8	$9.0	$42.6	
Commodities	$2.3	$2.4	$2.5	$2.7	$2.8	$12.7	
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
Indirect Costs (*25% of non-equip.*)	$ 24.4	$ 25.0	$ 25.6	$ 26.2	$ 26.9	$ 128.1	
SUBTOTAL	$121.8	$124.9	$128.0	$131.2	$134.5	$640.280	
General Administration (9% of subtotal)	$11.0	$11.2	$11.5	$11.8	$12.1	$57.6	N/A
PROJECT TOTAL	$132.7	$136.1	$139.5	$143.0	$146.6	$697.9	
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	

COMMENTS:

FY17-21

Project Title: Seward Line
Primary Investigator: Russ Hopcroft

NON-TRUSTEE AGENCY SUMMARY PAGE

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Hopcroft	Seward Line	0.5	16.1		8.0
Danielson	Seward Line	0.5	14.6		7.3
Coyle	Seward Line	0.5	10.3		5.1
Stockmar	Seward Line	6.0	8.9		53.5
Smoot	Seward Line	0.6	7.6		4.6
Shipton	Seward Line	0.6	7.8		4.7
					0.0
					0.0
					0.0
					0.0
		Subtotal	65.2	0.0	
				Personnel Total	$83.2

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
RT Fairbanks-Seward, by rented van ($600/year plus 10% increase/yea	0.7	1			0.7
Shared Lodging (shared lodging-10 ppl 2 ppl per room, 6 nights per trip		1	12	0.1	1.2
Meals & Incidentals (10 people for 10 days each per trip)		1	20	0.1	1.0
Ground Transportation ($200/trip plus 10% increase per year)		1	1	0.2	0.2
					0.0
RT Fairbanks - Anchorage - AMSS & PI Meetings					0.0
Airfare (base price of $200/trip plus 10% increase per year)	0.2	1			0.2
Lodging (3 nights per trip at $99/night)		1	3	0.1	0.3
Meals & Incidentals (4 days per trip, $60 per day)		1	4	0.1	0.2
Ground Transportation ($40/trip plus 10% increase per year)		1	1	0.0	0.0
					0.0
				Travel Total	$3.9

FY17

Project Title: Seward Line
Primary Investigator: Russ Hopcroft

FORM 3B
PERSONNEL & TRAVEL
DETAIL

Contractual Costs: Description	Contract Sum
Shipping to/from Seward	1.0
Crane and Dock fees	1.3
2 hrs extra/cruise Little Dipper	1.4
Nutrients -- assume 12x3/cruisex8cruise@$15	4.3
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$8.0

Commodities Costs: Description	Commodities Sum
Supplies	1.3
Chloro supplies	1.0
Commodities Total	$2.3

FY17

Project Title: Seward Line
Primary Investigator: Russ Hopcroft

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY17

Project Title: Seward Line
Primary Investigator: Russ Hopcroft

FORM 3B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Hopcroft	Seward Line	0.5	16.4		8.2
Danielson	Seward Line	0.5	14.8		7.4
Coyle	Seward Line	0.5	10.5		5.3
Stockmar	Seward Line	6.0	9.1		54.8
Smoot	Seward Line	0.6	7.8		4.7
Shipton	Seward Line	0.6	8.0		4.8
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	66.7	0.0	
				Personnel Total	$85.2

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
RT Fairbanks-Seward, by rented van ($600/year plus 10% increase/yea	0.7	1			0.7
Shared Lodging (shared lodging-10 ppl 2 ppl per room, 6 nights per trip		1	12	0.1	1.2
Meals & Incidentals (10 people for 10 days each per trip)		1	20	0.1	1.0
Ground Transportation ($200/trip plus 10% increase per year)		1	1	0.2	0.2
					0.0
RT Fairbanks - Anchorage - AMSS & PI Meetings					0.0
Airfare (base price of $200/trip plus 10% increase per year)	0.2	1			0.2
Lodging (3 nights per trip at $99/night)		1	3	0.1	0.3
Meals & Incidentals (4 days per trip, $60 per day)		1	4	0.1	0.2
Ground Transportation ($40/trip plus 10% increase per year)		1	1	0.0	0.0
					0.0
				Travel Total	$4.0

FY18

Project Title: Seward Line
Primary Investigator: Russ Hopcroft

FORM 3B
PERSONNEL & TRAVEL
DETAIL

Contractual Costs: Description	Contract Sum
Shipping to/from Seward	1.1
Crane and Dock fees	1.5
2 hrs extra/cruise Little Dipper	1.4
Nutrients--assume 12x3/cruisex8 cruise@$15	4.3
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$8.3

Commodities Costs: Description	Commodities Sum
Supplies	1.4
Chloro supplies	1.0
Commodities Total	$2.4

FY18

Project Title: Seward Line
Primary Investigator: Russ Hopcroft

FORM 3B CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY18

Project Title: Seward Line
Primary Investigator: Russ Hopcroft

FORM 3B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Hopcroft	Seward Line	0.5	16.7		8.4
Danielson	Seward Line	0.5	15.1		7.6
Coyle	Seward Line	0.5	10.7		5.4
Stockmar	Seward Line	6.0	9.4		56.2
Smoot	Seward Line	0.6	8.0		4.8
Shipton	Seward Line	0.6	8.2		4.9
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	68.1	0.0	
				Personnel Total	$87.2

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
RT Fairbanks-Seward, by rented van ($600/year plus 10% increase/yea	0.8	1			0.8
Shared Lodging (shared lodging-10 ppl 2 ppl per room, 6 nights per trip)		1	12	0.1	1.2
Meals & Incidentals (10 people for 10 days each per trip)		1	20	0.1	1.0
Ground Transportation ($200/trip plus 10% increase per year)		1	1	0.3	0.3
					0.0
RT Fairbanks - Anchorage - AMSS & PI Meetings					0.0
Airfare (base price of $200/trip plus 10% increase per year)	0.3	1			0.3
Lodging (3 nights per trip at $99/night)		1	3	0.1	0.3
Meals & Incidentals (4 days per trip, $60 per day)		1	4	0.1	0.2
Ground Transportation ($40/trip plus 10% increase per year)		1	1	0.1	0.1
					0.0
				Travel Total	$4.1

FY19

Project Title: Seward Line
Primary Investigator: Russ Hopcroft

FORM 3B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Shipping to/from Seward	1.2
Crane and Dock fees	1.6
2 hrs extra/cruise Little Dipper	1.4
Nutrients--assume 12x3/cruisex8@$15	4.3
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$8.6

Commodities Costs: Description	Commodities Sum
Supplies	1.5
Chloro supplies	1.0
Commodities Total	$2.5

FY19

Project Title: Seward Line
Primary Investigator: Russ Hopcroft

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY19

Project Title: Seward Line
Primary Investigator: Russ Hopcroft

FORM 3B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Hopcroft	Seward Line	0.5	17.1		8.5
Danielson	Seward Line	0.5	15.4		7.7
Coyle	Seward Line	0.5	10.9		5.5
Stockmar	Seward Line	6.0	9.6		57.6
Smoot	Seward Line	0.6	8.2		4.9
Shipton	Seward Line	0.6	8.4		5.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	69.6	0.0	
				Personnel Total	$89.3

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
RT Fairbanks-Seward, by rented van ($600/year plus 10% increase/yea	0.9	1			0.9
Shared Lodging (shared lodging-10 ppl 2 ppl per room, 6 nights per trip)		1	12	0.1	1.2
Meals & Incidentals (10 people for 10 days each per trip)		1	20	0.1	1.0
Ground Transportation ($200/trip plus 10% increase per year)		1	1	0.3	0.3
					0.0
RT Fairbanks - Anchorage - AMSS & PI Meetings					0.0
Airfare (base price of $200/trip plus 10% increase per year)	0.3	1			0.3
Lodging (3 nights per trip at $99/night)		1	3	0.1	0.3
Meals & Incidentals (4 days per trip, $60 per day)		1	4	0.1	0.2
Ground Transportation ($40/trip plus 10% increase per year)		1	1	0.1	0.1
					0.0
				Travel Total	$4.3

FY20

Project Title: Seward Line
Primary Investigator: Russ Hopcroft

FORM 3B
PERSONNEL & TRAVEL
DETAIL

Contractual Costs: Description	Contract Sum
Shipping to/from Seward	1.3
Crane and Dock fees	1.7
2 hrs extra/cruise Little Dipper	1.4
Nutrients--assume 12x3/cruisex8 cruise@$15	4.3
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$8.8

Commodities Costs: Description	Commodities Sum
Supplies	1.7
Chloro supplies	1.0
Commodities Total	$2.7

FY20

Project Title: Seward Line
Primary Investigator: Russ Hopcroft

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY20

Project Title: Seward Line
Primary Investigator: Russ Hopcroft

FORM 3B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Hopcroft	Seward Line	0.5	17.4		8.7
Danielson	Seward Line	0.5	15.7		7.9
Coyle	Seward Line	0.5	11.1		5.6
Stockmar	Seward Line	6.0	9.8		59.1
Smoot	Seward Line	0.6	8.4		5.1
Shipton	Seward Line	0.6	8.6		5.1
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	71.1	0.0	
				Personnel Total	$91.4

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
RT Fairbanks-Seward, by rented van ($600/year plus 10% increase/yea	1.0	1			1.0
Shared Lodging (shared lodging-10 ppl 2 ppl per room, 6 nights per trip)		1	12	0.1	1.2
Meals & Incidentals (10 people for 10 days each per trip)		1	20	0.1	1.0
Ground Transportation ($200/trip plus 10% increase per year)		1	1	0.3	0.3
					0.0
RT Fairbanks - Anchorage - AMSS & PI Meetings					0.0
Airfare (base price of $200/trip plus 10% increase per year)	0.3	1			0.3
Lodging (3 nights per trip at $99/night)		1	3	0.1	0.3
Meals & Incidentals (4 days per trip, $60 per day)		1	4	0.1	0.2
Ground Transportation ($40/trip plus 10% increase per year)		1	1	0.1	0.1
					0.0
				Travel Total	$4.4

FY21

Project Title: Seward Line
Primary Investigator: Russ Hopcroft

FORM 3B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Shipping to/from Seward	1.4
Crane and Dock fees	1.8
2 hrs extra/cruise Little Dipper	1.4
Nutrients--assume 12x3/cruisex8 cruise @$15	4.3
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$9.0

Commodities Costs: Description	Commodities Sum
Crusie supplies	1.8
Chloro supplies	1.0
Commodities Total	$2.8

FY21

Project Title: Seward Line
Primary Investigator: Russ Hopcroft

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY21

Project Title: Seward Line
Primary Investigator: Russ Hopcroft

FORM 3B
EQUIPMENT DETAIL

GULFWATCH ALASKA

August 24, 2016

Elise Hsieh, Executive Director
Exxon Valdez Oil Spill Trustee Council
4210 University Drive
Anchorage, AK 99508-4626

Dear Elise:

Final FY 2017-2021 Proposal Submittal for Long-term Monitoring

17120114-M. Prince William Sound Marine Bird Population Trends

Gulf Watch Alaska, the long-term monitoring program of the *Exxon Valdez* Oil Spill Trustee Council (EVOSTC), has finalized our program and project proposals for fiscal years 2017-2021 funding based on comments received from EVOSTC's Science Panel on May 19, 2016. Below is the final budget summary and response to Science Panel comments for the Prince William Sound marine bird population trends project.

EVOSTC Funding Requested *(including 9% GA)*

FY17	FY18	FY19	FY20	FY21	TOTAL
$24,900	$222,200	$24,900	$222,200	$24,900	$519,100

Non-EVOSTC Funding Available

FY17	FY18	FY19	FY20	FY21	TOTAL
$23,000	$56,000	$23,000	$56,000	$22,000	$180,000

Science Panel comment: *There are no project specific comments.*

PI Response:

- The proposal was not revised.

Sincerely,

Mandy Lindeberg
Gulf Watch Alaska Program Lead designate

Attachment: Gulf Watch Alaska: Pelagic Component Project Proposal: 17120114-M—Continuing the Legacy: Prince William Sound Marine Bird Population Trends

EVOSTC FY17-FY21 INVITATION FOR PROPOSALS
PROGRAM PROJECT PROPOSAL SUMMARY PAGE

Project Title

Gulf Watch Alaska: Pelagic Component Project:

17120114-M—Continuing the Legacy: Prince William Sound Marine Bird Population Trends

Primary Investigator(s) and Affiliation(s)

Dr. Kathy Kuletz, US Fish and Wildlife Service

Robb Kaler, US Fish and Wildlife Service

Date Proposal Submitted

24 August 2016

Project Abstract

We propose to conduct small boat-based surveys to monitor abundance of marine birds in Prince William Sound (PWS), Alaska, during July 2018 and July 2020. Historical data include fourteen surveys spanning 1989 to 2014 (a fifteenth survey will be conducted in July 2016) and have been used to monitor population trends for marine birds in PWS following the 1989 *Exxon Valdez* oil spill (EVOS). Continued long-term monitoring of marine birds in PWS and synthesis of the data are needed to determine recovery of marine bird populations injured by the spill, as well as evaluate the possible effects of climate variability and climate change on these populations. Data collected from 1989 to 2014 indicated that pigeon guillemots (*Cepphus columba*) and *Brachyramphus* murrelets had declined in the oiled areas of PWS. Furthermore, declines were observed of offshore-associated plantivorous and piscivorous genera of marine birds suggesting that changes have likely occurred in the pelagic food webs of PWS. Continuation of boat-based marine bird surveys in PWS will (i) build upon an important data set for long-term monitoring of population recovery of marine bird species following the EVOS, and (ii) provide managers and researchers with a tool to track impacts of climate variability and climate change on important groups of marine predators. Marine bird surveys compliment the benthic monitoring and forage fish monitoring aspects (including Middleton Island proposed project) of the Long-term Monitoring Project by providing a population trend index useful for interpreting marine ecosystem patterns observed in PWS.

EVOSTC Funding Requested *(must include 9% GA)*

FY17	FY18	FY19	FY20	FY21	TOTAL
$24.9	$222.2	$24.9	$222.2	$24.9	$519.1

Non-EVOSTC Funding Available

FY17	FY18	FY19	FY20	FY21	TOTAL
$23	$56	$23	$56	$22	$180

1. Executive Summary

Pelagic Component

In the aftermath of the 1989 *Exxon Valdez* oil spill (EVOS) it was difficult to distinguish between the impacts of the spill and natural variability in affected animal populations. The main problem for assessing impacts on pelagic species was that long-term baseline data were largely absent. As a result, managers struggled to make informed decisions regarding estimation of damages and recommendations for recovery. Ten years after the spill it became widely recognized that there had been a major climatic regime shift (from colder to warmer than average) that altered the marine ecosystem prior to the spill, including marine birds, marine mammals, groundfish, and the shared forage species they all consumed. As we begin to close the second decade of the 2000s we are experiencing anomalous ocean warming events driven by changing atmospheric conditions at both inter-decadal (i.e., Pacific Decadal Oscillation) and shorter (e.g., El Niño Southern Oscillation) time scales. These changes may have profound effects on pelagic ecosystems such as unusual mortality events, harmful algal blooms, and fishery closures.

During the first five years of the Gulf Watch Alaska (GWA) program, the pelagic component research team addressed two main questions: 1) What are the population trends of key pelagic species groups in PWS, and, 2) How can forage fish population trends in PWS be monitored most effectively? To answer these questions, five projects focused on species that play a pivotal role in the pelagic ecosystem as trophic indicators for short and long-term ecosystem change: forage fish, marine birds, humpback whales and killer whales. Monitoring of killer whales and marine birds benefitted from having pre-existing long-term data sets as a result of the damage assessment process following the EVOS (>25-year time series).

Moving forward for the next five years, the pelagic research team re-evaluated their primary objectives. The group's primary goal — to determine the long-term population trends of key pelagic species groups in PWS — will remain the same. The second primary objective was fundamentally different: Develop a means to effectively monitor forage fish. Based on knowledge gained in the first five years of the pelagic program, we have developed a broader focus that includes an integrated study of forage fish using marine bird and mammal predators as samplers of the forage base. In addition to providing a means to effectively monitor indices of forage fish trends, our integrated approach will also enhance our understanding of predator-prey relationships and help us identify some mechanisms of change in populations. Ultimately, the integrated surveys along with information from the GWA Environmental Drivers component will provide a way to evaluate climate variability and climate change on the PWS pelagic ecosystem.

Thus, the two over-arching questions for the pelagic component to answer in the next five years are:

1. What are the population trends of key upper trophic level pelagic species groups in Prince William Sound – killer whales, humpback whales, marine birds, and forage fish?
2. How do predator-prey interactions, including interannual changes in prey availability, contribute to underlying changes in the populations of pelagic predators in Prince William Sound and Middleton Island?

The pelagic component research team is proposing to continue monitoring key pelagic species groups in PWS using the same five projects focused on killer whales, humpback whales, forage fish, and marine birds. However, modifications have been made to some projects for greater integration, increased precision of information, and achieving new goals. Ultimately this will provide more information to the EVOS Trustee Council, agency resource managers, non-governmental organizations, and the public.

MARINE BIRD MONITORING

Boat-based marine bird surveys have been conducted in PWS over a 25-year period following EVOS. In order to better understand the dynamics of a marine bird community that has experienced the simultaneous effects of a major oil spill and climate variability, this project will collect additional information to monitor the distribution and abundance of marine birds in PWS. These data will be combined with data collected in 1989-91 (Klosiewski and Laing 1994), 1993 (Agler et al. 1994a), 1994 (Agler et al. 1995a), 1996 (Agler and Kendall 1997), 1998 (Lance et al. 1999, Irons et al. 2000, Lance et al. 2001) and 2000 (Stephensen et al. 2001), 2004 (Sullivan et al. 2005), 2005 (McKnight et al. 2006), 2007 (McKnight et al. 2008), 2010 and 2012 (Cushing et al. 2012) to examine trends in marine bird distribution and abundance.

The goals of this long-term study are to

1. Identify changes in marine bird populations, particularly in oiled and unoiled portions of PWS, and
2. Evaluate possible effects of climate variability and climate change on marine bird populations in PWS.

The proposed project will benefit restoration of PWS by determining whether populations that declined due to the spill are recovering and by identifying which species are still of concern. To evaluate possible effects of climate on marine bird populations, we will explore patterns of marine bird population trends with oceanographic data and environmental variables (e.g., sea surface temperatures, sea surface salinity) collected by partners and state and federal agencies (e.g., Alaska Department of Fish and Game, US Geological Survey, National Oceanic and Atmospheric Administration, GWA)

McKnight et al. (2008) examined whether marine bird and mammal species designated as injured by the EVOS Trustee Council (EVOSTC) had shown signs of recovery. Data collected from 1989 to 2007 in the oiled area indicated that common loons (*Gavia immer*) and cormorants (*Phalacrocorax* spp.) were increasing, while pigeon guillemots (*Cepphus columba*), and marbled murrelets (*Brachyramphus marmoratus*) declined. Pigeon Guillemots remain the only bird on the EVOSTC injured species list that has not recovered following the EVOS. Cushing (2014) examined spatial patterns of marine bird community composition in PWS from 1989 through 2012 and found that seven of 18 evaluated genera of marine bird declined in abundance over the study period while three increased in abundance. Genera of marine birds noted to have declined over the study period primarily feed on fish or zooplankton and results supported finding of Agler et al. (1999), who concluded that in PWS piscivorous taxa of marine birds were more likely than non-piscivorous taxa to have declined in abundance between 1972 and the early 1990s.

The marine bird data and environmental data will be collected following the standardized protocols and project design used since 1989. The marine bird protocol and study design was reviewed by the GWA Science Review Panel, which provided useful input and endorsed the standardized methods as a well-designed marine bird study with a useful study design for monitoring of population trends in PWS.

2. Relevance to the Invitation for Proposals

The proposed project is relevant to the Invitation for Proposals in terms of (i) monitoring the restoration of species impacted by EVOS, and (ii) contributing to an integrated evaluation of the possible effects of climate change on the pelagic ecosystem. Continuation of the PWS Marine Bird Population Trends project will add two new data points (2018 and 2020) to a legacy data set spanning 27 years (1989-2016), one of the longest data streams available for PWS and the northern coast of the Gulf of Alaska (GOA). These legacy data provide the EVOSTC and GWA researchers with a meaningful way to track species recovery following the spill. Furthermore, the proposal is relevant to the Invitation which noted the need to evaluate the possible effects of climate change. The marine bird survey contributes baseline information which will aid in interpretation of observations of pelagic bird species influenced by factors such as short-term climate variability (e.g., the Pacific Decadal Oscillation) and long-term climate change (i.e., global warming).

Data collected during the proposed marine bird survey project will provide detailed population trend data and distribution maps for approximately 21 species or species groups (e.g., loons, Brachyramphus murrelets) of birds in the PWS region, providing important information to managers (e.g., Bureau of Ocean Energy and Management, National Marine Fisheries Service, Chugach National Forest) and marine researchers (e.g., GWA, Prince William Sound Science Center, US Geological Survey, university researchers). Owing to their reliance on the marine ecosystem, marine bird species are important indicators of the status of pelagic ecosystems, and these data have broad utility in efforts to inform policy makers, resource managers, and the general public.

3. Project Personnel

Dr. Kathy Kuletz
US Fish and Wildlife Service
Wildlife Biologist/Seabird Coordinator
1011 East Tudor Road, Anchorage, Alaska 99503
907-786-3453
kathy_kuletz@fws.gov

Robb Kaler
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Wildlife Biologist
1011 East Tudor Road, Anchorage Alaska 99503
907-786-3984
robert_kaler@fws.gov

Please see 2 page CVs at end of this document

4. Project Design

A. Objectives

In order to assess population trends in the years following the EVOS, the first project objective is a continuation of the primary objective identified in the 2012-2016 PWS Marine Bird Population Trends project — determine population abundance, with 95% confidence limits, of marine bird populations in PWS during July in both oiled and unoiled regions. The secondary project objective is aimed at identifying factors influencing observed population trend patterns using field census data, field environmental data, and GWA and partner agency environmental data.

The continuation of the PWS Marine Bird Population Trends project will add two new data points (2018 and 2020) to a data set spanning 27 years (1989-2016). These legacy data provide GWA researchers with a meaningful way to track ecosystem recovery following the EVOS, as well as integrate additional complimentary biological and environmental data sets collected in the GOA by GWA researchers and other agency partners.

B. PROCEDURAL AND SCIENTIFIC METHODS

Survey methodology and design will remain identical to that of past marine bird surveys conducted by the US Fish and Wildlife Service in 1989, 1990, 1991 (Klosiewski and Laing 1994), 1993 (Agler et al. 1994), 1994 (Agler et al. 1995), 1996 (Agler and Kendall 1997), 1998 (Lance et al. 1999), 2000 (Stephensen et al. 2001), 2004 (Sullivan et al. 2005), 2005 (McKnight et al. 2006), 2007 (McKnight et al. 2008), and 2010, 2012 (Cushing et al. 2012). We will conduct two surveys: one during July 2018 and 2020. We will use three 7.7 m fiberglass boats traveling at speeds of 10-20 km/hr to survey transects over a 3-week period.

We will continue to use a stratified random sampling design containing three strata: shoreline, coastal-pelagic, and pelagic (Klosiewski and Laing 1994) (Figure 1). The shoreline stratum will consist of waters within 200 m of land. Irons et al. (1988a) divided this stratum, by habitat, into 742 transects with a total area of 820.74 km^2. We will locate shoreline transects by geographic features, such as points of land, to facilitate orientation in the field and to separate the shoreline by habitat (Irons et al. 1988a,b). Shoreline transects will vary in size, ranging from small islands with <1 km of coastline to sections of the mainland with over 30 km of coastline. Mean transect length will be 5.55 km. During summer, we plan to survey 212 shoreline transects. All transects were randomly chosen, and the same transects are used each survey (Klosiewski and Laing 1994).

C. DATA ANALYSIS AND STATISTICAL METHOD

As in previous surveys (Klosiewski and Laing 1994, Agler et al. 1994, 1995, Agler and Kendall 1997, Lance et al. 1999, Stephensen et al. 2001, Sullivan et al. 2005, McKnight et al. 2006, McKnight et al. 2008, Cushing et al. 2012), we will use a ratio estimator (Cochran 1977) to estimate population abundance. Shoreline transects will be treated as a simple random sample; whereas the coastal-pelagic and pelagic transects will be analyzed as two-stage cluster samples of unequal size (Cochran 1977). To do this, we will estimate the density of birds counted on the combined transects for a block and multiply by the area of the sampled block to obtain a population estimate for each block; any land or shoreline area (within 200m of land) intersecting a block will be subtracted from the total area of that block. We then will add the estimates from all blocks surveyed and divide by the sum of the areas of all blocks surveyed. We will calculate the population estimate for a stratum by multiplying this estimate by the area of all blocks in the strata. Population estimates for each species and for all birds in PWS will be calculated by adding the estimates from the three strata, and we will calculate 95% confidence intervals for these estimates from the sum of the variances of each stratum (Klosiewski and Laing 1994).

TRENDS IN THE OILED REGION

We will perform a linear regression on log-transformed population estimates over time (1989 – 2016) in the oiled region of PWS. Prior to calculating the log10 of each population estimate, we will add a constant of 0.167 to each estimate to avoid the undefined log10 of 0. In all analyses we will use a test size alpha = 0.10 to balance Type I and Type II errors. The reasons for this include: 1) variation is often high and sample sizes low (n = 14 survey years); and 2) monitoring studies are inherently different from experiments and the number of tests being run with a multi-species survey are many, therefore, controlling for the number of tests by lowering alpha levels (e.g., Bonferroni adjustment) might obscure trends of biological value.

COMPARING TRENDS BETWEEN OILED AND UNOILED REGIONS

We will use the regression technique detailed in (a) to perform regression analyses on population estimates (1989 – 2016) in the unoiled region. We will use a homogeneity of slopes test (Freud and Littell 1981) to compare population trends between the oiled and unoiled zones of PWS to examine whether species with population estimates of >500 individuals have changed over time. To do this, we must assume that marine bird populations increase at the same rate in the oiled and unoiled zones of PWS. Significantly different slopes would indicate that population abundance of a species or species group changed at different rates.

Taxa showing no difference in trends between the oiled and unoiled regions will be considered "not recovering." Taxa showing significantly greater trends in the oiled region compared with the unoiled region will be considered "recovering." Taxa showing significantly greater trends in the unoiled region compared to the oiled region will be considered to be suffering "continuing and increasing effects."

Overall, a species will be considered "recovering" if it meets the requirements for this category in either the regression analysis within the oiled region or the homogeneous slopes analysis.

To determine optimum survey frequency, we conducted a power analysis to estimate the probability of detecting trends in abundance using linear regression from a given number of samples (Taylor and Gerrodette 1993). We examined our power to detect trends when coefficient of variation (CV) of the population was 0.30 (greater than the mean CV from previous surveys for 73% of the injured species; Fig. 2) and when the CV = 0.13 (the mean summer CV for *Brachyramphus* murrelets, which had the lowest CV among injured species). Models of seabird population growth predict most species cannot increase more than 12% per year (Nur and Ainley 1992), so we used 10% for our comparisons. With CV=0.30 the probability of detecting an average annual change of 10% would be 92% based on using survey data from 1989-2010 (Figure 1).

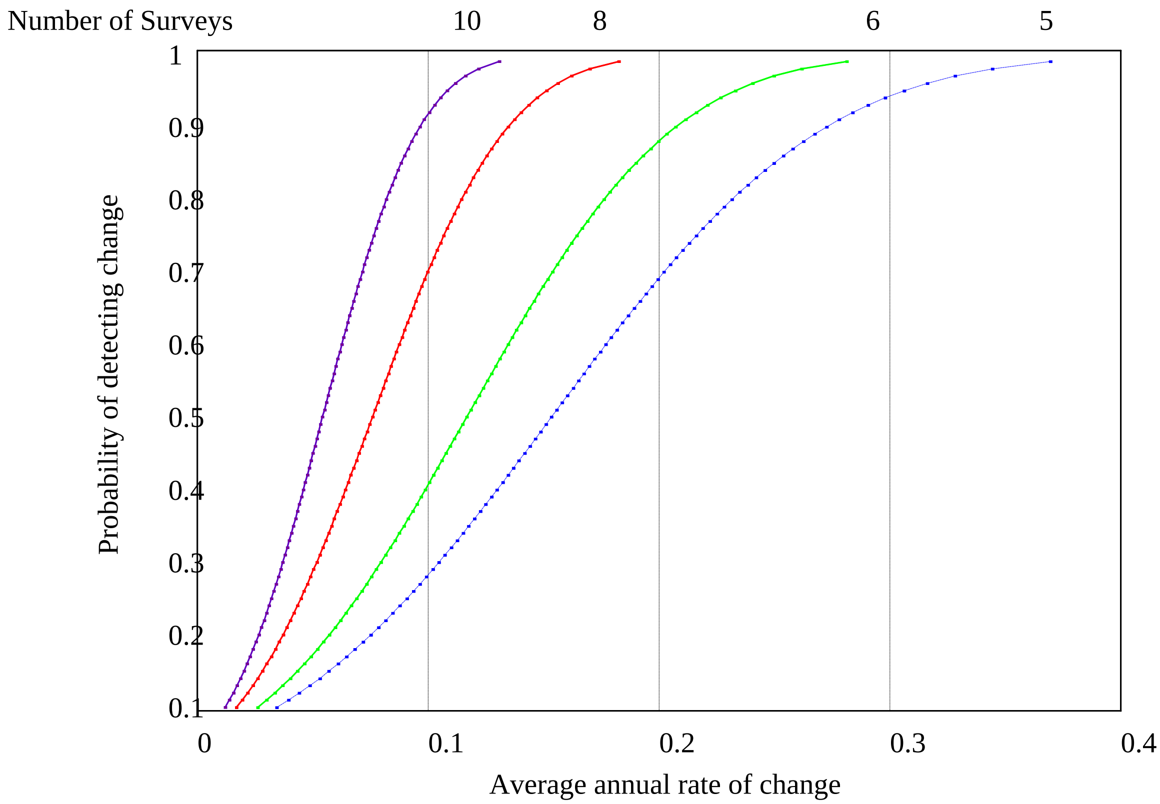

Figure 1. Estimated power based on numbers of surveys (5, 6, 8, and 10) conducted to detect a trend in marine bird populations in Prince William Sound when the CV = 0.30.

D. Description of Study Area

Our study area is the inside waters of PWS (Figure 2, bounding coordinates: 61.292, -148.74; 61.168, -146.057; 60.273, -145.677; 59.662, -148.238), an area of approximately 9000 km^2. Marine bird surveys were conducted in July during 12 years within the interval 1989-2012. Surveys were conducted from 7.6-m boats, using 200m-wide strip-transects. The same transects, totaling approximately 2000 linear km, are surveyed during each survey year (every even year since 2010).

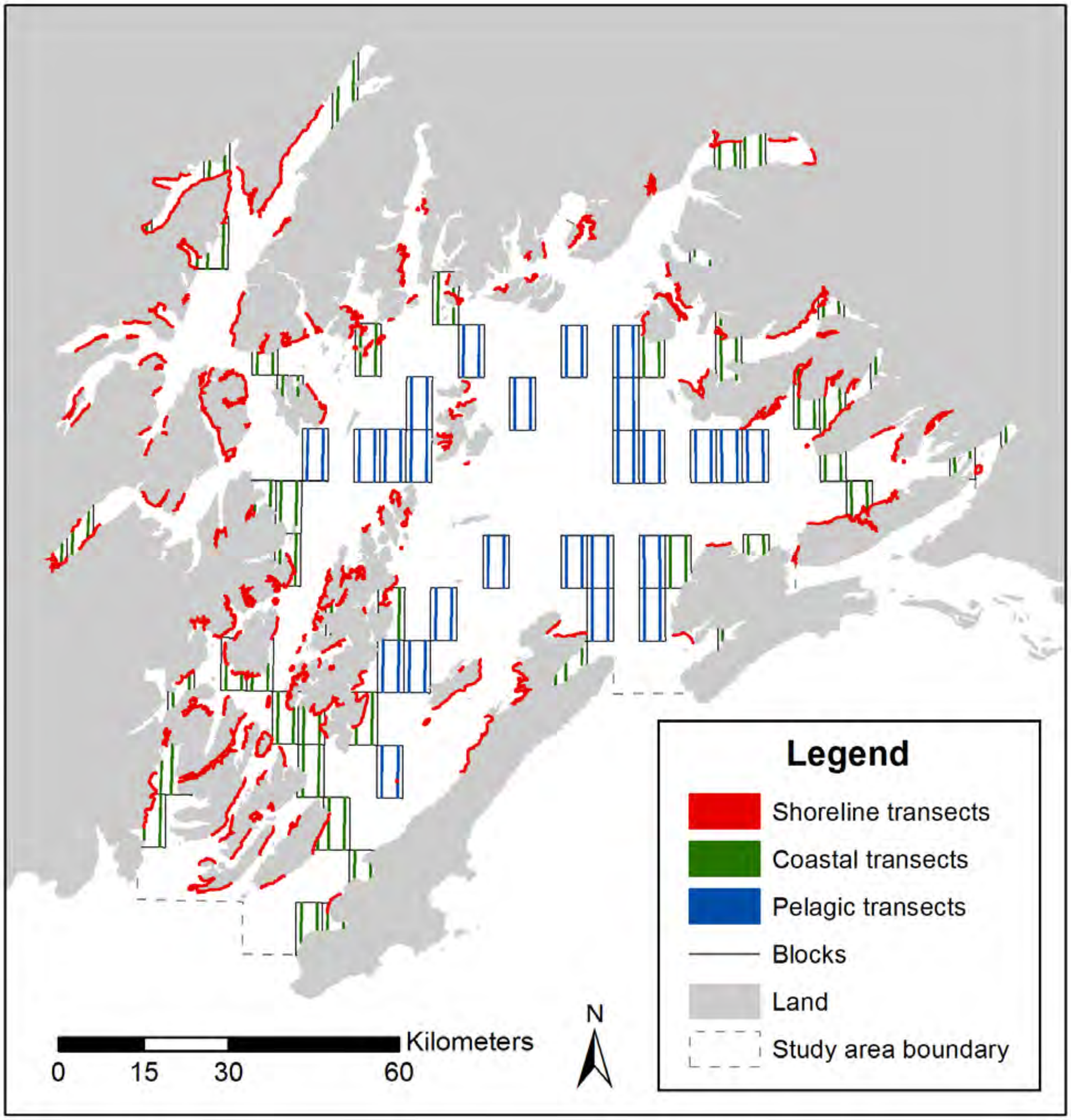

Figure 2. Location of marine bird survey transects within Prince William Sound, Alaska.

5. Coordination and Collaboration

Within the Program

Within GWA Coordination and Collaboration: The proposed project will collaborate closely with the Forage Fish project (Arimitsu/Piatt) in collection of marine bird data while conducting data collection of schools of forage fish. The proposed project will also collaborate with Winter Seabird Surveys (Bishop) to collect comparable marine bird data, allowing us to compare summer and winter seabird communities and distributions. The shoreline surveys of our project will also be complimentary to the Nearshore component of GWA, and allow for comparisons across marine habitats.

WITH OTHER EVOSTC-FUNDED PROGRAMS AND PROJECTS

With Other EVOSTC-funded Programs and Projects: The proposed project complements the EVOSTC-funded effort to restore Pigeon Guillemot to the Naked Island Complex (Naked, Peak, and Storey islands, Little Smith and Smith Islands). Robb Kaler and Dr. David Irons are co-Principle Investigators (PIs) for the pigeon guillemot restoration study. Data collected on marine birds from the Naked Islands region will be used to quantify population trends of species anticipated to benefit from mink removal efforts. Populations of marine birds anticipated to increase following mink suppression includes pigeon guillemots, tufted and horned puffins, parakeet auklets, and Arctic terns.

WITH TRUSTEE AND MANAGEMENT AGENCIES

With Trustee or Management Agencies: The proposed project supports the US Fish and Wildlife Service's (USFWS's) Migratory Bird Management mission to advance the conservation of migratory birds. The project will also inform other land management agencies (US Forest Service, National Park Service) with lands and waters adjacent to our study area. Additionally, Co-PI Dr. Kathy Kuletz (USFWS) is also a PI of the seabird component for two other long-term monitoring projects that complement the PWS marine bird survey and will allow us to examine oceanographic and plankton data in conjunction with seabird distribution and relative abundance, with a seasonal component, across the GWA study area and will inform the fisheries management process in the GOA. Additional long-term studies include:

1. Seabird surveys are a sub-award of the 'Seward Line' project funded by the North Pacific Research Board (Project 1427, "Measuring the pulse of GOA: Oceanographic observations along the Seward Line"; lead PI, Dr. R. Hopcroft, University of Alaska Fairbanks). Dr. Kuletz coordinates pelagic surveys of marine birds in conjunction with the oceanographic and plankton surveys. The project includes the transit along the outer coast of the Kenai Peninsula between Homer and Seward, the Seward Line (which runs to the shelf break), and transits between stations throughout western PWS. Two sampling cruises (May and September) are conducted each year for the next five years, with plans to continue additional years, pending funding.
2. Seabird surveys in lower Cook Inlet funded by the Bureau of Ocean Energy Management (BOEM; Intra-agency Agreement No. M14PG00031, "Seabird Abundance and Distribution with Respect to Ecological Processes in Lower Cook Inlet"). This project collects data for the upper trophic level component of the BOEM environmental studies program, in partnership with an existing multidisciplinary monitoring program (Monitoring temporal and spatial trends in lower Cook Inlet and Kachemak Bay waters, GWA, PIs A. Doroff (Kachemak Bay Research Reserve) and K. Holderied (National Oceanographic and Atmospheric Administration)). The USFWS/BOEM marine bird surveys are conducted in conjunction with oceanographic and plankton sampling across four transect lines in Lower Cook Inlet, four times per year (spring, summer, fall, winter), 2012 - 2016.

WITH NATIVE AND LOCAL COMMUNITIES

Involvement with the marine bird population trend project at the local and native community level will occur through the USFWS's Migratory Bird Management Outreach Biologist. As the marine bird survey stages operations from four areas across PWS (Whittier, Chenega, Cordova, and Valdez), opportunities to involve local and native communities are mostly information exchanges. The 2015-2016 murre wreck (a major seabird die-off event observed across the northern coast of the GOA) would be an ideal topic in which to engage local and native communities to gain valuable observation data from residence with years of experience and knowledge living in PWS and the GOA. For example, in February 2016 Dr. Kuletz was invited to give a presentation about the murre die-off at the quarterly webinar of One Health Group, led by the Alaska Native Tribal Health Consortium, and she will be providing regular updates to the group.

6. Schedule

Project Milestones

To determine population abundance, with 95% confidence limits, of marine bird populations in PWS during July 2018 and 2020 in both oiled and unoiled regions, as well as in PWS as a whole, in order to assess population trends in the years following the EVOS.

To be met by March 2019 and 2021.

Measurable Project Tasks

Measurable project tasks are presented by fiscal year and quarter graphically in Table 1 and descriptively below.

Table 1. Marine bird population trends monitoring task schedule.

Task	FY17				FY18				FY19				FY20				FY21			
	EVOSTC FY Quarter (beginning Feb. 1)																			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Task 1 admin & logistics																				
Contracting & hiring					X	X							X	X						
Recruit volunteers, housing/travel & permits					X	X							X	X						
Survey vessel Preparation & Winterization		X	X			X		X		X	X			X	X					
Task 2 data acquisition & processing																				
Boat-based marine bird survey							X								X					
Marine bird and mammal data processing								X	X						X	X				
Task 3 data management																				
Database mgmt./QAQC	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Metadata	X								X								X			
Workspace upload		X								X								X		
Task 4 analysis & reporting																				
Analysis and summary	X				X								X				X			
Annual Reports	X				X				X				X				X			
Annual PIs meeting				X				X				X				X				X
FY Work Plan			X				X				X				X					
Permit reports				X				X				X				X				X

FY 17 (Year 6)

FY 17, 1st quarter (February 1, 2017 - April 30, 2017)
February: *Submit final FY16 marine bird survey data to shared website*
March: *Submit FY16 annual report*

FY 17, 2nd quarter (May 1, 2017 - July 31, 2017)
June: *Repair boat hulls and outboard engines, as needed*
July: *No field work, non-survey year*

FY 17, 3rd quarter (August 1, 2017 - October 31, 2017)
August: *FY18 project proposal*
October: *Synthesis of 2012-2016 survey results and manuscript*

FY 17, 4th quarter (November 1, 2017 - January 31, 2018)
November: *Attend annual PI meeting*
January: *Attend Alaska Marine Science Symposium;*

FY 18 (Year 7)

FY 18, 1st quarter (February 1, 2018 - April 30, 2018)
February: *Prepare contractual agreement, purchase request*
March: *Submit FY17 Annual Report*
March: *Hire project personnel*
March –April: *Submit paperwork contractual agreements*

FY 18, 2nd quarter (May 1, 2018 - July 31, 2018)
May –June: *Prepare for field season*
June: *Finalize volunteer observer travel papers*
July: *Conduct 16th PWS marine bird survey*

FY 18, 3rd quarter (August 1, 2018 - October 31, 2018)
August: *Put away field gear and winterize (4) survey boats*
September: *QA/QC FY18 marine bird survey data*

FY 18, 4th quarter (November 1, 2018 - January 31, 2019)
November: *Attend annual PI meeting*
January: *Attend Alaska Marine Science Symposium*

FY 19 (Year 8)

FY 19, 1st quarter (February 1, 2019 - April 30, 2019)
February: *Submit final 2018 marine bird survey data to shared website*
March: *Submit FY18 annual report*

FY 19, 2nd quarter (May 1, 2019 - July 31, 2019)
May-July: *Analyze 1989-2018 marine bird data*

FY 19, 3rd quarter (August 1, 2019 - October 31, 2019)
August-October: *Prepare annual report*

FY 19, 4th quarter (November 1, 2019 - January 31, 2020)
November: *Attend annual PI meeting*
January: *Attend Alaska Marine Science Symposium*

FY 20 (Year 9)

FY 20, 1st quarter (February 1, 2020 - April 30, 2020)
February: *Prepare contractual agreement, purchase request*
March: *Hire project personnel*
March: *Submit FY19 Annual Report*
March –April: *Submit contractual agreements award*

FY 20, 2nd quarter (May 1, 2020 - July 31, 2020)
May –June: *Prepare for field season*
June: *Finalize volunteer observer travel papers*
July: *Conduct 16th PWS marine bird survey*

FY 20, 3rd quarter (August 1, 2020 - October 31, 2020)
August: *Put away field gear and winterize (4) survey boats*
September: *QA/QC 2018 marine bird survey data*

FY 20, 4th quarter (November 1, 2020 - January 31, 2021)
November: *Attend annual PI meeting*
January: *Attend Alaska Marine Science Symposium*

FY 21 (Year 10)

FY 21, 1st quarter (February 1, 2021 - April 30, 2021)
February: *Submit final 2020 marine bird survey data to shared website*
March: *Submit FY20 annual report*

FY 21, 2nd quarter (May 1, 2021 - July 31, 2021)
May-July: *Analyze 1989-2018 marine bird data*

FY 21, 3rd quarter (August 1, 2021 - October 31, 2021)
August: *FY22 project proposal*
August-October: *Prepare annual report*

FY 21, 4th quarter (November 1, 2021 - January 31, 2022)
November: *Attend annual PI meeting*
January: *Attend Alaska Marine Science Symposium*

7. Budget

BUDGET FORMS (ATTACHED)

Completed budget forms are attached.

Personnel: A project leader (GS 11) is needed to run the project and must possess supervisory skills to govern the activities of eight subordinate workers. A minimum of three persons per boat (3 boats) for a total of nine persons are needed to conduct the survey. We will need a supervisory biological technician for five months to assist in field preparation and equipment maintenance, we will need three other biological technicians and four volunteers (due to lack of funding) -- approximately 20 days of survey time plus 25 days for field gear preparation/maintenance and training. The project leader will allocate 8 months to the project during years with a survey and 3 months during the off years. The project leader will be responsible for conducting QA/QC on the data, entering data into the North Pacific Pelagic Seabird Database, conducting analysis, writing reports and meeting attendance.

Travel: Nine people will be traveling throughout PWS and will need approximately 15 nights of lodging the Sound (and additional 7 will be aboard the charter vessel). Per diem will be given to each person during each survey. A tunnel fee is assessed to every vehicle traveling through the tunnel near Portage and the truck/boat will make 8 round trips during each survey.

Contractual: PWS is large and requires extensive travel by boat. To make the survey cost effective, a support vessel will be contracted to provide lodging and food for 7 survey days. The boats will operate for hundreds of hours and will need repairs and replacement parts. There are also fees associated with launching and parking the boat in the harbors.

Commodities: Includes gas and oil to support boat transport and operation during the surveys; food for 9 people while on survey; and personal safety devices.

Equipment: We are using USFWS equipment for this survey as an in-kind contribution but the survey work takes a toll on boats; on average, each boat will run a total of 20 full days per survey. As a result, we are including funds for emergency replacement of motor parts that fail during the survey should that need arise.

SOURCES OF ADDITIONAL FUNDING

Over the life of the project, USFWS will make a substantial in-kind contribution of $180,000. Specifically, salary for Kathy Kuletz includes: 1 month for PWS marine bird surveys, 1 month for Lower Cook Inlet surveys (in collaboration with the Bureau of Ocean Energy Management), 1 month for the Seward Line project (in collaboration with the North Pacific Research Board and the University of Alaska Fairbanks.

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PROJECT DATA ONLINE

http://portal.aoos.org/gulf-of-alaska.php#metadata/6aac5903-f3af-4eb4-b4d7-11006e6ea497/project/files

Dr. KATHY J. KULETZ
Curriculum vitae
Wildlife Biologist/Seabird Coordinator, U.S. Fish and Wildlife Service
1011 East Tudor Road, Anchorage, Alaska 99503
Phone: 907-786-3453 Email: Kathy_Kuletz@fws.gov

PROFESSIONAL PREPARATION

Ph.D. Biology	Univ. of Victoria, British Columbia (2005); Dr. Alan Burger
M.S. Ecology & Evolutionary Biology	Univ. of California, Irvine (1983); Dr. G.L. Hunt, Jr
B. S. Wildlife Ecology	California State Polytechnic Univ., San Luis Obispo, (1974)

WORK EXPERIENCE - OVERVIEW

2015-current	Wildlife Biologist/Seabird Coordinator, Migratory Bird Management, U.S. Fish and Wildlife Service, Anchorage, Alaska
2005-2015	Wildlife Biologist/Seabird Specialist & Pelagic Program Coordinator, USFWS
2015-current	Chair, Pacific Seabird Group (http://www.pacificseabirdgroup.org/)
2009-current	Expert member, Circumpolar Seabird Group (CAFF Arctic Council)
2004-current	Short-tailed Albatross Recovery Team (Endangered Species/ USFWS)
2007-2012	Science & Statistical Committee of North Pacific Fisheries Management Council
2000–2006	NOAA/N. Pacific Fisheries Manage. Council Groundfish Fisheries Plan Team
1998-2005	Seabird Specialist, Migratory Bird Management, USFWS, Anchorage

RELEVANT SYNERNISTIC ACIVITIES

- PI for Seabirds in 'Seward Line Long-term Monitoring' (2014-2019; NPRB grant)
- Co-PI for Gulf Watch Alaska seabird surveys, Prince William Sound (2012-2016; EVOS grant)
- PI for Seabirds, 'Alaska Marine Biodiversity Observing Network' (2014-2019; BOEM)
- PI for 'Seabird Distribution & Abundance in Cook Inlet' (2014-2016; BOEM IA)
- PI for 'Seabird Distribution in the Offshore Environment' (2010–2015; BOEM IA)
- PI for 'Aleutian Islands Seabird Risk Assessment' (2012- 2015; USFWS special grant)
- PI or collaborator, Arctic research projects (ArcticEIS, SOAR, PacMARS; 2011-2014)
- 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 /Kachemak Bay (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 variety of peer-reviewed journals; lead reviewer for UN World Ocean Assessment (http://www.worldoceanassessment.org/)

SELECTED RELEVANT PUBLICATIONS

Bishop, MA, Watson, JT, **Kuletz**, KJ, and Morgan, T. 2015. Pacific Herring (Clupea pallasii) consumption by marine birds during winter in Prince William Sound, Alaska. *Fisheries Oceanography* 24:1-13.

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OTHER SIGNIFICANT PUBLICATIONS

Benoit-Bird KJ, Battaile BC, Heppell SA, Hoover B, Irons D, Jones N, **Kuletz** KJ, Nordstrom CA, Paredes R, Suryan RM, Waluk CM, Trites AW. (2013) Prey Patch Patterns Predict Habitat Use by Top Marine Predators with Diverse Foraging Strategies. *PLoS ONE* 8(1): e53348.

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.

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Renner, M. and **Kuletz, K**. J. 2015. A spatial-seasonal analysis of the oiling risk from shipping traffic to seabirds in the Aleutian Archipelago. *Marine Pollution Bulletin*, 101:127–136.

Sigler MF, **Kuletz** KJ, Ressler PH, Friday NA, Wilson CD, Zerbini AN. 2012. Marine predators and persistent prey in the southeast Bering Sea. *Deep Sea Research II* 65-70:292-303.

RECENT COLLABORATORS

C. Ashjian (Woods Hole Oceanographic Inst.); M.A. Bishop (PWS Science Center); Kelly Benoit-Bird (Oregon State U.); B. Bodenstien (USGS/NWHC); L. Cooper (U. Maryland); B. Day (ABR, Inc, Fairbanks); D. Irons (USFWS); E. Farley (NOAA, Juneau); M. Ferguson (NMML/NOAA, Seattle); A. Gall (ABR, Inc., Fairbanks); J. Grebmeier (U. Maryland); S Heppell (Oregon State U.); R. Hopcroft (U. of Alaska, Fairbanks); G. L. Hunt, Jr. (U. Washington); K. Iken U. Alaska, Fairbanks); D. Irons (USFWS); A. Kataysky (U. Alaska, Fairbanks); S. Moore (NOAA, Seattle); F. Mueter (U. Alaska, Juneau); S. Parker-Stetter (U. Washington); J. Piatt (Alaska Science Center, USGS); P. Ressler (NOAA, Seattle); H. Renner (USFWS); M. Renner (Tern Again Consulting); D. Roby (Oregon State U.); M. Sigler (Alaska Fisheries Science Center, NOAA); R. Suryan (Hatfield Marine Science Center, Oregon State U.); A. Trites (U. British Columbia).

<u>Graduate Students advised (on their committees and used data collected during my projects):</u>
Athina Catherine Pham (MS, current) – Hawaii Pacific University, Honolulu, HI
Dan Cushing (MS, 2015) – Oregon State University, Corvalis, OR
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

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EDUCATION

2007 – MS, Kansas State University, Manhattan, KS. (Biology)
1997 – BS, The Evergreen State College, Olympia, WA. (Wildlife Biology)

WORK EXPERIENCE (2005-present)

2010-present	Wildlife Biologist, Migratory Bird Management, US Fish and Wildlife Service (USFWS), Anchorage Alaska
2011-present	Principle Investigator: Kittlitz's murrelet breeding biology study at Adak Island, Migratory Bird Management-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
2005	Biological Science Technician, Alaska Maritime National Wildlife Refuge-USFWS: Attu to Agattu islands Evermann's Rock Ptarmigan reintroduction

PUBLICATIONS (2009-present)

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

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

COLLABORATIONS

Barb Bodenstein (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)

Budget Category:	Proposed FY 17	Proposed FY 18	Proposed FY 19	Proposed FY 20	Proposed FY 21	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$22.9	$108.1	$22.9	$108.1	$22.9	$284.8	
Travel	$0.0	$12.5	$0.0	$12.5	$0.0	$25.1	
Contractual	$0.0	$37.1	$0.0	$37.1	$0.0	$74.2	
Commodities	$0.0	$40.1	$0.0	$40.1	$0.0	$80.2	
Equipment	$0.0	$6.0	$0.0	$6.0	$0.0	$12.0	
SUBTOTAL	$22.9	$203.8	$22.9	$203.8	$22.9	$476.3	
General Administration (9% of subtotal)	$2.1	$18.3	$2.1	$18.3	$2.1	$42.9	N/A
PROJECT TOTAL	$24.9	$222.2	$24.9	$222.2	$24.9	$519.1	
Other Resources (Cost Share Funds)	$23.0	$56.0	$23.0	$56.0	$22.0	$180.0	

COMMENTS:
Boat-based seabird surveys conducted every other year. During the FY17-21 period surveys will be conducted in FY18 and FY20.

FY17-21

Project Title: PWS marine bird population trends
Primary Investigator: Kathy Kuletz & Robb Kaler
Agency: USFWS - Migratory Bird Management

TRUSTEE AGENCY SUMMARY PAGE

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
R. Kaler	Project Leader	3.0	7.6		22.9
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	7.6	0.0	
				Personnel Total	$22.9

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
None					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY17

Project Title: PWS marine bird population trends
Primary Investigator: Kathy Kuletz & Robb Kaler
Agency: USFWS - Migratory Bird Management

FORM 4B
PERSONNEL & TRAVEL
DETAIL

Contractual Costs: Description	Contract Sum
None	
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
None	
Commodities Total	$0.0

FY17

Project Title: PWS marine bird population trends
Primary Investigator: Kathy Kuletz & Robb Kaler
Agency: USFWS - Migratory Bird Management

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
None			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
None		

FY17

Project Title: PWS marine bird population trends
Primary Investigator: Kathy Kuletz & Robb Kaler
Agency: USFWS - Migratory Bird Management

FORM 4B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
R. Kaler	Project Leader	8.0	7.6		61.0
TBD	Supervisory Biological Science Technician	6.0	5.2		30.9
TBD	Biological Science Technician	1.5	3.6		5.4
TBD	Biological Science Technician	1.5	3.6		5.4
TBD	Biological Science Technician	1.5	3.6		5.4
Volunteer		0.0	0.0		0.0
Volunteer		0.0	0.0		0.0
Volunteer		0.0	0.0		0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	23.6	0.0	
				Personnel Total	$108.1

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Truck & boat tunnel fee (Portage - Whittier)	0.1	8			0.8
Per diem ($5/day), 9 people, 25 days summer			225	0.0	1.1
Per diem (travel rate), 9 people/2 days summer; 6 people /3 days training			36	0.2	6.3
Lodging, 6 nights, 3 rooms @ $120/night/room (Cordova)			18	0.1	2.2
Volunteer travel to Anchorage 2 people	1.0	2	2	0.1	2.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$12.5

FY18

Project Title: PWS marine bird population trends
Primary Investigator: Kathy Kuletz & Robb Kaler
Agency: USFWS - Migratory Bird Management

FORM 4B
PERSONNEL & TRAVEL
DETAIL

Contractual Costs: Description	Contract Sum
Charter vessel (summer - 7 days @ 3,500/day	24.5
Harbor fees	0.6
Emergency boat repairs and parts	12.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$37.1

Commodities Costs: Description	Commodities Sum
Boat fuel (70 gal/boat/day) 60 boat-days summer @ $6/gal	25.2
Outboard oil (4 gal/boat/survey), 3 boats @ $20/gal	0.2
Food ($20/person/day) 9 people 18 days in summer	3.2
Misc. commodities (cleaning supplies, replacement of emergency locator beacons, etc.)	5.5
Boat maintenance	6.0
Commodities Total	$40.1

FY18

Project Title: PWS marine bird population trends
Primary Investigator: Kathy Kuletz & Robb Kaler
Agency: USFWS - Migratory Bird Management

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
Emergency replacement of equipment	1.0	6.0	6.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$6.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
Immersion suit	9	USFWS
25' Boston Whaler, electronics (GPS Plotcharter, Sonar, Radar, VHF radio)	4	USFWS
Computer, laptop (survey only; no network access)	6	USFWS
Dinghy, inflatable	4	USFWS
F-350 diesel pickup truck to haul 25' survey vessel	1	USFWS
Pickup truck to transport field crew	1	USFWS
Salinity meter	4	USFWS

FY18

Project Title: PWS marine bird population trends
Primary Investigator: Kathy Kuletz & Robb Kaler
Agency: USFWS - Migratory Bird Management

FORM 4B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
R. Kaler	Project Leader	3.0	7.6		22.9
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	7.6	0.0	
				Personnel Total	$22.9

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
None					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY19

Project Title: PWS marine bird population trends
Primary Investigator: Kathy Kuletz & Robb Kaler
Agency: USFWS - Migratory Bird Management

FORM 4B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
None	
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
None	
Commodities Total	$0.0

FY19

Project Title: PWS marine bird population trends
Primary Investigator: Kathy Kuletz & Robb Kaler
Agency: USFWS - Migratory Bird Management

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
None			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
None		

FY19

Project Title: PWS marine bird population trends
Primary Investigator: Kathy Kuletz & Robb Kaler
Agency: USFWS - Migratory Bird Management

FORM 4B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
R. Kaler	Project Leader	8.0	7.6		61.0
TBD	Supervisory Biological Science Technician	6.0	5.2		30.9
TBD	Biological Science Technician	1.5	3.6		5.4
TBD	Biological Science Technician	1.5	3.6		5.4
TBD	Biological Science Technician	1.5	3.6		5.4
Volunteer		0.0	0.0		0.0
Volunteer		0.0	0.0		0.0
Volunteer		0.0	0.0		0.0
					0.0
					0.0
					0.0
		Subtotal	23.6	0.0	
				Personnel Total	$108.1

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Truck and boat tunnel fee (Portage - Whittier)	0.1	8			0.8
Per diem ($5/day), 9 people, 25 days summer			225	0.0	1.1
Per diem (travel rate), 9 people/2 days summer; 6 people/3 days training			36	0.2	6.3
Lodging, 6 nights, 3 rooms @ $120/night/room (Cordova)			18	0.1	2.2
Volunteer Tavel to Anchorage 2 people	1.0	2	2	0.1	2.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$12.5

FY20

Project Title: PWS marine bird population trends
Primary Investigator: Kathy Kuletz & Robb Kaler
Agency: USFWS - Migratory Bird Management

FORM 4B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Charter vessel (summer - 7 days @ 3,500/day)	24.5
Harbor fees	0.6
Emergency boat repairs and parts	12.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$37.1

Commodities Costs: Description	Commodities Sum
Boat fuel (70 gal/boat/day) 60 boat-days summer @ $6/gal	25.2
Outboard oil (4 gal/boat/survey), 3 boats @ $20/gal	0.2
Food ($20/person/day) 9 people 18 days in summer	3.2
Misc. Commodities (cleaning supplies, replacement of emergency locator beacons, etc.	5.5
Boat Maintenance	6.0
Commodities Total	$40.1

FY20

Project Title: PWS marine bird population trends
Primary Investigator: Kathy Kuletz & Robb Kaler
Agency: USFWS - Migratory Bird Management

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
Emergency replacement of equipment	1.0	6.0	6.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$6.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
Immersion suit	9	USFWS
25' Boston Whaler, electronics (GPS Plotcharter, Sonar, Radar, VHF radio)	4	USFWS
computer, laptop (survey only; no network access)	6	USFWS
dinghy, inflatable	4	USFWS
F-350 diesel pickup truck to haul 25' survey vessel	1	USFWS
Pickup truck to transport field crew	1	USFWS
Salinity meter	4	USFWS

FY20

Project Title: PWS marine bird population trends
Primary Investigator: Kathy Kuletz & Robb Kaler
Agency: USFWS - Migratory Bird Management

FORM 4B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
R. Kaler	Project Leader	3.0	7.6		22.9
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	7.6	0.0	
				Personnel Total	$22.9

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
None					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY21

Project Title: PWS marine bird population trends
Primary Investigator: Kathy Kuletz & Robb Kaler
Agency: USFWS - Migratory Bird Management

FORM 4B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
None	
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
None	
Commodities Total	$0.0

FY21

Project Title: PWS marine bird population trends
Primary Investigator: Kathy Kuletz & Robb Kaler
Agency: USFWS - Migratory Bird Management

FORM 4B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
None			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
None		

FY21

Project Title: PWS marine bird population trends
Primary Investigator: Kathy Kuletz & Robb Kaler
Agency: USFWS - Migratory Bird Management

FORM 4B
EQUIPMENT DETAIL

August 24, 2016

Elise Hsieh, Executive Director
Exxon Valdez Oil Spill Trustee Council
4210 University Drive
Anchorage, AK 99508-4626

Dear Elise:

Final FY 2017-2021 Proposal Submittal for Long-term Monitoring

17120114-N. Long-term Killer Whale Monitoring

Gulf Watch Alaska, the long-term monitoring program of the *Exxon Valdez* Oil Spill Trustee Council (EVOSTC), has finalized our program and project proposals for fiscal years 2017-2021 funding based on comments received from EVOSTC's Science Panel on May 19, 2016. Below is the final budget summary and response to Science Panel comments for the killer whale project.

EVOSTC Funding Requested *(including 9% GA)*

FY17	FY18	FY19	FY20	FY21	TOTAL
$152,800	$151,300	$142,100	$140,300	$139,500	$725,900

Non-EVOSTC Funding Available

FY17	FY18	FY19	FY20	FY21	TOTAL
$25,000	$25,000	$25,000	$25,000	$25,000	$125,000

Science Panel comment: *There are no project specific comments.*

PI Response:

- The proposal was not revised.

Sincerely,

Mandy Lindeberg
Gulf Watch Alaska Program Lead designate

Attachment: Gulf Watch Alaska: Pelagic Component Project Proposal: 17120114-N—Long-term killer whale monitoring in Prince William Sound/ Kenai Fjords

EVOSTC FY17-FY21 INVITATION FOR PROPOSALS
PROGRAM PROJECT PROPOSAL SUMMARY PAGE

Project Title

Gulf Watch Alaska: Pelagic Component Project:

17120114-N—Long-term killer whale monitoring in Prince William Sound/ Kenai Fjords

Primary Investigator(s) and Affiliation(s)

Craig Matkin, North Gulf Oceanic Society

Date Proposal Submitted

24 August 2016

Project Abstract

The proposed project is a continuation of the photo-identification based long term killer whale monitoring program that was initiated in 1984 in Prince William Sound (PWS). A primary focus has been on resident killer whales and the recovery of AB pod and the threatened AT1 population of transient killer whales. These groups of whales suffered serious losses at the time of the oil spill and have not recovered at projected rates. Monitoring of all the major pods and their population dynamics, feeding ecology, movements, range, and contaminant levels will help determine their vulnerability to future perturbations and environmental change, including oil spills. The project uses various techniques, as possible and in addition to the core photoidentification monitoring and annual skin and biopsy sampling. These include observations of predation and sampling of prey, remote acoustic monitoring to identify important habitat and seasonal use patterns, time depth tags to investigate feeding ecology, and photographic drones to examine morphometrics, relocating whales for feeding studies. It continues examination of feeding habits prey sampling coupled with innovative chemical techniques. The study will continue to monitor delineate and monitor important habitat and variations in pod specific use patterns using observation as well as non-invasive remote acoustic monitoring. We will continue to examine the role of both fish eating and mammal eating killer whales in the near-shore ecosystem and their interaction with prey species. Community based initiatives, educational programs, and programs for tour boat operators will continue to be integrated into the work to help foster restoration by improving public understanding and reducing harassment of the whales.

EVOSTC Funding Requested *(must include 9% GA)*

FY17	FY18	FY19	FY20	FY21	TOTAL
$152.8	$151.3	$142.1	$140.3	$139.5	$725.9

Non-EVOSTC Funding Available

FY17	FY18	FY19	FY20	FY21	TOTAL
$25	$25	$25	$25	$25	$125

1. Executive Summary

Pelagic Component

In the aftermath of the 1989 *Exxon Valdez* oil spill (EVOS) it was difficult to distinguish between the impacts of the spill and natural variability in affected animal populations. The main problem for assessing impacts on pelagic species was that long-term baseline data were largely absent. As a result, managers struggled to make informed decisions regarding estimation of damages and recommendations for recovery. Ten years after the spill it became widely recognized that there had been a major climatic regime shift (from colder to warmer than average) that altered the marine ecosystem prior to the spill, including marine birds, marine mammals, groundfish, and the shared forage species they all consumed. As we begin to close the second decade of the 2000s we are experiencing anomalous ocean warming events driven by changing atmospheric conditions at both inter-decadal (i.e. Pacific Decadal Oscillation) and shorter (e.g. El Niño Southern Oscillation) time scales. These changes may have profound effects on pelagic ecosystems such as unusual mortality events, harmful algal blooms, and fishery closures.

During the first five years of the Gulf Watch Alaska program, the pelagic component research team addressed two main questions: 1) What are the population trends of key pelagic species groups in Prince William Sound, and, 2) How can forage fish population trends in PWS be monitored most effectively? To answer these questions, five projects focused on species that play a pivotal role in the pelagic ecosystem as trophic indicators for short and long-term ecosystem change: forage fish, marine birds, humpback whales and killer whales. Monitoring of killer whales and marine birds benefitted from having pre-existing long-term data sets as a result of the damage assessment process following the EVOS (>25-year time series).

Moving forward for the next five years, the pelagic research team re-evaluated their primary objectives. The group's primary goal — to determine the long-term population trends of key pelagic species groups in PWS — will remain the same. The second primary objective was fundamentally different: Develop a means to effectively monitor forage fish. Based on knowledge gained in the first five years of the pelagic program, we have developed a broader focus that includes an integrated study of forage fish using marine bird and mammal predators as samplers of the forage base. In addition to providing a means to effectively monitor indices of forage fish trends, our integrated approach will also enhance our understanding of predator-prey relationships and help us identify some mechanisms of change in populations. Ultimately, the integrated surveys along with information from the GWA Environmental Drivers Program will provide a way to evaluate climate variability and climate change on the PWS pelagic ecosystem.

Thus, the two over-arching questions for the pelagic component to answer in the next five years are:

1. *What are the population trends of key upper trophic level pelagic species groups in Prince William Sound – killer whales, humpback whales, marine birds, and forage fish?*

2. *How do predator-prey interactions, including interannual changes in prey availability, contribute to underlying changes in the populations of pelagic predators in Prince William Sound and Middleton Island?*

The pelagic component research team is proposing to continue monitoring key pelagic species groups in PWS using the same five projects focused on killer whales, humpback whales, forage fish, and marine birds. However, modifications have been made to some projects for greater integration, increased precision of information, and achieving new goals. Ultimately this will provide more information to the EVOS Trustee Council, agency resource managers, non-governmental organizations, and the public.

Killer Whale Monitoring

Both resident ecotype (AB pod) and transient ecotype (AT1 population) killer whales suffered significant mortalities following EVOS. AB pod is recovering after 26 years but has still not reached pre-spill numbers. The AT1 population is not recovering and may be headed toward extinction (Matkin et al. 2008). This project has determined that killer whales are sensitive to perturbations such as oil spills, but has not yet determined the long term consequence (which may include extinction) or the recovery period required. As an apex predator, this species (both fish and mammal eating types) has important role in the ecosystem; additionally, they are a primary focus of viewing by a vibrant tour boat industry in the region. Data from this project is used by tour boats to enhance viewers experience and understanding of the local environment and fauna. Unlike many cetaceans, killer whales can be closely monitored and for resident (fish eating) killer whales detailed population dynamics monitored (Matkin et al. 2014). The AT1 transient population can be directly monitored by individual, and the wide ranging Gulf of Alaska transients (mammal eating) population monitored for trends (Matkin et al. 2012). We also contribute all photoidentification data for the offshore form of killer whale to a coast-wide data base at the Pacific Biological Station (Nanaimo, BC, Canada). This project is a unique opportunity to continue a comprehensive monitoring program for a keystone marine species, with three ecotypes, that was initiated in the early 1980s. The importance of long-term killer whale monitoring has been borne out by companion studies other regions such as Puget Sound and British Columbia.

The core project is the photoidentification based monitoring of population parameters, annual monitoring of contaminants, feeding, and trophic changes using blubber biopsy sampling and observation of predation and prey sampling. In addition, we will develop remote acoustic techniques that will allow monitoring geographic and temporal use patterns of resident killer whales. We have pioneered this type of work in Alaska in the past (Yurk et al. 2010) but will now employ new technologies. Additionally, when not compromising the core project, we will use time/depth/location tags to examine details of feeding ecology (Olsen et al. in prep) and explore the use of morphometrics obtained from drone captured, low altitude photos (Durban et al. 2010) to develop an annual index of individual and population health and possibly determine pregnancy rates.

Analysis includes population dynamics and modeling (Matkin et al. 2014), genetic sequencing as necessary for determination of population affiliation, stable isotope analysis of skin and chemical analysis of blubber, acoustic analysis of remote hydrophone data, and as possible morphometric analysis of drone captured overhead photographs and analysis and interpretation of time/depth/location tag data. Although we will focus on the southern Alaska resident and AT1 transient populations which were impacted by EVOS, the study also includes the other two recognized populations in the region, the Gulf of Alaska transients and offshore killer whales and contributes substantially to the National Marine Fisheries Service (NMFS) killer whale stock assessments.

Data will be collected during a minimum 50-day field season from May through October from the R/V Natoa, although opportunistic photographic data is contributed from other collaborating vessels. This is the continuation of a long-term project spanning 33 years and has benefited from continued support of mariners and the coastal communities of the north Gulf coast of Alaska.

2. Relevance to the Invitation for Proposals

This project is relevant in terms of restoration of species impacted by EVOS. It is of continued interest and importance as it provides a continuation of one of the longest running databases of a spill impacted and a keystone marine species in PWS and the North Gulf Coast. The following chart (Figure 1) depicts changes in oil impacted AB pod and AT1 population and continued tracking of these and the other pods/populations in the region is essential in the continued documentation of long term impacts and restoration of key species for which a long time series is available.

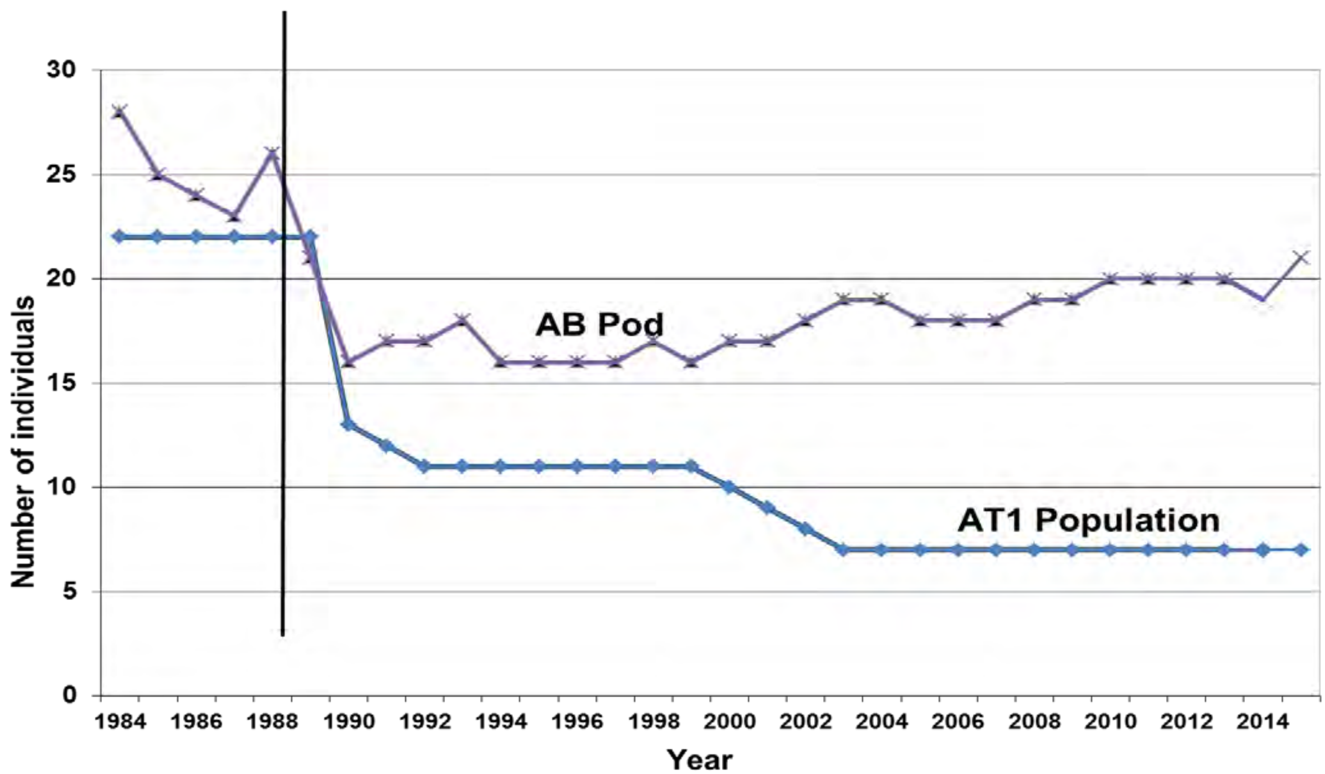

Figure 1. Numbers of whales in AB pod and AT1 population 1984-2015.

It is also relevant to the invitation as it ties in a key upper trophic level predator to the pelagic component as described in the Invitation. It uses proven monitoring techniques to provide detailed population level data and basic feeding and trophic level data on killer whales. These data will provide a baseline to interpret changes due to long-term oceanographic or climatic change or sudden perturbations. The project continues to develop and use other techniques that include drone borne cameras, remote acoustic recorders, and time/depth location tags to better track and understand killer whale movements, feeding ecology, and body condition over extended the years.

We expect to have detailed population and trend data for several populations of killer whales in the region that can be used by managers (in particular the NMFS) to maintain stock assessments as required for this species. It will add an upper level predator to the monitored species in the pelagic component of the Invitation. It will provide valued and requested information to the tour boat industry and general public regarding basic biology latest research results, and specific identities of animals that have become the most sought after for viewing.

3. Project Personnel

CRAIG O. MATKIN, B.A., M.S.
North Gulf Ocean Society Executive Director
3430 Main St. Suite B1
Homer, Alaska 99603
(907) 299-0677 (cell)
(907) 235-6590 (office)
comatkin@gmail.com
www.whalesalaska.org

Please see 2 page CV at end of this document

4. Project Design

This project continues a 33 year population monitoring and population dynamics program for southern Alaska resident and AT1 transient killer whales and monitoring of trends for the Gulf of Alaska transient population (Matkin et al. 2008, Matkin et al. 2012, Matkin et al. 2014). It has provided data for population and trend estimation for humpback whales (Terlink et al. 2014). It has also provided an assessment of killer whale interaction with prey (salmon for transients and marine mammals for transients) and will continue to contribute to this understanding and changes in these relationships.

The core project will continue monitoring of individual killer whales through photoidentification and maintain individual life histories that will allow continued development of population parameters and, in the case of resident whales, a population dynamics model. The project continues monitoring of blubber chemistry that regularly assesses contaminant levels and changes in dietary habits and is coupled with field sampling of prey remains (tissue, fish scales) and as possible, fecal material. Additionally, we will develop remote acoustic monitoring with semi- annual replacement and retrieval of submerged recording devices in key locations. This will yield specific information on timing and duration of use of key areas previously determined by tagging studies and long term encounter data. Although tagging data has been valuable to determine overall use patterns of key pods and identify important habitat, the invasive nature, costs involved, and the relatively short duration of tags makes acoustic monitoring a good choice for continued monitoring use patterns and to important habitat both spatially and temporally.

In addition to the core objectives and as time allows we will develop repeatable morphometric measurements for individual whales and groups using drone based aerial photogrammetry and assess body condition over time and possibly determine pregnancy rates, a missing parameter from our population model. Finally, as time and situations permit we will examine feeding ecology using time/depth/location tags coupled with concurrent prey sampling during feeding aggregations.

A. Objectives

1. Photo-identification of all major resident pods and AT1 transient groups that use PWS/Kenai Fjords on an annual basis. Realistically, all pods are completely documented only on a biennial basis, despite annual field effort. Extension of individual histories, identification catalogues of individuals and an annual update of population model are products of these data (**Core Objective**).

2. Collection of blubber samples for chemical monitoring of polychlorinated biphenyls (PCBs), dichlorodiphenyltrichloroethanes (DDTs) and polybrominated diphenyl ethers (PBDEs), lipids /fatty

acids and stable isotope values to gauge changes in contaminant loads as well as feeding habit changes. Most analytical costs are borne by NMFS (**Core objective**).

3. Collection of fish scale samples and marine mammal tissue from kill sites to monitor potential changes in feeding habits.
4. Using remotely deployed submerged sonic recorders to track killer whales using calls. This will provide use patterns information for areas already identified as most important for killer whales using tagging and encounter data during previous work (**Core objective**).
5. Collection of genetic tissue samples when necessary to determine population/ecotype affiliations (**Core objective**).
6. Use photogrammetry to develop morphometrics for individuals and groups to assess body condition over time and develop measures to determine pregnancy rate as an additional important population parameter (**secondary objective, completed as possible**).
7. Use time/depth/location satellite tags coupled with prey sampling to examine feeding ecology during fall and/or spring feeding aggregations (**secondary objective, completed as possible**).

B. Procedural and Scientific Methods

Our core work depends on accurate photo-identification of each individual in each pod/group that regularly uses the Sound, particularly AB pod and the AT1 population. It is important that researchers maximize the time actually spent with resident killer whales (particularly AB pod and other resident whales) to insure thorough identification of all individuals for population analysis and to continue to examine feeding ecology, which are the core elements of this study.

Methods proposed to obtain photographic data necessary to meet core monitoring objectives will be similar to those used by the North Gulf Oceanic Society in PWS/Kenai Fjords for the past 32 years with improvements due to significant technological advancements. Searches for whales will not be made on random transects, but based on current and historical sighting information. In addition, whales will be located by listening for killer whale calls with a directional hydrophone (calls can be heard up to 10 miles away), or by responding to very high frequency (VHF) radio calls from other vessels reporting sightings of whales. We have developed network of cooperating vessel owners and tour boat operators that regularly report whale sightings. In addition, requests for recent killer whale sightings will be made routinely on hailing Channel 16 VHF and working channel 72.

A vessel log and chart of the vessel track will be kept for each day the research vessels operate. A dedicated GPS unit will record tracklines of vessel searches and whale encounters and will be downloaded and converted to shapefiles on a daily basis. This format facilitates geographic information system (GIS) analysis and presentation of the location data. Distances surveyed, distances traveled by the whales and elapsed times are all recorded. Marks (time and location) are also recorded for changes in behavior of the whales and used in spatial behavioral analysis. Weather and sea state noted at regular intervals as they relate to working and observational conditions.

Basic summary data from the field sheets for each survey day and from each killer whale encounter are transcribed into an Access database and all vessel and whale tracks stored in a GIS database. Data recorded will include date, time, duration, and location of the encounter. Summary of the photographic record the estimated number of whales photographed are recorded.

Photographs for individual identification will be taken of the port side of each whale showing details of the dorsal fin and gray saddle patch. Photographs will be taken at no less than 1/1000 sec using Nikon D750 digital cameras or superior and a either a 300 mm f4.5 or 80-200 mm f2.8 zoom auto focus lens with 1.4x Nikon tele-extender. When whales are encountered, researchers will systematically move from one subgroup (or individual) to the next keeping track of the whales photographed. If possible, individual whales will be photographed several times during each encounter to insure an adequate identification photograph. Whales will be followed until all whales are photographed or until weather and/or darkness make photography impractical.

All digital photographs will be examined on an expanded screen Apple MacPro computer using Photomechanic software. All identifiable individuals in each frame will be recorded. When identifications are not certain, they will be noted but not included in further analysis. Unusual wounds or other injuries will be noted. Photographic negatives will be analyzed using a photographic database that spans 32 years. Data products include a frame by frame analysis of all digital images, with individual identifications digitally recorded and attached to the photo as well as summarized in separate spread sheets for each encounter listing the identities of the whales in each frame. Improvement photos of each individual are selected and placed in appropriate folders and used to update our working catalogue (for NGOS and public access) and provide reference for future identifications. The population dynamics data base that lists data on each individual (including newly recruited calves) is updated annually. This database maintains an annual record for each individual used in our analysis for every year of its life or since the time we started the focused study 32 years ago. Increasingly, whales that we track were born during the study improving the accuracy of our analysis of population parameters.

All vessel and whale encounter tracklines are stored in GIS format, ready for analysis. ARGOS tracklines are also placed in GIS format and initial analysis, including mapping and measures of effort completed on an annual basis.

Field observations of feeding will be made and prey parts collected when possible. Scales are retrieved from fish predations events and read for species and age at the Pacific Biological Station in Nanaimo, British Columbia, where a scale laboratory has been established and certified for over 25 years. The recent development of a genetic scale library, for Chinook salmon in particular, that now spans the waters of Washington, British Columbia, and southern Alaska has allowed identification of the rivers of origin for Chinook prey. Chinook are a species of high conservation concern with potential impacts involving both humans and killer whales. If mammal prey species cannot be identified visually, then genetic analysis will be conducted if bits of prey remains are collected. The University of British Columbia, Department of Zoology and Northwest Fisheries Science Center (NWFSC)/National Marine Mammal Laboratory (NMML) genetics laboratories maintain reference collections of genetic markers for each marine mammal species and Kim Parsons (NWFSC/NMML) will conduct species identification analysis.

Biopsy samples will be obtained from individually identified whales as described in Barrett Lennard et al. (1996). Samples (skin and blubber) will be stored as wet frozen materials on board vessel at -10C and then at the lab at -80C until analyzed for their chemical tracers. (All analysis completed at the NWFSC). Specifically, each biopsy sample was analyzed for their skin carbon and nitrogen stable isotope (SI) ratios, blubber fatty acids (FAs), and persistent organic pollutants (POPs).

Measurements of skin SIs will be conducted following the procedure described in Herman et al. (2005). In essence, the procedure will involve freeze-drying ~50-200 mg of wet skin tissue, removing lipid by accelerated solvent extraction (ASE) using methylene chloride, pulverizing the lipid-free skin to a powder in a micro ball mill, loading ~500ug of powder into tin cups and combusting the powder in a Costech elemental analyzer attached to a Thermo-Finnigan Delta Plus Isotope Ratio Mass Spectrometer. Carbon (13C) and nitrogen (15N) isotope ratios will be measured relative to Vienna Pee Dee Belemnite and atmospheric nitrogen, respectively.

Blubber fatty acids will be analyzed following the procedure described in Herman et al. (2005). Prior to analysis, all blubber biopsy samples are sub-sampled by performing two lateral cuts, the first ~1mm from the inside edge of the epidermis tissue and a second cut exactly 20mm from the epidermis-blubber interface. Because FAs are highly stratified in killer whale blubber tissues it is necessary to standardize all blubber samples in this fashion in order to represent a constant blubber depth. Blubber persistent organic pollutants will be analyzed using a method that involves clean-up of half or more of the lipid extract described in Herman et al. (2005) for the analysis of FAs (which also contains POPs) on a silica/alumina column to remove polar extraneous compounds, separation of the POPs from all lipids by High Performance Size Exclusion Chromatography (HPSEC), and finally separation and analysis on a 60m DB-5 capillary GC column equipped with a quadrupole mass spectrometer operated in the selected ion mode. PCB profile data are expressed on a wt % composition basis by dividing the lipid-normalized concentration of each individual PCB congener by the sum of the lipid-normalized concentrations of all congeners measured in the sample.

A new addition to our core program will be the use of autonomous submerged recording devices that will record calls of killer whales, particularly the vocal residents, for periods of up to 6 months and which we will attempt to redeploy at 6 month intervals to create a full year-long measure of habitat use. This will replace the location only satellite tagging that was developed to explore habitat use in the previous 5-year project. It has the distinct advantage of being more cost effective in the long run, able to assess year round patterns, and is non-invasive. We have used remote transmitting hydrophones in the past but these have required monitoring and placement that allowed transmission to a nearby town (Yurk et al. 2010).

We intend to use the SoundTrap 300 STD recorder, with the additional external battery housing (http://www.oceaninstruments.co.nz/product/st300b-external-battery-pack/). We will use a recording sample rate of around 16kHz for an effective bandwidth of ~8kHz. Intially we intend to employ a simple grapple style mooring. The recorder (attached to a float, i.e., Dragger ball) is tethered to a pier block with an eyebolt. Then we attach two 160ft polysteel lines extending opposite directions from the block, each ending at a 5 or 10kg bruce anchor. This set-up restricts device to relatively shallow (~20fathoms) areas with soft bottom, which can be limiting and induces more surface noise than deeper deployments. Alternatively we will investigate using a small scale acoustic release system such as the Desert Star Systems model (http://desertstar.com/product/arc-1xd/).

Placement locations will be Hinchinbrook Entrance and Montague Strait, the two major entrances to PWS and known seasonal focal areas for killer whales. A third site at the mouth of Resurrection Bay will be employed if time and expense allow. A recording sample rate of around 16 kHz will be used for an effective bandwidth of ~8 kHz. This will detect most discrete calls although it is not broadband enough to capture echolocation signals unless the whales are fairly close.

As an additional project (not part of our core objectives) and to be completed and developed as time and monies allow with personnel assistance from Southwest Fisheries Science Center (SWFSC)/NMFS (Dr. John Durban), we intend to use a small, unmanned hexacopter (APH-22; Aerial Imaging Solutions) as a method for collecting aerial photographs to measure killer whales at sea. There has been good initial success with this program in photographing the endanged Southern Resident Killer whales and our project would be for comparative purposes. We will deploy and retrieved the hexacopter by hand from the upper deck of the R/V Natoa boat, utilizing the aircraft's vertical takeoff and landing (VTOL) capability. The hexacopter is quiet and stable in flight, and therefore can be flown at relatively low altitudes without disturbing whales. The payload will be a Micro Four-Thirds system camera or similar that obtains still images from an altitude of 35–40 m above the whales. Tests have indicated a ground-resolved distance of <1.4 cm across the full extent of a flat and undistorted field of view, and an onboard pressure altimeter enabled measurements in pixels to be scaled to true size with an average accuracy of 5 cm. The images that were obtained in Southern Resident killer whale work were sharp enough to differentiate individual whales using natural markings (77 whales in total) and preliminary estimates resolved differences in whale lengths ranging from 2.6 to 5.8 m. Various measures of body size and shape indicate a good index of condition (body fat) and possibly pregnancy can be resolved.

Although we are completing and publishing our location only tracking work using remotely deployed satellite tags, we will, as possible after completing core objectives, use time/depth/location tags to look at diving behavior as it relates to feeding ecology coupled with concurrent sampling of prey. Tags are attached to the whale using an air rifle (Danjet air rifle) and fastened small barbed posts that attach to the dorsal fin of the whale. The satellite transmitter that we are proposing to deploy is approximately 3.8 cm in diameter in a half dome shape, with a maximum height of 2.2 cm. The transmitting antenna is approximately 1.5 mm in diameter and 17 cm long sticking out of the center of the half dome. On the flat side, opposite the point of the antenna protrusion will be one or two barbed attachment post that will be 5 cm long and 0.6 cm in diameter. Attachments will be made from distances of approximately 6-8 meters. Uplink schedules are set prior to tagging and data received through the Argos satellite system.

C. Data analysis and statistical methods

Because photographic and observational data are being collected in the same basic format as during the past 32 field seasons and using the techniques now standardized for studying killer whales, the data will be comparable with other data collected around the North Pacific. Since we identify every individual in each pod of resident killer whales that we use in our population dynamics analysis, and pod membership only changes through death or calf production, we can accurately assess changes in pods/population. Using genealogies, we have made age estimates for those whales born prior to the study, however, most of the population segment we use for population analysis has been born during the study. We monitor population parameters such as age at first reproduction, mortality and survival rates and use population modeling as a heuristic tool for comparison with observed population dynamics. Comparisons with other resident killer whale populations, such as the endangered Southern Residents of British Columbia, is a key piece of the program. Comparisons will have important management implications.

The report for the monitoring segment will include a summary of all field effort including that funded outside of this GWA program, and will include an annual summary of the pods and individuals encountered, photographed and a status report on AB pod of resident and the AT1 population of transient killer whales. Changes within AB pod will be examined with consideration for the age and sex structure of the pod and maternal groups within the pod and compared to previous and other population models.

Absolute population numbers for the Gulf of Alaska transient (mammal eating) population are difficult as the matrilines are not necessarily stable over years. Trends in transient killer whale sighting rates and demographics will be determined using mark/recapture models. To fully quantify uncertainty about unknown parameters a Baysian approach to model fitting and inference will be used, where estimates are presented as full probability distributions.

Feeding data will be summarized annually. This includes updating the database for scale samples in the case of resident killer whales and their fish prey and summarizing field observations and genetic data from prey of transient killer whales and their marine mammal prey. We will determine genetic population markers for Chinook salmon scale samples when possible. Trends in these data will be viewed in conjunction with the contaminant/fatty acid/stable isotope data collected from skin and blubber biopsy samples to examine of killer whale feeding habits (see Herman et al. 2005, Krahn et al. 2007 for detailed methodologies). We will statistically compare chemical markers indicative of diet between pods and from between different years and at different times of year (late winter/spring and late summer/fall).

Genetic analysis of killer whale tissues, when appropriate to determine population affiliation or sex, will be conducted using the methods detailed in Parsons et al. (2013) and will include mtDNA and nuclear DNA analysis. All multivariate and univariate analyses of the chemical marker data obtained in this study will be conducted using either JMP Statistical Discovery Software (PC professional edition version 5.01) or Primer-E Software (version 6.16).

We will use an automated detector for cetacean calls that has been developed by the Sea Mammal Research Institute (www.smruconsulting.com) and built into PAMGuard, an open-source acoustic analysis software package (www.pamguard.org). We will use the Whistle and Moan Detector, which is a spectrogram-based tonal detector that can be configured to work well with killer whale calls. It works by searching for sounds of a certain size (duration and pixels) that exceed a user defined amplitude threshold. We will run the detector on month-long batches of recordings, and then manually verify all detections to minimize false-positives, effectively bringing the false-positive rate to zero. As possible we will manually go through each of the recordings that we determine to contain killer whales in order to identify the whales vocalizing (to population, clan, subclan, pod, etc., as is possible).

Killer whale presence will be measured as the number of monthly days that killer whales are detected. Duration of calling bouts will be calculated when possible to indicate whether whales are remaining in the area or transiting. This is accomplished by calculating 'encounter duration', the length of time over which killer whales are calling 'continuously' without a gap of more than 2-4 hours (this may differ based on location of the recorder). Eventually, we will examine diversity of group detections over a months or years to differentiate between areas used regularly by only one group, from an area that a much larger proportion of the population uses regularly. If pod identities are possible, then estimates of actual numbers of whales present can be made (Yurk et al. 2010). We will also attempt to link concurrent behavioral observations from the field with recordings to "ground truth" and provide context to our interpretations of recordings.

If morphometrics work can be completed, we will use aerial photo data measurements to estimate whale body length L where the whale was in an apparently "flat" position and we can measure from tip of the rostrum and to the fluke notch, defined this as Lm (m = "measured"). Measurements in pixels will be converted to a true measurement on the sensor using information on the real sensor width of the camera and the number of pixels comprising this width. Measurements will then scaled to true lengths using the measured altitude and the lens focal length (scale = altitude / focal length). Two indices will be used to evaluate body shape: head width (HW = the width at 15% of the distance between the blowhole and anterior insertion of the dorsal fin) and breadth (B = the width at the anterior insertion of the dorsal fin); both were measured in pixels and expressed as a proportion of the total pixels in the same image. For all metrics, we will require a minimum of at least three estimates in order to include an individual in the subsequent data analyses.

If we can collect data from time/depth/ location tags that are deployed, it will be analyzed with the latest version of the Wildlife Computers Data Analysis Program (currently DAP 3.0.292). Data will be separated into deeper diving bouts that denote feeding and the shallower dives that denote resting or surface time. Time, depth and duration of dives, and location of dives will all be plotted and presented in a GIS format coupled with dive profiles. Dive data will be linked, as possible with onsite sampling of prey.

D. Description of study area

This project is part of an ongoing killer whale research in PWS and the Kenai Fjords region, Alaska. The overall study area stretches from the Nuka Bay, outer Kenai Peninsula region to Cordova on the eastern edge of PWS (Figure 2). However, the funding specifically requested in this proposal will be used primarily in western Prince William Sound and Kenai Fjords where likelihood of encountering the focal whales is most likely. We cannot predict the specific locations where encounters will occur.

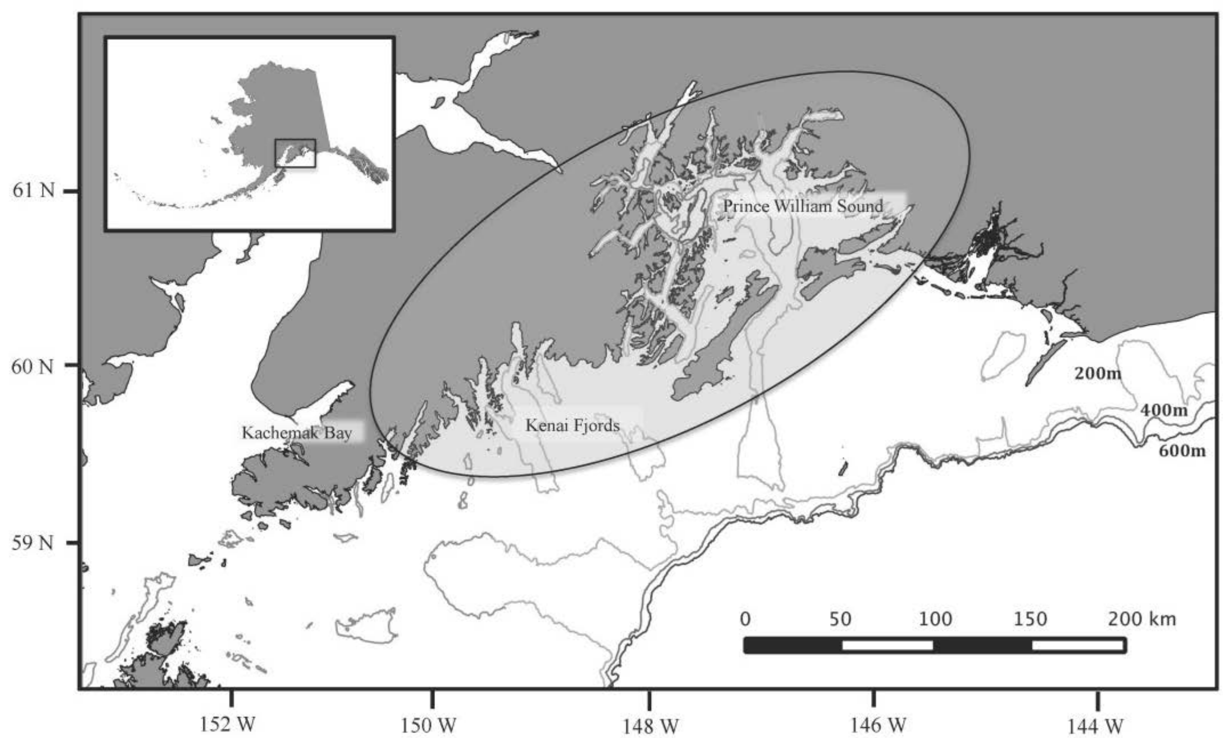

Figure 2. The survey area: Kenai Fjords and Prince William Sound, Alaska

5. Coordination and Collaboration

Within the Program

We will collaborate closely with the Humpback Whale and Herring Predation project (Moran/Straley). Our field work provides photographic and other data from our observations which have numbered from 20 to

40 encounters with humpback whales annually. We also receive data from all killer whale encounters that they log during their fieldwork. We are also working with Rob Campbell of the Oceanographic Conditions in Prince William Sound project (Environmental Drivers) who will fit his mid Sound mooring with recording hydrophones that will be used by this project to record vocalizations that may be used to determine how different pods of killer whales use the Hinchinbrook Entrance and mid Sound. The hydrophones will be serviced by Campbell and data passed on to our project. Campbell also will assist in developing battery packs for extended deployments and fabricating hydrophone mounts on the moorings. The Nearshore program (Dan Monson) will opportunistically provide killer whale identification photographs to our project as will the forage fish project (Mayumi Arimitsu).

WITH OTHER EVOSTC-FUNDED PROGRAMS AND PROJECTS

There is no planned coordination with other EVOS projects outside of the GWA program at this time.

WITH TRUSTEE OR MANAGEMENT AGENCIES

We will annually provide our data to the NMFS/NMML (Paul Wade) to update the killer whale stock assessments for Alaska and we will provide a review of current Alaska stock assessments, in part based on data collected in this project. Our genetic/contaminant/ and lipid and fatty acid data that spans two decades and will continue is housed at the NWFSC Contaminant Laboratory (Gina Ylitalo) where it will continue to be used in various projects and publications. Genetic samples/ data generated by this project are housed at NWFSC but subsamples are also provided to Southwest Fisheries Science Center (Phil Morin) for examination of worldwide killer whale stock structure and become part of a larger killer whale genetic database maintained at that facility.

WITH NATIVE AND LOCAL COMMUNITIES

Regular presentations will be given in many local communities including Cordova, Homer, Seward, and Anchorage and include talks specifically aimed at tour boat and commercial whale watching operators. This outreach provides the double benefit of increasing interest in killer whales and their conservation and in area wide conservation issues and in stimulating boaters (particularly tour boats) to provide photos that may be important in our identification work. With the quality of cameras and lenses in use today, photographs can be taken at distances that do not violate marine mammal protection laws and regulations. Viewing regulations and guidelines will be stressed at all presentations/meetings. In meetings that we have initiated as part of previous projects, the Kenai Fjords Tour boat operators have developed their own strict guidelines for viewing marine mammals.

As is possible, we will provide presentations at the Chenega native village school as we have in the past. Chenega is the only village within our study area and we make opportunistic visits there during field to discuss our work.

6. Schedule

PROJECT MILESTONES

- **Task 1**
  To annually prepare for and launch field collection of core project data including: identification photos, observation of predation and sampling of prey scales/tissue and fecal material (when possible) and collect annual biopsy samples for feeding habits/contaminants/genetics. Prepare and deploy acoustic recorders for year round monitoring of whale movements. Secondarily prepare for possible deployment of time depth tags to investigate details of feeding ecology as time and situations permit.

- **Task 2**
  Conduct analysis of identification photos, skin and blubber samples, scale samples and fecal samples, skin samples, and plot results of tagging efforts. Conducted annually, completion date for all laboratory analysis is February 2022.

- **Task 3**
  Annual update photographic catalogue, Argos tracking data displayed and analyzed, and population dynamics updated. Statistical analysis and compilation of data from all years of the project to be included in final report and/or other publication (draft by April 2022).

MEASURABLE PROJECT TASKS

Measurable project tasks are presented by fiscal year and quarter graphically in Table 1 and descriptively below.

Table 1. Project tasks and activities by fiscal year and quarter, beginning February 1, 2017.

	FY17				FY18				FY19				FY20				FY21			
Task	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Task 1 Collection																				
Field prep	X				X				X				X				X			
Field surveys		X	X			X	X			X	X			X	X			X	X	
Task 2 Data																				
Data summary/analysis				X	X			X	X			X	X			X	X			X
Hydrophone deployments		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Upload previous FY data					X				X				X				X			
Task 3 Reporting																				
Annual Reports					X				X				X				X			
Annual PI meeting				X				X				X				X				X
FY Work Plan (DPD)			X				X				X				X					

FY 2017 (Year 6)

FY17, 1st quarter (February 1, 2017 - April 30, 2017)
Finalize report/paper for first five years funding. Update photo catalogue and population dynamics database. All field preparation completed and boat outfitted for season, with photo equipment, GIS systems and computers, biopsy rifle and supplies, remote and boat based hydrophones, prey/fecal sampling nets and supplies, tagging rifle and supplies.

FY17, 2nd quarter (May 1, 2017 - July 31, 2017)
Initiate field season in early May with intensive field work lasting until early July. Deploy hydrophones. Vessel resupplied at 10-14 day intervals. Trips led by either Craig Matkin or Dan Olsen. Daily outreach through Facebook. In July the R/V Natoa will be on standby in Kenai Fjords to respond to unique encounters, however no scheduled trips.

FY17, 3rd quarter (August 1 2017 - October 31, 2017)
Intensive fieldwork begins again in late August and continues in September-early October. Retrieve hydrophones All field equipment will be cleaned and stored and data analysis will begin by mid-October. Samples will be sent to appropriate laboratories.

FY17, 4th quarter (November 1, 2017 - January 31, 2018)
Analysis continues along with preparation for annual GWA meeting in November and for Alaska Marine Science Symposium in January. Frame by frame photoidentification completed. Begin annual report, summarize annual results including outreach. Work on journal papers.

FY 2018 (Year 7)

FY18, 1st quarter (February 1, 2018 - April 30, 2018)
Complete annual report. Continue analysis, update identification catalogue and distribute. Complete annual update of databases and upload previous years data onto GWA site. Preparation of journal papers. All field preparation completed and boat outfitted for season, with photo equipment, GIS systems and computers, biopsy and tagging rifle and supplies, remote and boat based hydrophones, prey/fecal sampling nets and supplies.

FY18, 2nd quarter (May 1, 2018 - July 31, 2018)
Initiate field season in early May with intensive field work lasting until early July. Deploy hydrophones. Vessel resupplied at 10-14 day intervals. Trips led by either Craig Matkin or Dan Olsen. Daily outreach through Facebook. In July the R/V Natoa will be on standby in Kenai Fjords to respond to unique encounters, however no scheduled trips.

FY18, 3rd quarter (August 1, 2018 - October 31, 2018)
Intensive fieldwork begins again in late August and continues in September-early October. Redeploy hydrophones. All field equipment will be cleaned and stored and data analysis will begin by mid-October. Samples will be sent to appropriate laboratories.

FY18, 4th quarter (November 1, 2018 - January 31, 2019)
Analysis continues along with preparation for annual GWA meeting in November and for Alaska Marine Science Symposium in January. Frame by frame photoidentification completed. Begin annual report, summarize annual results including outreach. Work on journal papers.

FY 2019 (Year 8)

FY19, 1st quarter (February 1, 2019 - April 30, 2019)
Complete annual report. Continue analysis, update identification catalogue and distribute. Complete annual update of databases and upload previous years data onto GWA site. Preparation of journal papers. All field preparation completed and boat outfitted for season, with photo equipment, GIS systems and computers, biopsy and tagging rifle and supplies, remote and boat based hydrophones, prey/fecal sampling nets and supplies.

FY19, 2nd quarter (May 1, 2019 - July 31, 2019)
Initiate field season in early May with intensive field work lasting until early July. Redeploy hydrophones Vessel resupplied at 10-14 day intervals. Trips led by either Craig Matkin or Dan Olsen. Daily outreach through Facebook. In July the R/V Natoa will be on standy in Kenai Fjords to respond to unique encounters, however no scheduled trips.

FY19, 3rd quarter (August 1, 2019 - October 31, 2019)
Intensive fieldwork begins again in late August and continues in September-early October. All field equipment will be cleaned and stored and data analysis will begin by mid-October. Redeploy hydrophones. Samples will be sent to appropriate laboratories.

FY19, 4th quarter (November 1, 2019 - January 31, 2020)
Analysis continues along with preparation for annual GWA meeting in November and for Alaska Marine Science Symposium in January. Frame by frame photoidentification completed. Begin annual report, summarize annual results including outreach. Work on journal papers.

FY 2020 (Year 9)

FY20, 1st quarter (February 1, 2020 - April 30, 2020)
Complete annual report. Continue analysis, update identification catalogue and distribute. Complete annual update of databases and upload previous years data onto the GWA site. Preparation of journal papers. All field preparation completed and boat outfitted for season, with photo equipment, GIS systems and computers, biopsy and tagging rifle and supplies, remote and boat based hydrophones, prey/fecal sampling nets and supplies.

FY20, 2nd quarter (May 1, 2020 - July 31, 2020)
Initiate field season in early May with intensive field work lasting until early July. Redeploy hydrophones. Vessel resupplied at 10-14 day intervals. Trips led by either Craig Matkin or Dan Olsen. Daily outreach through Facebook. In July the R/V Natoa

will be on standy in Kenai Fjords to respond to unique encounters, however no scheduled trips.

FY20, 3rd quarter (August 1, 2020 - October 31, 2020)
Intensive fieldwork begins again in late August and continues in September-early October. Redeploy hydrophones All field equipment will be cleaned and stored and data analysis will begin by mid-October. Samples will be sent to appropriate laboratories.

FY20, 4th quarter (November 1, 2020 - January 31, 2021)
Analysis continues along with preparation for annual GWA meeting in November and for Alaska Marine Science Symposium in January. Frame by frame photoidentification completed. Begin annual report, summarize annual results including outreach. Work on journal papers. Preparation of budget proposal for next five year (FY22-FY26 period).

FY 2021 (Year 10)

FY21, 1st quarter (February 1, 2021 - April 30, 2021)
Complete annual report. Continue analysis, update identification catalogue and distribute. Preparation of proposal for next 5-year funding period (FY22-FY26 period). Complete annual update of databases and upload previous years' data onto GWA site. Preparation of journal papers. All field preparation completed and boat outfitted for season, with photo equipment, GIS systems and computers, biopsy and tagging rifle and supplies, remote and boat based hydrophones, prey/fecal sampling nets and supplies.

FY21, 2nd quarter (May 1, 2021 - July 31, 2021)
Initiate field season in early May with intensive field work lasting until early July. Redeploy hydrophones. Vessel resupplied at 10-14 day intervals. Trips led by either Craig Matkin or Dan Olsen. Daily outreach through Facebook. In July the R/V Natoa will be on standy in Kenai Fjords to respond to unique encounters, however no scheduled trips.

FY21, 3rd quarter (August 1, 2021 - October 31, 2021)
Intensive fieldwork begins again in late August and continues in September-early October. Final pickup of hydrophones. All field equipment will be cleaned and stored and data analysis will begin by mid-October. Samples will be sent to appropriate laboratories.

FY21, 4th quarter (November 1, 2021 - January 31, 2022)
Analysis continues along with preparation for annual GWA meeting in November and for Alaska Marine Science Symposium in January. Frame by frame photoidentification completed. Begin annual report, summarize annual results including outreach. Work on journal papers.

FY 2022 (Year 11)

FY22, 1st quarter (February 1, 2022 - April 30, 2022)
Preparation of final report/publications for second 5-year funding period. Final database/catalogue update and upload for second 5-year funding period. If a third 5-year period is approved, then preparation of vessel/equipment for fieldwork.

7. Budget

BUDGET FORMS (ATTACHED)

Completed budget forms are attached.

SOURCES OF ADDITIONAL FUNDING

The NMFS/Northwest Fisheries Science Center/Environmental Contaminant Lab will provide $8,000 annually in analysis and consulting.

The North Gulf Oceanic Society will provide approximately 12,000 in donated vessel time and personnel time to extend the field season.

The Norcross Foundation and other small donors will contribute approximately $5,000 annually to provide Equipment for the project.

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PROJECT DATA ONLINE

Publicly available data from this project are available online at the following link:
http://portal.aoos.org/gulf-of-alaska.php#metadata/2f42dd1c-d67a-4c49-8c2e-1d63387e0ad0/project/files

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EDUCATION
B.A. in Biology, University of California, Santa Cruz (1974)
M.S. in Zoology, University of Alaska Fairbanks (1980)

PROFESSIONAL EXPERIENCE
Executive Director, North Gulf Oceanic Society, Homer, Alaska, (1982-present)

Supervise and conduct research on cetaceans, primarily killer whales and humpback whales, oversee stranding network and educational operations, operate and outfit research vessels. Maintain collaborations with numerous institutions and oversee fiscal operations of NGOS.

Adjunct faculty, UA, Kenai Peninsula College, Kachemak Bay Campus, Homer, Alaska (1999-present)

Teaching of marine mammal classes and guest lectures on marine topics

Commercial Fisherman, Gulf of Alaska, Alaska (1977-1997)

Outfitting and operation of commercial fishing vessels harvesting, salmon, herring and various species of crab. Participation on boards of various fishing organizations.

RELATED EXPERIENCE
Mr. Matkin has conducted research on marine mammals in southern Alaska since 1977 when he initiated photo-identification work of killer whales and humpback whales in Prince William Sound in. Since 1982 he has worked as executive director of the North Gulf Oceanic Society, acted as principal investigator on numerous contracts from the National Marine Mammal Laboratory, National Marine Fisheries Service; the U.S. Fish and Wildlife Service; Sea Grant Marine Advisory Program; Alaska Council on Science and Technology, U.S. Marine Mammal Commission; Hubbs Sea World Research Institute, the *Exxon Valdez* Trustee Council, the North Pacific Universities Marine Mammal Research Consortium, and the Alaska Sea Life Center. He has directed the NGOS long-term photo-identification project examining killer whale population dynamics in Alaska since 1984. He has conducted population/distribution/genetics research on humpback whales from southeast Alaska to the Aleutian Islands and western Alaska, most recently as a regional supervisor for the SPLASH program. He has specialized in biopsy sampling of various cetaceans including killer whales, humpback whales, fin whales and sperm whales. Using the biopsy sampling technique he has investigated population genetics and environmental contaminant levels in killer whales and humpback whales, and most recently, feeding habits using stable isotopes and lipid/fatty acids. With collaborators he has developed small telemetry packages for remote attachment to killer whales and other cetaceans and applied tags and used ARGOS satellite systems to track killer whales and monitor diving behavior. He has supervised a killer whale research program that extends from southeastern Alaska to the Eastern Aleutians. For the past 29 years (1989-present) contracted by the and National Marine Fisheries Service he has directed work assessing the long-term impacts of the *Exxon Valdez* Oil Spill on killer whales under the aegis of the *Exxon Valdez* Oil Spill Trustee Council. Recently he reviewed the status of the Cook Inlet beluga whale and was a member of the Cook Inlet Beluga Recovery Team organized by the National Marine Fisheries Service.

Selected recent publications:

Saulitis, E., L.A Holmes, **C. Matkin,** K. Wynn, D. Ellifrit, and C. St. Amand. 2015. Bigg's killer whale (*Orcinus Orca*) predation on subadult humpback whales (*Megaptera novaeangliae)* in Lower Cook Inlet and Kodiak, Alaska. 2015. Aquatic Mammals 41(3), 341-344, Doi: 10.1578/AM.41.3.2015.341.

Filatova, O.A., P.J.O. Miller, H. Yurk, F.I.P. Samarra, E. Hoyt, J.K.B. Ford, **C.O. Matkin,** and L.G. Barrett-Lennard. 2015. Killer whale call frequency is similar across the oceans, but varies across sympatric ecotypes. 2015. J. Acoust. Soc. Am. 138 (1)5.

Matkin, C.O., G.W. Testa, G.M. Ellis, and E.L. Saulitis. 2014. Life history and population dynamics of southern Alaska resident killer whales (*Orcinus orca*). Marine Mammal Science 30(2):460-479.

Fernback, H., J.W. Durban, D.K. Ellifrit, J.M. Waite, **C.O. Matkin**, et al. 2014 Spatial and social connectivity of fish-eating resident killer whales (Orcinus orca) in the North Pacific. Marine Biology 161(2) 459-472.

Bodkin, J.L., D. Esler, S.D. Rice, **C.O. Matkin,** and B.E. Ballachey. 2014. The effects of spilled oil on coastal ecosystems: lessons from the *Exxon Valdez* spill. B. Maslo and J.L. Lockwood eds. In: Coastal Conservation, Cambridge University Press, U.K.

Terlink, S.F., O. von Ziegesar, J.M. Straley, T.J. Quinn II**, C.O. Matkin,** and E.L. Saulitis. 2014. First time series of estimated humpback whale (*Megaptera novaeangliae*) abundance in Prince William Sound. Environ. Ecol. Stat. Doi: 10.1007/s10651-014-0301-8.

Parsons, K., J.J.W. Durban, A.M. Burdin, V.N. Burkanov, R.L. Pitman, J. Barlow, L.G. Barrett-Lennard, R.G. LeDuc, K.M. Robertson, **C.O. Matkin**, and P.R. Wade. 2013 Geographic Patterns of Genetic Differentiation among Killer Whales in the Northern North Pacific. Journal of Heredity. Doi: 10.1093.

Filatova O.A., V.B. Deecke, J.K.B. Ford, **C.O. Matkin**, L.G. Barrett-Lennard. M.A. Guzeev, A.M. Burdin, and E. Hoyt. 2012. Call diversity in the North Pacific killer whale populations: implications for dialect evolution and population history. Animal Behaviour 83:595-603.

Filatova, O.A., J.K.B. Ford**, C.O. Matkin,** L.G. Barrett-Lennard, A.M. Burdin, and E. Hoyt. 2012. Ultrasonic whistles of killer whales (*Orcinus orca*) recorded in the North Pacific (L). J. Acoust. Soc. Am. 132 (6).

Matkin, C.O., J.W. Durban, E.L. Saulitis, R. D. Andrews, J.M. Straley, D.R. Matkin, and G.M. Ellis. 2012. Contrasting abundance and residency patterns of two sympatric populations of transient killer whales (*Orcinus orca*) in the northern Gulf of Alaska. Fish. Bull. 110:143–155.

Collaborators (not previously listed as coauthors):

Russ Andrews, Alaska Sea Life Center, Seward, Alaska; Manolo Casellote, NGOS/NMML; Rob Campbell, PWS Science Center; Dave Herman, Northwest Fisheries Science Center Seattle, WA; John Moran, NOAA, Auke Bay Lab, Juneau, Alaska; Gina Ylitalo, Northwest Fisheries Science Center, Seattle, WA

Budget Category:	Proposed FY 17	Proposed FY 18	Proposed FY 19	Proposed FY 20	Proposed FY 21	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$41.0	$41.0	$42.2	$42.2	$42.2	$208.5	
Travel	$3.2	$3.2	$3.5	$3.5	$3.5	$16.8	
Contractual	$49.5	$50.5	$52.3	$52.3	$54.0	$258.6	
Commodities	$33.8	$31.6	$20.6	$19.1	$16.7	$121.6	
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
Indirect Costs (*10%*)	$ 13	$ 13	$ 12	$ 12	$ 12	$ 61	
SUBTOTAL	$140.2	$138.8	$130.3	$128.7	$128.0	$666.0	
General Administration (9% of subtotal)	$12.6	$12.5	$11.7	$11.6	$11.5	$59.9	N/A
PROJECT TOTAL	$152.8	$151.3	$142.1	$140.3	$139.5	$725.9	
Other Resources (Cost Share Funds)	$25.0	$25.0	$25.0	$25.0	$25.0	$125.0	

COMMENTS:

FY17-21

Project Title: Long-term killer whale monitoring in PWS & Kenai Fjords
Primary Investigator: Craig Matkin

NON-TRUSTEE AGENCY SUMMARY PAGE

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Craig Matkin	P.I. Field Biologist	3.0	6.0		18.0
Field Assistant	Field Assistant/Data analysis	2.5	3.8		9.5
Dan Olsen	Field Biologist/Data analysis	3.0	4.5		13.5
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	14.3	0.0	
				Personnel Total	$41.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Attend annual Gulf Watch PI meeting	1.1	1	3	0.2	1.6
Attend annual Alaska Marine Science Symposium	1.1	1	3	0.2	1.6
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$3.2

FY17

Project Title: Long-term killer whale monitoring in PWS & Kenai Fjords
Primary Investigator: Craig Matkin

FORM 3B PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Vessel lease (R/V Natoa--50 days @ $600/day)	30.0
NWFSC Environmental Contaminant Lab Analytical Fees	5.0
GIS/Statistical Analysis	4.0
Photidentification Catalogue	6.5
Data input/Analysis	4.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$49.5

Commodities Costs: Description	Commodities Sum
Acoustic recorders and moorings	21.6
Field Food ($60/day for 50 days)	3.0
Fuel ($120/day for 50 days)	5.0
Misc electronic, photo supplies (memmory cards, hard drives, etc)	1.2
Field Communication, Tracking, Shipping, and Misc supplies	1.0
Camera body	2.0
Commodities Total	$33.8

FY17

Project Title: Long-term killer whale monitoring in PWS & Kenai Fjords
Primary Investigator: Craig Matkin

FORM 3B CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY17

Project Title: Long-term killer whale monitoring in PWS & Kenai Fjords
Primary Investigator: Craig Matkin

FORM 3B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Craig Matkin	P.I. Field Biologist	3.0	6.0		18.0
Field Assistant	Field Assistant/Data analysis	2.5	3.8		9.5
Dan Olsen	Field Biologist/Data analysis	3.0	4.5		13.5
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	14.3	0.0	
				Personnel Total	$41.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Attend annual Gulf Watch PI meeting	1.1	1	3	0.2	1.6
Attend annual Alaska Marine Science Symposium	1.1	1	3	0.2	1.6
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$3.2

FY18

Project Title: Long-term killer whale monitoring in PWS & Kenai Fjords
Primary Investigator: Craig Matkin

FORM 3B PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Vessel Lease (R.V. Natoa/ 50 days @600/day)	30.0
NWFSC Environmental Contaminant Lab, Analytical Fees	5.0
GIS/Statistical Analysis	4.0
Photoidentification/Catalogue	6.5
Data input/Analysis	5.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$50.5

Commodities Costs: Description	Commodities Sum
Time Depth tags	3.2
Acoustic recorders and moorings	17.2
Field Food ($60/day for 50 days)	3.0
Fuel ($120/day for 50 days)	6.0
Misc electronic, photo supplies (memmory cards, hard drives, etc)	1.2
Field Communication, Tracking, Shipping, and Misc supplies	1.0
Commodities Total	$31.6

FY18

Project Title: Long-term killer whale monitoring in PWS & Kenai Fjords
Primary Investigator: Craig Matkin

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY18

Project Title: Long-term killer whale monitoring in PWS & Kenai Fjords
Primary Investigator: Craig Matkin

FORM 3B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Craig Matkin	P.I. Field Biologist	3.0	6.0		18.0
Field Assistant	Field Assistant/Data analysis	2.5	3.9		9.8
Dan Olsen	Field Biologist/Data analysis	3.0	4.8		14.4
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	14.7	0.0	
				Personnel Total	$42.2

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Attend annual Gulf Watch PI meeting	1.1	1	4	0.2	1.7
Attend annual Alaska Marine Science Symposium	1.1	1	4	0.2	1.7
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$3.5

FY19

Project Title: Long-term killer whale monitoring in PWS & Kenai Fjords
Primary Investigator: Craig Matkin

FORM 3B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Vessel Lease (R.V. Natoa/ 50 days @650/day)	32.5
NWFSC Environmental Contaminant Lab, Analytical Fees	5.0
GIS/Statistical Analysis	4.0
Photoidentification/Catalogue	6.8
Data input/Acoustic Analysis	4.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$52.3

Commodities Costs: Description	Commodities Sum
Time Depth tags	3.1
Acoustic recorders and moorings	3.3
Field Food ($60/day for 50 days)	3.0
Fuel ($140/day for 50 days)	7.0
Misc electronic, photo supplies (memmory cards, hard drives, etc)	1.2
Field Communication, Tracking, Shipping, and Misc supplies	1.0
Camera body	2.0
Commodities Total	$20.6

FY19

Project Title: Long-term killer whale monitoring in PWS & Kenai Fjords
Primary Investigator: Craig Matkin

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY19

Project Title: Long-term killer whale monitoring in PWS & Kenai Fjords
Primary Investigator: Craig Matkin

FORM 3B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Craig Matkin	P.I. Field Biologist	3.0	6.0		18.0
Field Assistant	Field Assistant/Data analysis	2.5	3.9		9.8
Dan Olsen	Field Biologist/Data analysis	3.0	4.8		14.4
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	14.7	0.0	
				Personnel Total	$42.2

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Attend annual Gulf Watch PI meeting	1.1	1	4	0.2	1.7
Attend annual Alaska Marine Science Symposium	1.1	1	4	0.2	1.7
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$3.5

FY20

Project Title: Long-term killer whale monitoring in PWS & Kenai Fjords
Primary Investigator: Craig Matkin

FORM 3B
PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Vessel Lease (R.V. Natoa/ 50 days @650/day)	32.5
NWFSC Environmental Contaminant Lab, Analytical Fees	5.0
GIS/Statistical Analysis	4.0
Photoidentification/Catalogue	6.8
Data input/ Acoustic Analysis	4.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$52.3

Commodities Costs: Description	Commodities Sum
Time Depth tags	3.1
Acoustic recorders and moorings	1.8
Field Food ($60/day for 50 days)	3.0
Fuel ($140/day for 50 days)	7.0
Misc electronic, photo supplies (memmory cards, hard drives, etc)	1.2
Field Communication, Tracking, Shipping, and Misc supplies	1.0
Camera body	2.0
Commodities Total	$19.1

FY20

Project Title: Long-term killer whale monitoring in PWS & Kenai Fjords
Primary Investigator: Craig Matkin

FORM 3B
CONTRACTUAL &
COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY20

Project Title: Long-term killer whale monitoring in PWS & Kenai Fjords
Primary Investigator: Craig Matkin

FORM 3B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Craig Matkin	P.I. Field Biologist	3.0	6.0		18.0
Field Assistant	Field Assistant/Data analysis	2.5	3.9		9.8
Dan Olsen	Field Biologist/Data analysis	3.0	4.8		14.4
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	14.7	0.0	
				Personnel Total	$42.2

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Attend annual Gulf Watch PI meeting	1.1	1	4	0.2	1.7
Attend annual Alaska Marine Science Symposium	1.1	1	4	0.2	1.7
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$3.5

FY21

Project Title: Long-term killer whale monitoring in PWS & Kenai Fjords
Primary Investigator: Craig Matkin

FORM 3B PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Vessel Lease (R.V. Natoa/ 50 days @650/day)	32.5
NWFSC Environmental Contaminant Lab, Analytical Fees	5.0
GIS/Statistical Analysis	4.0
Photoidentification/Catalogue	7.0
Data input/Analysis	3.0
Acoustic analysis	2.5
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$54.0

Commodities Costs: Description	Commodities Sum
Time Depth tags	3.3
Acoustic recorders and moorings	1.2
Field Food ($60/day for 50 days)	3.0
Fuel ($140/day for 50 days)	7.0
Misc electronic, photo supplies (memmory cards, hard drives, etc)	1.2
Field Communication, Tracking, Shipping, and Misc supplies	1.0
Commodities Total	$16.7

FY21

Project Title: Long-term killer whale monitoring in PWS & Kenai Fjords
Primary Investigator: Craig Matkin

FORM 3B CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY21

Project Title: Long-term killer whale monitoring in PWS & Kenai Fjords
Primary Investigator: Craig Matkin

FORM 3B
EQUIPMENT DETAIL

August 24, 2016

Elise Hsieh, Executive Director
Exxon Valdez Oil Spill Trustee Council
4210 University Drive
Anchorage, AK 99508-4626

Dear Elise:

Final FY 2017-2021 Proposal Submittal for Long-term Monitoring

17120114-O. Long-term Monitoring of Humpback Whale Predation on Pacific Herring in Prince William Sound

Gulf Watch Alaska, the long-term monitoring program of the *Exxon Valdez* Oil Spill Trustee Council (EVOSTC), has finalized our program and project proposals for fiscal years 2017-2021 funding based on comments received from EVOSTC's Science Panel on May 19, 2016. Below is the final budget summary and response to Science Panel comments for the humpback whale project.

EVOSTC Funding Requested *(including 9% GA)*

FY17	FY18	FY19	FY20	FY21	TOTAL
$161,900	$155,000	$157,900	$154,900	$147,600	$777,400

Non-EVOSTC Funding Available

FY17	FY18	FY19	FY20	FY21	TOTAL
$146,000	$146,000	$146,000	$146,000	$146,000	$730,000

Science Panel comment: *There are no project specific comments.*

PI Response:

- The proposal was not revised.

Sincerely,

Mandy Lindeberg
Gulf Watch Alaska Program Lead designate

Attachment: Gulf Watch Alaska: Pelagic Component Project Proposal: 17120114-O—Long-term monitoring of humpback whale predation on Pacific herring in Prince William Sound

EVOSTC FY17-FY21 INVITATION FOR PROPOSALS
PROGRAM PROJECT PROPOSAL SUMMARY PAGE

Project Title

Gulf Watch Alaska: Pelagic Component Project:

17120114-O—Humpback Whales: Long-term monitoring of predation on Pacific herring in Prince William Sound

Primary Investigator(s) and Affiliation(s)

John R. Moran, National Oceanographic and Atmospheric Administration

Janice M. Straley, University of Alaska Southeast

Date Proposal Submitted

24 August 2016

Project Abstract

INTEGRATED PREDATOR-PREY SURVEYS 2017-2021: HUMPBACK WHALES, MARINE BIRDS, FORAGE FISH

Under the next five year monitoring program, we are proposing to integrate predator-prey survey efforts by combining monitoring work from three of the Prince William Sound (PWS) Pelagic Component projects and collaborating with the Herring Research and Monitoring program. We propose to combine the humpback whale, marine bird and forage fish (including euphausiids) projects into a single, integrated predator-prey survey. The integrated survey would be conducted during the fall, providing insight into predator-prey interactions at a crucial time when forage fish energy is maximized while marine birds and humpback whales are provisioning for the upcoming winter. In addition, the survey would estimate the availability, including species composition, density and depth distribution of prey near seasonally predictable predator aggregations in PWS. The survey would include concurrent habitat and nutrient measurements in conjunction with acoustic measurements of nekton biomass and predator density. A midwater trawl (max depth ~ 100 m) will be used to sample acoustic sign and collect samples of forage fish for further analysis (e.g., diet, energy). Marine bird observations will be conducted concurrent with acoustic transects and humpback whale distribution and abundance will be assessed at the same time and area from a smaller vessel. The simultaneous surveys will reduce vessel cost for the three projects while combining expertise with spatial and temporal consistency, allowing a more comprehensive understanding of the pelagic ecosystem. In addition to a planned research cruise in September/October, the proposed approach may also allow for in-kind contributions from National Oceanic and Atmospheric Administration (NOAA) for vessel charter and an additional survey in March, when humpback whales are returning from their migrations to feed and when we can assess the winter severity on forage fish. The NOAA funds will be applied for and awarded on an annual basis, and a March NOAA cruise, if awarded a second cruise would be an added value to the GWA pelagic monitoring program.

HUMPBACK WHALES: LONG-TERM MONITORING OF PREDATION ON PACIFIC HERRING IN PRINCE WILLIAM SOUND:

The humpback whale monitoring project is a component of the integrated fall/winter predator-prey survey. We will continue to evaluate the impact by humpback whales foraging on Pacific herring

populations in PWS. Following protocols established during the winters of 2007/08 and 2008/09 (EVOSTC project PJ090804). Prey selection by humpback whales will be determined through acoustic surveys, visual observation, scat analysis and prey sampling. Chemical analysis of skin and blubber biopsy samples will provide a longer term perspective on shifts in prey type (trophic level from stable isotopes) and quality (energy content). These data will be combined in a bioenergetic model that will allow us to assess the impact of recovering humpback whale populations on the PWS ecosystem. By integrating with the forage fish and winter seabird components, we will be able to provide a comprehensive understanding of bottom-up influences and top-down controls on herring abundance.

EVOSTC Funding Requested *(must include 9% GA)*

FY17	FY18	FY19	FY20	FY21	TOTAL
$161.9	$155	$157.9	$154.9	$147.6	$777.4

Non-EVOSTC Funding Available

FY17	FY18	FY19	FY20	FY21	TOTAL
$146	$146	$146	$146	$146	$730

1. Executive Summary

Pelagic Component

In the aftermath of the 1989 *Exxon Valdez* oil spill (EVOS) it was difficult to distinguish between the impacts of the spill and natural variability in affected animal populations. The main problem for assessing impacts on pelagic species was that long-term baseline data were largely absent. As a result, managers struggled to make informed decisions regarding estimation of damages and recommendations for recovery. Ten years after the spill it became widely recognized that there had been a major climatic regime shift (from colder to warmer than average) that altered the marine ecosystem prior to the spill, including marine birds, marine mammals, groundfish, and the shared forage species they all consumed. As we begin to close the second decade of the 2000s we are experiencing anomalous ocean warming events driven by changing atmospheric conditions at both inter-decadal (i.e., Pacific Decadal Oscillation) and shorter (e.g., El Niño Southern Oscillation) time scales. These changes may have profound effects on pelagic ecosystems such as unusual mortality events, harmful algal blooms, and fishery closures.

During the first five years of the Gulf Watch Alaska (GWA) program, the pelagic component research team addressed two main questions: 1) What are the population trends of key pelagic species groups in Prince William Sound, and, 2) How can forage fish population trends in PWS be monitored most effectively? To answer these questions, five projects focused on species that play a pivotal role in the pelagic ecosystem as trophic indicators for short and long-term ecosystem change: forage fish, marine birds, humpback whales and killer whales. Monitoring of killer whales and marine birds benefitted from having pre-existing long-term data sets as a result of the damage assessment process following the EVOS (>25 year time series).

Moving forward for the next five years, the pelagic research team re-evaluated their primary objectives. The group's primary objective— to determine the long-term population trends of key pelagic species groups in PWS — will remain the same. The second primary objective was fundamentally different:

Develop a means to effectively monitor forage fish. Based on knowledge gained in the first five years of the pelagic program, we have developed a broader focus that includes an integrated study of forage fish using marine bird and mammal predators as samplers of the forage base. In addition to providing a means to effectively monitor indices of forage fish trends, our integrated approach will also enhance our understanding of predator-prey relationships and help us identify some mechanisms of change in populations. Ultimately, the integrated surveys along with information from the GWA Environmental Drivers Program will provide a way to evaluate climate variability and climate change on the PWS pelagic ecosystem.

Thus, the two over-arching questions for the pelagic component to answer in the next five years are:

1. What are the population trends of key upper trophic level pelagic species groups in Prince William Sound – killer whales, humpback whales, marine birds, and forage fish?
2. How do predator-prey interactions, including interannual changes in prey availability, contribute to underlying changes in the populations of pelagic predators in Prince William Sound and Middleton Island?

The pelagic component research team is proposing to continue monitoring key pelagic species groups in PWS using the same five projects focused on killer whales, humpback whales, forage fish, and marine birds. However, modifications have been made to some projects for greater integration, increased precision of information, and achieving new goals. Ultimately this will provide more information to the EVOS Trustee Council (EVOSTC), agency resource managers, non-governmental organizations (NGOs), and the public.

Integrated Predator-Prey Surveys 2017-2021: Humpback Whales, Marine Birds, Forage Fish

In our initial GWA efforts, we have been able to identify several areas in PWS with seasonally predictable predator-prey aggregations. Given limited resources and patchy predator-prey distribution in the Sound, we propose using a combination of systematic transects in conjunction with predator guided surveys to hone in on important marine mammal and marine bird foraging areas with significant aggregations of prey. Our new proposed integrated predator-prey surveys will allow us to monitor the status and trends of individual pelagic ecosystem elements as a primary goal. Predator-prey indices will be measured concurrently, thus we will also be able to examine spatial and temporal covariance among indices to better understand the effects of perturbations in the environment. Our framework includes the following hypotheses:

1. *Predator distribution and abundance varies with prey availability (quantity and quality)*
2. *Changes in prey availability and quality occur in response to changes in habitat quality (phytoplankton/zooplankton and environment/temperature)*
3. *Variation in prey availability occurs in response to predation pressure*

Humpback Whales: Long-term monitoring of predation on Pacific herring in Prince William Sound

Monitoring humpback whales and their diets is important to understanding predator prey interactions in the pelagic waters of PWS. Because humpback whales are significant predators in the ecosystem, they may have the potential to control the distribution and abundance of forage fish. The humpback whale population in the North Pacific has rebounded from near extinction in the late 1960s to over 22,000 individuals, and parallel increases in whale abundance have been documented in PWS (Teerlink 2014). This rapid recovery has coincided with major natural and anthropogenic perturbations in the marine ecosystem (regime shift, Pacific Decadal Oscillation, EVOS). Over much of the same period the abundance of the dominant forage fish, Pacific herring, shifted from an abundant state to a diminished state. The lack of commercial fishery has not restored this population to their former abundance. Pacific herring were identified as an injured species following the EVOS. Understanding the mechanisms behind their failed recovery requires a comprehensive understanding of both top-down and bottom-up processes in the context of a changing ecosystem. Our previous work in PWS (EVOSTC project PJ090804) estimates that humpback whales are consuming 15% to 20% of the pre-spawning biomass of adult herring, roughly equivalent to the percentage of herring removed during the final years of the commercial herring fishery (Rice et al. 2011). In PWS humpback whales during 2007 to 2009 had a higher percentage of herring in their diet during the winter months and foraged longer on wintering herring shoals than their counterparts in Southeast Alaska, suggesting that top-down forcing may be limiting the recovery of herring in PWS. There is a need to continue evaluating predation pressure on herring stocks in PWS and to understand the ecosystem impacts of a humpback whale population that has been functionally absent from Gulf of Alaska for over 50 years.

This project specifically addresses a "project of interest" identified in the EVOSTC FY 17-21 Invitation for Proposals. However, we believe by integrating the humpback whale component with the forage fish and winter bird survey we can provided a more cost effective and scientifically sound survey, while still achieving the goals of the individual projects. Warmer water temperatures over the past two years combined with seabird and marine mammal die-offs, emphasize that the Gulf of Alaska is still undergoing major perturbations that impact species at the population level. Shifts in prey, predators, and environmental drivers identified through this collaborative effort will be instrumental in interpreting these changes.

2. Relevance to the Invitation for Proposals

This project specifically addresses HRM section, Interest Statement, Page 9 #8: The continued examination of the role of humpback whale population growth, changes in foraging behavior and consequent predation on herring and whether it is a potential limitation of herring recovery.

Humpback whales both prey upon and compete with forage fish. Long-term monitoring of humpback whales and their diet is relevant to the invitation because it ties a key upper trophic level predator to the pelagic component as described in the Invitation. These data will contribute to the long term baseline allowing us to not only address recovery of herring in PWS but to speculate on changes due to long-term oceanographic change, climate change or sudden perturbations. Information provided by this project will be crucial to NOAA Protected Resource managers in the implementation of the De-Listing Monitoring Plan for humpback whales.

Data collected during this project will be Public Access to Research Results (PARR) compliant and available at http://portal.aoos.org/gulf-of-alaska.php#metadata/54adceab-74cb-4419-b02c-bacb6d2acb8b/project/files

3. Project Personnel

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Please see 2 page CVs at end of this document

4. Project Design

A. Objectives

Pelagic Component

The following lists the two over-arching questions for the pelagic component to address in the next five years:

1. *What are the population trends of key pelagic species groups in PWS - killer whales, humpback whales, marine birds, and forage fish?*
2. *How do predator-prey interactions function as a mechanism underlying change in the PWS pelagic ecosystem?*

Integrated Predator-Prey Surveys 2017-2021: Humpback Whales, Marine Birds, Forage Fish

Fundamental to ecosystem monitoring is a basic understanding of the status and trends of individual biological components within the system. It is increasingly clear, however, that an understanding of the mechanisms underlying change requires knowledge of interactions among predators, prey and habitat. The main objectives of forage fish monitoring program are to:

1. Monitor the status and trends of co-occurring pelagic marine ecosystem components during Fall/Winter in areas with known seasonally predictable aggregations of predators and prey

   a. Estimate humpback whale abundance, diet, and distribution

   b. Estimate marine bird abundance and distribution in areas with known seasonally predictable aggregations of predators and prey.

      i. relate marine bird presence to prey fields identified during hydroacoustic surveys.

ii. characterize marine bird-humpback whale foraging dynamics

c. Estimate an index of forage fish availability

i. species composition and biomass within persistent predator foraging areas

ii. density and depth distribution

iii. energy density

d. Estimate an index of krill availability

i. species composition and biomass within persistent predator foraging areas

ii. density and depth distribution

iii. energy density

e. Relate whale, marine bird and forage fish indices to marine habitat

Humpback Whales: Long-term monitoring of predation on Pacific herring in Prince William Sound:
This project will directly address the following integrated predator-prey surveys objectives:

1. Estimating trends in humpback whale abundance, diet, and distribution
2. Evaluate prey quality and trophic position through chemical analysis (using bomb calorimetry and stable isotopes)
3. Estimating the impact of humpback whale predation on herring

B. PROCEDURAL AND SCIENTIFIC METHODS

Integrated Predator-Prey Surveys 2017-2021: Humpback Whales, Marine Birds, Forage Fish
To meet the goals of the program we propose an integrated survey design that brings together predator and prey components of the pelagic ecosystem. We propose to conduct an annual hydroacoustic-trawl survey that targets persistent humpback whale feeding locations in Montague Strait, Bainbridge passage and Port Gravina (Figure 1). As proposed, the survey will be conducted during the fall of each year. However, potential in-kind contributions from NOAA may facilitate expansion of the survey into two time periods: fall and winter (September/October and March). Proposed time periods will coincide with periods of high whale abundance in PWS. The pending in-kind contributions would support the charter costs for the vessels. For the humpback whale component the in-kind contributions would free up Trustee funds that would be applied towards the additional data management, field work and processing the increased number samples resulting from an additional survey. For the acoustic survey component, U.S. Geological Survey (USGS) will contribute further in-kind support to ensure that the second survey was staffed and the acoustic data analyzed. The fall/winter marine bird component will ensure that observers are aboard all surveys, however funded.

We propose to focus our survey on locations where whales have historically been observed foraging in PWS during the fall and winter. In September, this location is where herring can be found entering Montague Strait, as well as Bainbridge Passage and Port Gravina (Figure 2). The basic structure of the survey is for a vessel to conduct acoustic estimates along fixed transect lines, the locations of which are based on recent historical data on whale foraging locations (Figure 1). While the acoustic vessel is conducting transects a second smaller vessel will be used to assess whale abundance. The smaller vessel will depart from the acoustic vessel and work independently in the area where the acoustic data are being collected. This gives the whale vessel the ability to census and sample whales and scout for whales outside the fixed areas. At the end of the day the two vessels will join and share information. Data collected by the whale vessel include photograph the flukes of individual whales for identification, blubber and skin biopsies, observations of whale diets, and samples of tissues left by whales (e.g., stunned fish, scats, scales etc.). Onboard GPS and acoustics on the whale vessel will be used to identify layers to which whales may be diving and locations. These data will be compared with data from the acoustic vessel.

Hydroacoustic-trawl. The fixed transect layout was chosen to sample areas of persistent humpback whale habitat use identified in surveys conducted in 2006-2014. To estimate depth distribution and biomass of prey in the water column a calibrated SIMRAD 38-120 kHz split beam EK60 system will be towed beside the boat along pre-determined transects, and each transect will serve as a sample to estimate the abundance using the area each subregion (Figure 1).

We will use a midwater trawl and other means as necessary to verify species and size (length in mm, weight to 0.01 g) of organisms (krill and schooling fish) that contribute to hydroacoustic backscatter in each subregion. The net has an approximately 154 m^2 mouth (14 m x 11m) and is 22 m long. Mesh size diminishes from 38 mm at the mouth to 12 mm at the cod end (Innovative Net Systems, Inc.). The net is held open by two 0.4 m^2, series 2000 steel mid-water trawl doors (Nor 'Eastern, Inc.); each weighing approximately 76 lbs. The net will be towed at approximately 1.8 kt, trawl duration will depend on the vertical and horizontal distribution of acoustic targets. Depth of the headrope will be managed with a TrawlMaster system. Although we will try to accomplish ground-truthing of acoustic sign on daytime transects, logistical constraints (daylight hours, trawl depth limitations, etc.) may require that trawls occur at night when the scattering layer ascends in the water column. We will also attempt to ground truth untrawlable (e.g., shallow nearshore areas) acoustic backscatter with other means (e.g., underwater video, jigs, dipnets, cast nets).

Trawl catches will be enumerated, lengthed (TL and FL, mm) and weighed (0.01 g) by species. Fish samples will be taken for sex, diet, energetics, and isotope analysis. A subsample of the euphausiid catch will be preserved in 3-5% formaldehyde solution for laboratory analysis of species proportion and weight. Krill samples will also be analyzed for energetics.

In addition to fixed transects in persistent predator aggregation areas, we will also characterize prey density more closely associated with individual or groups of whales in each subregion (Montague, Bainbridge and Gravina). This will involve focal follows of individual whales, or prey mapping near groups of feeding whales.

Marine habitat. At six fixed stations in the study area we will measure oceanographic variables with a SBE19 plus v2 conductivity-temperature depth profiler (CTD). After each CTD cast we will also collect zooplankton samples with a 100 m vertical haul of a 150 µ-mesh zooplankton net. Concurrent sampling of ocean and zooplankton indices will provide spatial and temporal overlap of environmental and predator-prey indices.

During each cruise we will sample 80 km of transects, with associated trawls (max depth 100 m) to collect fish and krill and 6 CTD/zooplankton stations. We anticipate a typical survey will occur as follows (subject to changes as necessary for logistics and weather conditions):

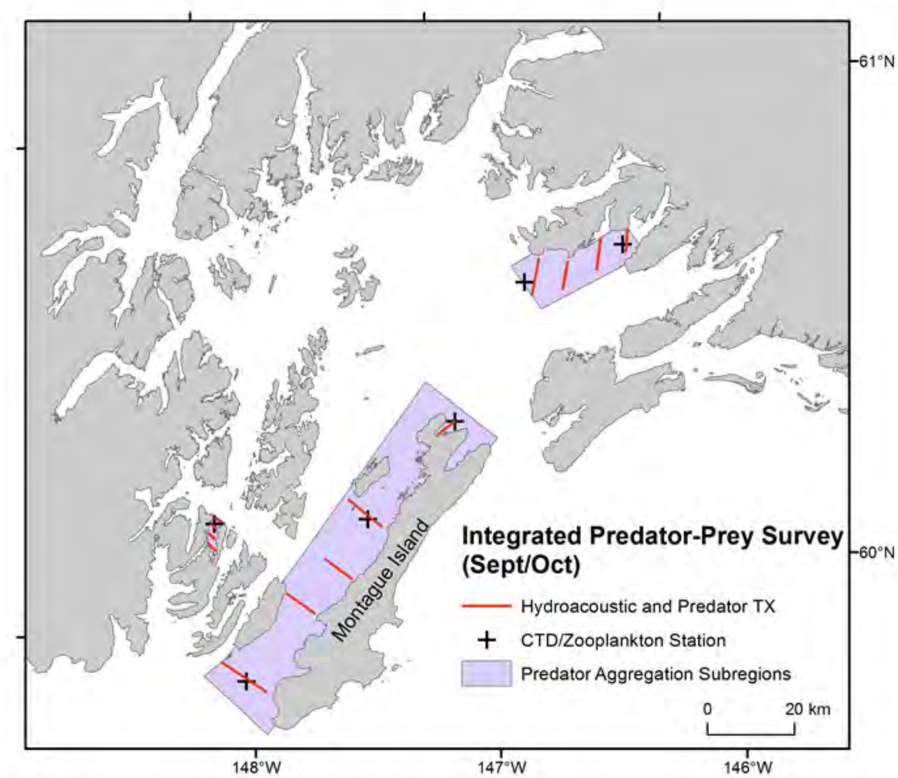

Figure 1. Proposed integrated marine bird - humpback whale - forage fish survey design. Marine bird and whale density will be assessed in conjunction with hydroacoustic transects for fish and krill. We will also assess changes in associated marine habitat with zooplankton tows and conductivity-temperature-depth profiles (CTD).

A typical survey schedule will consist of:

Day 1. Load, travel, calibrate hydroacoustics, passive noise test
Day 2. Zaikof/Montague (44 km/5 tx, 2 trawl, 3 CTD/zoop)
Day 3. Zaikof/Montague (44 km/5 tx, 2 trawl, 3 CTD/zoop)
Day 4 Finish Montague, focal follows or adaptive tx (2-3 hours). Transit.
Day 5. Bainbridge (8.3 km/ 4 tx, 1 trawl, 1 CTD/zoop, 1-2 hour focal/adaptive). Transit.
Day 6. Knowles/Gravina (28.7 km/4 tx 1-2 trawls, 2 CTD/zoop)
Day 7. Knowles/Gravina (28.7 km/4 tx 1-2 trawls, 2 CTD/zoop, 2-3 hour focal/adaptive)
Day 8. Weather or focal/adaptive effort
Day 9. Weather or focal/adaptive effort
Day 10. Transit. Unload.

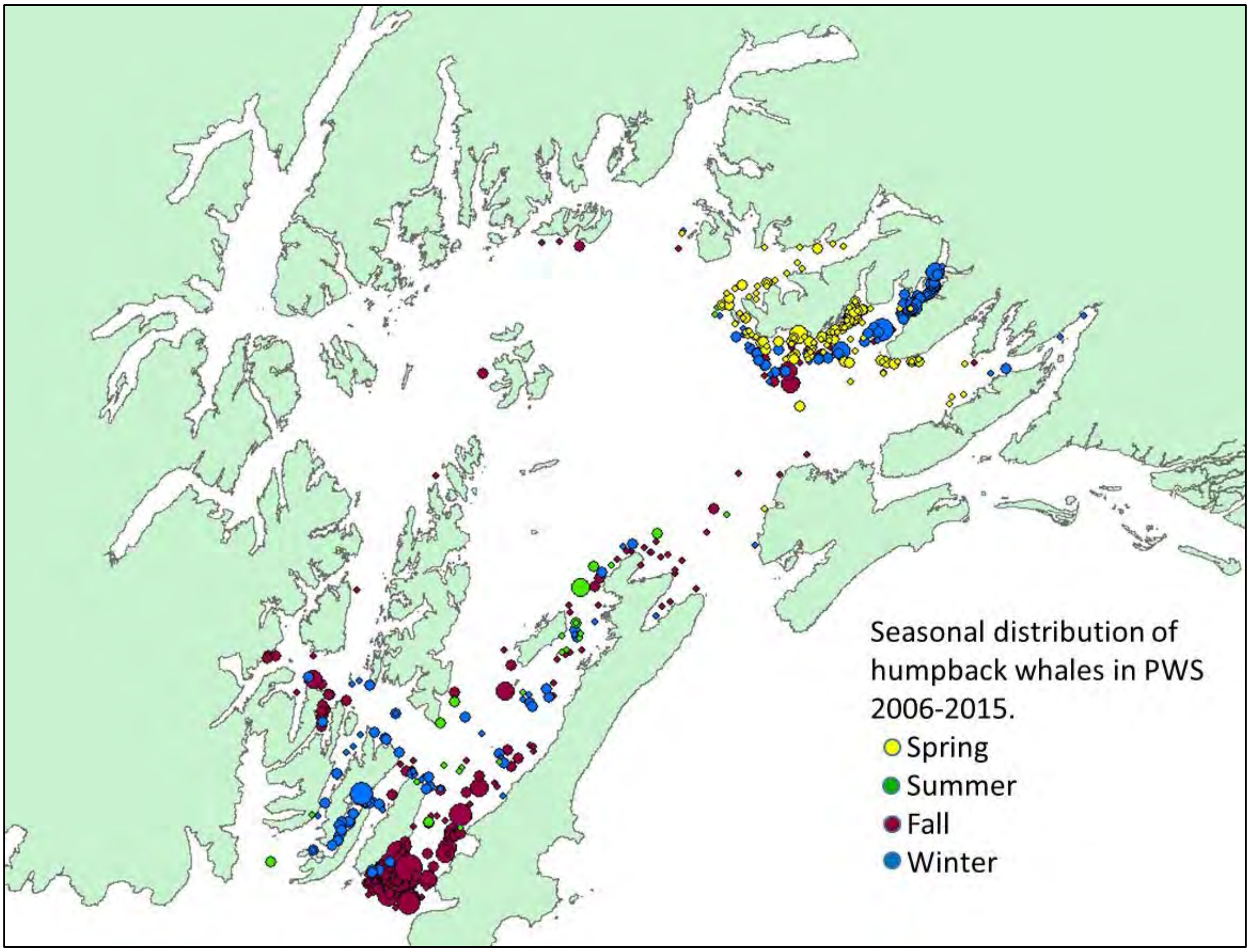

Figure 2. The seasonal distribution of humpback whales sighted on surveys conducted between 2006 and 2015. The diameter of the points reflects the relative abundance of whales present. Note that effort is not shown and includes areas where whales were not seen.

Humpback Whales: Long-term monitoring of predation on Pacific herring in Prince William Sound

When groups of whales are located and determined to be feeding, effort will made to determine the identities of the whales and what they are eating. Whales will be identified from the patterns on the ventral sides of their flukes. The patterns will be recorded using Nikon D-300, D-200, and D-700 cameras with 80-200 mm zoom or fixed 300mm lenses to capture digital images. The photos will be compared with the PWS catalog and sighting history database 511 whales managed by PI Straley at UAS. Direct observations of prey being consumed, remains after feeding, and sonar mapping of the prey fields observed on a dual 38/120 kHz frequency echosounder will be used to determine presumed target prey of humpback whales (see Arimitsu and Piatt forage fish proposal for details). Confirmation of target prey will be accomplished using herring jigs, trawls, zooplankton tows, and cast nets to collect surface fish near feeding whales. Scales and zooplankton will be collected behind whales feeding at the surface with a skim net. Fecal samples are collected when possible. Certainty of identification of the target prey will be recorded as certain, probable or undetermined. Only cases were the identification was certain or probable were used to identify specific prey.

Biopsies of whale skin will be collected for isotopic analysis to independently derive estimates of whale diets from the trophic level. Direct observation of diets provides only a "point-in-time" estimate and does not provide information on periods when whales are not being observed. Stable isotope analysis can provide a more time-integrated measure of whale diet. In addition stable isotope analysis can be used to estimate the trophic position of organisms. If whales in PWS consume large amounts of herring they should occupy a higher trophic position than herring. We will use both methods to better describe the impact of whales on forage fish including herring. Biopsies will be collected using a crossbow bolt with a coring tip. Samples will be recovered immediately, labeled, and placed in an ice chest. At the end of the day the contents of the ice chest will be transferred to a freezer on the acoustic vessel. At the end of the survey the biopsy samples will be transported to Auke Bay and stored at -80 °C until they are processed. Primary consumers will be collected and analyzed to establish an isotopic baseline for inter-annual trophic comparisons.

Sample Processing

Isotopic analysis will be conducted using a Thermo Delta V gas chromatograph/isotope ratio mass spectrometer. Prior to stable isotope analysis, tissues will be archived at -80 deg. F in freezers at NOAA Auke Bay Laboratories Juneau, Alaska. Pilot analyses showed that lipid content in tissues influenced $\delta^{13}C$ values; therefore, tissues will be lipid-extracted prior to quantification of stable isotope ratios. Stable isotope values (expressed in δ notation) will be generated for samples using the methods described in Seymour et al. (2014). The isotope ratio mass spectrometer is calibrated using certified standards from the International Atomic Energy Agency and US Geological Survey, which produce the international reference materials (reference standard for carbon is VPD and air for nitrogen) All sample analyses will be conducted with certified quality control standards for precision and accuracy] interspersed throughout the analytical run. If the quality assurance standard results differ from certified values by more than the known standard deviation of the reference material, the sample will be re-analyzed until results of quality assurance standards are within the expected tolerances.

The energy content of prey will be measured from each survey in order to estimate the number of prey consumed by humpback whales. Energy content will be measured using calorimetric methods as outlined in by Siddon et al. (2013). Putative prey will be obtained from trawls conducted on the acoustic vessel and samples collected by the whale vessel. Samples of prey will be weighed, dried, and the homogenized tissue will be pressed into pellets. The pellets will be combusted in a Parr Instrument 6725 Semimicro Bomb Calorimeter to measure the energy released. Quality assurance (QA) procedures include the use of duplicate samples to evaluate precision, reference materials to evaluate accuracy and blanks (benzoic acid) to evaluate cleanliness. Predetermined limits for variation observed in QA samples were set, where precision estimates from duplicate tissue and reference samples must not vary by more 15% CV.

C. DATA ANALYSIS AND STATISTICAL METHODS

Analysis of the data collected during the surveys is aimed at fulfilling objectives 1, 2 and 3 listed under the heading *Long-term monitoring of humpback whales predation on Pacific herring in Prince William Sound*. This includes assessing trends in the abundance and spatial distribution of whales, evaluating their diets and assessing their impact on PWS herring populations.

Estimating humpback trends in humpback whale abundance, diet, and distribution (Obj. 1)

Whale abundance will be estimated using mark-recapture techniques using the black and white pattern on the ventral surface of each whale's flukes as natural marks. The first photograph of a particular whale is treated as the "mark", and subsequent photographs of the same whale are "recaptures". Both closed and open population models will be examined. However, we will likely will employ the Huggins closed-capture model (White and Burnham 1999) using the program MARK. This is the approach employed in our previous efforts and those used by Teerlink et al. (2015). Photographs will be quality ranked for percent of flukes visible, angle of the flukes to the water surface and to the camera, clarity of the image and other attributes to reduce sampling bias. A poorly photographed distinctive whale with spectacular flukes would be a biased data point hence this quality control makes all patterns on the flukes equal. Photographs deemed poor or of insufficient quality will be excluded from the mark-recapture analysis to avoid this bias. Further, photographs of humpback whale calf flukes will also excluded, because the capture probability for a calf is complicated by their co-occurrence with their mothers (and is therefore not independent), and the probability of recapture in later years can be difficult as calf flukes tend to change more than adult flukes. Abundance estimates will represent the number of whales present in PWS in a given winter. Whale distributions will be examined by plotting whale observations on maps for each survey to identify locations where whales were most abundant and evaluate seasonal movements. These maps can be overlaid with maps derived from the forage fish survey to relate whale distributions to prey availability. Determining the number of humpback whales foraging in PWS a will require the full suite of sighting histories and covariates. Thus, final estimate will not be available until the all surveys have been completed, however, we will be able to provide preliminary abundance estimates that may be useful in determining whale population trends.

Evaluate whale diets, prey quality and trophic position (Obj. 2)

Direct observations of whale diets will be summarized to estimate whale diets for each winter. The proportion of prey type in the diet of observed feeding groups of whales will be determined for each survey. The survey design calls for identifying groups of foraging whales. Consequently, diets will be summarized for individual groups. Multiple groups are likely to be seen on a given day. Each group of whales associating together on a given day will be tallied across a survey to determine the total number of groups observed. The number observed eating a particular prey item (e.g., herring, krill, unknown) will be tallied for each survey to estimate the proportional contribution of each prey type to whale diets during a given survey. Pearson chi-square tests will be used to identify differences among the diets of groups in different parts of PWS during a survey (where there are sufficient data) and between surveys.

Estimating the impact of humpback whale predation on herring (Obj. 3)

Estimates of the number of herring consumed by whales over winter will be compared with estimates of the herring abundance to evaluate the impact of whale predation on PWS herring. Estimates of herring abundance will be taken from the pre-spawning biomass as estimated by the age-structured stock assessment to be produced by the Herring Monitoring Program. Estimates of herring consumption by humpback whales will combine estimates of the averaged daily metabolic demand by humpback whales with estimates of the number of whales present, the proportion of herring in their diet and the average energy content of the herring to determine the number of herring consumed following equation 1:

$$C = \sum_{t=1}^{182} \frac{p_t \sum_{i=1}^{100} K\left(\frac{n_t}{100} w_i\right)^{\beta}}{ED_t}$$

[Equation 1]

In equation (1) C is the total biomass removed by whales over the course of 182 days of winter; pt is the proportion of the whales known to be eating herring on day t of winter, nt is the number of whales foraging on day t, wi is the weight of a whale in the i-th size class, K and β are allometric parameters describing the metabolic rate of whales in the i-th size class and EDt is the energy density of herring on day t of winter. We propose to use historic whaling records to estimate the size distribution of humpback whales, and allometric parameters from published literature. Our observations of diet will be used to provide the estimate for pt and our calorimetric data will be used to estimate EDt.

The time step for the model is one day and the duration of winter is estimated to be the time between surveys. In the example of the equation 1 it is 182 days, but that may not be the case for each year. We will interpolate the number of whales present on a given day from a whale-day model. Previous surveys between 2006 and 2015 have provided observations of the number of unique whales present on different days of the winter. We will plot the number of whales present by Julian day and fit a curve describing the whale attendance pattern in PWS. For each winter we will scale the curve upward so that the maximum number of whales present in PWS equals the point estimate from our mark-recapture analysis. This will model the number of whales present on each day, and the integral from day 1 to day n is the number of whale days.

D. Description of Study Area

This study will occur in the waters PWS. In addition to the core transects depicted in Figure 2, a small boat will be deployed from the larger survey vessel to expand the humpback whale survey throughout the Sound. The season distribution of humpback whales (Figure 3) served as a guide in establishing these transects.

5. Coordination and Collaboration

Within the Program

Collaboration of GWA pelagic team principal investigators (PIs) will facilitate a broader understanding of humpback whale and seabird foraging dynamics and forage fish availability in PWS (Table 1). High concentrations of humpback whales and seabirds have been observed in the waters around Green Island and Montague Strait, Bainbridge Passage and Port Gravina during fall/winter. Unlike other areas of the Sound, where herring and euphausiids are identified as prey, determining diet in these waters has proven to be particularly challenging. An integrated survey will characterize the distribution, composition, and density of humpback whale prey to better understand interannual variability in whale population (numbers and distribution). Likewise, we will use predators as indicators of prey distribution in order to increase the sampling encounter rate of patchy forage fish schools in deep offshore waters. Combining efforts will lead to greater integration of the pelagic monitoring program. Additionally, killer whale and humpback whale photos, locations and counts will be exchanged with the killer whale project (Matkin). This collaboration expands the temporal and spatial scope of both projects.

Table 1. Integrated predator-prey collaborations by objective.

Objective	Index	Task	PI
a. Estimate humpback whale abundance, diet, and distribution			
	Whale counts by subregion	Integrated Surveys: whale counts, biopsies	Moran (NOAA)/ Straley (UAS)
	Whale Identification	Integrated Surveys: Photo ID	Moran (NOAA)/ Straley (UAS)
	Whale Diet	Integrated Surveys: scales, scat, biopsies, visual observations, hydroacoustics	Moran (NOAA)/ Straley (UAS)/ Arimitsu-Piatt (USGS)
b. Estimate marine bird abundance and distribution in seasonally predictable predator aggregation areas			
	Georeferenced marine bird counts, group size, behavior by species	Integrated Surveys: marine bird transects	Bishop (PWSSC)
b.i. Relate marine bird presence to prey fields identified during hydroacoustic surveys.			
	Spatial coherence of bird presence/ absence, acoustic estimates of forage fish and euphausiid biomass	Integrated Surveys: hydroacoustic and marine bird transects	Arimitsu-Piatt (USGS)/ Bishop (PWSSC)
b.ii. Characterize marine bird-humpback whale foraging dynamics			
	Georeferenced marine bird and whale counts, group size, behavior by species	Data Collection Integrated Surveys: marine bird transects; whale focal follows	Bishop (PWSSC)/ Moran (NOAA)/ Straley (UAS)/ Arimitsu-Piatt (USGS)
c. Estimate index of forage fish availability in seasonally predictable predator foraging areas			
	Species composition and biomass within persistent predator foraging areas	Integrated Surveys: hydroacoustic-trawl data	Arimitsu-Piatt (USGS)
	Density and depth distribution	Integrated Surveys: hydroacoustic-trawl data	Arimitsu-Piatt (USGS)
	Diet, energy density	Sample Analysis: forage fish	Moran (NOAA)
d. Estimate an index of euphausiid availability in seasonally predictable predator foraging areas			
	Species composition and biomass within persistent predator foraging areas	Integrated Surveys: hydroacoustic-trawl data	Arimitsu-Piatt (USGS)
	Density and depth distribution	Integrated Surveys: hydroacoustic-trawl data	Arimitsu-Piatt (USGS)
e. Relate whales, marine birds and forage fish indices to marine habitat			
	Oceanographic parameters and zooplankton biomass	Integrated Surveys: CTD and zooplankton samples	Arimitsu-Piatt (USGS)/ Moran (NOAA)/ Straley (UAS)/ Bishop (PWSSC)

With Other EVOSTC-funded Programs and Projects

As in the past, we will work closely with the Herring Research and Monitoring program, samples will be provided to the HRM for analysis of age at maturity and we are dependent on estimates of herring abundance developed through the age-structured assessment conducted by the Herring Research and Monitoring program.

WITH TRUSTEE AND MANAGEMENT AGENCIES

The unique timing and focus of this project provides Trustee and Management Agencies with valuable data and platforms for both management and research. The acoustic component of this project is the only directed forage fish survey in the Gulf of Alaska. These data will be consumed directly into the North Pacific Fishery Management Council's annual forage fish stock assessment. Data collected on humpback whale abundance will be of direct value to NOAA Protected Resource managers in the implementation of the De-Listing Monitoring Plan for humpback whales. NOAA is required by statute to evaluate the whale population to ensure that delisting was warranted. Collections of juvenile forage fish, particularly age-0 pollock, are of direct interest to the NOAA Alaska Fisheries Science Center, which is actively engaged in understanding how winter influences pollock survival. We anticipate working with the Alaska Fisheries Science Center when they conduct winter acoustic surveys in PWS as part of their normal pollock assessment work for the Gulf of Alaska. During our surveys we will also photograph Steller sea lion brands whenever possible. These data represent brand re-sights and are of interest to both the Alaska Department of Fish and Game and NOAA and are used in identifying movements of SSL.

WITH NATIVE AND LOCAL COMMUNITIES

When possible we will work in collaboration with the PWS Science Center to seek local and traditional ecological knowledge.

6. Schedule

PROJECT MILESTONES

- **Task 1**
  Annually prepare for and launch field collection of core project data including: identification photos, observation of predation and sampling of prey. Collect annual biopsy samples for feeding habits.
- **Task 2**
  Conduct analysis of identification photos, annually update photographic catalogue. Preliminary estimates of whale abundance. Annual report.
- **Task 3**
  Chemical analysis of skin and blubber, and prey samples. Conducted annually, completion date for all laboratory analysis is February 2022.
- **Task 4**
  Estimations of the impact of humpback whale predation on herring from all years of the project to be included in final report and/or other publication (draft by April 2022). All required reporting will be completed on an annual basis in addition to final report and publications.

MEASURABLE PROJECT TASKS

Measurable program tasks for monitoring humpback whale predation on herring include tasks involving administration and logistics, data acquisition and processing, dedicated data management, analysis and reporting (Table 2).

Table 2. Task schedule for monitoring humpback whale predation on herring.

Task	FY17				FY18				FY19				FY20				FY21			
	Quarter (EVOSTC FY beginning Feb. 1)																			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Task 1																				
Integrated predator-prey surveys (EVOSTC funded)			X				X				X				X				X	
Alternate Survey schedule (with additional NOAA funds)	X		X		X		X		X		X		X		X		X		X	
Task 2																				
Photographic analysis			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Annual reports/data upload to portal					X				X				X				X			
Task 3																				
Chemical analysis			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Task 4 Reporting																				
Estimate whale impact																				X
Final report and publications																				X
Data management, QAQC, workspace upload				X	X			X	X			X	X			X	X			X
Annual PI meeting				X				X				X				X				X
FY Work Plan (DPD)			X				X				X				X					

FY 17 (Year 6)

FY 17, 1st quarter (February 1, 2017 - April 30, 2017)
March: *Secure vessel charter*

FY 17, 2nd quarter (May 1, 2017 - July 31, 2017
May-June: *Field gear preparation*

FY 17, 3rd quarter (August 1, 2017 - October 31, 2017)
October: *FY Work Plan (DPD)*
October: *Field logistics*

FY 17, 4th quarter (November 1, 2017 - January 31, 2018)
November: *10 day integrated survey of PWS*
December: *Data entry QA/QC*
January: *Alaska Marine Science Symposium*

FY 18 (Year 7)

FY 18, 1st quarter (February 1, 2018 - April 30, 2018)
February-April: *Data entry QA/QC*
February-April: *Chemical analysis*
February: *Annual Report/data upload to portal*
March: *Secure vessel charter*

FY 18, 2nd quarter **(May 1, 2018 - July 31, 2018)**
May-July: *Data entry QA/QC*
May-July: *Chemical analysis*

FY 18, 3rd quarter **(August 1, 2018 - October 31, 2018)**
August-October: *Chemical analysis*
October: *FY Work Plan (DPD)*
October: *Field logistics*

FY 18, 4th quarter **(November 1, 2018 - January 31, 2019)**
November: *10 day integrated survey of PWS*
January: *Alaska Marine Science Symposium*

FY 19 (Year 8)

FY 19, 1st quarter **(February 1, 2019 - April 30, 2019)**
February: *Annual Report/data upload to portal*
March: *Secure vessel charter*

FY 19, 2nd quarter **(May 1, 2019 - July 31, 2019)**
May-July: *Data entry QA/QC*
May-July: *Chemical analysis*

FY 19, 3rd quarter **(August 1, 2019 - October 31, 2019)**
August-October: *Chemical analysis*
October: *FY Work Plan (DPD)*
October: *Field logistics*

FY 19, 4th quarter **(November 1, 2019 - January 31, 2020)**
November: *10 day integrated survey of PWS*
January: *Alaska Marine Science Symposium*

FY 20 (Year 9)

FY 20, 1st quarter **(February 1, 2020 - April 30, 2020)**
February: *Annual Report/data upload to portal*
March: *Secure vessel charter*

FY 20, 2nd quarter **(May 1, 2020 - July 31, 2020)**
May-July: *Data entry QA/QC*
May-July: *Chemical analysis*

FY 20, 3rd quarter **(August 1, 2020 - October 31, 2020)**
August-October: *Chemical analysis*
October: *FY Work Plan (DPD)*
October: *Field logistics*

FY 20, 4th quarter **(November 1, 2020 - January 31, 2021)**
November: *10 day integrated survey of PWS*
January: *Alaska Marine Science Symposium*

FY 21 (Year 10)

FY 21, 1st quarter **(February 1, 2021 - April 30, 2021)**
February: *Annual Report/data upload to portal*
March: *Secure vessel charter*

FY 21, 2nd quarter **(May 1, 2021 - July 31, 2021)**
May-July: *Data entry QA/QC*
May-July: *Chemical analysis*

FY 21, 3rd quarter **(August 1, 2021 - October 31, 2021)**
August-October: *Chemical analysis*
October: *FY Work Plan (DPD)*
October: *Field logistics*

FY 21, 4th quarter **(November 1, 2021 - January 31, 2022)**
November: *10 day integrated survey of PWS*
January: *Alaska Marine Science Symposium. Final report.*

7. Budget

BUDGET FORMS (ATTACHED)
Completed budget forms are attached.

SOURCES OF ADDITIONAL FUNDING
Over the life of this project, NOAA will make a substantial contributions: salary ($350 K) for PI Moran (7 months, GS-12), all field and laboratory equipment required ($50 K), and small vessel/charters ($330 K). Total in-kind by NOAA for this project is $730 K.

PERMITS
Authorization for all whale related activities are permitted under J. Straley's research permit (#14122) issued by NOAA Office of Protected Resources under and the University of Alaska Fairbanks Institutional Animal Care and Use Committee (157884-14). NOAA (Moran) retains all permits for collecting fish with the State of Alaska. Permit numbers subject to change as study progresses and permits are renewed.

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PROJECT DATA ONLINE

Data collected during this project will be Public Access to Research Results (PARR) compliant and available at http://portal.aoos.org/gulf-of-alaska.php#metadata/54adceab-74cb-4419-b02c-bacb6d2acb8b/project/files

John R. Moran

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EDUCATION
University of Alaska Fairbanks, M.S. in Fisheries, August 2003.
University of New Hampshire, B.A. in Zoology, minor in Marine Biology, May 1989.

PROFESSIONAL EXPERIENCE
Research Fisheries Biologist, *U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Auke Bay Laboratory, Juneau AK. August 2006- present*
Research Associate, *University of Alaska Southeast, Juneau, AK.* September 2003- August 2006
Research Assistant, *University of Alaska Fairbanks, Juneau, AK*. January 2002-May 2003
Weir Crew Leader, *SWCA, Salt Lake City, UT.* September 2001-November 2001
Graduate Intern, *Alaska Department of Fish and Game, Juneau, AK.* April 2000-April 2001
Teaching Assistant, *University of Alaska Fairbanks, Juneau, AK.* September 1999-December 2000
Biological Technician (Fisheries), *U.S. Fish and Wildlife Service, Togiak NWR, Dillingham, AK***.** April 1998-August 1999
Biological Science Technician (Wildlife), *U.S. Fish and Wildlife Service, Togiak NWR, Dillingham, AK*
Fisheries Technician/Tagger/Diver, *Prince William Sound Aquaculture, Cordova, AK.* February 1992-April 1993

RELAVENT PUBLICATIONS
Heintz, R., Moran, J., Straley, J., Vollenweider, J., Boswell, K., and Rice, S. In Review. Regional variation in the intensity of humpback whale predation on Pacific herring in the Gulf of Alaska. Fisheries Oceanography.

Moran, J.R., Straley, J.M., Rice, S.D., Heintz. R, Quinn III, T.J., and S.F. Teerlink. In Review. Late-season abundance and seasonal trends of humpback whales on three important wintering grounds for Pacific herring in the Gulf of Alaska. Fisheries Oceanography.

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Heintz, Ron, John Moran, Johanna Vollenweider, Jan Straley, Kevin Boswell, and Jeep Rice. "Humpback whale predation and the case for top-down control of local herring populations in the Gulf of Alaska." *Alaska Fisheries Science Center Quarterly Report October/November* (2010): 1-6

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Kelly, Brendan P., Oriana H. Badajos, Mervi Kunnasranta, and John Moran. "Timing and re-interpretation of ringed seal surveys." *US Department of the Interior, Minerals Management Service, Alaska OCS Region* (2006).

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Moran, J.R. 1994. Small mammal studies and observations at Cape Peirce, Alaska, 1993. USFWS report, 5 pp. Dillingham, AK.

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Brendan P. Kelly, Oriana H. Badajos, Mervi Kunnasranta, John R. Moran, Micaela Ponce, Douglas Wartzok, and Peter Boveng. Seasonal Home Ranges and Fidelity to Breeding Sites among Ringed Seals. (accepted to Polar Biology 15 March 2010).

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Recent Collaborators:

Adkinson, Shannon UAF
Andrews,Russel UAF
Arimitsu, Mayumi USGS
Barton, Mark FIU
Bishop, Mary Anne, PWSSC
Blackburn, Jason UF
Boswell, Kevin FIU
Cates, Kelly UAF
Chenoweth, Ellen UAF
Csepp, David AFSC
Fauquier, Deborah Marine Mammal Health and Stranding Response Program
Heintz, Ron AFSC
Hodgkiss, William Scripps Inst Oceanography
Jensen, Aleria AKRO
Jones, Meagan, Maui Whale Trust
Kuerman, William Scripps Inst Oceanography
Lunsford, Chris AFSC
Mathias, Delphine Scripps Inst. Oceanography
Matikin, Craig, NGOS
Nammack, Marta NMFS' National ESA Listing Coordinator
Pearson, Heidi UAS
Rice, Stanley AFSC
Quinn, Terry UAF
Rieucau, Guillaume FIU
Savage, Kate AKRO
Sheffield, Gay Marine Advisory Program
Sarkar, Jit Scripps Inst Oceanography
Straley, Janice UAS
Thode, Aaron Scripps Inst Oceanography
Verlinden, Chris Verlinden, Chris
Vollenweider, JJ AFSC
Zenone, Adam FIU

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Professional Preparation
University of Washington, Seattle, WA BS Fisheries and Wildlife 1975
University of Alaska Fairbanks, Fairbanks, AK. MS, Biological Oceanography, 1994

Thesis: Straley, J. M. 1994. Seasonal characteristics of humpback whales (*Megaptera novaeangliae*) in southeastern Alaska. pp. 121. University of Alaska Fairbanks, Fairbanks, Alaska.

Appointments and Honors

2015	Professor, University of Alaska Southeast
2013	Meritorious Service Award, University of Alaska Board of Regents
2013	Pew Fellows Program in Marine Conservation nominee
2012	Ocean Leadership Award for Excellence in Marine Science, Alaska SeaLife Center
2005-P	Joint Faculty, University of Alaska Fairbanks, School of Fisheries and Ocean Sciences
2010-P	Associate Professor of Biology, University of Alaska Southeast-Sitka Campus
1994-2014	Assistant Professor, University of Alaska Southeast-Sitka and University of Alaska Fairbanks, College of Rural Alaska, Rural Alaska Science and Math Network.
1988-1992	Marine Biologist, Humpback Whale Monitoring Program, Glacier Bay National Park, AK
1987-1988	Biology Instructor, University of Alaska Southeast-Sitka Campus
1980-1984	Fisheries Biologist, Northern Southeast Regional Aquaculture Assn., Sitka, AK
1979-1999	Independent Marine Biologist, humpback and killer whale research in Alaskan waters
1979	Wildlife Biologist, U.S. Forest Service, Sitka, Alaska
1977-1978	Biological Technician, U.S. Fish and Wildlife Service, Sitka, Alaska

Activities related to proposed project: Ms. Straley has conducted independent research on large whales in Alaskan waters since 1979. Her research focus over the past 14 years has been to work with industry to understand sperm whales depredation on longlines and humpback whale predation at hatchery release sites on juvenile salmon. She actively works on realistic recommendations to fishermen to minimize interactions with marine mammals.

Products
Relevant:
Straley, J, Schorr, G., Calambokidis, J., Thode, A., Lunsford, C., Chenoweth, E., O'Connell, V. and Andrews, R. (2014). Depredating sperm whales in the Gulf of Alaska: local habitat use and long distance movements across putative population boundaries. Endangered Species Research vol.24 124-135.

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Herman, D., Gina M.Ylitalo, Jooke Robbins, Janice M. Straley, Christine M. Gabriele, Phillip J. Clapham, Richard H. Boyer, Karen L. Tilbury, Ronald W. Pearce, Margaret M. Krahn. 2009. Age determination of humpback whales (*Megaptera novaeangliae*) through blubber fatty acid compositions of biopsy samples. Marine Ecology Progress Series Vol. 392: 277–293.

Gabriele, C.M., C. Lockyear, J. Straley, C. Jurasz and H Kato. 2009. Sighting history of a naturally marked humpback whale (*Megaptera novaeangliae*) suggests ear plug growth layer groups are deposited annually. Marine Mammal Science 26(2): 443-450.

Hendrix, N., J. Straley, C. Gabriele and S. Gende. 2012. Bayesian estimation of humpback whale (Megaptera novaeangliae) population abundance and movement patterns in southeast Alaska. Can. J. Fish. Aquat. Sci. 69: 1783–1797.

Herman DP, Matkin CO, Ylitalo GM, Durban JW B. Hanson, M.Dahlheim, J. Straley, P. Wade, K. Tilbury, R. Boyer, R. Pearce1, M. Krahn 2008. Assessing age-distributions of killer whale (Orcinus orca) populations from the composition of endogenous fatty acids in their outer-blubber layers. Mar Ecol Prog Ser 372:289–302.

Synergistic Activities (P = present)

2011	University of Alaska statewide invitational speaker Science in Alaska lecture series winter 2011
2010	Invitational workshop the review of maximum sustainable yield rate for baleen whales, International Whaling Commission, 20-24 April, Seattle, WA.
2007	Founding board member Sitka Sound Science Center
2006-P	Steering committee to develop a research strategy for a study of North Pacific killer whales with a focus on predation and the impact upon marine mammal populations.
2004-P	Southeast Alaska Sperm Whale Avoidance Project-designed and implemented fishermen network to collect behavioral data on sperm whales removing fish from longline gear
2004-P	Regional coordinator for North Pacific humpback whale study (SPLASH).
2002-P	Steering committee to develop a basin wide study of North Pacific humpback whales
1997-P	Science Director, Sitka WhaleFest, dedicated to celebrating marine wildlife in the North Pacific through community and educational events. Annual budget $100,000.
1996-P	Appointment by NMFS to the Alaska Regional Scientific Review group for marine mammals.
1985-P	Alaska Stranding Network Member and Large Whale Disentanglement Team

Collaborators: Baker, Scott; Barrett-Lennard, Lance; Behnken, Linda; Calambokidis, John; Cerchio, Sal; Craig, Allison; Darling, Jim; Deecke, Volker; Ellis, Graeme; Gabriele, Christine; Glockner-Ferrari, Debbie; Hills, Sue; Herman, Lou; Jurasz, Charles; Kohler, Nikki; Liddle, Joe; Lunsford, Christopher; Matkin, Craig; Matkin, Dena; Mesnick, Sarah; Mizroch, Sally; Neilson, Janet; O'Connell, Victoria; Quinn, Terrence III; Sigler, Mike; Thode, Aaron; Teloni, Valeria; Trites, Andrew; Riley, Heather; Witteveen, Briana; Wynne, Kate; Von Ziegesar, Olga

Budget Category:	Proposed FY 17	Proposed FY 18	Proposed FY 19	Proposed FY 20	Proposed FY 21	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$6.0	$0.6	$0.6	$0.6	$0.6	$8.4	
Travel	$7.8	$7.8	$7.8	$7.8	$7.8	$39.0	
Contractual	$119.7	$119.8	$122.5	$119.7	$109.5	$591.3	
Commodities	$15.0	$14.0	$14.0	$14.0	$17.5	$74.5	
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
SUBTOTAL	$148.5	$142.2	$144.9	$142.1	$135.5	$713.2	
General Administration (9% of subtotal)	$13.4	$12.8	$13.0	$12.8	$12.2	$64.2	N/A
PROJECT TOTAL	$161.9	$155.0	$157.9	$154.9	$147.6	$777.4	
Other Resources (Cost Share Funds)	$146.0	$146.0	$146.0	$146.0	$146.0	$730.0	

COMMENTS:
Over the life of this project, NOAA will make a substantial contributions: salary ($350 K) for PI Moran (7 mos. GS-12), all field and laboratory equipment required ($50 K), and small vessel/charter ($330 K). Total in kind by NOAA for this project is $730 K.

FY17-21

Project Title: Monitoring of humpback whale predation on Pacific herring in PWS
Primary Investigator: John Moran & Jan Straley
Agency: NMFS

TRUSTEE AGENCY SUMMARY PAGE

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Moran	Humpback Whale (2 field trips; OT only)			6.0	6.0
	(12 days per trip with 64 hrs OT)				0.0
Moran	in kind labor ($10 K/mo)	7.0	0.0		0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	0.0	6.0	
				Personnel Total	$6.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
JNU - CDV	0.6	2	24	0.2	5.2
JNU - ANC Annual GW PI Meeting	0.6	1	4	0.2	1.3
JNU - ANC AMSS	0.6	1	4	0.2	1.3
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$7.8

FY17

Project Title: Monitoring of humpback whale predation on Pacific herring in PWS
Primary Investigator: John Moran & Jan Straley
Agency: NMFS

FORM 4B
PERSONNEL & TRAVEL
DETAIL

Contractual Costs: Description	Contract Sum
Grant (UAS Straley)	44.2
Lager Vessel charter (3,200/day at 10 days)	32.0
Small boat Katmai driver/field tech (2 trips; OA grade 2 tech)	10.0
Sample processing:	
Prey/Diet (ABL) - forage fish & humpback whale	15.0
Nutritional health (ABL) - forage fish & humpback whale	10.0
Isotopes - forage fish & humpback whale	6.0
Genetics - humpback whales	2.5
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$119.7

Commodities Costs: Description	Commodities Sum
Shipping & moorage of Katmai in PWS	10.0
Fuel for Katmai (2 trips)	2.5
field supplies	2.5
Commodities Total	$15.0

FY17

Project Title: Monitoring of humpback whale predation on Pacific herring in PWS
Primary Investigator: John Moran & Jan Straley
Agency: NMFS

FORM 4B CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
None			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
NOAA small boat - R/V Katmai (~32') fully outfitted, permits, certificates, etc.	1	NOAA
NOAA large vessel charter - Cobb funds (2 surveys = 24 days @ $3,200/day	1	NOAA
bomb calorimeter	2	
muffle furnace	5	
HPLC, GC/FID, GC/FID, ACE	1	
microscopes	12	
glassware, chemicals		
freezers	5	
balances	5	
computers - contractors, running instruments	10	

FY17

Project Title: Monitoring of humpback whale predation on Pacific herring in PWS
Primary Investigator: John Moran & Jan Straley
Agency: NMFS

FORM 4B
EQUIPMENT DETAIL

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Moran	Humpback Whale (2 field trips; OT only)			0.6	0.6
	(12 days per trip with 64 hrs OT)				0.0
Moran	in kind labor ($10 K/mo)	7.0	0.0		0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	0.0	0.6	
				Personnel Total	$0.6

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
JNU - CDV	0.6	2	24	0.2	5.2
JNU - ANC Annual GW PI Meeting	0.6	1	4	0.2	1.3
JNU - ANC AMSS	0.6	1	4	0.2	1.3
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$7.8

FY18

Project Title: Monitoring of humpback whale predation on Pacific herring in PWS
Primary Investigator: John Moran & Jan Straley
Agency: NMFS

FORM 4B PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Grant (UAS Straley)	44.3
Lager Vessel charter (3,200/day at 10 days)	32.0
Small boat Katmai driver/field tech (2 trips; OA grade 2 tech)	10.0
Sample processing:	
Plankton (AFSC) - forage fish & humpback whale	
CTD (AFSC?) - forage fish	
Prey/Diet (ABL) - forage fish & humpback whale	15.0
Nutritional health (ABL) - forage fish & humpback whale	10.0
Isotopes - forage fish & humpback whale	6.0
Genetics - humpback whales	2.5
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$119.8

Commodities Costs: Description	Commodities Sum
Shipping & moorage of Katmai in PWS	10.0
Fuel for Katmai (2 trips)	2.5
field supplies	1.5
Commodities Total	$14.0

FY18

Project Title: Monitoring of humpback whale predation on Pacific herring in PWS
Primary Investigator: John Moran & Jan Straley
Agency: NMFS

FORM 4B CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
NOAA small boat - R/V Katmai (~32') fully outfitted, permits, certificates etc.	1	
NOAA Large vessel charter - Cobb funds (two surveys = 24 days@ $3,200/day)	1	
bomb calorimeter	2	
muffle furnace	5	
HPLC, GC/FID, GC/FID, ACE	1	
microscopes	12	
glassware, chemicals		
freezers	5	
balances	5	
computers - contractors, running instruments	10	

FY18

Project Title: Monitoring of humpback whale predation on Pacific herring in PWS
Primary Investigator: John Moran & Jan Straley

FORM 4B
EQUIPMENT DETAIL

Agency: NMFS

Personnel Costs: Name	Project Title	Months Budgeted	Monthly Costs	Overtime	Personnel Sum
Moran	Humpback Whale (2 field trips; OT only)			0.6	0.6
	(12 days per trip with 64 hrs OT)				0.0
Moran	in kind labor ($10 K/mo)	7.0	0.0		0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	0.0	0.6	
				Personnel Total	$0.6

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
JNU - CDV	0.6	2	24	0.2	5.2
JNU - ANC Annual GW PI Meeting	0.6	1	4	0.2	1.3
JNU - ANC AMSS	0.6	1	4	0.2	1.3
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$7.8

FY19

Project Title: Monitoring of humpback whale predation on Pacific herring in PWS
Primary Investigator: John Moran & Jan Straley

FORM 4B PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Grant (UAS Straley)	47.0
Lager Vessel charter (3,200/day at 10 days)	32.0
Small boat Katmai driver/field tech (2 trips; OA grade 2 tech)	10.0
Sample processing:	
Plankton (AFSC) - forage fish & humpback whale	
CTD (AFSC?) - forage fish	
Prey/Diet (ABL) - forage fish & humpback whale	15.0
Nutritional health (ABL) - forage fish & humpback whale	10.0
Isotopes - forage fish & humpback whale	6.0
Genetics - humpback whales	2.5
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$122.5

Commodities Costs: Description	Commodities Sum
Shipping & moorage of Katmai in PWS	10.0
Fuel for Katmai (2 trips)	2.5
field supplies	1.5
Commodities Total	$14.0

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
None			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
NOAA small boat - R/V Katmai (~32') fully outfitted, permits, certificates etc.	1	
NOAA Large vessel charter - Cobb funds (two surveys = 24 days@ $3,200/day)	1	
bomb calorimeter	2	
muffle furnace	5	
HPLC, GC/FID, GC/FID, ACE	1	
microscopes	12	
glassware, chemicals		
freezers	5	
balances	5	
computers - contractors, running instruments	10	

Personnel Costs:		Months Budgeted	Monthly Costs	Overtime	Personnel Sum
Name	Project Title				
Moran	Humpback Whale (2 field trips; OT only)			0.6	0.6
	(12 days per trip with 64 hrs OT)				0.0
Moran	in kind labor ($10 K/mo)	7.0	0.0		0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	0.0	0.6	
				Personnel Total	$0.6

Travel Costs:	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
Description					
JNU - CDV	0.6	2	24	0.2	5.2
JNU - ANC Annual GW PI Meeting	0.6	1	4	0.2	1.3
JNU - ANC AMSS	0.6	1	4	0.2	1.3
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$7.8

Contractual Costs: Description	Contract Sum
Grant (UAS Straley)	44.2
Lager Vessel charter (3,200/day at 10 days)	32.0
Small boat Katmai driver/field tech (2 trips; OA grade 2 tech)	10.0
Sample processing:	
Plankton (AFSC) - forage fish & humpback whale	
CTD (AFSC?) - forage fish	
Prey/Diet (ABL) - forage fish & humpback whale	15.0
Nutritional health (ABL) - forage fish & humpback whale	10.0
Isotopes - forage fish & humpback whale	6.0
Genetics - humpback whales	2.5
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$119.7

Commodities Costs: Description	Commodities Sum
Shipping & moorage of Katmai in PWS	10.0
Fuel for Katmai (2 trips)	2.5
field supplies	1.5
Commodities Total	$14.0

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
NOAA small boat - R/V Katmai (~32') fully outfitted, permits, certificates etc.	1	
NOAA Large vessel charter - Cobb funds (two surveys = 24 days@ $3,200/day)	1	
bomb calorimeter	2	
muffle furnace	5	
HPLC, GC/FID, GC/FID, ACE	1	
microscopes	12	
glassware, chemicals		
freezers	5	
balances	5	
computers - contractors, running instruments	10	

FY20

Primary Investigator: John Moran & Jan Straley
Agency: NMFS

EQUIPMENT DETAIL

Personnel Costs:		Months Budgeted	Monthly Costs	Overtime	Personnel Sum
Name	Project Title				
Moran	Humpback Whale (2 field trips; OT only)			0.6	0.6
	(12 days per trip with 64 hrs OT)				0.0
Moran	in kind labor ($10 K/mo)	7.0	0.0		0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	0.0	0.6	
				Personnel Total	$0.6

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
JNU - CDV	0.6	2	24	0.2	5.2
JNU - ANC Annual GW PI Meeting	0.6	1	4	0.2	1.3
JNU - ANC AMSS	0.6	1	4	0.2	1.3
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$7.8

FY21

Project Title: Monitoring of humpback whale predation on Pacific herring in PWS

FORM 4B
PERSONNEL & TRAVEL

Contractual Costs: Description	Contract Sum
Grant (UAS Straley)	44.0
Lager Vessel charter (3,200/day at 10 days)	32.0
Small boat Katmai driver/field tech (2 trips; OA grade 2 tech)	10.0
Sample processing:	
Plankton (AFSC) - forage fish & humpback whale	
CTD (AFSC?) - forage fish	
Prey/Diet (ABL) - forage fish & humpback whale	
Nutritional health (ABL) - forage fish & humpback whale	15.0
Isotopes - forage fish & humpback whale	6.0
Genetics - humpback whales	2.5
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$109.5

Commodities Costs: Description	Commodities Sum
Shipping & moorage of Katmai in PWS	10.0
Fuel for Katmai (2 trips)	2.5
supplies	5.0
Commodities Total	$17.5

FY21	Pacific herring in PWS Primary Investigator: John Moran & Jan Straley Agency: NMFS	FORM 4B CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
None			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
NOAA small boat - R/V Katmai (~32') fully outfitted, permits, certificates etc.	1	
NOAA Large vessel charter - Cobb funds (two surveys = 24 days@ $3,200/day = $76.8K)	1	
bomb calorimeter	2	
muffle furnace	5	
HPLC, GC/FID, GC/FID, ACE	1	
microscopes	12	
glassware, chemicals		
freezers	5	
balances	5	
computers - contractors, running instruments	10	

Project Title: Monitoring of humpback whale predation on

FY21	Pacific herring in PWS Primary Investigator: John Moran & Jan Straley Agency: NMFS	FORM 4B EQUIPMENT DETAIL