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-I—Long-term Monitoring of Oceanographic Conditions in the Alaska Coastal Current from Hydrographic Station GAK-1

Primary Investigator(s) and Affiliation(s)

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Project Abstract

This project continues a 45-year time-series of temperature and salinity measurements at hydrographic station GAK-1. The data set, which began in 1970, now consists of quasi-monthly conductivity-temperature versus depth casts and a mooring outfitted with seven temperature/conductivity recorders distributed throughout the water column and a fluorometer at 20 m depth. The project monitors five important Alaska Coastal Current (ACC) ecosystem parameters that quantify and help us understand hourly to seasonal, interannual, and multi-decadal period variability in: 1) temperature and salinity throughout the 250 m-deep water column, 2) near surface stratification, 3) surface pressure fluctuations, 4) fluorescence as an index of phytoplankton biomass, and 5) along-shelf transport in the ACC. All of these parameters are basic descriptors that characterize the workings of the inner shelf and the ACC, an important habitat and migratory corridor for organisms inhabiting the northern Gulf of Alaska, including Prince William Sound and resources injured by the *Exxon Valdez* oil spill. We are aware of 69 publications utilizing data collected at station GAK-1, and since 2000 the citation list has grown by nearly three publications per year. Topics covered by these publications range from physical oceanography and climate through trophic (including commercial fisheries) level components and ecosystem analyses. Recent water temperatures have returned to average in the upper 100 m, but warmer than average water remains below 100 m. A recently awarded National Science Foundation Long-term Ecological Research program (awarded to Gulf Watch Alaska principal investigators R. Hopcroft and S. Danielson) will leverage and compliment this and other environmental drivers sampling within Gulf Watch Alaska. We are not proposing any major changes to this project in FY19.

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

FY17	FY18	FY19	FY20	FY21	TOTAL
$146,800	$148,400	$132,600	$125,600	$127,400	$680,800

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

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

1. PROJECT EXECUTIVE SUMMARY

The goal of the GAK-1 project is to provide a long-term high-quality reference dataset for the coastal northern Gulf of Alaska (GOA) that enables scientists, students, commercial and subsistence fishers, and resource managers to better understand climatic and ecological conditions, their changes, and ramifications of change (Fig. 1). Understanding, anticipating, and responding to change requires a stationary frame of reference in the form of long-term in situ observations. Such datasets are the best means to guide our assessments and interpretations of system variability. Untangling the relations between climatic and other drivers of change (e.g., oil spills or fishing regulations) similarly requires long reference time-series. Environmental time-series data can provide information valuable to the management of fish and shellfish populations and fisheries (Anderson and Piatt 1999, Munro and Tide 2014).

There exists no other full water column temperature and salinity time-series in the northern GOA with comparable data quality, temporal extent, and frequency of sampling. Hence, the GAK-1 dataset is the premier reference dataset for evaluating hypotheses that seek mechanistic descriptions of the regional ocean environment and ecosystem. As shown by an ever-increasing number of publications that utilize the GAK-1 dataset, the value of this unique time-series continues to grow and even accelerate with the passing years and decades.

The GAK-1 dataset is collected under the fundamental hypothesis that oceanic conditions are important to the physical and biological functioning of the Prince William Sound and GOA ecosystems. To that end, many dozens of papers have examined this hypothesis from numerous perspectives (for a comprehensive listing, see the GAK-1 home page at http://www.ims.uaf.edu/gak1/). As the chemical and biological datasets begin to catch up (via quality of resolution, duration, and frequency) to the physical measurements we expect that the insights gleaned through interdisciplinary analyses will grow in kind. To date, the 47-year GAK-1 time-series has helped show:

1. There are large interannual differences associated with El Nino and La Nina events, including substantial differences in the spring bloom between these phenomena (Weingartner et al. 2003, Childers et al. 2005).
2. There is an intimate connection between coastal freshwater discharge and the depth-varying evolution of winter and spring temperatures over the shelf (Janout 2009, Janout et al. 2010).
3. GAK-1 provides a reliable index of Alaska Coastal Current (ACC) transports of mass, heat, and freshwater (Weingartner et al. 2005).
4. GAK-1 near-surface salinities are correlated with coastal freshwater discharge from around the GOA (Weingartner et al. 2005).
5. There are variations in mixed-layer depth in the northern GOA, which affects primary production (Sakar et al. 2006).
6. GAK-1 data demonstrate decadal scale trends in salinity and temperature, (Royer 2005, Royer and Grosch 2006, Weingartner et al. 2005, Janout et al. 2010, Kelley 2015).
7. There are relationships between temperature and salinity variations and the Pacific Decadal Oscillation and the strength and position of the Aleutian Low (Royer 2005, Weingartner et al. 2005, Janout et al. 2010),

8. The GAK-1 record can guide understanding of the variability in iron concentrations, a potentially limiting micro-nutrient required by many phytoplankton; preliminary efforts indicate that iron and surface salinity are correlated at least in certain seasons (Wu et al. 2008).

9. Between about 1000 and 1500 years before present, the northern GOA likely experienced a cooler, more sluggish and higher salinity ACC, whereas between 600 and 1000 years before present a stronger Aleutian Low may have driven a stronger and fresher ACC (Hallmann et al. 2011).

10. Ocean acidification (carbonate) system variability can be described using multiple linear regression models to predict dissolved inorganic carbon and total alkalinity using observations of nitrate, temperature, salinity, and pressure (Evans et al. 2013).

11. There is a decoupling of near-surface and near-bottom waters through increased stratification (Kelley, 2015) with implications for nutrient resupply to the euphotic zone and long-term changes in shelf productivity.

As shown and discussed by Mueter et al. (1994), Mueter (2004), and Spies (2009), these factors affect and relate to many ecosystem processes on both the shelf and within Prince William Sound and lower Cook Inlet/Kachemak Bay. Therefore, GAK-1 provides critical contemporary and historic reference points for all components of the Gulf Watch Alaska Program.

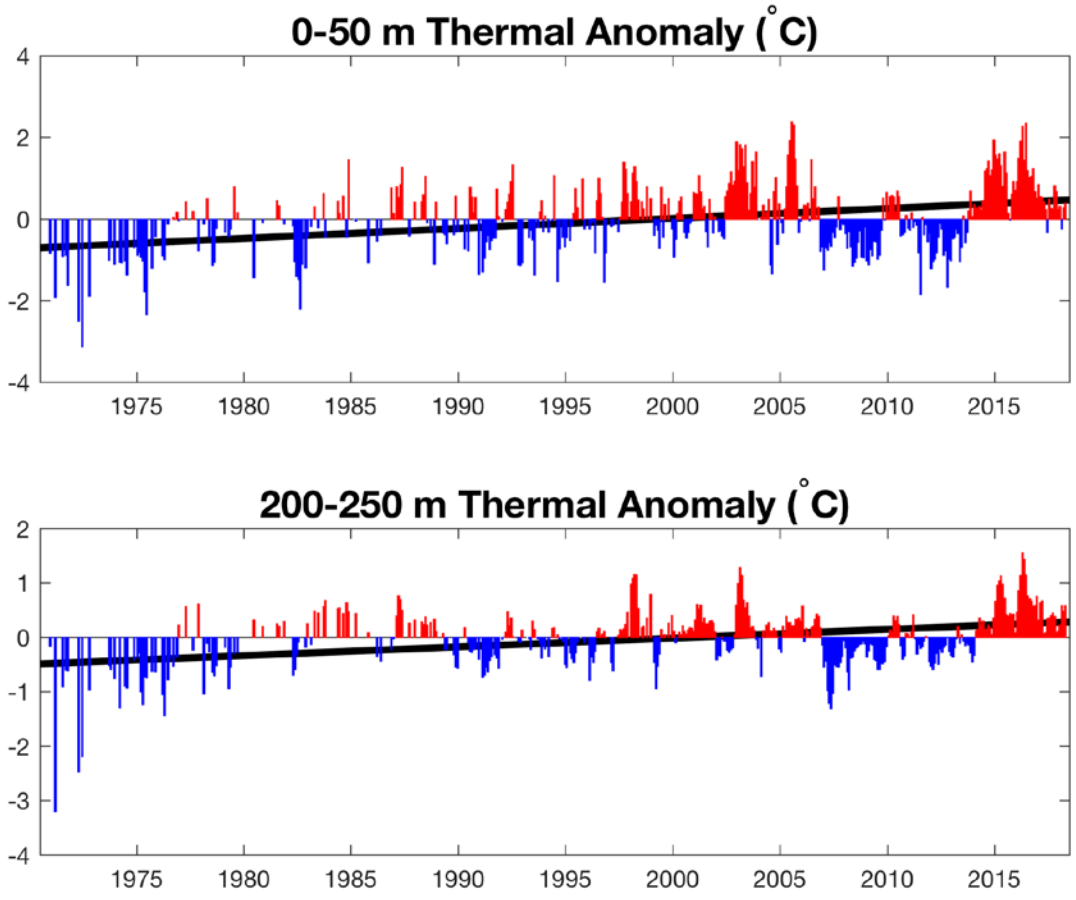

Figure 1. Time series 1970-2018. Temperature anomalies from the GAK-1 dataset over the upper 50 m depths (upper) and over 50 m close to the seafloor (lower) exhibit a long-term trend in warming along with signals associated with the cycles of El Nino and other phenomena. Black lines show the least squares best fit trend over the period of record.

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: Data collection & processing																				
Monthly CTD Cruises	C	C	C	C	C	C	X	X	X	X	X	X	X	X	X	X	X	X	X	X
CTD Data Processing	C	C	C	C	C	C	X	X	X	X	X	X	X	X	X	X	X	X	X	X
CTD Data Upload to Web	C	C	C	C	C	C	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Mooring Turnaround	C					C			X				X				X			
Moored Data Processing				C				X				X				X				X
Mooring Data Upload to Web				C				X				X				X				X
Milestone 2: Reporting																				
Annual Reports	C				C				X				X				X			
Annual PI meeting				C				X				X				X				X
FY Work Plan (DPD)			C				C				X				X					

B. **Explanation for not completing any planned milestones and tasks**

Milestones and tasks have been completed as planned.

C. Justification for new milestones/tasks

No new milestones/tasks proposed.

3. PROJECT COORDINATION AND COLLABORATION

A. Within an EVOSTC-funded Program

GAK-1 data provide high-resolution long-term contextual environmental data for the Gulf Watch Alaska scientific team, other researchers and agency personnel and the public at large. Data are available online at the GAK-1 website home page (http://www.ims.uaf.edu/gak1/) and through the Alaska Ocean Observing System (AOOS) Gulf of Alaska Data Portal served by Axiom. After processing, the data are posted to the GAK-1 website, submitted to the Gulf Watch Alaska data management team for archiving, and published to the AOOS-Axiom Gulf of Alaska Data Portal.

Gulf Watch Alaska

This project is part of the EVOSTC-funded Long-term Monitoring Program associated with the Environmental Drivers portion of Gulf Watch Alaska. We share data with all other projects within this portion of the Gulf Watch Alaska program including the following: Continuous Plankton Recorder, Seward Line, Oceanographic Condition in Lower Cook Inlet, and Oceanographic conditions in Prince William Sound. We share logistics at least twice per year with the Seward Line project. We are examining the spatial and temporal coherence in temperature and salinity with the Cook Inlet and Prince William Sound projects. The latter effort is to determine the degree of spatial heterogeneity in these variables over the inner shelf of the Gulf of Alaska.

Herring Research and Monitoring

The primary value of the GAK-1 data set is to provide the principal investigators of other programs an appreciation of the longer-term variability of the Gulf of Alaska as they examine their data sets. The GAK-1 project makes physical and biological data available to the Herring Research and Monitoring program and has been used to assess energetic costs of overwintering herring (Heintz, pers. comm).

Data Management

This project coordinates with the data management program by submitting data and preparing metadata for publication on the Gulf of Alaska Data Portal and DataONE within the timeframes required.

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

Our data have been used in the National Oceanic and Atmospheric Administration Gulf of Alaska Ecosystem Considerations report to the North Pacific Fishery Management Council annually since 2009 (Zador 2013). Like other Environmental Driver components, GAK-1 data also are available to the Alaska Department of Fish and Game for salmon forecasting.

Also, we have assisted the National Park Service (NPS) in establishing a similar monthly sampling and data processing protocol in Glacier Bay National Park and Preserve through the Inventory and Monitoring program (http://science.nature.nps.gov/im/units/sean/default.aspx), which also serves their data online. The sampling in Glacier Bay therefore provides a complementary data set that is collected upstream in terms of the general circulation characteristics of the GOA shelf. Collectively, the Glacier Bay, Prince William Sound, Cook Inlet, and GAK-1 data sets provide a broad-scale perspective of the GOA shelf environment. We are collaborating at no cost to this proposal with NPS scientists using conductivity-temperature-depth sampling and analysis protocols identical to those at GAK-1. Since southeast Alaska waters contribute to the ACC, the 26-year Glacier Bay time-series provides the opportunity to assess variability in the northeast and northwest GOA and to understand how these regions co-vary and how the ACC evolves as if flows westward toward PWS.

GAK-1 data are also used by the AOOS-supported ocean acidification monitoring study on the surface buoy nearby to GAK-1, which is known as mooring GAK-OA (Evans et al. 2013). Many other similar examples can be found in the extensive publication list at the GAK-1 website (http://www.ims.uaf.edu/gak1/).

4. PROJECT DESIGN – PLAN FOR FY19 (YEAR 7)

Overall Project Objectives

The fundamental goal of this program is to provide high quality, long-term data to quantify and understand variations that occur over short (hours to days) to long (inter-annual to multi-decadal) period variability of the GOA shelf. This measurement provides the broader temporal and spatial perspective important to our ecosystem-level understanding and management of the northern GOA. Specifically, we will:

Objective 1. Measure temperature and salinity throughout the water column

Objective 2. Measure near-surface pressure fluctuations

Objective 3. Measure water column stratification since this affects phytoplankton bloom dynamics

Objective 4. Measure chlorophyll fluorescence as an index for phytoplankton standing crop

A. Changes to Project Design and Objectives

Summer 2017: We note that the University of Alaska (UAF) Seward Marine Center coastal research vessel, the R/V Little Dipper, recently suffered an engine failure. The Dipper will likely be repaired and usable at least as a fair weather vessel but this is not an ideal long-term or year-round solution. In the meantime, we will likely need to charter the M/V Dora on a more regular basis, at a somewhat more costly day rate to the project, although at the moment we do not see need for a revised budget. The age of the vessel, its hull condition, safety for the crew and other factors have propelled us to begin seeking replacement options. In an optimistic scenario, we may be able to take delivery of a new vessel mid-way through the 2018 sampling year; however, full funding for this has not been secured to date. We do not anticipate disruptions to our annual sampling schedule.

Summer 2018: UAF has identified funding sources for a replacement upgrade for the R/V Little Dipper, has defined the requisite minimum specifications, and has issued a Request for Proposals from vessel manufacturers. Proposals are presently being evaluated and a contract could be issued this fall. We anticipate having a replacement vessel in place by August 2019. In the meantime we continue to charter the M/V Dora from Seward to accomplish the monthly sampling.

5. PROJECT PERSONNEL – CHANGES AND UPDATES

No changes to report.

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 changes to report.

C. Sources of Additional Project Funding

The new National Science Foundation-funded Gulf of Alaska Long-Term Ecological Research (LTER) program, listed under the Seward Line project, leverages, complements, and enhances the GWA program

activities. The LTER program will provide many years of additional significant research activities that will naturally blend and add value to the Gulf Watch Alaska program. For example, the first five-year block of the LTER program will fund at least three UAF graduate students who will spend time working with both Gulf Watch Alaska and LTER data collections.

From a consortium of funding partners, we secured $710,000 for the construction of a moored ecosystem observatory that will be deployed near the Seward Line on the outer/mid Northern Gulf of Alaska continental shelf. This new set of moorings will greatly expand and enhance the water column time series provided by the GAK1 mooring, by extending our physical time series measurements farther offshore and by adding numerous additional biological and chemical parameters. Equipment for Gulf of Alaska Moored Ecosystem Observatory (GEO) will come from the M.J. Murdock Charitable Trust ($350,000), the Alaska Ocean Observing System ($200,000), UAF ($90,000), the LTER program ($25,000), and the Gulf Watch Alaska GAK1 project ($20,000 in each of two years). Mooring servicing and turn-arounds will be accomplished annually by LTER/Gulf Watch Alaska Seward Line cruises on board R/V Sikuliaq. Once the moored observatory is in place, we will have access to an additional $42,600 of "seed funding" from the Murdock Trust that can be used to entrain new users of the observatory.

7. FY18 PROJECT PUBLICATIONS AND PRODUCTS

Publications

Weingartner, T. J., and S. L. Danielson. 2018. Long-term monitoring of oceanographic conditions in the Alaska Coastal Current from hydrographic station GAK1 over 1970-2016. *Exxon Valdez* Oil Spill Long-Term Monitoring Program (Gulf Watch Alaska) Final Report (*Exxon Valdez* Oil Spill Trustee Council Project 16120114-P), *Exxon Valdez* Oil Spill Trustee Council, Anchorage, Alaska.

Danielson, S. L., and T. J. Weingartner. 2018. Long-term monitoring of oceanographic conditions in the Alaska Coastal Current from hydrographic station GAK1. FY17 annual report to the *Exxon Valdez* Oil Spill Trustee Council, project 17120114-I.

Published Datasets

Research Workspace: 2017 CTD and mooring data uploaded to Research Workspace and undergoing QC. Data will be added to Gulf of Alaska Data Portal on schedule.

Presentations

Danielson, S. *Marine heatwaves in the North Pacific & Pacific Arctic 2013-2017*, UAF-CFOS Fisheries and Oceanography Seminar Series. 22 Nov. 2017

Outreach

None.

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