1. Project Number:

20120114-I

2. Project Title:

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

3. Principal Investigator(s) Names:

Seth L. Danielson and Thomas J. Weingartner, University of Alaska Fairbanks

4. Time Period Covered by the Report:

February 1, 2020-January 31, 2021

5. Date of Report:

March 2021

6. Project Website (if applicable):

www.gulfwatchalaska.org

http://research.cfos.uaf.edu/GAK-1/

https://portal.aoos.org/gulf-of-alaska#metadata/3c4ecb88-6436-4312-8281-ed584e020b0e/project

7. Summary of Work Performed:

The GAK-1 project achieved a major milestone in 2020 by completing its first full half-century of observations spanning December 1970 to December 2020 (Fig. 1). Immediately following the December 2020 cast, principal investigator (PI) Danielson published an Op-Ed piece in the Anchorage Daily News titled *The importance of University of Alaska-based monitoring of our oceans*, using GAK-1 as a focal example of the means in which scientific data are beneficial to the public interest. The Op-Ed text is included in this report at the end of this Section.

The GAK-1 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 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.

The primary GAK-1 long-term data set (Fig. 1) consists of nominally monthly conductivity-temperature versus depth casts, and despite two cancelled cruises due to the COVID-19 pandemic, we still managed to get conductivity and temperature at depth (CTD) profiles in 9 of the 12 months in 2020 (a third cruise was cancelled due to weather conditions). In 1998, year-round sampling at six discrete depth levels was initiated by means of a mooring outfitted with temperature/conductivity dataloggers distributed across the water column. The 2020 mooring turn-around was delayed by two months due to the pandemic, but the recovered data were good through the deployment (Fig. 2) and fresh sensors were re-deployed in May 2020 on a special Northern Gulf of Alaska (NGA) Long Term Ecological Research (LTER) cruise on R/V Sikuliaq. This cruise was the first University National Oceanographic Laboratory System (UNOLS)-approved expedition following the idling of the entire US academic fleet in March 2020. Our cruise received national attention as it generated the first National Science Foundation (NSF)-approved protocol for COVID-19-safe research cruise operations.

Our updated trend analyses (Table 1) were submitted to the annual National Oceanographic and Atmospheric Administration (NOAA) Ecosystem Status Report (Ferriss and Zador 2020) and show that recent water temperatures remain warmer than the 50-year climatology throughout the water column, while near-surface waters have freshened over time and near-bottom waters have salinized. The increased stratification associated with the trends in both the heat and haline parameters carries important implications for Gulf of Alaska biological productivity and ecosystem dynamics.

Table 1. Statistics of the near surface (0-50m) and near seafloor (200-250m) salinity and temperature trends over the period of record at GAK-1.

Parameter	**Date Range**	**Depth Range (m)**	**N (months)**	**Slope (per decade)**	**r^2**	**P**
Temperature (ºC)	1970-2020	0-50	429	+ 0.243 ± 0.058	0.14	1.30E-15
Temperature (ºC)	1970-2020	200-250	427	+ 0.177 ± 0.034	0.20	7.05E-22
Salinity	1970-2020	0-50	429	– 0.056 ± 0.030	0.03	2.84E-04
Salinity	1970-2020	200-250	427	+ 0.036 ± 0.017	0.04	2.35E-05

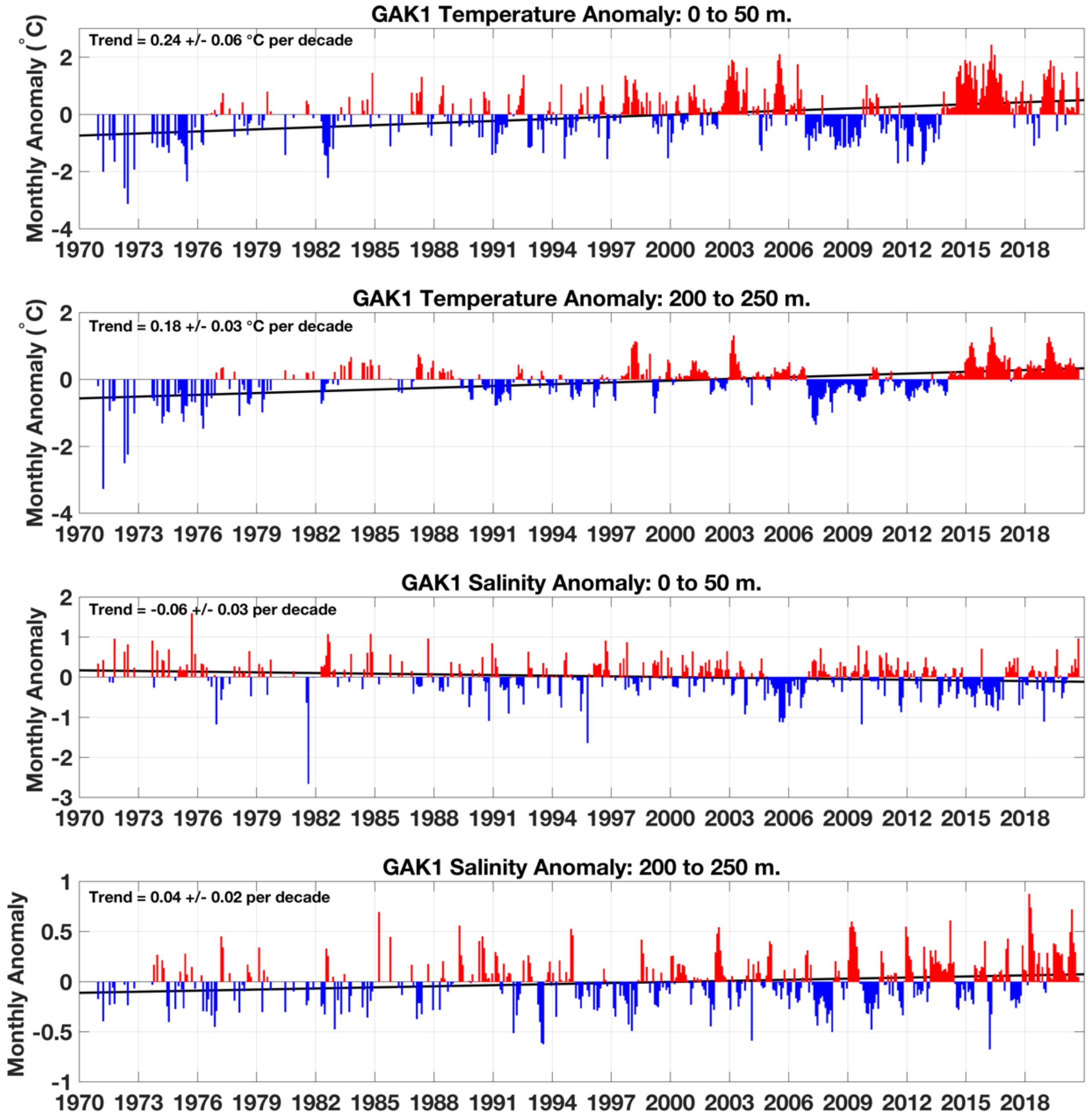

Figure 1. 1970 to 2020 half century record of temperature (upper two) and salinity (lower two) monthly anomalies from GAK-1.

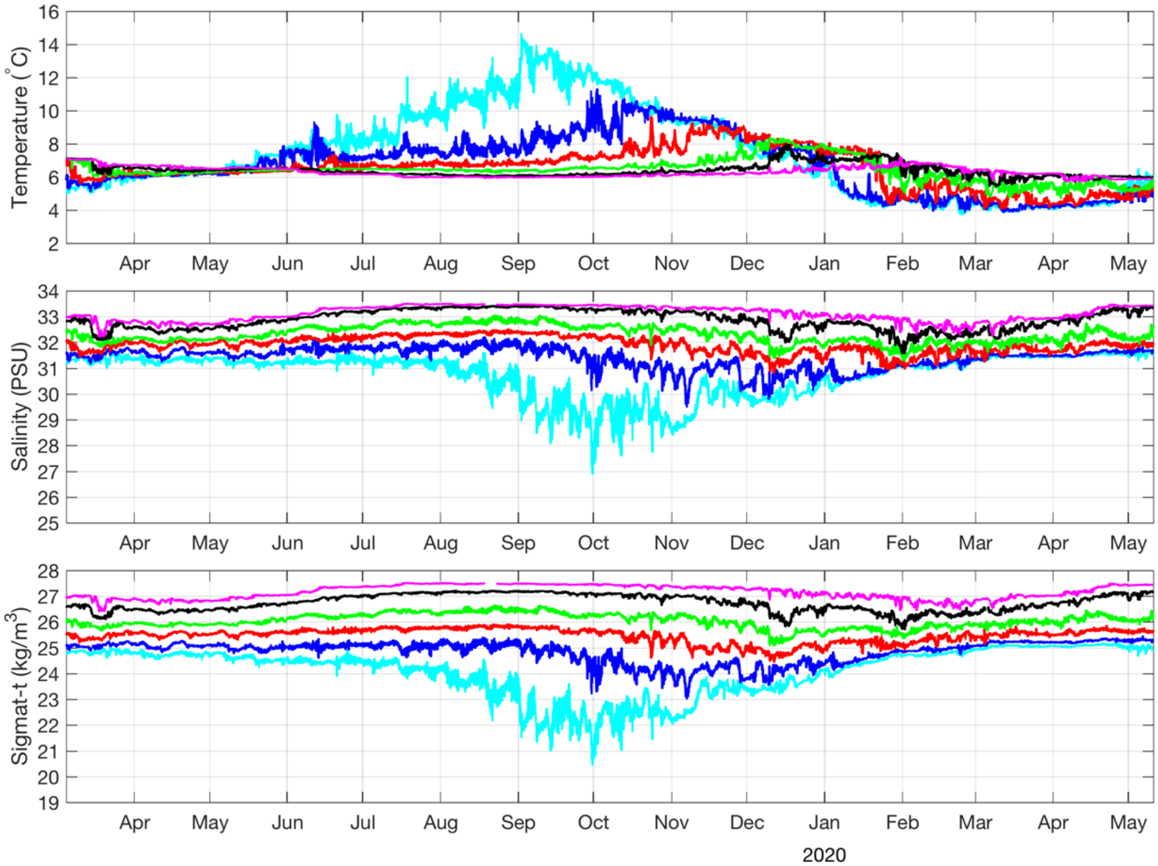

Figure 2. Time series of the 2019-2020 GAK-1 mooring records. Colors denote the nominal depth of each instrument from shallow (cyan, 20 m) to deep (magenta, 250 m).

The time series data from the recovered 2019-2020 mooring (Fig. 2) were generally of high quality and all instruments returned usable data. Synoptic-scale fluctuations in late summer and fall months – common in the mooring record – are most prominent in the upper 100 m of the water column. These features are likely related to atmospheric forcing and internal motions that may be propagating around the rim of the Gulf of Alaska. Other signals are clearly bottom-enhanced, and although their amplitudes are smaller than the surface-driven features, they likely provide a proxy for changes in the near-seafloor nutrient concentrations.

We are now aware of over 100 publications utilizing data collected at station GAK-1, and since 2010 the citation list continues to grow by about five publications per year. In 2020 we published a journal article in a special issue (Coastal Hydrology and Oceanography) of the Journal of Geophysical Research. Danielson et al. (2020) describes a 3-d high resolution ice and ocean circulation model of the northwest Gulf of Alaska (NWGOA). It uses a wetting-and-drying algorithm to accurately reproduce the large Cook Inlet tides, and it uses the high-resolution terrestrial runoff estimates of Beamer et al. (2016) to provide a coastal boundary forcing function of freshwater inputs. GAK-1 data are used to assess model performance (Figs. 3 and 4).

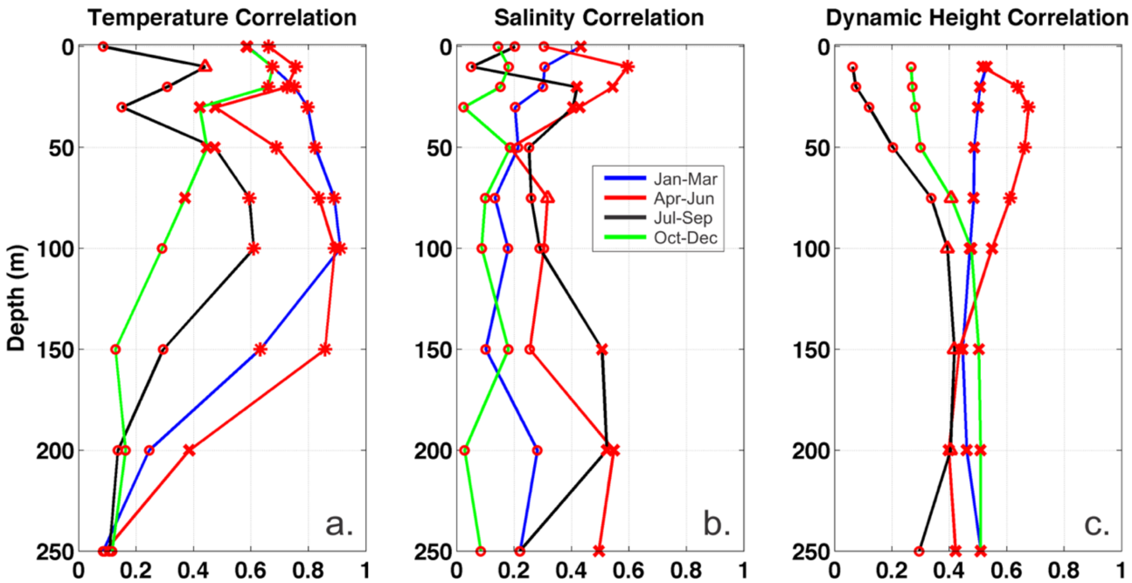

Figure 3. Correlation coefficients (r) between monthly anomalies of observations made at GAK-1 and monthly anomalies of hindcasts from the Danielson et al. (2020) ocean model. Parameters include temperature (a), salinity (b) and dynamic height referenced to the surface (c). Line colors represent January-March (blue), April-June (red), July-September (black) and October-December (green). Symbols show correlations that are not significant (circles) and significant at the 90%, 95% and 99% levels (triangles, crosses, and asterisks, respectively).

Fig. 3 shows that the Danielson et al. (2020) hindcast reproduces GAK-1 monthly anomalies of temperature, salinity and dynamic height with varying levels of fidelity through the water column and through seasons. For salinity (Fig. 3b), the strongest correlations ($r=0.5-0.6$, $p < 0.05$) are found near the surface (10-20 m depths) and in the lower portion of the water column (below 200 m depth) in spring (April-June). This season corresponds to the rapid annual increase of coastal discharge caused by the spring snowpack melt and often includes the annual discharge peak in June (Beamer et al. 2016). In summer (July-September), the maximum near-surface salinity correlation weakens ($r \sim 0.4$, $p < 0.05$) and is located slightly deeper in the water column (20-30 m), while the correlation remains near $r = 0.5$ at 200 m depth. The model mostly does not reproduce any significant portion of the observed anomalies in fall and winter (October-March). Unsurprisingly, fall and winter are the most difficult to hindcast, as the runoff rate is low and the signal-to-noise ratio for salinity is small.

The NWGOA model also exhibits some success in hindcasting temperature and dynamic height fluctuations. Temperature anomalies are best hindcast ($r \sim 0.9$, $p < 0.001$) in the first half of the year (January-June). Except for late in the year, when fall winds begin to destratify the water column, the maximum temperature correlations occur in the middle of the water column. The modeled 0-200 dbar dynamic height anomaly is significantly correlated with the observed anomaly in all seasons ($p < 0.05$ except $p < 0.1$ for spring) within a fairly narrow range of correlation coefficients of $r = 0.4-0.5$. Weingartner et al. (2005) showed that the GAK-1 0-200 dbar dynamic height is a proxy for the ACC June-August baroclinic ($r = 0.93$, $p < 0.05$) and freshwater transports ($r = 0.79$, $p < 0.05$) and also a proxy for the ACC November-May freshwater transport ($r = 0.62$, $p < 0.05$) and freshwater content ($r = 0.85$, $p < 0.05$). The numerical model's ability to provide statistically significant predictions of the dynamic height monthly anomalies is a necessary step in being able to eventually link atmospheric and terrestrial processes that drive discharge fluctuations with their downstream consequences for the marine system.

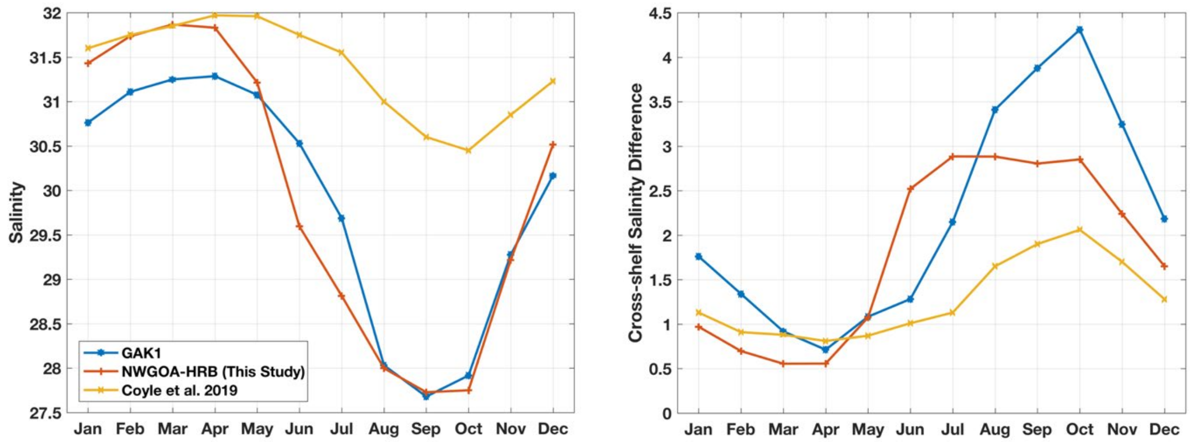

Figure 4. Comparison of the GAK-1 near surface (0-20m) observed climatology (blue) with the new northwest Gulf of Alaska (NWGOA; red) numerical model described by Danielson et al. (2020) and another recent numerical model (Coyle et al. 2019).

The incorporation of a coastal wall mass flux boundary condition in the NWGOA model is a significant step forward for Gulf of Alaska circulation modeling. Improvements occur because the proper amount of freshwater can be added to the model domain at the correct place, and the model physics are then able to dictate the mixing, transport, and diffusion of fresh water away from the coast. These improvements are clearly seen in comparisons to GAK-1 data and to a similar ocean circulation model (Coyle et al. 2019) that uses the “old” fashion of distributing freshwater in the form of a spatially prescribed virtual precipitation (Fig. 4). Such improvements are important if we are to rely on numerical models to accurately predict ecological responses to environmental variability.

The importance of UA-based scientific monitoring in Alaska's oceans

Published as an Anchorage Daily News Op-Ed

By Seth Danielson

December 12, 2020

Data is the lifeblood of science. It provides scientists with a way to prove, refine, or disprove our ideas about how the world works. Data from the University of Alaska Fairbanks (UAF) is providing valuable information for oil spill response, public safety, and economic development efforts in the 49th state.

UAF passed a remarkable milestone this month when scientists from the College of Fisheries and Ocean Sciences completed a half-century of regular observations at a Gulf of Alaska oceanographic station. Station GAK-1 is located near Seward at the mouth of Resurrection Bay, and it has the longest set of sustained measurements of surface-to-seafloor temperature and salinity in all of Alaska's coastal and offshore waters.

What does this mean for our state? GAK-1 is providing data to drive good decision-making and help us evaluate risks to Alaska's marine ecosystem and economy as the ocean becomes warmer and more acidic due to climate change. This monitoring contributes to our understanding of melting glacier runoff in the ocean, variations in Alaska's commercial fisheries, and the population status of marine mammals.

Data collected at GAK-1 and elsewhere across Alaska's oceans provide public benefit by contributing to responsible development of marine resources, vessel operations, tourism, and public safety. Observations made from ships, autonomous underwater gliders, and oceanographic moorings all support sustainable fisheries management practices and direct responses to warming-induced blooms of paralytic shellfish poisoning.

In the Arctic, land-based ocean current mapping systems staged in Bering Strait and near Utqiaġvik are assisting marine navigation and helping the US Coast Guard with oil spill response and search and rescue missions. Moored ecosystem observatories that track everything from ocean physics and chemistry to fishes and whales are our eyes on the offshore Arctic waters through the months when ice excludes vessel traffic.

The first GAK-1 observation was taken in December 1970 by UAF faculty member Tom Royer, who then began visiting the site every month or two. Royer later used the data to help accurately predict the time it would take oil from the 1989 *Exxon Valdez* oil spill to reach Kodiak.

We recognize that compared to thousands of years of Indigenous observations, 50 years is a blink of an eye. While useful, long-term systematic scientific data collections are just one cornerstone of a comprehensive resource management framework. Scientific knowledge and Indigenous knowledge accumulated through Alaska Native oral traditions both provide critically important references for assessing change. Both are necessary for responsible and equitable management of Alaska's marine resources, and the University of Alaska is an ideal place for bridging the two systems of knowledge.

Although monitoring can be expensive, the alternative—not establishing and maintaining key data records—can be even more costly, far beyond dollars and cents, to ecological, cultural, and social impacts that affect the well-being of us all.

Every dollar the state of Alaska spends on research at the University of Alaska brings in about six more. Diminished funding to our university system threatens our research capacity, and, in turn, jobs, public safety, and our economy. Our shared goals of healthy ecosystems and subsistence harvests, responsible development, and public safety depend in part on a strong University of Alaska.

Seth Danielson is an associate professor of oceanography at the College of Fisheries and Ocean Sciences at the University of Alaska Fairbanks.

8. Coordination/Collaboration:

A. Long-term Monitoring and Research Program Projects

1. Within the Program

The primary value of the GAK-1 data set is to provide the Gulf Watch Alaska PIs and PIs of other programs a means to assess long-term environmental variability of the Gulf of Alaska as they examine their data sets. GAK-1 data are also provided to the Gulf Watch Alaska environmental drivers, nearshore, and pelagic components to assist data analyses as needed.

The GAK-1 project coordinates closely with the Seward Line project (20120114-L, PI Hopcroft) and this helps reduce operating costs because the GAK-1 project is able to avoid a dedicated vessel charter in months that the Seward Line program occupies the GAK-1 site.

GAK-1 scientists contributed to two chapters of the Gulf Watch Alaska science synthesis report finalized by the *Exxon Valdez* Oil Spill Trustee Council during FY20 (Suryan et al. 2020). Additionally, we collaborated within the program to turn these synthesis chapters into peer-reviewed publications. Suryan et al. (in press) will be published in Scientific Reports and Danielson et al. (in review) was submitted to Deep Sea Research II for inclusion in a Gulf of Alaska special issue.

2. Across Programs

a. Herring Research and Monitoring

The GAK-1 project makes physical and biological data available to the Herring Research and Monitoring program. For instance, PI Heintz has been used GAK-1 data assess energetic costs of overwintering herring. In addition, PI Bishop of the Herring Research and Monitoring program inquired about the availability of GAK-1 as a platform for mounting an acoustic tag receiver for the purpose of detecting tagged herring. We installed this sensor on the GAK-1 mooring deployed in spring 2019, spring 2020, and will continue to do so for future deployments as needed.

Danielson's oceanography lab also operates a fleet of Teledyne Webb autonomous underwater Slocum gliders. In 2020, we upgraded a glider to carry a Vemco RxLive receiver so that we could listen for tagged fish and get detections returned in near real time. This is work done in partnership with PWSSC PIs Mary Anne Bishop (herring tagging project 20160111-B) and Rob Campbell (PWS oceanography project 20120114-G), and NOAA Auke Bay Labs scientist John Eiler. The upgrades were implemented in summer/fall 2020 and the glider was deployed January 20, 2021 and recovered on February 23.

b. 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. Individual Projects

University of Alaska Fairbanks-College of Fisheries and Ocean Sciences is spinning up a Subarctic Oceanography Field Techniques intensive August-mester field course in August 2021. Half of the two-week course will be based out of the Seward Marine Center and we anticipate visiting GAK-1 as part of this course. We will offer the students opportunities to work with the GAK-1 data and learn how to program, service, and deploy the GAK-1 instrumentation.

C. With Trustee or Management Agencies

We contribute reports and indicator time series to NOAA's Gulf of Alaska Ecosystem Status Report to the North Pacific Fisheries Management Council (Ferriss and Zador 2020), https://www.fisheries.noaa.gov/resource/data/ecosystem-status-report-2020-gulf-alaska. Data include GAK-1 near surface and near seafloor salinity and temperature, 1970–2020 and GAK-1 monthly anomaly time series for the 1970–2020. In addition, as a dataset with a 50-year time series that is publicly available, GAK-1 data are used for a wide variety of research and management purposes.

The GAK-1 project collaborates with the Ocean Acidification Research Lab to help facilitate the GAK-OA buoy turnaround and provides the GAK-1 mooring as a platform for OARC sensors. The GAK-OA mooring is located close to GAK-1, in Sunny Cove and is funded by NOAA's Ocean Acidification program.

The Danielson lab's fleet of Teledyne Webb autonomous underwater Slocum gliders are operated in partnership with NOAA scientist John Eiler. The glider, upgrades, and piloting were supported by via funding from the Integrated Ocean Observing System and its regional partner, the Alaska Ocean Observing System (AOOS). See the interactive tool online for the glider "Shackleton" at AOOS (https://portal.aoos.org/?ls=vmAmhyRR#platform/07197b36-867c-596b-bfc6-c059eefd3941/v2?c=rainbow&interp=grid&pid=12). Our plans are to next deploy the glider for a second month-long mission and then attempt to fly the glider from Prince William Sound to Seward, pausing at the GAK-1 mooring for some continuous days of late-winter hydrographic sampling. If this proof-of-concept test flight goes well, then we may consider future glider missions to GAK-1.

9. Information and Data Transfer:

A. Publications Produced During the Reporting Period

1. Peer-reviewed Publications

The recent publications listed below employ data collected at GAK-1, bringing the total to 105 publications from the last 50 years. A complete listing is at: http://research.cfos.uaf.edu/gak1/.

Blackmon, T.J. 2020. Growth of Pacific razor clams in Cook Inlet, Alaska. Doctoral dissertation, Alaska Pacific University.

Cieslak, M.C., A.M. Castelfranco, V. Roncalli, P.H. Lenz, and D.K. Hartline. 2020. t-Distributed Stochastic Neighbor Embedding (t-SNE): A tool for eco-physiological transcriptomic analysis. Marine genomics 51 p.100723.

Danielson, S.L., T.D. Hennon, D.H. Monson, R.M. Suryan, R.W. Campbell, S.J. Baird, K. Holderied, and T.J. Weingartner. in review. Marine temperature variations in the northern Gulf of Alaska across years of marine heatwaves and cold spells. Submitted to Deep-Sea Research II Special Issue.

Danielson, S.L., D.F. Hill, K.S. Hedstrom, J. Beamer, and E. Curchitser. 2020. Coupled terrestrial hydrological and ocean circulation modeling across the Gulf of Alaska coastal interface. WRR/JGR Oceans special issue on Coastal Hydrology and Oceanography, DOI:10.1029/2019JC015724

Laurel, B.J., and L.A. Rogers. 2020. Loss of spawning habitat and prerecruits of Pacific cod during a Gulf of Alaska heatwave. Canadian Journal of Fisheries and Aquatic Sciences 77:644-650.

Litzow, M.A., M.J. Malick, N.A. Bond, C.J. Cunningham, J.L. Gosselin, and E.J. Ward. 2020. Quantifying a Novel Climate Through Changes in PDO Climate and PDO Salmon Relationships. Geophysical Research Letters p.e2020GL087972

Litzow, M.A., M.E. Hunsicker, E.J. Ward, S.C. Anderson, J. Gao, S. Zador, S. Batten, S. Dressel, J. Duffy-Anderson, E. Fergusson, and R.R. Hopcroft. 2020. Evaluating ecosystem change as Gulf of Alaska temperature exceeds the limits of preindustrial variability. Progress in Oceanography p.102393.

Sanchez-Montes, M.L., E.L. McClymont, J.M. Lloyd, J. Muller, E.A. Cowan, and C. Zorzi. 2020. Late Pliocene Cordilleran Ice Sheet development with warm northeast Pacific sea surface temperatures. Climate of the Past 16:299-313.

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. Sweeney, M. Szymkowiak, B. Weitzman, J. Bodkin, and S. Zador. in press. Ecosystem response to a prolonged marine heatwave. Scientific Reports.

2. Reports

Danielson S.L. 2020. Oceanographic station GAK-1 water column conditions. *In* Ferriss, B., and S. Zador (editors), Gulf of Alaska Ecosystem Status Report 2020. Resource Ecology and Fisheries Management, Alaska Fisheries Science Center, NOAA. North Pacific Fishery Management Council, Anchorage, AK

Danielson, S.L., T.D. Hennon, D.H. Monson, R.M. Suryan, R.W. Campbell, S.J. Baird, K. Holderied, and T.J. Weingartner. 2020. Chapter 1 A study of marine temperature variations in the northern Gulf of Alaska across years of marine heatwaves and cold spells. In M.R. Suryan, M.R. Lindeberg, and D.R. Aderhold, eds. The Pacific Marine Heatwave: Monitoring During a Major Perturbation in the Gulf of Alaska. Gulf Watch Alaska Long-Term Monitoring Program Final Synthesis Report (*Exxon Valdez* Oil Spill Trustee Council Program 19120114). *Exxon Valdez* Oil Spill Trustee Council, Anchorage, Alaska.

Danielson, S.L., and R.R. Hopcroft. 2020. Seward Line May Temperatures. *In* Ferriss, B., and S. Zador (editors), Gulf of Alaska Ecosystem Status Report 2020. Resource Ecology and Fisheries Management, Alaska Fisheries Science Center, NOAA. North Pacific Fishery Management Council, Anchorage, AK

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. 2020. Chapter 4 Ecosystem response to a prolonged marine heatwave in the Gulf of Alaska. In M.R. Suryan, M.R. Lindeberg, and D.R. Aderhold, eds. The Pacific Marine Heatwave: Monitoring During a Major Perturbation in the Gulf of Alaska. Gulf Watch Alaska Long-Term Monitoring Program Draft Synthesis Report (*Exxon Valdez* Oil Spill Trustee Council Program 19120114). *Exxon Valdez* Oil Spill Trustee Council, Anchorage, Alaska.

3. Popular articles

Baily, A. 2020. UAF's Seward Marine Center celebrates 50 years, UAF press release, 18 Dec. 2020

Danielson, S.L. 2020. The importance of University of Alaska-based monitoring of our oceans. Anchorage Daily News Op-Ed, 12 Dec. 2020. (This was also a UAF press release and was re-printed in January 2021 by deltawindonline.com.)

B. Dates and Locations of any Conference or Workshop Presentations where EVOSTC-funded Work was Presented

1. Conferences and Workshops

Brydie, A., and S.L. Danielson, 2020. Copper River discharges in the Northern Gulf of Alaska: freshwater distribution and evolution during the July 2019 freshet, Poster presentation. AGO-ASLO Ocean Sciences Meeting, San Diego, CA. Feb.

Danielson, S.L. 2020. Freshwater in the Gulf of Alaska: New Observations and Model Results. Presentation to NOAA Coastal and Marine Modeling Branch (CMMB) seminar series. Distance video presentation. 15 Dec.

Danielson, S.L., 2020. Presentation to the Northern Gulf of Alaska Long Term Ecological Research Program: 2020 Field Updates, Nov. 2020

Danielson, S.L. 2020. Presentation to GWA PI meeting: 2020 Field Updates, Nov.

Danielson, S.L. 2021. Presentation to the Northern Gulf of Alaska Long Term Ecological Research Program PI meeting, Jan.

2. Public presentations

Danielson, S.L. 2020. Presentation and Q&A for Chugach School District classrooms in Chenega Bay, Tatitlik, and Whittier, 10 Nov.

Danielson, S.L. 2020. Three classroom visits with Chugach School District individual classrooms in Chenega Bay, Tatitlik, and Whittier, 24 Nov.

C. Data and/or Information Products Developed During the Reporting Period, if Applicable

Development of "signature data sets" for the NSF NGA LTER program. This will include a synthetic GAK-1 dataset comprised of both mooring and CTD profile data.

Development of GWA Environmental Drivers component conceptual models for outreach and other presentation purposes.

We continue to provide annual updates of Gulf of Alaska thermal and haline trends for the NOAA Ecosystem Status Report (Ferriss and Zador et al. 2020).

D. Data Sets and Associated Metadata that have been Uploaded to the Program's Data Portal

GAK-1 hydrographic profile and mooring data have been uploaded to the Research Workspace (https://workspace.aoos.org/project/23194/files).

10. Response to EVOSTC Review, Recommendations and Comments:

Science Panel Comment (FY21): It was not clear to the SP if cancelled and reduced surveys led to a reduction in costs. If so, what are the proposed plans for the surplus?

Danielson Response (FY21):

We were able to avoid a few thousand dollars in vessel charter costs, however, these costs were offset by increased personnel expenses caused by needing to implement adjustments to the planned field activities and in having to establish new field protocols. In addition, our overall productivity decreased due to reduced access to our lab facilities so the personnel cost of getting the work done has increased. The modest cost savings realized from reduced surveys were offset by these additional personnel expenses and resulted in minimal change to the original budget.

At this point we have a working set of protocols that allows us to accomplish our field work with reduced COVID-19 risk by dictating on-board social distancing, low-risk pre-cruise behaviors, and other safety measures. Going forward, we hope that we will be able to continue our operations without major additional adjustments. Each month's cruise is assessed on a case-by-case basis that includes consideration of ongoing rates of community spread, whether any field party member has been in close contact with any COVID-19-positive individuals, and other factors. Unspent vessel charter funds will be applied in FY21 to 1) help cover the increased salary costs of planning and executing each field activity and to 2) upgrade our mooring acoustic releases, which are aging to the point of unserviceability by the manufacturer.

Like all customers, we are experiencing backups at the datalogger manufacturer's calibration facility and, while we hope that this does not preclude getting the mooring instruments recalibrated in time for the 2021 deployment, if this were to happen, we can turn to other instruments in our inventory. These backup instruments have been identified already and set aside to prepare for this possibility.

Science Panel Comment (FY20): The Science Panel recognizes that this is an important project to monitor oceanographic changes, which are relevant to all the projects conducted in the GOA. The project continues to produce useful and informative data.

Danielson Response (FY20):

Thank you for your comments. We appreciate the positive feedback.

11. Budget:

For 2021 we will request a re-allocation of $7500 from contractual services into equipment (acoustic releases) because the existing mooring acoustic releases are aging beyond serviceability by the manufacturer and we have had some recent failures in our acoustic release inventory. Due to COVID-19 health mandates, cruises of opportunity and low fuel prices, we did not spend as much on vessel charters as anticipated (two cruises cancelled due to COVID-19) so we have some available funds to shift without impacting salary or other budget components. This purchase will help us reduce risk to the mooring instrumentation and data.

The GAK-1 project benefits from cruise-of-opportunity CTD sampling of GAK-1 by other projects. The R/V Sikuliaq occupies GAK-1 when feasible when entering or leaving Resurrection Bay, including Seward Line cruises. Such assistance helps fill in data gaps that would exist due to weather limitations of small boat operations. Additional unquantifiable in-kind benefits also derive from the Seward Line and the National Science Foundation-funded Northern Gulf of Alaska Long-Term Ecological Research program.

Other in-kind equipment and resources are used on an annual basis for this project, including mooring and vessel instrumentation ($200K) and CTD ($75K). Additional resources include mooring shop storage space, service and manufacturing tools and facilities (e.g., instrument test tank), and institutional equipment (e.g., forklifts) at Seward Marine Center, IT support for software and hardware of very large oceanographic datasets, and small boat research vessel (replacement R/V Nanuq $700K).

Budget Category:	Proposed FY 17	Proposed FY 18	Proposed FY 19	Proposed FY 20	Proposed FY 21	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$47.1	$48.2	$49.3	$50.4	$51.6	$246.6	$163.1
Travel	$4.4	$4.4	$4.4	$4.4	$4.4	$21.9	$13.5
Contractual	$18.7	$18.7	$18.7	$18.7	$18.7	$93.3	$68.8
Commodities	$6.1	$6.1	$6.1	$6.1	$6.1	$30.5	$26.3
Equipment	$39.3	$39.5	$23.7	$15.8	$16.0	$134.3	$106.1
Indirect Costs (*25% of non-equip.*)	$19.1	$19.3	$19.6	$19.9	$20.2	$98.1	$58.1
SUBTOTAL	$134.6	$136.2	$121.7	$115.2	$116.8	$624.6	$436.0
General Administration (9% of	$12.1	$12.3	$11.0	$10.4	$10.5	$56.2	N/A
PROJECT TOTAL	$146.8	$148.4	$132.6	$125.6	$127.4	$680.8	
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$285.0	$290.0	$575.0	

LITERATURE CITED

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