

# UC San Diego

## Capstone Papers

### **Title**

A Synthesis of Climate Adaptation Planning Needs in Alaska Native Communities

### **Permalink**

<https://escholarship.org/uc/item/7f58n91k>

### **Author**

Meeker, Danielle

### **Publication Date**

2017-06-01

# **A Synthesis of Climate Adaptation Planning Needs in Alaska Native Communities**

Danielle Meeker  
Scripps Institution of Oceanography

# Glossary

**ACCAP:** Alaska Center for Climate Assessment and Policy  
**ACCP:** Alaska Community Coastal Protection  
**ACIMP:** Alaska Climate Change Impact Mitigation Program  
**ACRC:** Alaska Climate Research Center  
**AFE:** Alaska Forum on the Environment  
**AINE:** Association of Interior Native Educators  
**ANTHC:** Alaska Native Tribal Health Consortium  
**AOOS:** Alaska Ocean Observing System  
**APIA:** Aleutian Pribilof Islands Association  
**BIA:** Bureau of Indian Affairs  
**CEDP:** Community Economic Development Program  
**CRRC:** Chugach Regional Resources Commission  
**CSU:** Climate Solutions University  
**CSC:** Climate Science Center  
**CTKWG:** Climate and Traditional Knowledges Working Group  
**DCRA:** Division of Community and Regional Affairs  
**DCCED:** Department of Commerce, Community and Economic Development  
**DGGS:** Division of Geological and Geophysical Surveys  
**DOI:** Department of the Interior  
**EPA:** Environmental Protection Agency  
**GAP:** General Assistance Program  
**IARC:** International Arctic Research Center  
**IAWG:** Immediate Action Workgroup  
**IPCC:** Intergovernmental Panel on Climate Change  
**ITEP:** Institute of Tribal Environmental Professionals  
**LCC:** Landscape Conservation Cooperatives  
**LEO:** Local Environmental Observer  
**MFPP:** Model Forest Policy Program  
**NBITWC:** Norton Bay Inter-Tribal Watershed Council  
**NEC:** Nome Eskimo Community  
**NOAA:** National Oceanographic and Atmospheric Administration  
**NPRB:** North Pacific Research Board  
**NSF:** National Science Foundation  
**SNAP:** Scenarios Network for Arctic Planning  
**TCRP:** Tribal Climate Resilience Program  
**TEK:** Traditional Ecological Knowledge  
**UAF:** University of Alaska Fairbanks  
**USACE:** U.S. Army Corps of Engineers  
**USFWS:** U.S. Fish and Wildlife Service  
**USGS:** U.S. Geological Survey

# Table of Contents

<b>INTRODUCTION</b>	<b>1</b>
<i>WHAT IS THE CURRENT LEVEL OF TRIBAL CLIMATE ADAPTATION PLANNING IN ALASKA?</i>	<i>4</i>
<i>WHAT ARE THE BARRIERS TO TRIBAL CLIMATE ADAPTATION PLANNING IN ALASKA?</i>	<i>10</i>
<i>HOW IS CLIMATE SCIENCE USED IN TRIBAL CLIMATE ADAPTATION PLANS?</i>	<i>13</i>
<i>HOW ARE TRADITIONAL ECOLOGICAL KNOWLEDGE (TEK) AND LOCAL OBSERVATIONS USED IN TRIBAL CLIMATE ADAPTATION PLANS?</i>	<i>15</i>
<i>WHAT ARE THE CLIMATE SCIENCE NEEDS RELATED TO CLIMATE ADAPTATION PLANNING IN ALASKA NATIVE COMMUNITIES?</i>	<i>17</i>
<b>DISCUSSION: OVERCOMING BARRIERS TO CLIMATE ADAPTATION</b>	<b>20</b>
<b>CONCLUSION</b>	<b>22</b>
<b>REFERENCES</b>	<b>22</b>
<b>APPENDIX A. INDEX OF COLLECTED LITERATURE AND EVENTS</b>	<b>26</b>
<b>APPENDIX B. COLLECTED LITERATURE AND EVENTS BY TYPE AND SOURCE</b>	<b>29</b>
<b>APPENDIX C. CLIMATE ADAPTATION PLANS</b>	<b>30</b>
<b>APPENDIX D. CLIMATE ADAPTATION TRAININGS &amp; WORKSHOPS</b>	<b>33</b>

## Introduction

As Alaska experiences temperature increase at a rate more than double that of the rest of the United States, the state is already witnessing the effects of climate change through phenomena such as thawing permafrost, reduced sea ice, and drier landscapes (Stewart et al. 2013). In addition to impacts on Alaska's diverse flora and fauna, these physical changes affect the state's three largest industries of energy production, mining and fishing, posing a potential threat to the state economy if not addressed properly (Chapin et al. 2014). Especially vulnerable to the socioeconomic impacts of climate change are rural Alaska Native communities, which face challenges to critical infrastructure and the subsistence resources on which they depend. Improving the capacity of Alaska Native communities to prepare for and respond to climate-related environmental hazards remains a significant need (President's Task Force 2014).

In recent years, there has been a growing interest amongst tribes to learn about climate change and to prepare for its physical and socioeconomic impacts (Wotkyns & González-Maddux 2014). These preparation measures include conducting training, requesting technical assistance and applying for funding to support mitigation and adaptation efforts. Many tribes are seeking to either create a specific climate adaptation plan or incorporate climate change preparedness into existing plans. In addition to the two completed climate adaptation plans for Alaska Native villages, several Native communities are taking preliminary steps to adaptation planning, such as raising community awareness of climate change impacts and conducting vulnerability assessments.

Previous publications have highlighted existing barriers and constraints to climate adaptation planning in tribal communities, as noted in academic research and expressed by tribal participants in workshops and interviews across the U.S. These include inadequate funding, limited capacity and resources, a lack of usable climate data and ineffective agency response and leadership at the local, state and federal levels (Wotkyns & González-Maddux 2014). These obstacles are exacerbated by existing non-climate stressors (such as poverty and infrastructure needs), which both hinder natural adaptive capacity and result in competing priorities for limited funding and resources (Karl et al. 2009). In addition to the barriers to adaptation planning that are common to all tribes in the United States, Alaska Natives are faced with unique challenges due to the state's complex web of stakeholders and "a chasm between policymakers in Juneau, Anchorage, Fairbanks and Washington D.C. and those who live in remote, rural communities" (McNeeley 2012).

Although several tribal workshops, climate adaptation plans and needs assessments have been conducted over the past decade to understand and address climate-related environmental hazards in rural Alaska (e.g. Cochran 2004; Research Needs Work Group 2009; Johnson & Gray 2014), there are remaining knowledge gaps in climate adaptation planning among Alaska Native tribes. First, there is a limited understanding of the full extent of climate adaptation planning among Alaska Native communities. Information regarding ongoing and completed adaptation planning

efforts is needed to inform communities which want to collaborate with other stakeholders and scientists who have participated in previous adaptation planning efforts. Second, there is a lack of information regarding the current use of climate science and traditional knowledge in these planning efforts (President's Task Force; Knapp & Trainor). It is important to know if current efforts are making use of the best available information and if research organizations are successfully integrating traditional ecological knowledge with western science. A third knowledge gap stems from uncertainty regarding existing social and policy barriers. Previous research has explored the way that state and federal institutions and regulations have constrained Natives' access to resources and ability to relocate, but a synthesis of this information is required in order to be useful to policy makers (McNeeley 2012; Bronen & Chapin 2013). Lastly, there is an identified knowledge gap surrounding the utility of existing climate science data as it applies to existing adaptation planning (President's Task Force). This information regarding the utility of science is needed to prioritize research needs and to strengthen the relationship between scientists and tribes.

To fill these knowledge gaps, this report summarizes the climate adaptation planning efforts of Alaska Native communities through a review of grey literature. In addition to identifying the extent and key components of existing adaptation planning, this report discusses additional issues which contribute to a more comprehensive understanding of planning efforts within Alaska Native communities. This literature review was guided by the five following research questions:

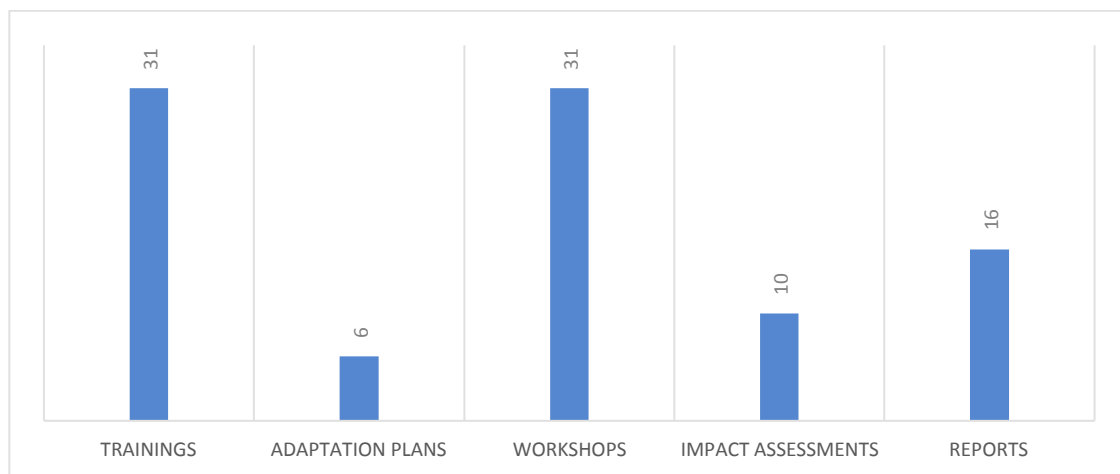
- **What is the current level of tribal climate adaptation planning in Alaska?**
- **What are the barriers to tribal climate adaptation planning in Alaska?**
- **How is climate science used in tribal climate adaptation plans?**
- **How are traditional ecological knowledge (TEK) and local observations used in tribal climate adaptation plans?**
- **What are the climate science needs related to climate adaptation planning among Alaska Native communities?**

The findings of this literature review are intended to inform climate adaptation planning efforts in Alaska Native communities. Due to the limited resources and complex network of stakeholders within Alaska, it is crucial that future policy decisions and adaptation strategy development be based on the best possible information. Answering the five defined research questions provides a platform to guide the work of interested agencies, research institutions, and tribal organizations, as well as those who work at the intersection of science and policy.

## Methods Summary

Content analysis was used to address each of the five research questions by synthesis of a wide variety of grey literature, including workshop proceedings and reports, adaptation plans, impact assessments and reports. This review also includes a compiled list of relevant trainings and workshops that did not produce any documents, as they provide valuable information about the scope of adaptation planning within Alaska Native communities and the contributing organizations and partnerships.

The identification of grey literature related to climate adaptation planning in Alaska Native communities began through extensive web-based search on Google in April 2017.<sup>1</sup> This initial list was expanded upon by a review of references in the collected literature, online databases of tribal climate adaptation planning-related efforts documents in the US, and presentation slides. The compiled list of documents and events was reviewed by experts for completeness. The final inclusion criteria for the literature review required that a document and relate to climate adaptation planning in Alaska Native communities. The literature search identified 39 published documents and 55 events which did not produce documents (Figure 1, Appendix A, B).



**Figure 1. Alaska Tribal Climate Adaptation Planning Literature and Events Included in Literature Review.**

**Trainings:** In-person trainings and webinars related to tribal climate adaptation planning. **Adaptation Plans:** Completed and in-progress climate adaptation plans. **Workshops:** Workshop, conferences and summits that include presentations or discussion related to tribal climate adaptation planning. **Impact Assessments:** Alaska Native Tribal Health Consortium (ANTHC) assessments of climate impacts in Alaska Native communities. **Reports:** Publications from government agencies, non-profits and interdisciplinary organizations relating to climate adaptation planning in Alaska Native communities

---

<sup>1</sup> Search terms such as “climate adaptation plan”, “Alaska Native”, “workshop”, “training” and “climate adaptation grants” were used in various combinations to find relevant literature.

NVivo content analysis software was used to manually categorize and analyze the documents for themes related to tribal climate adaptation plans and planning-related activities, climate science needs, other informational needs, use of TEK and climate science in adaptation plans, existing barriers to adaptation planning and recommendations for overcoming barriers.<sup>2</sup> Although the analysis was intended to identify barriers to adaptation planning, the literature review also examined the most frequently cited barriers to adaptation. This holistic approach to understanding barriers was guided by the belief that a comprehensive view of factors that hinder natural adaptive capacity is necessary to create a well-coordinated adaptation plan that aligns with communities' own goals of self-sufficiency and sustainability.)

## What is the Current Level of Tribal Climate Adaptation Planning in Alaska?

Tribal climate adaptation planning in Alaska consists of both formal climate adaptation plans and pre-planning activities, such as trainings, workshops, monitoring programs and vulnerability assessments, which are often conducted as preliminary steps to inform the development of an adaptation plan. Such efforts provide valuable data, observations and public input that can be incorporated into future initiatives. The geographic distribution of all identified tribal climate adaptation plans and planning-related events is displayed in Figure 2.

---

<sup>2</sup> The literature review defined barriers as both constraints and limits to climate adaptation planning. Constraints as defined by the IPCC, are “factors that make it harder to plan and implement adaptation actions”(Klein et al. 2014). Constraints include limited funding, insufficient technical expertise, poor communication between stakeholders and limited policy coordination between different levels of government. Limits are defined as factors for which “no adaptations exist, or an unacceptable measure of adaptive effort is required to maintain societal objectives or the sustainability of a natural system” (Klein et al. 2014). Limits include non-climate stressors such as poverty, a high cost of living, health risk from resource development and lifestyle changes that inhibit the cultivation of traditional knowledge by younger generations (Leiserowitz et al. 2006).



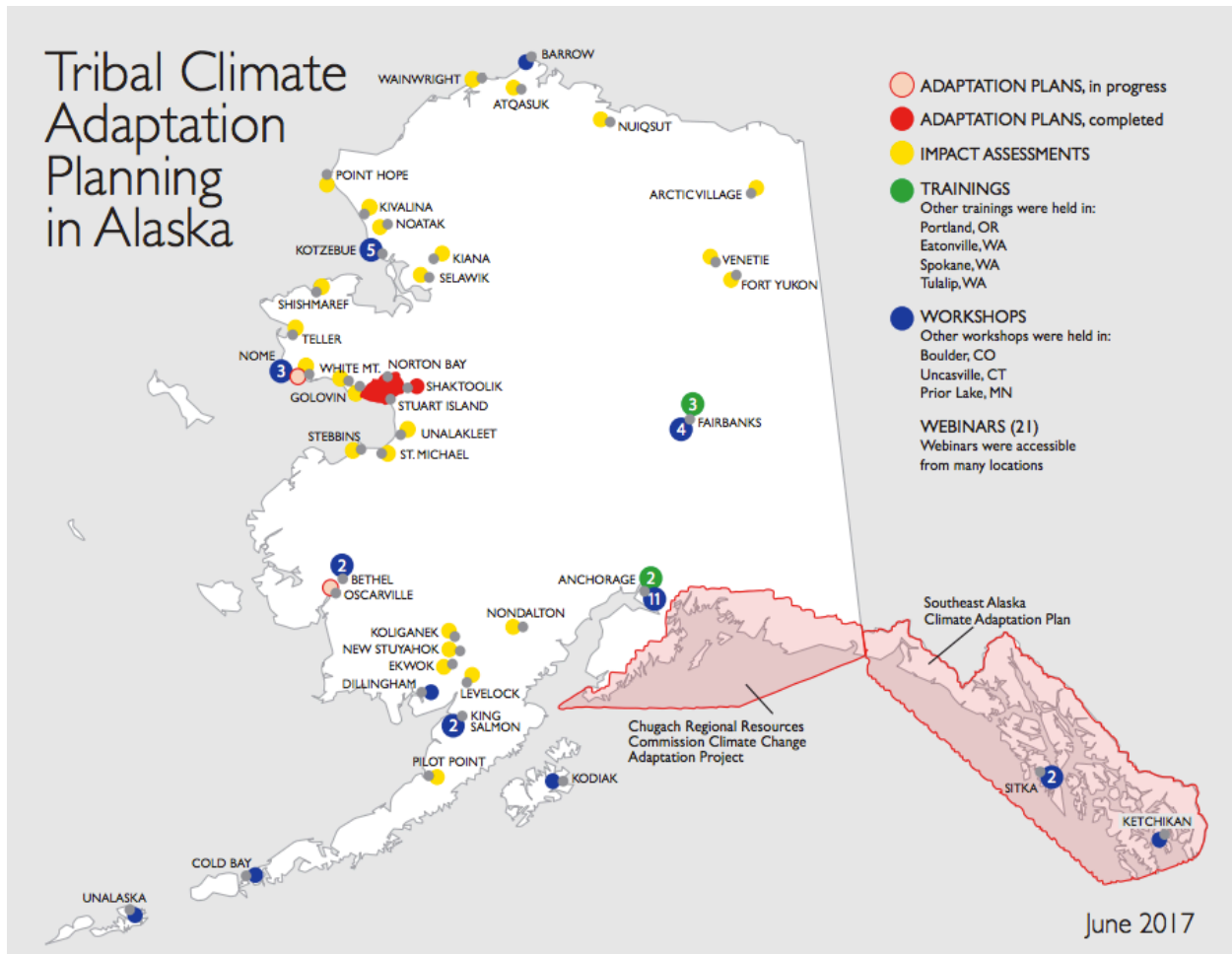


Figure 2. Map of Tribal Climate Adaptation Planning Events & Documents

The following sections describe completed and ongoing climate adaptation plans, trainings, workshops, assessments and monitoring programs.

## Tribal Climate Adaptation Plans

The literature review identified two completed tribal climate adaptation plans for Alaska Native communities; a 2014 plan for the community of Shaktoolik (Johnson & Gray 2014) and a 2013 plan for the Norton Bay Watershed (Murray et al. 2013). The Shaktoolik Climate Change Adaptation Plan is the product of two-year project coordinated by Alaska Sea Grant. The plan, prepared by Alaska Sea Grant and Glenn Gray and Associates, outlines nine measures to protect the community infrastructure and increase emergency preparedness. The Norton Bay Watershed Climate Adaptation and Action Plan was prepared by the Norton Bay Watershed Inter-Tribal Committee (NBWITC) as part of a year-long adaptation planning curriculum from Climate Solutions University (CSU), part of the Model Forest Policy Program (MFPP) (MFPP n.d.). The plan lists seven goals designed to increase community resilience, including public outreach efforts and the protection of subsistence resources.

Four climate adaptation planning projects with the goal of producing adaptation plans were identified through the literature review. These projects are led by the Chugach Regional Resources Commission (CRRC), the Central Council of Tlingit and Haida Indian Tribes of Alaska (CCTH), the Nome Eskimo Community (NEC), and the Traditional Village of Oscarville. The CRRC project has produced a preliminary report, which was included in the literature review. The NEC and CCTH projects have not yet produced reports but are referenced in other sources and are listed online. The Oscarville project is known to be in progress through discussion at an ACCAP meeting in May 2017. The CRRC published a final report on Phase I of the Chugach Regional Resources Commission Climate Change Adaptation Project, which was included in the literature review. Phase I of the project consists of comprehensive assessment planning, which will be followed by the Phase II Vulnerability Assessment and Phase III Adaptation Plan (Bergman & Hetrick 2016). The NEC climate adaptation plan will be a product of a two-year collaboration between ACCAP and four tribes in the Nome area (Nome Eskimo Community, Native Village of Solomon, King Island Native Community and the Native Village of Council). The planning process involved hiring a local coordinator, interviewing community members, facilitating community workshops, and identifying and prioritizing adaptation actions (ACCAP n.d.). The NEC plan will be completed in Fall 2017. The ongoing efforts of the CCTH project are guided by the findings of the Southeast Alaska Climate Adaptation Summit, which was held in September 2016 by CCTH, Southeast Alaska Tribal Ocean Research (SEATOR), and the Sitka Tribe of Alaska (Holen 2017). The summit discussions identified climate impacts of concern to local tribes, as well as recommendations for the adaptation planning process (Holen 2017). The specific details and objectives of each plan are included in Appendix C.

Funding for the Shaktoolik and Norton Bay Watershed climate adaptation plans came from the NOAA Sea Grant Program and a ANTHC Community Environmental Demonstration Project (CEDP) grant, respectively. Funding for all four plans that are in progress came from the Bureau of Indian Affairs (BIA) Tribal Climate Resilience Program (TCRP), which was the greatest identified source of funding for tribal climate adaptation planning efforts. The TCRP awards grants to fund adaptation planning efforts within Alaska Native communities. These grants are intended to develop climate adaptation plans, vulnerability assessments and data analysis. TCRP awarded eight Category 2 (adaptation planning) grants between 2013 and 2016. These eight awards are listed in Table 1.

**Table 1. BIA Tribal Climate Resilience Program Awards- Category 2: Adaptation Planning (FY 2013-2016)**

Fiscal Year	Recipient	Tribal Communities	Description
2016	Central Council of the Tlingit & Haida Indian Tribes of Alaska	Sitka Tribe of Alaska, Klawock Coop. Assoc., Craig Tribal Assoc., Yakutat Tlingit Tribe, Petersburg Indian Assoc., Organized Village of Kasaan, Wrangell Coop. Assoc., Chilkat Indian Villages, Chilkoot Indian Assoc., Hydaburg Coop. Assoc., Ketchikan Indian Community, Douglas Indian Assoc., Hoonah Indian Assoc., Organized Village of Kake, Angoon Community Association, Metlakatla Indian Community	To develop a Climate Adaptation Plan Template to help Central Council and other Southeast Alaska Tribes prepare for and increase their resilience to climate-and weather-related events.
2016	Chilkoot Indian Association	Chilkoot Indian Assoc.	To build the capacity of the Tribe to complete a climate change vulnerability assessment and adaptation plan for changes in the Eulachon and sockeye fish populations and to develop training.
2016	Council of Athabascan Tribal Governments	Arctic Village Trad'l Council, Beaver Trad'l Council, Birch Creek Tribal Council, Canyon Village Trad'l Council, Chalkyitsik Trad'l Council, Circle Trad'l Council, Fort Yukon (Gwichyaa Zhee Gwich'in), Rampart Trad'l Council, Stevens Village IRA Council, Venetie Trad'l Council	To assess the vulnerability of communities to climate change-related air pollution that affects health and traditional ways of life and to develop the basis for climate adaptation plans.
2016	Native Village of Elim	Native Village of Elim, Native Village of Koyuk, Native Village of Unalakleet, Native Village of Shaktoolik	To conduct climate adaptation planning and implementation activities to address climate impacts through restoration of TEK and integration into conventional data collection and analysis and to establish a network of Native Villages and other stakeholders.
2016	Oscarville Traditional Village	Oscarville Trad'l Village	To enable the Oscarville Trad'l Council and Cold Climate Housing Research Center to build on a cooperative pilot project to establish a Coordination Center to create the climate adaptation and sustainability plan.
2015	Metlakatla Indian Community,	Metlakatla Indian Community	To perform a survey of the waters and lands of Annette Islands Reserve to determine climate change impacts.
2015	Nome Eskimo Community	Nome Eskimo Community, Native Village of Solomon, King Island Native Community, Native Village of Council	To develop a Nome Tribal Climate Adaptation Plan to ensure tribal members are prepared to address the effects of climate change.
2013	Chugach Regional Resources Commission	Port Graham Village Council, Valdez Native Tribe, Native Village of Eyak, Native Village of Tatitlek, Native Village of Nanwalek, Native Village of Chenega,, Qutekcak Native Tribe	To coordinate regional adaptation planning

## Other Adaptation Planning Efforts

In addition to independent climate adaptation plans, this review identified 88 planning-related efforts, including trainings (n=31), workshops (n=43) and impact assessments (n=15) and related reports.

### **Trainings**

31 adaptation planning-related training events occurring between 2012 and 2017 were identified (Appendix D). One-third of these events were held in-person (n=10), while the rest were conducted via webinar. Training topics for climate adaptation planning included guidance through the competitive federal award process and assistance in the design of vulnerability assessments. Over three-quarters of identified trainings were part of a recurring training series (n=23), such as the Alaska Tribal Climate Change Webinar Series by the Institute for Tribal Environmental Professionals (ITEP) and the Environmental Protection Agency (ITEP n.d.). This quarterly webinar series is designed to share information and resources with Alaska Native tribes that wish to implement their own mitigation or adaptation strategies (ITEP n.d.). The 2015-2016 Policy & Climate Adaptation, Mitigation, and Planning for Alaska Natives webinar series, produced by the Alaska Center for Climate Assessment and Policy (ACCAP) and Water Policy Consulting, LLC, was intended to provide Native villages with “an understanding of how water policies, regulation, and laws apply to Alaska Native communities and can be utilized to find solutions to environmental solutions, including climate change” (ACCAP n.d.). Additional series and independent trainings were conducted by agencies and non-profit organizations, including the Alaska Native Tribal Health Consortium (ANTHC) and the BIA.

### **Workshops**

43 workshops, summits and meetings between 1998 and 2017 were identified (Appendix D). Half of all identified workshops produced proceedings or reports (n=23). (In some instances, several meetings or workshops were synthesized in one report.) The identified workshops focused on multiple levels - including national, state-wide, regional and local – and included a presentation or discussion related to climate adaptation planning in Alaska Native communities, including research needs and/or existing barriers to adaptation. For example, the Aleutian Pribilof Islands Association (APIA) held four workshops in the hub communities of Nome, Unalaska, King Salmon and Kotzebue in 2016. These workshops were intended to foster dialogue between stakeholders about threats to coastal communities and available tools and resources, with a focus on increasing resilience in coastal communities (Pletnikoff et al. 2017). The themes of other workshops and meetings included community participation in research (Northwest Arctic Borough 2013) and the development of a relocation framework for communities threatened by coastal erosion (Alaska Institute for Justice 2017). The most frequent organizers of included events were the five Alaskan Landscape Conservation Cooperatives (LCCs) (n=9): Aleutian and Bering Sea Islands LCC, Arctic LCC, North Pacific LCC,

Northwest Boreal LCC and Western Alaska LCC. The next most frequent organizing institutions were the Aleutian Pribilof Islands Association (n=4), the Alaska Native Science Commission (n=4) and ANTHC (n=3).

### ***Climate Impact Assessments***

Between 2010 and 2016, the ANTHC conducted climate impact assessments of 25 Alaska Native communities and published 15 assessment reports. These reports include climate data and projections for the area, as well as observations of climate change within each community. For identified climate impacts of concern, the assessments list recommendations on potential mitigation and adaptation strategies (Alaska Native Tribal Health Consortium n.d.). The assessments were supported by partnerships with various Native associations, cities, LCCs and federal agencies.

### ***Assistance Programs***

In addition to these identified pre-planning events, there are several ongoing efforts in Alaska Native communities that seek to relocate due to coastal erosion. Two adaptation planning-related programs under the Division of Community and Regional Affairs (DCRA) of the DCCED were identified (Johnson & Gray 2014; Pletnikoff et al. 2017; Brookings Institution 2014; Immediate Action Workgroup 2009). The Alaska Community Coastal Protection Project is part of the Alaska Coastal Impact Assistance Program, which is funded by oil and gas revenues that are administered by U.S. Fish and Wildlife Service (USFWS) and the Department of the Interior (DOI) (Division of Community and Regional Affairs 2017). The Alaska Community Coastal Protection Project oversees resilience efforts in the villages of Kivalina, Shaktoolik and Shishmaref, which are threatened by coastal erosion. These efforts are focused on local capacity-building (through funding and technical assistance), the development of a strategic management plan and the creation of interagency planning work groups for each community. The second DCRA effort is the Alaska Climate Change Impact Mitigation Program (ACCIMP). The program assists communities that are threatened by climate-related hazards, such as erosion, flooding and permafrost thaw. ACCIMP provides technical assistance by conducting hazard impact assessments in threatened communities and awards funding through Community Planning Grants. The grants are used by recipient communities to implement the recommendations of the hazard impact assessments, including shoreline protection and building of relocation sites. For a more extensive review of coastal erosion mitigation and relocation efforts in threatened communities, see Community of Newtok, 2011 or Brookings Institution, 2014.

## What Are the Barriers to Tribal Climate Adaptation Planning in Alaska?

Several barriers to tribal climate adaptation and climate adaptation planning in Alaska were identified. This included financial, cultural, and institutional or regulatory constraints, which restricted the ability of Alaska Native communities to identify and address the impacts of climate change. The existence of multiple, related barriers compounds the difficulty in developing and implementing adaptation plans, and also exacerbates community vulnerability to climate change.

Inadequate funding was the most frequently cited barrier to climate adaptation planning, as mentioned in more than half of reviewed documents (n=23). Funding is needed to establish community pre-planning projects (such as monitoring programs), support travel to planning events and agency meetings, conduct vulnerability and hazard assessments, hire full-time staff and implement short-term adaptation measures (Brookings Institution 2014; Kawerak Marine Program 2017; Pletnikoff et al. 2017). Raising awareness and concern for local impacts of climate change requires public outreach and education, which also requires funding (Center for Global Change and Arctic System Research 1999). Without sufficient funding to conduct these pre-planning efforts, tribes are limited in their ability to collect the information and resources necessary to develop and implement climate adaptation plans.

Challenges associated with inadequate funding for climate adaptation planning are exacerbated by a host of non-climate stressors. The impacts of climate change in Alaska Native communities are often exacerbated by the high cost of living – a result of remote location, extreme weather, a small population size and the high cost of fuel (Brubaker et al. 2015). In addition to climate change, Alaska Native communities are challenged to find ways to adapt to development activities, such as increased marine shipping, construction, and the extraction of natural resources (Kawerak Marine Program 2017). Increased development can attract visitors to the region, which puts pressure on limited resources (Bergman & Hetrick 2016). In some regions, recreational hunting and fishing are in competition with subsistence hunting and can lead to overharvesting, which often results in more stringent regulations that negatively affect Alaska Native communities (Kawerak Marine Program 2017). Subsistence access is one of the most frequently cited issues of concern, and food security is a basic need of tribes that must be accounted for in adaptation plans. Participants of various workshops also described stressors of insufficient educational opportunities, physical and mental health problems and a loss of culture in younger generations (Center for Global Change and Arctic System Research 1999; Pletnikoff et al. 2017; NCAR 2015).

Due to the simultaneous challenges of financial constraints and significant non-climate stressors, communities without outside funding must decide whether to allocate their limited financial resources to climate adaptation efforts or to other competing priorities (Wotkyns & González-

Maddux 2014). Other issues in the community (such as substandard housing) may be given preference by tribal leadership and community members who do not consider climate adaptation to be an immediate priority (Wotkyns & González-Maddux 2014). If an adaptation planning effort does not receive support from the tribal leadership through a resolution or informal approval, it can be difficult to get public support and necessary resources (Wotkyns & González-Maddux 2014).

Many communities also lack the necessary human capital, technical expertise and technology to implement the preliminary steps to adaptation planning. To conduct an erosion assessment, for example, a village will require shore monitoring equipment, trained surveyors, and a full-time coordinator to oversee the project. Many adaptation initiatives require administrative support in order to build organizational capacity (Wotkyns & González-Maddux 2014; Immediate Action Workgroup 2009). Remote communities in need of communications infrastructure have difficulty accessing necessary information and relaying their needs to outside institutions (Pletnikoff et al. 2017). Without necessary resources inside the community, young adults may seek education and work outside of the village (Bergman & Hetrick 2016). This move outside of the community, coupled with reduced subsistence access (due to declining sea ice, permafrost thaw and other climate impacts) can restrict the transmission of TEK and traditional adaptation strategies to younger generations (Hetrick 2016; NCAR 2015; Pletnikoff et al. 2017). Youth outreach and the incorporation of climate science and traditional knowledge into public education curricula were cited by more than one-third of documents (n=15) as a major need to increase community resilience to climate change. All of these examples of limited capacity could potentially restrict a community's ability to implement an adaptation plan.

Institutional barriers associated with complex laws and policies contributed to a host of barriers to tribal climate adaptation efforts in Alaska (Brookings Institution 2014; Bergman & Hetrick 2016; Johnson & Gray 2014; NCAR 2015; Pletnikoff et al. 2017). One such barrier lies in the process and requirements for communities to receive federal funding. Two cited elements of the financial barrier to adaptation are 1) the “stove-piped” approach to competitive agency awards and 2) the requirement of some agencies that adaptation efforts pass a cost-benefit analysis. The “stove-piped” nature of program funding refers to the fact that individual community programs are managed in isolation from each other. This segregated approach forces individual programs to compete with one another for approval and funding and does not provide a comprehensive view of community needs (Immediate Action Workgroup 2009). The cost-benefit analysis that is often required for competitive federal awards is criticized for not reflecting the true value of climate mitigation and adaptation efforts in Alaska Native communities (Brookings Institution 2014; Immediate Action Workgroup 2009; Norton-Smith et al. 2016). Programs in these communities often benefit a small population at high cost, making them appear less beneficial than they actually are (Brookings Institution 2014; US GAO 2009). This type of analysis excludes the non-monetary factors of adaptation efforts, including subsistence access,

community health and the preservation of traditional culture (Brookings Institution 2014). Also, cost-benefit analyses are ineffective for hazard mitigation projects (such as erosion protection), because they do not estimate the financial consequences of an unmitigated future disaster (such as a devastating storm, which can cost millions in clean-up and restoration costs) (Immediate Action Workgroup 2009).

Several reviewed documents stated that the natural adaptive capacity of Alaska Natives is hindered by outdated policy that is based on historical factors and does not account for climate change (Adaptation Advisory Group 2010; Pletnikoff et al. 2017). This barrier was usually mentioned in relation to natural resource management and access to subsistence resources (Bergman & Hetrick 2016; Kawerak Marine Program 2017; Northwest Arctic Borough 2013; Pletnikoff et al. 2017; Walker Mallott Transition Team 2014). The link between policy barriers and adaptation planning was described by APIA Promoting Coastal Resilience & Adaptation workshop participants and coordinators in the follow-up work session in May 2017. Participants described how policy barriers will hinder the long-term success of climate adaptation plans, and how future plans should outline and address existing policy barriers in order to draw attention to potential obstacles to the implementation of the plan.

Another identified barrier exists in situations where state and federal agencies do not provide sufficient or timely support (Adaptation Advisory Group 2010; Brookings Institution 2014; Leiserowitz et al. 2006; Pletnikoff et al. 2017). Several documents state that agency response is too slow and does not match the pace of climate impacts (Bergman & Hetrick 2016; Leiserowitz et al. 2006; Pletnikoff et al. 2017). Additionally, the review identified instances where there is no appropriate federal agency in charge of specific adaptation efforts or where there is a noted lack of necessary framework (Adaptation Advisory Group 2010; Brookings Institution 2014; US Army Corps of Engineers 2011). There is currently no lead agency to oversee the erosion mitigation efforts in Alaskan coastal communities, nor is there a federal program that provides relocation assistance to villages that seek to relocate (US GAO 2009; U.S. Army Corps of Engineers 2006). Federal agencies, such as the Federal Emergency Management Agency (FEMA), have contributed to erosion protection devices (which have an expected lifespan of ten years), but are unable to assist in relocation efforts, due to the requirements of the Stafford Act (Brookings Institution 2014). Without established guidelines for relocation, both Kivalina and Shishmaref voted to relocate to sites that were later deemed unsuitable by the Army Corps of Engineers (Brookings Institution 2014). Without timely, effective agency response, communities will be limited in their ability to develop and implement a climate adaptation plan.

The cited need for tribal sovereignty in adaptation planning is complicated by the multi-level governance structure of Alaska Native communities. Decision-making power and regulatory authority rests with multiple entities, including Tribal governments, village corporations and regional Native corporations, rather than a single entity (Bergman & Hetrick 2016). Overlapping



jurisdictions of these governments and competing priorities between tribes and landowners can result in “conflicting directives that prevent the coordinated delivery of vital services that will enable endangered villages, traditional culture, and vulnerable communities to adapt in the face of climate change” (Adaptation Advisory Group 2010). The successful implementation of future climate adaptation plans will require improved agency coordination and an alignment of plan objectives with community goals for self-sufficiency.

The lack of tribal representation in agency decisions is related to the previously discussed barrier of conflicting governance and the need for tribal sovereignty. Many reports and workshop participants express concern that tribes are excluded from the decision-making process, and that outside agencies are not seeking community participation or input (Kawerak Marine Program 2017; NCAR 2015; Norton-Smith et al. 2016; Pletnikoff et al. 2017). One example included of minimal tribal representation is the President’s State, Local, and Tribal Leaders Task Force on Climate Preparedness and Resilience, which included 24 state and local leaders and only two tribal representatives (President’s Task Force 2014). By excluding indigenous perspectives from policy decisions, agencies fail to incorporate traditional knowledge into regulatory and strategy decisions. This exclusion of valuable knowledge can reduce the success of climate change initiatives (Norton-Smith et al. 2016).

In addition to the exclusion of local perspective from agency activities, there also exists an identified barrier in the separation of modern science and traditional knowledge, which has historically been neglected as a valid source of data (Leiserowitz et al. 2006; Maynard & Wildcat 2014; NCAR 2015). This boundary has been embedded in national research organizations and peer-reviewed journals, and has been reinforced through research efforts that occur without community input and approval (ARCUS 2011; NCAR 2015). Reviewed documents underscored a need for tribal participation and consent in research endeavors, and included recommendations for scientists and research institutions to establish trust with Alaska Native communities. These recommendations are described in the Discussion section.

## **How Is Climate Science Used in Tribal Climate Adaptation Plans?**

Use of climate science within the two completed climate adaptation plans and planning-related efforts varied. Although both completed climate adaptation plans (Johnson & Gray 2014; Murray et al. 2013) used peer-reviewed studies and data from the Scenarios Network for Arctic Planning (SNAP), use of climate data differed based on the plan objectives and the availability of local data. The Shaktoolik plan used site-specific data to predict the potential threat from climate change and extreme weather events (Johnson & Gray 2014), while the Norton Bay plan used regional data to validate local observations of climate change and its effects, such as declining

sea ice and reduced access to subsistence resources (Murray et al. 2013). The detailed use of climate science in each of the plans is discussed below.

**Shaktoolik Climate Adaptation Plan.** The Shaktoolik plan includes climate data in reference to 15 identified climate impacts of concern, with emphasis on flooding and coastal and riverine erosion. The plan incorporates both temperature and precipitation trends and 100-year projections from SNAP. The plan was informed by the 2011 Shaktoolik Coastal Flooding Analysis from the US Army Corps of Engineers, which estimated the probability of future flooding events and subsequent risk to the community using NOAA storm and bathymetry data and model projections of wind, wave and storm surge levels (US Army Corps of Engineers 2011). The findings of a 2011 hazard assessment from the Alaska Division of Geological & Geophysical Surveys, which collected local baseline data and created beach profiles, were also used in the plan (Kinsman & DeRaps 2012). While the Shaktoolik plan acknowledges the need for further research and monitoring, the project partners chose to create the plan based on available information, rather than waiting for further studies (Johnson & Gray 2014).

**Norton Bay Watershed Climate Adaptation and Action Plan.** The Norton Bay Watershed Climate Change Adaptation Plan references regional and national-level data from SNAP, the U.S. Global Change Research Program, UAF, EPA, IPCC and NASA in reference to 14 identified climate impacts in Alaska (Murray et al. 2013). These impacts include a longer snow-free season, the drying of lakes, changes in forest habitat, declining sea ice, sea level rise, ocean acidification and permafrost thaw and methane release. The plan uses temperature and precipitation projections from SNAP and the EPA, as well as UAF studies on sea level rise and wildfire risk and NASA satellite data on glacial melt and sea ice extent to estimate the effects of climate change on natural resources and community health. The plan recommends further collaboration with SNAP, the Alaska Climate Research Center (ACRC), the Alaska Climate Science Center (CSC) and the University of Alaska to conduct relevant research and develop climate scenarios and maps (Murray et al. 2013).

It is difficult to precisely assess the use of climate science in other ongoing tribal climate adaptation planning efforts in Alaska because of limited documentation. However, it appears that climate science is being incorporated into the adaptation planning process. Descriptions of the Nome Eskimo Community planning project suggest climate science is being integrated into the planning process (cite) Further, the report from Phase 1 of the Chugach Regional Resources Adaptation Planning project suggests that climate data, including SNAP projections of temperature and precipitation change, and shoreline change models (e.g., NOAA Sea Level Affecting Marshes Model) could be incorporated into the future adaptation plan (Bergman & Hetrick 2016).

In addition to climate data, several adaptation planning efforts are supported by informational tools and projects, such as the ANTHC-led Local Environmental Observer (LEO) Network, which is a web-based tool for participants worldwide to share local observations of climate change and other environmental phenomena (Alaska Native Tribal Health Consortium n.d.). The LEO program includes the Community Camera Project, which uses time-lapse cameras to monitor environmental change through still photographs, which are compiled into videos. There are currently 33 fully-installed cameras and 32 pending installations in Alaska, which can be located on Google Maps.

## How Are Traditional Ecological Knowledge (TEK) and Local Observations Used in Tribal Climate Adaptation Plans?

TEK and local observations are incorporated into several aspects of tribal climate adaptation planning; however, the usage of traditional and local knowledge in completed adaptation plans varies. Both completed adaptation plans (Shaktoolik Climate Action Plan and Norton Bay Watershed Climate Change Adaptation and Action Plan) solicited community input through meetings and tribal representation on planning committees. The Shaktoolik Plan does not specifically cite the usage of traditional knowledge in the creation of the plan (Johnson & Gray 2014). The Norton Bay plan includes a three-year period for the gathering of TEK (March 2014-March 2017), and lists the Norton Sound Native Health Consortium as a potential source for TEK data related to fish and wildlife habitat (Murray et al. 2013). Included in the implementation plan for the Norton Bay plan is the specification that it will be updated with additional data and TEK in November 2017 (Murray et al. 2013).

In addition to their use in formal climate adaptation plans, traditional and local knowledge have been used to guide the development of research partnerships between communities and outside institutions, including government agencies and scientific institutions (ARCUS 2011; Northwest Arctic Borough 2013; Pletnikoff et al. 2017). The results of these programs can be used in preliminary adaptation efforts, such as vulnerability assessments and advocacy efforts. Several research partnerships that were described by workshop participants as successful examples of integration of TEK with western science are listed below.

**Bering Sea Integrated Ecosystem Research Program.** Directed by the North Pacific Research Board (NPRB) and the National Science Foundation (NSF), this collaborative project consisted of 44 individual studies of the Bering Sea ecosystem. The project incorporated traditional knowledge and tribal consultation into its research on subsistence resource availability and the socioeconomic effects of climate change in the Bering Sea

region, which includes more than 30 Alaska Native communities (Arctic Research Consortium of the U.S. 2011; North Pacific Research Board n.d.).

**BeringWatch.** This online community-based monitoring tool and database makes use of existing Citizen Sentinel programs (such as those in the Aleutian and Pribilof Islands). The database and observational network is similar to LEO and encourages interaction between technical experts and local observers. Community members can share both local observations and traditional knowledge, and trained individuals can collect more specialized data from monitored species (BeringWatch n.d.; Pletnikoff et al. 2017).

**Native Village of Kotzebue.** The efforts of the Kotzebue IRA were cited in the literature as an example of the successful integration of western science and traditional knowledge (Pletnikoff et al. 2017). Kotzebue has conducted several studies of bearded seals and ring seals, including work with the UAF Wildlife Toxicology Lab to study contaminants in seals that could potentially pose a health threat to consumers of subsistence harvest (Pletnikoff et al. 2017; Northwest Arctic Borough 2013).

**Subsistence Mapping Projects.** The literature review identified collaborative subsistence mapping projects organized by the Bristol Bay Native Association, the Northwest Arctic Borough and Kawerak, Inc. These projects utilize community input and oversight in their efforts to collect data on important marine habitat and subsistence use areas (Northwest Arctic Borough 2013). The Northwest Arctic Borough protects the privacy of community-provided information by using aggregated data, which does not reveal individual subsistence hunting areas (Pletnikoff et al. 2017). The results of these subsistence mapping projects can be used to inform future policy and adaptation planning efforts by ensuring that crucial subsistence use areas receive adequate protection (Pletnikoff et al. 2017).

**U.S. EPA Science to Achieve Results Program.** Funded by a 2008-2011 grant from the EPA, this program formed a partnership between ANTHC physicians, university researchers and the communities of Akutan, Seldovia and Point Hope. The program used community observations of climate change and data about the bioactive properties of wild berries to determine the potential effects of climate change on wild berry abundance and community health. The project concluded that there is a need to monitor wild berry species that are part of a subsistence diet in Alaska Native communities (Norton-Smith et al. 2016).

Due to the proprietary nature of TEK, it can be difficult to know the full extent to which traditional and local knowledge are being used by agencies (Pletnikoff et al. 2017). As a result, the findings of this literature review might not reflect the full extent of the incorporation of TEK in climate adaptation planning efforts. Researchers and tribes are working together to protect TEK with certain measures, such as not publishing subsistence resource data, signing

Memorandums of Understanding (MOUs) to establish privacy rights, and exempting federally-funded tribal research from the requirement to be publically available through the Freedom of Information Act (Pletnikoff et al. 2017; Norton-Smith et al. 2016). The University of Alaska has successfully created MOUs with Native villages to establish property rights and guidelines for data sharing (Northwest Arctic Borough 2013).

## What Are the Climate Science Needs Related to Climate Adaptation Planning in Alaska Native Communities?

Nearly half of the reviewed documents identified specific climate science needs to support climate adaptation planning in Alaska Native Communities (n=19). These specific research needs include projected changes in water temperature and depths, ocean currents, pH, precipitation, sea level rise and permafrost melt (Adaptation Advisory Group 2010; Arctic LCC 2013; Northwest Arctic Borough 2013).

Although some climate science needs were identified, the majority of identified research needs are associated with the impacts of climate change on community lifestyle and health, rather than traditional climate science data of historical trends and projections of phenomena. The climate impacts with communities seek to understand with data from outside institutions can be broadly classified as threats to infrastructure (permafrost thaw, flooding), coastal changes (erosion, storm surge, sea level rise, changing ice patterns and coastal permafrost thaw), changes to subsistence availability (habitat changes, species population, health and phenology) and changes to the nearshore environment (ocean acidification, contaminants, increasing water temperature, currents) (Adaptation Advisory Group 2010; Bergman & Hetrick 2016; Northwest Arctic Borough 2013; Pletnikoff et al. 2017). Understanding such impacts requires downscaled climate models which integrate multiple projections and reflect local variability. The spatially-explicit output of these models can then be used to inform site-specific planning (Arctic LCC 2013; ARCUS 2011; Brubaker et al. 2015).

### **Local Monitoring & Observations**

Almost two-thirds of the reviewed documents cited a need for community-based monitoring of activity and landscape changes, including harvest surveys, the spread of vector-borne diseases and contaminants, ice extent, water quality, coastal and riverine erosion, invasive species, air quality and soil temperature (n= 25) (Adaptation Advisory Group 2010; ABSI LCC 2013; ARCUS 2011; Brubaker et al. 2015; Northwest Arctic Borough 2013).

Community-based monitoring and local observational networks not only encourage community participation in research, but also can also be used to develop adaptation plans by creating a set

of baseline information, which allows scientists to document the effects of climate change. A need for spatially explicit baseline data to fill data gaps and support requests for climate mitigation and adaptation-related funding was identified in the literature review (Adaptation Advisory Group 2010; Arctic LCC 2013; ARCUS 2011; Bergman & Hetrick 2016; Johnson & Gray 2014). Specific baseline data needs were cited for topics such as hydrology, species monitoring, and ocean chemistry (ARCUS 2011; Pletnikoff et al. 2017).

Much of the reviewed literature expressed a need for vulnerability assessments and hazard information, which can be considered as early steps in the adaptation planning process (Adaptation Advisory Group 2010; ABSI LCC 2013; Brubaker, Jacob Bell, et al. 2014; Immediate Action Workgroup 2009). Hazard analyses and comprehensive risk scenarios are critical for guaranteeing the safety of current infrastructure and for choosing the location of future development. Coordinated studies of geo-hazards will determine the need for a community to implement protection measures or, if necessary, to seek relocation (Adaptation Advisory Group 2010; Brubaker et al. 2012, 2014).

### ***Threats to Infrastructure***

The most commonly identified need for specific data is further site-specific study of permafrost thaw (Adaptation Advisory Group 2010; ARCUS 2011; Arctic LCC 2013). Monitoring and projections of permafrost thaw and changing snow cover are needed to assess the threat to community infrastructure (including housing, roads, sanitation and waste disposal systems) and hydrology and vegetation patterns (Adaptation Advisory Group 2010; ARCUS 2011). This data can also be used to determine the suitability of potential new infrastructure and relocation sites in adaptation planning efforts (Brubaker et al. 2010; NCAR 2015).

### ***Coastal Changes***

High-resolution, local-level data related to coastal changes including sea level rise, erosion, storm surge, changing ice patterns and coastal permafrost thaw are desired to inform future adaptation planning efforts. Coastal communities require flood and storm surge projections that integrate sea level rise and elevation data with actual and projected erosion data (Brubaker et al. 2010; Brubaker, Bell, et al. 2014; Johnson & Gray 2014). Communities also require assessment, monitoring and modeling of the impacts of changes in sea ice, which has effects on both subsistence hunting and coastal infrastructure (Adaptation Advisory Group 2010). Combined erosion, storm and sea level data are also needed to revise flood risk maps, which can be used to assess communities' need for a climate adaptation plan and to prioritize specific adaptation efforts. (Adaptation Advisory Group 2010)

## ***Subsistence Availability***

Understanding potential impacts of climate change on community access to subsistence resources is needed to identify priority actions to protect food security, which is a key consideration in the creation of an adaptation plan. Workshop participants expressed a desire for more data concerning species distribution, migration and habitat, as well as weather information to better ensure safe access to subsistence resources (ARCUS 2011; Norton-Smith et al. 2016; NCAR 2015; Northwest Arctic Borough 2013). For example, community workshop and assessment participants requested improved meteorological forecasting and real-time ice data to inform subsistence hunters' decision to travel on ice (Brubaker et al. 2010; Brubaker et al. 2011; Pletnikoff et al. 2017). There is also a need to project climate change-induced changes to wildlife habitat and health, such as impacts to calving grounds for the Western Arctic Caribou Herd and salmon phenology (Northwest Arctic Borough 2013; Pletnikoff et al. 2017).

## ***Nearshore Environment***

Reviewed literature cited a need for further study of the effects of climate change on nearshore water temperature, currents, ocean acidification and the spread of contaminants through marine species (Arctic LCC 2013; ARCUS 2011; Northwest Arctic Borough 2013; Pletnikoff et al. 2017). The findings of these studies can be used to assess the climate change-induced threats to community health and subsistence access in the nearshore environment, which is necessary to define adaptation actions in a climate adaptation plan. A report from the Southeast Alaska Climate Adaptation Summit suggests that more research needs to be done to understand the effects of ocean acidification on phytoplankton, zooplankton and salmonids (Holen 2017). Such studies would build on the research being done by the Alaskan Ocean Observing System (AOOS). Reports from the Arctic LCC and the Southeast Alaska Climate Adaptation Summit recommend that future projects investigate how changes in water temperature and salinity, combined with sea level rise, will affect fish distribution (Arctic LCC 2013; Holen 2017). More research is needed to determine if increased saltwater mixing in estuarine areas will affect local phenology (Arctic LCC 2013). Further study of climate-driven changes to nearshore processes will provide more data for effective natural resource management, which is a component of climate adaptation planning. Participants in the Southeast Alaska Climate Adaptation Summit expressed a concern for the impact of increased precipitation on contaminant runoff from mineral development projects in Southeast Alaska and British Columbia (Holen 2017). Tribal participants from the Juneau area described a need to understand if precipitation will leach contaminants from mines, potentially affecting marine subsistence species (Holen 2017).

## Discussion: Overcoming Barriers to Climate Adaptation

Several recommendations were identified to facilitate overcoming barriers to climate adaptation planning associated with tribal sovereignty, insufficient coordination between federal agencies, and inflexible natural resources policy. These recommendations include amending restrictive policy, encouraging economic growth within Alaska Native villages, improving the relationship between researchers and tribes, and increasing the utility of science in adaptation planning efforts.

Amendments to policies that encourage a better government-to-government relation and increased collaboration on climate change efforts will better facilitate adaptation planning efforts among tribes (Pletnikoff et al. 2017; Norton-Smith et al. 2016). Beneficial policy amendments and interagency collaboration would be encouraged by the creation of an independent entity that can coordinate the efforts of different agencies (Adaptation Advisory Group 2010). Specific examples include the creation of a single federal program to prioritize and coordinate assistance to community relocation efforts (US GAO 2009) and greater flexibility in resource and land management regulations. Participants in coastal resilience workshops recommended amending harvest regulations to place a limit on total amount harvested, rather than a daily limit, which would benefit subsistence users (Pletnikoff et al. 2017). Similar recommendations to change the dates of hunting seasons are being pursued by organizations such as the Bristol Bay Native Association (BBNA) (Pletnikoff et al. 2017). This flexibility in hunting regulations would incorporate the uncertainty and variability created by climate change (Leiserowitz et al. 2006).

Future climate adaptation plans could be strengthened by addressing the connection between climate and economic resilience (Pletnikoff et al. 2017). It is critical that climate adaptation plans work towards advancing tribal sovereignty and future sustainability. Several workshop participants stressed that sustainable economic development is a climate adaptation strategy in itself, and that tribes are eager to support efforts that enhance economic stability (Pletnikoff et al. 2017). Youth involvement in youth caucuses, regional and state networks, and national international forums –made possible by funded scholarships- was also recommended as a strategy for equipping future generations with an understanding of climate change and climate adaptation strategies (Adaptation Advisory Group 2010; Kawerak Marine Program 2017; Leiserowitz et al. 2006; Pletnikoff et al. 2017; NCAR 2015)

Adaptation planning efforts require research that not only produces credible data, but also fosters trust and respect between researchers and Alaska Native communities (Bergman & Hetrick 2016; Northwest Arctic Borough 2013; Pletnikoff et al. 2017). A beneficial relationship between scientists and the users of science encourages the sharing of TEK and community participation and education, and also creates a foundation for further collaboration. The following



recommendations to improve the relationship between scientific community and Alaska Native tribes were made by workshop participants:

- To protect the proprietary nature of traditional and local knowledge, researchers should receive community consent and protect intellectual property rights through written agreements (Northwest Arctic Borough 2013).
- To gain community trust, researchers should encourage two-way communication with local communities through all steps of the research process and create parity between locals and scientists (ARCUS 2011).
- To increase the utility of research findings, researchers should ensure the delivery of appropriate, usable data to affected communities (NCAR 2015).
- To promote future initiatives and collaborations, researchers should foster the creation of regional and international informational networks to share climate-related efforts and solutions (NCAR 2015).
- To avoid duplication of efforts and fatigue in Native communities that participate in studies, research results should be synthesized and disseminated through a data-sharing mechanism (Pletnikoff et al. 2017).

One identified element of successful research partnerships is the creation of research guidelines by Alaska Native communities, which establish the rights of the community and the responsibilities of involved researchers. For example, the Northwest Arctic Borough has a standardized protocol of 12 standardized requirements for researchers, including submission of an outline of proposed research for approval, consultation with appropriate parties and a guarantee of anonymity for research participants (Northwest Arctic Borough 2013). Additionally, researchers are required to share their results with the community after their work is completed (Northwest Arctic Borough 2013). The directing ordinance also recommends that those who share traditional knowledge be fairly compensated (Northwest Arctic Borough 2013). Similar research guidelines were identified for the Bristol Bay Native Association (Northwest Arctic Borough 2013).

Local observations, through formal community-based monitoring programs or informal observational networks (e.g., The Local Environmental Observer network), can be used to improve the accuracy of scientific models and encourage community participation in research (Pletnikoff et al. 2017). One example of a community-based monitoring program is the DGGS “Stakes for Stakeholders” program, in which three-person teams use relatively inexpensive tools to measure shoreline change (Pletnikoff et al. 2017). This monitoring allows for storm-driven erosion events to be distinguished from long-term erosion trends (Pletnikoff et al. 2017). There is also a need for coordination amongst local observer programs to streamline the data collection process, reduce redundancy, and support collaboration between communities (Pletnikoff et al.

2017). This collaboration will require an interagency effort between technical experts (from the University of Alaska and local NGO's), land managers (including LCCs and federal agencies) and local tribal experts (Holen 2017).

A need for a data sharing mechanism or clearinghouse, which would standardize and coordinate data collection across different sources in a particular region, was also identified in the literature review. (Adaptation Advisory Group 2010; ARCUS 2011; Holen 2017; Pletnikoff et al. 2017). This framework would allow for a structured analysis and dissemination of existing data, and would enable the identification of remaining science needs and areas for further research (Immediate Action Workgroup 2009). Improved data coordination is recommended to reduce the “information overload” on agencies and tribes and to mitigate research redundancy and duplication, improving the utility of data in adaptation planning efforts. According to a report from the CRRC Adaptation Planning Project, “we don't need more data, we need to be able to use the data exists. The amount of data for fish, e.g. in any one community is overwhelming” (Bergman & Hetrick 2016) The report recommends the compiling of a reference list of all plans and research related to individual communities to serve as a database of existing information (Bergman & Hetrick 2016).

For climate science to be used in adaptation planning, it is critical that scientists produce data in a form that is applicable to decision-making (Adaptation Advisory Group 2010; NCAR 2015). The literature identified a need for “co-produced” or “stakeholder-driven” science that can be used by multiple audiences to enable action (Adaptation Advisory Group 2010; Bergman & Hetrick 2016; Immediate Action Workgroup 2009; NCAR 2015). To better inform policymakers, several documents recommend the creation of a “performance feedback loop” to continually update the analyses, scenarios and assumptions used by state and federal agencies with new climate, economic and demographic data (Adaptation Advisory Group 2010). Current efforts for actionable science are driven by “boundary organizations”, such as LCC's, and Regional Integrated Science Assessments (RISAs), which connect environmental knowledge to action (NCAR 2015).

## Conclusion

This literature review illustrates the amount and depth of grey literature discussing climate adaptation planning needs in Alaska Native communities. Overall, there was much agreement between sources about existing barriers and needs, as well as recommendations for future actions. The review identified numerous tribal climate adaptation planning projects and related efforts (including trainings and workshops), highlighting a clear interest among Alaska Native communities to better understand and prepare for the impacts of climate change. Financial and

administrative support for these efforts currently comes from a variety of institutions and agencies, which suggests that there is potential for future collaboration between stakeholders.

Limited financial resources was revealed to be the most frequent barrier to financial planning, compounded by non-climate stressors and agency requirements for funding. Institutional barriers to adaptation planning are reinforced by minimal tribal representation in decision-making and insufficient agency coordination, as well as the existence of inflexible policy that does not address community needs in the context of climate change. Climate science data was found to be used in existing climate adaptation plans; however, there remains a need for local baseline data to fill data gaps. The majority of reviewed documents suggest that this local data be collected through community-based monitoring. The use of traditional and local knowledge in climate adaptation planning was difficult to detect, but the literature review identified a need for the integration of TEK with western science through partnerships between research institutions and Alaska Native communities. The analysis revealed that the majority of stated research needs were related to the impacts of climate change to community lifestyle and health, especially the effects on infrastructure and subsistence species.

The stated recommendations to these identified barriers and needs focus on encouraging agency coordination and policy amendments, increasing tribal sovereignty, building relationships between researchers and tribes, and producing data that is applicable to decision-making. Specific recommendations include the incorporation of climate data into natural resource management regulations, the establishment of research protocols by Native associations, and creation of a data sharing mechanism.

To encourage future climate adaptation planning in Alaska Native communities, it is necessary to determine how institutions can best collaborate and provide support to tribes. Reviewed literature suggests that there is a clear need for holistic plans that account for many different community needs, rather than the current system of segregated plans and support from different agencies. Further research is needed to what climate adaptation data and resources can be shared between agencies, research institutions, and non-profits and how to make those resources available to interested communities. Such an effort is currently underway in support of the future Alaska Sea Grant Adapt Alaska website, which is intended to be a portal to adaptation planning resources for tribes, including data, grant opportunities and training events. To gather ideas and support for the website, attendees at a two-day workshop in Anchorage in May 2017 designed a framework for future efforts. This framework included specific action items for improving the adaptation planning process, and is intended to guide collaboration between institutions in the near future. This report recommends that stakeholders who want to participate climate adaptation planning efforts in Alaska Native communities seek involvement in the development of the Adapt Alaska website and –once published- its future maintenance.

This report also recommends that future research focus on the mapping of climate efforts to identify networks and partnerships that were not revealed in this initial review. Such research is needed to determine where there is established trust between researchers, agencies and communities, and could be used to guide future adaptation efforts. An investigation of existing partnerships (both formal and informal) would benefit from interviews, surveys, and feedback from institutions and community leaders.

## **Acknowledgments**

I would like to thank Capstone Advisory Committee Chair Dr. Nathan Kettle for his supervision of research, proofreading and making this project possible with support from ACCAP. I am also grateful to Dr. Davin Holen, BIA Alaska Tribal Climate Science Liaison Malinda Chase, and additional researchers and representatives who provided expert insight and feedback throughout the literature review process. Lastly, I thank the Scripps and UCSD faculty who provided academic guidance and review.

## References

- ABSI LCC, 2013. *Strategic Science Plan*,
- ACCAP, Alaska Policy & Climate Adaptation Webinar Series. Available at: [https://accap.uaf.edu/policy\\_adaptation](https://accap.uaf.edu/policy_adaptation) [Accessed May 23, 2017a].
- ACCAP, Tribal Climate Adaptation Planning in Nome. Available at: [https://accap.uaf.edu/Nome\\_adaptation](https://accap.uaf.edu/Nome_adaptation) [Accessed May 23, 2017b].
- Adaptation Advisory Group, 2010. *Alaska's climate change strategy: Addressing impacts in Alaska. Final Report submitted by the Adaptation Advisory Group to the Alaska Climate Change Sub-Cabinet.*, Juneau.
- Alaska Institute for Justice, 2017. *Rights, Resilience, and Community-Led Relocation: Perspectives from Fifteen Alaska Native Coastal Communities*,
- Alaska Native Tribal Health Consortium, Alaska Tribal Conference on Environmental Management. Available at: <http://www.atcemak.com/> [Accessed May 14, 2017a].
- Alaska Native Tribal Health Consortium, Center for Climate & Health. Available at: <https://anthc.org/what-we-do/community-environment-and-health/center-for-climate-and-health/> [Accessed May 14, 2017b].
- Alaska Native Tribal Health Consortium, LEO Network. Available at: <http://leonetwork.org/en/> [Accessed May 14, 2017c].
- Arctic LCC, 2013. *Strategic Science Plan Public Review Draft*,
- ARCUS, 2011. *Synthesis Report of Local Meetings- Western Alaska Landscape Conservation Cooperative*,
- Bergman, B.G. & Hetrick, J., 2016. *Chugach Regional Resources Commission Climate Change Adaptation Planning Project Final Report*,
- BeringWatch, What is BeringWatch? Available at: <http://www.beringwatch.net/site/> [Accessed May 15, 2017].
- Bronen, R. & Chapin, F.S., 2013. Adaptive governance and institutional strategies for climate-induced community relocations in Alaska. *Proceedings of the National Academy of Sciences of the United States of America*, 110(23), pp.9320–5.
- Brookings Institution, 2014. *Climate Change and Internal Displacement*,
- Brubaker, M., Bell, J., et al., 2014. *Climate Change in Atkasuk, Alaska Strategies for Community Health*,

- Brubaker, M. et al., 2011. *Climate Change in Noatak, Alaska Strategies for Community Health*, ANTHC.
- Brubaker, M., Bell, J., et al., 2014. *Climate Change in Nuiqsut, Alaska Strategies for Community Health*,
- Brubaker, M. et al., 2010. *Climate Change in Point Hope, Alaska Strategies for Community Health*,
- Brubaker, M. et al., 2012. *Climate Change in Selawik, Alaska Strategies for Community Health*,
- Brubaker, M. et al., 2015. *Climate Change in the Bering Strait Region*,
- Center for Global Change and Arctic System Research, 1999. Assessing the Consequences of Climate Change for Alaska and the Bering Sea Region. In Gunter Weller and Patricia A. Anderson, ed.
- Chapin, F.S. et al., 2014. *Climate Change Impacts in the United States Recommended Citation for Chapter On the Convening Lead Authors Lead Authors*,
- Cochran, P., 2004. Current Issues and Research Agendas from Alaska Native Communities.
- Division of Community and Regional Affairs, 2017. Alaska Division of Community and Regional Affairs. Available at: <https://www.commerce.alaska.gov/web/dcra/PlanningLandManagement.aspx> [Accessed May 15, 2017].
- Division of Community and Regional Affairs, 2016. *Shaktoolik Strategic Management Plan*,
- Hetrick, W., 2016. Chugach Regional Resources Commission Climate Change Adaptation Project.
- Holen, D., 2017. *Southeast Alaska Environmental Conference: Report on the Climate Change Adaptation Summit*,
- Immediate Action Workgroup, 2009. *Recommendations Report to the Governor's Sub-Cabinet on Climate Change*, Juneau.
- ITEP, ITEP Training. Available at: [http://www7.nau.edu/itep/main/training/training\\_wbnrs\\_ccAr](http://www7.nau.edu/itep/main/training/training_wbnrs_ccAr) [Accessed May 23, 2017].
- Johnson, T. & Gray, G., 2014. *Shaktoolik, Alaska: Climate Change Adaptation for an At-Risk Community Adaptation Plan*,
- Karl, T.R., Melillo, J.M. & Peterson, T.C., 2009. *Global Climate Change Impacts in the United States*,
- Kawerak Marine Program, 2017. *Bering Strait Voices: Vision for Action Summit Report*, Nome, Alaska.

- Kinsman, N.E.M. & DeRaps, M.R., 2012. *Coastal hazard field investigations in response to the November 2011 Bering Sea storm, Norton Sound, Alaska*,
- Klein, R.J. et al., 2014. *Chapter 16: Adaptation opportunities, constraints, and limits*, Cambridge University Press.
- Knapp, C.N. & Trainor, S.F., 2015. Alaskan stakeholder-defined research needs in the context of climate change. *Polar Geography*, 38(1), pp.42–69.
- Leiserowitz, A., Gregory, R. & Failing, L., 2006. Climate change impacts, vulnerabilities, and adaptation in Northwest Alaska. In Decision Research.
- Maynard, N.G. & Wildcat, D., 2014. Native Peoples- Native Homelands II Climate Change Workshop Final Report. In Prior Lake, Minnesota.
- McNeeley, S.M., 2012. Examining barriers and opportunities for sustainable adaptation to climate change in Interior Alaska. *Climatic Change*, 111(3–4), pp.835–857.
- MFPP, Model Forest Policy Program. Available at: <http://www.mfpp.org/> [Accessed June 3, 2017].
- Murray, E., Ryan, J. & Shepard, H., 2013. *Climate Adaptation and Action Plan for the Norton Bay Watershed, Alaska*, Sagle, ID.
- NCAR, 2015. *Third Rising Voices Workshop on Learning and Doing: Education and Adaptation through Diverse Ways of Knowing Workshop Report*, Boulder, Colorado.
- North Pacific Research Board, Bering Sea Project. Available at: <https://www.nprb.org/bering-sea-project/about-the-project/> [Accessed May 15, 2017].
- Northwest Arctic Borough, 2013. *Improving Local Participation in Research in Northwest Alaska Final Workshop Summary and Workgroup Recommendations*, Kotzebue.
- Norton-Smith, K. et al., 2016. *Climate Change and Indigenous Peoples: A Synthesis of Current Impacts and Experiences*,
- Pletnikoff, K. et al., 2017. *Promoting Coastal Resilience and Adaptation: a synthesis from four regional workshops in the Alaskan Arctic [in prep.]*, Anchorage, Alaska.
- President’s Task Force, 2014. *President’s State Local and Tribal Task Force on Climate Preparedness and Resilience: Recommendations to the President*, Washington DC.
- Research Needs Work Group, 2009. *Recommendations on Research Needs Necessary to Implement an Alaska Climate Change Strategy*,
- Stewart, B.C. et al., 2013. *Regional Climate Trends and Scenarios for the U.S. National Climate Assessment Part 7. Climate of Alaska*, Washington DC.
- The Alaska Forum, Alaska Forum on the Environment. Available at:

<http://www.akforum.org/afe/>

U.S. Army Corps of Engineers, 2006. *Alaska Village Erosion Technical Assistance Program*,

U.S. Census Bureau, 2015. 2011-2015 American Community Survey 5-Year Estimates. *U.S. Census Bureau FactFinder*. Available at:  
<https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=CF>  
[Accessed May 10, 2017].

US Army Corps of Engineers, 2011. *Shaktoolik Coastal Flooding Analysis*,

US GAO, 2009. *Alaska Native Villages: Limited Progress Has Been Made on Relocating Villages Threatened by Flooding and Erosion*,

Wotkyns, S. & González-Maddux, C., 2014. *Climate Change Adaptation Planning Training, Assistance and Resources for Tribes*,



## Appendix A. Index of Collected Literature and Events

<b>TRAINING</b>			
<b>Date</b>	<b>Organized By</b>	<b>Location</b>	<b>Title</b>
<i>In-Person</i>			
<b>Jul 28-31, 2014</b>	AINE & IARC	Tanana River, Alaska	Signs of the Land: Reaching Arctic Communities Facing Climate Change (ReAC)
<b>Sep 2-3, 2014</b>	ITEP	Portland, Oregon	Tribal Climate Change Adaptation Planning Workshop
<b>Sep 28-Oct 1, 2015</b>	NWBLCC & NCTC	Fairbanks, Alaska	Climate Conservation Training w/ Scenario Planning
<b>Dec 8-10 2015</b>	ITEP & NPLCC & CCTH	Tulalip, Washington	Climate Change Adaptation Training
<b>Apr 19-21, 2016</b>	ITEP & ANTHC	Anchorage, Alaska	Climate Change Adaptation Planning Course
<b>Jun 14-17, 2016</b>	AINE & IARC	Tanana River, Alaska	Signs of the Land II: Reaching Arctic Communities Facing Climate Change (ReAC)
<b>Jun 19-25, 2016</b>	ATNI & USET & BIA & ITG	McCall, Idaho	National Tribal Climate Boot Camp
<b>Feb 21-23 2017</b>	ITEP & ANTHC	Anchorage, Alaska	Climate Change Adaptation Planning Course
<b>Mar 14-16 2017</b>	ITEP	Spokane, Washington	Climate Change Adaptation Planning Course
<b>Jul 30-Aug 4, 2017</b>	ATNI & Institute for Tribal Gov't	Eatonville, Washington	Tribal Climate Camp
<i>Webinar</i>			
<b>Mar 14, 2012</b>	ITEP & EPA		Alaska Tribal Climate Change Webinar
<b>Jun 20, 2012</b>	ITEP & EPA		Alaska Tribal Climate Change Webinar
<b>Nov 15, 2012</b>	ITEP & EPA		Alaska Tribal Climate Change Webinar
<b>Mar 12, 2013</b>	ITEP & EPA		Alaska Tribal Climate Change Webinar
<b>Nov 6, 2013</b>	ITEP & EPA		Alaska Tribal Climate Change Webinar
<b>Jan 28, 2014</b>	ITEP & EPA		Alaska Tribal Climate Change Webinar
<b>Apr 29, 2014</b>	ITEP & EPA		Alaska Tribal Climate Change Webinar
<b>Oct 22, 2014</b>	ITEP & EPA		Alaska Tribal Climate Change Webinar
<b>Mar 19, 2015</b>	ITEP & EPA		Alaska Tribal Climate Change Webinar
<b>Aug 25, 2015</b>	ITEP & EPA		Alaska Tribal Climate Change Webinar
<b>Oct 20, 2015</b>	BIA & ITEP		BIA Climate Change Award Process Overview Webinar
<b>Nov 20, 2015</b>	BIA & ITEP		BIA Climate Change Award Process Overview Webinar
<b>December 17, 2015</b>	ITEP & EPA		Alaska Tribal Climate Change Webinar
<b>Nov 2015- May</b>	ACCAP		Policy & Climate Adaptation Mitigation and

<b>2016</b>			Planning for Alaska Natives webinars series.
<b>Feb 23, 2016</b>	ACCAP		Evaluating Scenario Planning to Understand Climate Change
<b>Mar 1, 2016</b>	ITEP & USGS		Development & Implementation of a Regional Tribal Engagement Strategy
<b>Mar 23, 2016</b>	ITEP		The Importance of TEK in Adaptation Planning
<b>Apr 12, 2016</b>	ITEP & BIA		BIA TCRP & Ocean/Coastal Planning, Travel Support, Youth Planning & Capacity Building
<b>November 2, 2016</b>	ITEP & EPA		Alaska Tribal Climate Change Webinar
<b>Jul 2016-May 2017</b>	Elim & NBITWC		Norton Sound Communities Climate Adaptation Training

<b>ADAPTATION PLANS</b>			
<b>Year</b>	<b>Funder</b>	<b>Location</b>	<b>Title</b>
<b>2013</b>	Norton Bay Alaska Native Villages	Norton Bay	Climate Adaptation and Action Plan for the Norton Bay Watershed, Alaska
<b>2014</b>	Nat'l Sea Grant Program	Shaktoolik	Shaktoolik, Alaska: Climate Change Adaptation for an At-Risk Community
<b>2014</b>	EPA	Region 10	EPA Region 10 Climate Change Adaptation Plan
<b>2014</b>	BIA	Chugach Region	Chugach Regional Resources Commission Climate Change Adaptation Planning Project
<b>2016</b>	BIA	SE Alaska	SE Alaska Climate Adaptation Plan
<b>2015-2017</b>	BIA	Nome	Tribal Climate Adaptation Planning in Nome

<b>WORKSHOPS</b>			
<b>Date</b>	<b>Organized by</b>	<b>Location</b>	<b>Title</b>
<b>October 1998</b>	UAF/ Global Change Research Prog.	Fairbanks, Alaska	Assessing the Consequences of Climate Change for Alaska and the Bering Sea Region
<b>January 2003</b>	ANSC, funded by NSF	Kotzebue, Alaska	Northwest Alaska Regional Meeting
<b>May 2003</b>	ANSC, funded by NSF	Anchorage, Alaska	Southcentral Alaska Regional Meeting
<b>January 2004</b>	ANSC, funded by NSF	Sitka, Alaska	Southeast Alaska Regional Meeting
<b>March 2004</b>	ANSC, funded by NSF	Bethel, Alaska	Yukon-Kuskokim Regional Meeting
<b>May 2006</b>	Decision Research	Kotzebue, Alaska	Climate Change Impacts, Vulnerabilities and Adaptation in NW Alaska
<b>November 2009</b>	NASA & Haskell University	Prior Lake, Minnesota	Native Peoples- Native Homelands Climate Change Workshop II
<b>October-November 2010</b>	Western AK LCC	Various	Synthesis Report of Local Meetings
<b>March 29-30, 2011</b>	North Slope Science Initiative	Barrow, Alaska	Science, Natural Resources, and Subsistence in Alaska's Arctic Lands and Waters: A Continuing Dialogue on Working Together to Understand our Changing Arctic
<b>January 2013</b>	ABSI LCC	Anchorage, Alaska	Strategic Science Plan Workshop Report
<b>April 2013</b>	NW Arctic Borough & UAF Chukchi	Kotzebue, Alaska	Improving Local Participation in Research in NW Alaska
<b>November 2013</b>	NW Boreal LCC	Fairbanks, Alaska	Building a Landscape Conservation Foundation for the NW Boreal Partnership
<b>September 2014</b>	ABSI LCC	Fairbanks, Alaska	Understanding Climate Change Impacts in the Aleutian Islands

<b>November 2014</b>	SE AK Tribal Toxins Partnership	Sitka, Alaska	Southeast Alaska Tribal Toxins Partnership Workshop
<b>November 2014</b>	AK CSC & LCCs	Anchorage, Alaska	Climate, Conservation & Community in Alaska & NW Canada
<b>July 2015</b>	NCAR/Rising Voices	Boulder, Colorado	Third Rising Voices Workshop on Learning and Doing: Education and Adaptation through Diverse Ways of Knowing
<b>October 2015</b>	ANTHC	Anchorage, Alaska	Alaska Tribal Conference on Environmental Management
<b>February 2016</b>	Alaska Forum on the Environment	Anchorage, Alaska	Alaska Forum on the Environment
<b>March 2016</b>	CRRC	Anchorage, Alaska	CRRC Climate Change Workshop Outcomes
<b>May 2016</b>	ABSI LCC & APIA	Nome, Alaska	Bering Strait Resilience Workshop
<b>August 2016</b>	ABSI LCC & APIA	Unalaska, Alaska	Aleutian Life Forum Workshop
<b>August 2016</b>	ITEP	Uncasville, Connecticut	Tribal Lands and Environment Forum
<b>September 2016</b>	AIJ, NOAA & ANSC	Anchorage, Alaska	Rights, Resilience & Community-Based Adaptation
<b>September 2016</b>	ABSI LCC & APIA	King Salmon, Alaska	Bristol Bay Resilience Workshop
<b>September 2016</b>	AK Sea Grant, CCTH	Ketchikan, Alaska	Southeast Alaska Climate Change Summit
<b>October 2016</b>	Kawerak	Nome, Alaska	Bering Strait Voices: Vision for Action Summit Report
<b>October 2016</b>	ANTHC	Anchorage, Alaska	Alaska Tribal Conference on Environmental Management
<b>December 2016</b>	ABSI LCC & APIA	Kotzebue, Alaska	Northwest Arctic Resilience Workshop
<b>February 2017</b>	Alaska Forum on the Environment	Anchorage Alaska	Alaska Forum on the Environment
<b>April 2017</b>	NCAR/Rising Voices	Boulder, Colorado	Fifth Rising Voices Workshop for Collaborative Science with Indigenous Knowledge for Collaborative Solutions
<b>August 2017</b>	ANTHC	Anchorage,	7G Climate Change Adaptation Planning

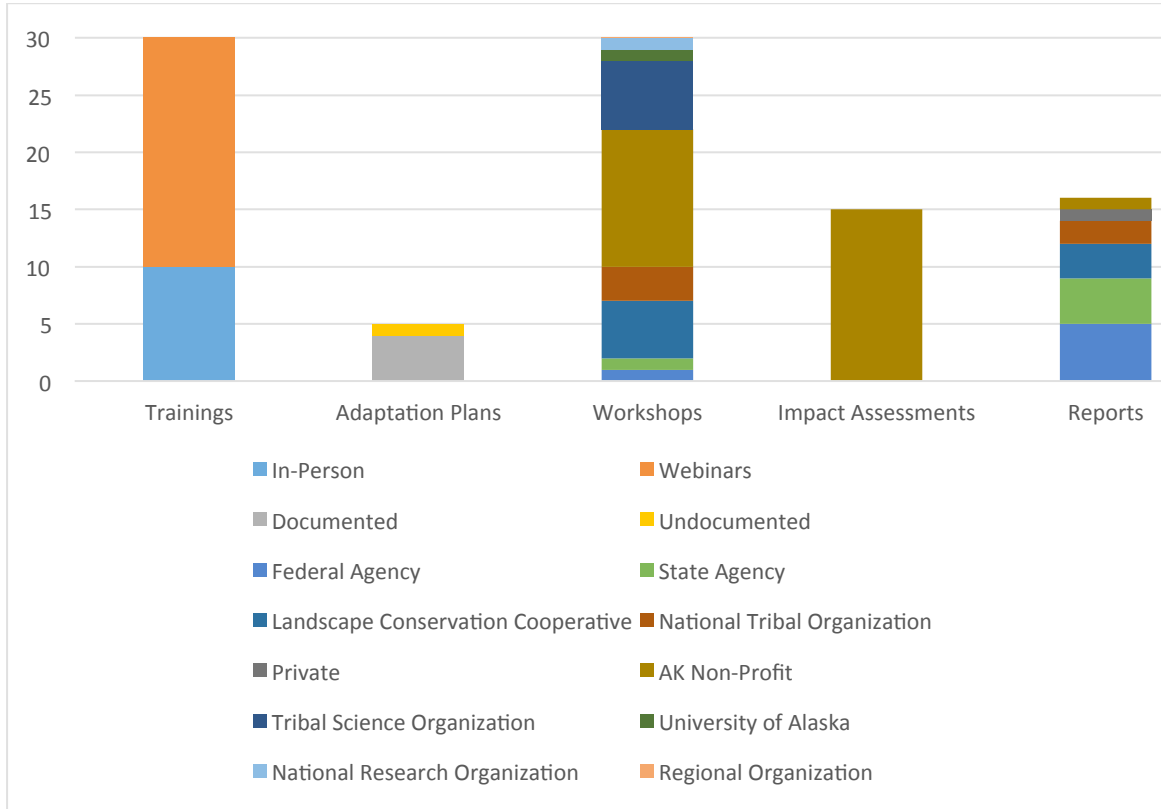
		Alaska	
--	--	--------	--

<b>IMPACT ASSESSMENTS</b>			
<b>Year</b>	<b>Author</b>	<b>Location</b>	<b>Title</b>
2010	ANTHC	Point Hope	Climate Change in Point Hope, Alaska: Strategies for Community Health
2011	ANTHC	Kiana	Climate Change in Kiana, Alaska, Strategies for Community Health
2011	ANTHC	Noatak	Climate Change in Noatak, Alaska, Strategies for Community Health
2011	ANTHC	Kivalina	Climate Change in Kivalina, Alaska
2012	ANTHC	Selawik	Climate Change in Selawik, Alaska, Strategies for Community Health
2013	ANTHC	Nondalton	Climate Change in Nondalton, Alaska
2013	ANTHC	Pilot Point	Climate Change in Pilot Point, Alaska
2014	ANTHC	Atqasuk	Climate Change in Atqasuk, Alaska, Strategies for Community Health
2014	ANTHC	Pilot Point, Levelock, Nondalton	Climate Change and Health Effects in the Bristol Bay Region
2014	ANTHC	Nuiqsut	Climate Change in Nuiqsut, Alaska, Strategies for Community Health
2014	ANTHC	Wainwright	Climate Change in Wainwright, Alaska, Strategies for Community Health
2014	ANTHC	Koliganek, New Stuyahok, Ekwok	Community Observations on Climate Change, Upper Nushagak River Trip Report
2014	ANTHC	Levelock	Climate Change in Levelock, Alaska
2015	ANTHC	Arctic Village, Fort Yukon & Venetie	Community Observations on Climate Change, Arctic Village, Fort Yukon & Venetie, Alaska
2015	ANTHC	Shishmaref, Teller, White Mountain, Nome, Golovin, Unalakleet, St. Michael, Stebbins	Climate Change in the Bering Strait Region

<b>REPORTS</b>		
<b>Date</b>	<b>Author</b>	<b>Title</b>
2006	USACE	An Examination of Erosion Issues in the Communities of Bethel, Dillingham, Kaktovik, Kivalina, Newtok, Shishmaref and Unalakleet
2009	GAO	Limited Progress Has Been Made on Relocating Villages Threatened by Flooding and Erosion
2009	Immediate Action Workgroup	Recommendations to the Governor's Subcabinet on Climate Change
2010	Adaptation Advisory Group	Alaska's Climate Change Strategy: Addressing Impacts in Alaska
2010	ANTHC	Climate Change and Mental Health: Uncertainty and Vulnerability for Alaska Natives
2011	AK Dept of	Relocation Report: Newtok to Metarvik

	Commerce, Community & Economic Development	
<b>2011</b>	USDA	Social Vulnerability and Climate Change: Synthesis of Literature
<b>2012</b>	North Pacific LCC	North Pacific LCC Strategy for Science & Traditional Ecological Knowledge
<b>2013</b>	Brookings Institute	Climate-Induced Displacement of Alaska Native Communities
<b>2013</b>	Arctic LCC	Arctic LCC Strategic Science Plan
<b>2013</b>	North Pacific LCC	Implementation Plan for the NPLCC Science and Traditional Ecological Knowledge Strategy
<b>2014</b>	Climate & Traditional Knowledges Working Group	Guidelines for Considering Traditional Knowledges in Climate Change Initiatives
<b>2014</b>	ITEP	Climate Change Adaptation Planning, Training, Assistance and Resources for Tribes
<b>2014</b>	Walker/Mallott Transition Team	Arctic Policy & Climate Change
<b>2015</b>	UAF & BOEM	Subsistence Sharing Networks & Cooperation: Kaktovik, Wainwright & Venetie
<b>2016</b>	USDA	Climate Change and Indigenous Peoples: A Synthesis of Current Impacts and Experiences

## Appendix B. Collected Literature and Events by Type and Source



## Appendix C. Climate Adaptation Plans

### Shaktoolik

Shaktoolik is a village on the east coast of Norton Bay with an estimated population of 223 in 2015 (U.S. Census Bureau 2015). The village is inhabited by descendants of the Unalut and Malemut people. The village is currently situated one mile north from its original site, having relocated in the mid-1970s due to erosion concerns (Johnson & Gray 2014). Shaktoolik is affected by flooding and erosion from both Norton Bay and the Tagoomenik River. The community is located within the 100-year flood plain (US Army Corps of Engineers 2011).

The Shaktoolik Climate Change Adaptation Plan was funded by the NOAA National Sea Grant Program and prepared by both Alaska Sea Grant and Glenn Gray and Associates (Johnson & Gray 2014). The two-year planning project incorporated input from the Shaktoolik Planning Committee, made up of representatives of the Native Village of Shaktoolik, the City of Shaktoolik and the Shaktoolik Native Corporation. The committee held six meetings over the two year-period, which were open to the public and conducted under the guidance of the part-time local Project Coordinator. This Project Coordinator was hired by the Native Village of Shaktoolik, and was the designated point of contact with the community. The Project Coordinator worked with Sea Grant staff and the private consultant from Glenn Gray and Associates to conduct meetings with outside experts, develop a range of flooding and erosion mitigation options, reach out and network with other coastal communities, and seek out additional sources of funding. Due to limited relocation resources, the Planning Committee agreed to implement a “defend in place” approach, which prioritizes the cost-effective protection of their current location from coastal erosion and flooding.

The Shaktoolik Climate Change Adaptation Plan outlines the following nine measures designed to protect the community’s inhabitants and infrastructure:

1. Construction of a **vegetated berm** in front of the community to deflect wave energy
2. Construction of a **mound** above the 500-year flood level to serve as refuge
3. Seek funding to construct a **multipurpose building** to house the community during storms
4. Explore options to relocate the community’s two **tank farms** to a site further away from the beach
5. Develop **background papers and funding proposals** for submittal to outside organizations
6. Update the **local hazard mitigation plan** to reflect current priorities
7. Initiate a **community-based monitoring system** and encourage agencies to continue **hazard monitoring**
8. Pursue funding for **new studies** that will be needed to implement the adaptation plan
9. Develop local **guidelines for development** to protect structures from storms

The Shaktoolik Climate Change Adaptation Plan built upon previous climate-related planning efforts, including the following:

- A 2009 Local Multi-Hazard Mitigation Plan prepared by the Native Village of Shaktoolik and the City of Shaktoolik, WHPacific and Bechtol Planning and Development. *(The Shaktoolik Adaptation Plan recommends the updating of this hazard mitigation plan to include new information and update the stated goals.)*



- A 2007 Local Economic Development Plan from Kawerak, Inc, the regional Tribal organization. (This plan was later updated in 2013.)
- The 2010 Emergency Operations Plan, Evacuation Plan, and Continuity of Operations Plan, all prepared by the Division of Homeland Security and Emergency Management.
- The Norton Bay Climate Adaptation and Action Plan (discussed below).

The efforts of the Shaktoolik Sea Grant Project were communicated to the public through panel discussions at the 2013 and 2014 Alaska Forum on the Environment (AFE) (Johnson & Gray 2014). The 2013 discussion included representatives from other coastal communities facing climate impacts (Newtok, Shishmaref and Kivalina.) The 2014 panel session discussed the Shaktoolik project. Through these sessions at AFE, community members and project participants were able to share their experience with other tribal representatives, scientists and agency staff.

The Shaktoolik Sea Grant Project concluded in late 2014. The Division of Community and Regional Affairs (DCRA) within the Alaska Department of Commerce, Community and Economic Development (DCCED) now oversees the implementation of the Shaktoolik Adaptation Plan through its Alaska Community Coastal Protection (ACCP) Project. The ACCP Project includes Shaktoolik, Kivalina and Shishmaref, and provides for the creation of an interagency work group to oversee the development of a strategic management plan, under the guidance of a local project coordinator and outside consultant (Johnson 2014). The Shaktoolik Strategic Management Plan was released in September 2016, and is intended to guide adaptation efforts until 2018 (Division of Community and Regional Affairs 2016).

### **Norton Bay Watershed**

The Norton Bay Watershed Climate Adaptation and Action Plan includes Norton Bay and its tributaries on the Seward Peninsula in northwestern Alaska. The Native villages on Norton Bay are Elim, Koyuk, Shaktoolik and Unalakleet. Village residents are descendants of both Yupik and Inupiat cultures. Population size ranges from 200 to 500 people per village. Climate change-related impacts range from reduced access to subsistence resources to coastal erosion and sea level rise, and many of these impacts are exacerbated by mining and road development activities in the surrounding area (Murray et al. 2013).

The Climate Adaptation and Action Plan for the Norton Bay Watershed was prepared by the Norton Bay Inter-Tribal Watershed Council (NBITWC) in partnership with the Norton Bay Alaska Native Villages. The NBITWC was created by a 2012 Community Environmental Demonstration Project (CEDP) grant from the Alaska Native Tribal Health Consortium (ANTHC). The NBITWC Climate Change Adaptation Planning Group was guided in the development of the plan by the Climate Solutions University (CSU) Plan Development Program, part of the Model Forest Policy Program. The year-long CSU assessment and planning process included the formation of a local planning team, the assessment of local risks and opportunities, analysis of possible adaptation strategies, and the building of public support to implement the plan. The plan incorporated tribal input through community meetings in Elim and Koyuk in 2012.

The Norton Bay Watershed Climate Adaptation and Action Plan has the following seven goals:

1. Obtain **funding for emergency preparedness** and/or relocation of native villages in the Norton Bay Watershed most critically impacted by coastal erosion and flooding.
2. **Mitigate and/or adapt to impact of rising water temperature/stream bank erosion** on aquatic habitat.
3. Increase safe **access to subsistence resources** within the watershed.
4. **Protect subsistence resources** in 100% of watershed.
5. **Increase education and outreach opportunities** for Native villagers to learn about climate change impacts with a focus on local issues and adaptation strategies.
6. Set precedent in Norton Sound Region for **data collection, watershed assessment** and **climate change adaption planning**.
7. **Improve economic conditions** in Norton Bay Native villages.

The Climate Adaptation and Action Plan is intended to build upon the Economic and Comprehensive plans of the individual Norton Bay villages with the inclusion of climate impacts and changes in population. The NBITWC, together with the cooperation of the Elim, Koyuk, Unalakleet and Shaktoolik, is responsible for overseeing the implementation of the Climate Change Adaptation Plan. In conjunction with the plan, the NBITWC worked to develop a Watershed Assessment of the Tubutulik River. This Watershed Assessment was funded by a 2012 grant from the Alaska Native Fund, as well as the 2012 ANTHC CEDP grant. The NBITWC will use this assessment to apply to EPA for “State” status, which will enable the establishment and enforcement of water quality standards (Murray et al. 2013).

## Appendix D. Climate Adaptation Trainings & Workshops

### *Trainings*

**Signs of the Land I & II: Reaching Arctic Communities Facing Climate Change Academy.** Held in July 2014 & July 2016, Signs of the Land is supported by a collaboration between the Association of Interior Native Educators (AINE), the International Arctic Research Center (IARC) at the University of Alaska Fairbanks and Columbia University, under a grant from the National Science Foundation. Two four-day sessions were held on the Tanana River near Fairbanks. These trainings aimed to educate Alaska Native educators, planners and leaders about climate impacts, provide planning resources and tools, and encourage the sharing of knowledge through dissemination plans. **Link:** <http://www.ainealaska.org>

**ITEP Tribal Climate Change Training.** ITEP offers both in-person training and webinars related to climate adaptation planning. Between 2012 and 2017, ITEP offered 14 adaptation planning-related webinars and five in-person adaptation planning trainings in Alaska and the Pacific Northwest. (Additional trainings outside of these regions were excluded from the literature search.) In-person trainings in Alaska were collaborations between ITEP and the Alaska Native Tribal Health Consortium (ANTHC). The Alaska Tribal Climate Change Webinar Series is supported by the EPA and features different presentations from the University of Oregon, the Department of Energy, BIA and other institutions. In addition to the Tribal Climate Change Webinar Series, ITEP has coordinated other trainings with BIA and the U.S. Geological Survey (USGS) relating to tribal engagement, capacity-building and funding in climate adaptation planning. **Link:** <http://www7.nau.edu/itep/main/tcc/Home/Events>

**Alaska Policy & Climate Adaptation Webinar Series.** Between October 2015 and May 2016, the Alaska Center for Climate Assessment and Policy (ACCAP) and Water Policy Consulting, LLC offered six webinars related to the application of existing policy and indigenous rights to climate change mitigation and adaptation efforts. Webinars included presentations on the tribal management of natural resources, tribal representation in federal and international decision-making and the application of Alaska Native water rights. **Link:** [http://accap.uaf.edu/policy\\_adaptation](http://accap.uaf.edu/policy_adaptation)

**Norton Sound Communities Climate Adaptation Training (NSCCAT).** Between July 2016 and May 2017, the NBITWC and the Native Village of Elim presented a curriculum of webinars, conference calls and in-person meetings designed to support climate risk assessment and adaptation planning in Norton Bay communities. This series of trainings was funded by a 2015 Category 1 award from the BIA. The curriculum was presented by Water Policy Consulting, LLC and representatives from CSU. Monthly educational webinar sessions were supplemented with four face-to-face meetings in Nome, which gave participants the opportunity to hear additional presentations and collaborate with other tribal representatives. The intended final product of the training is “a completed adaptation plan that identifies the local, specific risks to address for each community and

outlines adaptation strategies for future action locally and regionally.” **Link:** <http://www.waterpolicyconsulting.com>

### *Workshops*

**Alaska Tribal Conference on Environmental Management.** The ANTHC Community Environment & Health Department has hosted two conferences (April 2015 and April 2016) in Anchorage. These weeklong workshops are designed to bring together tribes, non-profits and state and federal agencies for a discussion of environmental issues in Alaska Native communities. Both conferences included presentations on community-led adaptation planning and ongoing climate impact monitoring programs (Alaska Native Tribal Health Consortium n.d.). **Link:** <http://www.atcemak.com>

**Alaska Forum on the Environment.** The nonprofit organization The Alaska Forum, Inc., together with an extensive network of partner organizations, sponsors an annual forum in Anchorage. Since its first meeting in 1990, this large gathering of government agencies, non-profit and private businesses, community members and scientists offers educational sessions on a wide variety of environmental topics, including climate adaptation planning and the use of TEK in adaptation efforts. The forum seeks to provide participants with the opportunity to present diverse perspectives and exchange ideas to encourage the solving of complex environmental issues (The Alaska Forum n.d.). **Link:** <http://www.akforum.org/afe/>

**Bering Strait Voices: Vision for Action Summit.** Sponsored by the regional non-profit organization Kawerak Inc. and Pew Charitable Trusts, the October 2016 summit in Nome was a product of a three-year regional effort in response to climate change and increased marine shipping. The summit was the last of three workshops organized by the Kawerak Marine Program to assess the needs of Bering Strait communities. Summit participants from 15 tribes agreed upon a shared vision for the future and outlined advocacy efforts, policies and strategies that will encourage this vision (Kawerak Marine Program 2017). **Link:** <http://www.kawerak.org/marine.html>

**Promoting Coastal Resilience and Adaptation in Arctic Alaska.** Created by a partnership between the Aleutian Pribilof Islands Association (APIA) and Kawerak Inc., Maniilaq, the Qawalangin Tribe of Unalaska, the Bristol Bay Native Association and three Alaskan LCC’s (Aleutian Bering Sea Islands LCC, Western Alaska LCC and Arctic LCC), this project included four workshops in western communities between May and December 2016. These workshops in Nome, Unalaska, King Salmon and Kotzebue brought together partner organizations, resource managers and community members to discuss current efforts to protect coastal resilience. The goal of the workshops was to increase the participants’ understandings of climate impacts and adaptation strategies while also promoting collaboration between stakeholders (Pletnikoff et al. 2017). **Link:** <http://www.northernlatitudes.org/workshop/>

**Rising Voices: Collaborative Science with Indigenous Knowledge for Climate Solutions.** The National Center for Atmospheric Research (NCAR) in Boulder, Colorado

hosts an annual workshop to encourage collaboration on climate issues between indigenous communities nationwide. The workshops bring together community members (including students), physical and social scientists to discuss the impacts of climate change, protection of TEK, opportunities for research partnerships and the development of adaptation and mitigation strategies (NCAR 2015). **Link:** <http://risingvoices.ucar.edu>

**Southeast Alaska Climate Adaptation Summit.** Funded by the North Pacific LCC and held by Central Council of Tlingit and Haida Tribes of Alaska (CCTH), in collaboration with Southeast Alaska Tribal Ocean Research (SEATOR), the two-day workshop took place in Ketchikan, Alaska on September 2016. The 80 participants in the workshop included 30 agency, university and non-profit representatives and 50 representatives from 17 tribes in Southeast Alaska. Group discussions encouraged participants from tribal communities to describe their concerns related to climate change, and also allowed outside stakeholders to share relevant climate science information and resources. The key outcome of the summit was the commitment to encourage future collaboration through long-term activities, such as community-based water monitoring. The workshop also identified a need for a central portal to serve as a “one-stop shop” for communities seeking information on climate change. Additional funding provided by the Aleutian Bering Sea Islands LCC and the Aleutian Pribilof Islands Association will be used to create the Adapt Alaska website, which will have both original content and links to other resources, such as monitoring tools and stories of successful community climate change adaptation.