FY 22-31 *PROJECT* PROPOSAL
LONG-TERM RESEARCH AND MONITORING PROGRAM

Does this proposal contain confidential information? ☐Yes ☒No

Project Number and Title

Gulf Watch Alaska Long-Term Research and Monitoring Program: Nearshore Component

22120114-H Nearshore Ecosystems in the Gulf of Alaska

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Project Abstract (maximum 300 words)

Long-term monitoring provides a foundation of knowledge capable of recognizing and responding to changes in marine ecosystems in the Gulf of Alaska (GOA) and across the globe. We propose to extend ongoing monitoring of a diverse suite of taxa throughout the nearshore food web and across the GOA to provide continued evaluation of the status and trends of more than 200 species, including most of those injured by the 1989 *Exxon Valdez* oil spill (EVOS). The Gulf Watch Alaska (GWA) Nearshore monitoring program connects ecosystem components by sampling ecologically important and human-valued species throughout the nearshore food web, from primary producers to mid-level consumers to top predators. The monitoring design includes spatial, temporal, and ecological features that support inference regarding drivers of change. Recent examples of the application of the monitoring data include assessment of change in sea otter populations related to EVOS recovery in Prince William Sound and density-dependent factors on the Katmai coast; assessment of the relative roles of static versus dynamic drivers in structuring benthic communities; mussel population dynamics across the northern GOA; timelines and mechanisms of recovery of nearshore EVOS injured resources; the response of rocky intertidal communities to the recent Pacific marine heatwave (PMH); documenting changes in sea star communities after onset of sea star wasting syndrome; and responses of mussel populations to loss of sea stars across the northern GOA. Nearshore data have also contributed to a larger GWA synthesis on responses of marine systems to the PMH, including contrasts of pelagic and nearshore biomes. History tells us to expect the unexpected and that change is inevitable. Continued monitoring will facilitate science, conservation, and management of nearshore

marine resources by identifying ecological change at appropriate spatial and temporal scales across the GOA and allow ongoing evaluation of the status of spill injured resources.

EVOSTC Funding Requested* (must include 9% GA)

FY22	FY23	FY24	FY25	FY26	FY22-26 Total
$668,712	$700,465	$734,488	$601,513	$607,275	$3,312,453
FY27	**FY28**	**FY29**	**FY30**	**FY31**	**FY27-31 Total**
$617,415	$627,883	$638,002	$648,470	$652,144	$3,183,914
				FY22-31 Total	*$6,496,367*

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

Non-EVOSTC Funds to be used, please include source and amount per source:

FY22	FY23	FY24	FY25	FY26	FY22-26 Total
$572,400	$577,500	$567,700	$573,100	$578,700	$2,869,400
FY27	**FY28**	**FY29**	**FY30**	**FY31**	**FY27-31 Total**
$584,400	$590,300	$596,300	$602,600	$609,000	$2,982,600
				FY22-31 Total	*$5,852,000*

Non-EVOSTC funds are in-kind contributions from federal agencies. These include salaries of permanent staff, field travel, contracts (charter boats, scientist contracts), commodities, and equipment use (boats, spotting scopes, oceanographic instruments, etc.).

1. EXECUTIVE SUMMARY (maximum ~1500 words, not including figures and tables)

Nearshore marine ecosystems face significant challenges at local, regional, and global scales, with threats arising from both adjacent lands and oceans. An example of such threats was the 1989 grounding of the T/V *Exxon Valdez* in Prince William Sound (PWS) that affected marine systems across the northern Gulf of Alaska (GOA). 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 across multiple spatial and temporal scales is essential when responding to and managing present and anticipated threats.

The nearshore is broadly recognized to be 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, Wethey et al. 2011, Vinagre et al. 2016). 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, Kaplanis et al. 2020), 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). As an example from the northern GOA, we recently described responses of rocky intertidal communities to a prolonged Pacific marine heatwave (Weitzman et al. 2021). 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, Chemello et al. 2018). 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 limited home ranges, providing a geographic context to sources of change. Nearshore habitats will undoubtedly have detectable levels of change in the future, and our monitoring design will allow us to discern local from regional sources of change, tease apart human induced from naturally induced changes, and provide opportunities for management actions to reduce human induced impacts or mitigate natural variation.

The overarching goal of the nearshore component of the Gulf Watch Alaska (GWA) - Long-Term Research and Monitoring (LTRM) program is to understand drivers of variation across the nearshore food web in the GOA (see Fig. 1). The foundational hypotheses of the nearshore component include: (1) What is the current structure of the GOA nearshore ecosystems, and what are the spatial and temporal scales over which change is observed? (2) Are observed changes caused by 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 component 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 *Exxon Valdez* oil spill (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 (Fig. 1), 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 allows accurate and defensible measures of change and supports management and policy needs addressing nearshore resources.

Harnessing the power of long-term datasets, several of the GWA-LTRM nearshore component's data streams are continuations from preceding time series, some reaching as far back as 1971 (Calkins 1978). Building GWA monitoring on this legacy has resulted in many important insights and management-relevant findings thanks to longer time series. As an example, decades of data on sea otter population dynamics, including GWA data, have revealed that patterns of change in abundance differ among regions. Changes in sea otters are driven largely by local conditions, although drivers may vary by location (e.g., recovery from the EVOS in PWS, recolonization following fur harvest in Katmai and Kachemak Bay, and prey availability in Kenai Fjords; Bodkin 2015; Coletti et al. 2016, Davis et al. 2019). In contrast, our regionally explicit monitoring design allowed us to show that broader-scale drivers were important in other nearshore processes. Data on rocky intertidal communities indicated that static physical attributes did not differ markedly across regions, and neither did intertidal biota (Konar et al. 2016), findings that have subsequently been confirmed in other regions of the world (Hacker et al. 2019). Similarly, we observed losses of sea stars, important nearshore predators, and the emergence of sea star wasting syndrome synchronized with the onset of warming trends across all regions (Konar et al. 2019). During the recent Pacific marine heatwave (PMH), our long-term monitoring data from the rocky intertidal indicated synchronous shifts in community structure across all four regions, indicating that the PMH perturbation was a stronger driver of community structure than local-scale drivers (Weitzman et al. 2021). The accumulated work of the GWA-LTRM Nearshore Component shows that we have implemented a powerful monitoring program that is able to detect ecological impacts on relevant spatial and temporal scales. The conceptual framework for monitoring in the nearshore that was implemented over the last decade contains the following key elements:

1. Synoptic sampling of select physical parameters (e.g., temperature and salinity) over the GOA nearshore regions. This synoptic nearshore sampling is complemented by offshore measurements in the GOA through the Environmental Drivers Component of the GWA program.

2. Sampling of diverse species and a variety of specific biological parameters (e.g., abundance and size of intertidal organisms, abundance, productivity, and diet of selected birds and marine mammals) in all four GOA nearshore regions. Because the nearshore was disproportionately affected by the EVOS, this 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 both temporal and spatial scales. For example, nearshore communities are sampled annually with replicates along various tidal strata at multiple sites within a region, and across four regions (Katmai National Park [KATM], Kachemak Bay [KBAY], Kenai Fjords National Park [KEFJ], and western PWS [WPWS]).

4. The design is focused explicitly in 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 (Fig. 1).

5. Coordination with externally funded, short-term (2-5 years) studies aimed at identifying important processes regulating, causing, or reflecting changes within a given system or subsystem. Examples are highlighted in Section 5, Coordination and Collaboration, of this proposal.

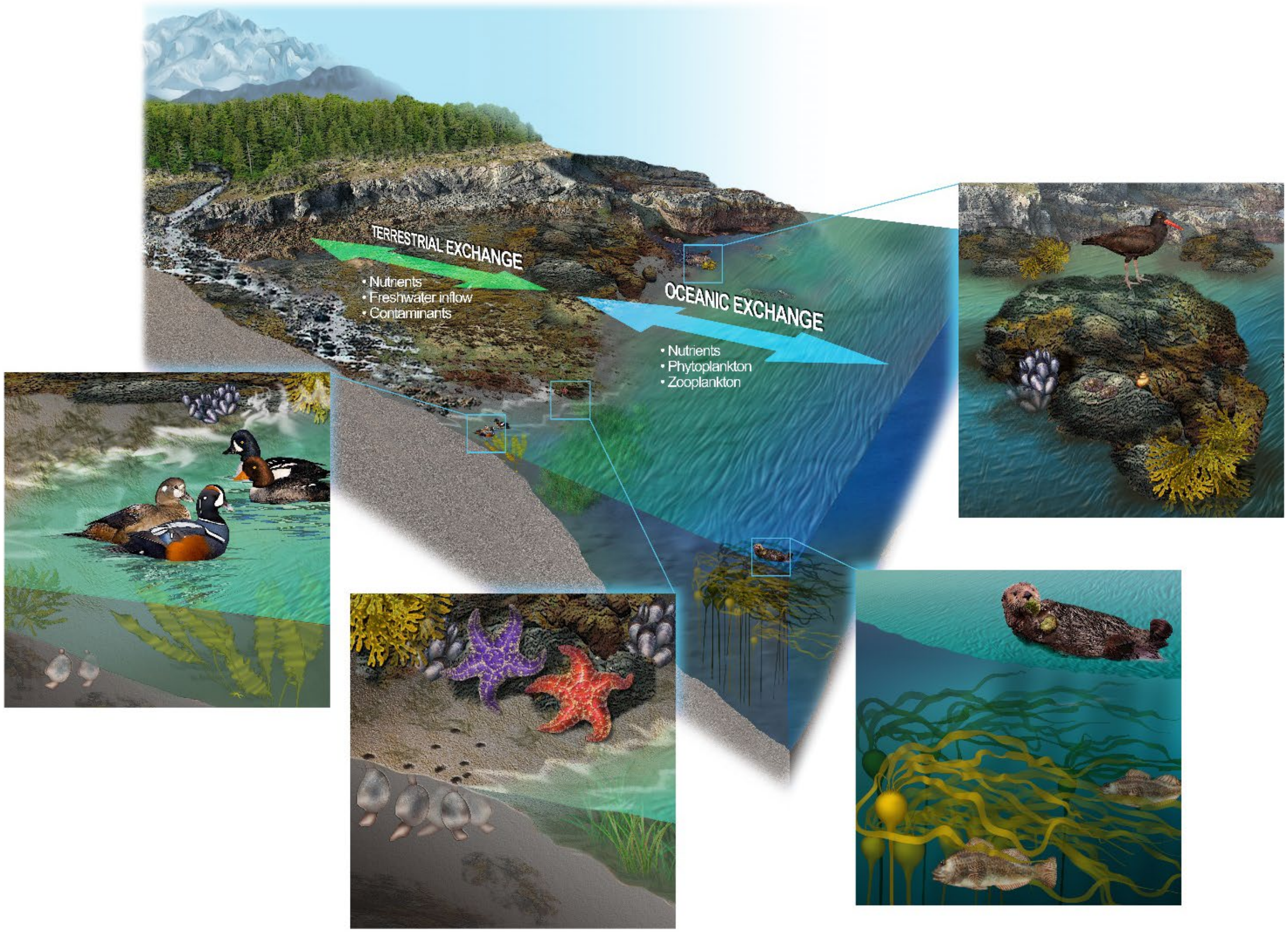

Figure 1. Conceptual model of the nearshore food web with terrestrial and oceanic influences illustrated. In this model, sea otters, black oystercatchers, sea ducks and sea stars act as the top-level consumers in a system where primary productivity originates mostly from macroalgae and sea grass and moves through benthic invertebrates to top level consumers.

Building on historic data, including our first 10 years of GWA Nearshore monitoring, our goals for the second, 10-year phase are to extend the time series on our Nearshore metrics using our proven design to address our overarching hypotheses. There are relatively few opportunities to generate consistently collected, long-term ecological data and the opportunity to extend existing data by another decade is nearly-unprecedented for nearshore time series, the critical scientific and conservation value of which is becoming increasingly apparent (Hughes et al. 2017). We will also capitalize on the first decade of available data on nearshore ecosystem structure by synthesizing existing data and conducting select process studies that can explain biological and environmental relationships. We have a demonstrated record of value-added leveraging of our GWA work with other projects and will continue to do so, in addition to including post-doc and graduate student-led special projects. The existing and continually accumulated information also will be synthesized with other components of GWA to identify potential causes and scales of change, including those related to EVOS and climate change. An excellent recent example of such synthesis is our Nearshore contribution to the GOA-wide synthesis on persistent ecosystem changes resulting from the PMH (Suryan et al. 2021). We will continue to use existing and new information from this third phase to communicate findings to the public and resource managers.

2. RELEVANCE TO THE INVITATION (maximum 300 words)

This project proposal addresses the EVOS Trustee Council's (EVOSTC's) request for long-term monitoring plans for the nearshore ecosystem directly impacted by the EVOS. It constitutes a strategic 10-year continuation of the first and second 5-year phases of the GWA program, with the same study design and personnel as the previous work. 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 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., 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 2012 supports the accomplishment of these goals, with the nearshore system being an essential component of this plan.

As demonstrated during the first 10 years, we anticipate that this monitoring program will continue to elucidate spatial and temporal patterns of change in a wide variety of nearshore organisms and relationships. In turn, these will contribute to a more complete scientific understanding of marine nearshore biomes in the northern GOA, as well as delivering specific information relevant for a variety of management agencies and other stakeholders. See Section 5.F. for specific examples of management applications.

3. PROJECT HISTORY (maximum 400 words)

This project is the proposed continuation of the nearshore component of GWA (project 21120114-H). 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 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 National Park Service's (NPS's) Vital Signs Long-Term Monitoring Plan and implemented in KATM in 2006 and in KEFJ in 2007. In 2010, EVOSTC Project 10100750 (PIs J. Bodkin and T. Dean, Fig. 1) 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). At the onset of GWA (2012), there were two Nearshore projects (16120114-R Nearshore Benthic Systems in the Gulf of Alaska and 16120114-L, Ecological Trends in Kachemak Bay). The two projects have worked closely over the past several years to ensure that data from all sites are comparable when possible, allowing the strongest possible inferences about causative factors and the spatial extent of changes in nearshore systems. In 2017, the two nearshore projects integrated into a single, coordinated project (project 21120114-H) to enhance collaboration across the GWA and expand upper trophic-level nearshore monitoring to Kachemak Bay. This coordination and collaboration has resulted in many peer reviewed publications, reports, and presentations, all either directly related to or leveraged by GWA (Table 1). Numerous outreach products in the form of resource briefs, websites, social media posts and media articles have also been produced.

Table 1. Cumulative list of products from the Nearshore Component of the Gulf Watch Alaska long-term monitoring program, 2012-2021.

Metric	Number	Details
Peer reviewed publications	42	Includes direct and indirect support from Gulf Watch Alaska (GWA)
Reports	38	Includes annual and final *Exxon Valdez* Oil Spill Trustee Council annual and final reports as well as agency reports
Professional presentations	93	Includes oral and poster presentations
Published standard operating protocols	10	Links provided below
Completed field seasons	10	Since the start of GWA
Publicly accessible datasets	47	15 with digital object identifiers published through U.S. Geological Survey and 32 publicly accessible through the Gulf of Alaska data portal and DataONE

4. PROJECT DESIGN

A. Objectives and Hypotheses

We propose to continue our long-term restoration and ecosystem monitoring program in four regions across the GOA. We will continue to leverage off and integrate with existing monitoring efforts on the Katmai coast and the Kenai Peninsula through the NPS to cost-effectively monitor many areas of the spill-affected region and provide critical information and reference for recovery and restoration of injured resources. The foundational hypotheses of the nearshore project include the following:

1) What is the current structure of the GOA nearshore food web, and 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 sampling design follows that initially put forward in the first GWA phase starting in 2012 and consists of four primary sampling locations in nearshore habitats in the central GOA region: KATM, KBAY, KEFJ and WPWS. We propose to continue sampling these regions on an annual basis through 2031. 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 because of the EVOS (Dean and Bodkin 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 (in partnership with the Lingering Oil Component). The nearshore monitoring program will also continue to use 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 Nearshore and Pelagic Components of GWA will facilitate understanding how various drivers influence these two important food webs, as was shown in recent synthesis efforts (Arimitsu et al. 2021, Danielson et al. in review, Suryan et al. 2021).

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. Continue EVOS restoration monitoring in the nearshore to evaluate the current status of injured resources in oiled areas and identify factors potentially affecting present and future trends in population status.
5. Link core nearshore monitoring data to process-oriented studies relating to performance (e.g., growth) of key taxa, trophic relationships, experimental studies to test the effects of specific environmental drivers, etc. through the involvement of graduate students and a post doc.
6. Communicate these to the public and to resource managers to preserve nearshore resources.

B. Procedural and Scientific Methods

The nearshore monitoring protocol (Dean and Bodkin 2006, Dean et al. 2014) describes the design and approach for sampling key components of the nearshore system in the GOA that are both numerically and functionally important to the system's health, including many that were injured by the EVOS, as well as several key environmental drivers. Measured attributes 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 components of the nearshore is summarized below, with detailed descriptions in foundational documents (Bennett et al. 2006, Dean et al. 2014). Monitoring will follow the same standard operating protocols (SOPs) that have been established from the onset, and in many cases prior to, the GWA Nearshore program to ensure consistency of the data streams. **SOPs describe methods in more detail than required here links to published SOPs are provided below.**

Objectives 1-3: Nearshore Component protocol narrative (Dean et al. 2014):
https://irma.nps.gov/DataStore/DownloadFile/488741

1) ***Kelp, other algae, 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 algae 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.

SOP for rocky intertidal site monitoring in KEFJ, KATM and WPWS (Dean and Bodkin 2011a):
https://irma.nps.gov/DataStore/DownloadFile/428529

SOP for rocky intertidal site monitoring in KBAY (Iken and Konar 2012):
https://workspace.aoos.org/published/file/fa30bafb-3fc8-439f-b144-1fc225be6ba7/SOP_EcologicalTrendsInKachemakBay.pdf?source=catalog&portalId=8

SOP for eelgrass bed monitoring in KBAY (Iken and Konar 2012):
https://workspace.aoos.org/published/file/fa30bafb-3fc8-439f-b144-1fc225be6ba7/SOP_EcologicalTrendsInKachemakBay.pdf?source=catalog&portalId=8

2) ***Marine Intertidal Invertebrates*** provide critical food resources for shorebirds, sea 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.

SOP for rocky intertidal site monitoring in KEFJ, KATM and WPWS (Dean and Bodkin 2011a):
https://irma.nps.gov/DataStore/DownloadFile/428529

SOP for rocky intertidal site monitoring in KBAY (Konar and Iken 2012):
https://workspace.aoos.org/published/file/fa30bafb-3fc8-439f-b144-1fc225be6ba7/SOP_EcologicalTrendsInKachemakBay.pdf?source=catalog&portalId=8

SOP for mixed sediment invertebrate sampling in all 4 regions (Weitzman et al. 2017):
https://irma.nps.gov/DataStore/DownloadFile/577315

SOP for mussel bed sampling in all 4 regions (Bodkin et al. 2016):
https://irma.nps.gov/DataStore/DownloadFile/548246

3) ***Marine Birds*** are predators near the top of marine nearshore food webs. Marine birds are long-lived, conspicuous, abundant, and 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. Studies have documented that their behavior, diet, productivity, and survival change as environmental conditions change. Public concern exists for the welfare of seabirds because they are affected by human activities like oil pollution and commercial fishing.

SOP for marine bird and mammal surveys (Bodkin 2011a):
https://irma.nps.gov/DataStore/DownloadFile/428463

4) ***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 the nearshore community resulting from human or other disturbances.

SOP for black oystercatcher data collection (Bodkin 2011b):
https://irma.nps.gov/DataStore/DownloadFile/428462

5) ***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 approaching the western edge of our study area. As a result of these declines, the southwestern Alaska stock of sea otters (which includes those in KATM), was federally listed as threatened in September 2005 under the Endangered Species Act.

SOP for Sea otter carcass surveys (Dean and Bodkin 2011b):
https://irma.nps.gov/DataStore/DownloadFile/428528

SOP for sea otter forage data collection (Bodkin 2011c): https://irma.nps.gov/DataStore/DownloadFile/428470

SOP for sea otter abundance estimation (aerial surveys) (Bodkin 2011d):
https://irma.nps.gov/DataStore/DownloadFile/428467

6) ***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.

SOP for water contaminant monitoring (Dean and Bodkin 2011a):
https://irma.nps.gov/DataStore/DownloadFile/428529

Methods for water temperature monitoring (Weitzman et al. 2021):
https://www.frontiersin.org/articles/10.3389/fmars.2021.556820/full

Central to each metric identified above is the objective of estimating trends in abundance (or values, e.g., for temperature or contaminants) and distribution over time. In addition, for some invertebrates we estimate size distributions (e.g., mussels and limpets) and for black oystercatchers and sea otters we estimate diets and reproductive rates, and for sea otters we estimate age at death distributions, reflecting annual mortality. Fundamentally, our nearshore monitoring is explicitly designed to document both expected changes (e.g., climate change) and those unexpected (e.g., oil spills, earthquakes, and volcanoes), and to be able to distinguish effects from such large-scale perturbations from the underlying natural variation in the ecosystem.

Our integrated approach allows us to address how each metric or species may change over time and how specific metrics may change relative to one another (e.g., predator-prey abundances, or species abundance related to change in water chemistry or quality). Through comparable sampling methods at four regions across the GOA we ask how trends in metrics change over space, as well as over time. In addition to asking how individual species change over time, we can ask how assemblages of species or communities change over time and space or as a response to environmental or ecological factors (e.g., multi- level trophic interactions).

Because marine bird communities differ between summer and winter, we sample this group in both seasons. For black oystercatchers and sea otters we ask how diets and reproduction change over time and space and in relation to estimated prey abundances and for sea otters how patterns of mortality change over time and among regions. We also ask how changes within any of the sampled metrics change over time in relation to environmental conditions. Because of the spatially nested sampling design and sampling across multiple trophic levels within a discrete food web that includes more than 200 inter-related species, an almost unlimited number of questions can be asked of the data streams at the level of sites, regions, and Gulf wide, concerning potential causal relations and as a result, in many cases we will be able to infer cause of change over time.

Most metrics are sampled on an annual basis, although some metrics are sampled less frequently. 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 (in collaboration with the Lingering Oil Component). Marine bird and mammal transects are sampled each summer, while winter surveys are conducted in each block at 3–4-year intervals. Aerial surveys of sea otter abundance and distribution are conducted on an annually rotating basis among KATM, KEFJ, and WPWS regions.

The number and location of sampling units can 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 specific SOPs (see links above), but in general were guided by preliminary estimates of effort required to detect ecologically meaningful levels of change (Dean and Bodkin 2006). In three of the four regions, sampling sites were selected to provide a random, spatially balanced distribution. An exception to this random site selection occurred in KBAY, however we added two randomly selected sites on the north side of the Kachemak Bay to better represent the KBAY region. The design allows for detection of large temporal or spatial-scale changes (e.g., changes that may occur over the entire GOA over time or differentially among regions or sites within regions).

Objective 4: Much of the acute and chronic injury to species and communities resulting from the EVOS took place in nearshore habitats and within the nearshore food web in western PWS (Rice et al. 1996, Ballachey et al. 2015). The genesis of the Nearshore monitoring program we report on here was explicitly designed to contribute to restoration and recovery of EVOS injured resources through continued monitoring of their status and trends and through comparisons across the GOA (EVOSTC 2006). Nearshore monitoring continues to contribute data to evaluate the status of 16 of 24 recovered resources and 3 of 4 resources not yet recovered (https://evostc.state.ak.us/status-of-restoration/), including marine invertebrates, birds, and mammals, with intensive focus on sea otters and black oystercatchers, as described above. The results of our monitoring and its contribution to recovery and restoration of injured resources is referenced in the following publications (Bodkin et al. 2014, Ballachey et al. 2015, Bowen et al. 2016, Monson et al. 2011, Esler et al. 2018). We expect our project will continue to contribute to evaluation of EVOS injured resources through continued monitoring and spatial contrasts.

Objective 5: Long-term monitoring is only effective if sampling locations, methodologies and target metrics remain constant over time so that consistent long-term data sets develop. The more we learn about a system through long-term monitoring, however, the more questions arise about specific processes that drive these systems, which may not be answered through the core monitoring. This creates a conundrum that we would be better able to interpret nearshore patterns in relation to local or regional drivers if we were to understand underlying processes; however, with limited resources, we are unable to target such questions without compromising our ability to continue the core monitoring. The GWA LTRM Nearshore Component approaches this next 10-year monitoring phase prepared to tackle this conundrum by engaging graduate students in our work, with the explicit intent of using existing data or projects that can be added to existing efforts to address process questions. We anticipate supporting 4-5 MS-level graduate students over the course of the next nearshore monitoring decade, as well as continuing to support the post doc position from FY22-24. Graduate students will be under the direct supervision of Principal Investigators and benefit from the wealth of information and the regionally explicit and expansive long-term datasets of the GWA Nearshore Component but will be able to add targeted studies as their thesis work that will help our understanding of nearshore ecosystem processes. For example, targeted projects could include specific studies linking nearshore primary productivity with performance (e.g., growth or reproduction) of nearshore consumers. Other studies could focus on the role of settlement versus post-settlement processes in the success of populations reestablishing after a disturbance. Such a study could also include a comparison of invertebrate pelagic larval stages in comparison to recruiting or adult populations. Targeted graduate student studies could also provide an opportunity to employ and test new technologies and assess their relationship to traditional approaches. These examples provide just a few ideas that could enhance our core monitoring data, enhance linkages to other components or enhance our ability to better interpret variability in long-term datasets.

Objective 6: The Nearshore Component of GWA has demonstrated a commitment to communicating science and we propose to continue those efforts into the next 10 years of this project. Communication outlets have taken both traditional and alternative forms. We have presented findings through peer-reviewed journal articles, reports, and presentations at scientific proceedings. We also have presented findings to resource managers and public audiences through resource briefs, newspaper articles, story maps, press releases, public presentations, websites, and social media posts.

Design Considerations - Compatibility with existing programs

In the process of developing the Nearshore monitoring program we investigated most, if not all of the active nearshore monitoring programs along the west coast of North America in early 2000 (e.g., PISCO, MARINe, LIMPET, NAGISA, PSP, National Oceanographic and Atmospheric Administration [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., sea 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 age-at-death distributions (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, which 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 because of their large spatial extent and high species diversity, were located on the south side of the bay. When the two Nearshore Component projects joined GWA in 2012, we added two additional sites on the north side of the Kachemak Bay to better represent the KBAY 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 temperature), 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 birds and mammals as apex predators (i.e., black oystercatchers, sea ducks and the sea otter, Fig. 1). 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.

C. Data Analysis and Statistical Methods

As indicated above, the objective of the sampling program is to assess abundance of diverse species of kelps, seagrass, invertebrates, birds, and mammals that comprise the nearshore food web and how those metrics change over time and how those changes vary with respect to various spatial scales. The levels of change that we can expect to detect and the time and spatial scales over which they are to be detected will vary with metric. In general, the goal for most biological metrics (e.g., abundance of sea otters, harlequin ducks, or dominant intertidal invertebrates like mussels or entire community composition) is to detect levels of change that are deemed to be of ecological importance (see Dean et al. 2014 for a discussion of determination of levels of change that are deemed ecologically important for each metric). 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 regions (and in some cases sites nested within each block) with replicate samples within the region (or at the site level). Various mixed models we have used in analysis of these datasets over the past 10 years examined the extent of variation for a particular metric attributed to location (e.g., region or sites within a region), 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. 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.

A selection of common data analyses and statistical methods that we use to evaluate changes in the nearshore environment are detailed in Dean and Bodkin (2006), Dean et al. (2014), Konar et al. (2016), and Weitzman et al. (2021). 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). For community-level data, we will employ multivariate, permutation-based ordination techniques and advanced models that allow linking biological responses with environmental conditions (Clarke et al. 2014). These statistical applications produce statistical significance levels that are being used to determine change and the sources of change.

We have successfully used the above-outlined techniques in the analysis of the GWA Nearshore data to date, in addition to including some longer time series. For example, Coletti et al. (2016) in a publication in Ecosphere 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 indicated 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 regional scales across the larger GOA. These data, therefore, 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 an analysis of mussel abundance, Bodkin et al. (2018) used an information-theoretic approach to data analysis that contrasted support for multiple hypotheses (and corresponding GLM models) about the spatial and temporal scales over which abundance varied. This analysis considered the degree of support for hypotheses that posited that mussel abundance varied at spatial scales from very local (site-specific) versus regional (at block levels) versus GOA-wide. Similarly, different linear and nonlinear effects of time (year) were considered. We found that mussel abundance generally varied by block but was nonlinearly related to time over all blocks, with declines in abundance during the first years of GWA and increases in later years. These consistent trends over time indicated that drivers of variation in mussel abundance were likely expressed at broad geographic scales. This ability to contrast varying spatial and temporal scales of change is an important attribute of the overall Nearshore Component study design.

An example of multivariate community analysis is a paper published in Estuaries and Coasts (Konar et al. 2016) that 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 the GOA 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 the site and across regions levels. 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 concluded at that time that longer time series at our monitoring sites should be able to tease apart the interactions of static and dynamic drivers. With the continued data collection since this publication and the anticipated continuation of data collection, we will soon be able to conduct such dynamic analyses.

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

Western PWS (5 intensive sites): This study area was funded by EVOSTC (Projects 10100750 and 12120114-R, covering data collection during 2010-2021. We are requesting funds to continue monitoring the long-term study sites annually through 2031.

Katmai and Kenai Fjords National Parks (5 intensive sites each park): These study areas were initially 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, through 2031.

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 originated under the Census of Marine Life program in 2002 and have, therefore, 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; these modifications were based on detailed comparisons and calibrations of protocols between KBAY and the other regions in 2015 and were found to be similar (in Konar et al. 2016). We request support for continued work in KBAY through 2031.

All sampling locations are within the EVOSTC-defined spill-affected area (Fig. 2).

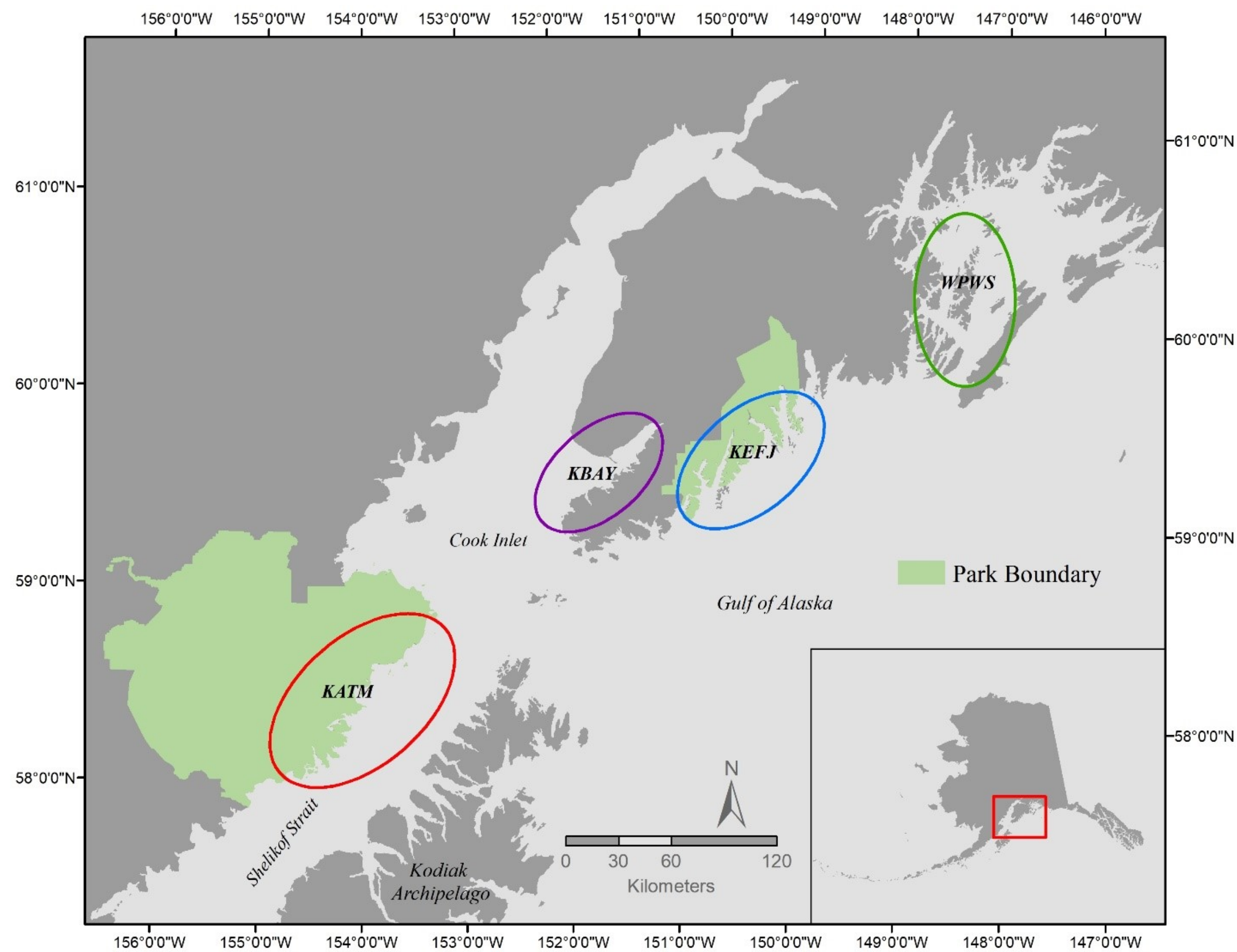

Figure 2. Study areas for the Nearshore Component of Gulf Watch Alaska: Katmai National Park and Preserve (KATM), Kachemak Bay (KBAY), Kenai Fjords National Park (KEFJ), and western Prince William Sound (WPWS).

5. COORDINATION AND COLLABORATION

A. With the Alaska SeaLife Center or Prince William Sound Science Center

The Nearshore Component collaborates with scientists from these organizations who are members of other LTRM components (see below). This has proven to be particularly valuable for program-wide syntheses.

B. Within the EVOSTC LTRM Program

Environmental Drivers Component

We have worked with the GWA Environmental Drivers Components to identify data sets and logistical synergies that can be shared. For example, Environmental Drivers data were used extensively in an analysis of mussel trends across the GOA, presented in the GWA Science Synthesis report (Monson et al. 2015). More recently, we collaborated on a synthesis publication that combined Nearshore data streams with those from the Environmental Drivers group to evaluate whether temperature changes in nearshore systems correlate with offshore oceanographic conditions (Danielson et al. in review). We also have collaborated with the Environmental Drivers Component to develop plans to compare meroplankton data from the environmental drivers group that could be correlated to the rocky intertidal community composition or the clam community composition data from the Nearshore Component. To leverage additional funds for this collaboration we have submitted a study plan description to the Bureau of Ocean Energy Management (BOEM) to add genetic analyses to allow species-level meroplankton analyses, which has been listed in the recent BOEM Fiscal Year 2022-2023 Studies Development Plan (SDP).

Pelagic Monitoring Component

We have collaborated with the Pelagic Component on a variety of projects. Nearshore marine bird survey data, specifically common murre abundance and distribution, were used in analyses to assess how the synchronous collapse of forage fish species disrupted trophic transport during the marine heatwave. (Arimitsu et al. 2019, Arimitsu et al. 2021). Also, we are working with the killer whale project of the Pelagic Component, providing logistical support to deploy a hydrophone in Kachemak Bay and University of Alaska Fairbanks (UAF) student time to process hydrophone data. In general, the geographic scale of our study (GOA-wide) will continue to provide greater ability to discern both potential linkages across these diverse components, as well as among the study areas within the Nearshore Component, allowing us to evaluate variability and relations among the nearshore resources. Two Pelagic Component projects of the overall GWA program of particular importance to the Nearshore Component are surveys of nearshore marine birds in PWS, including summer (22120114-M) and fall-winter (22120114-E) marine bird population trend projects (for additional long-term data sets of marine birds, see Irons et al. 2000, Stocking et al. 2018, Cushing et al. 2018). The nearshore project conducts comparable surveys in KEFJ and KATM, and since 2018 in KBAY. Contrasting the changes occurring in the pelagic and nearshore environments during the recent years when GOA waters have warmed by several degrees (https://alaskapacificblob.wordpress.com/2016/02/09/subsurface-warmth-persists/) may be particularly illuminating.

A cross-component (nearshore and pelagic) effort continues (projects 22120114-C, E, H, L, M, and O) with the intent to integrate bird survey data to examine spatial and temporal trends in a variety of species and guilds across the northern Gulf of Alaska. The pelagic and Nearshore Components worked with ABR Inc. to create a survey tool (SeaLog) and a processing tool (QAQSea) for rapid QA/QC as well as automating the processing required to upload survey data into the North Pacific Pelagic Seabird Database (NPPSD) maintained by the U.S. Geological Survey (USGS). Previous efforts compiled nearshore survey data from all four regions and provided to USGS for the NPPSD v3 release in 2020 (Drew and Piatt 2015). Incorporation of all GWA marine bird survey data into NPPSD will allow for larger scale analyses of marine bird trends throughout the north Pacific over time. Further collaboration between the nearshore and Pelagic Components is highlighted in chapter 3 of the synthesis effort (Arimitsu et al. 2019, Arimitsu et al. 2021), which utilized GWA nearshore marine bird survey data from KATM. Nearshore marine bird survey data were also used in the GWA science synthesis chapter 4 (Suryan et al. 2019, Suryan et al. 2021). Overall, the Nearshore Component contributed to all the FY17-21 science synthesis products produced by GWA.

Nearshore Monitoring Component

This project represents the nearshore monitoring component. Between the FY12-16 and FY17-21 funding cycles the two Nearshore Component projects merged into one to combine sampling methods and analyses. We propose to continue the integration of the projects.

Lingering Oil Monitoring Component

The Nearshore Component of GWA historically has been closely linked with the lingering oil component, given that lingering oil occurs predominantly in nearshore habitats and affects nearshore species. Although the

EVOSTC has treated lingering oil as a separate program in the past 5-year period, we understand that it will be considered a component under the GWA LTRM program in the future. The conceptual and collaborative linkages with the Nearshore Component remain. Data collected by the Nearshore Component are relevant for understanding ecosystem recovery with respect to the lingering oil component; for example, sea otter abundance, energy recovery rate, and age-at-death data have been used to evaluate population recovery (Ballachey et al. 2014, Bodkin et al. 2014). Contaminant samples (mussels) collected during the 2018 field season were analyzed for a broad suite of compounds, including hydrocarbons. This analysis, led by NOAA's Mussel Watch program, culminated in a report that combined results from other locations as well as historic results in the northern GOA in a report (Rider et al. 2020). Results indicated that there are no contaminants concerns at this time within our study areas. We anticipate continued lingering oil collaborations in the future.

Herring Research and Monitoring component

The Nearshore Component has not had any direct collaborations to date with the Herring Research and Monitoring program (HRM), but discussions are in progress with respect to coastal herring spawning habitat.

Synthesis and Modeling Component

We have produced research that synthesizes data from the Nearshore Component in collaboration with the Environmental Drivers Component. The Pacific marine heatwave provided an opportunity to examine rocky intertidal community resilience and stability in the face of a climatic disturbance that will likely become more frequent in the future with climate change. Changes in rocky intertidal communities before and after the Pacific marine heatwave that constitute a functional shift from communities dominated by primary producers to primary consumers were described by Weitzman et al. (2021). Also, mussel abundance has recently increased across the GOA and we are currently examining the relative roles of the environmental disturbance of the Pacific marine heatwave versus the biological disturbance of the sea star wasting syndrome outbreak in driving these changes (Traiger et al. in prep).

Synthesis efforts across nearshore, environmental drivers, and Pelagic Components are currently underway. Vertebrate mussel predators have likely been affected by the increase in mussel abundance and change in size structure. We will examine changes in black oystercatcher diet in the context of changes in large mussel abundance. An additional synthesis project centered on clams is currently in development. This project will investigate drivers of clam populations including supply side dynamics (bivalve larvae data from the Pelagic Component), environmental drivers, and predation pressure from sea otters and sea stars.

We recently collaborated with all GWA components, HRM, and non-EVOSTC programs to assess GOA-wide responses across all ecosystem components and trophic levels in response to the recent Pacific marine heatwave (Suryan et al. 2021). These efforts present examples of recent or ongoing syntheses that will continue in collaboration with the GWA LTRM Synthesis and Modeling Component (PI Suryan). By continuing the collection of long-term data of the nearshore environment we will also continue to increase our ability to synthesize data within the Nearshore Component as well as across GWA LTRM components.

Data Management Project

This project coordinates with the data management project by submitting data and preparing metadata for publication on the Gulf of Alaska Data Portal and DataONE within the timeframes required. Lead principal investigators (PIs) of the Nearshore Component conduct annual meetings with members of the data management project to discuss any data management, quality control, and data publication questions.

C. With Other EVOSTC-funded Projects (not within the LTRM Focus Area)

Current EVOSTC-funded projects not within the LTRM focus area have not intersected with this project so far. As the EVOSTC funds future projects outside the GWA LTRM program we will evaluate their applicability to our project and coordinate as appropriate.

D. With Proposed EVOSTC Mariculture Focus Area Projects

GWA nearshore co-PI Konar is a member of a team that will be submitting a EVOSTC Mariculture proposal. She is leading the *Benthic Impacts* component of the proposal, coordinating sampling in Kachemak Bay, Kodiak, and PWS. She is also interacting with other mariculture proposal components to ensure that they are aware of the data streams and activities of the GWA nearshore monitoring component. She is, therefore, well positioned to ensure future communication between the two projects. Because most mariculture efforts occur in nearshore waters, the conceptual link and information exchange between the two programs is natural.

E. With Proposed EVOSTC Education and Outreach Focus Area Projects

The GWA LTRM program will develop an outreach plan that includes coordination and collaboration with the Trustee's Education and Outreach Program and projects. We look forward to participating in education and outreach opportunities where our project findings can contribute to a better understanding of the Gulf of Alaska ecosystem by the general public.

F. With Trustee or Management Agencies

A central goal of the GWA LTRM program is relevance to scientific and management communities. Information from Nearshore Component monitoring has been used in a variety of contexts with direct management implications by resource management agencies. The following represent examples:

- U.S. Fish and Wildlife Service (USFWS) has used our survey data for marine birds and mammals directly as part of risk assessments for vessel groundings and oil spills, both hypothetical in drills and in real-world incidents .
- Also, USFWS Marine Mammals Management uses our sea otter distribution and abundance data in management documents for the species, such as stock assessments and species status assessments; given the status of the Southwest Alaska stock as threatened under the Endangered Species Act, data that we generate on status and trends of sea otters in Katmai is particularly important.
- The Nearshore Component contributed nearshore indices to NOAA Fisheries for the annual GOA Ecosystems Considerations Report to the North Pacific Fisheries Management Council (Coletti et al. 2020, Ferriss and Zador 2020). The health of nearshore ecosystems informs managers on essential fish habitat and sensitive early life stages of federally managed fish species mandated through the Magnuson-Stevens Act.
- NPS has incorporated our data into a number of their natural resource management instruments, including Resource Stewardship Strategies (RSSs), Natural Resource Condition Assessments, State of the Park Reports, and upcoming Wilderness Character assessments. For many of their marine resources, our data are the only data.
- Finally, data from the Nearshore Component have been used by the EVOSTC and trustee agencies to

evaluate population recovery of injured species (e.g., sea otters and harlequin ducks). In addition, Nearshore Component data have been used to inform activities well beyond the GOA including the Deepwater Horizon case and risk assessments of pipelines and tanker traffic.

The Nearshore Component has been involved in an array of science collaborations and other contributions to marine science. In addition to the logistical, administrative, and in-kind support that the NPS, USGS, and NOAA have provided to ensure success of the GWA Nearshore Component, there are several additional projects with trustee and management agencies that the Nearshore Component of GWA is currently or has collaborated with in the past. Below are several recent examples. We expect to continue these kinds of related 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. The field portion of the study was completed in 2016. Lab analyses have been completed. Initial data analyses indicate that mussel energy density varies seasonally, likely corresponding to spawning condition. Further, we found that mussel consumption by otters varied seasonally in association with varying mussel energy density, but overall mussel consumption was high in KEFJ across seasons. Data analysis and write-up are ongoing.

NPRB sea otter study (USGS and NPS)

Nearshore GWA PIs (Bodkin, Ballachey, Coletti, Esslinger, Kloecker, Konar, Monson and Weitzman) contributed to an international study supported in part by the North Pacific Research Board (NPRB; Project 717) to delineate the cause and constraints to recovery of a declining sea otter population listed under the Endangered Species Act as “Threatened” across the North Pacific. Our GWA nearshore data from KATM and WPWS contributed sea otter abundance, diet, and energetics data, which were combined with data obtained from sites at the Commander Islands in the west to PWS in the eastern Pacific. Contrasts across areas identified the range of decline and identified predation as the likely cause and constraint to recovery (Estes et al. 2010, Tinker et al. in press) . Results identify KATM and WPWS as beyond the area of decline in 2011. These data and results are shared with the USFWS Marine Mammals Management, the agency responsible for sea otter management.

NPS Changing Tides

Nearshore GWA PIs (Ballachey, Bodkin, and Coletti) are working 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 GWA 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 Changing Tides 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 KATM. Specimens were kept live in small aquarium-like containers, and condition and performance metrics were assessed in the laboratory by Alaska SeaLife Center collaborators Tuula Hollmen and Katrina Counihan. Additional specimens were used to for genetic transcription diagnostics (gene expression) to measure the physiologic responses of individuals to stressors, in collaboration with Liz Bowen and Keith Miles of USGS. Several papers have been published stemming from this work including three focused on the bivalve portion (Counihan et al. 2019, Bowen et al. 2020, Coletti et al. in prep). 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.

Building on the Changing Tides work and earlier EVOSTC studies (Bowen et al. 2018), GWA PIs (Coletti and Ballachey) are collaborating with L. Bowen (USGS) and A. Love (PWS Regional Citizens' Advisory Council) to develop genetic transcription diagnostics (gene expression) to measure *Mytilus trossulus* responses to stressors. Results on mussels sampled in in 2019 in PWS (various sites in Port Valdez) have been summarized and suggest gene transcription assays in mussels will be a useful additional tool for monitoring of contaminants; this collaboration is anticipated to continue (Bowen et al. 2019).

Further building on GWA and Changing Tides work, in the summer of 2019, we (Coletti and Ballachey) collaborated with Maya Groner (now with PWSSC), Maureen Purcell, and Paul Hershberger (USGS Western Fisheries Research Center) on their study of the bacterial gill pathogen NIX in razor clams. Razor clams are economically and ecologically important along coastlines in Alaska, as well as in Washington and Oregon where they are known to be affected by NIX disease. However, NIX is not thought to affect razor clams in Alaska; we provided razor clams from the KATM coast for the NIX study as a negative control sample (Travis et al. 2021). We also provided additional sample of razor clam tissue to the Alaska Department of Fish and Game for genetic and morphometric analyses.

Additional work examining the interaction between bears and marine mammals was added in 2016 (initiated by D. Monson). Previously, it was believed that bears generally forage on marine mammals via scavenging of beached carcasses. This project has shed light on the importance of marine mammals (primarily sea otters and harbor seals) as live prey taken on offshore islands along the Katmai coast (Monson et al. in review).

BOEM Nearshore community assessments

Nearshore Component PIs (Coletti, Iken, Konar, and Lindeberg) have completed recommendations to the BOEM for nearshore community assessment and long-term monitoring (Jones et al. 2020). The BOEM Proposed Final Outer Continental Shelf (OCS) Oil and Gas Leasing Program included proposed Lease Sale 258 in the Cook Inlet Planning Area in 2021. Until this leasing program, an OCS Cook Inlet Lease Sale National Environmental Policy Act (NEPA) analysis had not been undertaken since 2003. Updated nearshore information was needed to support the environmental analyses associated with the planned lease sale. The overall objective of this study was to provide data on habitats and sensitive species to support environmental analyses for NEPA documents, potential future Exploration Plans, and Development and Production Plans. Throughout this process, a goal has been to utilize existing Nearshore monitoring protocols already developed through GWA when possible to ensure data comparability across all regions. All data are being provided to the Alaska Ocean Observing System Gulf of Alaska data portal.

CMI Nearshore food webs in Cook Inlet

Funded through the Coastal Marine Institute (CMI), a partnership between BOEM and UAF, GWA PIs Iken and Konar worked with a student on analyzing food web structure in western Cook Inlet (above-mentioned BOEM project) and at GWA sites in Kachemak Bay by using carbon and nitrogen stable isotope analyses. Intertidal taxa at western Cook Inlet are clearly adapted to using some of the more terrestrial material available from river and glacial discharge than the more marine production-feeding taxa in Kachemak Bay. This adds valuable information about the energetic links among the species that are analyzed for their abundance and distribution through GWA. A final report has been submitted to CMI and BOEM and a manuscript has been submitted to the Gulf of Alaska Special Issue in Deep-Sea Research II and is currently under review (Siegert et al. in review). A student within the EPSCoR Fire and Ice program (see below) is currently investigating nearshore food web structure in glacially influenced watersheds in Kachemak Bay, which will provide a complementary dataset to the above-mentioned work at the GWA sites under an expanded environmental setting.

BOEM sea otter assessment for lower Cook Inlet

Nearshore GWA PIs (Monson and Kloecker) are working on a BOEM-funded project quantifying sea otter distribution, abundance, habitat use, and foraging relative to oil and gas lease sale areas in Cook Inlet. This project is in early stages, with the first intensive field work slated for 2021. This work will benefit from ongoing GWA studies in Kachemak Bay, which provide a longer-term perspective on sea otter population status in the area. Similarly, GWA monitoring in Kachemak Bay will benefit by having a broader geographic perspective on sea otters and their prey. There also will be numerous meaningful synergies between the projects, including logistical efficiencies, consistent personnel, and vessel support that will benefit both projects.

Drones to collect monitoring data

Nearshore GWA PIs (Iken and Konar) tested the use of unmanned aircraft systems (UASs) for various aspects of coastal biological monitoring in KBAY. With BOEM and CMI funding, UASs were compared to traditional methods of rocky intertidal and seagrass sampling with some success and suggestions for future work (Konar and Iken 2018). After this success, UASs were tested to determine their feasibility to complete sea otter foraging observations in KBAY with USGS funding (Monson and Weitzman).

In August 2019, GWA PIs (Hondolero and Weitzman) with an academic collaborator (Tom Bell – University of California Santa Barbara) used a UAS to map canopy kelp and eelgrass habitats in Kachemak Bay with support from NOAA – Kasitsna Bay Lab. The pilot effort proved successful, resulting in a poster at the 2020 Alaska Marine Science Symposium. The Kasitsna Bay Laboratory intends to pursue more UAS mapping of kelp and other nearshore habitats in 2021.

In collaboration with NPS, during recent Nearshore monitoring trips on the Katmai coast, the GWA Nearshore project (GWA PI Monson and NPS collaborator Martyn) tested use of a small UASs to map intertidal sites. The elevation data collected by the UAS will allow us to track changes in topography over time and enable us to correlate species presence and abundance with elevation in the intertidal zone. The high-resolution elevation data may also be critical for future assessments of ecosystem change due to sea-level rise, earthquakes, or other natural phenomena. Collection of UAS based aerial imagery for each site allows for documentation of physical disturbances (e.g., rocks turned over from storm activity), which can be valuable when trying to interpret variation in community structure within sites. Data collected from 2017-2019 are currently being analyzed. UAS flights in KATM will not take place in 2021 as the Department of Interior has issued a ‘stand down’ of all NPS UAS operations.

The Pacific Nearshore project

In kind support from GWA and NPS was provided to the USGS Pacific Nearshore Project (https://pubs.usgs.gov/fs/2010/3099/) that investigated methods to assess overall health of nearshore ecosystems across the north Pacific. In particular, samples were collected during GWA trips to KATM and WPWS to examine the sources of primary productivity to two fish species that differed in their feeding mode (kelp greenling/nearshore benthic vs. black rockfish/pelagic). Stable isotope analyses showed that both benthic foraging and pelagic foraging fish species derive their energy from a combination of macro- (kelps) and micro-algae (phytoplankton) sources (von Biela 2016a). Initial stable isotope analyses from across the GOA of a variety of nearshore invertebrates supports the concept that kelps are a primary contributor of carbon to nearshore ecosystems in the GOA (unpublished data). Further work was completed by von Biela et al. (2016b), with support from GWA, examining the role of local and basin-wide ocean conditions on growth rates of benthic foraging and pelagic foraging fish species. In 2018, we initiated a pilot study to build on the Pacific Nearshore Project by sampling fish and mussels across all four regions. Objectives are to 1) examine relative contributions of macroalgae and phytoplankton to nearshore intertidal mussels and subtidal fishes over space and time, 2) examine variation in the relative contributions of primary producers and determine if that variation is related to growth performance, and 3) assess annual growth rates of mussels and fish to determine if they are synchronous with other GWA environmental drivers or indicators of productivity in nearshore or pelagic ecosystems. Sample collection is on-going throughout all four regions of the Nearshore Component. This project forms the foundation of a new MS student project that started in 2021, supported by NPS and carry over dollars not expended due to COVID-19.

Nearshore ecosystem responses to glacial inputs

Nearshore GWA PIs (Esler, Coletti, Robinson, Weitzman), in collaboration with NPS, have initiated work aimed at documenting variation in nearshore physical oceanography in relation to tidewater glacial input, and quantify biological responses to that variation across trophic levels in KEFJ. This work will allow prediction of changes in nearshore ecosystems in the face of ongoing glacier mass loss and retreat from the marine environment. This proposed work relies heavily on GWA nearshore monitoring data and will build on our understanding of nearshore marine processes.

Academic collaborations

In addition to the collaborations with other agencies, there are many academic research projects for which collaboration with the Nearshore Component has provided conceptual overlap, shared expertise, logistical support, an opportunity for sample collection, or an extension of GWA goals. Several examples follow below.

Nearshore GWA PIs (Konar and Iken) in collaboration with researchers at University of Alaska Anchorage (UAA) and University of Alaska Southeast (UAS) have received funding from the National Science Foundation (NSF) Established Program to Stimulate Competitive Research (EPSCoR) program to examine how the timing, duration, and character of the freshwater flux from precipitation vs glacial melt influences nearshore biological communities. This five-year project (titled Fire and Ice) will examine an array of sites in Lynn Canal in southeast Alaska and in Kachemak Bay. GWA and EPSCoR are sharing environmental data (temperature, salinity) and some biological data. One EPSCoR graduate student, Amy Dowling, is using the KBAY GWA sites as oceanic endpoints in her MS research, which is examining mussel size frequency distributions along a glacial gradient and in relation to a variety of environmental drivers . A student examining nearshore food web linkages in the glacially influenced watersheds of the EPSCoR project in Kachemak Bay complements the study of nearshore food web structure recently completed at the Kachemak Bay rocky intertidal sites (Siegert et al. in revision).

In collaboration with other UAF researchers, GWA PIs (Konar and Iken) received a Field Station and Marine Laboratories Award from the National Science Foundation. An array of SeapHOx sensors in Kachemak Bay to monitor pH, oxygen, salinity, and temperature at multiple sites and an experimental system to manipulate ocean variables to determine responses in marine organisms was installed at the Kasitsna Bay Marine Lab in 2019. These data will be available for all GWA PIs.

In collaboration with GWA PIs (Esler, Coletti, and Robinson), a study was initiated with Simon Fraser University to determine connectivity between breeding areas and non-breeding areas of black oystercatchers in the North Pacific. We recognize that migration strategies and large-scale movements of the black oystercatcher may play a role in their overall condition, in addition to the diet monitoring conducted by GWA. By using GPS and geolocator technology, this work will elucidate the migration strategies and identify the overwintering locations of Alaskan breeding birds. Black oystercatchers were captured and tagged in all four regions of the Nearshore Component in 2019 and in three regions in 2020. Recaptures and new captures are planned to occur at all four regions in 2021. Taken together this work will highlight the times and places when and where conservation action can directly benefit black oystercatchers that breed in Alaskan coastal parks and will serve to facilitate risk assessment to a key wildlife species throughout the year.

GWA PI Kloecker has been working with professors and students at Alaska Pacific University, seeking opportunities for undergrad projects that utilize GWA Nearshore component data. For example, an undergrad (Emily Reynolds) will be looking at relationships between mussel size class structure and temperature from our study sites. These are mutually beneficial ventures, with students getting access to robust data sets and scientific expertise, and the Nearshore Component benefits from the focused data analysis that we otherwise would not have time to pursue.

International collaborations

We initiated collaborations with the MBON Pole to Pole (P2P) project, an international program focusing on nearshore biodiversity monitoring across the Americas from the Arctic to the Antarctic (https://marinebon.org/p2p/). The P2P project is currently funded by NOAA and NASA and has important links to global biodiversity observing programs through GEO BON (Group on Earth Observations – Biodiversity Observation Networks). The long-term time series of the GWA Nearshore Component and our proven ability to discern nearshore changes in response to environmental variation (e.g., Weitzmann et al. 2021) can serve as a role model for other monitoring networks. Additionally, the focus of the P2P program is to provide globally available data through OBIS (Ocean Biogeographic Information System) as well as the capacity to provide regional programs (such as the GWA Nearshore Component) with satellite-derived environmental data. This will add significant capability to the GWA Nearshore Component to expand the use of remotely sensed information.

G. With Native and Local Communities

The GWA-LTRM program and this project are committed to involvement with local and Alaska Native communities. Our vision for this involvement will include active engagement with the Education and Outreach Focus Area (see above), program-directed engagement through the Program Management project (22120114), and project-level engagement. During the first year of the funding cycle (FY22), the GWA LTRM program will reach out to local communities and Alaska Native organizations in the spill affected area to ask what engagement they would like from us and develop an approach that invites involvement of PIs from each project, including this one. Our intent as a program is to provide effective and meaningful community involvement that complements the work of the Education and Outreach Focus Area and allows communities to engage directly with scientists based on local interests.

The nearshore component will continue to participate in these outreach activities, especially engaging with local communities as we have done during the first 10 years of the program, including listening sessions throughout spill-effected communities and contributing newsletter contributions.

6. DELIVERABLES

The nearshore component of the GWA-LTRM program will submit reports on an annual basis. We will also periodically update our portion of the GWA website, which was most recently updated in fall 2020. Synthesis and final reports will be submitted as required. We expect to present several times per year on GWA LTRM – related topics at both public and scientific proceedings, as we have in the past decade. We expect to publish peer-reviewed journal articles each year, as we have consistently since 2012. We will continue to consult with management agencies and present findings as requested (e.g., USFWS Marine Mammal Management). We will have publicly accessible data within a year of collection on the AOOS data portal. Social media posts, films and other outreach products will be developed in collaboration with partners such as NPS, OASLC, and the Outreach and Education component.

7. PROJECT STATUS OF SCHEDULED ACCOMPLISHMENTS

Project milestones and tasks by fiscal year and quarter, beginning February 1, 2022. Fiscal Year Quarters: 1= Feb. 1-April 30; 2= May 1-July 31; 3= Aug. 1-Oct. 31; 4= Nov. 1-Jan 31.

	FY22				FY23				FY24				FY25				FY26			
Milestone/Task	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Milestone – Field Work																				
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 in rocky habitats (mixed sediment sampling is every other year)		X				X				X				X				X		
Task 5 - Sampling of sea grasses (KBAY)		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 KBAY, KATM and KEFJ)		X				X				X				X				X		

Milestone/Task	FY22				FY23				FY24				FY25				FY26			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Task 8 - Marine bird and mammal surveys (winter KATM, KEFJ, or KBAY alternate years)	X				X				X				X				X			
Task 9 - Stable isotope analysis of selected nearshore species		X				X				X				X				X		
Task 10 - Contaminant analysis (Lingering Oil collaboration)														X						
Milestone – Graduate Student progress																				
Task 11 - Start **new** student project (n=2 for FY22-26)							X								X					
Task 12 – Student project presentations and publications	X				X				X				X				X			
Post Doc support for integration and synthesis	X	X	X	X	X	X	X	X	X	X	X	X								
Reporting																				
Annual reports					X				X				X				X			
Deliverables																				
Peer reviewed paper				X				X				X				X				X
Data posted online				X				X				X				X				X

Milestone/Task	FY27				FY28				FY29				FY30				FY31			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Milestone – Field Work																				
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 in rocky habitats (mixed sediment sampling is every other year)		X				X				X				X				X		
Task 5 - Sampling of sea grasses (KBAY)		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 KBAY, KATM and KEFJ)		X				X				X				X				X		
Task 8 - Marine bird and mammal surveys (winter KATM, KEFJ, or KBAY alternate years)	X				X				X				X				X			
Task 9 - Stable isotope analysis of selected nearshore species		X				X				X				X				X		

Milestone/Task	FY27				FY28				FY29				FY30				FY31			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Task 10 - Contaminant analysis (Lingering Oil collaboration)														X						
Milestone – Graduate Student progress																				
Task 11 - Start **new** student project (n=2 for FY27-31)							X								X					
Task 12 – Student project presentations and publications	X				X				X				X				X			
Reporting																				
Annual reports	X				X				X				X				X			
Final report																				X
Deliverables																				
Peer reviewed paper				X				X				X				X				X
Data posted online				X				X				X				X				X

8. BUDGET

A. Budget Forms (Attach)

Please see Gulf Watch Alaska Long-Term Research and Monitoring workbook.

Budget Category:	Proposed FY 22	Proposed FY 23	Proposed FY 24	Proposed FY 25	Proposed FY 26	5-YR TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$354,453	$367,215	$377,899	$264,718	$271,730	$1,636,014	
Travel	$14,837	$14,895	$14,955	$15,017	$15,080	$74,784	
Contractual	$170,600	$173,400	$191,065	$191,600	$189,600	$916,265	
Commodities	$26,000	$26,975	$27,999	$22,730	$21,000	$124,704	
Equipment	$25,937	$37,247	$38,417	$33,645	$34,935	$170,181	
Indirect Costs (varies by proposer)	$21,670	$22,897	$23,507	$24,137	$24,788	$116,999	
SUBTOTAL	$613,497	$642,629	$673,842	$551,847	$557,133	$3,038,947	
General Administration (9% of subtotal)	$55,215	$57,837	$60,646	$49,666	$50,142	$273,505	N/A
PROJECT TOTAL	$668,712	$700,465	$734,488	$601,513	$607,275	$3,312,453	
Other Resources (In-Kind Funds)	$572,400	$577,500	$567,700	$573,100	$578,700	$2,869,400	

Budget Category:	Proposed FY 27	Proposed FY 28	Proposed FY 29	Proposed FY 30	Proposed FY 31	5-YR TOTAL PROPOSED	ACTUAL CUMULATIVE	TEN YEAR TOTAL
Personnel	$278,940	$286,359	$293,986	$301,833	$309,907	$1,471,026		$3,107,040
Travel	$15,144	$15,210	$15,278	$15,347	$15,419	$76,398		$151,182
Contractual	$189,600	$189,600	$189,600	$189,600	$188,600	$947,000		$1,863,265
Commodities	$21,000	$21,000	$20,500	$20,000	$13,806	$96,306		$221,010
Equipment	$36,290	$37,711	$39,205	$40,772	$42,418	$196,396		$366,577
Indirect Costs (varies by proposer)	$25,462	$26,159	$26,754	$27,375	$28,147	$133,896		$250,895
SUBTOTAL	$566,436	$576,039	$585,323	$594,927	$598,297	$2,921,022		$5,959,969
General Administration (9% of subtotal)	$50,979	$51,844	$52,679	$53,543	$53,847	$262,892	N/A	$536,397
PROJECT TOTAL	$617,415	$627,883	$638,002	$648,470	$652,144	$3,183,914		$6,496,367
Other Resources (In-Kind Funds)	$584,400	$590,300	$596,300	$602,600	$609,000	$2,982,600		$5,852,000

This project is a collaborative effort among co-PIs from Trustee agencies (USGS and NPS) and a non-Trustee organization (UAF). Over the course of the 10-year funding period, each organization requests the following amounts (not including GA):

- Trustee agencies combined (USGS and NPS): $4,416,916
- Non-Trustee organization (UAF): $1,543,053

B. Sources of Additional Funding

Non-EVOSTC Funds to be used, please include source and amount per source:

FY22	FY23	FY24	FY25	FY26	FY22-26 Total
$572,400	$577,500	$567,700	$573,100	$578,700	$2,869,400
FY27	**FY28**	**FY29**	**FY30**	**FY31**	**FY27-31 Total**
$584,400	$590,300	$596,300	$602,600	$609,000	$2,982,600
				FY22-31 Total	*$5,852,000*

Non-EVOSTC funds in the table above are in-kind contributions from federal agencies. These include salaries of permanent staff, field travel, contracts (charter boats, scientist contracts), commodities, and equipment use (boats, spotting scopes, oceanographic instruments, etc.) in support of Nearshore component monitoring. Details of in-kind support are in the table below (Table 2), with values representing the total over the 10-year period of performance (FY22-31).

Table 2. In-kind support by agency, National Park Service (NPS), U.S. Geological Survey (USGS), and National Oceanic and Atmospheric Administration (NOAA).

	NPS	USGS	NOAA
Personnel	$1,942,000	$1,700,000	$100,000
Travel	$30,000	$0	$0
Contractual	$330,000	$0	$0
Commodities	$50,000	$100,000	$0
Equipment	$1,000,000	$600,000	$0
TOTAL	*$3,352,000*	*$2,400,000*	*$100,000*

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10. PROJECT PERSONNEL

Overall project management will be the responsibility of H. Coletti, D. Esler, B. Konar and K. Iken. We anticipate that J. Bodkin, B. Ballachey, D. Monson, K. Kloecker, G. Esslinger, D. Hondelero, M. Lindeberg, B. Robinson, S. Traiger and B. Weitzman with additional support from USGS, NPS, UAF and NOAA scientific staff, will continue the data collection and sampling in all regions. 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 since 2000 working in various coastal areas of Alaska and are currently leading the Nearshore monitoring in KBAY. They both have been Principal Investigators (PIs) on previous EVOS studies and the Census of Marine Life with ecological work in Kachemak Bay. B. Ballachey and J. Bodkin 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 and KATM. J. Bodkin and T. Dean have been central in development and implementation of both the NPS and the USGS/EVOS Nearshore monitoring programs. M. Lindeberg brings decades of experience in nearshore ecosystems of the GOA as well as being the lead scientist for GWA in the previous decade. K. Kloecker, G. Esslinger and D. Monson of the USGS joined the project in the summer of 2012 and bring 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. B. Robinson joined the project in 2015 and brings several years of experience working in the GOA, in particular with black oystercatchers and other marine bird species. S. Traiger joined the team in 2020 and has started leading synthesis efforts of Nearshore data streams. 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. Coordination and continued communication and collaboration is being ensured through bi-weekly conference calls. We will attend an annual meeting of the larger group of GWA 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.

PRINCIPAL INVESTIGATOR: Nearshore Component
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RELEVANT PROFESSIONAL EXPERIENCE

Current position and Relevant Profession Experience: Marine Ecologist, National Park Service Southwest Alaska Network (SWAN) Inventory and Monitoring (I&M) Program tasked with 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 (GWA). Component lead of the Nearshore Component of GWA since 2017.

MOST RELEVENT PUBLICATIONS

Arimitsu, M., J. Piatt, R.M. Suryan, S. Batten, M.A. Bishop, R.W. Campbell, **H. Coletti**, D. Cushing, K. Gorman, S. Hatch, S. Haught, R.R. Hopcroft, K.J. Kuletz, C. Marsteller, C. McKinstry, D. McGowan, J. Moran, R.S. Pegau, A. Schaefer, S. Schoen, J. Straley, and V.R. von Biela. In Review. Synchronous collapse of forage species disrupts trophic transfer during a prolonged marine heatwave. Global Change Biology.

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Suryan, R.M., M. Arimitsu, **H. Coletti**, R.R. Hopcroft, M.R. Lindeberg, S. Batten, M.A. Bishop, R. Brenner, R. Campbell, D. Cushing, S. Danielson, D. Esler, T. Gelatt, S. Hatch, S. Haught, K. Holderied, K. Iken, D. Irons, D. Kimmel, B. Konar, K. Kuletz, B. Laurel, J.M. Maniscalco, C. Matkin, C. McKinstry, D. Monson, J. Moran, D. Olsen, S. Pegau, J. Piatt, L. Rogers, A. Schaefer, J. Straley, K. Seeeney, M. Szymkowiak, B. Weitzman, J. Bodkin, and S. Zador. In Press. Ecosystem response to a prolonged marine heatwave. Scientific Reports.

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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

2006 Master of Science, Natural Resources: Environmental Conservation (University of New Hampshire, Durham, New Hampshire).

1997 Bachelor of Science, Zoology (University of Rhode Island, Kingston, RI).

COLLABORATORS

Brenda Ballachey (USGS), James Bodkin (USGS), Michael Booz (ADF&G), Lizabeth Bowen (USGS), Katrina Counihan (ASLC), Thomas Dean, Dan Esler (USGS), George Esslinger, Grant Hilderbrand (NPS),Katrin Iken (University of Alaska Fairbanks), Tahzay Jones (NPS), Robert Kaler (USFWS), Kim Kloecker, Brenda Konar (University of Alaska Fairbanks), Mandy Lindeberg (NOAA), Daniel Monson (USGS) , Brian Robinson, John Piatt (USGS), Benjamin Pister (NPS), Robert Suryan (NOAA), Vanessa Von Biela (USGS), Ben Weitzman. (Note: full listing of Gulf Watch Alaska PI's not given here; available upon request).

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RELEVANT PROFESSIONAL EXPERIENCE

Leader, 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 (August 2013 – present).

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

MOST RELEVANT PUBLICATIONS

Konar, B., T.J. Mitchell, K. Iken, H. Coletti, T. Dean, **D. Esler**, M. Lindeberg, B. Pister, and B. Weitzman. 2019. Wasting disease and static environmental variables drive sea star assemblages in the northern Gulf of Alaska. Journal of Experimental Marine Biology and Ecology 520.

Esler, D., B.E. Ballachey, C.O. Matkin, D. Cushing, R. Kaler, J. Bodkin, D. Monson, G.G. Esslinger, and K. Kloecker. 2018. Timelines and mechanisms of wildlife population recovery following the *Exxon Valdez* oil spill. Deep Sea Research II 147:36-42.

Bowen, L., A.K. Miles, B.E. Ballachey, S. Waters, J.L. Bodkin, M. Lindeberg, and **D. Esler**. 2018. Gene transcription patterns in response to low level petroleum contaminants in *Mytilus trossulus* from field sites and harbors in southcentral Alaska. Deep Sea Research II 147:27-35.

Bodkin, J.L., H.A. Coletti, B.E. Ballachey, D. Monson, **D. Esler**, and T.A. Dean. 2018. Spatial and temporal variation in Pacific blue mussel, *Mytilus trossulus*, abundance in the northern Gulf of Alaska, 2006-2015. Deep Sea Research II 147:87-97.

Willie, M., **D. Esler**, W.S. Boyd, P. Molloy, and R.C. Ydenberg. 2017. Spatial variation in polycyclic aromatic hydrocarbon exposure in Barrow's goldeneye (*Bucephala islandica*) in coastal British Columbia. Marine Pollution Bulletin 118:167-179.

Esler, D., B.E. Ballachey, L. Bowen, A.K. Miles, R.D. Dickson, and J.D. Henderson. 2016. Cessation of oil exposure in harlequin ducks after the *Exxon Valdez* oil spill: cytochrome P4501A biomarker evidence. Environmental Toxicology and Chemistry 36:1294-1300.

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. Pp. 311-346 in B. Maslo and J. L. Lockwood, eds. Coastal Conservation. Cambridge University Press.

Esler, D., B. E. Ballachey, K. A. Trust, S. A. Iverson, J. A. Reed, A. K. Miles, J. D. Henderson, B. W. Wilson, B. R. Woodin, J. R. Stegeman, M. McAdie, and D. M. Mulcahy. 2011. Cytochrome P4501A biomarker indication of the timeline of chronic exposure of Barrow's goldeneye to residual *Exxon Valdez* oil. Marine Pollution Bulletin 62:609-614.

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.

OTHER SIGNIFICANT PUBLICATIONS

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.

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.

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.

COLLABORATIONS

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), Green, David (Simon Fraser University), Hogan, Danica (Environment Canada), Hollmen, Tuula (UAF/Alaska SeaLife Center), Iken, Katrin (UAF), Konar, Brenda (UAF), Kurtz, Deborah (NPS), Lok, Erika (Environment Canada), Lindeberg, Mandy (NOAA), Rice, Jeep (NOAA-retired), Schmutz, Joel (USGS), Thompson, Jonathan (Alberta Provincial Covernment), Tinker, Tim (USGS/University of California Santa Cruz), Uher-Koch, Brian (USGS), Ward, David (USGS), Weitzman, Ben (NOAA), Willie, Megan (Simon Fraser University), Ydenberg, Ron (Simon Fraser University)

PRINCIPAL INVESTIGATOR: Nearshore Component

Katrin Iken
Professor in Marine Biology
College of Fisheries and Ocean Sciences**,** University of Alaska Fairbanks
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Relevant Professional Experience

PI or Co-PI on several long-term monitoring projects in different Alaskan waters. Engaged in numerous nearshore ecological projects in Alaska, focusing on community composition and trophic linkages. Major advisor of 17 past and 5 current MS and PhD students. Director of the Kasitsna Bay Marine Lab in Kachemak Bay.

Appointments:

2012-present	Professor in Marine Biology, University of Alaska Fairbanks Director Kasitsna Bay Marine Lab, UAF
2007-2012	Associate Professor in Marine Biology, University of Alaska Fairbanks Program Chair for the Graduate Program in Marine Science and Limnology
2002-2007	Assistant Professor in Marine Biology, University of Alaska Fairbanks
1999-2001	Postdoctoral Research Fellow, University of Alabama at Birmingham, USA
1996-1999	Postdoctoral Research Fellow, Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany

10 Relevant Research Products: (Students underlined)

Weitzman B, Konar B, **Iken K**, Coletti H, Monson D, Suryan R, Dean T, Hondolero D and Lindeberg M (2021) Changes in rocky intertidal community structure during a marine heatwave in the Northern Gulf of Alaska. Frontiers in Marine Science 8:556820. doi: 10.3389/fmars.2021.556820

Konar B, Mitchell TJ, **Iken K**, Coletti H, Dean T, Esler D, Lindeberg M, Pister B, Weitzman B. (2019) Wasting disease and environmental variables drive sea star assemblages in the northern Gulf of Alaska. *Journal of Experimental Marine Biology and Ecology*. https://doi.org/10.1016/j.jembe.2019.151209

Iken K, Mueter FJ, Grebmeier J, Cooper L, Danielson SL, Bluhm B (2019) Developing an observational design for epibenthos and fish assemblages in the Chukchi Sea. *Deep-Sea Research II* 162: 180-190. https://doi.org/10.1016/j.dsr2.2018.11.005

Walsh JE, Thomen RL, Bhatt US, Bieniek PA, Brettschneider B, Brubaker M, Danielson S, Lader R, Fetterer F, Holderied K, **Iken K**, Mahoney A, McCammon M0, Partain J (2018) The high latitude marine heat wave of 2016 and its impacts on Alaska. *Bulletin of the American Meterological Society* 99: S39-S43. https://doi.org/10.1175/BAMS-D-17-0105.1

Konar B, **Iken K,** Coletti H, Monson D, Weitzman B (2016) Influence of static habitat attributes on local and regional rocky intertidal community structure. *Estuaries and Coasts* 39: 1735-1745. https://doi.org/10.1007/s12237-016-0114-0

Spurkland T, **Iken K**. (2012) Seasonal growth patterns of *Saccharina latissima* in a glacially-influenced subarctic estuary. *Phycological Research* 60: 261-275. https://doi.org/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. https://doi.org/10.4490/algae.2012.27.2.115

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.

Spurkland T, Iken K (2011) Kelp bed dynamics in estuarine environments in subarctic Alaska. *Journal of Coastal Research* 27: 133-143. https://doi.org/10.2112/JCOASTRES-D-10-00194.

Iken K, Konar B, Benedetti-Cecchi L, Cruz-Motta JJ, Knowlton A, Pohle G, Mead A, Miloslavich P, Wong M, Trott T, Mieszkowska N, Riosmena-Rodriguez R, Airoldi L, Kimani E, Shirayama Y, Fraschetti S, Ortiz Touzet M, Silva A (2010) Large-scale spatial distribution patterns of echinoderms in nearshore rocky habitats. *PLoS One* 5(11): e13845

5 Other Significant Publications (Students underlined)**:**

Huntington HP, Danielson SL, Wiese FK, Baker M, Boveng P, Citta JJ, De Robertis A, Dickson DM, Farley E, George JC, **Iken K,** Kimmel DG, Kuletz K, Ladd C, Levine R, Quakenbush L, Stabeno P, Stafford KM, Stockwell D, Wilson C. (2020) Evidence suggests potential transformation of the Pacific Arctic ecosystem is underway. *Nature Climate Change* 10(4): 342-348.

Sutton L, **Iken K**, Bluhm BA, Mueter FJ. (2020) Comparison of functional diversity of two Alaskan Arctic shelf epibenthic communities. Mar*ine Ecology Progress Series* 651: 1-21.

Divine LM, Mueter FJ, Kruse GH, Bluhm BA, Jewett SC, **Iken K.** (2019) New estimates of weight-at-size, maturity-at-size, fecundity, mortality and biomass of snow crab, *Chionoecetes opilio*, in the Arctic Ocean off Alaska. *Fisheries Research* 218: 246-258

Konar B, **Iken K** (2018) The use of unmanned aerial vehicle imagery in intertidal monitoring. *Deep-Sea Research II* 147: 79-86; https://doi.org/10.1016/j.dsr2.2017.04.010

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. https://doi.org/10.1007/s12237-013-9668-2

Education:

University of Düsseldorf, Germany	Biology	B.S. 1987
University of Bayreuth, Germany	Ecology	M.S. 1991
Alfred Wegener Institute for Polar and Marine Research, Germany	Polar Ecology	Ph.D. 1995

Collaborations:

Amsler, Charles (University of Alabama at Birmingham), Archambault, Philippe (Laval University, Canada), Ashjian, Carin (WHOI), Ballachey, Brenda (USGS), Belanger, Simon (Université du Québec à Rimouski), Blicher, Martin (Greenland Institute of Natural Resources), Bluhm, Bodil (University of Tromso Norway), Bodkin, James (USGS), Chavez, Francisco (MBARI), Coletti, Heather (NPS), Collins, R. Eric (University of Manitoba), Cooper, Lee (University of Maryland Center for Environmental Science), Crump, Byron (Oregon State University), Danielson, Seth (UAF), Dean, Tom (Coastal Resources Associates, CA), Denisenko, Nina (Russian Academy of Sciences, St. Petersburg, Russia), Duffy, J. Emmett (Smithsonian Institute), Dunton, Ken (University of Texas), Esler, Dan (USGS), Galloway, Aaron (University of Oregon), Galaska, Matt (NOAA), Grebmeier, Jacqueline (University of Maryland Center for Environmental Science), Hardison, Amber (Virginia Institute of Marine Science), Hondolero, Dominic (NOAA), Holderied, Kris (NOAA), Hopcroft, Russ (UAF), Kavanaugh, Maria (Oregon State University), Masakazu, Hori (Fisheries Research Agency, Japan), Mundy, CJ (University of Manitoba), Miller, Robert (University of California Santa Barbara), Montes, Enrique (University of South Florida), Mueller Karger, Frank (University of South Florida), Jorgensen, Lis Lindal (Institute of Marine Research Tromso, Norway), Kasper, Jeremy (UAF), Kedra, Monica (Polish Academy of Sciences, Poland), Klein, Andrew (Texas A&M), Konar, Brenda (UAF), Kuletz, Kathy (USFWS), Lindeberg, Mandy (NOAA), Logerwell, Libby (NOAA), Lougheed, Vanessa (University of Texas El Paso), McClelland, Jim (University of Texas), McClintock, Jim (University of Alabama at Birmingham), McMeans, Bailey (University of Toronto), Monson, Dan (USGS), Mueter, Franz (UAF), Nakaoka, Masahiro (Hokkaido University, Japan), Pister, Benjamin (NPS), Poste, Amanda (Norwegian Institute for Water Research), Rawlins, Michael (University of Massachusetts), Roy, Virginie (Canadian Museum of Nature, Canada), Ruesink, Jennifer (University of Washington), Runge, Jeffrey (University of Maine), Saupe, Sue (CIRCAC), Sejr, Mikael (University of Aarhus, Denmark), Soreide, Janne (UNIS, Norway), Spitz, Yvette (Oregon State University), Stafford, Kate (University of Washington APL), Tweedie, Craigh (University of Texas at El Paso), Weitzman, Ben (NOAA), Von Biela, Vanessa (USGS), Weslawski, Jan Marcin (Institute of Oceanology Polish Academy of Sciences, Poland), Wooller, Matthew (UAF).

PRINCIPAL INVESTIGATOR: Nearshore Component
BRENDA KONAR

Professor and Associate Dean of Research
College of Fisheries and Ocean Sciences**,** University of Alaska Fairbanks
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Relevant Professional Experience

PI or Co-PI on multiple nearshore ecology projects, many of which are based in Kachemak Bay. Mentor of 24 past and 7 current MS and PhD students, many of which have worked on nearshore projects in Kachemak Bay.

Appointments:

2014 – Pres. Associate Dean, College of Fisheries and Ocean Sciences (CFOS), University of Alaska Fairbanks (UAF)
2012 – 2014 Academic Program Head, Graduate Program Marine Sciences & Limnology, UAF
2009 – Pres. Professor, CFOS, UAF
2004 – 2009 Associate Professor. CFOS, UAF
2000 – 2004 Assistant Professor, CFOS, UAF
1999 – 2000 Research Assistant Professor, CFOS, UAF

10 Relevant Research Products:

Edwards M, **B Konar**, J-HKim, S Gabara, G Sullaway, TA McHugh, M Spector, and SL Small. 2020. Marine deforestation leads to widespread loss of ecosystem function. PLoS ONE 15:e0226173
Ulaski BP, **B Konar**, and EO Otis. 2020. Seaweed reproduction and harvest rebound in southcentral Alaska: implications for wild stock management. In Press in Estuaries and Coasts 43: 2046-2062.
Konar B, TJ Mitchell, K Iken, H Coletti, T Dean, D Esler, M Lindeberg, B Pister, and B Weitzman. 2019. Wasting disease and static environmental variables drive sea star assemblages in the northern Gulf of Alaska. Journal of Experimental Marine Biology and Ecology 520.
Metzger JR, **B Konar**, and MS Edwards. 2019. Assessing a macroalgal foundation species: community variation with shifting algal assemblages. Marine Biology 166:156.
Lind AC and **B Konar**. 2017. Effects of abiotic stressors on kelp early life-history stages. Algae 32:223-233.
Traiger SB and **B Konar**. 2017. Supply and survival: glacial melt imposes limitations at the kelp microscopic life stage. Botanica Marina 60:603-617.
Konar B, K Iken, D Monson, and B Weitzman. 2016. Influence of static habitat attributes on local and regional rocky intertidal community structure. Estuaries and Coasts 39:1735-1745.
Traiger SB, **B Konar**, A Doroff, and L McCaslin. 2016. Sea otters versus sea stars as major clam predators: evidence from foraging pits and shell litter. Marine Ecology Progress Series 560:73-86.
Stewart N, **B Konar**, and 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.
Konar B, K Iken, M Edwards. 2009. Depth-stratified community zonation patterns on Gulf of Alaska rocky shores. Marine Ecology 30:63-73

5 Other Significant Publications:

Rasher DB, RS Steneck, J Halfar, KJ Kroeker, JB Ries, MT Tinker, PT Chan, J Fietzke, NA Kamenos, **BH Konar**, and JS Lefcheck. 2020. Keystone predators govern the pathway and pace of climate impacts in a subarctic marine ecosystem. Science 369:1351-1354.

Edwards MS and **B Konar**. 2020. Trophic downgrading reduces spatial variability on rocky reefs. Scientific Reports 10:1-12.

Gabara SS, BP Weitzman, **BH Konar**, and MS Edwards. 2020. Macroalgal defense phenotype correlates with herbivore abundance. Marine Biology, 167:1-12.

Gabara SS, BP Weitzman, **BH Konar**, and MS Edwards. 2020. Macroalgal defense phenotype correlates with herbivore abundance. Marine Biology 167:1-12.

Krumhansl KA, DK Okamoto, A Rassweiler, M Novak, JJ Bolton, KC Cavanaugh, SD Connell, CR Johnson, **B Konar**, et al. 2016. Global patterns of kelp forest change over the past half-century. PNAS 29:13785-13790.

Education:

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, CA	Biology	Ph.D. 1998

Collaborations:

Ballachey, Brenda (USGS), Benedetti-Cecci, Lisandro (University of Pisa, Italy), Bodkin, James (USGS), Byrnes, Jarrett (University of Massachusetts, Boston), Carr, Mark (University of California, Santa Cruz), Coletti, Heather (NPS), Connell, Sean (The University of Adelaide), Dunton, Ken (University of Texas), Edwards, Matt (San Diego State University), Esler, Dan (USGS), Estes, James (University of California, Santa Cruz), Holderied, Kris (NOAA), Iken, Katrin (UAF), Johnson, Craig (University of Tasmania, Hobert, Australia), Kelley, Amanda (UAF), Kenner, Michael (University of California, Santa Cruz), Krumhansl, Kira (Simon Fraser University), Lindeberg, Mandy (NOAA), Ling, Scott (University of Tasmania, Hobert, Australia), McTeague, Nathan (University of Texas), Micheli, Fiorenza (Stanford University), Miloslavich, Patricia (Simon Bolivar University, Venezuela), Monson, Dan (USGS), Munk LeeAnn (University of Alaska Anchorage), Norderhaug, Kjell (Norwegian Institute for Water Research), Perez-Matus, Alejandro (Universidad de Los Lagos, Chile), Rasher, Doug (Bigelow Laboratory), Reed, Dan (University of California, Santa Barbara), Saupe, Sue (CIRCAC), Schonberg, Susan (University of Texas), Schram, Julie (University of Alaska Southeast), Steneck, Robert (University of Maine), Tinker, Tim (University of California, Santa Cruz), Umanzor, Schery (UAF), Veasey, Pips (UAF), Wernberg, Thomas (University of Western Australia, Australia)

Principal Investigator: Nearshore Component
BRENDA E. BALLACHEY

Scientist Emeritus, U.S. Geological Survey, Alaska Science Center
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403.397.3073

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 Science Center, USGS, Anchorage, AK; *2015*, ongoing.
Board Member, Alberta Environmental Appeals Board & Public Lands Appeal Board, *2016*, ongoing.
Research Physiologist, Alaska Biological Science Center, USGS, Anchorage, AK, *1990-2015.*
General Biologist, Alaska Fish and Wildlife Research Center, USFWS, Anchorage, AK, *1989-1990.*
Staff Officer, Board on Agriculture, National Research Council, Washington, DC, USA, *1987-1989*.
Research Associate, Department of Chemistry, South Dakota State University, *1986-1987*.

SELECTED PUBLICATIONS

Bowen, L., Counihan, K.L., Ballachey, B., Coletti, H., Hollmen, T., Pister, B., & Wilson, T.L. 2020. Monitoring nearshore ecosystem health using Pacific razor clams (*Siliqua patula*) as an indicator species. PeerJ, 8, e8761.

Counihan, K.L., Bowen, L., Ballachey, B., Coletti, H., Hollmen, T., Pister, B., & Wilson, T.L. 2019. Physiological and gene transcription assays to assess responses of mussels to environmental changes. PeerJ, 7, e7800.

Bodkin, J.L., Coletti, H.A., Ballachey, B.E., Monson, D.H., Esler, D., & Dean, T.A. 2018. Variation in abundance of Pacific blue mussel (*Mytilus trossulus*) in the Northern Gulf of Alaska, 2006–2015. Deep Sea Research Part II: Topical Studies in Oceanography 147, 87-97.

Bowen, L., Miles, A.K., Ballachey, B., Waters, S., Bodkin, J., Lindeberg, M., & Esler, D. 2018. Gene transcription patterns in response to low level petroleum contaminants in *Mytilus trossulus* from field sites and harbors in southcentral Alaska. Deep Sea Research Part II: Topical Studies in Oceanography 147, 27-35.

Esler, D., Ballachey, B.E., Matkin, C., Cushing, D., Kaler, R., Bodkin, J., Monson, D., Esslinger, G., and Kloecker, K. 2018. Timelines and mechanisms of wildlife population recovery following the *Exxon Valdez* oil spill. Deep Sea Research Part II: Topical Studies in Oceanography 147, 36-42.

Esler, D., Ballachey, B. E., Bowen, L., Miles, A. K., Dickson, R. D., & Henderson, J. D. 2017. Cessation of oil exposure in harlequin ducks after the *Exxon Valdez* oil spill: Cytochrome P4501A biomarker evidence. Environmental Toxicology and Chemistry 36(5), 1294-1300.

Bowen, L., A.K. Miles, B. Ballachey, S. Waters and J. Bodkin. 2016. 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., Bodkin, J. L., Monson, D. H., Ballachey, B. E., & Dean, T. A. 2016. Detecting and inferring cause of change in an Alaska nearshore marine ecosystem. *Ecosphere*, *7*(10), e01489.

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, NOAA. (Note: full listing of Gulf Watch Alaska PI's not given here; available upon request).

Principal Investigator: Nearshore Component
JAMES L. BODKIN

Scientist Emeritus, US Geological Survey, Alaska Science Center
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Relevant Professional Experience:

Leader, Nearshore Marine Ecosystems Research Program of the Alaska Science Center, USGS. My program conducted studies to document and understand underlying causes of change in nearshore marine systems (1990-2012).

Currently marine biological consultant, JL Bodkin Consulting

Most relevant publications

Bodkin, J., Heather A. Coletti, Brenda E. Ballachey, Daniel H. Monson, Daniel Esler and Thomas A. Dean. 2018. Variation in Abundance of Pacific Blue Mussel (*Mytilus trossulus*) in the Northern Gulf of Alaska, 2006-2015. Deep Sea Research II, 147:87-97. https://doi.org/10.1016/j.dsr2.2017.04.008

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Bodkin, J.L., D.H. Monson, and G.G. Esslinger. 2007. Population status and activity budgets derived from time-depth recorders in a diving mammal. J. Wildlife Management 71(6):2034-2044.

Peterson, C.H., S.D. Rice, J.W. Short, D. Esler, **J.L. Bodkin**, B.E. Ballachey, 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, A.K. Fukuyama, S.C. Jewett, L.M. McDonald, D.H.Monson, C.E. O'Clair and G.R. VanBlaricom. 2002. Sea otter population status and the process of recovery from the *Exxon Valdez* oil spill. Marine Ecology Progress Series. 241:237-253.

Bodkin, J.L., B.E. Ballachey, M.A. Cronin and K.T. Scribner. 1999. Population demographics and genetic diversity in remnant and re-established populations of sea otters. Conservation Biology 13(6):1278-1385.

Other significant publications

Bowen, L, K.A. Miles, B.E. Ballachey, S. Waters, **J.L. Bodkin**, M. Lindeberg and D.E. Esler. 2018. Gene transcription patterns in response to low level petroleum contaminants in *Mytilus* *trossulus* from field sites and harbors in southcentral Alaska. Deep Sea Research II. https://doi.org/10.1016/j.dsr2.2017.08.007

Dean, T.A**., J.L. Bodkin**, A.K. Fukuyama, S.C. Jewett, D.H. Monson, C.E. O'Clair, and G.R. VanBlaricom. 2002. Food limitation and the recovery of sea otters in Prince William Sound. Marine Ecology Progress Series. 241:255-270.

Bodkin, J.L., B.E. Ballachey, T.A. Dean, A.K. Fukuyama, S.C. Jewett, L.M. McDonald, D.H.Monson, C.E. O'Clair and G.R. VanBlaricom. 2002. Sea otter population status and the process of recovery from the *Exxon Valdez* oil spill. Marine Ecology Progress Series. 241:237-253.

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Education

B.S. 1976 Biology, California State University Long Beach

MSc 1985 Wildlife Biology, Cal Poly San Luis Obispo

Collaborators

Ballachey, Brenda (USGS), Bowen, Liz (USGS), Coletti, Heather (NPS), Davis, Randall (Texas A & M), Dean, Tom (Coastal Resources), Estes, James (UC Santa Cruz), Esler, Daniel (USGS), Katrin Iken (University of Alaska Fairbanks), Konar, Brenda (University of Alaska Fairbanks), Larson, Shawn (Seattle Aquarium, Lindeberg, Mandy (NOAA), Miles, Keith (USGS), Monson, Daniel (USGS), Murray, Michael (Monterey Bay Aquarium), Piatt, John (USGS), Suryan, Robert (NOAA), Tinker, Tim (Enhydra Research),Von Biela, Vanessa (USGS).

PRINCIPAL INVESTIGATOR: Nearshore Component
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RELEVANT PROFESSIONAL EXPERIENCE

Wildlife Biologist, Nearshore Marine Ecosystem Research Program, Alaska Science Center, USGS. My research has centered around sea otters and learning how they interact with nearshore marine ecosystems (April 1993-present).

MOST RELEVANT PUBLICATIONS

Tinker, M.T., J.L. Bodkin, L. Bowen, B.E. Ballachey, G. Bentrall, A. Burdin, H.A. Coletti, **G.G. Esslinger**, B. Hatfield, M. Kenner, K. Kloecker, B. Konar, A. Miles, D.H. Monson, M. Murray, B.P. Weitzman, J. Estes. In press. Sea otter population collapse in southwest Alaska: assessing ecological covariates, consequences and causal factors. Ecological Monographs.

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OTHER SIGNIFICANT PUBLICATIONS

Womble, J.N., P.J. Williams, X. Lu, L.F. Taylor, and **G.G. Esslinger**. 2020. Spatio-temporal abundance of sea otters in Glacier Bay National Park from 1993 to 2018. Natural Resource Data Series NPS/SEAN/NRDS-2020/1283. National Park Service. Fort Collins, Colorado.

Tinker, M.T., V. Gill, **G.G. Esslinger**, J.L. Bodkin, M. Monk, M. Mangel, D.H. Monson, W.W. Raymond, M. Kissling. 2019. Trends and carrying capacity of sea otters in southeast Alaska. Journal of Wildlife Management 83:1073-1089.

Garlich-Miller, J., **G.G. Esslinger**, B.P. Weitzman. 2018. Aerial surveys of sea otters (*Enhydra lutris*) in lower Cook Inlet. U.S. Fish and Wildlife Service Report, Anchorage, AK.

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

EDUCATION

2011 - Master of Science, Biological Sciences, University of Alaska, Anchorage, AK

1993 - Bachelor of Science, Wildlife, Humboldt State University, Arcata, CA

COLLABORATIONS

Ballachey, Brenda (USGS-emeritus), Beatty, William (USFWS), Bodkin, James (USGS-emeritus), Bower, Mike (NPS), Coletti, Heather (NPS), Eisaguirre, Joe (USFWS), Estes, James (University of California Santa Cruz), Garlich-Miller, Joel (USFWS), Kenner, Mike (USGS), Kissling, Michelle (USFWS), Kloecker, Kim (USGS), Mevin Hooten (USGS/Colorado State University), Monson, Dan (USGS), Murray, Mike (Monterey Bay Aquarium), Clint Leach (Colorado State University), Schuette, Paul (USFWS), St. Martin, Michelle (USFWS), Taylor, Rebecca (USGS), Tinker, Tim (USGS/University of California Santa Cruz), Tomoleoni, Joe (USGS), Weitzman, Ben (NOAA), Williams, Perry (Colorado State University/University of Nevada Reno), Womble, Jamie (NPS)

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I have directly participated in the capture of more than 550 sea otters over the past 20 years. Captures have taken place in California, British Columbia, Southeast Alaska, Prince William Sound, Kachemak Bay, and the Alaska Peninsula. My duties on these trips range from net tending, diver tending, assisting the veterinarian, otter handling, sample collection, sample processing, and data management. I have also worked with others to train personnel new to sea otter captures.

Professional Experience

1998 – Present Biologist, USGS, Alaska Science Center, Anchorage, AK 1996 – 1998 Ecologist, USGS, Alaska Biological Science Center, Anchorage, AK 1993 – 1995 Peace Corps Volunteer, U.S. Peace Corps, Fiji

1991 – 1993 Tech, U.S. Fish & Wildlife Service, Santa Cruz, CA, Anchorage, AK

1992 – 1992 Specialist, R/V Nathaniel B. Palmer Weddell Sea, Antarctica

Education

Master of Science in Marine Sciences 1993

University of California, Santa Cruz, California

*Bachelor of Scienc*e in Biological Science 1989

Michigan State University, E. Lansing, Michigan

Representative Publications and Technical Reports

Coletti, H., D. Esler, B. Ballachey, J. Bodkin, G. Esslinger, **K. Kloecker**, D. Monson, B. Robinson, B. Weitzman, T. Dean, and M. Lindeberg. 2018. Gulf Watch Alaska: Nearshore benthic systems in the Gulf of Alaska. Long-Term Monitoring Program (Gulf Watch Alaska) Final Report (*Exxon Valdez* Oil Spill Trustee Council Project 16120114-R). *Exxon Valdez* Oil Spill Trustee Council. Anchorage, Alaska

Esler, D., Ballachey, B.E., Matkin, C., Cushing, D., Kaler, R., Bodkin, J., Monson, D., Esslinger, G., **Kloecker, K.,** 2017. Timelines and mechanisms of wildlife population recovery following the *Exxon Valdez* oil spill. Deep-Sea Research Part II. DOI:10.1016/j.dsr2.2017.04.007.

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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.

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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. doi: 10.3354/meps09523.

Bodkin, J. L., B. E. Ballachey, **K. A. Kloecker**, G. G. Esslinger, D. H. Monson, 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. USGS Scientific Investigations Report 2007-5047, 246 pp.

Bodkin, J. L., B. E. Ballachey, **K. A. Kloecker**, G. G. Esslinger, D. H. Monson, H. A. Coletti and J. A. Estes. 2004. Sea Otter Studies in Glacier Bay. Annual Report 2003. USGS Alaska Science Center, Anchorage AK.

Ballachey, B. E. and **K. A. Kloecker**. 1997. EVOS State/Federal NRDA Final Reports, USFWS, Anchorage, AK.

- 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.

Other Reports

Kloecker, K. A. 2007-2019. Annual Permit Report--PRT MA067925-1 Activities conducted in 2006-2018. Report to FWS Department of Management Authority.

Kloecker, K. A. 2007. Standard Operating procedure: Sea Otter Capture, Routine Sampling, and Routine Surgery with Chemical Immobilization. USGS Alaska Science Center SOP.

Kloecker, K. A. 2007. Standard Operating procedure: Sea Otter Plasma Volume Determination. USGS Alaska Science Center SOP.

Collaborators

USGS/USGS Emeritus: Daniel Esler, Brenda Ballachey, James Bodkin, Daniel Monson, George Esslinger, Joseph Tomoleoni, Mike Kenner, Lizbeth Bowen, Brian Hatfield, Sandy Talbot; NPS: Heather Coletti, Jamie Womble; FWS: Lilian Carswell, Michelle St. Martin, William Beatty, Brad Benter; NOAA: Benjamin Weitzman, Mandy Lindeberg, Gary Shigenaka, Chris Holdereid; Academic/ Private/NGO: M. Tim Tinker, Jennifer Burns, Michelle Staedler, Michael Murray, Erin Rechsteiner, Pam Tuomi, Carrie Goertz, Shawn Larson, Amy Olsen, Caroline Hempsted

Principal Investigator: Nearshore Component
MANDY R. LINDEBERG

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RELEVANT PROFESSIONAL EXPERIENCE

Long-Term Marine Ecosystem Monitoring (2011 - Present): Currently providing leadership to the Gulf Watch Alaska (GWA) Program as Program Lead to 28 principal investigators (2017-21). Previous roles included GWA Pelagic Component Lead (2013-16), GWA co-Principal Investigator for the Nearshore Component (2011-21), and GWA co-Principal Investigator for the Lingering Oil Component (2011-21). In leading the Gulf Watch Alaska program during the past four years, the program has thrived producing: 24 key ecosystem indicators to resource managers (NPFMC) on an annual basis, 63 peer reviewed journal publications, 45 published datasets, 81 scientific reports, over 250 presentations at professional conferences, and a diversity of outreach efforts (e.g. website, newsletters, agency social media, and traditional ecological knowledge exchange with remote spill-affected communities).

Oil Spill Research in the marine environment (1990 - Present): Extensive experience with oil spill research for over 30 years. Research includes investigations of damage assessment, recovery of injured resources, long-term ecosystem monitoring of nearshore flora and fauna, and lingering *Exxon Valdez* oil in the marine environment. Also participated in the injury assessment of the Deepwater Horizon oil spill under NRDA's Submerged Aquatic Vegetation TWIG. Recently, a collaborator in a four-year assessment for BOEM in a NEPA analysis associated with the Oil & Gas Leasing Program in Cook Inlet (2015-18).

Coastal Habitat Mapping (2004 - Present): A core steering committee member for over 17 years and lead biologist for the successful Alaska *ShoreZone* coastal habitat mapping project and online tools for agencies, educators, and the public.

Essential Fish Habitat (2005 - Present): Conducting research on essential fish habitat under the Magnuson-Stevens Act, focusing on nearshore marine forage fish and promoting the development of online tools for a statewide catch database (Alaska Nearshore Fish Atlas).

Specialized Expertise (1990 - present): Scientific expertise lies with coastal ecology, specializing in the taxonomy and ecology of seaweeds throughout Alaska's coastal regions. Author of two popular books: *A Field Guide to Seaweeds of Alaska* and co-author of *A Handy Field Guide to Nearshore Fishes of Alaska*.

MOST RELEVANT PUBLICATIONS

Aderhold, D. G. R, M. R. **Lindeberg**, K. Holderied, and S.W. Pegau. 2018. Introduction: Spatial and temporal ecological variability in the northern Gulf of Alaska: What have we learned since the *Exxon Valdez* oil spill? Deep-Sea Research Part II Special Issue. doi:10.1016/j.dsr2.2017.11.015.

Bowen, L., B. Ballachey, A. K. Miles, J. Bodkin, M. **Lindeberg**, and D. Esler. 2018. Mussels and Oil: Gene transcription patterns as a new approach for evaluation of injury and recovery following the *Exxon Valdez* oil spill. Deep Sea Research II Special Issue. http://www.sciencedirect.com/science/article/pii/S0967064516302855.

Konar, B., T. J. Mitchell, K. Iken, H. Coletti, T. Dean, D. Esler, M. **Lindeberg**, B. Pister, B. Weitzman. 2019. Wasting disease and static environmental variables drive sea star assemblages in the Northern Gulf of Alaska. JEMBE. Vol. 520. ISSN 0022-0981. https://doi.org/10.1016/j.jembe.2019.151209.

Lindeberg, M. R., J. Maselko, C. Fugate, L. Holland, and M. G. Carls. 2017. Persistent *Exxon Valdez* oil on beaches in Prince William Sound 26 years later. Deep Sea Research II Special Issue. http://www.sciencedirect.com/science/article/pii/S0967064516304234.

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.

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**, P. M. Harris, J. Maselko, J. 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.

Suryan, R. M., M. Arimitsu, H. Coletti, R. R. Hopcroft, M. R. **Lindeberg**, S. Batten, M. A. Bishop, R. Brenner, R. Campbell, D. Cushing, S. Danielson, D. Esler, T. Gelatt, S. Hatch, S. Haught, K. Holderied, K. Iken, D. Irons, D. Kimmel, B. Konar, K. Kuletz, B. Laurel, J.M. Maniscalco, C. Matkin, C. McKinstry, D. Monson, J. Moran, D. Olsen, S. Pegau, J. Piatt, L. Rogers, A. Schaefer, J. Straley, K. Seeeney, M. Szymkowiak, B. Weitzman, J. Bodkin, and S. Zador. *In review*. Ecosystem response to a prolonged marine heatwave in the Gulf of Alaska. Scientific Reports.

Weitzman, B., B. Konar, K. Iken, H. Coletti, D. Monson, R.M. Suryan, T. Dean, D. Hondolero, and M.R. **Lindeberg**. *In review*. Changes in rocky intertidal community structure during a marine heatwave in the northern Gulf of Alaska. Frontiers in Marine Science.

OTHER SIGNIFICANT PUBLICATIONS

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.

Lindeberg, M. R. and S. C. Lindstrom. 2019. Assessment and Catalog of Benthic Marine Algae from the Alaska Peninsula, May 2016. U. S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-389, 501p.

Lindeberg, M. R. and S. C. Lindstrom. 2015. Field Guide to Seaweeds of Alaska. *Updated and reprinted*. Fairbanks, Alaska: Alaska Sea Grant College Program. University of Alaska Fairbanks. 188 p. ISBN 978-1-56612-156-9. doi.10.4027.fgsa.2010.

EDUCATION

B.S. 1989, Marine Biology, Western Washington University, Bellingham, Washington.

COLLABORATIONS

Apeti, Dennis (NOAA NOS); Coletti, Heather (NPS); Coon, Catherine (BOEM); Iken, Katrin (UAF); Jones, Tahzay (NPS); Konar, Brenda (UAF); Lewis, Steve (Alaska Regional Office, NMFS); Lindstrom, Sandra (UBC); Pister, Benjamin (NPS); Saupe, Sue (Cook Inlet RCAC); Stickle, William (LSU); Weitzman, Ben (NOAA NOS).

PRINCIPAL INVESTIGATOR: Nearshore Component
DANIEL MONSON

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RELEVANT PROFESSIONAL EXPERIENCE

I serve as the sea otter research lead within the Nearshore Marine Ecosystem Research Program of the Alaska Science Center where I have three decades of experience conducting multi-disciplinary research on sea otters and their nearshore environment. Over much of that time I have focused on developing metrics of sea otter population status, which provide important insights into the health and function of nearshore systems. In addition, I am a PI for the Nearshore component within the Gulf Watch Alaska Program (https://gulfwatchalaska.org/) where I focus on understanding natural and anthropogenic factors affecting nearshore ecosystems that will be critical for ecosystem-based management of these resources and inform managers on the current and future state of this valuable ecosystem.

MOST RELEVANT PUBLICATIONS

Tinker, M.T., J.L. Bodkin, L. Bowen, B. Ballachey, G. Bentall, A. Burdin, H. Coletti, G. Esslinger, B.B. Hatfield, M.C. Kenner, K. Kloecker, B. Konar, A.K. Miles, **D.H. Monson**, M J. Murray, B. Weitzman, and J.A. Estes. In press. Sea otter population collapse in southwest Alaska: assessing ecological covariates, consequences, and causal factors. Ecological Monographs.

Weitzman B, B. Konar, K. Iken, H. Coletti, **D. Monson**, R. Suryan, T. Dean, D. Hondolero and M. Lindeberg. 2021. Changes in Rocky Intertidal Community Structure During a Marine Heatwave in the Northern Gulf of Alaska. Front. Mar. Sci. 8:556820. doi: 10.3389/fmars.2021.556820.

Tinker, M. T., V. Gill, G.G. Esslinger, J.B. Bodkin, M. Monk, M. Mangel, **D.H. Monson**, W.W. Raymond and M.L. Kissling. 2019. Trends and Carrying Capacity of Sea Otters in Southeast Alaska. Journal of Wildlife Management. 83:1073-1089.

Bodkin, J., H. Coletti, B. Ballachey, **D. Monson**, D. Esler, T. Dean. 2017. Variation in Abundance of Pacific Blue Mussel (*Mytilus trossulus*) in the Northern Gulf of Alaska, 2006-2015. Deep-Sea Research II Topical Studies in Oceanography DOI:10.1016/j.dsr2.2017.04.008.

Esler, D., B.E. Ballachey, C. Matkin, D. Cushing, R. Kaler, J. Bodkin, **D. Monson**, G. Esslinger, K. Kloecker. 2017. Timelines and Mechanisms of Wildlife Population Recovery Following the *Exxon Valdez* Oil Spill. Deep-Sea Research II Topical Studies in Oceanography DOI:10.1016/j.dsr2.2017.04.007.

Coletti, H.A., J.L. Bodkin, **D.H. Monson**, B.E. Ballachey, T.A. Dean. 2016. Detecting and inferring cause of change in an Alaska nearshore marine ecosystem. Ecoshpere. 7: e01489-n/a.

Konar, B., K. Iken, H. Coletti, **D. Monson**, B. Weitzman. 2016. Influence of static habitat attributes on local and regional rocky intertidal community structure. Estuaries and Coasts. 39:1735-1745.

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.

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.

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? Ecological Applications 21:2917-2932.

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.

Bodkin, J.L., **D.H. Monson**, and G.G. Esslinger. 2007. Activity budgets derived from Time–Depth recorders in a diving mammal. J. Wildl. Manage. 71:2034-2044.

Laidre, K.L., J.A. Estes, M.T. Tinker, J. Bodkin, **D. Monson**, and K. Schneider. 2006. Patterns of growth and body condition in sea otters from the Aleutian archipelago before and after the recent population decline. J. of Animal Ecol. 75:978–989.

Bodkin, J.L., B.E. Ballachey, T.A. Dean, A.K. Fukuyama, S.C. Jewett, L. McDonald, **D.H. Monson**, C.E. O'Clair, and G.R. VanBlaricom. 2002. Sea otter population status and the process of recovery from the 1989 '*Exxon Valdez*' oil spill. Marine Ecology Progress 241:237-253.

Dean, T.A., J.L. Bodkin, A.K. Fukuyama, S.C. Jewett, **D.H. Monson**, C.E. O'Clair, and 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.

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.

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.

OTHER SIGNIFICANT PUBLICATIONS

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.

EDUCATION

2009 Ph.D. Ecol. & Evol. Biology. University of California Santa Cruz, Santa Cruz, CA, USA.

1995 M.Sc. Marine Science. University of California Santa Cruz, Santa Cruz, CA, USA.

1985 B.A. Biology. Luther College, Decorah, Iowa, USA.

COLLABORATIONS

Ballachey, Brenda (USGS-retired), Bodkin, James (USGS-retired), Bowen, Liz (USGS), Carswell Lilian (USFWS), Chinn, Sarah (University of California Santa Cruz), Coletti, Heather (NPS), Danielson, Seth (UAF), Davis, Randy (Texas A&M), Dean, Tom (Coastal Resources Inc.), Doak, Dan (Univsersity of Colorado, Boulder), Estes, James (University of California Santa Cruz), Iken, Katrin (UAF), Konar, Brenda (UAF), Hilderbrand, Grant, (NPS), Holderied, Kris (NOAA), Jones, Tahzay (NPS), Larson, Shawn (Seattle Aquarium), Lindeberg, Mandy (NOAA), Murray, Mike (Monterey Bay Aquarium), Newsome, Seth (University of New Mexico), Raymond, Rick (BOEM), Schuette, Paul (USFWS), Suryan, Rob (NOAA), Tinker, Tim (USGS/University of California Santa Cruz), Weitzman, Ben (NOAA), Womble, Jamie (NPS)

PRINCIPAL INVESTIGATOR: Nearshore Component
BRIAN ROBINSON

Wildlife Biologist
Nearshore Marine Ecosystem Research Program, Alaska Science Center-U.S. Geological Survey
4210 University Drive, Anchorage, Alaska 99508
(907) 786-7000, brobinson@usgs.gov

RELEVANT PROFESSIONAL EXPERIENCE

Wildlife Biologist, Nearshore Marine Ecosystems Research Program (NMERP) of the Alaska Science Center, USGS. Our program conducts studies to document and understand underlying causes of change in nearshore marine systems (2016 – present).

Research Assistantship, University of Alaska Fairbanks. Conducted research on the feeding ecology and survival of Black Oystercatchers in Southcentral Alaska, in collaboration with USGS and NPS (2013-2014).

MOST RELEVANT PUBLICATIONS

Coletti, H. A., Kloecker, K. A., **Robinson, B**., Esler, D. and Bodkin, J. L., 2017, Gulf Watch Alaska Nearshore Component: Black Oystercatcher Nest Density and Chick Diets Data from Prince William Sound, Katmai National Park and Preserve, and Kenai Fjords National Park, 2006-2016: U.S. Geological Survey data release, https://doi.org/10.5066/F7WH2N5Q.

Coletti, H., D. Esler, B. Konar, K. Iken, K. Kloecker, D. Monson, B. Weitzman, B. Ballachey, J. Bodkin, T. Dean, G. Esslinger, **B. Robinson**, and M. Lindeberg. 2019. Gulf Watch Alaska: Nearshore Ecosystems in the Gulf of Alaska. *Exxon Valdez* Oil Spill Restoration Project Annual Report (Restoration Project 18120114-H), *Exxon Valdez* Oil Spill Trustee Council, Anchorage, Alaska.

Coletti, H., J. Bodkin, T. Dean, D. Esler, K. Iken, B. Ballachey, K. Kloecker, B. Konar, M. Lindeberg, D. Monson, **B. Robinson**, R. Suryan and B. Weitzman. 2019 Intertidal Ecosystem Indicators in the Northern Gulf of Alaska in Zador, S. G., and E. M. Yasumiishi. 2019. Ecosystem Status Report 2019: Gulf of Alaska. Report to the North Pacific Fishery Management Council, 605 W 4th Ave, Suite 306, Anchorage, AK 99301.

Coletti, H., D. Esler, B. Konar, K. Iken, K. Kloecker, D. Monson, B. Weitzman, B. Ballachey, J. Bodkin, T. Dean, G. Esslinger, **B. Robinson**, and M. Lindeberg. 2019. Gulf Watch Alaska: Nearshore Ecosystems in the Gulf of Alaska. *Exxon Valdez* Oil Spill Restoration Project Annual Report (Restoration Project 18120114-H), *Exxon Valdez* Oil Spill Trustee Council, Anchorage, Alaska.

Esslinger, G. G., **B. H. Robinson**, D. H. Monson, D. Esler, B. P. Weitzman, and J. Garlich-Miller. Abundance and distribution of sea otters (*Enhydra lutris*) in the Southcentral Alaska stock, 2014, 207, and 2019. USGS Open File Report. *In Prep.*

Robinson, B.H., H. A. Coletti, L. M. Phillips, and A.N. Powell. 2018. Are prey remains accurate indicators of chick diet? A comparison of diet quantification techniques for Black Oystercatchers. Wader Study 125(1): 20-32. doi:10.18194/ws.00105. http://www.waderstudygroup.org/article/10823/

OTHER SIGNIFICANT PUBLICATIONS

Robinson, B. H., L. M. Phillips, and A. N. Powell. 2019. Energy intake rate influences survival of Black Oystercatcher *Haematopus bachmani* broods. Marine Ornithology 47: 277–283

EDUCATION

2016 M.Sc. Wildlife Biology and Conservation. University of Alaska Fairbanks, Fairbanks, Alaska, USA.

2010 B.Sc. Wildlife: Conservation Biology and Applied Vertebrate Ecology. Humboldt State University, Arcata, CA, USA.

COLLABORATIONS

Ballachey, Brenda (USGS-retired), Bodkin, James (USGS-retired), Bowen, Liz (USGS), Coletti, Heather (NPS), Green, David (Simon Fraser University), Hollmen, Tuula (UAF/Alaska SeaLife Center), Iken, Katrin (UAF), Konar, Brenda (UAF), Kurtz, Deborah (NPS), Lindeberg, Mandy (NOAA), Mearn, Alan (NOAA-retired), Phillips, Laura (NPS), Powell, Abby (FSU), Rankin, Cole (Simon Fraser University), Weitzman, Ben (NOAA), Ware, Lena (Simon Fraser University)

PRINCIPAL INVESTIGATOR: Nearshore Component

SARAH B. TRAIGER

U. S. Geological Survey phone: (323) 369-5488
1910 Alex Holden Way email: straiger@usgs.gov
Juneau, AK 99801 website: sites.google.com/view/sarahtraiger/home

EDUCATION

2013 – 2017 Ph.D., Marine Biology, University of Alaska Fairbanks
2006 – 2010 B.S., Marine Biology, University of California, Santa Cruz

RELEVENT EXPERIENCE

2020 – Present Biologist, U. S. Geological Survey, Juneau, Alaska
2018 – 2020 Postdoctoral Researcher, California State University Northridge, Northridge, California
2017 NSF East Asia and Pacific Summer Institute Fellow
University of Auckland, Leigh Marine Research Laboratory, New Zealand
2012 – 2017 Graduate Research and Teaching Assistant, University of Alaska Fairbanks
2012 Aquatic Intern, Golden Gate National Recreation Area, San Francisco, California
2011 Student Conservation Association Intern, Channel Islands National Park, Ventura, California
2010 – 2011 Waterfront Research Intern, School for Field Studies Center for Marine Resource Studies, Turks and Caicos Islands
2009 NSF Research Experience for Undergraduates Intern, University of California Davis**,**
Bodega Marine Laboratory, Bodega, California
2008 Subtidal Intern, Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO), Santa Cruz, California
2007 Research Technician, Occidental College, Vantuna Research Group, Los Angeles, California

PUBLICATIONS

Hirsh HK, K Nickols, Y Takeshita, **SB Traiger**, DA Mucciarone, S Monismith, RB Dunbar (2020) Drivers of biogeochemical variability in a central California kelp forest and implications for local amelioration of ocean acidification. *Journal of Geophysical Research: Oceans* 125(11): e2020JC016320

Traiger SB (2019) Effects of elevated temperature and sedimentation on grazing rates of the green sea urchin: implications for top-down control in kelp forests exposed to increased sedimentation with climate change. *Helgoland Marine Research* 73:5 https://doi.org/10.1186/s10152-019-0526-x

Traiger SB, B Konar (2018) Mature and developing kelp bed community composition in a glacial estuary. *Journal of Experimental Marine Biology and Ecology* 501: 26-35 http://doi.org/10.1016/j.jembe.2017.12.016

Traiger SB, B Konar (2017) Supply and survival: glacial melt imposes limitations at the kelp microscopic life stage. *Botanica Marina* 60(6): 603-617 http://doi.org/10.1515/bot-2017-0039

Konar B, M Edwards, A Bland, J Metzger, A Ravelo, **SB Traiger**, B Weitzman (2017) A swath across the great divide: kelp forests across the Samalga Pass biogeographic break. *Continental Shelf Research* 143: 78-88 doi: http://dx.doi.org/10.1016/j.csr.2017.06.007 2

Traiger SB, B Konar, A Doroff, L McCaslin (2016) Sea otters versus sea stars as major clam predators: evidence from foraging pits and shell litter. *Marine Ecology-Progress Series* 560:73-86 doi: 10.3354/meps11871

Claydon JA, MC Calosso, **SB Traiger** (2012) Progression of invasive Lionfish in seagrass, mangrove and reef habitats. *Marine Ecology-Progress Series* 448:119-129 doi: 10.3354/meps09534

INVITED SEMINARS

2019 Occidental College, Los Angeles, California
2017 University of Auckland Leigh Marine Research Laboratory, Leigh, New Zealand
2013 Seldovia Public Library, Seldovia, Alaska

CONFERENCE PRESENTATIONS

2021 Oral, Alaska Marine Science Symposium, Virtual
2020 Oral, Western Society of Naturalists Meeting, Virtual
2020 Poster, Ocean Science Meeting, San Diego, California
2019 Oral, Western Society of Naturalists Meeting, Ensenada, Mexico
2018 Oral, Western Society of Naturalists Meeting, Tacoma, Washington
2017 Oral, Western Society of Naturalists Meeting, Pasadena, California
2017 Oral, Alaska Marine Science Symposium, Anchorage, Alaska *(Best PhD Student Oral)*
2016 Oral, Western Society of Naturalists Meeting, Monterey, California
2016 Poster, Alaska Marine Science Symposium, Anchorage, Alaska *(Best PhD Student Poster)*
2015 Oral, Kachemak Bay Science Conference, Homer, Alaska
2015 Poster, Alaska Marine Science Symposium, Anchorage, Alaska
2014 Oral, Western Society of Naturalists Meeting, Tacoma, Washington
2011 Oral, Western Society of Naturalists, Vancouver, Washington
2011 Poster, Gulf and Caribbean Fisheries Institute Conference, Puerto Morelos, Mexico
2010 Oral, Western Society of Naturalists Annual Meeting, Monterey, California

PROFESSIONAL SERVICE AND ORGANIZATIONS

Journal Article Peer Review:
Community Ecology
Limnology and Oceanography
Marine Biology
Journal of Experimental Marine Biology and Ecology
Journal of Phycology
2021 Panel member for "Changes in nearshore ecosystems and relevance to coastal communities in the Gulf of Alaska" at the Alaska Marine Science Symposium
2019 Cientifico Latino Graduate School Mentorship Initiative, Mentor
2019 Panel member for "Jobs in Academia" workshop hosted by the CSUN Marine Biology Graduate Student Association
2018 – 2020 Journal of Experimental Marine Biology and Ecology, Managing Editor
2019 – 2020 California State University Northridge Postdoctoral Association, Vice President
2019 – 2020 Graduate Women in Science, Member
2018 – 2020 Phycological Society of America, Member
2016 – 2017 University of Alaska Diving Control Board, Student Representative

COLLABORATIONS

Ballachey, Brenda (USGS), Bodkin, James (USGS), Coletti, Heather (NPS), Daly, Margaret (Stanford U), Dean, Tom (Coastal Resource Associates), Dunbar, Robert (Stanford U), Esler, Dan (USGS), Gravem, Sarah (OSU), Hirsh, Heidi (U Miami), Iken, Katrin (UAF), Lindeberg, Mandy (NOAA), Monismith, Stephen (Standford U), Monson, Dan (USGS), Mucciarone, David (Stanford U), Nickols, Kerry (CSUN), Suryan, Robert (NOAA), Takeshita, Yui (MBARI), Weitzman, Ben (NOAA)

PRINCIPAL INVESTIGATOR: Nearshore Component
BENJAMIN P. WEITZMAN

Wildlife Biologist
US Fish & Wildlife Service, Marine Mammals Management, Sea Otter Program
1011 E Tudor Rd. Anchorage, AK 99503, USA
(907) 205-8336; benjamin_weitzman@fws.gov

Relevant Professional Experience
Wildlife Biologist, US Fish & Wildlife Service, Marine Mammals Management, Sea Otter Program, Anchorage, AK
Duties focus on providing the best information possible for sea otter management decisions. Including leading dynamic projects, species stock assessments and status reports, compilation and synthesis of long-term data sets, public speaking/outreach on sea otters and coordinating intra- and inter-agency efforts. (April 2021-present)

Ecologist, NOAA, National Ocean Service, National Center for Coastal Ocean Science: Kasitsna Bay Laboratory, Homer, AK
Duties included compilation and synthesis of large data sets, public speaking/outreach on natural history and nearshore ecology, and coordination of collaborative intra- and inter-agency projects. (August 2019-April 2021)

Graduate Student Researcher, Biologist, & Wildlife Biologist, US Geological Survey: Alaska Science Center, Nearshore Marine Ecosystems Research Program, Anchorage, AK & USGS Western Ecological Resource Center, Santa Cruz, CA
Duties included conducting variety of specialized surveys of nearshore organisms in the North Pacific, data management and analysis in contribution to summaries, reports, and publications, public speaking/outreach and coordination of collaborative intra- and inter-agency projects and extensive field logistics. (April 2010 – August 2019)

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. (March 2008 – April 2010)

Relevant Publications
•**Weitzman, B**., Konar, B., Iken, K., Coletti, H., Monson, D., Suryan, R., Dean, T., Hondolero, D., and Lindeberg, M.. (2021) Changes in rocky intertidal community structure during a marine heatwave in the northern Gulf of Alaska. Frontiers in Marine Science 8:556820. doi: 10.3389/fmars.2021.556820
•Suryan, R., Arimitsu, Y., ..., **Weitzman, B**., ... 45 others (2021) Ecosystem response persists after a prolonged marine heatwave. Scientific Reports
•Konar B, Mitchell TJ, Iken K, Coletti H, Dean T, Esler D, Lindeberg M, Pister B, **Weitzman B.** (2019) Wasting disease and environmental variables drive sea star assemblages in the northern Gulf of Alaska. Journal of Experimental Marine Biology and Ecology. https://doi.org/10.1016/j.jembe.2019.151209
•Garlich-Miller, J., Esslinger, G., and **Weitzman, B.** (2018) Aerial surveys of sea otters (Enhydra lutris) in lower cook inlet, Alaska, May, 2017. USFWS Technical Report MMM 2018-01. U.S. Fish & Wildlife Service, Marine Mammals Management. Anchorage, AK
•**Weitzman, B.**, Bodkin, J., Kloecker, K., and Coletti, H. (2017) SOP for monitoring intertidal bivalves on mixed-sediment beaches — version 2.0: Southwest Alaska Inventory and Monitoring Network. Natural Resource Report NPS/SWAN/NRR—2017/1443. National Park Service, Fort Collins, Colorado.
•Konar B, Iken K, Coletti H, Monson D, **Weitzman B** (2016) Influence of static habitat attributes on local and regional rocky intertidal community structure. Estuaries and Coasts 39: 1735-1745. https://doi.org/10.1007/s12237-016-0114-0

Significant Publications

•Tinker, M.T., Bodkin, J., Bowen, L., Ballachey, B., Bentall, G., Burdin, A., Coletti, H., Esslinger, G., Hatfield, B., Kenner, M., Kloecker, K., Konar, B., Miles, A.K., Monson, D., Murray, M., **Weitzman, B**., and Estes, J. (2021) Sea otter population collapse in southwest Alaska: assessing ecological covariates, consequences, and causal factors. Ecological Monographs

•**Weitzman, B.**, and Konar, B. (2021) Biological correlates with sea urchin recruitment in kelp forest and sea urchin barren habitats. Marine Ecology Progress Series

•Rasher, D., Steneck, R., Halfar, J., Kroeker, K., Ries, J., Tinker, M.T., Chan, P., Fietzke, J., Kamenos, N., Konar, B., Lefcheck, J., Norley, C., **Weitzman, B.**, Westfield, I., and Estes, J. (2020) Climate Change Amplifies Trophic Cascades in a Kelp Forest Ecosystem. Science, 369(6509), pp.1351-1354. https://doi.org/10.1126/science.aav7515

•Gabara, S.S., **Weitzman, B.P.**, Konar, B.H. and Edwards, M.S. (2020) Macroalgal defense phenotype correlates with herbivore abundance. Marine Biology

•Tinker, M.T., Tomoleoni, J., **Weitzman, B.**, Staedler, M., Jessup, D., Murray, M.J., Miller, M., Burgess, T., Bowen, L., Miles, A.K. and Thometz, N. (2019) Southern sea otter (Enhydra lutris nereis) population biology at Big Sur and Monterey, California--Investigating the consequences of resource abundance and anthropogenic stressors for sea otter recovery (No. 2019-1022). US Geological Survey.

Education

2015-2020 Ph.D. Marine Biology, University of Alaska Fairbanks
2010-2013 M.A. Ecology & Evolutionary Biology, University of California Santa Cruz
2004-2008 B.Sc. Marine Biology, University of California Santa Cruz

Collaborators

Ballachey, Brenda (USGS), Bodkin, James (USGS), Bowen, Lizbeth (USGS), Cate, Jenipher (USFWS), Coletti, Heather (NPS), Cummings, Caroline (USFWS), Dean, Tom (Coastal Resource Associates), Edwards, Matt (SDSU), Esler, Dan (USGS),Esslinger, George (USGS), Estes, James (UCSC), Gabara, Scott (UAF) Garlich-Miller, Joel (USFWS), Holderied, Kris (NOAA), Hondolero, Dominic (NOAA), Iken, Katrin (UAF), Kenner, Michael (UC Santa Cruz), Kloecker, Kim (USGS), Kroeker, Kristy (UCSC) Lindeberg, Mandy (NOAA), Monson, Dan (USGS), Pister, Benjamin (NPS), Rasher, Doug (Bigelow Laboratory), Ries, Justin (Northeastern University), Schuette, Paul (USFWS), Steneck, Robert (University of Maine), Suryan, Robert (NOAA), Tinker, Tim (UCSC/Nyhdra), Tomoleoni, Joseph (USGS), Traiger, Sarah (USGS), Westfield, Isaac (Northeastern University)

United States Department of the Interior

NATIONAL PARK SERVICE
Inventory & Monitoring Program - Southwest Alaska Network
240 West 5th Avenue
Anchorage, Alaska 99501

Date: 21 July 2021

To: Mandy Lindeberg - NOAA, GWA-LTRM Program Lead
Shiway Wang, EVOSTC Executive Director

Re: Letter of Commitment

We are pleased to provide this letter of commitment for the proposed project "Nearshore Ecosystems in the Gulf of Alaska, 22120114-H" led by principal investigator (PI), Coletti. This proposal was drafted by the PI in response to the EVOSTC's FY22-31 Invitation for Proposals and subsequent request for final submission on August 13, 2021. The cost for this project over a ten-year period will be $5,959,969 (without EVOSTC GA). This includes some non-EVOSTC funds that are in-kind contributions we (NPS) support totaling an estimated $3,351,875 for the life of the project (e.g., salaries of permanent staff, field travel, contracts, commodities, and equipment use).

This project proposal is part of the larger multi-agency Gulf Watch Alaska Long-Term Research and Monitoring (GWA-LTRM) program proposal package. This package represents a continued commitment of the successful long-term research and monitoring projects supported by the EVOSTC and various agencies and organizational investments since 2006.

NPS funds included as in-kind or as contributions are included for planning purposes only and nothing contained in this proposal shall be construed as binding NPS to expend in any one fiscal year any sum in excess of its appropriations, or funding in excess of what it has received for the collaborative work outlined in this proposal, unless otherwise allowed by law.

Sincerely,

Amy Miller, PhD
Supervisory Ecologist/SWAN Program Manager
Authorized Representative of NPS
amy_e_miller@nps.gov; (907) 644-3683

United States Department of the Interior
U.S. GEOLOGICAL SURVEY
ALASKA SCIENCE CENTER
4210 University Dr.
Anchorage, Alaska 99508

July 23, 2021

To: Mandy Lindeberg - NOAA, GWA-LTRM Program Lead
Shiway Wang, EVOSTC Executive Director

Re: Letter of Commitment

We are pleased to provide this letter of commitment for the proposed project "22120114-H Nearshore Ecosystems in the Gulf of Alaska", which is a collaborative, multi-partner program that includes USGS principal investigators (PIs) Dan Esler, Brenda Ballachey (emeritus), Jim Bodkin (emeritus), George Esslinger, Kim Kloecker, Dan Monson, Brian Robinson, and Sarah Traiger. This proposal was prepared in response to the EVOSTC's FY22-31 Invitation for Proposals and subsequent request for final submission on August 13, 2021. The funding request for this project over a ten-year period is $5960 K (without EVOSTC GA), of which $3402 K will come to USGS. Support for the program includes some non-EVOSTC funds that are in-kind contributions totaling $5852 K for the life of the project (e.g., salaries of permanent staff, laboratory facilities, and equipment use), of which $2400 K will come from USGS.

This project proposal is part of the larger multi-agency Gulf Watch Alaska Long-Term Research and Monitoring (GWA-LTRM) program proposal package. This package represents a continued commitment of the successful long-term research and monitoring projects supported by the EVOSTC and various agencies and organizational investments since 2012.

However, USGS funds included as in-kind or as contributions are included for planning purposes only and nothing contained in this proposal shall be construed as binding the USGS to expend in any one fiscal year any sum in excess of its appropriations or funding in excess or what it has received for the collaborative work outlined in this proposal or involving the federal government in any obligation to pay money before funds have been appropriated for that purpose unless otherwise allowed by law.

Sincerely,

Digitally signed by member: 720CC750-FB79-4BCC-8333-30E70ED4311F C059F91D-241C-4DFA-B845-A2FEE3F297A8
Date: 2021.07.29 16:18:10 -08'00'

Christian E. Zimmerman
Director, USGS Alaska Science Center
czimmerman@ugsgs.gov, 907-786-7071

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Alaska Fisheries Science Center
7600 Sand Point Way N.E.
Seattle, Washington 98115-0070
Tel: 907.789.6617 Fax: 206.526.4004

July 7, 2021

Shiway Wang
Exxon Valdez Oil Spill Trustee Council
4230 University Drive, Ste. 220
Anchorage, AK 99508-4650

Dear Ms. Wang,

We are pleased to provide this letter of commitment for the Gulf Watch Alaska – Long-Term Research and Monitoring (GWA-LTRM) program proposal and two embedded project proposals to the *Exxon Valdez* Oil Spill Trustee Council (EVOSTC). These proposals were drafted in response to the EVOSTC's FY22-31 Invitation in March and subsequent request for final submission by August 13, 2021. AFSC will provide support for Mandy Lindeberg as the GWA Program Lead and Rob Suryan as Science Lead. AFSC also supports John Moran as a principal investigator (PI) for the humpback whale monitoring project and Mandy Lindeberg as a co-PI for the periodic lingering oil project. We support AFSC's role in leading and conducting research for this long-term program with in-kind contributions by our agency.

If these proposals are funded over the next 10 years, in-kind support is estimated to be:

- GWA-LTRM Program proposal 2222LTRM: $100K/year = salaries (6 mos/year combined salary for Lindeberg and Suryan).
- Humpback Whale project #22120114-O: $140K/year = $90K/year for salary (7 mos/year for PI Moran); and all field and laboratory equipment required ($50 K/year).
- Lingering Oil project # 22220114-P: $84K = salary (5 mos/10 years) for PI Lindeberg.

Sincerely,

Robert J. Foy, Ph.D.
Science and Research Director

COLLEGE OF FISHERIES AND OCEAN SCIENCES
University of Alaska Fairbanks
P.O. Box 757220, Fairbanks, Alaska 99775-7220

S. Bradley Moran, Dean
Office 907-474-7210
Fax 907-474-7204
sbmoran@alaska.edu
www.uaf.edu/cfos

July 29, 2021

To: Mandy Lindeberg - NOAA, GWA-LTRM Program Lead
Katrina Hoffman - PWSSC, President and CEO
Shiway Wang, EVOSTC Executive Director

Re: Letter of Commitment

We are pleased to provide this letter of institutional commitment for the following University of Alaska Fairbanks projects proposed as part of the Gulf Watch Alaska Long-Term Research and Monitoring program:

- 22120114-I, Oceanographic Station GAK-1 Long Term Monitoring of the Alaska Coastal Current, principal investigator (PI) Seth Danielson, $1,558,434
- 22120114-H, Nearshore Ecosystems in the Gulf of Alaska, PIs Katrin Iken and Brenda Konar, $1,543,053
- 22120114-L, Seward Line, PIs Russell Hopcroft and Seth Danielson, $1,961,848
- 22220111-L, Ecological Interactions Between Pacific Herring and Pacific Salmon in Prince William Sound, PI Kristen Gorman, $426,792

This proposal was drafted by the PIs in response to the *Exxon Valdez* Oil Spill Trustee Council's (EVOSTC's) FY22-31 Invitation for Proposals and subsequent request for final submission on August 13, 2021. The costs listed above for each project are for the 10-year period from 2022 through 2031 and do not include EVOSTC general administration fees. UAF indirect costs have been included at the negotiated F&A rate for State of Alaska-sponsored, 25.0% of Modified Total Direct Costs.

These proposals represent a continued commitment of the successful long-term research and monitoring projects supported by the EVOSTC and various agencies and organizational investments.

Sincerely,

S. Bradley Moran, Dean
College of Fisheries and Ocean Sciences

Naturally Inspiring.