EVOSTC FY17-FY21 INVITATION FOR PROPOSALS
FY19 (YEAR 8) CONTINUING PROJECT PROPOSAL SUMMARY PAGE

Project Number and Title

Gulf Watch Alaska: Environmental Drivers Component Project

19120114-J—Long-term Monitoring of Oceanographic Conditions in Cook Inlet/Kachemak Bay, Alaska

Primary Investigator(s) and Affiliation(s)

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Steve Baird, Kachemak Bay National Estuarine Research Reserve (KBNERR)/Alaska Center for Conservation Science (ACCS)/ University of Alaska Anchorage (UAA)

Date Proposal Submitted

August 17, 2018

Project Abstract

The Cook Inlet/Kachemak Bay monitoring project provides year-round, high temporal resolution oceanographic and plankton community data to assess the effects of seasonal and inter-annual oceanographic variability on nearshore and pelagic species affected by the Exxon Valdez Oil Spill. We continue a 7-year time-series of shipboard oceanography surveys along the estuarine gradient from Kachemak Bay into southeast Cook Inlet, as well as a 17-year time series of continuous nearshore water quality station observations in Kachemak Bay. Shipboard sampling includes conductivity-temperature-vs-depth (CTD) casts, and phytoplankton and zooplankton net tows. Outputs from the project include seasonally-resolved oceanographic patterns, plankton abundance and community composition, and cycles for harmful algal species. The project provides oceanographic data to support Gulf Watch Alaska (GWA) Nearshore Component monitoring in Kachemak Bay. It also provides year-round information on estuary-shelf oceanographic gradients for the GWA Environmental Drivers component to help evaluate local (within estuary) and remote (shelf, North Pacific) climate forcing effects on nearshore and pelagic ecosystems. Results show that: 1) water temperatures in 2017 were cooler than during the 2014-2016 marine heat wave but still above long-term averages; 2) zooplankton response to environmental variability in Kachemak Bay was higher between years than spatially; and 3) summer abundances of the toxic phytoplankton species that causes paralytic shellfish poisoning were sensitive to warm temperatures and higher in Kachemak Bay than lower Cook Inlet. The only proposed change for FY19 is for Steve Baird to replace Jessica Shepherd as Kachemak Bay National Estuarine Research Reserve co-principal investigator.

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

FY17	FY18	FY19	FY20	FY21	TOTAL
$169,700	**$174,400**	**$183,400**	**$135,800**	**$133,300**	**$796,500**

Non-EVOSTC Funds to be used, please include source and amount per source: (see Section 6C for details)

FY17	FY18	FY19	FY20	FY21	TOTAL
$205,000	**$213,000**	**$215,000**	**$217,000**	**$194,000**	**$1,044,000**

1. PROJECT EXECUTIVE SUMMARY

The Cook Inlet/Kachemak Bay Environmental Drivers monitoring project conducts year-round, high temporal resolution oceanographic and plankton sampling to assess the effects of seasonal and inter-annual oceanographic variability on nearshore and pelagic species injured by the *Exxon Valdez* oil spill. In FY19, we continue a 7-year time-series of shipboard oceanography surveys along the estuarine gradient from Kachemak Bay into southeast Cook Inlet, as well as a 17-year time series of continuous nearshore oceanography observations in Kachemak Bay (Fig. 1). Our overall project goal is to continue and enhance time-series of oceanographic and plankton data in lower Cook Inlet and Kachemak Bay to help understand what drives variations in nearshore and pelagic food webs.

Important fish, shellfish, seabird, shorebird and marine mammal species forage in Cook Inlet and Kachemak Bay and long-term oceanographic and lower trophic data are required to understand how climate variability can affect upper trophic species through bottom-up ecosystem processes. Data on variability and change in both nearshore and shelf water column conditions are required to evaluate several hypotheses that have been put forward to explain climate-driven changes in Gulf of Alaska biological production (summarized in Mundy and Spies 2005). These include the match-mismatch hypothesis (Mackas et al. 2007, Anderson and Piatt 1999), pelagic-benthic split hypothesis (Eslinger et al. 2001), and optimum stability window hypothesis (Gargett 1997). The Gulf Watch Alaska (GWA) Environmental Drivers component provides the long-term, high quality, time-series data needed for these regional evaluations of ecosystem dynamics, as well as for distinguishing between natural and anthropogenic changes in species populations (e.g., oil spills, fishing, aquaculture, nutrient runoff, climate change).

The Cook Inlet/Kachemak Bay oceanography monitoring project provides year-round, seasonally resolved oceanographic and plankton data to the GWA program, with critical information on nearshore patterns and estuary to shelf oceanographic gradients. This project supports the GWA Nearshore Component intertidal monitoring project, as well as ongoing pelagic seabird and marine mammal monitoring efforts, in Kachemak Bay. Sampling at shipboard survey stations includes: 1) conductivity-temperature vs depth (CTD) profiler casts to collect temperature, salinity, pressure, fluorescence, turbidity, and dissolved oxygen data; 2) surface phytoplankton tows; and 3) vertical zooplankton tows. Continuous oceanographic (temperature, salinity, pressure, dissolved oxygen, turbidity and chlorophyll) and monthly nutrient and chlorophyll data are collected year-round at Kachemak Bay water quality stations in the Seldovia and Homer harbors, and during ice-free months (March to November) at a Bear Cove mooring (Fig. 1). The sampling provides data with sufficient temporal resolution to detect seasonal shifts in oceanographic patterns and community composition changes and sufficient spatial resolution to characterize along- and cross-estuary gradients. Continued sampling in FY19 will investigate whether a return to more normal oceanographic conditions in 2017-2018 persists, following the long warm perturbation of the 2014-2016 Pacific marine heat wave (DiLorenzo and Mantua, 2016) and how plankton communities respond. We will work with principal investigators (PIs) in the Environmental Drivers component to compare results from relatively high frequency plankton sampling in Cook Inlet (this project), Prince William Sound (19120114-G), Resurrection Bay (19120114-I and 19120114-L) and with the Continuous Plankton Recorder (19120114-D) to assess lower trophic level responses to both the Pacific marine heat wave (2014-2016) and subsequent cooling at local and regional scales across the northern Gulf of Alaska study region.

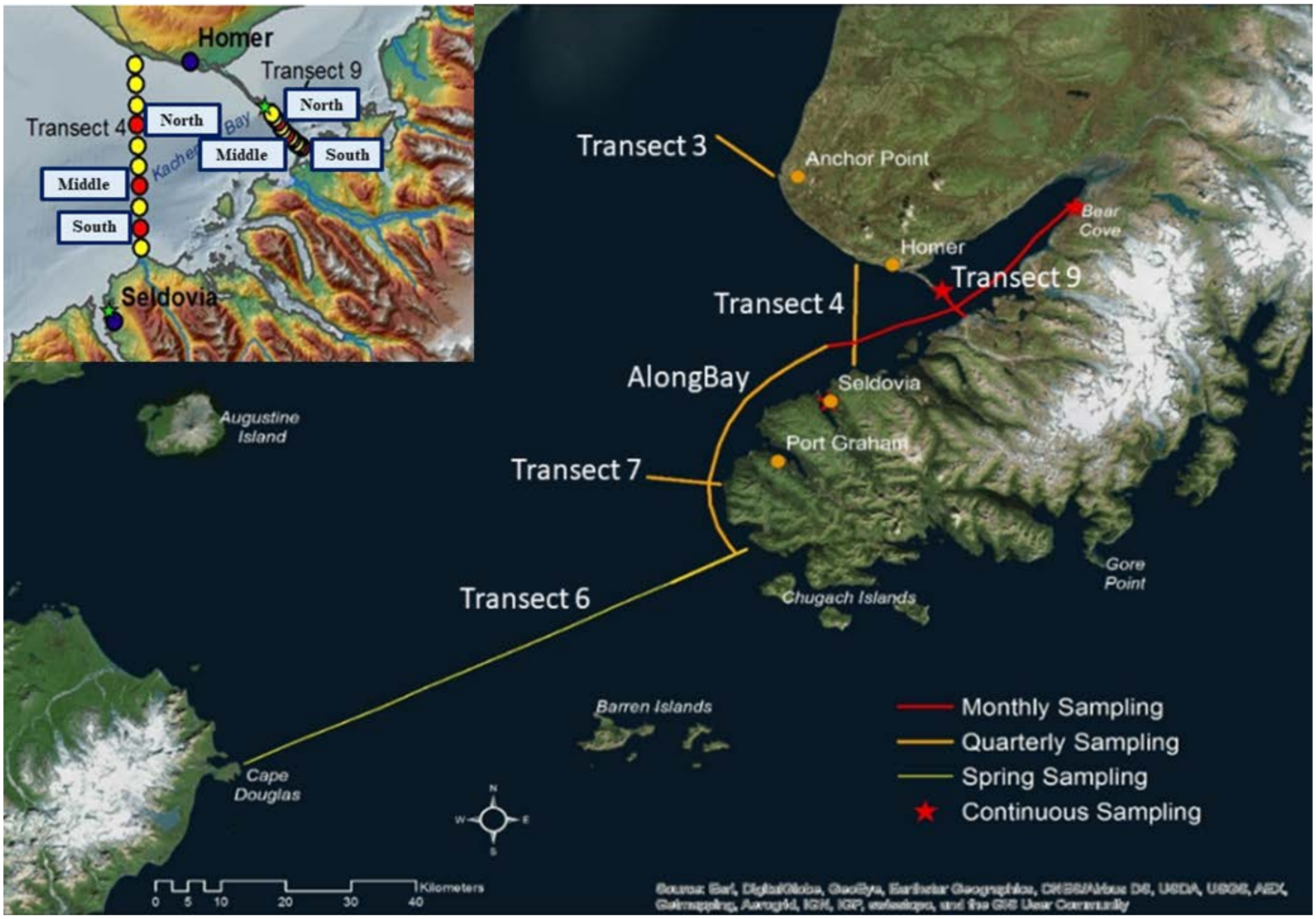

Figure 1. Map of the lower Cook Inlet/ Kachemak Bay study area with FY17-21 sampling locations and frequency. Red stars depict continuous water quality monitoring station locations at Seldovia, Homer and Bear Cove. Inset map shows location of cross-bay sampling transects and stations in Kachemak Bay.

In FY18 (year 7 of GWA program) we continued data analyses to assess seasonal, interannual and spatial patterns and plankton response to environmental drivers. Selected results include the following:

1. Continuous water quality station data from Kachemak Bay show that there were consistent changes in temporal variability along the estuarine gradient, with the least seasonal variability at the more oceanic, outer bay site in Seldovia harbor and the most variability at the Bear Cove mooring near the head of the bay (Fig. 2). The Bear Cove location also consistently had the warmest summer surface water temperatures of the three sampling sites (Fig. 2, top). Differences in temperature (Fig. 2) and salinity (not shown) between near-surface and near-bottom sensors were greater at the Homer harbor site than the Seldovia harbor site, which is consistent with the greater influence of freshwater input in the inner bay and north side of Kachemak Bay. In 2017, water temperatures cooled relative to the anomalously warm conditions observed during the 2014-2016 Pacific marine heat wave, but monthly average temperatures remain above their sixteen-year means (Fig. 3). Project data, along with information from GWA nearshore component monitoring in Kachemak Bay, contributed to an assessment of Alaska-wide ecosystem impacts of the marine heat wave in Walsh et al (2018).

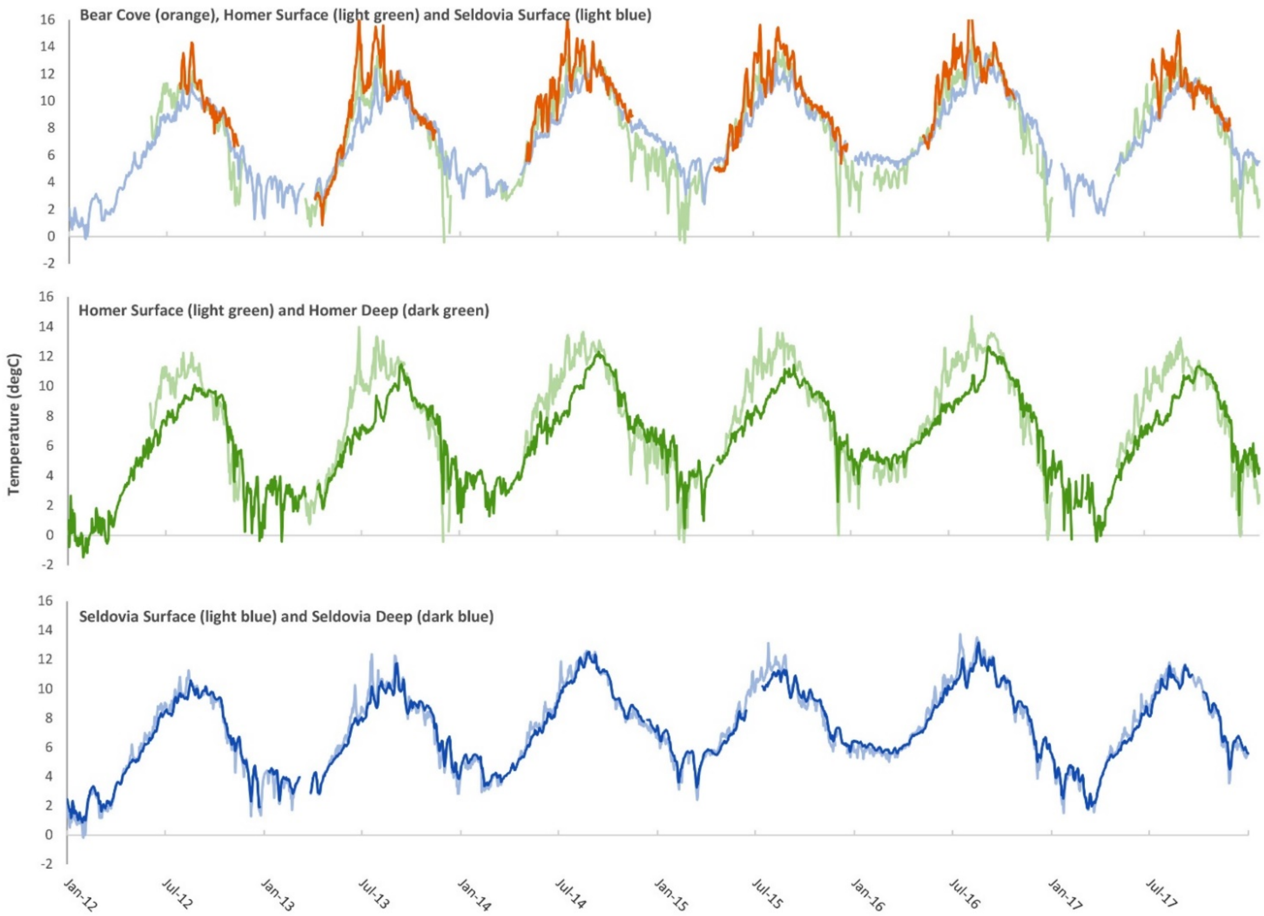

Figure 2. Daily averaged near-surface sea temperature (°C) from three locations in Kachemak Bay, Alaska for 2012-2017. Seldovia (blue) and Homer (green) harbor sites have two sensors, with one located 1 m below the surface and one located 1 m above the sea floor. Bear Cove (orange) has one surface sensor, which is removed in winter months. Note the very warm temperatures in winter 2015-2016, especially at the Seldovia site.

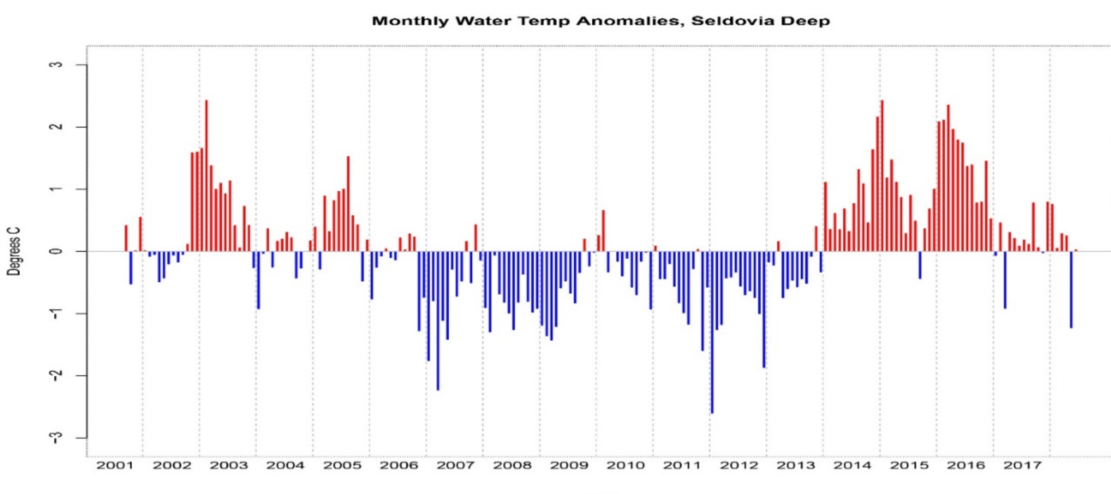

Figure 3. Monthly average water temperature anomalies (red bars-warm, blue bars-cool) calculated from continuous data from the near-bottom sensor at the Seldovia harbor KBNERR water quality monitoring station.

2. Cooler water temperatures were also observed throughout the water column in 2017, relative to the 2014-2016 warm period, especially during late winter/early spring months, although conditions were not as cool as during the relatively cold year of 2012. Fig. 4 shows an example of temperature (top) and salinity (bottom) time series from the mid-Kachemak Bay CTD station. Cooler winter temperatures in 2017 are circled. In 2017, the deeper waters in Kachemak Bay had greater salinities in winter to summer months (circled), which was a return to normal conditions from the slight freshening that was observed consistently in 2015-2016.

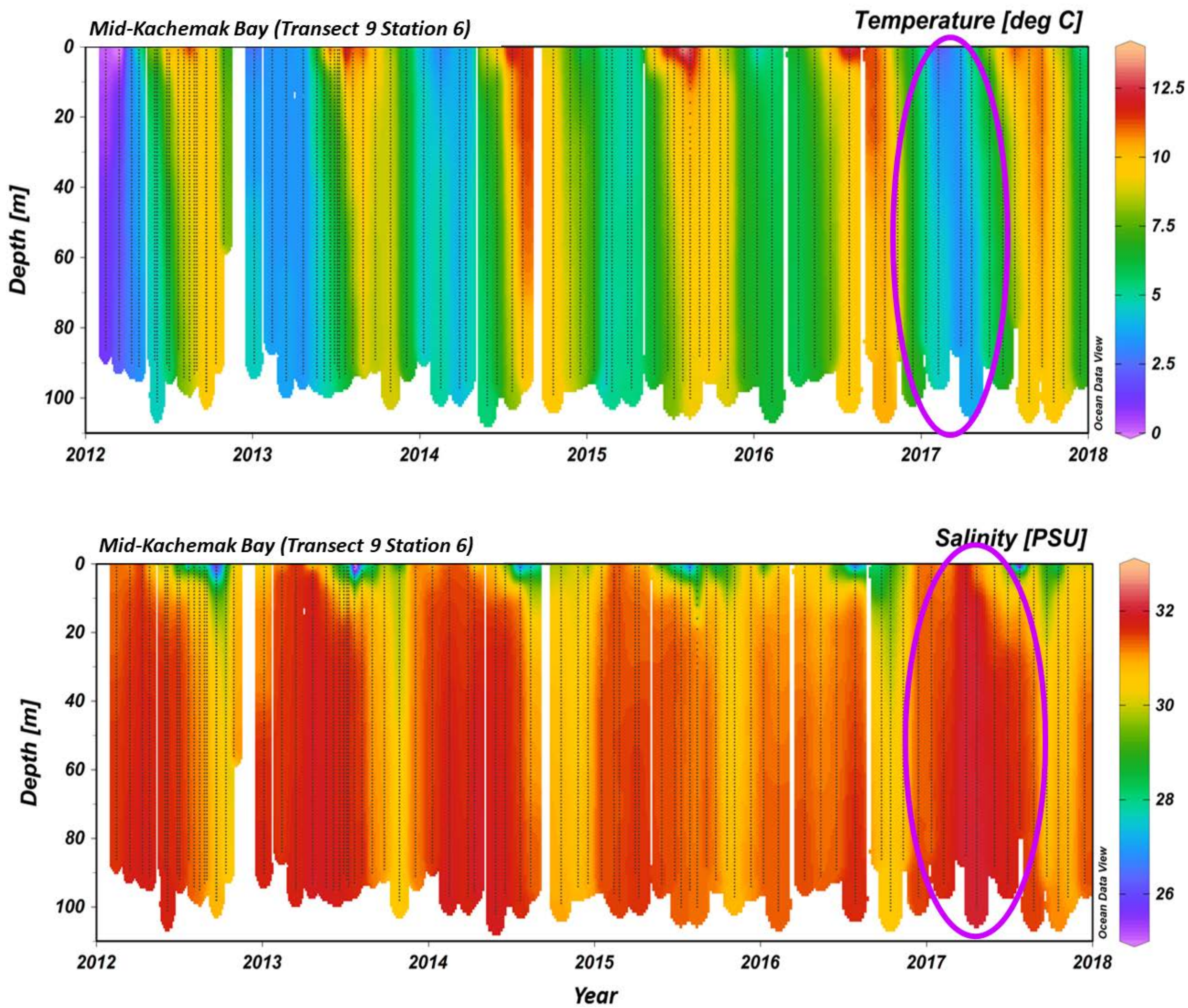

Figure 4. Time series of vertical profiles of water column temperature (top, °C) and salinity (bottom, practical salinity units (PSU)) from 2012-2016 collected from monthly CTD casts at a mid-Kachemak Bay station.

By conducting monthly along-estuary sampling for the FY17-21 GWA program, we are able to better resolve spatial and seasonal changes in the estuary-shelf oceanographic gradients. Fig. 5 provides temperature and salinity time series from some of the along-bay monthly surveys in 2017. Coldest temperatures and mixed conditions were observed during the late March survey, warmest water temperatures were observed throughout the water column in September and freshening was observed consistently in deeper waters from September through November, likely reflecting the influence of intrusions of Alaska Coastal Current waters from the shelf.

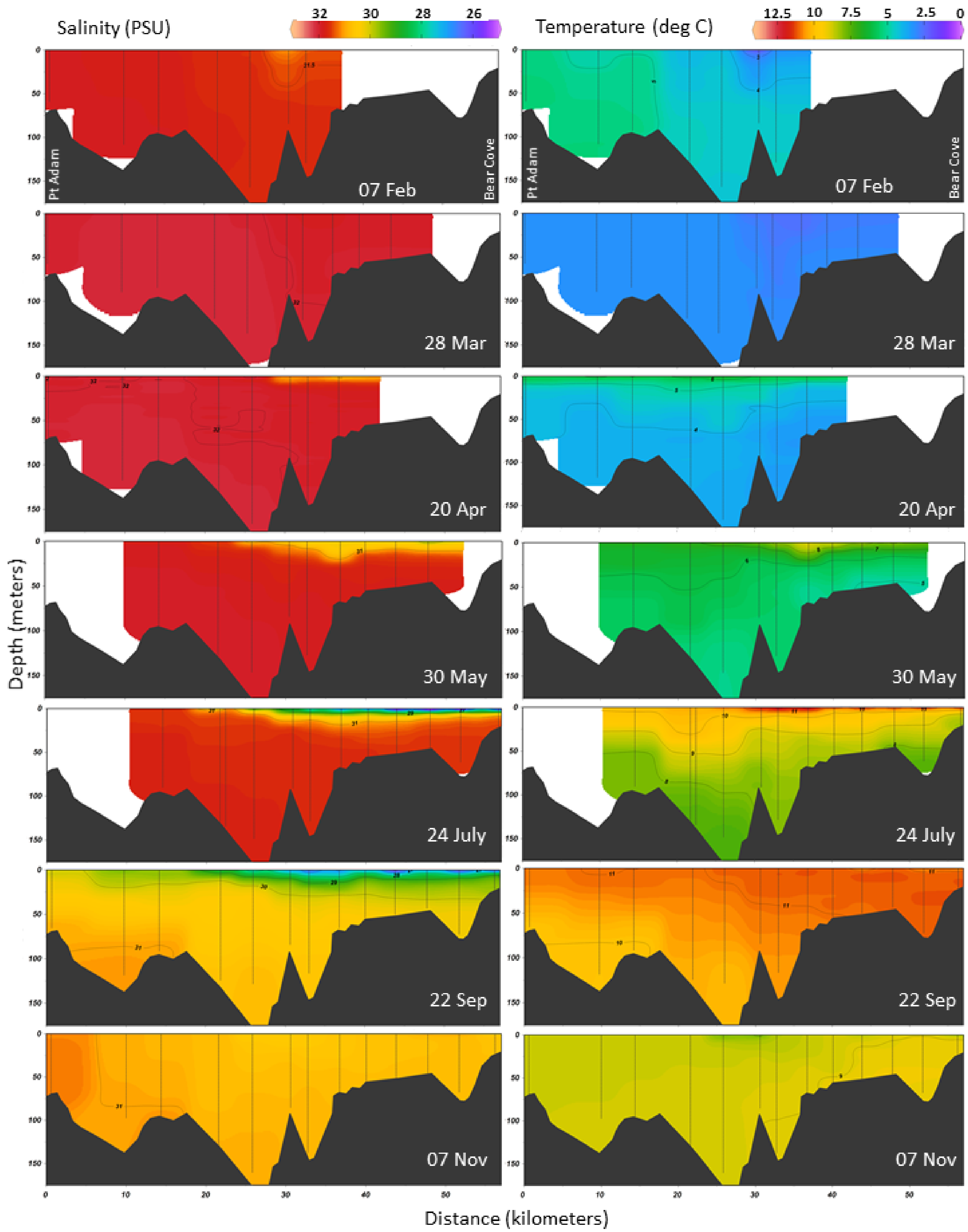

Figure 5. Contour plots of 2017 seasonal variation (top to bottom) in salinity (left) and temperature (right) from selected oceanographic surveys on the Along-Bay transect. View in each plot is from southeast Cook Inlet (near

Point Adam) on left to the head of Kachemak Bay (near Bear Cove) on right. Vertical lines indicate sample sites.

3. During FY18, we began an initial examination into how the environmental variables correlate with the zooplankton community in the spring months (March – May) in Kachemak Bay, using data from sampling stations in the mid-bay (Transect 9) and outer bay (Transect 4). The six taxa that contributed most to interannual variability for all years (2012 – 2016) were *Acartia spp*., barnacle nauplii, crab zoea, unidentified egg, *Neocalanus spp*., and *Pseudocalanus* spp., with eggs more abundant in 2012 and barnacle nauplii most abundant after that (Fig. 6). In 2016, *Pseudocalanus* spp. increased in abundance at all sites. To examine linkages between environmental conditions and the zooplankton community, we ran a principal component analysis (PCA) in PRIMER, with 78.6% of the variability in community composition explained by two principal components (Fig. 7). PC1 correlated positively with density (and salinity) and dissolved oxygen, and negatively with temperature. PC2 correlated positively with chlorophyll and negatively with photosynthetically active radiation (PAR). There was no trend observed spatially, either between mid and outer bay or cross-estuary, but a clear pattern was seen temporarily between years (Fig. 7).

Figure 6. The abundance of the top six zooplankton species that contribute most to interannual variability over the spring months (March – May) in Kachemak Bay during 2012 – 2016. Three cross-estuary sampling sites are located along survey transects in the mid-bay (Transect 9) and outer bay (Transect 4).

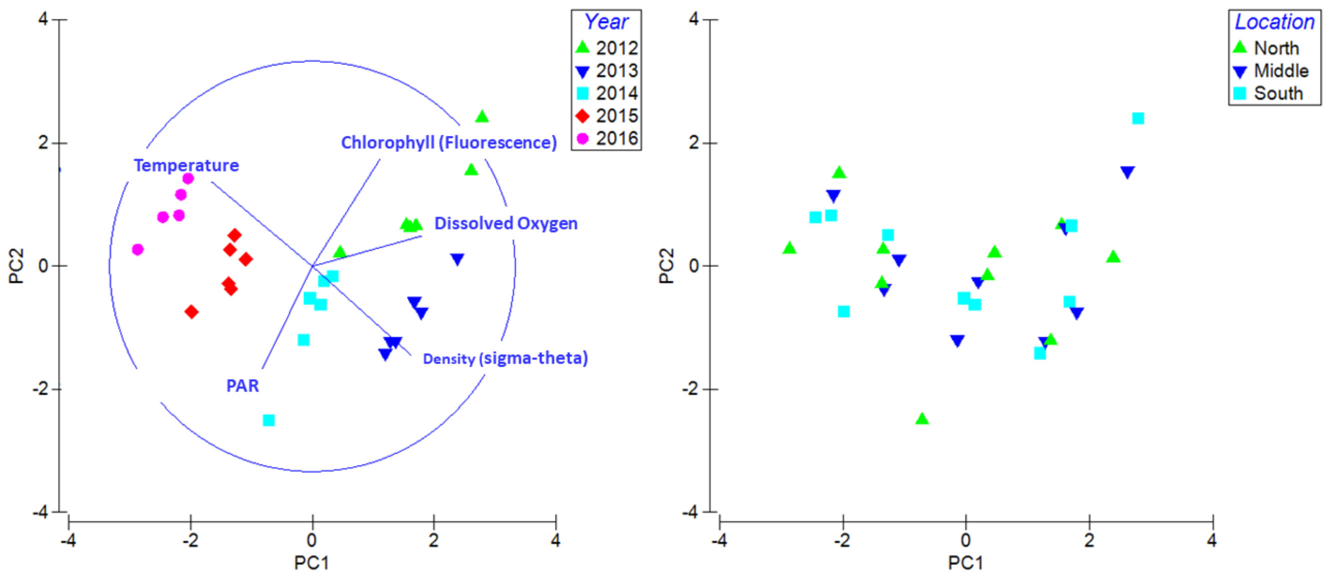

Figure 7. Principal components analysis (PCA) plot explaining variability in zooplankton community composition associated with environmental parameters. Points are for individual sampling events (at six sites for five years), colored by year (left) and cross-estuary location (right).

4. The toxic phytoplankton *(Alexandrium* spp.*)* that causes paralytic shellfish poisoning (PSP) was present in lower Cook Inlet and Kachemak Bay during each year of sampling, however maximum cell concentrations increased with warming water conditions in 2014-2016 (Fig. 8). PSP events had not been observed in Kachemak Bay for over a decade prior to 2015, but occurred in 2015, 2016 and 2017.

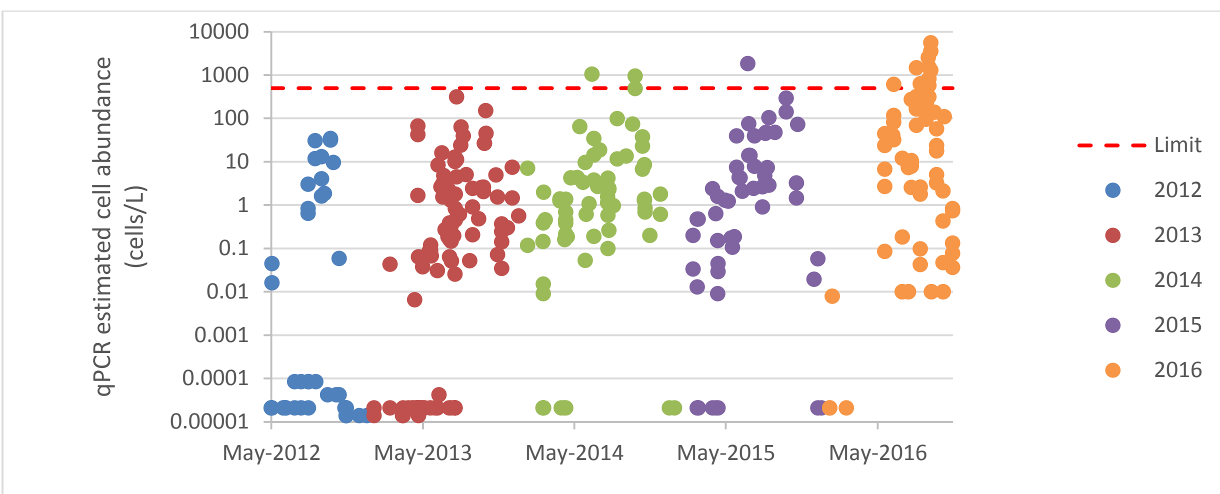

Figure 8. *Alexandrium* cell abundance estimated from quantitative polymerase chain reaction (qPCR) analyses for all phytoplankton samples collected in lower Cook Inlet and Kachemak Bay, 2012-2016. Note logarithmic scale for cell abundance on the y-axis. Paralytic shellfish poisoning toxins are likely to be detected in shellfish tissues for cell abundances above a limit of 500 cells/liter (red dashed line on figure).

Results of our phytoplankton research were published in the journal Harmful Algae in June of 2018 in an article titled: *Environmental factors influencing the distribution and abundance of* Alexandrium catanella *in Kachemak Bay and lower Cook Inlet, Alaska* (Vandersea et al., 2018). Important findings showed that there was a positive correlation between temperature and *Alexandrium* cell concentrations (Fig. 9), but little relationship with salinity (Figure 9). Nutrients did not appear to be a limiting factor in *Alexandrium* abundance (Vandersea et al., 2018). Although nutrients were lower in the upper layer of the stratified water column during the summer, it is likely that *Alexandrium* were able to take advantage of higher nutrients below the stratified layer through vertical migration. Mean cell abundances of *Alexandrium* at sites in Kachemak Bay were consistently higher than at those in lower Cook Inlet (Fig. 10). The results suggest that monitoring water temperatures may identify times with higher risk of PSP events, though actual toxic algal bloom formation depends on more factors.

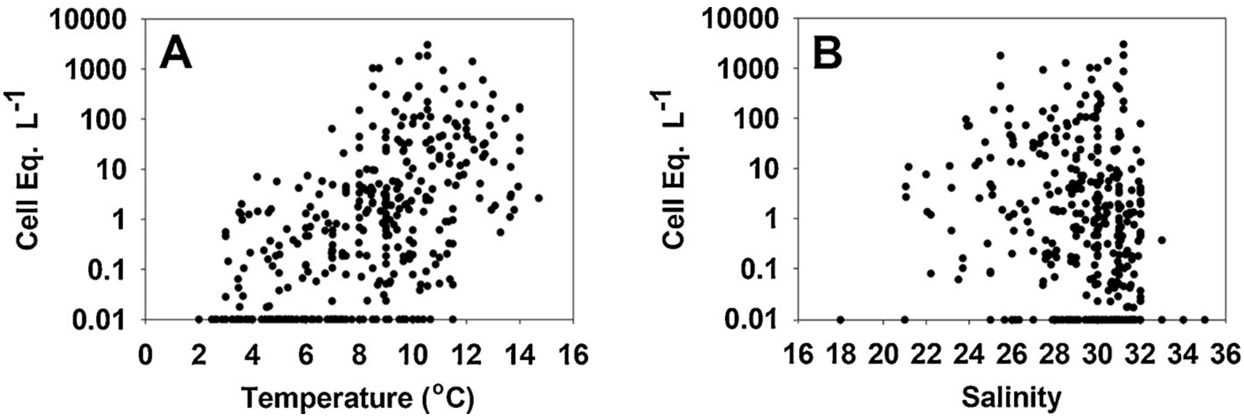

Figure 9. *Alexandrium catanella* cell abundances as a function of (A) temperature and (B) salinity. Note the logarithmic scale for cell abundance on y-axis. From Vandersea et al. (2018).

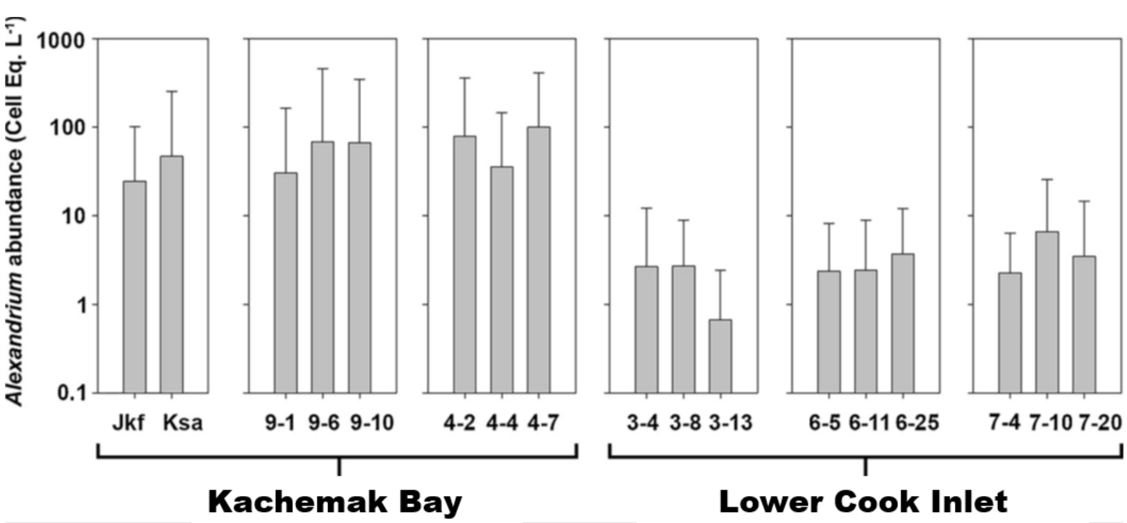

Figure 10: Distribution of *Alexandrium* cells at sub-bay sites (Jakolof Bay, Jkf and Kasitsna Bay, Ksa) and along Kachemak Bay and Cook Inlet transects. Kachemak Bay sites are in mid-bay (Transect 9) and outer bay (Transect 4) and Cook Inlet locations are across the entrance (Transect 6), from Flat Island to Augustine Volcano (Transect 7) and from Anchor Point to Red River (Transect 3). The only significant difference in cell abundances was between Kachemak Bay and Cook Inlet (Kruskal-Wallis rank ANOVA, H=16.83, $p < 0.001$).

2. PROJECT STATUS OF SCHEDULED ACCOMPLISHMENTS

A. Project Milestones and Tasks

Table 1. Project milestone and task progress by fiscal year and quarter, beginning February 1, 2017. C = completed, X = not completed or planned. Fiscal Year Quarters: 1= Feb. 1-April 30; 2= May 1-July 31; 3= Aug. 1-Oct. 31; 4= Nov. 1-Jan 31.

	FY17				FY18				FY19				FY20				FY21			
Milestone/Task	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Milestone 1: Field Sampling																				
Monthly Surveys	C	C	C	C	C	C	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Spring Surveys (all)	C				C				X				X				X			
Summer Surveys		C				C				X				X				X		
Fall Surveys			C				X				X				X				X	
Winter Surveys	C				C				X				X				X			
SWMP Water quality	C	C	C	C	C	C	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SWMP Nutrients	C	C	C	C	C	C	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SWMP Meteorological	C	C	C	C	C	C	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Milestone 2: Data Delivery	C			C	C			X	X			X	X			X	X			X
Milestone 3: Reporting																				
Annual Reports	C				C				X				X				X			
Annual PI meeting				C				X				X				X				X
Annual Work Plan			C				C				X				X				X	

B. Explanation for not completing any planned milestones and tasks

Sampling for 2017 and first two quarters of 2018 was completed in accordance with our proposal and with sampling protocols available on AOOS workspace. Due to a combination of adverse weather and contract vessel availability issues, we were not able to sample the entire Cook Inlet entrance line in April 2018. The remainder of spring surveys were completed. We were able to use the personnel time for an additional small boat survey in June 2018 on the entire along-bay line, which is normally sampled only quarterly. This survey data provides additional temporal resolution of the estuary to shelf oceanographic conditions and plankton communities during the spring/summer phytoplankton bloom period.

C. Justification for new milestones/tasks

No new milestones/tasks

3. PROJECT COORDINATION AND COLLABORATION

A. Within an EVOSTC-funded Program

Gulf Watch Alaska

1) Environmental Drivers component: We continue to coordinate on oceanographic and zooplankton sampling protocols and synthesis of monitoring results with other Environmental Drivers component PIs through teleconferences, joint field work, and PI meetings. We are collaborating with Rob Campbell (PWS environmental drivers component 19120114-G) at the Prince William Sound Science Center on zooplankton sample analyses. The project provides year-round, seasonally resolved oceanographic and plankton data and detailed information on along- and across-estuary gradients to the GWA program. Monthly sampling provides year-round oceanographic context for the April to November sampling of the Continuous Plankton Recorder (19120114-D) in lower Cook Inlet and the adjacent shelf, as well as for comparison with seasonal oceanographic sampling in Prince William Sound (19120114-G) and continuous sampling at the GAK1 mooring (19120114-I). We continue to collaborate with other Environmental Drivers PIs on patterns in zooplankton abundance and community composition (19120114-D, 19120114-G, and 19120114-L).

2) Nearshore component: The Cook Inlet/Kachemak Bay project provides information on seasonal and inter-annual patterns in water temperature, stratification, freshwater content and nutrients to the GWA Nearshore component PIs to assess drivers of intertidal ecosystem changes at their Kachemak Bay sites. In FY19 we will continue a collaboration to assess oceanographic variability across the GWA study area.

3) Pelagic component: We provide opportunities to GWA Pelagic component (Kathy Kuletz, US Fish and Wildlife Service (USFWS) Migratory Bird Management office) to host a seabird/marine mammal observer on our shipboard surveys.

Herring Research and Monitoring (HRM)

We coordinate informally with Scott Pegau (HRM program lead) to compare long-term changes in oceanographic patterns across the northern Gulf of Alaska. We coordinated with Maya Groner on an outreach event at Port Graham in spring 2018.

Data Management

We work closely with the Alaska Ocean Observing System (AOOS)/Axiom data management team and provide data and metadata to the Research Workspace and AOOS Gulf of Alaska Data Portal within required timeframes. In FY19 we will continue a collaboration with Axiom, AOOS and the Alaska Harmful Algal Bloom Network to improve an online tool for paralytic shellfish poisoning risk assessment that is based on real-time water temperature observations.

B. With Other EVOSTC-funded Projects

This project will coordinate with other EVOSTC-funded projects as appropriate by providing data, discussing the relevance and interpretation of data, and collaborating on reports and publications.

C. With Trustee or Management Agencies

1) National Oceanic and Atmospheric Administration (NOAA): We collaborate with researchers at the National Ocean Service/ National Centers for Coastal Ocean Science (NOS/NCCOS) Beaufort Laboratory

(North Carolina) to use the project oceanography and phytoplankton sampling data to identify environmental triggers for increases in the phytoplankton species (*Alexandrium* spp.) that cause paralytic shellfish poisoning events. In FY19 we will also investigate the potential for forage fish to provide a vector for PSP toxins to seabirds and whales. We collaborate with NOAA National Marine Fisheries Service (NMFS) on the NOAA Kachemak Bay Habitat Focus Area, including clam restoration and PSP risk assessment efforts.

2) State of Alaska agencies – The Alaska Department of Fish and Game (ADFG) and the Alaska Department of Environmental Conservation (ADEC): We provide real-time and historical trends for water temperature data to shellfish managers with the Alaska Department of Fish and Game (Commercial and Sportfish Divisions) in Homer and Kenai, and with the Alaska Department of Environmental Conservation in Anchorage. Project data helps inform management for shellfish harvest, mariculture operations, harmful algal bloom event response and marine invasive species monitoring.

3) USFWS: We collaborate with Kathy Kuletz of the USFWS Migratory Bird Management office to opportunistically host shipboard seabird/marine mammal observers on our shipboard surveys. We coordinate with the USFWS Marine Mammals Office on sea otter stranding and sampling programs and project data is provided to USFWS (Alaska Maritime National Wildlife Refuge) and NOAA (NMFS Protected Resources) to help understand potential causes of seabird, sea otter and whale mortality events.

4) North Pacific Research Board (NPRB): Holderied participated in the NPRB-funded FY16-18 synthesis effort for the Gulf of Alaska Integrated Ecosystem Research Program with researchers from NOAA, USFWS, ADFG and other organizations. Project data are being used to help understand how linkages between nearshore and shelf waters affect forage fish distributions and groundfish recruitment.

4. PROJECT DESIGN

A. Overall Project Objectives

Objective 1: Determine the thermohaline structure of Kachemak Bay and the southeastern Cook Inlet entrance at seasonal and longer time scales.

Objective 2: Determine long-term trends and variability from daily to inter-annual time scales in Kachemak Bay oceanography.

Objective 3: Determine seasonal patterns of phytoplankton and zooplankton species abundance and community composition within Kachemak Bay and southeastern Cook Inlet.

Objective 4: Assess inter-annual changes in oceanographic structure and phytoplankton/zooplankton species composition across the Cook Inlet entrance.

Objective 5: Assess seasonal patterns in oceanography, macronutrients, and plankton between Kachemak Bay, southeastern Cook Inlet and the adjacent shelf (collaboration with Seward Line and CPR projects).

Objective 6: Determine temporal patterns and linkages in oceanographic conditions and plankton communities between Kachemak Bay/lower Cook Inlet, the Gulf of Alaska shelf and Prince William Sound, in collaboration with other Environmental Drivers component projects.

Objective 7: Provide environmental forcing data for correlation with biological data sets in the nearshore benthic project component and pelagic components of GWA.

Objective 8: Provide ADFG, ADEC, NOAA, and USFWS resource managers with assessment of oceanographic trends and seasonal conditions.

B. Changes to Project Design and Objectives

There are no changes proposed to the project design or objectives.

5. PROJECT PERSONNEL – CHANGES AND UPDATES

We are requesting approval from EVOSTC to transition the Kachemak Bay National Estuarine Research Reserve (KBNERR) project principal investigator from Jessica Shepherd to Steve Baird. Steve Baird is the acting Research Coordinator for KBNERR and has led the KBNERR water quality monitoring effort for several years, including throughout the period of the GWA program (2012-2018). Jessica Shepherd will continue to provide her expertise to the project for outreach. A copy of Steve Baird's CV is attached.

6. PROJECT BUDGET FOR FY19

A. Budget Forms (See GWA FY19 Budget Workbook)

Please see project budget forms compiled for the program.

B. Changes from Original Project Proposal

No major budget changes for FY19 from our original proposal. KBNERR budget has been modified to include Steve Baird as the project co-PI and reduce costs for Jessica Shepherd. We have also moved a small amount of funds from the KBNERR to Kasitsna Bay Laboratory budgets in FY19 (~$8K) to cover data analysis efforts by Kasitsna Bay Laboratory contract staff. There is no change to the total budget amount for the project.

C. Sources of Additional Project Funding

1. KBNERR System-wide monitoring program: this long-term monitoring program provides continuous water quality data in Kachemak Bay for temperature, conductivity, dissolved oxygen, pressure (depth), pH, turbidity and chlorophyll fluorescence (measure of phytoplankton biomass). Water samples are collected monthly for nutrients (nitrite + nitrate, ammonium, orthophosphate, and Silicate) and chlorophyll. Nutrients are analyzed at the Virginia Institute of Marine Science (VIMS) Lab. Chlorophyll-a and Phaeophytin pigments are analyzed at KBNERR from water samples collected at five sites. KBNERR also provides real-time and archival meteorological data (air temperature, relative humidity, barometric pressure, wind speed, wind direction, total solar radiation, precipitation, and photosynthetically available radiation) from two sites to this project. Collectively, these data provide a longer term and continuous context for comparison to data from oceanographic surveys in this project. KBNERR monitoring efforts contribute $120K/year in kind to the project.
2. NOAA National Ocean Service/National Centers for Coastal Ocean Science (NCCOS)/Kasitsna Bay Laboratory and Beaufort Laboratory harmful algal bloom monitoring: NCCOS provides funding and staff time for phytoplankton and HAB species monitoring and laboratory analysis. NCCOS efforts contribute $65K/year in kind to the project.
3. NOAA Kasitsna Bay Laboratory and AOOS: NOAA KBL and AOOS have an ongoing collaboration to assess oceanography, ocean acidification and harmful algal bloom conditions in Kachemak Bay, and to develop

risk assessment tools for paralytic shellfish poisoning. AOOS plans to provide $25K in FY19 to support these efforts.

7. FY18 PROJECT PUBLICATIONS AND PRODUCTS

Publications

Doroff, A., and K. Holderied. 2018. Long-term monitoring of oceanographic conditions in Cook Inlet/Kachemak Bay to understand recovery and restoration of injured near-shore species. *Exxon Valdez* Oil Spill Long-term Monitoring Program (Gulf Watch Alaska) Final Report (*Exxon Valdez* Oil Spill Trustee Council Project 16120114-G), *Exxon Valdez* Oil Spill Trustee Council, Anchorage, Alaska.

Holderied, K., and J. Shepherd. 2018. Long-term monitoring of oceanographic conditions in Cook Inlet/Kachemak Bay to understand recovery and restoration of injured near-shore species. FY17 annual report to the *Exxon Valdez* Oil Spill Trustee Council, project 17120114-J.

Vandersea, M.W., S.R. Kibler, P.A. Tester, K. Holderied, D.E. Hondolero, K. Powell, S. Baird, A. Doroff, D. Dugan, R.W. Litaker. 2018. Environmental factors influencing the distribution and abundance of *Alexandrium catenella* in Kachemak Bay and lower Cook Inlet, Alaska. Harmful Algae, 77:81-92. https://doi.org/10.1016/j.hal.2018.06.008

Walsh, J.R., R. Thoman, U.S. Bhatt, P.A. Bieniek, B. Brettschneider, M. Brubaker, S. Danielson, R. Lader, F. Fetterer, K. Holderied, K. Iken, A. Mahoney, M. McCammon, and J. Partain. 2018. The high latitude marine heat wave of 2016 and its impacts on Alaska [in “Explaining Extreme Events of 2016 from a Climate Perspective”]. Bull. Amer. Meteor. Soc. 99 (1). S39-43. doi:10.1175/BAMS-D-17-0105.1

Published and updated datasets

DataONE: https://doi.org/10.24431/rw1k12, published data updated in August 2018 with final 2016 zooplankton data.

Research Workspace: 2017 CTD, phytoplankton, and water quality monitoring station data uploaded to Research Workspace with QC completed. Data will be added to Gulf of Alaska Data Portal on schedule. 2017 zooplankton data still being processed by R. Campbell at Prince William Sound Science Center, per schedule.

Presentations

Holderied, K., K. Powell, S. Baird, and J. Schloemer. 2018. Variability in estuarine salinity and stratification in Kachemak Bay, Alaska from 2012-2017. Poster presentation at Alaska Marine Science Symposium, Anchorage AK. Jan 2018.

Powell, K., J. Schloemer, K. Holderied, and A. Doroff. 2018. Oceanographic characteristics associated with spring zooplankton community structure in Kachemak Bay, Alaska from 2012 to 2016. Poster presentation at Alaska Marine Science Symposium, Anchorage AK. Jan 2018.

Renner, M., K. Holderied, K. Powell, D. Hondolero, J. Schloemer, A. Doroff, K. Kuletz. 2018. Ecosystem variability in Lower Cook Inlet across trophic levels, space, seasons, and climate regimes. Oral presentation at Alaska Marine Science Symposium, Anchorage, AK. Jan 2018.

Vandersea, M., P. Tester, K. Holderied, D. Hondolero, S. Kibler, K. Powell, S. Baird, A. Doroff, W. Litaker. 2018. Distribution and abundance of *Alexandrium catenella* in Kachemak Bay and Lower Cook Inlet, Alaska. Poster presentation at Alaska Marine Science Symposium, Anchorage, AK. Jan 2018.

Holderied, K. 2018. Alaska Coastal Science and Management Examples. Oral presentation at Joint Polar Satellite System Arctic Summit, Anchorage, AK. May 2018.

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Mackas, D. L., S. Batten, M. Trudel. 2007. Effects on zooplankton of a warmer ocean: Recent evidence from the Northeast Pacific. Progress in Oceanography 75(2):223–252.

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Experience

December 2001-present	**Biologist / Research Analyst**. *Kachemak Bay National Estuarine Research Reserve (University of Alaska).* Research Coordinator, Stewardship Coordinator, GIS analyst, biologist on a wide range of research projects. Oversight of KBRR's long-term monitoring program for water-quality and weather. Lead on salt marsh plant community mapping and monitoring.
June- December 2001	**GIS Specialist.** *Cook Inletkeeper.*
April 2000-December 2002	**Land Manager.** *Kachemak Heritage Land Trust.*
Spring 1994	**Assistant Professor.** *Antioch New England.*
January 1994	**Expedition Ornithologist.** *Belize Zoo, Belize, Central America.* Member of an expedition into a previously unexplored mountainous region of Belize. Responsibilities included censusing bird community, general expedition support, data analysis, and report writing.

Education

1989-1996	PhD candidate, *Dartmouth College, Department of Biological Sciences, Hanover, NH. Graduate research* assessing the importance of habitat selection and sexual segregation in determining over-winter survival of American redstarts on their winter grounds in Belize, Central America, 1990-1993. Voluntary withdrawal, 1996.
1980-1983	BA in Human Ecology, *College of the Atlantic, Bar Harbor, ME.*
1978-1980	Environmental Studies/Biology major. *Colby College, Waterville, ME.*

AWARDS

Fulbright Scholar. September 1991-April 1992. Fulbright Scholarship for foreign study awarded by The Institute of International Education. Funding for work in Belize, Central America.

PEER-REVIEWED PUBLICATIONS

M.W. Vandersea, S.R. Kibler, P.A. Tester, K. Holdereid, D.E. Hondolero, K. Powell, **S. Baird**, A. Doroff, D. Dugan, and R.W. Litaker. 2018. Environmental factors influencing the distribution and abundance of *Alexandrium catenella* in Kachemak Bay and lower Cook Inlet, Alaska. Harmful Algae 77:81-92. DOI: 10.1016/j.hal.2018.06.008

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Whigham, D.F., C.M. Walker, R.S. King, and **S.J. Baird**. 2012. Multiple scales of influence on wetland vegetation associated with headwater streams in Alaska, USA. Wetlands, 32(3):411-422.