FY 22-31 *PROJECT* PROPOSAL
DEVELOPMENT OF MARICULTURE (EXCLUDING FINFISH)

Proposals requesting FY22 - 31 funding are due to shiway.wang@alaska.gov and linda.kilbourne@alaska.gov by March 29, 2021. Please note that the information in your proposal and budget form will be used for funding review. Please refer to the Invitation for the specific proposal requirements for each Focus Area. The information requested in this form is in addition to the information requested in each Focus Area and by the Invitation. We may make inquiries regarding the project and proposer(s), including consulting with agencies or other parties. Project proposals may be submitted in response to only one current Invitation (FY 22-31 or FY 22-26). A project that is submitted under both Invitations may be disqualified from consideration. Please indicate below if your proposal contains confidential information.

Does this proposal contain confidential information? ☐Yes ☒No

Project Number* and Title

22220300 Prince William Sound Kelp Mariculture Development for Habitat Restoration and Local Economy

Primary Investigator(s) and Affiliation(s)

Willow Hetrick-Price, Executive Director, Chugach Regional Resources Commission (CRCC)

Date Proposal Submitted

26 March 2021

Project Abstract (maximum 300 words)

The abstract should provide a brief and concise 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 EVOSTC Public Advisory Committee and other parties.

The Chugach Regional Resources Commission (CRRC), in partnership with the Native Conservancy, is spearheading a five-year project to enable Native Alaskan and coastal communities to play a significant role in building a regenerative ocean farming economy in Prince William Sound (PWS). Our hypothesis is that careful and evidence-based kelp farming in oil-spill impacted areas of PWS will enhance localized water quality and habitat and sustain a profitable mariculture industry in the region through conservation-based kelp farming. Our overall goal is to establish this sustainable kelp farming industry in PWS based on best practices that fulfill long-term restorative economic development goals through specific objectives to:

- Objective 1: Scale the infrastructure to increase the production capacity of the Alutiiq Pride Marine Institute and Community Kelp Seed Nurseries to meet projected kelp seed string demands of the region.
- Objective 2: Develop effective, affordable, and sustainable practices for Native kelp farming through specific array designs, deployment methods, and seed cultivation strategies that will lead to the long-term restoration of oil-spill impacted areas of PWS.
- Objective 3: Conduct a comprehensive landscape analysis by deploying research kelp sites and kelp dropper lines to develop commercial farm capacity rating per region. Collect, analyze, and share data related to water quality, kelp tissue composition, sea life and other factors that may indicate the viability of a site for commercial kelp farms.

The project builds on three years of training coastal and Native Alaskan kelp farmers, kelp-nursery development at CRRC's Alutiiq Pride Marine Institute (APMI) in Seward, Alaska, the establishment of seven test-line sites, research

into native species, and technology transfer of best-practices in kelp farming and conservation practices. The project will pave the for **2000 acres of a recovering ecosystem capable of producing 30 million pounds of kelp annually through 100 Native-owned kelp farms.** Our long-term goal is to support the development of the mariculture industry, to be led by Native-owned farms. We will adjust our vision to align with the Mariculture Development Plan. While we will not develop these farms directly, our kelp seed nurseries and test sites established under this proposal will allow us to confidently advise and support future farmers. Leveraging a mix of Native farmer training, infrastructure and market development, and metrics-driven research, this initiative will lay the necessary groundwork for networks of Native-owned ocean farms and kelp seed nurseries, processing hubs and value-added kelp businesses throughout Alaska.

EVOSTC Funding Requested (round to the nearest hundred, must include 9% GA)

FY22	FY23	FY24	FY25	FY26	FY22-26 Total
$808,445	$614,545	$588,385	$621,085	$129,013	$2,761,472
FY27	**FY28**	**FY29**	**FY30**	**FY31**	**FY27-31 Total**
				FY22-31 Total	***$2,761,472***

Non-EVOSTC Funds to be used, (round to the nearest hundred) please include source and amount per source:

FY22	FY23	FY24	FY25	FY26	FY22-26 Total
$500,000	$75,000	$75,000	$50,000	$0.00	$700,000
FY27	**FY28**	**FY29**	**FY30**	**FY31**	**FY27-31 Total**
				FY22-31 Total	***$700,000***

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

Please provide a summary of the project including key hypotheses and overall goals. Describe the background and history of the problem. Include a scientific literature review that covers the most significant previous work history related to the project. Include which injured resources and services will be studied and describe how these affected resources, services and ecosystems will benefit from this project. Projects are limited to species historically found in the Spill Area or shellfish species currently cultured in Alaska that can meet the State Alaska's licensing and permitting requirements – does this project meet this requirement?

The Chugach Regional Resources Commission (CRRC), in partnership with the Native Conservancy, seeks two million dollars over five years for the *Prince William Sound Kelp Mariculture Development for Habitat Restoration and Local Economy* project that will enable Native Alaskan and coastal communities in the Spill Area to play a significant role in building a regenerative ocean farming economy.

Our hypothesis is that careful and evidence-based Kelp farming in oil-spill impacted areas of PWS will support **the local economy** by building a sustainable and environmentally friendly kelp farming industry. Preliminary

research indicates this industry may improve fish habitat (herring and other fish spawning grounds), reduce ocean acidification, and sustain profitable human mariculture in the region. The overall goal is to establish this sustainable kelp farming industry in PWS based on best practices that fulfill long-term restoration goals for the ecosystem. The specific objectives are to:

- Objective 1: Scale the infrastructure to increase the production capacity of the Alutiiq Pride Marine Institute and Community Kelp Seed Nurseries to meet projected kelp seed string demands of the region.
- Objective 2: Develop effective, affordable, and sustainable practices for Native kelp farming through specific array designs, deployment methods, and seed cultivation strategies that will lead to the long-term restoration of oil-spill impacted areas of PWS.
- Objective 3: Conduct a comprehensive landscape analysis by deploying research kelp sites and kelp dropper lines to develop commercial farm capacity rating per region. Collect, analyze, and share data related to water quality, kelp tissue composition, sea life and other factors that may indicate the viability of a site for commercial kelp farms.

Over the last three years, CRRC and the Native Conservancy have laid the groundwork for Native subsistence-based and fishing cultures to work together to enhance ocean habitat and regenerate local economy These initiatives established a kelp seed nursery and research test lines and collected information on the impacts of farming three native kelp species. Native and local communities are permitting farms that will integrate emerging mariculture science to sustainably manage kelp and mariculture species with traditional ecological knowledge gained from millennia of practice.

CRCC and the Native Conservancy are leveraging the momentum of the mariculture industry to position kelp enhancement as the basis of an ocean regenerative economy for Alaskan coastal communities.

Following numerous discussions with tribal leaders in the EVOS spill zone organized by the Native Conservancy and Chugach Regional Resources, the Native Conservancy, Alaska Conservation Foundation and GreenWave have collectively launched the Native Alaskan Kelp Initiative which aims to build a network for farms throughout the state managed by Indigenous institutions (tribes, ANCSA corporations, and Indigenous nonprofits). The project will pave the for **2000 acres of a recovering ecosystem capable of producing 30 million pounds of kelp annually through 100 Native-owned kelp farms.** Our long-term goal is to support the development of the mariculture industry, to be led by Native-owned farms. We will adjust our vision to align with the Mariculture Development Plan. While we will not develop these farms directly, our kelp seed nurseries and test sites established under this proposal will allow us to confidently advise and support future farmers. Leveraging a mix of Native farmer training, infrastructure and market development, and metrics-driven research, this initiative will lay the necessary groundwork for networks of Native-owned ocean farms and kelp seed nurseries, processing hubs and value-added kelp businesses throughout Alaska.

Working with collaborators (Dr. Schery Umanzor, Marine Ecology specialist at the University of Alaska in Juneau; GreenWave, a leading organization on kelp farming for regenerative ocean farming; and coastal and Native communities in PWS) the project will establish best practices in regenerative kelp farming for the region, provide data to understand the impacts, and manage the industry in a way that helps rebuild healthy ecosystems in the Sound.

2. RELEVANCE TO THE INVITATION (maximum 300 words)

Discuss how the project addresses the projects of interest listed in the Invitation and the overall goals and objectives of the Focus Area. Describe the results you expect to achieve during the project, the benefits of success as they relate to the topic under which the proposal was submitted, and the potential recipients of these benefits.

This proposal is in response to the 2021 Mariculture Development invitation announced by the EVOS Trustee Committee. Kelp farming has shown promise as a sustainable mariculture approach that can promote marine habitat recovery (Grebeab 2019). Our ongoing pilot project of raising and seeding test farms sites in PWS over the last two years demonstrated optimal conditions for its establishment in the Spill Area. Native-species kelp farming, such as we propose, avoids harvesting plants in which local herring and other fish have spawned and has **a positive net benefit on the marine environment.** It requires no pesticides or fertilizers. It has been shown to be helpful for improving water quality and habitat for native marine life (Visha 2020, Steineck 2002). It can improve restoration efforts, fisheries productivity, and alternative livelihoods development (Grebeab 2019) and promote storm damage mitigation (Bouchard 2018), and carbon sequestration (World Bank 2016) and facilitate natural recovery of the ecosystem.

Kelp farming has already garnered significant interest among PWS coastal communities. Subsistence kelp gathering is a long-standing traditional practice of Alaska Native communities in the region. This project will lay the groundwork for regenerative kelp cultivation, which requires an infrastructure that can reliably supply the specific seed-line needs of farmers and disseminate best practices to promote marine habitat and water quality improvements in PWS. This project will provide evidence-based industry research that is critical to building kelp farming as a long-term viable industry in PWS.

We have carefully piloted this effort over the last two years as a strategy for both habitat enhancement and alternative livelihood development by engaging experienced kelp biologists, permitting consultants, and aquaculture specialists. Strong Alaska Native community involvement is also incorporating centuries of traditional knowledge in understanding and managing kelp and mariculture resources.

3. PROJECT HISTORY (maximum 400 words)

Is this a new or continuing project? If continuing, please describe the history of the project and what has been accomplished to date (i.e., numbers of publications, presentations, podcasts etc.). Please include detailed references to products (i.e., publications, reports, and websites) in the literature cited section.

CRRC, in partnership with the Native Conservancy, successfully initiated the Community Kelp Seed Nursery (CKSN) in 2020 and built a stationary kelp nursery at CRRC's APMI in Seward, Alaska. Accomplishments include the full build-out and operation of the stand-alone seed nursery, completed in 2020, development of a Best Practices manual, groundwork for full operational nursery in APMI and expanded research capacity in 2021.

APMI, built in the mid-1990s, provides the only shellfish hatchery in south-central Alaska and the lead hatchery and mariculture research facility for the Alaskan mariculture industry. Its mission is to produce shellfish seed stock for the mariculture industry and for Tribes for direct consumption to supplement traditional foods and ensure food security, and to conduct research on shellfish recruitment and survival. APMI produces geoduck clams, Pacific oysters, basket cockles, and more (see https://alutiiqprideak.org/).

We have established partnerships with GreenWave, University of Alaska, Alaska Coastal Rainforest Center and Alaska Conservation Foundation to catalyze conservation-promoting kelp farming in PWS. Beyond the

establishment of the nursery and test sites, this has included training and assistance for both small-scale kelp farms, and the transfer and integration of best practices and technologies to the region.

To date, the CKSN has successfully cultivated and delivered 80 spools and three species of native kelp--*Saccharina Latissima* (sugar kelp), *Alaria Marginata* (ribbon kelp), and *Nereocystis Luetkeana* (bull kelp) --to seven research test sites in the PWS. Various cultivation processes are being incorporated, including varying light and temperature, streamlining equipment sanitation, and testing tank-change methods to minimize hock and contamination of seed spools. After successful delivery of the seed spools, nursery equipment has been disassembled, cleaned, and packaged within the container. Our partner, the Native Conservancy, compiled lessons from the first stage of the project into a best practices manual shared with key partners (Lankard & Bobrycki 2021).

The seven research test sites were selected to include a wide geographical range, including regions in PWS (Southwest, North, and East). Each site met the basic parameters thought to be conducive to kelp farming including, salinity, temperature, currents, and accessibility/use. Performance varied between the sites, confirming the necessity of testing sites prior to establishing full farms. While pinpointing the impacts specific environmental factors is challenging in an uncontrolled environment, experts in the field are supporting us in establishing performance conclusions. We will publish our data and recommendations after the study is concluded, once we have multiple years and observations logged.

By 2022, the CKSN will build out and operate the community kelp seed nursery to full capacity, and grow 60,000ft of kelp seed line. In total, it will result in seven research test sites, two years of appropriate, locally sourced kelp cultivation, refined kelp farm arrays, and proven research and data management techniques.

4. PROJECT DESIGN

A. Objectives and Hypotheses

List the objectives of the proposed project and concisely state why the project is important. Also include an outline of specific restoration objectives independent of mariculture objectives. If your proposed project builds on recent work, provide justification that the data are valuable and will remain valuable and if any changes are proposed. If the proposed project is for new work, provide justification of how the project will provide data useful to addressing management objects, Focus Area goals, and further the Council's mission of recovering injured natural resources and their services.

If applicable (research projects supporting the development of mariculture), clearly state the hypotheses, and describe how these hypotheses contribute to supporting the development of mariculture in the Spill Area.

Project Hypothesis

Based on experience in other mariculture environments in the US and other countries, we believe that kelp farming is ideally suited for both habitat restoration and alternative livelihood development in PWS. Our hypothesis is that careful, evidence-based kelp farming in oil-spill impacted areas of PWS will fulfill mariculture development goals of establishing the infrastructure and best practices to launch a sustainable and profitable kelp industry in PWS, Alaska.

Main Objectives

- Objective 1: Scale the infrastructure to increase the production capacity of the Alutiiq Pride Marine Institute and Community Kelp Seed Nurseries to meet projected kelp seed string demands of the region.
- Objective 2: Develop effective, affordable, and sustainable practices for Native kelp farming through specific array designs, deployment methods, and seed cultivation strategies that will lead to the long-term restoration of oil-spill impacted areas of PWS.
- Objective 3: Conduct a comprehensive landscape analysis by deploying research kelp sites and kelp dropper lines to develop commercial farm capacity rating per region. Collect, analyze, and share data related to water quality, kelp tissue composition, sea life and other factors that may indicate the viability of a site for commercial kelp farms.

B. Study Design, Procedural and Scientific Methods

For each objective listed in A. above, describe the study design and identify the specific methods that will be used to meet the objective. Project proposals that seek to continue to contribute new data to the data sets collected in previous years using the same protocols and project design must provide justification that the past methods applied are still appropriate. If changes are needed based on current information a justification for the changes must be provided.

In describing the methods for lab work, field work, collection and analysis, identify measurements to be made and the anticipated precision and accuracy of each measurement and describe the sampling equipment in a manner that permits an assessment of the anticipated raw-data quality.

If applicable, discuss alternative methods considered, and explain why the proposed methods were chosen. In addition, projects that will involve the lethal collection of birds or mammals must comply with the EVOSTC's policy on collections, available on our website.

We will conduct essential ongoing industry research through seven test-line sites and in the kelp nursery.

The kelp farm research test sites are located in Nelson Bay, Simpson Bay, Sheep Bay, Port Gravina, Tatitlek Village region (Port Fidalgo), Latouche Island, and Foxfarm Island. These test sites are contiguous with small to mid-range, independent, and Native village farm locations. State and federal permits have been issued for setting anchors, chains, lines and buoys. Each research site currently has four cement anchors and 24 buoys that support three, 100-foot grow lines suspended seven feet below the water surface. Each grow line hosts different species of kelp (sugar, bull, or ribbon kelp) aimed at determining whether and how well the kelp species will grow at that site and/or in that region. To better understand the impacts on habitat and water quality, as well as develop restorative, sustainable array designs, we seek to expand these sites to 16, 400ft arrays. This mimics a farm array, providing more targeted research and development to future farmers as well as increase the impact and sample size for water quality impact and data analysis.

Test sites will continue to develop conservation-promoting farming techniques and provide critical data to support restoration efforts. In particular, test sites will determine how we expand the APMI kelp nursery and prepare the CKSN for timely delivery of kelp seed for PWS kelp farms from 2022 to 2025, with videography, analysis and reporting concluding in 2026. As nursery capacity expands, we will modify permits to expand the arrays and test new anchors or designs, to better inform future farmers.

The project will deliver cultured seed to the seven expanded test sites, and more than a dozen kelp farms comprised of independent farmers and Native Alaskan Tribes who are starting family-owned and commercial kelp farms over the next five years. The project will train these farmers in conservation-promoting practices and provide them with ongoing monitoring assistance and data collection.

The kelp nursery at APMI is key to the project's success as a conduit for ongoing mariculture research and for native seed stock production. Access to native seed stock (essential for maintaining the integrity and restoring marine ecosystems) is the bottleneck to the kelp mariculture industry in Alaska and is fundamental to establishing kelp mariculture in PWS. Currently, the small CKSN maintains the only nursery for kelp or seaweeds in the immediate region; there are only two seed nurseries in the state: in Ketchikan and on Kodiak Island. CKSN is permitted by the State of Alaska for seaweed cultivation activities and is near PWS.

A. Data Analysis (If Applicable), Statistical Methods (If Applicable) and Measuring Project Success

If applicable, describe the process for analyzing data. Describe the statistical power of the proposed sampling program for detecting a significant change in numbers based on statistical analyses such as power or sensitivity analysis. To the extent that the variation to be expected in the response variable(s) is known or can be approximated, proposals should demonstrate that the sample sizes and sampling times (for dynamic processes) are of sufficient power or robustness to adequately test the hypotheses. For environmental measurements, what is the measurement error associated with the devices and approaches to be used?

Analyses and methods proposed must be justified. Project proposals that seek to continue to contribute new data to the data sets collected in previous years using the same protocols and project design must provide justification that the past methods applied are still appropriate. If changes are needed based on current information a justification for the changes must be provided.

Describe a plan that will be used to evaluate and measure the success of this project.

Upon recommendations from reviewers and our scientific partners, we have concluded that we cannot accomplish a defensible research design given the numerous environmental factors and inability to conduct controlled experiments. We will continue to collect and analyze water and tissue samples to further develop our test site datasets with the aim of informing practical application for future farmers. Carbon levels in tissue samples could inform farmers about the capacity of their farm site and the stage of development of the plants when sampled. Nitrogen testing of the water and tissue could inform farmers of nutrient dense locations and areas that can support larger farms. Temperature readings in the spring could inform farmers when to expect biofouling to begin and ideal harvest times. Salinity readings can let farmers know if there are significant fresh water mixing at their sites and if they should sink their arrays deeper to prevent blistering of their kelp.

Water quality data at each of the research test sites will be collected throughout the growing period from December – May of each year and made available to the public in the Summer, beginning FY23 and each subsequent year. Water parameters measured include salinity, Ph, turbidity, dissolved oxygen, flow rates, and nutrients.. Kelp grown will also be tested each year for carbon, nitrogen, and heavy metals.

The exact number of plants per test line will vary depending on how well and evenly the sorus settles on the seed spools in the nursery, however on a 100ft line there will assuredly be over 1000 plants per line, allowing for a variety of sampling to occur at each site. For the carbon and nitrogen sampling directed by Dr. Schery Umanzor we collect 5 tissue samples per line at different intervals.

Ribbon and Sugar kelp plants are primarily made of "blades" with small stipes and holdfasts at the base of each plant. Blade tissue sampling of these species is considered represented by the plant (weight and size measurements are also provided at the time of sampling). Bull kelp has a long stipe, pneumatocyst, and blade. Testing this species is in the early phases and we will defer to best practices laid out by Dr. Umanzor. Carbon stored in the plants is low during much of the life cycle as it is being used for its astonishingly fast development. It is not until the peak growing period tapers off that excess carbon begins to be stored in the tissue. These samples are most useful in determining whether the kelp has past that peak and is ready for harvest.

- Our permit requires us to monitor each site 2x per month. During each site visit we will record the following water quality indicators and anecdotal specific sea life observations. We will also report on any entanglement issues. The primary goal of developing conservation promoting array is to limit any negative environmental impacts of kelp arrays. **Indicators of water quality** (salinity, temperature, oxygen dissolution, nutrient availability, pH) Data collection will be performed 120, 90, 60, and 30 days prior to harvest and at harvest. We will provide samples to specialists to investigate acidification, carbon, and nitrogen relationships.

- **Progress in kelp out-growth and performance, carbon capture of kelp blades** (as shown in ton yields from seed lines and time-until-maturity) Test line crew will monitor from the time of deployment until harvest. Samples will be sent to APMI and UAF laboratories for chemical analysis.

- **Observational recordings of sea life diversity.** A full marine life inventory is beyond the scope of this program. However, our aquaculture specialists and collaborating Native fishermen will monitor marine life species in the kelp beds, per permitting requirements. Herring and other spawn on the kelp species will be left in place and not harvested. We maintain a logbook for observations that will track date, site, time, species, amount, and other indicators useful for future comparisons. Observations will be made both underwater and from the boat.

Dr. Schery Umanzor, research scientist at the College of Fisheries and Science in Juneau, Alaska, is a collaborator in data management related to the marine ecology of the kelp areas. She will advise the Native Conservancy monitoring team on data collection and observation.

<u>Measuring project success</u>

Overall, the project will be measured against the outcome we seek: **2000 permitted acres of a recovering ecosystem capable of producing 30 million pounds of kelp annually through 100 Native-owned kelp farms**

In terms of growing a sustainable kelp industry, success will be measured in terms of:

1. **Success rate of nursery seed lines used in native kelp cultivation**, from the current 30-percent successful cultivation of seed line spools and three native species cultivated to more than 60-percent successful cultivation of seedling spools.

    - Success in the nursery will be measured by number of spools successfully inoculated and quality of growth on spools. Spools will be rated on a scale between 1-5, from no-growth to evenly and fully settled spools.

4. Successful increased capacity is threefold: 1) CKSN and APMI nurseries fully scaled with equipment, meaning the space is maximized with number of racks and tanks. This is 12 operation tanks for the CKSN and 30 for APMI. 2) Sufficient staff and interns are recruited and trained to operate both nurseries. 3) New nursery methods are tested (such as direct seeding) to begin developing alternatives to the labor-intensive seed spool and tank method. This is crucial to meet the predicted demand in the coming years. **Improved capacity to support sustainable kelp farming** in the spill-affected PWS regions as measured by the amount of seed lines produced and the number of Native or fisherman-owned farms established.

5. **Sustainable, site specific low-impact kelp farm arrays designed** for the seven research test sites, ensuring arrays and anchors cause little to no impact on sea life and community use. Developing site specific designs to account for heavy currents and weather, steep slopes, low nutrients and more. Developing species-specific designs, particularly for bull kelp, experimenting with increasing the depth of submerged grow lines to reduce temperature and light for bull kelp seedlings, and width between lines to allow for more nutrient flow and less entanglement issues.

6. **Increased kelp production of three species** on the research test sites, successfully growing up to 5lbs/ft of sugar kelp, bull kelp, and ribbon kelp. Identification of ideal harvest timing and conditions.

7. **PWS Fully Mapped for Suitable Commercial Kelp Farming Sites,** providing key data to future farmers on ideal locations for their farm sites and species-specific regions noted.

B. Description of Study Area

Is the study area within the Spill Area? Describe the study area, including maps and figures, if applicable, decimally-coded latitude and longitude readings of sampling locations or the bounding coordinates of the sampling region (e.g., 60.8233, -147.1029, 60.4739, -147.7309 for the north, east, south and west bounding coordinates).

The study area is within the Spill Area.

The research test sites aim to study 7 unique ecological regions with the spill zone, namely Nelson Bay, Simpson Bay, Sheep Bay, Port Gravina, Tatitlek Village region (Port Fidalgo), Latouche Island, and Foxfarm Island. The sites were chosen based on the proximity to Native villages, therefore increasing the practical relevancy of the data and information produced from this study. In addition, each site presents unique challenges of exposure, water quality, ocean floor topography, currents and more. Each kelp array will be required to adapt to site specific challenges and will provide a comprehensive analysis on a variety of designs and methods of restorative kelp farming.

Research test site locations noted in red, Chugach Regional Resources Commission Tribes listed.

While the Prince William Sound region lacks a formal Borough boundary, it is generally agreed to cover an expanse of 20,000 square miles of marine waters surrounded in large part by the Chugach National Forest in Southcentral Alaska. Land ownership patterns reflect those throughout Alaska: “The federal government is the dominant majority landowner, followed by state lands, Alaska Native corporations, municipal lands, and other private lands'' (PWSEDD Sound Opportunities CEDS, 2019 Update). Total regional population across the five main communities of Chenega, Tatitlek, Whittier, Valdez, and Cordova have a population of 6,654. Prince William Sound represents the northernmost extent of the coastal temperate rainforest in the Pacific Northwest, contributing to thriving salmon fisheries (subsistence, sport, and commercial), critical migratory bird and waterfowl habitat, and vast recreational opportunities for visitors and residents. These Native communities bring significant traditional knowledge of the native kelp, which they have long harvested.

A number of environmental factors drive marine ecosystems and thus affect the recovery of species and ecosystem services injured by the 1989 Exxon Valdez oil spill. These include currents, water temperature, salinity (salt content of the ocean tempered by fresh water from rivers and runoff from the land), concentrations of dissolved oxygen, nutrients, and chlorophyll; and the phytoplankton and zooplankton communities that are at the base of marine food webs. Water temperatures and salinities vary within the ocean water column as water masses become seasonally stratified or mixed by winds and currents.

This is a remote region, with travel largely limited to small aircraft, charter aircraft, and boat travel, with seasonal Alaska marine highway service. Travel by boat is the primary means of transportation and shipping in the region, and the infrastructure in the communities mentioned above reflects that. Prince William Sound includes three port communities and four Alaska Native villages spread out along the rim. Two of the five towns and villages have road access (Valdez and Whittier), the other three are accessible by air or by boat only (Cordova, Chenega, and Tatitlek). The largest community, Valdez, has a population of approximately 4,000 people, while the smallest community of Chenega has a population of 60. Direct Alaska Native beneficiaries of this proposal include the Tatitlek Village IRA Council, the Native Village of Eyak (Cordova), Chenega IRA Council,

Qutekcak Native Tribe (Seward), and the Valdez Native Tribe. These people, known as Alutiiq, or Sugpiaq, are a southern coastal people of Alaska.

5. COORDINATION AND COLLABORATION

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

A preferred requirement for all proposals is to partner with the ASLC, PWSSC, or both Centers. If not collaborating with either of these Centers, please provide information as to the inquiries and efforts extended to ASLC and PWSSC researchers and/or administrators.

These organizations are aware that we are submitting this application although no formal partnership has been established. Whereas we value the work of both Centers of Excellence, these two organizations are not mariculture-focused nor are they as versed in the mariculture industry as CRRC's APMI and the Native Conservancy. Partnering with Centers of Excellence on this project would simply be for administrative purposes which is not needed. Our organization manages equal amounts of federal and non-federal funding, as you will see in the supplemental information packet, and did not see any benefit to adding another fiscal layer to the project.

B. With the EVOSTC LTRM Program

Provide a list and clearly describe the functional and operational relationships with the other EVOSTC proposed projects in the LTRM Program. This includes any coordination that has taken or will take place and what form the coordination will take (project guidance, shared field sites or researchers, research platforms, sample collection, data management, equipment purchases, etc.).

Environmental Drivers Component

None

Pelagic Monitoring Component

None

Nearshore Monitoring Component

21200127 in collaboration with 20120114 - Gulf Watch Ocean Acidification Sampling

Chugach Regional Resources Commission received EVOSTC funding to continue APMI's Ocean Acidification research and include the samples within its Gulf Watch Program. There is a natural information sharing relationship between this program and our mariculture research proposal. All water quality samples, and analysis will be included in APMI's ongoing research and shared with Gulf Watch Alaska.

Lingering Oil Monitoring Component

None

Herring Research and Monitoring component

None

Synthesis and Modeling Component

None

Data Management Project

Provide a clear timeline for the submission of data and metadata by individual researchers and when the data will be made available to the public (see Section 7). Data collected by researchers employed by any federal agency must comply with Federal Open Data Policy Requirements.

We are removing the environmental research designs from this proposal. Anecdotal data collected bimonthly at each site can be made available to a central data management organization, if accepted.

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

Indicate how your proposed project relates to, complements, or includes collaborative efforts with the existing projects funded by the EVOSTC that are not part of an EVOSTC-funded program. Anticipated continuing individual projects for FY22 include project numbers 21210128, 21200127, and 21110853. Use the project search function for project details.

None

D. With Other Proposed EVOSTC Mariculture Focus Area Projects

Indicate how your proposed project relates to, complements, or includes collaborative efforts with proposed EVOSTC mariculture focus area projects.

This proposal complements the "Social, cultural and economic assessment of kelp mariculture opportunities for coastal villages within the EVOS spill zone" proposal from Alaska Conservation Foundation in partnership with GreenWave, Chugach Regional Resources Commission, and Native Conservancy to create a GIS & Story Map of historic cultural seaweed harvest sites by various communities throughout the Prince William Sound. The data collected in this proposal on wild kelp forests will be shared to help inform how kelp forests have changed over time. Additionally, The Listening Tour survey of Native communities aims to provide information on the history, needs and wants for our Native villages around mariculture farming. The two nurseries in this proposal aim to provide kelp seed for future Native farmers supported in the listening tour, and the research kelp test sites will help inform future Native farmers to determine the best sites to farm and the best methods for low-impact restorative farming.

E. With Proposed EVOSTC Education and Outreach Focus Area Projects

Indicate how your proposed project relates to, complements, or includes collaborative efforts with proposed EVOSTC education and outreach focus area projects.

None

F. 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 or program, note this and explain why.

CRRC has held meetings with Mr. Doug Vincent-Lang, Acting Commissioner, **Alaska Dept. of Fish and Game** about the APMI's kelp culturing efforts and other mariculture initiatives.

Dune Lankard of Native Conservancy has held meetings with David E. Schmidt, Regional Forester, Alaska Region **USFS/USDA**, about the potential for a regenerative mariculture industry in the Spill Zone and inclusion of indigenous communities in restoration proposals.

G. With Native and Local Communities

Provide a detailed plan for local and Alaska Native community involvement in the project. ***This is a mandatory requirement for all proposals.***

The proposed project is a collaboration between two Alaska Native owned and/or led organizations: Chugach Regional Resource Commission (CRRC) and the Native Conservancy. By virtue of our organizations and constituents, Alaska Native community involvement is inherent. CRRC was established by the seven Tribes of the Chugach Region, each of whom holds a seat on the CRRC Board of Directors. The CRRC Board serves at the pleasure of each Tribal Council and are chosen specifically because of their natural resource management inclinations. As part of this project, CRRC will be providing regular updates to the Board of Directors and Tribal members through a variety of outreach efforts (discussed in more detail in the Supplemental package, section 4.c). CRRC will also work closely with Chugachmiut, the social services and cultural education arm of the Tribes in the Chugach Region, Local Cultural Coordinators in each of the seven communities.

As the goal of this project is to develop Alaska Native-led and owned kelp farms in the Spill Area, outreach, education, infrastructure and collaboration is inherent. CRRC has already been working closely with three communities (Chenega, Tatitlek and Eyak) in the Spill Area to locate suitable kelp farm locations and have begun to seek funding for these Tribes and/or Tribal members to enter the kelp farming industry. Through this project, the seven communities in the Chugach Region (Port Graham, Nanwalek, Valdez, Tatitlek, Chenega, and Cordova) will have their natural resource entity (CRRC/APMI) fully committed to development of a burgeoning kelp industry with the utmost capacity for assisting, both financially and technically, and to remove roadblocks so as ensure farm success.

Native Conservancy is led by a 100% Native board of directors and commits to a minimum of 70% Native staff. The organization has deep ties in the Eyak and neighboring communities. Native Conservancy provides monthly fresh seafood deliveries to Native elders at no-cost, provides Eyak language revitalization workshops, hosts annual Eyak Culture camps, and leads participatory mapping initiatives to restore Eyak placenames and stories to pave the way for land reparations. All Native Conservancy's programs are based on Native community needs and interests, including this program to spearhead a regenerative, restorative kelp farming industry.

6. DELIVERABLES

List and describe expected products that will come from this project. Deliverables include but are not limited to papers, reports, recordings, films, websites, presentations, data, and metadata. Project PI(s) will be responsible for all deliverables unless otherwise noted below.

- Objective 1: Scale the infrastructure to increase the production capacity of the Alutiiq Pride Marine Institute and Community Kelp Seed Nurseries to meet projected kelp seed string demands of the region.

- **The APMI seed nursery is scaled to 7500sq.** The plans are for this to be fully operational and able to increase production to meet the demand for conservation-promoting cultivation of seed lines.
- **The CKSN seed nursery is scaled to full capacity**. This auxiliary nursery will be working at scale to produce kelp lines and monitor conditions from the test lines.
- **CKSN water delivery and kelp cultivation systems improved.** The delivery of a constant stream of filtered sea water and the incorporation of lessons learned in seed cultivation will improve nursery success rate.
- **New sori cultivation methods tested.** Initial success was reached with two out of three cultivated species locally sourced from test lines. Adapting lessons in sori cultivation will improve the capacity of the nursery to focus on resilient indigenous kelp species.
- **Nursery development report produced & shared.** It is important to document and share lessons learned in kelp nursery development from results of over 610,000 feet of test line over the five years of this project.

- Objective 2: Develop effective, affordable, and sustainable practices for Native kelp farming through specific array designs, deployment methods, and seed cultivation strategies that will lead to the long-term restoration of oil-spill impacted areas of PWS.
  - **7 Research test sites expanded, and new arrays tested.** Refining array build, deployment, out planting & monitoring is crucial to the efficacy of kelp farming. Incorporating lessons learned and new technology to streamline infrastructure and operations to better inform future farmers and expand the regional restorative impact of the sites on local ecology.
  - **Informational Videos produced and shared**. Visual documentation of all components of Alaska restorative kelp farming aimed to help answer the main questions of future Native kelp farmers.

- Objective 3: Conduct a comprehensive landscape analysis by deploying research kelp sites and kelp dropper lines to develop commercial farm capacity rating per region. Collect, analyze, and share data related to water quality, kelp tissue composition, sea life and other factors that may indicate the viability of a site for commercial kelp farms.
  - **Deploy Dropper Lines in Promising Bays and Passages.** Identify promising regions and sites for commercial kelp farms and deploy single dropper seeded lines to determine the viability of a site and the ideal depth for grow lines.
  - **Annual test site data compiled in database.** Water quality and tissue samples will be collected and analyzed to provide applied insights to future farmers about suitability of sites and best practices for out planting and harvest. This data will be managed by Schery Umanzor of the University of Alaska, Fairbanks, shared with university researchers and be made available to the Gulf Watch Alaska program to consider the interrelation between kelp and other species.

- **Public report on data analyses produced and shared**. A comprehensive landscape analysis rating sites for suitability for kelp farming based on key parameters including nutrients, current, salinity, temperature, marine corridors, and more.

7. PROJECT STATUS OF SCHEDULED ACCOMPLISHMENTS

Milestones are annual steps to meet overall objectives.

Tasks are annual steps to meet milestones (for example, sample collection, data analysis, manuscript submittal, etc.)

Deliverables are products that will be produced from the project (see section 6 above).

For each milestone, task, and deliverable listed, specify by each quarter of each year these will be accomplished. C = completed, X = planned or not completed.

For multi-year projects, reviewers will use this information in conjunction with project reports to assess whether the project is meeting its objectives and is suitable for continued funding.

Project milestone and task progress by fiscal year and quarter, beginning February 1, 2022. 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. *Annual review and reporting policy will be discussed at the January 2020 Council meeting. Any changes will be posted on the website.

Objective 1: Scale the infrastructure to increase the production capacity of the Alutiiq Pride Marine Institute and Community Kelp Seed Nurseries to meet projected kelp seed string demands of the region.

Milestone/Task	FY22				FY23				FY24				FY25				FY26			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Milestone: Produce Seed line			X	C			X	C			X	C			X	C				
Collect seed		X	C			X	C			X	C			X	C					
Operate nursery at full capacity		X	X	X		X	X	X		X	X	X		X	X	X				
Seed development research	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
Milestone: Nurseries expanded to 7500sq ft & constant seawater filtration deployed																				
Build physical infrastructure APSH	X	X			X	C														
Install automatic seawater filtration for CKSN									X	X	C									
Milestone: Wild kelp forests mapped																				

Mapping wild kelp forests in region		X	C																
Monitoring wild kelp forests						X	X			X	X			X	X				
Milestone: Lessons learned report																			
Produce report on methods of nursery development																X	C		
Reporting																			
*Annual reports				X	C			X	C			X	C						
FY work plan			X	C			X	C			X	C			X	C			
Final report																X	C		
Deliverables																			
APSH scaled to 7500sq ft					C														
Field Data Collected & Made Available to the Public					X	C			X	C			X	C			X	C	
CKSN seed nursery scaled									C										
Systems improved													C						
New sori cultivation methods tested																			
Nursery development report produced & shared																	C		
Creation of informational videos of sorus collection & seed development													X	X	X	X	X	X	C

Objective 2: Develop effective, affordable, and sustainable practices for Native kelp farming through specific array designs, deployment methods, and seed cultivation strategies that will lead to the long-term restoration of oil-spill impacted areas of PWS.

Milestone/Task	FY22				FY23				FY24				FY25				FY26			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Milestone: Baseline data recorded at all sites	C																			
Milestone: Ecosystem friendly designs tested and added																				
Test two new anchor types: 600-lb Danforth & 400-lb Dormors			X	C																
Expand and deploy grow lines (10 - 7200ft, 16-11200ft)		X	C			X	C			X	C			X	C					
Harvest & analyze kelp at test sites				X	C			X	C			X	C			X	C			
Launch a Bull-kelp only test site		X	C																	
Site monitoring & data collection	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
Reporting																				
*Annual reports				X	C			X	C			X	C							
FY work plan			X	C			X	C			X	C			X	C				
Final report																X	C			
Deliverables																				
Annual test site data	X	X	X	X	C	X	X	X	C	X	X	X	C	X	X	X	C			
Public report on Analyses & data															X	X	C			
Creation of informational videos of restorative farming arrays, deployment, and harvest													X	X	X	X	X	X	C	

Objective 3: Conduct a comprehensive landscape analysis by deploying research kelp sites and kelp dropper lines to develop commercial farm capacity rating per region. Collect, analyze, and share data related to water quality, kelp tissue composition, sea life and other factors that may indicate the viability of a site for commercial kelp farms.

Milestone/Task	FY22				FY23				FY24				FY25				FY26			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Milestone: Promising commercial farm sites identified	C																			
Milestone: Single seeded dropper lines deployed in identified sites				C				C				C				C				
Milestone: Water quality and tissue sample data recorded at all sites, throughout grow season				X	X			X	C			X	C			X	C			
Site monitoring & data collection	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
Reporting																				
*Annual reports				X	C			X	C			X	C							
FY work plan			X	C			X	C			X	C			X	C				
Final report																X	C			
Deliverables																				
Annual test site data	X	X	X	X	C	X	X	X	C	X	X	X	C	X	X	X	C			
Public report on data, site ratings and recommendations															X	X	C			

8. 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. Costs associated with outreach or education should be included in the Program budget. Include a screen shot of the "Summary" worksheet (example below).

Budget Category:	Proposed FY 22	Proposed FY 23	Proposed FY 24	Proposed FY 25	Proposed FY 26	5- YR TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$218,268	$218,268	$218,268	$218,268	$61,652	$934,725	
Travel	$11,050	$11,050	$11,050	$11,050	$2,550	$46,750	
Contractual	$254,410	$209,810	$189,810	$214,810	$34,432	$903,272	
Commodities	$107,449	$30,707	$30,707	$30,707	$0	$199,570	
Equipment	$26,900	$0	$0	$0	$0	$26,900	
Indirect Costs Rate = 20%	$123,615	$93,967	$89,967	$94,967	$19,727	$422,243	
SUBTOTAL	$741,693	$563,802	$539,802	$569,802	$118,361	$2,533,460	
General Administration (9% of subtotal)	$66,752	$50,742	$48,582	$51,282	$10,652	$228,011	N/A
PROJECT TOTAL	$808,445	$614,545	$588,385	$621,085	$129,013	$2,761,472	
Other Resources (In-Kind Funds)	$500,000	$75,000	$75,000	$50,000		$700,000	

B. Sources of Additional Funding

Fill out the summary table below (should match the table on page 2). Provide a narrative that Identifies 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.

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

FY22	FY23	FY24	FY25	FY26	FY22-26 Total
CRRC - $300,000 NC - $200,000	CRRC - $25,000 NC - $50,000	CRRC - $25,000 NC - $50,000	CRRC - $25,000 NC - $25,000		$700,000
FY27	**FY28**	**FY29**	**FY30**	**FY31**	**FY27-31 Total**
				FY22-31 Total	

The Chugach Regional Resources Commission and Native Conservancy commit to providing $700,000 over four years of supplemental funding to this initiative. Please see Letters of Support from each organization in the supplemental information packets (Annex 4 in each), confirming this commitment to provide additional funding. Native Conservancy has already invested $300,000 to launch the year one pilots of the CKSN kelp nurseries as well as the 7 kelp research test sites in 2020-2021.

CRRC has invested over $100,000 in 2020-2021 to build and operate the kelp nursery pilot in APMI and facilitate GreenWave nursery trainings to key personnel. One existing award will be provided as a match for the proposed project. These are currently funding the establishment of the kelp program and will provide for materials and limited sample analysis through FY22.

Bureau of Indian Affairs: "P.L. 638 Funding"
Award period: September 30, 2021-September 29, 2022
Award amount: FY21: $100,00
This award provides funding for natural resource projects in the region at the discretion of CRRC. The CRRC Board of Directors has committed a portion of the organization's base P.L. 638 funding to further the kelp mariculture industry in the region.

9. LITERATURE CITED

Provide literature cited in the proposal.

Alaska Department of Fish and Game, Our Wealth Maintained: A Strategy for Conserving Alaska's Diverse Wildlife and Fish Resources. April, 2006.

Bouchard, Deborah. 2018. Attenuating Waves with Kelp Farms. University of Maine.

Estes, J.A., Danner, E.M., Doak, D.F., Konar, B., Springer, A.M., Steinberg, P.D., Tinker, M.T. and Williams, T.M. 2004. ComplexTrophic Interactions in Kelp Forest Ecosystems. Marine Mammal Science. 74(3): 621-638.

Flavin, K., Flavin, N. & Flahive, Bill. 2013. Kelp Farming Manual, also known as the Ocean Approved Manual. Ocean Approved.

Gentry, Rebecca, et al. 2016. Offshore aquaculture: Spatial planning principles for sustainable development. Ecology and Evolution.

Grebeab, Gretchen, et al. An ecosystem approach to kelp aquaculture in the Americas and Europe. Agriculture Reports, v15, Nov 2019.

GreenWave, GreenWave Kelp Nursery Manual.

Gulf Watch, https://gulfwatchalaska.org/monitoring/

Johnson, S.W., M.L. Murphy, D.J. Csepp, P.M. Harris, and J.F. Thedinga. 2003. A survey of fish assemblages in eelgrass and kelp habitats of southeastern Alaska. NOAA Technical Memorandum NMFS-AFSC-139.

Lankard, Dune & Bobrycki, Tesia. 2021. Best Practices, Community Kelp Seed Nursery, Native Conservancy and Denali Commission.

PWSEDD. Sound Opportunities CEDS, 2019 Update.

Sound Opportunities: Economic Growth for the Prince William Sound Region, Vision - Strategy - Action 2016 - 2021, 2019 Update. Produced by Prince William Sound Economic Development District: 610 East Fifth Avenue, Suite 104a, Anchorage, Alaska 99501.

Stekoll, Michael S., The Seaweed Resource of Alaska. Botanica Marina, v62, issue 3.

Steineck, R.S., et al. 2002. Kelp Forest Ecosystems: Biodiversity, Stability, Resilience and Future. v29, Environmental Conservation.

Webb, R.M., Silverman-Roati K., and Gerrard, M.B. 2021. Removing Carbon Dioxide Through Ocean Alkalinity Enhancement and Seaweed Cultivation: Legal Challenges and Opportunities. Sabin Center for Climate Law, Columbia Law School.

Vischa W., et al. Environmental Impact of Kelp (Saccharina latissima) Aquaculture. v155, June 2020, Marine Pollution Bulletin.

Woody, Todd. Seaweed 'forests' can help fight climate change, National Geographic, 19 November 2019.

World Bank Group. Seaweed Aquaculture for Food Security, Income Generation, and Environmental Health,2016.

10. PROJECT PERSONNEL

*The CV's of all Principal Investigators and other senior personnel involved in the proposal must be provided. Each resume is limited to **two** consecutively numbered pages and must include the following information:*

- *A list of professional and academic credentials, mailing address, and other contact information (including e-mail address)*
- *A list of up to 10 of your most recent publications most closely related to the proposed project and up to five other significant publications. Do not include additional lists of publications, lectures, etc.*
- *A list of all persons (including their organizational affiliations) in alphabetical order with whom you have collaborated on a project or publication within the last four years. If there have been no collaborators, this should be indicated.*

See following pages for CVs of primary project personal:

- Willow Hetrick-Price, Executive Director, Chugach Regional Resources Commission
- Jeff Hetrick, Mariculture Director Project Manager, Chugach Regional Resources Commission's Alutiiq Pride Marine Institute
- Dune Lankard, Founder and President, Native Conservancy
- Dr. Schery Umanzor, Marine Ecology specialist at the University of Alaska in Juneau

1840 Bragaw Street, Suite 150
Anchorage, Alaska 99507
(907) 330-9085
willow@crrcalaska.org

WILLOW HETRICK-PRICE

Dynamic biologist and Executive Director with over eleven years specialized experience providing project management, regulatory compliance, financial management and program development to sea and land-based environmental projects throughout Alaska.

- Possess unique combination of marine ecology expertise, outstanding community outreach record, strong program development background, and wide network of business and professional contacts throughout Alaska's commercial, government, and non-profit sectors.
- Comprehensive knowledge of non-profit management, marketing, client development, financial management, community relations and customer service. Strong desire for success, embracing organizational goals as personal challenges.
- Extensive experience in grants management and accounting concepts, principles, practices, techniques, and procedures, as well as experience in reviewing and analyzing grant applications and summaries, ensuring effective management and accountability of funds.

AREAS OF EXPERISE

- Scientific Analysis
- Biological Studies
- Regulatory Compliance
- Aerial Wildlife Survey Methods
- Wildlife Management Programs
- Geographic Information Systems
- Stakeholder Relations
- Complex Presentations
- Training/Supervision

EDUCATION

UNIVERSITY OF ALASKA SOUTHEAST, Juneau, AK
Master of Public Administration, GPA: 4.0, 05/2018

UNIVERSITY OF ALASKA, Anchorage, AK
Graduate Certificate in Environmental Regulations & Permitting, 05/2018

UNIVERSITY OF HAWAII AT MANOA, Honolulu, HI
Master of Science in Natural Resources and Environmental Management, 05/2009
Bachelor of Science in Marine Resource Management, 12/2006

RECENT PROFESSIONAL EXPERIENCE

CHUGACH REGIONAL RESOURCES COMMISSION, Anchorage, AK 09/2018 - Present
Executive Director
Responsible for a non-profit Inter-Tribal fish and wildlife commission involved in projects and programs related to the natural resources, subsistence, climate change, environmental management and research, as well as community economy development related to natural resources and the environment. Responsible for subsistence advocacy, development of traditional natural resource management programs in the Chugach Region villages, as well as addressing other natural resources and environmental issues, including food security and food sovereignty, development of natural resource education and training programs and conducting training and special issues workshops in the communities in areas related to CRRC's mission. Work directly with Tribal leaders and their respective Councils to plan and implement community and economic development projects and other areas germane to CRRC's mission. Responsibilities include:

- General oversight of the financial management system of the organization, as well as developing annual budgets and monitoring the budgets for each program.
- Perform financial statement preparation, analysis of accounting reports, establishing, or reviewing of internal control systems, and management of financial accounting systems.
- Built solid relationships and developed network throughout Alaska with businesses and external stakeholders, greatly enhancing company ability to maintain positive customer satisfaction and maximize revenue-enhancing opportunities.

- Interpret grant application guidelines, performing comprehensive research on all necessary data, and successfully securing grants due to strict adherence to writing and qualifications requirements.
- Foster and maintain professional relationships with funders and community leaders, serving as agency's representative on community committees and work groups.
- Serve as communications liaison, facilitating more organized flow of information, and allowing for greater cooperative community relations strategy implementation.
- Coordinate with organizational leaders to monitor current organizational goals developments, recommend priorities, and assist in revising positions.

SELECTED PUBLICATIONS

Peer-Reviewed Publications

Branson, M.A., **Hetrick-Price, W.,** Wisdom, S. Polar Bear (Ursus maritimus) behavioral response to vessel presence in the Chukchi and Beaufort Seas. In prep.

Hetrick, W., Cox, L.J, Atkinson, S.K., Malecha, S.R. (2010) Survival of Red King Crab (Paralithodes camtschaticus) Juveniles on Natural and Artificial Substrates. *Journal of Life Sciences* 4(3) pages 1-8

Conference Abstracts and Proceedings

Branson, M.A., Hetrick J.J., & **Hetrick-Price,** W. (2021). Tribal Monitoring and Recovery of Native Clams in the Chugach Tribe's Subsistence Shellfish Use Areas. Alaska Marine Science Symposium. Anchorage, AK, USA.

Branson, M.A., Hetrick, J.J., Ramsay, J., Atkinson, S., & **Hetrick-Price,** W. (2021) The Chugach Regional Ocean Monitoring program: comprehensive biotoxin, phytoplankton, and water chemistry monitoring throughout southcentral Alaska. Kachemak Bay Science Conference and Kenai Peninsula Fish Habitat Science Symposium. Homer, AK, USA.

Branson, M.A., Hetrick, J.J., Ramsay, J., Atkinson, S., & **Hetrick-Price,** W. (2021) Building capacity for safe and sustainable harvest of traditional shellfish resources in Southcentral Alaska. University of Alaska Fairbanks OneHealth Conference. Fairbanks, AK, USA.

Kovalcsik, C., **Hetrick-Price, W.** & Schwalenberg, P. Preserving Traditional Food Resources in a Changing Environment. Alaska Food Policy Council Festival and Conference. Homer, AK, USA.

COLLABORATORS

- Boyd Selanoff, Member of the CRRC Board, Member of the Chenega IRA Council
- Jackie Keating (project), Subsistence Resource Specialist III, Division of Subsistence, Southern Region, Alaska Department of Fish & Game
- Jenn Mintz (project), Education & Outreach Coordinator, NOAA Ocean Acidification Program
- Jim Ujioka (project), Vice Chairman of the CRRC Board, Vice President of The Eyak Corporation and President of the Valdez Native Tribe
- Melody Wallace (project), Member of the CRRC Board, Council member of the Qutekcak Native Tribal, Board member of North Pacific Rim Housing Authority
- Nanci Lee Robart (project), Member of the CRRC Board, The Tatitlek Corporation Board, Chief of the Tatitlek IRA Council
- Patrick Norman (project), Chairman of the CRRC Board and Chief of the Port Graham Village Council
- Priscilla Evans, Secretary/Treasurer of the CRRC Board, Second Chief of the Nanwalek IRA Council
- Roberts Henrichs (project), Member of the CRRC Board, ANTHC Board (bylaws and Policy Committee, Executive Committee, Finance and Audit Committee, Leadership Planning Committee, Maintenance and Improvement Resource Allocation Committee), Healthy Alaska Natives Foundation Board of Directors, the Chair of the ANMC Joint Operating Board and Chairman of the Board at Alaska Village Initiatives
- Sydney Thielke (project), Regional Wetlands Coordinator, U.S. Fish and Wildlife Service

101 Railway Avenue
Seward, AK 99631
(907) 362-2378
jjh@seward.net

JEFF HETRICK

Over 36 years' experience with aquaculture in Alaska

- Possess unique combination of marine ecology expertise, outstanding community outreach record, strong program development background, and wide network of business and professional contacts throughout mariculture industry.
- Responsible for the long- term planning, financial management, staff supervision, facility oversight, budgeting and program direction for the Alutiiq Pride Shellfish Hatchery.
- Interacts with University researchers, State and Federal agencies and industry members on project development, permitting, cooperative projects, grant writing and administration

EDUCATION

PORTLAND STATE UNIVERSITY, Portland, OR,
Master of Business Administration, 1995

UNIVERSITY OF MARYLAND, College Park, MD
BS in Biological Science, 1980

PROFESSIONAL EXPERIENCE

ALUTIIQ PRIDE SHELLFISH HATCHERY Seward, AK 04/2001 – Present
(Division of the Chugach Regional Resources Commission)
Director
Oversee all operations, administration, and budget (>$500k) for shellfish hatchery and mariculture technical center.

- Coordinate shellfish management and aquaculture science activities to provide seed stock for aquatic farm industry, develop seed for new species for aquatic farming, shellfish enhancement projects and conduct research.
- Obtain and adhere to Alaska Department of Fish and Game, transport, genetic and pathology policies, obtain permits and complete reporting requirements.
- Coordinate production of juvenile shellfish, algae culture, Ocean acidification laboratory and research projects.
- Manage all community outreach and hatchery marketing activities, generating and providing presentations, tour and out each.
- Interview, hire. train, supervise, evaluate, and counsel team of up to five hatchery personnel including Ocean Acidification Supervisor, Production Manager, maintenance contractors, interns, and seasonal employees.
- Manage all aspects of grants including generating grant requests, serving as liaison and administering grants
- Ensure all safety and biosecurity measures are being complied with and develop new and improved standard operating procedures as appropriate.
- Utilize Excel, Word, and PowerPoint to develop estimates of abundance, distribution, density, survival, and recruitment of marine wildlife species and generate repots. Present technical information for public in layperson language.

SELECTED ACCOMPLISHMENTS:

- Developed hatchery technologies for introduction of new edible species to include Blue King Crab, Red King Crap, Sea Cucumbers, Purple-hinge Rock Scallops and Alaskan Soft-Shell clams.
- Successfully managed uninterrupted continuation of hatchery and research center operations through austere economic cycles.
- Successfully managed project with seven remote communities, providing over eight years of ocean acidification data.

COOK INLET AQUACULTURE ASSOCIATION, Soldotna, AK 07/19886 -04/2001

Hatchery Manager

Managed all aspects of operations at salmon hatcheries, including personnel, fish husbandry, system maintenance, education, community outreach and industry liaison. Supervised staff of up to ten hatchery employees and administered budget.

- Performed fish culturist duties including feeding, spawning, transferring, and sampling of fish. Oversaw disease control activities.
- Provide disease treatment and control, designing feeding regimes, determining load capacity of tanks and other hatchery techniques.

SELECTED ACCOMPLISHMENTS:

- Developed sockeye salmon pathology protocols to combat IHNV enabling the mass production of sockeye salmon smolt.
- Pioneered and launched age zero smolt technology and developed production scale thermal marking program.

*Served as Assistant Hatchery Manager from 1984 to 1988

SELECTED PUBLICATIONS

Evans, W., Mathis, J. T., Ramsay, J., & **Hetrick, J.** (2015). On The Frontline: Tracking Ocean Acidification in an Alaskan Shellfish Hatchery. *PLoS one*, *10*(7), 1-14.

Apeti, D. A., Hartwell, S. I., Myers, M., **Hetrick, J.**, & Davenport, J. (2013). Assessment of Contaminant Body Burdens and Histopathology of Fish and Shellfish Species Frequently Used for Subsistence Food by Alaskan Native Communities. *North Pacific Research Board Project Final Report*, 1-60.

Swingle, J. S., Daly, B., & **Hetrick, J.** (2013). Temperature Effects on Larval Survival, Larval Period, and Health of Hatchery-Reared Red King Crab, *Paralithodes camtschaticus*. *Aquaculture*, *384*, 13-18.

Hetrick, J., Swingle, J., Daly, B., & Hatchery, A. P. S. (2009). Development of Large Scale Hatchery Production Technology for Red King Crab (*Paralithodes camtschaticus*). *International Symposium on Aquaculture, Biology and Management of Commercially Important Crabs*, 22.

Swingle, J., Daly, B., **Hetrick, J.**, Eckertc, G., & Hatchery, A. P. S. (2009). Continuing Development of Large Scale Hatchery Technology for Red King Crab (*Paralithodes camtschaticus*). *International Symposium on Aquaculture, Biology and Management of Commercially Important Crabs*, 93.

Brown-Schwalenberg, P., **Hetrick, J.**, & Daisy, D. (1996). Nanwalek/Port Graham/Tatitlek Subsistence Clam Restoration. *Exxon Valdez Oil Spill Restoration Project Annual Report, Alaska Department of Fish and Game, Habitat and Restoration Division*, 1-9.

Daisy, D., **Hetrick, J.**, Brooks, K. M., & Agosti, J. (1997). Clam restoration project. *Exxon Valdez Oil Spill Restoration Project Annual Report, Alaska Department of Fish and Game, Habitat and Restoration Division*, 4.

Daisy, D., **Hetrick, J.**, Brooks, K. M., & Agosti, J. (1999). Clam restoration project. *Exxon Valdez Oil Spill Restoration Project Annual Report, Alaska Department of Fish and Game, Habitat and Restoration Division*, 1-37.

COLLABORATORS

- Dr. Amanda Kelly, University of Alaska Fairbanks School for Ocean Sciences
- Dr. Brad Harris, Alaska Pacific University
- Dr. Chris Long, Alaska Fisheries Science Center's Kodiak Laboratory, National Oceanic and Atmospheric Administration
- Dr. Wiley Evan, Hakai Institute
- Bobby Hudson, Pacific Shellfish Institute
- Dr. Robert Foy, Alaska Fisheries Science Center, National Oceanic and Atmospheric Administration

NATIVE CONSERVANCY

Dune Lankard, Founder and President • dune@nativeconservancy.org • 907.952.5265

BIO

Dune Lankard, an Eyak Athabaskan Native of the Eagle Clan, grew up in Cordova, in southcentral Alaska. Born into a fishing family, his life education as a subsistence and commercial fisherman began at age five. After graduating from high school, he earned a living as a fishery and processing consultant and commercially fished for wild salmon, herring, crab, halibut and cod in the Copper River Delta and Prince William Sound until March 24, 1989 - when the Exxon Valdez spewed over 11 million gallons of crude oil into his beloved Prince William Sound. Dune became a passionate community activist and social change activist that day on, and has been fighting to preserve and restore Native and fishing culture and wild salmon habitat ever since. Dune has been offered several higher education scholarships, in law.

Native and Tribal Affiliations

• Eyak Name: Jamachakih – Eyak translation: "Little Bird that screams really loud (in the forest) and won't shut up." Eagle Clan member of the Copper River Delta
• Eyak Traditional Elders Council – Co-Founder and Tribal Member
• Native Village of Eyak – Tribal Member
• The Eyak Corporation (village) and the Chugach Alaska Corporation (regional) – Alaska Native Claims Settlement Act (ANCSA, 1971) shareholder in both Alaska Native Corporation's

Professional *(partial)*

• Native Conservancy Land Trust – Founder and President (2003 – current)
• Eyak Preservation Council – Founder and President (1989 – current)
• FIRE Fund (Fund for Indigenous Rights and the Environment) – Dune helped form and run endowment
• Alaska Representative, Center for Biological Diversity (2017 for one year)

Experience *(partial)*

• Speaker and Commentator on Alaskan, Indigenous, cultural, legal and environmental issues throughout the country and overseas at universities, law schools, grade schools, conferences and various symposiums.
• Articles/quotes/editorials/op eds published– summary list: *The Cordova Times, Anchorage Daily News, Alaska Dispatch News, The Seattle-Post Intelligencer, The Los Angeles Times,* and *San Francisco Examiner/Chronicle*, *Wall Street Journal* and numerous publications and magazines
• Highlighted in numerous books: Including "*Hope and Heroes: Portraits of Integrity," London Street Press* and published narrative and photo essay in "*Alaska Native Ways" Graphic Arts Center Publishing, "Climate Change and Environmental Ethics" Transaction Publishers*
• Appeared and spoken in videos: *The Thin Green Line, Thunderstorm, Sierra Club Chronicles-The Day the Ocean Died,* and *The Third Trustee* - and numerous local and national newspapers, radio and TV interviews.

Notable Achievements

• 1989: Reunited the Eyak Traditional Elders Council (ETEC) after 100 years – the traditional tribal council of the Eyak Nation. ETEC won the Alaska Supreme Court decision that granted "public interest litigant status" to the Eyak people, so they didn't have to pay a $50M bond and $500,000 in attorney fees

• 1992 to present – Dune and EPC helped unite Indigenous peoples, ANCSA corporations, scientists, fishermen, logging industry, highest levels of ocean government (Exxon Valdez Oil Spill Trustee Council) and the conservation community around conservation easements in the Exxon spill zone, leading to the preservation of over 700,000 acres of wild salmon habitat along 1,500-miles of Gulf of Alaska coastline
• 1992 and 1995 – Dune filed an "Eyak Cultural" lawsuit in 92' and a "Shareholder Derivative" lawsuit in 1995 against The Eyak Corporation to stop the clearcutting of his beloved Eyak homelands, these cases led to the preservation of 75,000 acres of the Eyak Rainforest in eastern PWS and the Copper River Delta
• 1998 and 1999: testified, upon request, before the House Committee on Resources opposing the planned 55-mile Bering River/Carbon Mountain road access easement across Copper River Delta
• 1998: Dune led the charge to defeat the Chugach Road Rider (Bering River/Carbon Mountain, road access easement), introduced by the Alaska Representative Don Young and the Chugach Alaska Corporation that would have granted an irrevocable 55-mile, 250-foot-wide, right-of-way road for resource extraction to be built w/o and Environmental Impact Statement (EIS), Restoration Bond or Environmental Assessment (EA)
• 1999: went to Geneva, Switzerland and NYC, USA as a delegate for Alaska Indigenous peoples to the Intergovernmental Forum on Forests at the United Nations
• 2004: helped stop oil drilling on 65,000 acres in the Katalla region, east of the Copper River Delta
• 2016: helped permanently preserve 115,000 acres of wild salmon habitat in the Chugach National Forest and retire 62,000 acres of Chugach Alaska Corporation coal rights in the headwaters of the Bering River region

Elected and Founding Memberships
• SEVA Foundation – Advisory Board member for last 17 years – current
• Bioneers Board member – Dune was on their board for 6 years – term ended 2015
• International Funders for Indigenous Peoples (IFIP) Board member – for 5 years – term ended 2014
• Patagonia – Wild Salmon Sourcing Team member

Fellowships and Awards
• Time Magazine: Chosen as one of Time Magazine's Hero for the Planet – 1999
• Ashoka Foundation Fellow
• Hunt Alternative Fund: Prime Movers Fellow
• Future of Fish Fellow

Publications authored by Dune Lankard:
Cultural Survival - Healing Our Waters, Healing Ourselves Through A Sustainable Economy – Dec 2020
Medium Future Of - Dune Lankard, on the Future of Climate-Changing-Everything – Aug 2019

Collaborators:

Alaska Conservation Fund (ACF)
Michael Barber: 1227 W. 9th Ave., Suite 300 Anchorage, Alaska 99501 **Direct**: (907) 433-8205
Email: mbarber@alaskaconservation.org

Alutiiq Pride Shellfish Hatchery
Jeff Hetrick: Seward Hatchery Manager **E:** jjh@seward.net **O:** 907-362-2378

GreenWave
Bren Smith: Executive Director
43 E Pearl Street New Haven, CT 06513 O: (203) 654-9690 **E:** bren@greenwave.org

Schery Umanzor, Ph.D.

Research Assistant Professor
University of Alaska Fairbanks
17101 Lena Point Rd, Juneau

EDUCATION AND TRAINING

Doctor of Science in Marine Ecology — **2014- 2017**
CICESE, Baja California
Research topic: Biological response to the physical changes driven by intertidal macroalgae as ecosystem engineers.

Master´s degree in Biology: Ecology and Evolution — **2006- 2008**
New Mexico State University, USA
Research topic: Phylogenetic analysis of the Chromodoridídae using a combined approach

Bachelor´s degree in Marine and Freshwater Biology — **2001- 2005**
National University of Costa Rica
Research topic: Community structure of macroinvertebrates associated to seagrasses along the Caribbean coast of Costa Rica

PROFESSIONAL APPOINTMENTS

Research Assistant Professor
University of Alaska Fairbanks — **2020**

Postdoctoral fellow/ Research Associate I — **2018-2020**
University of Connecticut, Stamford
Seaweed Biotechnology Laboratory, Department of Ecology and Evolutionary Biology

- Optimize protocols for microscopic development of *Saccharina* for breeding purposes
- Develop direct seeding protocol to attach kelp gametophytes on grow-out substrates
- Measure nutrient bioextraction capacity by kelp in open water systems
- Develop mass cultivation of the tropical red seaweed, *Eucheumatopsis isiformis*

Principal Investigator — **2017**
Blue Forest

- Develop protocols and test the feasibility of low-cost reforestation of *Macrocystis* in Baja California, Mexico.

Short-term intern fellow — **2017**
Institute of Marine Science Research, TAS, Australia

- Assessed microphytobenthic settlement underneath kelp patches as a function of amelioration of the physical environment by *Ecklonia radiata*

Research Associate — **2013-2014**
FUNDEVI- University of Costa Rica (UCR)

- Developed protocols for the cultivation of terrestrial crops on floatation
- Developed prototypes to hold small farms on floatation
- Coordinated a binational (Costa Rica-Nicaragua) effort to measure yields on different farm setups

Research Assistant — **2011-2013**
FUNDEVI- University of Costa Rica (UCR)

- Developed protocols for the cultivation of tropical seaweeds for human consumption
- Design seaweed farms prototypes for exposed coastal sites
- Tested processing techniques to include seaweeds as an ingredient of daily meals
- Contributed to bringing seaweed consumption to the public

HONORS AND AWARDS

Commencement speaker, PhD graduation ceremony – CICESE, Baja California — **2017**
NF-POGO-NUIG Ocean & Climate Scholarship - NF-POGO-NUIG Ocean & Climate — **2017**

Programme II, University of Galway, Ireland	
CONACyT International Scholarship – Short-term internship, University of Tasmania, Australia	**2016**
CONACyT award – Fully funded doctoral degree, CICESE, Baja California	**2014-2017**
United Nations/International Seabed Authority Scholarship - Technical Assistance Program for Marine Scientific Research (TAPMAR II), National Institute of Oceanography, Goa, India	**2010**
1st place symposium award - Graduate School Department, NMSU	**2008**
International Student Exchange Program (ISEP) award - Fully funded master's degree programme, New Mexico State University	**2006-2008**

PUBLICATIONS

Peer reviewed:

Umanzor, S., Han, S., Song, H.-I., Critchley, A.T., Yarish, C. and Jang, J.K. (2020) Can the interaction of seaweed-derived biostimulants and temperature induce the formation of conchocelis in *Pyropia yezoensis*? *Submitted to the Journal of Applied Phycology*

Umanzor, S., Li, Y. and Yarish, C. (2020). Effect of direct "seeding" binders and embryonic sporophyte sizes on the development of the sugar kelp, *Saccharina latissima*. *Submitted to the Journal of Applied Phycology*

Mao, X., Augyte, S., Huang, M., Hare, M. P., Bailey, D., **Umanzor**, S., Marty-Rivera, M., Robbins, K. R., Yarish, C., Lindell, S., & Jannink, J.-L. (2020). Population genetics of sugar kelp in the Northwest Atlantic region using genome-wide markers. BioRxiv, 2020.04.21.050930. https://doi.org/10.1101/2020.04.21.050930

Umanzor, S., Jang, S., Antosca, R. Critchley, A.T., Yarish, C. and Kim, J.K. (2020). Optimizing the application of selected biostimulants to enhance the growth of *Eucheumatopsis isiformis*, a carrageenophyte with commercial value, as grown in land-based nursery systems. Journal of Applied Phycology. doi: 10.1007/s10811-020-02091-7

Cabrera R., Díaz-Larrea J., **Umanzor** S., Clero L., Alfonso, Y., Núñez-García L.G. (2020) Comparative growth and demographics of *Thalassia testudinum* meadows in Cuba using direct and reconstructive methods approaches to inform conservation efforts. Int J Recent Sci Res 11:37446–37452. doi: 10.24327/IJRSR

Augyte, S., G. Wikfors, S. Pitchford, M. Marty- Rivera, **Umanzor**, S., Yarish, C., Bailey, D. and Lindell, S. (2020). The application of flow cytometry for kelp meiospore isolation. Accepted: Algal Research, 48: 101810. doi.org/10.1016/j.algal.2020.101810

Umanzor, S., Shin, S. Marty-Rivera, M., Augyte, S., Yarish, C. and Kim, J.K. (2019) Exploratory evaluation of the effects of Kelpak® seaweed extract on cultivated kelp *Saccharina* spp. exposed to sublethal and lethal temperatures. Journal of World Aquaculture Society, 1-10. doi.org/10.1111/jwas.12687

Umanzor, S., Ramírez, M.M., Sandoval-Gil, J.M., Zertuche-González, J.A., and Yarish, C. (2019). Evaluation of the photoacclimative capacity of early-juvenile sporophytes of *Macrocystis pyrifera*, cultivated at different depths. Accepted: Journal of Phycology, doi: 10.1111/jpy.12951

Cabrera, R., Díaz-Larrea, J., **Umanzor**, S., Núñez García, LG (2019). Using a macroalgal functional form approach to assess the level of disturbance of seagrass meadows in Bahía of Nuevitas, Cuba (2000-2002). American Journal of Plant Sciences 10(11):2020-2033

Cabrera, R., **Umanzor**, S., Díaz-Larrea, J., Araújo, P.G. (2019) *Kappaphycus alvarezii* (Rhodophyta): New Record of an Exotic Species for the Caribbean Coast of Costa Rica. American Journal of Plant Sciences. doi: 10.4236/ajps.2019.1010133

Cabrera, R., Díaz-larrea, J., **Umanzor**, S. (2019) New records of marine macroalgae on the Caribbean Coast of Costa Rica. American Journal of Plant Sciences. doi: 10.4236/ajps.2019.1010122

Umanzor, S., Shin, S. Marty-Rivera, M., Augyte, S., Yarish, C. and Kim, J.K. (2019). Preliminary assessment on the effects of the commercial seaweed extract, AMPEP, on growth and thermal tolerance of the kelp *Saccharina* spp. from the Northwest Atlantic. Journal of Applied Phycology. doi.org/10.1007/s10811-019-01852-3

Umanzor, S., Ladah, L. Calderon-Aguilera, L.E. and Zertuche-González, J.A. (2019). Testing the relative importance of intertidal macroalgae as ecosystem engineers across extreme scenarios. Journal of Experimental Marine Biology and Ecology 511: 100–107

Umanzor, S., Ladah, L. and Zertuche-González, J.A. (2018). Intertidal seaweeds modulate a contrasting response in understory macroalgal and microphytobenthic recruitment. Frontiers in Marine Science 5:296. doi.org/10.3389/fmars.2018.00296

Umanzor, S., Ladah, L. and Zertuche-González, J. A. (2017). The influence of species, density, and diversity of macroalgal aggregations on microphytobenthic settlement. Journal of Phycology. doi: 10.1111/jpy.12565

Umanzor, S., Ladah, L., Calderon-Aguilera, L. E. and Zertuche-González, J.A. (2017). Intertidal macroalgae influence macroinvertebrate distribution across stress scenarios. Marine Ecology Progress Series. doi:10.3354/meps12355.

11. SUGGESTED REVIEWERS (for new project proposals only)

Please identify person(s) not associated with individuals or institutions submitting this proposal, but with sufficient expertise and credentials to review the proposal in an unbiased and objective manner. Full contact information is required for a minimum of 5 people. These individuals may be asked to conduct a peer review of your proposal. It is suggested that you contact your proposed reviewers to confirm that they are willing to provide a review. Peer review may also be conducted by others not identified here.

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7250 Redwood Blvd #300, Novato, CA 94945
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DATA MANAGEMENT PLAN

The *Exxon Valdez* Oil Spill Trustee Council's data policy encourages full and open access to, and confident use of, the data and information used in and produced by programs and projects of the *Exxon Valdez* Oil Spill Trustee Council (EVOSTC). These data need to be easily understandable, electronically accessible and well organized to allow policy makers, researchers, managers, and the general public to make well-informed decisions. As such, Axiom Data Science, through it's partnership with the Alaska Ocean Observing System (AOOS) have considerable experience developing scientific data management infrastructure, and they provide experienced personnel to manage both data and metadata documentation according to federal quality control standards. This project will use the AOOS data management infrastructure (developed and maintained by Axiom Data Science) to manage and share the data generated through this effort, in accordance with the EVOSTC Data Management Procedures. This system uses the standards and best practices defined by the NOAA U.S. IOOS Data Management and Communications committee (IOOS, 2010). Among this infrastructure is an operational stack of open source software components developed by Axiom Data Science, with support from the NOAA Integrated Ocean Observing System (IOOS), EVOSTC, the National Science Foundation and more, which manages large numbers of continuous data feeds and a data catalog framework to integrate and disseminate a variety of data products. Data and data products generated by this project will be posted on the Research Workspace together with standards-compliant metadata for access by the EVOSTC. At the end of the project term, final QA/QC'd data and metadata will be made publicly available through the Gulf of Alaska data portal and made publicly accessible through the AOOS Gulf of Alaska data portal and distributed to DataONE for long-term preservation.

Data Types, Formats, and Metadata: This project will generate the following data: i) water samples from each of the research test sites during the growing period (December – May), including salinity, Ph, turbidity, dissolved oxygen, flow rates, nutrients, and acidification, ii) chemical analyses of kelp out-growth, including carbon, nitrogen, and heavy metals tested annually, and iii) observations and abundance of marine life residing within kelp beds (including date, site, time, species, amount, and other indicators useful for future comparisons).

Data will be stored in non-proprietary formats to ensure re-use and long-term preservation. Project data may initially exist in proprietary or binary formats as primary-level data, depending on the source provider. Though the data may be in a state which can be easily utilized by the research team, in many cases the primary-level data is not in a form ready to be shared with the broader science community or integrated with other datasets. As such, the final format for project data will be in open standard suitable for long-term archiving, such as:

- Containers: TAR, GZIP, ZIP
- Databases: CSV, XML
- Tabular data: CSV
- Geospatial vector data: SHP, GeoJSON, KML, DBF, NetCDF
- Geospatial raster data: GeoTIFF/TIFF, NetCDF, HDF-EOS
- Moving images: MOV, MPEG, AVI, MXF
- Sounds: WAVE, AIFF, MP3, MXF
- Statistics: ASCII, DTA, POR, SAS, SAV

- Still images: TIFF, JPEG 2000, PDF, PNG, GIF, BMP
- Text: XML, PDF/A, HTML, ASCII, UTF-8
- Web archive: WARC.

Comprehensive metadata using the latest national and international technology and community standards will be written for each data collection generated. The Research Workspace includes an integrated metadata editor, allowing researchers to generate metadata conforming to the FGDC-endorsed ISO 19110 and 19115-2 suite of standards. Axiom will provide technical assistance to project researchers to ensure robust and standards-compliant metadata are generated for final project datasets prior to data publication and archive.

Data Access and Timeframes: Among the Axiom data system infrastructure is the Research Workspace, a web-based scientific collaboration and data management tool used by researchers to secure and centralize project data, generate standards-compliant metadata, and ultimately elect data files and derived data products to be published openly on public data portals and in long-term data archives. Following the EVOSTC data sharing policies, all monitoring data from this project will be transfer as they become available to the Research Workspace. These data shall be replaced in the Research Workspace with QA/QC'd and metadata when available and no later than 1 year after collection, after which they will be made publicly available through the GOA data portal. The Research Workspace is the gateway for PIs to elect and publish data and metadata to the GOA data portal. The exception is for process studies which are research-oriented in nature and do not have annual timeseries data. Process studies require data and metadata to be made publicly available through the GOA data portal by the end of the project term.

Data Storage, Preservation, and Archiving: The Axiom data center and services are housed on highly redundant storage and compute resources at a data center in Portland, OR, and are geo-replicated using Amazon Glacier Cloud Archive Services. All databases and code repositories are routinely backed-up, and servers undergo routine maintenance to swiftly address security vulnerabilities. Servers containing source code and databases are located behind an enterprise-level firewall and are physically secure with environmental regulation systems, redundant power, and fire suppression. Axiom's HPC resources are composed of approximately 2500 processing cores staged in a series of interconnected blade arrays as well as 1.8 petabytes of storage. Dedicated disc-space in the amount of 30 TBs will be allocated for long-term storage of all preliminary and finalized data resources produced by this effort.

For long-term preservation, all final data and metadata will be transferred to a national data center. The data developed in this project will be open source and licensed in the public domain. The planned archive for the data collected by this effort is the Research Workspace's DataONE Member Node. The Research Workspace hosts an integrated system for automating dataset submission to the NSF-sponsored DataONE federation of data repository. The Research Workplace supports and issues Digital Object Identifiers (DOIs), so datasets can be confidentially referenced in the published literature. Upon final permission from the project PI at the end of the project term, final data or data products will be submitted for archive with technical support by Axiom data management staff to ensure appropriate use and compliance with the data center archive requirements.