EVOSTC FY22 CONTINUING INDIVIDUAL PROJECT PROPOSAL

Proposals requesting FY22 funding are due to shiway.wang@alaska.gov and linda.kilbourne@alaska.gov by August 13, 2021. Please note that the information in your proposal and budget form will be used for funding review. Late proposals, revisions or corrections may not be accepted.

Project Number and Title

22200127 Gulf Watch Ocean Acidification Monitoring

Primary Investigator(s) and Affiliation(s)

Jeff Hetrick, Director, Alutiiq Pride Marine Institute
Rob Campbell, Prince William Sound Science Center
Steve Baird, Kachemak Bay National Estuarine Research Reserve
Wiley Evans, Hakai Institute

Date Proposal Submitted

Original submission: August 11, 2020
FY22 continuation: August 13, 2021

Project Abstract

The Chugach Regional Resources Commission (CRRC) operates the Alutiiq Pride Marine Institute (APMI), and its Ocean Acidification Research Laboratory (OAR Lab), in Seward Alaska. This project incorporates dissolved inorganic carbon (DIC) sampling for the purposes of quantifying ocean acidification into the Gulf Watch Program currently funded by *Exxon Valdez* Oil Spill Trustee Council (EVOSTC). The Gulf Watch program, through its routine sampling, has added the collection of DIC samples to several of its sampling sites. This has added to the current data sets from these locations and offers a broader understanding of ocean acidification in Prince William Sound and Lower Cook Inlet. The Prince William Sound Science Center (PWSSC) and the Kachemak Bay National Estuarine Research Reserve (KBNERR) are current partners in the Gulf Watch program and routinely conduct marine (vessel-based) sampling transects on a time series. The cost to sample and process DIC samples ($34,323 per year) is the only additional cost to the PWSSC and KBNERR existing programs and would go directly to CRRC.

**The abstract should provide a brief overview of the overall goals and hypotheses of the project and provide sufficient information for a summary review as this is the text that will be used in the public work plan and may be relied upon by the PAC and other parties.*

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

FY20	FY21	FY22	FY23	FY24	TOTAL
$34,323	$34,323	$34,323	$0	$0	$102,969

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

FY20	FY21	FY22	FY23	FY24	TOTAL
$0	$0	$0	$0	$0	$0

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

1. PROJECT EXECUTIVE SUMMARY

Provide a summary of the program including key hypotheses and overall goals, as submitted in your original proposal. Please include a summary and highlights from your FY21 work: preliminary results with figures and tables should be accompanied with interpretation and short discussion to assist with proposal evaluation. If there are no preliminary results to present, please explain why (i.e., lab analysis is still in progress). List any publications that have been submitted and/or accepted since you submitted your last proposal and other products in Section 7. If applicable, FY20 Annual Reports will be included with this proposal for review.

Ocean acidification has been studied in the open ocean for many years. APMI developed the OAR Lab in 2013 in response to industry leaders recognizing the impacts of ocean acidification on shellfish. The OAR Lab at APMI has achieved the goal of providing high quality data to Tribal partners, researchers, and community stakeholders alike. These data adhere to strict measurements of quality held by APMIs academic and agency partners, and are sufficient to identify relative spatial patterns and short-term variations, supporting mechanistic response to, and impact on, local immediate ocean acidification dynamics.

Since 2013, APMI has developed a continuous monitoring program of intake water from Resurrection Bay. This program is funded by the Alaska Ocean Observing System and is distributed nationally through the Integrated Ocean Observing Systems Partner Across Coasts database. APMI also runs an extensive discrete sampling program with 15 partners, including Tribal communities in Prince William Sound and Lower Cook Inlet. A project funded by the Bureau of Indian Affairs (BIA) in 2016 provided two years of support to sample coastal marine waters in the communities of Lower Cook Inlet and Prince William Sound. During this project, CRRC solicited samples from both PWSSC and KBNERR while conducting their Gulf Watch sampling to broaden the geographical coverage of this sampling program. That funding has expired, and CRRC has now received EVOSTC support to continue these efforts.

Since the initiation of this project in FY20, Gulf Watch partners have collected samples as proposed.

To date, the OAR Lab has analyzed 44 samples from Prince William Sound in 2020, and six samples from Prince William Sound in 2021. Final review and analysis of these samples is ongoing. Three cruises remain for collection in FY21, and several samples from FY21 cruises are still pending transport from PWSSC to APMI. Samples collected by partners at KBNERR in Lower Cook Inlet have been received, and a total of 66 samples from 2020 and 78 samples from 2021 are awaiting analysis at APMI. Sample acquisition is ongoing for 2021 for both Prince William Sound and Lower Cook Inlet sites.

APMI experienced significant delays in obtaining the chemical standards necessary to operate analytical equipment during the COVID-19 Pandemic and has recently returned to pre-pandemic laboratory operations. APMI expects to continue processing samples at normal rate to generate the final deliverables for this project.

CRRC is requesting that the EVOSTC continue to support the processing of ocean acidification samples within its Gulf Watch Program for FY22. This currently funded project is an addition to existing monitoring capability to the Gulf Watch Program currently funded by the EVOSTC.

2. PROJECT STATUS OF SCHEDULED ACCOMPLISHMENTS

Milestones are annual steps to meet overall project objectives.
Tasks are annual steps to meet milestones (for example, sample collection, data analysis, manuscript submittal, etc.)
For each milestone and task listed, specify by each quarter of each year their status (completed, planned), as submitted in your original proposal.
Reviewers will use this information in conjunction with annual program reports to assess whether the program is meeting its objectives and is suitable for continued funding.

A. Project Milestones and Tasks

Table 1. Project milestones and task progress by fiscal year and quarter, beginning February 1. Additional milestones and/or tasks have been added in red. C = completed, X = planned or not completed. Fiscal year quarters: 1 = Feb 1 – April 30; 2 = May 1 – July 31; 3 = Aug. 1 – Oct. 31; 4 = Nov. 1 – Jan. 31.

	FY20				FY21				FY22				FY23				FY24			
Milestone/Task	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Milestone 1:																				
Collect Samples	C	C	C	C	C	X	X	X	X	X	X	X								
Milestone 2:																				
Process Samples		C	C	C	C	X	X	X	X	X	X	X								
Milestone 3:																				
Annual Reports					C				X											
Upcoming FY Workplans			C				X													
Final Report													X							

B. Explanation for not completing any planned milestones and tasks

For each milestone and task listed in the table that has not been completed as scheduled, please provide an explanation and when you expect to complete it. If all milestones and tasks have been completed, write a complete sentence stating that. Reviewers will use this information in conjunction with annual program reports to assess whether the program is meeting its objectives and is suitable for continued funding.

Due to the COVID-19 pandemic, some of the sampling trips outlined in this project have been postponed.

- KBNERR completed its first quarterly sampling cruise from T6_4, T4_4 (same as KBO3), and T9_6 which amounts to 18 samples. This represents a loss of either two or three sampling transects from the six that were scheduled in 2020. Sampling has since resumed and was completed as scheduled for the remainder of FY20.
- PWSSC completed one sampling trip, and missed one of the five sampling trips scheduled for 2020. PWSSC collected samples as planned for the remainder of 2020.

Also due to pandemic related disruptions in supply chains nationwide, the availability of stock chemicals for the creation of chemical standards necessary for successful assay completion was limited. APMI staff were unable to procure necessary reagents for a significant period of FY20/FY21. Thus, sample analyses were delayed through FY21. Analytical capabilities have since been restored and sample processing has recently returned to pre-pandemic laboratory operations. APMI expects to continue processing samples at normal rate to generate the final deliverables for this project.

C. Justification for new milestones/tasks

Please provide justification for any new milestones or tasks that are being proposed. If none are proposed, write a complete sentence stating that.

Reviewers will use this information in conjunction with annual program reports to assess whether the program is meeting its objectives and is suitable for continued funding.

No new milestones/tasks are being proposed.

3. PROJECT COORDINATION AND COLLABORATION

A. Within an EVOSTC-funded Program

Provide a list and clearly describe the functional and operational relationships with any EVOSTC-funded Program (Herring Research and Monitoring, Long-Term Research and Monitoring or Data Management Programs). This includes any coordination that has taken or will take place and what form the coordination will take (shared field sites or researchers, research platforms, sample collection, data management, equipment purchases, etc.).

Gulf Watch Alaska

This project is a collaboration with a currently funded EVOSTC Gulf Watch under the Long-Term Research and Monitoring (LTRM) Program. APMI has a long-standing relationship with PWSSC and KBNERR through collection

and processing of ocean acidification samples for the aforementioned project funded by the BIA Landscape Conservation Program. This project is utilizing the existing Gulf Watch scheduled cruises and sampling sites to collect water samples to analyze for DIC as an indicator of ocean acidification, and only requires partners to collect and preserve additional ocean acidification samples. All samples are collected in compliance with APMI's Quality Assurance Project Plan (QAPP) standards (CRRC, 2018).

APMI Director Jeff Hetrick and OAR Supervisor Jacqueline Ramsay have been involved with the ocean acidification research community since 2013, when the first continuous monitoring device was installed at the APMI in Seward. Since that time, APMI staff have been active partners with the Alaska Ocean Observing System, Northwest Association of Networked Ocean Observing Systems, University of Alaska (UAF), Hakai Institute, Oregon State University (OSU), and researchers in Alaska and throughout the west coast.

In addition to the long-term "Monitoring for Ocean Acidification near coastal villages and communities in south-central Alaska: Building Capacity and Assessing Vulnerability" project, originally funded by the BIA and continued by CRRC, APMI has coordinated sampling programs with the Tribes in the Chugach region including; Tatitlek, Chenega Bay, Valdez, Eyak, Qutekcak, Port Graham, Nanwalek, and Seldovia through funding from the Environmental Protection Agency's Indian General Assistance Program. APMI has also processed samples for the National Park Service, PWSCC, KBNERR, and Kasitsna Bay Laboratory. Recently, APMI began partnerships with communities outside their region, including; King Cove, Nome, Kotzebue, and Utqiagvik.

APMI has also collaborated with the UAF Fairbanks College of Fisheries and Ocean Sciences to conduct carbonate exposure studies in a range of shellfish, finfish, and algae species.

Herring Research and Monitoring
None at this time.

Data Management
All data are processed by APMI under its QAPP (CRRC, 2018) and further reviewed by the OAR Supervisor before uploading to the APMI website for public access (www.alutiiqprideak.org/oar). In addition to the website, these data are stored on both the CRRC/APMI internal drive and the APMI google drive. This project also coordinates with the EVOSTC funded Data Management Program objectives for submitting data and preparing metadata for publication as part of the Gulf of Alaska Data Portal, within the timeframes required.

B. With Other EVOSTC-funded Projects

Indicate how your proposed project relates to, complements, or includes collaborative efforts with other proposed or existing projects funded by the EVOSTC that are not part of an EVOSTC-funded program.

Water chemistry data are vital to all researchers studying the marine environment in Prince William Sound and Lower Cook Inlet. The Gulf Watch Program is a well-developed water sampling program, and the addition of processing ocean acidification sampling is only limited to the cost of processing the samples at the OAR Lab in Seward.

These data have the potential to augment numerous studies funded by EVOSTC with the addition of an analytical parameter that may factor into observed environmental changes. For example, the PWSSC is testing innovative plankton monitoring systems at its profile site near Naked Island. Inorganic chemistry data will add another layer of data to help understand the dynamics of these plankton populations. That research is funded by a variety of sources including Scripps Institute of Oceanography and the North Pacific Research Board.

C. With Trustee or Management Agencies

Please discuss if there are any areas which may support EVOSTC trust or other agency work or which have received EVOSTC trust or other agency feedback or direction, including the contact name of the agency staff. Please include specific information as to how the subject area may assist EVOSTC trust or other agency work. If the proposed project requires or includes

collaboration with other agencies, organizations, or scientists to accomplish the work, such arrangements should be fully explained, and the names of agency or organization representatives involved in the project should be provided. If your proposal is in conflict with another project, note this and explain why.

This proposal requires lead scientists and staff at KBNERR (Steve Baird) and PWSCC (Rob Campbell) to schedule and include ocean acidification sampling in their marine sampling trips. Collaborators send samples to Seward and ensure the QAPP (CRRC, 2018) is adhered to during field sampling. If any sampling deficiencies are discovered, the QAPP has provisions for samplers to make adjustments to ensure samples are being collected properly. There are no known conflicts with other projects or programs.

4. PROJECT DESIGN

A. Overall Project Objectives

Identify the primary objectives for your project as submitted in your original proposal.

The objective of the proposal is to extend the sampling coverage of CRRCs Ocean Acidification Program and take advantage of EVOSTCs existing investments into the Gulf Watch Program. CRRC has funded cooperation with the Gulf Watch Program through BIA funds which have expired. Long term data sets are important for documenting ocean acidification changes temporally and spatially.

Procedural and Scientific Methods

Field Sampling

APMI has developed a field kit designed for researchers and community members to take discrete samples that are shelf stable. In order to attain a data set that temporally represents a locale with robust data, a reliable sampling protocol has been adopted. Our method of collecting samples was adapted from NOAA's Pacific Marine Environmental Laboratory (PMEL) protocols (Dickson et al., 2007; Bockman and Dickson, 2015). This sample acquisition protocol was modified to apply to shoreside collection at remote Alaskan sites by collaboration with Dr. Wiley Evans at the Hakai Institute, Dr. Burke Hales at OSU, and Jacqueline Ramsay at APMI. In the field, 350 mL samples are collected in amber glass bottles. Samples are preserved with 80 µl mercuric chloride onsite prior to shipping to the OAR in Seward.

Wet Lab Analysis

Once in Seward, all the laboratory processes at APMI, from liquid bag construction and glassware preparation to data finalization, are adapted from both OSU and Hakai Institute protocols for analyzing like samples with identical equipment. Additionally, all system maintenance is performed according to manufacturer's suggestions for specific system components. The analytical equipment used to process the seawater samples is a unique state of the art system developed for analyzing TCO_2 and pCO_2, called the *Burke-O-Lator* [Dakunalytics, LLC]. Each sample is analyzed for inorganic carbon chemistry; total alkalinity, aragonite and calcite saturation states (Ωarag, Ωcalc), concentrations of bicarbonate ion ([HCO_3–]), carbonate ion ([CO_3(2–)]), and dissolved carbon dioxide ([CO_2]) using CO2SYS software (van Heuven et al., 2011). The methods used for analyzing discrete bottle samples using the *Burke-O-Lator* were developed at OSU and written into protocol by the Hakai Institute. The complete protocol details specific instrumentation and analysis parameters to be followed to acquire acceptable data utilizing a *Burke-O-Lator*, within the standards set forth by the research community (Pimenta and Grear, 2018).

QA/QC

Liquid standards are prepared gravimetrically, from laboratory grade sodium carbonate (Na_2C0_3), sodium bicarbonate ($NaHC0_3$), and hydrochloric acid (HCl). Technicians are guided by an excel template developed through the OSU that allows users to input actual values and acquire real time chemical concentrations targeting specific alkalinity and $TC0_2$ targets. Three liquid standard concentrations are produced in the lab on a monthly basis, and are stored in airtight Mylar© bags. The three concentrations are run in series to calculate a liquid standard curve for $TC0_2$. Certified reference materials (CRMs) and known liquid standards, produced by Andrew Dickson at University of California San Diego (UCSD), are used to ascertain the error of the liquid standards. Gas standards of three CO_2 concentrations (150, 750, and 1500 ppm) [Praxair] are used to run standard curves for $pC0_2$. The gas standards, liquid standards, and CRMs are analyzed at the beginning and end of each set of samples

that are analyzed in a day to correct for drift over time (changing temperature or atmospheric pressure) during a sample run.

Data Analysis

Data acquired during sample analysis through LabView software developed by Dr. Hales at OSU are input into an excel spreadsheet designed to integrate the liquid, gas, and CRM standard values and return data that is ready to be processed through C02SYS to obtain finalized $TC0_2$, $pC0_2$, pH, saturation state of aragonite (Ωarag), and total alkalinity. Final QA/QC data will be made public on the APMI website, and will be analyzed in a time series with the goal of identifying nay significant trends. Ultimately, APMI hopes to incorporate these analyses into a peer-reviewed publication.

Protocols and Records

CRRC has developed a QAPP for its Ocean Acidification Program (CRRC, 2018). The QAPP has been approved by the EPA and is part of CRRC's IGAP water monitoring program in the Chugach region. The manual details all of the sampling protocols, including methods for taking the samples, preserving samples, shipping, data collecting, corrective actions and data processing protocols.

Data Analysis and Statistical Methods

Data collected in the field by Gulf Watch partners adheres to previously described and implemented procedures. Field measurements of temperature, salinity, and dissolved inorganic carbon are recorded with each sample as described in CRRC's QAPP (CRRC, 2018). Samples are preserved while in the field with mercuric chloride, which makes the samples shelf stable. Following collection, samples are sent to the APMI OAR for processing.
The APMI OAR in Seward utilizes the *Burke-O-Lator* to process samples. Each "run" of samples requires calibration with liquid standards, which allows adjustments of calculations and results in 0.001% accuracy. The OAR in Seward is one of very few in the nation that produces data at this precision and accuracy level. The sample size for each location has been determined from previous sampling programs. Samples that yield levels outside expected range trigger review by the QAPP (CRRC, 2018). All data generated by analysis of the *Burke-O-Lator* are adjusted relative to the standards before and after daily processing. The data generated at the OAR receives a secondary review by the partner institutions prior to entering the ocean acidification data portal.

APMI evaluates the data for outliers and trends over time. These data are typically visualized in time series, however, APMI may also engage with collaborating oceanographers to interpret data sets in another fashion. Finalized raw data are furnished to collaborators and the public upon successful QA/QC.

Description of Study Area

This study is taking place in Lower Cook Inlet and Prince William Sound, Alaska (Figure 1) within in the EVOS spill area.

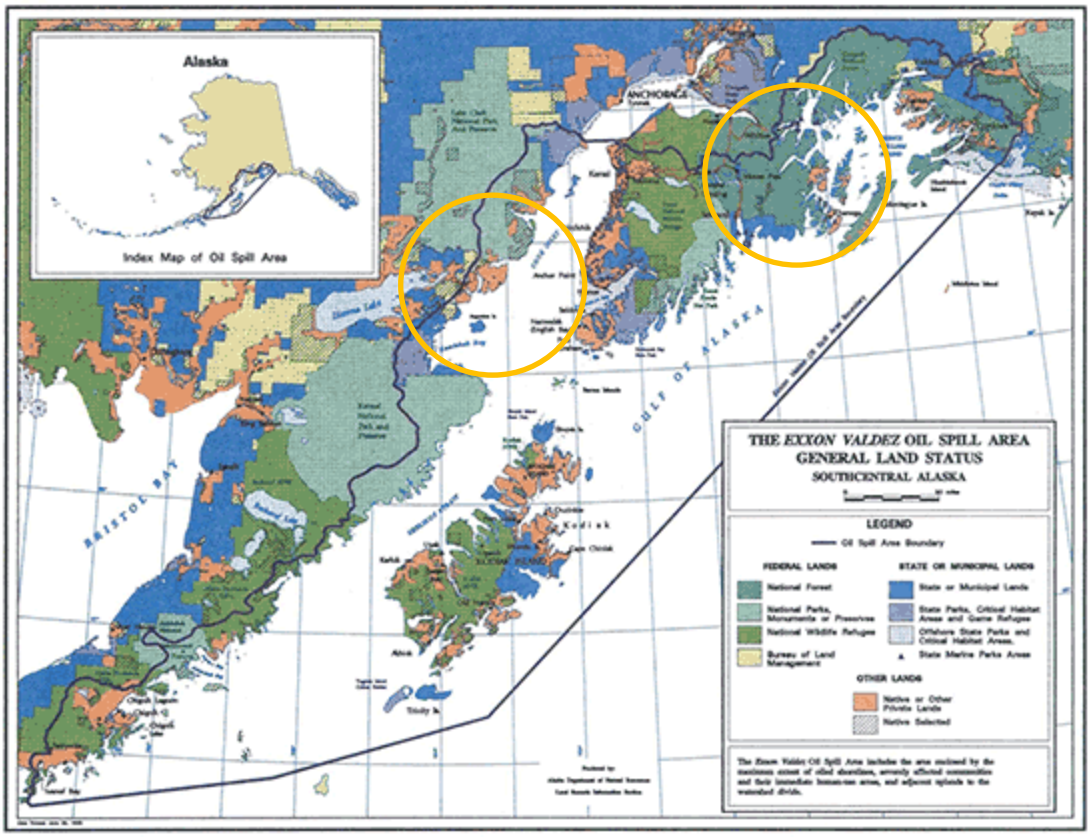

Figure 1. Current study areas in Prince William Sound and Lower Cook Inlet.

The KBNERR conducts water sampling under its Gulf Watch Program. KBNERR samples transects across Kachemak Bay (Figure 2; Table 1) and has selected two transects (four and nine) to be included into an ocean acidification monitoring program.

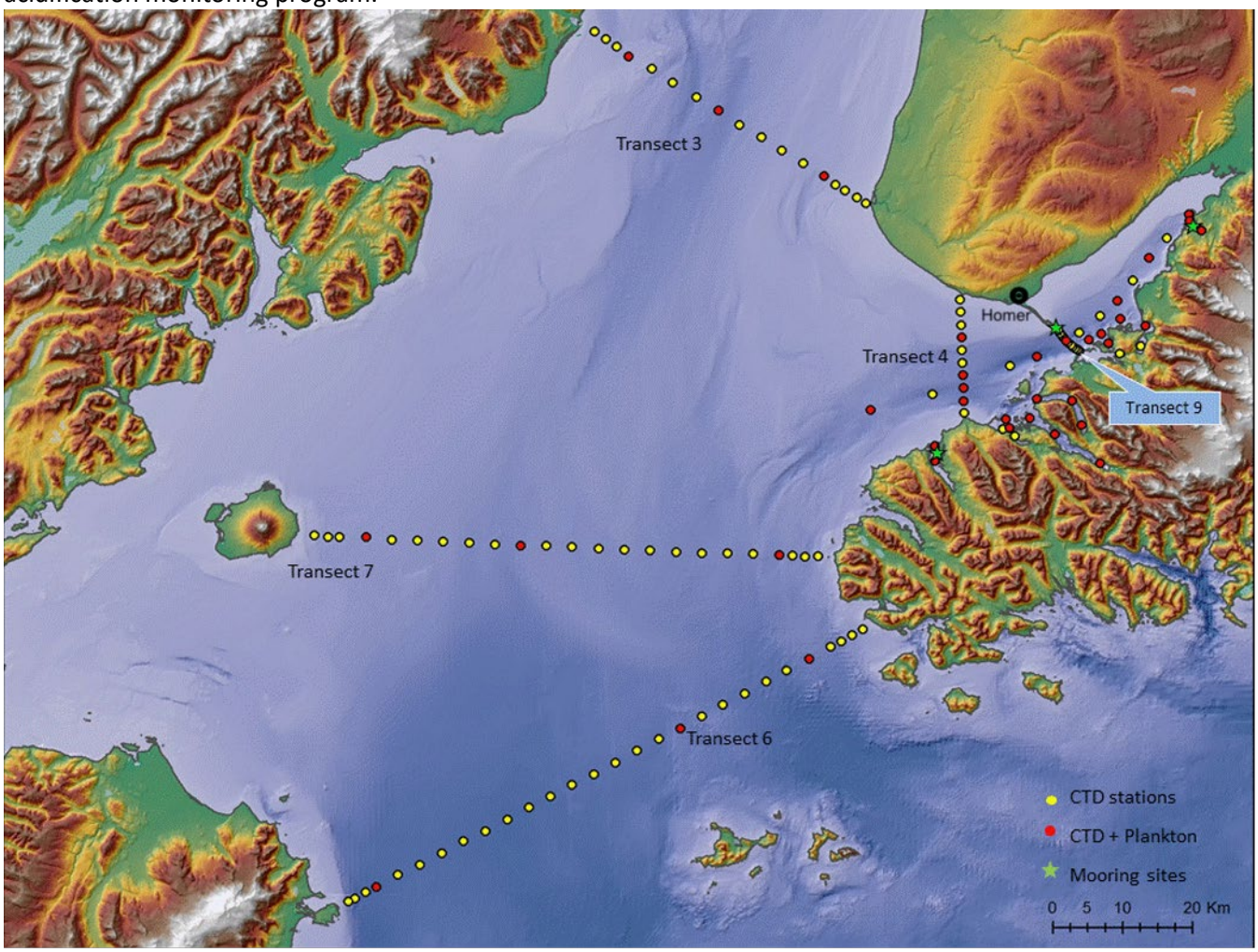

Figure 2. Current study areas in Lower Cook Inlet.

Table 1. Kachemak Bay sample sites

Sample Site	Latitude	Longitude	Sample Site	Latitude	Longitude
4-1	59.49200	-151.6500	9-1	59.56900	-151.35012
4-2	59.50500	-151.6500	9-2	59.57241	-151.36669
4-3	59.52500	-151.6500	9-3	59.57241	-151.37129
4-4	59.54200	-151.6500	9-4	59.57508	-151.36669
4-5	59.55800	-151.6500	9-5	59.57720	-151.37129
4-6	59.57500	-151.6500	9-6	59.57998	-151.37727
4-7	59.59200	-151.6500	9-7	59.58303	-151.38287
4-8	59.60800	-151.6500	9-8	59.58645	-151.38747
4-9	59.62500	-151.6500	9-9	59.58981	-151.39220
4-10	59.64200	-151.6500	9-10	59.59310	-151.39708
			9-11	59.59664	-151.40165

The PWSSC conducts water sampling in Prince William Sound during March, May, June, August, October and November. Three sites have been selected for ocean acidification sampling (Figure 3; Table 2). The Naked Island site is the profile site selected for the PWSCC sampling program, Simpson Bay is representative of the eastern Prince William Sound, and Whale Bay is in western Prince William Sound.

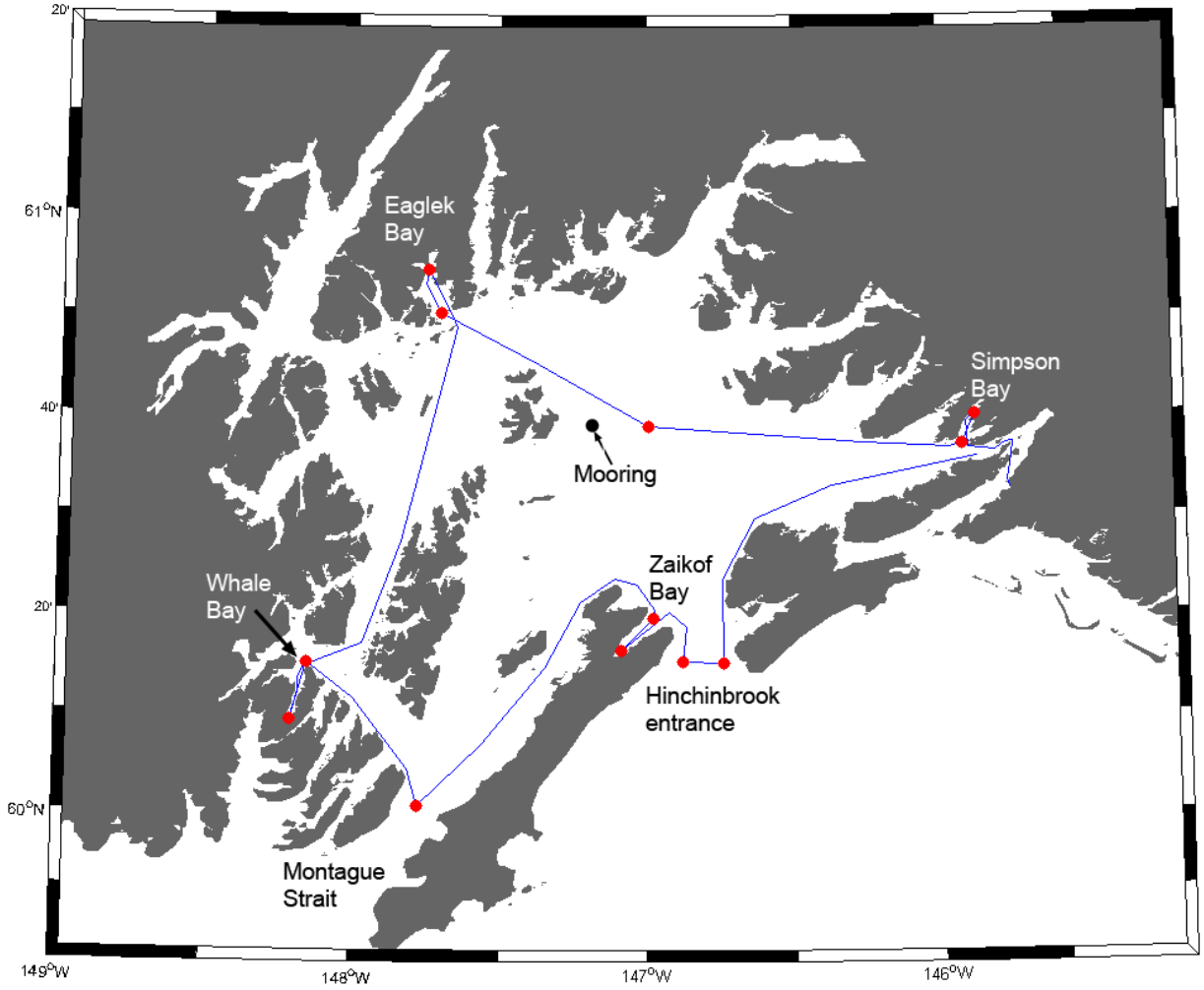

Figure 3. Current study areas in Prince William Sound.

Table 2. Prince William Sound sample sites

Sample Site	Latitude	Longitude
Naked Island	60.61	-147.2
Whale Bay	60.23	-148.17
Simpson Bay	60.61	-145.91

B. Changes to Project Design and Objectives

If the project design has changed from your original proposal, please identify any substantive changes and the reason for the changes. Include any information on problems encountered with the research or methods, if any. This may include logistic or weather challenges, budget problems, personnel issues, etc. Please also include information as to how any problem has been or will be resolved. This may also include new insights or hypotheses that develop and prompt adjustment to the project.

No changes have been made from the original proposed project.

5. PROJECT PERSONNEL – CHANGES AND UPDATES

Note any staffing changes to Primary Investigators or other senior personnel. Please provide CV's for any new personnel and describe their role on the project.

No changes in personnel have occurred on this project.

6. PROJECT BUDGET

A. Budget Forms (Attach)

Please provide completed budget forms (Excel workbook). Please note that costs associated with international travel for meetings, symposia, or presentations will not be considered for funding. Include a screen shot of the "Summary" worksheet.

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
PROGRAM PROJECT BUDGET PROPOSAL AND REPORTING FORM

Budget Category:	Proposed FY 20	Proposed FY21	Proposed FY22	Proposed FY23	Proposed FY24	TOTAL PROPOSED
Personnel	$ 15,075.00	$ 15,075.00	$ 15,075.00	$ -	$ -	$ 45,225.00
Travel	$ -	$ -	$ -	$ -	$ -	$ -
Contractual	$ 11,925.00	$ 11,925.00	$ 11,925.00	$ -	$ -	$ 35,775.00
Commodities	$ 250.00	$ 250.00	$ 250.00	$ -	$ -	$ 750.00
Equipment	$ -	$ -	$ -	$ -	$ -	$ -
Indirect Costs (*will vary by proposer*)	$ 4,239.00	$ 4,239.00	$ 4,239.00	$ -	$ -	$ -
SUBTOTAL	$ 31,489.00	$ 31,489.00	$ 31,489.00	$ -	$ -	$ 81,750.00
General Administration (9% of subtotal)	$ 2,834.01	$ 2,834.01	$ 2,834.01	$ -	$ -	$ 8,502.03
PROJECT TOTAL	**$ 34,323.01**	**$ 34,323.01**	**$ 34,323.01**	**$ -**	**$ -**	**$102,969.03**
Other Resources (Cost Share Funds)	$ -	$ -	$ -	$ -	$ -	$ -

B. Changes from Original Project Proposal

If your FY22 funding request differs from your original proposal, provide a detailed list of the changes and discuss the reason for each change.

No changes have been made from the FY20 proposal.

C. Sources of Additional Project Funding

Identify non-EVOSTC funds or in-kind contributions used as cost-share for the work in this proposal. List the amount of funds, the source of funds, and the purpose for which the funds will be used. Do not include funds that are not directly and specifically related to the work being proposed in this proposal. Please attach documentation from additional project funding sources which confirms and describes matching funds, including date(s) the matching funds are/will be authorized.

No sources of additional funding are currently being used for this project.

7. PROJECT PUBLICATIONS AND PRODUCTS

Products include publications (include in prep and in review), published and updated datasets, presentations, and outreach since the start of the project.

Publications

None

Published and updated datasets

Final QA/QC numerical data from this project are being disseminated to both collaborating scientists and the public via the new APMI website (www.alutiiqprideak.org/oar).

Outreach

Due to the COVID-19 pandemic, no plans for outreach have been made at this time.

Presentations

Due to the COVID-19 pandemic, scheduled presentations have been cancelled. No presentations have been made for this project to date.

8. LITERATURE CITED

Bockmon, E. E., & Dickson, A. G. (2015). An inter-laboratory comparison assessing the quality of seawater carbon dioxide measurements. *Marine Chemistry*, *171*, 36–43. https://doi.org/10.1016/j.marchem.2015.02.002

Chugach Regional Resources Commission. (2018). *Quality Assurance Project Plan; Seawater Quality Monitoring Program*

Dickson, A., Sabine, C., & Christian, J. (2007). *Guide to Best Practices for Ocean C02 Measurements*. www.pices.int

Pimenta, Adam, R., Grear, Jason, S. (2018). *Guidelines for Measuring Changes in Seawater pH and Associated Carbonate Chemistry in Coastal Environments of Eastern United States*. www.epa.gov/ord

Van Heuven, S. M. A. C., Pierrot, D., Rae, J. W. B., Lewis, E., & Wallace, D. W. R. (2011). *MATLAB program developed for CO2 system calculations.*