I. Project Information*

Project Director	Willow Hetrick
Project Title	When the Water Lives, We Live: Cohort-Based Community Engagement and Planning in Southcentral Alaska
Project Location	The Chugach Regional Resources Commission serves several communities located throughout the Prince William Sound Region, including Member Tribes of the Chugach Region including the Tatitlek Village Indian Reorganization Act (IRA) Council, Native Village of Eyak (Cordova), Port Graham Village Council, Nanwalek IRA Council, Chenega Bay IRA Council, Qutekcak Native Tribe (Seward), and the Valdez Native Tribe. There are approximately 1,000 tribal members living in these communities which are connected through common cultural, linguistic, and historical ties. These people, known as Alutiiq, or Sugpiaq, are a southern coastal people of Alaska. The seven Tribes of CRRC are located in Prince William Sound and Lower Cook Inlet, a remote region limited in travel to small aircraft, charter aircraft and boat travel, with seasonal Alaska marine highway service. Full-time, year-round employment is scarce in Tatitlek, Port Graham, Nanwalek, and Chenega, and residents there rely heavily on natural resources as both a traditional, healthy, affordable source of food and for seasonal income in industries such as commercial fishing, hatchery operations, and firefighting to name a few examples. Even in the larger communities of Cordova, Seward, and Valdez, wild foods are an important part of a healthy, traditional diet and economies are closely intertwined with the natural environment. Cordova is a major commercial fishing hub, Valdez an important sport fishing port, and Seward's economy relies heavily on tourism to the Kenai Fjords National Park and surrounding areas. The Chugach region is no stranger to environmental hazards, both man-made and natural. In 1964 the Good Friday Earthquake caused severe damage and loss of life in several communities. Twenty-five years later, the Exxon Valdez Oil Spill heavily impacted the region, greatly disrupting the maritime ecosystems upon which local communities depended on for food and income. Today, residents still remember these tragedies

	and often speak of climate change as an additional stressor on top of other multiple impacts to health, food, and livelihoods in their communities. Although this project focuses on climate change, it will also make space to discuss and understand the cumulative impacts of multiple events and how communities can adapt to a changing climate in a dynamic world with multiple stressors on ecosystems and communities alike.
Project Summary	Alaska Native Tribes are on the frontlines of climate change, seeing daily reminders of the environmental change that is affecting their livelihoods and well-being. This is particularly true in the rural communities of Southcentral Alaska, many of which are not on the road system and are heavily dependent on plants, animals, and other resources, primarily from the sea, for food, cultural activities, and economic opportunities. Building on the Chugach Regional Resources Commission's (CRRC) regional vulnerability assessment, we propose a community engagement effort that: 1) engages a cohort, of two people from each of the seven communities in the region, to participate in a series of two workshops focused on adaptation planning to enhance community wellbeing; 2) works with the cohort to co-create information or tools that improve the accessibility and access of real-time data to enhance the communities ability to adapt to climate change (ex: safely harvest subsistence marine species); and 3) installs a mural and interactive kiosks on the Alutiiq Pride Marine Institute (APMI), a Tribal shellfish hatchery and ocean acidification research center managed by CRRC, to elevate Tribal voices about climate change, sharing a positive message about adaptation underway in the region with the thousands of people who visit Seward, Alaska annually. When the Water Lives, We Live, uses a range of culturally appropriate, innovative engagement methods to build capacity and address immediate adaptation needs of the region's communities, while empowering residents to share their narrative about climate change adaptation in the region with a broader audience.

II. Progress Report Questions

1. Please revisit your proposal and review your goals and the outcomes you were seeking to achieve through this grant. How successful were you in meeting your goals? Please assess your success against the criteria you set in your proposal and use any combination of anecdotes, stories, graphs, charts, visuals as well as data to explain your success. Upload supporting files if you choose.*

Please see the uploaded attachment: “Summary of Deliverables” for materials and deliverables supporting this project. A summary of successes and lessons learned are included below.

Enhance regional capacity and engagement in climate change adaptation

Overall, this portion of the grant was successful, though some aspects of it were more successful than others. In particular, this project was very successful in engaging community voices to inform regional planning and data sharing efforts. Rather than two workshops, the grant paid for three workshops that informed the adaptation plan and data sharing tool, and also supplemented a year-long online educational course for Cohort members. It was highly successful in engaging some of our communities to inform regional adaptation planning and educating select community members about climate change and climate adaptation resources. We were also successful in developing a regional adaptation plan informed by the Climate Cohort, available starting on page 10 of the attachment: However, Cohort members were often participating the program in addition to unrelated full time jobs, on top of other community and family obligations. We had difficulty recruiting the full contingent of Cohort members we had hoped to recruit and ended up with seven people from four communities rather than fourteen people from seven communities, had high levels of attrition, and cohort members did not have time to work with their Tribal councils and engage their communities.

In May of 2022, after two months of advertising and only being able to recruit 6 people from 4 communities, CRRC was approached by Chugachmiut, a sister organization that provides health and social services, including workforce development, to the region. Chugachmiut had received funding to host a climate education and planning series and were also having difficulty recruiting participants. After some negotiations with Chugachmiut and the Gulf Research Program, we agreed to combine forces and develop the Climate Cohort as a year-long program with a monthly stipend. Participants would participate in twice-monthly webinars where they would identify and learn about climate topics of interest to them through a self-guided learning process facilitated by Chugachmiut’s contractor the Model Forest Policy Program. Chugachmiut offered to assist with recruitment for the cohort. We recruited through e-mail, flyers, Facebook, and word of mouth through summer 2022 and began the program in September 2022 (see figures 1 and 2 of the attachment for advertising examples). We were only able to recruit one more participant and commenced the program in September 2022 with seven participants, including 2 individuals from Qutekcak/Seward, 2 individuals from Valdez, 2 individuals from Port Graham, and 1 individual from Nanwalek.

Throughout the course of the program, we had difficulty retaining Cohort members as life and other obligations occupied their time. One Valdez tribal member moved away and dropped out of the program in week two. In February 2023 we lost another Cohort member when she left her position with the Valdez Native Tribe. A third withdrew from the program due to family obligations and a fourth due to leaving his position with Chugachmiut in March 2023. We also had difficulty holding twice-monthly webinars during the summer of 2023 due to Cohort members' schedules, and so switched the webinars to monthly. A summary of webinar dates and topics is included in Table 1 of the attachment.

The difficulties with recruitment and the high attrition rate among attendees speaks to some of the challenges delivering remote programming to rural Alaskan communities. The first and foremost lesson learned from this is the need for dedicated staff and resources to address climate change and climate impacts. Climate Cohort members all joined because they are passionate about climate change and their communities, but all had multiple competing priorities that made scheduling gatherings and such a time commitment difficult. We had hoped to alleviate this challenge partially by compensating people for their time. However, what we realized is that the training we were providing was useful training for someone working in the field full time, but not a good fit for the Climate Cohort audience. We worked to adjust our approach mid-way through the year to emphasize more guest speakers and provide more basic education around climate change and climate science. However, the format of the online coursework was more suited to someone currently working full time as a climate change professional and not passionate but busy community members. Additionally, Port Graham and Nanwalek experienced a weeks-long internet and phone outage in November – December 2022 that made it difficult for them to participate in the online portion of the class. It was also very difficult to find times for the workshops that worked for everyone and holding them in winter meant that we lost a few people to weather at the last minute. While having dedicated staff to work on climate issues would help eliminate some of the capacity challenges experienced by the Climate Cohort members, internet and weather outages are not something we could readily plan for or work around. We did our best to provide online opportunities to participate in workshops and plan the workshops around cultural events so that there would be more incentive for Climate Cohort members to attend.

A second lesson learned from this project is the strong need for more general climate education in our region in general. Despite having years to decades of experience living in rural communities and practicing a subsistence lifestyle, cohort members felt they did not know enough about climate change and their environment to inform planning efforts and take action on climate change. Furthermore, there was an expressed interest in finding ways to incorporate Indigenous Knowledge, youth, and Western forms of science. But, doing this well also raises bigger questions about data accessibility and data sovereignty, which came in up the context of the Story Map. In addition, they referenced the break in sharing culture that happened as a result of many factors, including the Exxon Valdez Oil Spill of 1989, as a major challenge to resilience for youth and adults alike. Thus, education and knowledge sharing between people in the region of all ages became a major focus of the adaptation plan.

Increase the Access and Useability of CRRC data

Overall, this project was successful at increasing access to and useability of CRRC data and has led to new partnerships for information sharing. The Climate Cohort helped inform the development of the '7 Generations of Climate Change StoryMap' which includes both scientific data sets and interviews with Indigenous knowledge holders to tell the story of Climate Change in the region. Prior to the development of this StoryMap, much of CRRC's climate data was not hosted online or was spread around throughout various websites on the CRRC homepage and APMI. This StoryMap helped create a central repository for this data. In addition, the contractor who worked with CRRC to develop the StoryMap was inspired by this work, and independently applied for and received a National Science Foundation grant to build an interactive dashboard that will make the data even more useful and relevant. Though not funded by this project, the advanced climate dashboard would not have happened without the ICEM grant and StoryMap project and will develop a tool with even more functionality for sharing data and stories from the region to inform climate decision-making.

Elevate local Tribal voices in discussions about climate change impacts and adaptation

StoryMap

This project has been very successful in elevating local Tribal voices in discussions about climate change impacts and adaptation. Our original vision for this outcome was to develop a StoryMap, an interactive kiosk, and a mural on the Alutiiq Pride Marine Institute to provide avenues for Tribal voices to be part of the local conversations around climate change. We successfully completed all of these, with input from the Climate Cohort. Though the full impact of these tools is hard to assess considering some of the delays in deploying them, we believe they will be very successful in helping visitors and locals alike to understand climate impacts in the region. For example, the Kenai Fjords National Park has asked to feature the StoryMap on their website and in their training programs. As one national park manager wrote in a feedback review session: "I can't think of anything that would do a better job of communicating a sense of climate impact in our immediate area and making the essential connection to people and community here."

An image of the mural is included in the attachments as figure six, with details enlarged in Appendix A. The StoryMap can be accessed online at https://storymaps.arcgis.com/stories/5208e109a6aa4a4d83f43f5e177193a3. During the course of this project, CRRC also received funding to build a new facility in Anchorage. The kiosk has not been installed yet as it would need to be torn up for construction almost immediately, but all equipment for the kiosk has been purchased and is ready for install into the new building's lobby once constructed. In the meantime, CRRC has utilized a mobile kiosk display purchased under this grant program to display the StoryMap at their Anchorage office, to bring to communities for educational events, and to have for booths at conferences and workshops.

Optional File Upload

Final report supplemental materials.pdf

Filename: Final report supplemental materials.pdf **Size:** 5.1 MB

2. How has your work benefited your organization, professional field, community, or other stakeholders?*

This work has benefitted our organization by providing funding and time to build connections and establish dialogue with Tribes and concerned community members around climate impacts and climate adaptation. One participant specifically noted they appreciated getting to know CRRC better, as well as others in the region, and feel better equipped to leverage these relationships for future efforts. It has helped strengthen CRRC's Climate Adaptation Strategy by including local voices and local input into the strategy. The strategy in turn will help our organization by directing and guiding the future of CRRC's climate work. This work has also helped advance communication work at the intersection of climate change and human dimensions. As we finished this work, project partners began to hear about other similar projects, including a '7 Generations of Climate Change' StoryMap being developed on the statewide level. Humanizing the context of climate change and identifying ways to address the human dimensions of climate change are vital components of building resilience in communities. This work provides a first look at how this can be done through close communication with affected communities.

3. Are there any other successes related more broadly to this project that you would like to share with us?*

This project has directly led to several partnership opportunities that are either confirmed or in the works, which will help empower local Tribes around issues related to climate adaptation and food sovereignty, increase the exchange of knowledge between Tribes and resource managers, and build more resilient communities. First, as mentioned in the response to question1, the contractor for the StoryMap, Two Bears Consulting, is continuing to work on and improve the data sharing tool, creating new products and visualizations through which to model and understand the interactions between people and the environment. This work will be done closely with CRRC and the Tribes CRRC serves, so will continue to elevate Tribal voices and a two-eyed seeing approach to climate knowledge that values both western and Indigenous science.

This project has also built and strengthened regional partnerships. In February 2024, CRRC's Climate Change Coordinator worked with a partnership of four regional Tribes and five regional organizations to submit a NOAA Climate Regional Resilience Challenge planning grant. This partnership would not have been possible without the relationship building and communication efforts of this grant, which helped new personnel and leadership at CRRC rebuild connections to the Tribes we serve that had been lost. There is still work to do in building trust and collaboration regionally between the Tribes and the Tribal Consortium in the Chugach region, but engaging with the Climate Cohort and Tribes regularly throughout this grant period allowed for that trust building to begin. The grant the partnership applied for addressed many of the high priority items identified by the Climate Cohort and written in the regional adaptation plan, including funding full-time, benefited climate community coordinators in each partnering community to address local climate priorities and provide education and outreach on climate change, funding a regional climate and culture coordinator to help Tribes work on knowledge sharing and adaptation around traditional resources, and provide region-wide workshops for Tribal and non-Tribal partners to continue communicating and build a two-eyed understanding of climate change and climate adaptation.

This work also helped build connections around a specific regional climate change risk, landslide generated tsunamis, which are becoming of increasing concern as glaciers recede and permafrost thaw occurs throughout the region. Shew and Timm are both Co-PI's on a NSF planning grant that was recommended for funding focused on better understanding community priorities so that future research can be responsive to community needs and communicated in effective ways.

4. What did you learn (positive or negative) as a result of this grant? What lessons would you share with other organizations or the field at large?*

As mentioned previously, some of our biggest lessons learned related to capacity-building in the communities we serve. There is a need for more basic education around climate change, climate adaptation, and climate impacts, both for school-age students and community members in general. Expanding CRRC and Chugachmiut's climate education programs in a way that is culturally relevant would be a good first step towards building climate-ready communities throughout the region. One participant noted that the peer-to-peer learning model was useful to them, because they appreciated learning what others around the region in similar positions were doing. This model could possibly be shared with others in the field.

In addition, there is a strong need for paid professional positions at the local level to integrate climate considerations into local and regional planning efforts. Presumably, this would enable participants to engage more fully. The difficulty in scheduling was frustrating for some participants, diminishing the experience somewhat. The education portion of the project was less successful than it could have been because participants had limited time and competing interests. In turn, there was less feedback and interaction with the communities themselves about the regional adaptation strategy and the StoryMap than originally intended, with few opportunities for outreach to community members beyond the Climate Cohort and Tribal staff and leadership.

This project also emphasized the importance of consistent, steady communication with the Tribes in our region, a process that can take a long time and that doesn't always align with the timing of grant funding cycles for climate programs. Many milestones took longer than expected because of competing seasonal interests, such as fishing in the summer and hunting in the fall. Scheduling, planning, identifying ways to try to make the program more accommodating, and gathering feedback was difficult. Oftentimes, a few individuals in the smaller communities wear many hats, and climate change seems less pressing than other more immediate issues such as fixing phone lines or keeping the runway clear of snow. Programs and projects need to account for this in their timeline and providing additional paid professional positions at the local level, with supportive training programs like the one developed for this grant, can help alleviate some of the capacity issues that come from a small number of people trying to accomplish a great many complex activities to keep their communities running.

5. How do you characterize your relationship with the GRP and what suggestions do you have for improvement?*

I feel that our relationship with the GRP is very good. They have been supportive and communicative throughout the grant period. We appreciate that the GRP has been willing to work with us through delays and challenges and extend our grant performance period to help us be successful and do this project the right way rather than the easy way.

While not necessarily needed for 'improvement', I think an annual workshop with all grantees, whether in-person or virtual, would help build networks among groups working on similar issues and share lessons learned along the way. I know there are more Gulf grantees than Alaska grantees, so it would also help us share knowledge across regions and feel more connected to other grantees.

6. Please provide any other feedback or comments you have for the GRP.*

Thank you for funding this project. We're proud of the work we've been able to co-produce with community members as a result of this funding and feel that it's made excellent progress towards our goals of building capacity for climate action, increase the accessibility and useability of CRRC and other climate data sets, and elevate Tribal voices for visitors and land managers around climate impacts and needed climate action.

7. If applicable, please identify and describe the ways you or your organization leveraged GRP's grant (e.g., other funders, volunteers who worked on the program, in-kind donations etc.) Please specify the value and/or number/hours of volunteers if possible.

N/A

2024

Deliverables and supporting materials

FOR THE FINAL REPORT FOR WHEN THE WATER LIVES, WE LIVE: COHORT-BASED COMMUNITY ENGAGEMENT AND PLANNING IN SOUTHCENTRAL ALASKA

CHUGACH REGIONAL RESOURCES COMMISSION

Build skills and knowledge to help your community thrive in the

CLIMATE COHORT

FAQ

What is the Climate Cohort?
The Climate Cohort is a 1-year leadership training and planning effort to increase the Chugach region's ability to prepare for and respond to impacts from climate change.

What are the benefits?
Through the Cohort, you will:

- increase leadership and communication skills
- build a network of climate experts and regional resources
- learn more about climate change in the Chugach region
- contribute to regional planning efforts
- increase your knowledge of project management and grant writing.

Who can join?
Any Chugach-region Tribal member or Tribal staff. We are looking for individuals who:

- Want to serve your community
- Want to preserve culture and subsistence ways of life
- Want to learn from and share knowledge with your communities and each other

What is the time obligation?
We anticipate 8-10 hours monthly, including two 90-minute calls per month. In addition, there will be three 1-day workshops in September 2022, November 2022, and March 2023.

What is the compensation?
Cohort members will receive a stipend totaling $500 per month from August 2022 - July 2023 ($6,000 total).

Engage in a learning and planning process to protect health, well-being, and subsistence ways of life in a changing climate

The Chugach region needs leaders to guide our response to climate change, protecting people, villages, and natural systems.

The Climate Cohort is a partnership between Chugachmiut, Chugach Regional Resources Commission, the University of Alaska Fairbanks and the Model Forestry Policy Program to build knowledge and skills among Tribes in the Chugach region to build resilience to climate impacts. Through twice-monthly training calls and three regional planning workshops, you will learn about climate change in the region and develop plans to prepare for it. By the end of the program, you will have developed a regional plan and learned skills to apply for funding community planning or preparedness projects.

Drawing: Sarah Glaser, Photo: Erin Shew

CONTACTS:

Kert LaBelle
kert@Chugachmiut.org
(907) 334-0110

Erin Shew
erin@crrcalaska.org
(907) 385-7670

Figure 1: One-pager detailing the Climate Cohort that was shared with Tribes.

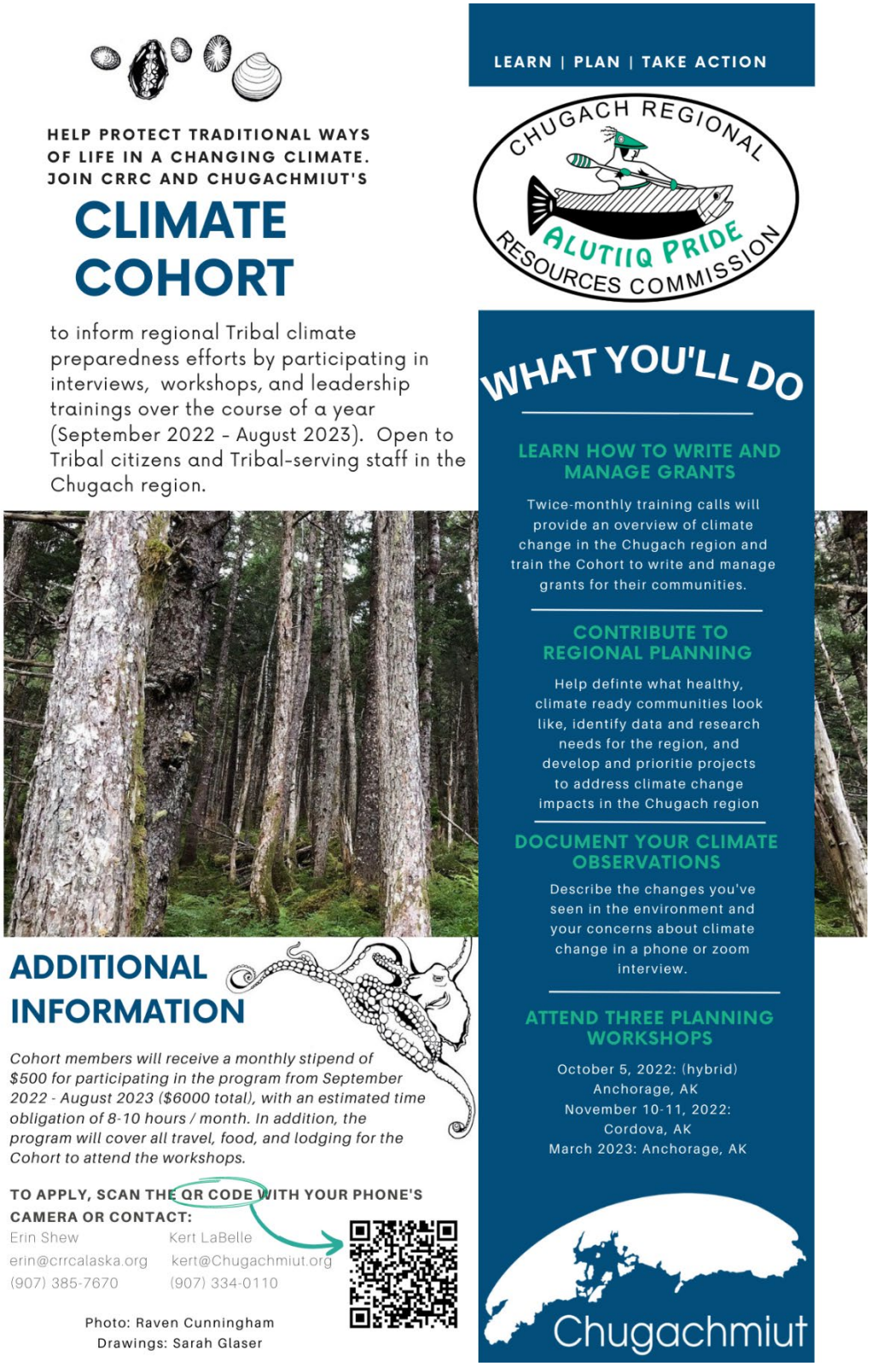


Figure 2: Flyer advertising the Climate Cohort that was shared with CRRC Board, sent to Tribal Administrators and staff in the region, and posted to Facebook.

Table 1: A list of webinar topics and presenters.

Date	Session	Project Guidance	Climate Topic & Co-Leader	Leadership Topic & Co-Leader
9/7/2022	#01	Introductions & Overview		
9/21/2022	#02	Learn-By-Doing Topics Review	Learning Topics Proritization	
10/5/2022	#03	Working Session / **CRRC Workshop #1**	Warming Temperatures and Chugach Changes - **Nancy Yeaton**	Grant Research Skills - **Jamilyn Fenn**
10/19/2022	#04a	Abbreviated - low attendance		
11/7/2022	#04b	Learning Session		
11/21/2022	#05	Working Session **CRRC Workshop #1 Review**	How to Be Climate Resilient **Ari Schablein**	Strategic Planning - **Anna Bateman**
12/12/2022	#06	Learning Session		
1/09/22023	#07	Working Session	Elder Wisdom & TEK **Naomi McMullen**	Good Communications **Kert LaBelle**
1/23/2023	#08	Learning Session		
2/6/2023	#09	Special Topic Session	Climate Adaptation Planning Framework **Gwen Griffith & Erin Shew**	
2/21/2023	#10	Special Topic Session	Curriculum Adjustments and Village Engagement Opportunities **Gwen Griffith & Erin Shew**	
3/6/2023	#11	Working Session	Coastal Impacts **Nancy Yeaton**	Public Speaking & Presentations **Kert LaBelle**
3/20/2023	#12	Learning Session	Postponed	Public Speaking & Presentations **Kert LaBelle** **Jim LaBelle**
4/3/2023	#13	Working Session	Coastal Impacts **Nancy Yeaton**	Climate Awareness **Naomi McMullen**
4/17/2023	#14	Special Topics (Presentations cancelled)	CRRC Next Steps **Erin Shew**	BIA Grant Homework **Gwen Griffith**
5/1/2023	#15	Learning Session	Coastal Impacts **Nancy Yeaton** **Jacqueline Ramsay**	CRRC Next Steps Mural Discussion **Erin Shew**

5/15/2023	#16	Working Session	Funding Sources **Jamilyn Fenn**	CRRC Data Tool for Regional Adaptation **Two Bears Consulting**
6/5/2023	#17	Learning Session	TEK & Subsistence **Ari Schablein**	CRRC Data Tool for Regional Adaptation **Two Bears Consulting**
7/10/2023	#18	Learning Session	Recap of Project Cohort Next Steps **Gwen Griffith**	Funding Sources for Chugach Region **Jamily Fenn**
8/28/2023	#19	Wrap Up Session	Climate Cohort Aug-Dec 2023	Climate Grant Proposals BIA and NOAA

Figure 3: October 5 workshop agenda (Workshop 1, Anchorage AK)

CHUGACH REGIONAL RESOURCES COMMISSION

Alutiiq Pride

Workshop 2 Goals:

- Identify desired outcomes (goals) for important subsistence species and other resilience factors
- Draft strategies and projects to support those strategies and identify ways to better incorporate community voices into the refinement of the plan
- Discuss existing data sources and identify what to include in a data tool aimed at 1) education and 2) decision-making

December 1: Adaptation plan discussion and drafting

9-10am: breakfast and setup at Cordova Center Mayor's Conference Room
10am – 10:15am: welcome
10:15am – 11:00am: presentation of workshop 1 results and discussion (Erin Shew)
11:00 – 11:45: Resist Accept Direct adaptation planning presentation (Dr. John Morton)
11:45-12:30: MFPP's Adaptation Planning Process (Dr. Gwen Griffith)
12:30 – 1:30 lunch (catered by Rachel Hoover, Salmon chowder)
1:30 – 2:00: Discussion – What do we want our adaptation plan to include (format and strategies)?
2:00 – 2:50: Discussion – What does success look like for these strategies?
3:00 – 4:00: Discussion - Planning next steps: How should we share this info and solicit community input and feedback?
4:00 – 5:00pm (tentative): Ilanka Cultural Center tour
6:00pm – Dinner at Reluctant Fisherman or Powder House

December 2: Data needs and tool development

9-10am: breakfast and setup at Cordova Center Mayor's Conference Room
10 - 10:45 am: SNAP data tools for the Chugach region (Dr. Nancy Fresco, SNAP)
11:00 – 12:00 (tentative): Prince William Sound Science Center Tour
12:00 – 1:00: lunch (catered by Rachel Hoover, gluten-free gnocci)
1:00 – 2:00: CRRC APMI research (Emily Mailman and Maile Branson, Alutiiq Pride Marine Institute)
2:00-2:45: Discussion: Sharing other data tools Cohort members find useful and talking about what makes a good data tool/visualization.
2:45 – 3:00: break
3:00 – 3:45pm: Discussion: What data do we want a regional data tool to include? How should we show that data? Does the data/format differ for decision-makers and educators?
3:45 – 4:00pm: wrap-up and next steps
5:00pm: dinner at Reluctant Fisherman or Powder House
6:00pm: Christmas tree lighting ceremony and Holiday Bazaar

A Tribal Organization Focusing on Natural Resource Issues Affecting the Chugach Region of Alaska
Chenega • Eyak • Nanwalek • Port Graham • Qutekcak Native Tribe • Tatitlek • Valdez Native Tribe

P.O. Box 111686
Anchorage, Alaska 99511-1686

(907) 224-5181
www.crrcalaska.org

Figure 4: December 1-2 agenda (Workshop 2, Cordova, AK)

CHUGACH REGIONAL RESOURCES COMMISSION

Alutiiq Pride

Climate Change Cohort
Workshop #3
Hotel Captain Cook, Anchorage, AK
March 22, 2023

Workshop Goals

1. Review, refine, and fill-in gaps in the climate adaptation strategy.
2. Identify metrics to measure the impacts of climate change on local human health and the environment.
3. Learn about the Chugachmiut Heritage Climate Change Kit and brainstorm additional lesson goals and activities.
4. Brainstorm and assess feasibility of mitigation strategies for traditional foods resources of concern from the vulnerability assessment.
5. Discuss and plan for how to best share results and receive feedback for the climate adaptation strategy and other deliverables with CRRC communities.

Agenda

9:00 - 9:30 am **Morning Gather & Mingle**

9:30 am - 12:30 pm **Morning Session**
- Invocation & Workshop Orientation
- Climate Adaptation Strategy Review & Feedback
- Measuring Climate Change Impacts on Local Human Health & the Environment
- Chugachmiut Heritage Climate Change Kit Presentation & Brainstorm

12:30 - 1:15 pm **Lunch**

1:15 - 4:30 pm **Afternoon Session**
- Resources of Concern Mitigation Strategy Brainstorm & Feasibility Assessment
- Climate Adaptation Strategy Community Tour Brainstorm & Planning
- Closing

A Tribal Organization Focusing on Natural Resource Issues Affecting the Chugach Region of Alaska
Chenega • Eyak • Nanwalek • Port Graham • Qutekcak Native Tribe • Tatitlek • Valdez Native Tribe

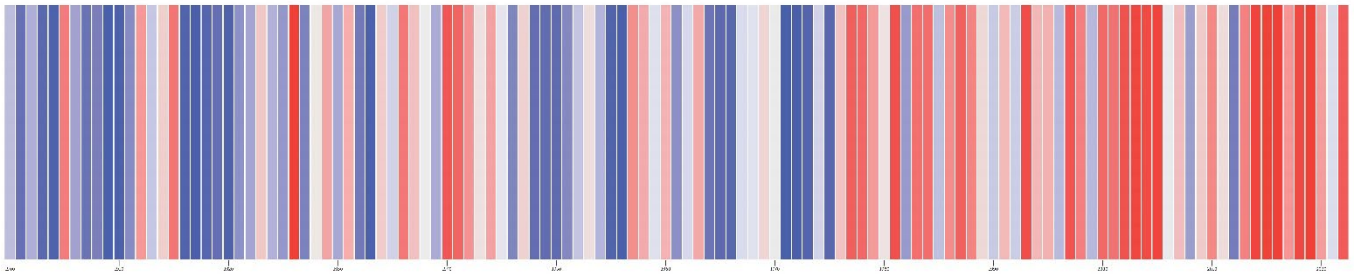
P.O. Box 111686
Anchorage, Alaska 99511-1686

(907) 224-5181
www.crrcalaska.org

Figure 5: March 22 workshop agenda (Workshop 3, Anchorage, AK)

Figure 6: APMI Mural. See Appendix A for high quality, zoomable details.

Appendix A: Detail of Mural by section



Seward, Alaska Climate Stripes, 1900 - 2022

Data Source: berkeley earth

Cooler — Warmer

"Elders have seen changes during their lifetime: temperatures increased, glaciers melting, less snow, bigger storms, resources no longer available or far away. As a child, I remember snow was so deep, it covered everything, sometimes we did not go outside because it was so cold and the lagoon would freeze, which it does not anymore. In the last 10 years, snow is not what it used to be; it no longer sticks around until April, the snow does not get deep and the winters are warmer."

– Nancy Yeaton, Nanwalek

"Qangirllat napuit picurtutut. Nuna cimirtuq, imarpet maqailuni, aqllat tugniluten, qiteqcagluni, aniui'llni."

"Old people's (Elders') words are true. The land is changing, the ocean is warming up, the winds getting stronger, and it is raining a lot with no snow."

– Lillian Moonin Elvsaas, Port Graham

Imam Cimiucia: Our Changing Sea

CLIMATE STRIPES

No words. No numbers. No graphs. Just a series of colored bars. These "climate stripes" are visual representations of Seward temperatures since 1900. Each band represents the average temperature in Seward for a single year, relative to the average temperature from 1900-2022. The color shade corresponds to the rank of each year from coldest (dark blue) to warmest (bright red).

The darkest blue corresponds to the coldest average annual temperature for this period (1971 with an average temperature of 29.6° F). The brightest red corresponds to the warmest (2016 with an average temperature of 37.1° F). Colors between dark blue and bright red represent temperatures in between these extremes.

The warming trend in Seward is remarkable. The numerous and consistently bright red stripes on the right-hand side of the wall show the undeniable warming trend in Seward over the past three decades. At the Chugach Regional Resources Commission we are working to understand the changing climate and make a difference for the future of Chugach region Alaska Natives.

OCEAN ACIDIFICATION

One of the biggest challenges that climate change creates for the Chugach people is ocean acidification. The ocean absorbs CO2 that is released in the atmosphere. As levels of atmospheric CO2 increase, so do the levels in the ocean, causing seawater to become more acidic.

Alaska is experiencing the effects of ocean acidification faster and more intensively than anywhere else in the nation. Since 2013 the Alutiiq Pride Marine Institute has been monitoring seawater with the help of tribal communities around the state for ocean acidification parameters.

Many marine species are sensitive to a slight change in pH. The full extent of impacts are unknown, but negative effects are starkly observed in those organisms that make shells or structures out of calcium carbonate at early larval stages such as crabs, pteropods, clams, mussels, and oysters - the same species that are heavily relied upon and valued by subsistence users.

This installation was funded by Chugach Regional Resources Commission through the National Academy of Sciences Gulf Research Program, Agreement Number 2000010645. Rick Thoman with the International Arctic Research Center and Alaska Center for Climate Assessment and Policy generated the data. The climate stripes concept was originally created by Ed Hawkins at the University of Reading.

ACCAP Alaska Center for Climate Assessment and Policy

CHUGACH REGIONAL RESOURCES COMMISSION

ALUTIIQ PRIDE MARINE INSTITUTE

NATIONAL ACADEMIES GULF RESEARCH PROGRAM

RISING TIDE


cimiqatartuq :: starting to change
(Lower Cook Inlet dialect)
qulwarluni :: rise
(Prince William Sound & Lower Cook Inlet dialects)
uruglluni :: melt
(Prince William Sound & Lower Cook Inlet dialects)
imam mera maqaruartuq :: warm ocean water
(Lower Cook Inlet dialect)

Appendix B: CRRC Regional Adaptation Strategy

Chugach Regional Tribal Climate Resilience Plan

Prepared by:

Chugach Regional Resources Commission

Updated April 2024

Acknowledgements

The Chugach Regional Tribal Climate Adaptation Plan is the result of the hard work and persistence of many people (see list below), including staff from various Tribes and organizations, consultants, and reviewers who spent many hours researching, writing, pouring through spreadsheets, and reviewing this plan.

A special thanks to the Bureau of Indian Affair's (BIA) Tribal Resilience Program and the National Academy of Sciences Gulf Research Program's (NAS GRP) Innovative Community Engagement Methods program for supporting this planning process through grant award numbers A20AP00204 and 2000013198, respectively.

In the spirit of our ancestors and with deep respect for the land that sustains us, we dedicate this plan to our families, our friends, and the children of the Chugach region. This plan is our promise to the future generations who will walk this land after us and a commitment to uphold the legacy and wisdom of our elders, not only for our human relatives but for all our relatives, human, fish, plant, and animal. May our successes today pave the way for future prosperity, ensuring they inherit a world where our traditions, our culture, and our communities continue to thrive in harmony with the land and sea.

Chugach Regional Resources Commission:
Erin Shew, Climate Change Coordinator
Allison Carl, Lab Manager
Willow Hetrick, Executive Director

Climate Cohort:
Anna Bateman
Jamilyn Fenn
Kert LaBelle
Naomi McMullen
Ari Schablein
Nancy Yeaton

Chugach Regional Resources Commission's Climate Change Program

Alaska's Chugach region, which encompasses over 6 million acres of land and 5,000 miles of coastline in Southcentral Alaska, has been home to the dAXunhyuu (Eyak) and Alutiit/Sugpiat people since time immemorial. Today, over 1,500 Tribal members still live and work in seven communities throughout Prince William Sound and the Lower Cook Inlet: Chenega, Cordova (Eyak), Nanwalek, Port Graham, Seward (Qutekcak), Tatitlek, and Valdez. The Chugach Regional Resources Commission (CRRC) is an inter-Tribal fish and wildlife commission authorized as a Tribal consortium under the Indian Self Determination and Education Assistance Act of 1991. CRRC is authorized by our seven member Tribes to provide essential government services to Tribal citizens around natural resource management, subsistence activities, climate change adaptation and environmental concerns, food security, and access to healthy traditional foods and clean water.

In 2014, CRRC's Board of Directors, comprised of one elected representative from each of the Tribes CRRC serves, raised concerns about climate change's impacts in the region and directed CRRC to start a climate program to assess and address those impacts. Between 2015-2017, CRRC held regional workshops that revealed climate impacts on traditional foods and the loss of opportunity to pass on traditional knowledge and livelihoods to future generations were the most pressing climate concerns for the Chugach region. In 2022, CRRC completed a traditional foods vulnerability assessment that summarized the results of community meetings, a region-wide survey, and a scientific literature review to understand the vulnerability of the twenty top harvested subsistence species in the region to climate change. This strategy document directly follows from that vulnerability assessment.

Figure 1: Alaska's Chugach Region showing current communities (blue dots) and traditional place names.

In 2021, CRRC was funded by the Bureau of Indian Affair's Tribal Resilience Program to develop a climate resilience plan focusing on traditional foods. The start of that work was delayed due to due to the severity of the COVID pandemic and subsequent travel restrictions that stalled the vulnerability assessment upon which this document depends, with work on the resilience strategy beginning in 2022. Additionally, in 2022, CRRC was funded by the National Academy of Science's Gulf Research Program to host a group of community members in a climate education and planning program. Over the course of three workshops, CRRC and this group of community members, the Climate Cohort, developed this climate resilience strategy for the Chugach region. This strategy is meant to be a guide for actions CRRC can take at the regional level to support Tribes in understand and adapting to climate change, with a particular focus on what CRRC can do to help support and sustain traditional foods and other natural resources in a changing climate. It focuses on information gaps and short-to-medium term actions that can be taken to support climate adaptation and community resilience, prioritizing traditional foods, and as such is not a complete listing of all climate actions the region could take. For example, it does not focus or address climate change mitigation measures to reduce carbon emissions, such as renewable energy or energy efficiency investments. It is intended to be a living document, reviewed and updated periodically as our collective understanding of the science behind climate change, the impacts to our region, and effective adaptation options grow.

Priority Projects

"Resilience" is a term that's often used in climate adaptation discussions but can be defined several ways. As part of the Climate Cohort's work, the group created a unified vision of resilience to help define what the end goal of a climate resilience plan will look like. The group decided that a resilient community is a thriving community that people want to stay in, or return to after leaving for school, and where they can find affordable, safe housing, good-paying jobs, connection to culture and community, and access to healthy subsistence foods. Resilience requires healthy communities and healthy ecosystems, built on thousands of years of stewardship experience. Resilience also requires acknowledgement of and work to heal from historical traumas and losses. The following climate adaptation strategies have been developed to foster the connections between people and the land and will be used to guide CRRC's future climate resilience.

> "A resilient community is a thriving community that people want to stay in, or return to after leaving for school, and where they can find affordable, safe housing, good paying jobs, connection to culture and community, and access to healthy subsistence foods. Resilience requires healthy communities and healthy ecosystems, built on thousands of years of stewardship experience. Resilience also requires acknowledgement of and work to heal from historical traumas and losses."
>
> Resilience as defined by the Climate Cohort for the Chugach Region

The proposed strategies and priority actions are targeted to actions that can be taken at the local and regional scale. CRRC supports further action at the state, national, and international level to protect ecosystem services and address the impacts of climate change on ecosystems and livelihoods, and coordinated action to reduce greenhouse gas emissions, the root cause of the dramatic climate change the region is already witnessing.

Strategy 1: Engage with policy makers and resource managers to address institutional barriers to resilience

Protect and enhance Tribal Sovereignty on traditional lands to increase community and ecosystem resilience.

A 2019 UN report issued dire warnings for ecosystems worldwide, noting that pollution, degradation, segmentation, and other impacts to ecosystems and ecosystem function associated with Western development are exacerbated by climate change. The same report noted that lands and waters managed by Indigenous peoples are declining less rapidly than other natural areas (IPBES, 2019). Policies that enhance Tribal control over traditional lands and waters help protect ecosystem health and promote the mental, physical, and cultural health of local communities.

> ACTION: Advocate for Tribal Co-management agreements around important ecosystems and resources so that Tribes are involved in decision-making for climate adaptation in their traditional territories.
>
> ACTION: Develop Tribal Conservation Districts to open new avenues of funding for Tribal priorities around resilience, food systems, and conservation.

Additionally, while not directly related to climate change, other actions that would promote Tribal Sovereignty in the Chugach region and thus better enable Tribes to respond to climate impacts include:

> ACTION: Recognize Valdez Native Tribe and Qutekcak Native Tribe as Federally recognized Tribes
>
> ACTION: Recognize traditional use and dependence on subsistence foods by granting Valdez and Seward rural status and allow for subsistence harvests on Federal lands.
>
> ACTION: Conduct Tribal censuses in regional communities as these are inaccurately captured by the US Census

Advocate for hunting and fishing regulations that reflect the new climate reality.

> ACTION: Network with other Tribes and regional organizations to share knowledge and resources and support on subsistence regulations
>
> ACTION: Provide education, outreach, and support to Tribal members about the processes and decisions being considered by regulatory bodies such as the Boards of Fish and Game, the Federal Subsistence Board, the North Pacific Fisheries Management Council, the Alaska Migratory Bird Co-Management Council, and other entities that manage hunting and fishing regulations.
>
> ACTION: Develop a research library on how climate change is impacting fish and wildlife in the region and adaptation options to address those impacts. Identify funding and research opportunities to fill in research gaps.
>
> ACTION: Develop tools to analyze and communicate what climate projections implicate for fish and wildlife species in the region.

Send a regional Tribal Climate delegation to Congress to raise awareness of regional climate impacts and advocate for programs and fundings to address those impacts.

ACTION: Develop a program for Tribal Climate Coordinators similar to the IGAP program

ACTION: Expand funding for implementation funding in the BIA's Tribal resilience Program

ACTION: Request standard set-asides in energy and infrastructure projects for Tribes that have a low-or-no match requirement and include technical assistance upon request

Strategy 2: Increase regional climate literacy through a two-eyed seeing approach that values the contributions of traditional knowledge and western science to understanding and adapting to climate change.

The National Oceanic and Atmospheric Administration (NOAA) defines climate literacy as understanding "the influence of climate on yourself and society – and your influence on climate" (NOAA, 2023). The idea of two-eyed seeing comes from Mi'kmaw Elder Albert Marshall, who defines it as "learning to see from one eye with the strengths of Indigenous knowledges and ways of knowing, and from the other eye with the strengths of Western knowledges and ways of knowing… and learning to use both these eyes together, for the benefit of all" (Reid, et al., 2021). Traditional knowledge provides deep insights into how climate influences and impacts communities and individuals in our region, and vice-versa, as documented through generations of observations and interactions with the local ecosystems. Western science can develop and run models, provide microscopic understanding of ecosystem processes, and provide other information about climate change that cannot be observed by the naked eye. Building climate literacy that is fluent in multiple ways of understanding the world will build regional capacity to understand and act on climate change at the local level.

Educate students and the workforce to prepare them for future careers in natural resource management in our region, building a local workforce to manage local resources in a changing climate

ACTION: Work with local commercial fishers to develop climate-ready fisheries fleets. This could include:

- Education and outreach about new technologies to reduce fleet emissions, including partnering on revolving loan or grant programs to help retrofit fleet vessels
- Develop an education and marketing program that documents climate-friendly fishing practices. This could be used to increase the value of Copper River and other local products. No certification for climate-neutral fisheries currently exists
- Conduct research and provide information on environmental conditions and model projections, and how conditions might impact fisheries species
- Work with the fishing fleet to monitor for invasive species and other ecosystem changes

ACTION: Identify or develop training and scholarship programs to train workers in recent technologies such as renewable energy systems operation, electric engine maintenance and repair, mariculture technology, and other identified emerging fields.

ACTION: Collaborate with School Districts to develop a culturally-relevant climate curriculum for schools and HeadStart, building on the work done through the Chugachmiut Heritage Preservation program's Cultural Heritage Kit on Climate Change.

ACTION: Develop natural resource management education and leadership pipelines for training the next generation of leaders and resource managers, providing paid internships and other experiences to students.

ACTION: Develop educational activities centered around subsistence and climate change that engage all generations to educate each other about traditional harvesting and climate knowledge.

ACTION: Host culture camps that involve elders, youth, and parents that teach traditional skills and knowledge and have climate education components. Identify opportunities to bring science education to existing culture camps.

ACTION: Host community education events such as beach walks that bring together experts from different backgrounds, including western scientists, elders, active hunters, fishermen, kelp farmers, and other knowledge holders, to discuss what they know and see happening in the environment and invite community members to ask questions and join the discussion.

Document and share stories about how climate change is impacting the region

ACTION: Document local observations of change and unusual phenomena to build a better understanding of what is changing and how quickly

ACTION: Work with elders and youth to develop media that shares traditional knowledge and observations of change. These media formats might include:

- Youth engagement project with video storytelling
- Climate storytelling workshops in communities
- Climate book with stories from the region
- Self-guided tour app for communities that talks about change

Develop ecosystem and food health observation and monitoring programs together with local Tribes and harvesters.

Strategy 3: Increase local capacity to mitigate and respond to climate impacts

Assist Tribes with incorporating climate change into strategic planning and everyday operations

ACTION: Review and update or establish strategic planning documents that incorporate current understanding of climate impacts and climate models

ACTION: Review and update or establish coastal flood risk maps

ACTION: Conduct a First Nations Development Institute Food Sovereignty Assessment: https://www.firstnations.org/wp-content/uploads/publication-attachments/2015_Food_Sovereignty_Assessment_Tool.pdf

ACTION: Update or establish hazard mitigation plans that incorporate climate risks. Assist Tribes in developing FEMA-approved hazard mitigation plans under the new Tribal Hazard Mitigation Planning Policy that will be released by FEMA in 2025 (https://www.fema.gov/emergency-managers/risk-management/tribal-updates).

Work with regional Tribal governments to build up human resources to address climate impacts at the local level

ACTION: Establish climate coordinator positions in every community to assist with education, outreach, networking, and project planning, and provide a climate risk perspective to local decision-making

ACTION: Provide training for capacity building in Climate change adaptation, including regional grant-writing workshops for upcoming grants and developing "train the trainer" programs to teach local leadership about climate adaptation planning.

Develop downscaled data tools and models to help decision-makers in the region understand and plan for climate-related changes.

ACTION: Work with researchers on modeling future environmental conditions such as ocean chemistry, temperature and precipitation averages, and extreme weather events and provide tools to help contextualize that data for local decision-makers.

Develop renewable energy and energy efficiency projects that decrease carbon emissions, increase air quality, and enhance local circular economies.

ACTION: Identify opportunities for new renewable energy projects that have minimal impacts on salmon runs. Conduct updated feasibility studies on wind, solar, and hydro options.

ACTION: Develop a grant and/or rebate program for installing heat pumps and other proven energy efficiency technologies in residential homes around the region.

ACTION: Implement community garden and composting programs to divert food waste and cardboard from waste streams and reduce shipping emissions and waste for food.

ACTION: Work with local electricity providers to identify workforce development needs for RE/EE projects and train local employees

ACTION: Provide rebate and grant programs for fishing fleet and vessel upgrades to reduce greenhouse gas emissions.

Strategy 4: Build our regional understanding of how climate change is impacting human and community health and take actions to mitigate those impacts

Understand and reduce the risks to human and community health from wildfires

ACTION: Monitor the prevalence of beetle-killed and other diseased trees

ACTION: Montor understory fuel loads and collaborate with land managers to conduct thinning and clearing of fuel loads near communities and cultural sites

Identify alternative drinking water reservoirs for Nanwalek and Port Graham

ACTION: Map stream flow and ground water reserves on the lower Kenai

ACTION: Assist with stockpiling and delivering water in the short term, and work with Tribes and other entities to develop more sustainable drinking water solutions for the future.

Understand links between climate change, erosion, and landslides, and build a system to communicate risk from these events

ACTION: Work with communities and researchers to co-produce knowledge about landslides and erosion in our region

ACTION: Build on existing work and local knowledge to identify unstable slopes with landslide potential, and conduct LIDAR surveys in our region to map potential risk areas

ACTION: Map the rates and direction of erosion and instability in coastlines and slopes, particularly where there are threats to infrastructure, cultural resources, or human health

ACTION: Understand ecosystem impacts of landslides, tsunamis, and erosion, and how they will impact resource health long-term

Monitor human and environmental health over time to track the success of resilience initiatives

ACTION: Develop and track regionally-relevant metrics of long-term resilience based on the regional definition, including:

- Migration/outmigration rate
- Cost and availability of housing compared to Alaska state averages
- Unemployment rate
- Average household income
- Food security
- Participation in subsistence and cultural activities

ACTION: Develop metrics and monitor the progress of the strategies included in this document though:

Strategy 1: break down institutional barriers to resilience

- Number of regional Tribal members participating in public processes
- Number of co-stewardship and/or co-management agreements reached between Tribes and resource managers

- Number of acres of land directly stewarded by Tribes

Strategy 2: increase regional climate literacy through a two-eyed seeing approach

- Number of local citizen science programs implemented and producing useable data in the region
- Number of Tribally-led or co-produced research programs implemented in the region
- Number of policy documents, land management documents, academic papers, and other peer-reviewed and public process documents co-authored by Tribal members and staff

Strategy 3: increase local capacity to mitigate and respond to climate impacts

- Regional funding for climate adaptation, resilience, and mitigation programs
- Number of Tribes that have active climate and/or environmental programs
- Number of hazard mitigation or strategic planning documents that include climate change considerations in their plans

Strategy 4: understand and take action to address climate impacts on human health

- Number of annual heat-related injuries reported in the region
- Number of people diagnosed with asthma and other chronic respiratory conditions
- Number of incidents of paralytic shellfish poisoning and other harmful algal bloom related illnesses
- Quality and availability of drinking water in communities

Strategy 5: develop programs to manage and protect traditional foods and the ecosystems upon which they depend to support local food and water sovereignty

- Pounds of local subsistence food harvested
- Pounds of local food grown in community gardens
- Number of youth engaged in hunting and fishing activities
- Number of youth participating in culture camps

ACTION: Periodically review and revise these resilience metrics to ensure they still reflect the needs and priorities of the region

Strategy 5: Develop programs to manage and protect traditional foods and support local food and water sovereignty

Climate change threatens the ecosystems and wild foods that Chugach region Tribes have relied on since time immemorial. Subsistence is an important contributor to individual and community health. It helps support physically healthy communities by providing nutritious foods that are not associated with many of the negative health impacts of Western diets, at a much more affordable price than costly imported fresh food. Subsistence also helps support mental health through connecting people with their

culture and heritage and improving informal social safety nets through concepts of reciprocity and respect that are imbedded in traditional ways of teaching about and sharing subsistence harvests. Finally, many of the communities in the Chugach region are isolated and can be difficult to access, particularly in winter.

Facilitate the exchange of traditional knowledge and technology around food and water

ACTION: Develop and hold classes on proper food preparation and storage

ACTION: Support local Tribal efforts to facilitate the exchange of traditional harvesting and preparation techniques between elders and youth. Include opportunities for parents to participate and learn as well.

ACTION: Collaborate with land and water managers to incorporate TEK into research questions and management considerations

Identify and support new approaches to building local food sovereignty

ACTION: Provide emergency community food and survival gear for communities in the region

ACTION: Develop and hold classes on emergency preparedness and water purification.

ACTION: Expand food security complexes in each community that provide food processing and storage capability and develop classes and build management capacity for them within Tribes.

ACTION: Establish and support community farming projects. Identify funding for greenhouses and community gardening projects and provide training and support to local staff to operate them.

ACTION: Work with Chugachmiut's Forestry program and local Tribes to develop a demonstration agroforestry and permaculture farming project

Develop local data and document changes to habitat and subsistence foods that can be used to inform wildlife management policy, including:

ACTION: Develop better estimates for populations of important subsistence species in the Chugach region, particularly species such as marine mammal populations that are officially monitored in aggregate with larger populations.

ACTION: Map suitable habitat for kelp and clam garden co-location and conduct any pre-permitting activities.

ACTION: Map current habitats in the Chugach region and work with modelers to understand how those habitats are changing over time, including localized temperature and precipitation data and surveys of native plant species

ACTION: Work with community members to document unusual environmental phenomenon such as mass mortality events, changing diets of subsistence resources, invasive or rare species, or unusual signs of sickness or disease and use this information to inform research needs and priorities.

Implement programs and projects that protect traditional foods and the ecosystems upon which they depend. Initial priority projects identified through the Climate Cohort workshops include:

General

Marine heatwaves like those that occurred in 2014-2016 will become more frequent, from a once-in-a-century events to events that could occur multiple times a decade (Oliver, Perkins-Kirkpatrick, Holbrook, & Bindoff, 2018).

IMPACT: Concerns about the safety of subsistence foods and the increasing scarcity of subsistence resources mean there is less opportunity to learn how to harvest food and pass on traditions to the next generation.

ACTION: Facilitate learning and food trade networks to share knowledge and resources between communities.

ACTION: Develop Tribal and regional harvest monitoring efforts, such as Tribally-led subsistence harvest surveys based off the Alaska Department of Fish and Game's harvest surveys, to inform fish and wildlife management processes and track the success of programs aimed at increasing Tribal food sovereignty.

ACTION: Expand programs designed to monitor resource safety and provide clear, consistent communication about the status of resources.

Harmful Algal Bloom Monitoring through water quality testing, blue mussel testing at sites near harvesting beaches, and direct sampling of specimens sent to APMI.

Work with harvesters to develop a monitoring system for resource health and train community members on signs of common diseases or parasites that can impact human health.

Salmon

IMPACT: Development impacts salmon streams, creating compounding stressors that can negatively influence salmon survival.

ACTION: Assist with cataloguing bridges and culverts in Prince William Sound and the lower Kenai and prioritize upgrades to improve salmon passage. Port Graham and Nanwalek have not been assessed / updated since 2004. Seward's last survey was in 2017.

Resources: Copper River Watershed Project's Culvert Mapper (Cordova, Valdez, upper Copper River); Alaska Fish Resource Monitor

ACTION: Establish voluntary development and logging set-backs of 200' feet on either side of anadromous streams.

ACTION: Work with landowners to revegetate stream banks and shorelines, particularly in more developed areas like Seward and Valdez.

IMPACT: Warming temperatures in streams induce heat stress in salmon, threatening survival

ACTION: Map cold-water refugia and flows in important salmon streams and develop an emergency plan for manual salmon transportation to refugia sites in times of extremely warm or low water.

ACTION: Develop a pilot project to measure the impacts of beavers and beaver dam analogues on salmon stream habitat, and work with Tribes to expand the program if successful to important salmon streams.

IMPACT: Changing precipitation patterns mean that stream flows have changed, impacting salmon migration

ACTION: Map water flow for at least 5 years to develop baseline data to apply for stream conservation status in years of low water

ACTION: Examine options for water storage and release if seasonal flows shift significantly. Such systems could be designed as part of a low-impact hydropower generation or drinking water storage system for remote communities.

IMPACT: Ocean acidification and increasing ocean temperatures affect salmon food webs (Holsman, Aydin, Sullivan, Hurst, & Kruse, 2018). Additionally, ocean acidification appears to interfere with salmon's homing ability.

ACTION: More research on this topic is needed. Pilot projects should be established to quantify the ecological services provided by kelp farming in the region, including local impacts on the food web and phytoplankton survival, and impacts to straying rates.

Halibut

IMPACT: Decreasing size-at-age of halibut and a shift towards younger halibut in the Gulf of Alaska (Holsman, Aydin, Sullivan, Hurst, & Kruse, 2018)

ACTION: Advocate for a moratorium on sports fishing until adult populations recover.

IMPACT: Warmer conditions increase metabolic demands on halibut, reduce the availability of high quality prey species, and increase competition for prey particularly with Arrowtooth Flounder (Holsman, Aydin, Sullivan, Hurst, & Kruse, 2018).

ACTION: Support important prey fish such as herring, cod, pollock, etc.

ACTION: Conduct research on stomach contents of halibut to understand what they are eating and the nutritional value of it.

IMPACT: Mushy flesh has people concerned about the safety of eating halibut.

ACTION: Mushy halibut syndrome may be linked to nutritional deficiencies (Alaska Department of Fish and Game). To better understand this phenomenon, CRRC should conduct research on halibut stomach contents and nutritional values and develop programs to test this hypothesis. While conducting research to better understand mushy halibut syndrome, CRRC should also pursue programs

to support populations of high-quality prey species such as herring, cod, pollock, and other forage fish.

Forage fish (herring, tomcods, sandlance, eulachon, walleye pollocks)

IMPACT: Decreasing biomass of forage fish species appears to be due to changes in crustacean phytoplankton that are an important food source for young pollock and other species (Johnson, 2016) (Suryan, 2023). These impacts on forage fish appear to be cascading through the food web, impacting salmon, halibut, and other commercially and culturally important species. In the Gulf of Alaska, particularly, these impacts seem to largely correlate with fluctuations in sea surface temperatures and impacts to early life stages of these fish (Villalobos, Love, & Olson, 2020) (Laurel, et al., 2021).

ACTION: Develop studies on food webs and climate impacts, perhaps recreating the work of Robert M. Suryan in PWS and Kachemak Bay (https://www.openaccessgovernment.org/article/food-webs-and-fish-ocean-climate-change-in-alaska-gulfwatch/162947/).

ACTION: Study potential for forage fish hatcheries to rear these species through vulnerable early life stages which are particularly susceptible to heat mortality. Hatcheries have been successful in supplementing fishery populations overseas, like Japan (https://www.hatcheryinternational.com/japans-herring-hatcheries-1062/).

Shellfish

IMPACT: Fewer large, adult shellfish available for harvest.

ACTION: Identify suitable habitat for shellfish outplanting, and expand the species outplanted to include crabs and bidarki.

ACTION: Support hunter education programs to teach youth about traditional sea otter hunting and fur sewing, reducing predation pressures on clam and other shellfish populations, and creating a connection for youth to elders and culture.

ACTION: For clam species, identify suitable habitat for clam gardens (https://www.clamgarden.com/) and offer technical assistance and training for regional Tribes on funding, building, and maintaining. Assist Tribes with funding, building, and maintaining the sites if requested, and provide environmental monitoring through APMI for safety and sustainability.

ACTION: Continue and expand upon APMI's shellfish mariculture programs to include additional important subsistence species such as bidarki, and king and [Dungeness?] crabs. In addition, there may be opportunities to expand production of more temperate species as ocean temperatures warm, including increasing oyster mariculture.

ACTION: Assist communities seeking to impose voluntary harvest moratoriums with education, outreach, and monitoring of the target species.

ACTION: Support community-based science to assess the health and long-term viability of local populations through developing trainings, writing QAPPs for methodology, and analyzing and processing data.

IMPACT: Increasing prevalence of harmful algal blooms causes concerns about the safety of harvesting shellfish.

ACTION: Build on APMI's existing PSP monitoring work, expanding on existing water quality work and adding blue mussel and direct sample testing capabilities. Develop a clear and accessible communication plan for sharing information about shellfish safety for the region

IMPACT: Changes to populations and distributions because of climate change.

ACTION: Support and partner with researchers on projects to understand how ocean conditions are changing and will impact important subsistence shellfish species. Bidarki life histories and ecology need to be better understood to develop successful adaptation plans for these species. Local populations of crabs and shrimp also need to be better studied to understand how ocean conditions are impacting these populations.

Marine Mammals (general)

IMPACT: Observations of marine mammals in unusual locations such as chasing fish further upriver, changing migration patterns, etc., including reporting of species not native to the region like California Sea Lions and walrus.

ACTION: Expand research and monitoring programs to partner with Tribes and Tribal consortia and utilize local knowledge for survey method development. Incorporate harvester observations and findings into planning and management.

Harbor Seals

IMPACT: Hunters describe sick and malnourished seals. Harvested seals are often skinnier, and harvesters are concerned about the safety of consuming sick seals.

ACTION: Offer services to test the safety of harvested seal meat for human consumption in the case of sick seals. Provide information and education about food safety and preparation.

IMPACT: Retreating sea ice and other habitat changes impact pupping grounds.

ACTION: Experiment with artificial floating platforms to provide artificial seal pup platforms. These could be combined with mariculture production.

ACTION: Request voluntary seal habitat closures that restrict charter boats and sea kayakers from approaching seal pupping areas during important times.

IMPACT: Past harvest moratoriums and fears about contamination after EVOS means that youth are not learning how to harvest and prepare seals.

ACTION: Develop butchering facilities at docks for harvesters to use.

ACTION: Provide education and harvesting opportunities for youth and adults alike.

Sea Otters

IMPACT: Sea otter numbers have increased significantly, leading to inter and intra-species competition for food, starvation, and a higher prevalence of disease.

ACTION: Increase opportunities for sea otter hunting through delegating control over who is eligible to hunt to local Tribes who have traditionally hunted sea otters.

ACTION: Develop education and training programs to expose youth and adults who have not had the opportunity to hunt sea otters to learn how to do so.

Moose

IMPACT: Snowier winters make it more difficult for moose to find food in winter.

ACTION: Propagate moose forage in high population areas.

IMPACT: Increasing temperatures can create new disease vectors for parasites and diseases that impact moose.

ACTION: Partner with wildlife managers and harvesters to monitor moose health, looking for threats such as winter ticks, brain worms, and heat stress. Educate harvesters on signs of these diseases and how to report them to management.

IMPACT: Shifting environmental conditions, particularly during hunting season, can limit hunters' ability to harvest moose and pass this tradition onto youth.

ACTION: Educate and train harvesters on how to engage with regulatory bodies to advocate for changes to hunting and fishing regulations that impede harvest.

Mountain Goats

IMPACT: Harvesters have observed shifting migration patterns and local herds breaking up.

ACTION: Monitor mountain goat populations to identify seasonal patterns and establish population baselines to inform harvest management.

IMPACT: Mountain goat habitat is diminishing as vegetation moves to higher elevations and tundra / alpine habitats diminish.

ACTION: Map existing habitat refugia and work with forecasters like SNAAP to develop projections for future refugia for conservation and protection.

Sitka Deer

IMPACT: Sitka deer are increasing in number and moving onto the Kenai peninsula.

ACTION: Conduct a study on potential impacts of Sitka Deer introduction to plant and ecology composition on the Kenai peninsula.

ACTION: Assess road safety and any needed migration corridors or controls to reduce deer-vehicle crashes on the road system.

ACTION: Support Tribes in advocating for the introduction of Sitka deer to the lower Kenai to supplement dwindling moose and mountain goat harvests.

Birds (general)

IMPACT: Bird flu and other new diseases impact bird populations.

ACTION: Work with state and federal officials to monitor bird health.

ACTION: Collaborate with subsistence users to monitor harvest for signs of disease, including developing public education and outreach campaigns.

Seabirds

IMPACT: Marine heat waves lead to massive bird die-offs.

ACTION: Continue and expand research impacts of HAB outbreaks on seabirds

ACTION: Conduct research on ways to support primary productivity or otherwise supplement the food web during periods of marine heat waves.

ACTION: Conduct research into the impacts of cumulative stressors on seabird survival to better understand the impacts of heat wave vs other potential stressors

ACTION: Support marine habitats that increase biodiversity such as eelgrass beds, kelp forests, and estuaries.

ACTION: Provide supplemental nutrition near breeding colonies in marine heat wave years.

Migratory Birds

IMPACT: Starting to see changes to migratory patterns, including overwintering of migratory species.

ACTION: Identify current and model potential future habitat refuges for migratory bird species and consider additional protections against development or habitat destruction in these areas.

ACTION: Upgrade public lighting to bird-friendly LED lights, which can also be used to enhance public safety and public warning systems.

Ptarmigan and Grouse

IMPACT: Disappearing habitat and phenological mismatches

ACTION: Conduct additional research and monitoring to predict future habitat for conservation

Plants (general)

IMPACT: Shrinking tundra and wetlands habitats.

ACTION: Model potential future biomes under a variety of scenarios to understand future conservation and biodiversity hotspots for planning purposes

ACTION: Fund native plant nurseries to provide seed and starts for remediation and revegetation initiatives after development projects, fires, or other disturbances.

IMPACT: Drought on the Kenai

ACTION: Strategically introduce beaver and install beaver analogue dams to help retain wetlands and associated ecosystem functions.

Berries

IMPACT: More variability in abundance of berries from year to year

ACTION: Conduct habitat mapping for additional berry species similar to blueberry mapping and modeling conducted by Chugachmiut.

ACTION: Provide selective treatment to important berry patches to improve growing conditions and reduce stress and variability in berry production.

IMPACT: Berries are more prone to worms and bugs

ACTION: Conduct selective application of non-chemical pesticides to culturally important berry patches to reduce predation from caterpillars. Bacillus thuringiensis is a naturally occurring bacteria that is deadly to caterpillars but has no impact on birds, fish, wildlife, people, and even other insects.

Become leaders in kelp mariculture research and production to provide jobs, food, and ecosystem benefits to the region

ACTION: Quantify the ecosystem benefits of kelp mariculture to support existing food webs, particularly the abundance of copepods and other nutrient-rich food sources. While temperature appears to the main driver of early life stage mortality in Pacific Herring (Villalobos, Love, & Olson, 2020), Pacific Cod (Laurel, et al., 2021), and other forage fish species (Suryan, 2023), ocean acidification appears to be a compounding stressor that can increase mortality in times of elevated ocean temperatures.

ACTION: Identify and support the research and development of new markets for kelp such as potential biofuel, fertilizer, carbon market and biodiversity credits, and/or food products. On example might be investigating the use of biodigesters (Can Biodigesters Save America's Small Dairy Farms? - Modern Farmer) fertilizer production and sale, or supporting value-added food products.

ACTION: Quantify the ecosystem benefits of kelp mariculture to support existing food webs, particularly the abundance of copepods and other nutrient-rich food sources.

Strategy 6: Periodically review and update this plan to reflect current needs and priorities, as well as current knowledge of climate impacts in the region.

References

Alaska Department of Fish and Game. (n.d.). *Mushy Halibut Syndrome.* Retrieved from Non-Infectious Diseases: https://www.adfg.alaska.gov/static/species/disease/pdfs/fishdiseases/mushy_halibut_syndrome.pdf

Holsman, K. K., Aydin, K., Sullivan, J., Hurst, T., & Kruse, G. H. (2018). Climate effects and bottum-up controls on growth and size-at-age of Pacific halibut (Hippoglossus stenolepis) in Alaska (USA). *Fisheries Oceanography*, 345-358. doi:https://doi.org/10.1111/fog.12416

IPBES. (2019). *Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.* E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). Bonn, Germany.: IPBES secretariat. doi:https://doi.org/10.5281/zenodo.3831673

Johnson, T. (2016). *Climate Change and Alaska Fisheries.* Fairbanks, AK: Alaska Sea Grant, University of Alaska Fairbanks. Retrieved from https://alaskaseagrant.org/wp-content/uploads/2018/02/Climate-Change-and-Fisheries_Johnson_WEB.pdf

Laurel, B. J., Hunsicker, M. E., Ciannelli, L., Hurst, T. P., Duffy-Anderson, J., O'Malley, R., & Behrenfeld, M. (2021). Regional warming exacerbates match/mismatch vulnerability for cod larvae in Alaska. *Progress in Oceanography, 193*. doi:https://doi.org/10.1016/j.pocean.2021.102555

NOAA. (2023, March 13). *Ocean and Climate Literacy: Essential principles and fundamental concepts*. Retrieved from National Ocean Service: https://oceanservice.noaa.gov/education/literacy.html

Oliver, E., Perkins-Kirkpatrick, S., Holbrook, N., & Bindoff, N. (2018). Anthropogenic and natural influences on record 2016 marine heat waves. *[in: "Explaining extreme events of 2016 from a climate perspective"]. Bulletin of the American Meteorological Society, 99*(1), S44-S49. doi:https://doi.org/10.1175/BAMS-D-17-0093.1

Reid, A. J., Eckert, L. E., Lane, J.-F., Young, N., Hinch, S. G., Darimont, C. T., . . . Marshall, A. (2021). "Two-Eyed Seeing": An Indigenous framework to transform fisheries research and management. *Fish and Fisheries*, 243-261. Retrieved from https://onlinelibrary.wiley.com/doi/pdfdirect/10.1111/faf.12516

Suryan, R. M. (2023). Food webs and fish: Ocean climate change in Alaska. *Open Access Government*. Retrieved from https://www.openaccessgovernment.org/article/food-webs-and-fish-ocean-climate-change-in-alaska-gulfwatch/162947/

Villalobos, C., Love, B. A., & Olson, M. B. (2020). Ocean Acidification and Ocean Warming Effects on Pacific Herring (Clupea pallasi) Early Life Stages. *Frontiers in Marine Science*. doi:10.3389/fmars.2020.597899