Metlakatla Indian Community

Climate Change Adaptation

Plan

Prepared for the Metlakatla Indian Community
2017 – 2027

Metlakatla Indian Community
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Forward

By
Karl S. Cook Jr.
Mayor/City Manager of Metlakatla
Tribal Chairman of the Metlakatla Indian Community

The Metlakatla Indian Community has always governed itself to the best of its capability, even going beyond what is required. Those serving the community pursue every opportunity that comes to our attention to expand our control over our government and resources. The Metlakatla Indian Community Climate Change Adaptation Plan, is just one of many strategic plans that exemplify our pursuit for the betterment of the Tribe's future generations. This document will serve as a guide to preserving our resources for food security, traditional practices, and our sovereignty as a strong nation.

This document describes all of our resources, including those that are used for traditional practices and the commercial industries. There are strategies to the adaptations, we as a tribe will have to make in the next ten years while this document is in effect. Those strategies will preserve what is important, without breaking our connection to our ancestors. Throughout this document, we frequently refer to the local T.E.K, or Traditional Ecological Knowledge. This document is an extension of what elders have been observing and adapting to over the generations.

After a year of diligent research and hard work putting the Climate Change Adaptation Plan together, we are excited to begin the implementation of the strategies listed in this document. We will work diligently to find funding to implement the necessary projects to move us forward. Adaptation is our future. We invite the community to embrace these adaptations, thus helping the community to remain healthy and strong, ensuring that future generations will be able to enjoy the resources of Annette Islands Reserve for generations to come.

The land and everything it provides has always been central to our identity. It has been this way for time immemorial. Despite the environmental changes being seen, we will adapt. We are strong and resilient.

Karl S. Cook

Karl S. Cook Jr.
Mayor/City Manager and Tribal Chairman
Metlakatla Indian Community

2-8-18
Date

COUNCIL ANNETTE ISLANDS RESERVE
METLAKATLA INDIAN COMMUNITY

KARL S. COOK, JR., MAYOR
JUDITH A. EATON, SECRETARY
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RESOLUTION #18-08
ESTABLISHED 1887

METLAKATLA INDIAN COMMUNITY

BY THE COUNCIL ANNETTE ISLANDS RESERVE

Metlakatla Indian Community Climate Adaptation Plan 2017-2027

WHEREAS, the Metlakatla Indian Community Council is the governing body of the Metlakatla Indian Community, Annette Islands Reserve, Alaska, by the authority of the Constitution and By-laws of the Metlakatla Indian Community approved on August 23, 1944 by the Secretary of the Interior; and

WHEREAS, the Metlakatla Indian Community is an American Indian Tribe organized pursuant to the provision of Section 16 of the Federal Indian Reorganization Act, 25 U.S.C.; and

WHEREAS, the Metlakatla Indian Community has completed a comprehensive climate adaptation survey and assessment, and developed the Climate Adaptation Plan 2017-2027; and

WHEREAS, the Metlakatla Indian Community, adopts this Climate Adaptation Plan and will work to implement the suggested strategies to mitigate the impacts of a changing climate as related to subsistence food gathering, gardening, food security, sustainability, energy, commercial pursuits and natural resources protection; and

WHEREAS, the Metlakatla Indian Community will pursue Best Management methods to protect our Natural Resources using the Climate Adaptation Plan and will continue to pursue funding, as available, to support applications of the recommended mitigation strategies; and

WHEREAS, the Metlakatla Indian Community will continue to educate the public with information regarding sustainability and our changing climate; and

NOW THEREFORE, LET IT BE RESOLVED, the Metlakatla Indian Community Council adopts the Metlakatla Indian Community Climate Plan 2017-2027.

DATED this 6th Day of February 2018 at Metlakatla, Alaska

METLAKATLA INDIAN COMMUNIITY

Karl S. Cook

Karl S. Cook Jr., Mayor

ATTEST:

Judith Eaton, Executive Secretary

CERTIFICATION

I hereby certify that the foregoing resolution was duly passed at a Council/Executive meeting held on the 6th day of February, 2018 at which a quorum was present by a vote of 11 for and 0 against, the Mayor being authorized to sign said resolution.

Judith Eaton, Executive Secretary

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Metlakatla Indian Community Mission Statement

The mission of the Metlakatla Indian Community is to improve the lives of members, and preserve heritage and culture, through effective self-governance, a commitment to self-sufficiency, and the exercise and strengthening of tribal sovereignty; encouraging the progress while honoring ancestors, and protecting land and water resources for future generations; promoting sustainability by utilizing and respecting natural resources, developing economic and social opportunities for members, and implementing efficient and effective systems of governance to enhance our members' safety, health, and welfare. The Council and tribal executives are dedicated to governing the affairs of the Annette Islands Reserve acting under the authority of the Constitution, ordinances, and policies to fulfill this mission.

Executive Summary

The Metlakatla Indian Community Climate Change Adaptation Plan was composed to provide support to the Metlakatla Indian Community as they are impacted by a changing climate on the Annette Islands Reserve (AIR). Throughout this document the Metlakatla Indian Community will be referred to as "the Tribe", this term will be used to describe the entire Metlakatla Indian Community. The Tribe acknowledges the changing climate and advocates addressing the potential effects through the integration of Traditional Ecological Knowledge (TEK) and scientific evidence. This document will include the background on the AIR, local interviews on TEK, resource analysis, vulnerability assessment, and potential adaptation strategies to assist the Tribe in preparation for a changing climate.

A changing climate is of global concern, but for the purpose of this document the main focus will remain directly on the AIR. The Tribe has compiled specific evidence in assisting the determination of climatic forces on the community. The intended goal of this plan is to align the Tribe's cultural, economic, environmental, recreational, and social demands through a Climate Change Adaptation Plan. With the use of TEK and scientific evidence the Tribe is able to prepare for potential climatic impacts on the AIR through recommended adaptation strategies. This document will promote conservation, preservation, and sustainability for the future of the Tribe's resources. Definitive tasks will be provided to meet the objectives of the plan; such as scoping vulnerabilities, investigative technical work, mapping, analyzing resource risks, identifying potential impacts, evaluating data, developing strategies, and considering futuristic adaptation options. A variety of strategies must be developed to cope with a changing climate due to a high level of uncertainty. This Climate Change Adaptation Plan will prepare the Tribe for a changing climate and assurance that local resources are the preserved.

Alaska's Climate is Changing

- Spring is arriving earlier
- Vegetation is budding sooner
- Growing seasons are becoming longer
- Invasive species are establishing themselves
- Species migrations are being altered
- Precipitation patterns are shifting
- Severe storms are occurring more frequently
- Shoreline erosion is causing infrastructure damage and habitat destruction
- Ocean chemistry is being altered impacting subsistence practices

Why plan for adaptation now? The AIR is a highly advanced rural community, and environmental distress is currently being felt. Developing efficient adaptation strategies will allow for a more effective and less expensive option to protect a sustainable and consistent lifestyle for the Tribe. Proactive planning will aid in the mitigation or lessen the potential impacts of a changing climate on the Tribe.

Vulnerabilities being addressed

- Coastal Erosion
- Invasive Species
- Salmon
- Shifting Precipitation Patterns
- Overall Subsistence Practices including Yellow Cedar, Berries, and Shellfish
- Human Health

The AIR is located on the western coast of Southeast Alaska, making it susceptible to severe weather events. Natural resource assets are appearing to be affected due to an evolving climate, particularly drastic changes are occurring alongside ecological thresholds. Various cultural resources will be altered and/or lost, which will directly affect the Tribe's traditional practices. Abrupt environmental changes will result in both direct and indirect impacts on cultural, commercial, environmental, recreational, and social practices. There are multiple alternatives in reducing such impacts; these will be discussed in later sections (Page 62). Listed below are the Community's priorities that will allow for a stable framework and an effective adaptation plan to be implemented.

Metlakatla Indian Community Priorities

- Preserve traditional lifestyle
- Protect natural resources
- Ensure the continuation of local subsistence practices
- Conserve natural ecosystems
- Provide community education
- Establish efficient management practices
- Secure cultural, economic, environmental, recreational, and social opportunities
- Integrate TEK with scientific knowledge to further connections for a holistic plan

- Develop adaptations to existing and potential conditions adaptations for future plans
- Consolidate management practices into future plans

This Climate Change Adaptation Plan identifies the Tribe's goals to address short and long term challenges posed by a changing climate on the AIR. An ambitious timeline holds the Tribe to a standard in developing adaptations and will encourage the development of those standards into actions. The primary goal of adaptation is resiliency. Resiliency maintains the Tribe's path towards achieving successful adaptation goals. This document will provide guidance for the Tribe through implementation of climate change adaptation strategies.

Climate Change Adaptation Target Dates

- Following Year 1
  - Update vulnerability status
  - Revise assessments
  - Input new available data
- Following Year 5
  - Re-evaluate vulnerabilities and assessments
  - Update new available data
- Following Year 10
  - Update plan completely

The intention of this document is to cover a ten year period from 2017 to 2027. Following ten years, it will be necessary for the Tribe to reevaluate and assess adaptation strategies. Climate change adaptation practices must be integrated into the Tribe's management plans, specifically the following: Land Use and Community Development Plan (2017), Forest Management Plan (in draft, final review to be completed in 2018, Fisheries Management Plan (annual), Invasive Species Environmental Assessment (2017), Invasive Species Management Plan (2017), Strategic Energy Plan (2017), and the Community Strategic Plan (2016).

Not all change is necessarily destructive, change may also be beneficial. It is paramount to keep an open mind, while recognizing that all future climatic impacts will be affected by the decisions made today.

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Section 1

Section 1: Introduction

The Metlakatla Indian Community (MIC or Tribe) is on the only Federally recognized Indian Reserve in the State of Alaska, located on the Annette Islands Reserve (AIR). The Secretary of Interior recognized the AIR by the authority of the Constitution and By-laws of the MIC as approved on August 23, 1944. The MIC is a Federally recognized Indian Tribe established under Provisions Section 16 of the 1971 Indian Reorganization Act. 25, U.S.C Section 476. Delegations from the Secretary of Interior have responsibility to the MIC to prescribe rules and regulations governing use of the AIR. Every governance decision is decided by a Tribal Council of twelve elected individuals and three executives.

The Reserve covers approximately 132, 332 acres of land and has a 3, 000 foot water boundary at Mean Low Water (MLW). The Metlakatla Indian Community is located 16 miles south of the nearest hub, Ketchikan, Alaska and 700 miles north of Seattle, Washington. The AIR has a maritime coastal climate consisting of cool winters and mild summers. The region is classified as a temperate rainforest, therefore rainfall is prevalent, with an average of 105 inches per year and snowfall with an average of 41 inches per year. Analysis of the National Oceanic and Atmospheric Administration (NOAA) data and communication with local residents acknowledge that climate change is affecting the coastal region of Metlakatla, Alaska and its 1, 460 residents[1].

[1] American FactFinder - Community Facts. (2010).

Figure 1-1: Photographic Mosaic of Annette Island Reserve, Metlakatla, Alaska.

1.1 Background

The Background Profile of Metlakatla Indian Community and the Annette Islands Reserve will be specified below. Section 1.2 on the AIR will provide information covering Climate, Terrain, Vegetation, Water, and Wildlife and Section 1.3 on the MIC Profile will include descriptions on Demographics, Culture, and Economy.

1.2 Annette Islands Reserve

The Annette Islands Reserve is located in the southern region of the Alexander Archipelago of Southeast Alaska. The island is measured at approximately 200 square miles. The AIR lies approximately 900 miles southeast of Anchorage, Alaska and 700 miles northwest of Seattle, Washington. To the northwest, Ketchikan, Alaska is the closest community to the AIR.

Figure 1-2: State of Alaska Map, Southeast Alaska is circled in red. Location of Metlakatla is found at the far southern portion of the map, southeast of the red circle. (Source: Google).

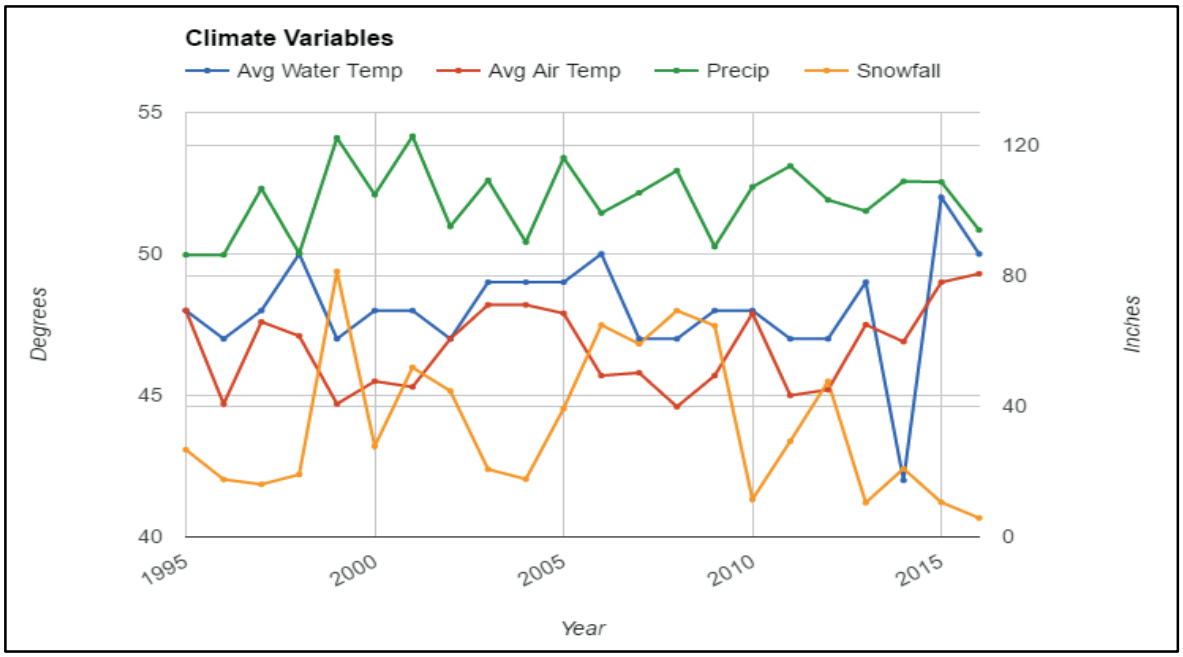
The Metlakatla Peninsula has an area of approximately eight miles long by three miles wide. The town of Metlakatla is located on the southwestern portion of Annette Island. All sides of Annette Island are bordered by saltwater bodies; Revillagigedo Channel the north, Felice Strait to the east, Clarence Strait to the south, and Nichols Passage to the west.

1.2.1 Climate

The Metlakatla Peninsula is characterized by its temperate maritime coastal climate, this is fairly typical for Southeast Alaska. The seasonal climate consists of moderately warm summers and cool winters, with ample precipitation. Average precipitation rates for this location are recorded at approximately 105 inches of rainfall and 41 inches of snowfall annually[2]. Summer temperatures (June-August) average around 63ºF, while winter temperatures (December-February) average around 36°F. The AIR experiences significant seasonal variations each year with cloud cover. The months of April through September is considered the clearer portion of the year, with clear, mostly clear, or partly cloudy measurements around 44 percent and mostly cloudy, or overcast around 56 percent. Although the cloudier portion of the year begins in mid-September and lasts until late April, records represent that overcast weather occurs

[2] XmACIS2. (2017).

approximately 78 percent and mostly clear, or partly cloudy 22 percent of the time[3]. Across Southeast Alaska, wind flow is mainly controlled by the region's rugged terrain, direction and speed of the wind. The mean wind speed is approximately nine miles per hour (MPH) with mean wind gusts recorded around 24 mph; both blowing from west-southwest to south-southeast.[4]There are about six months of consistent wind. Annual wind speeds average approximately nine mph and average wind gusts are reported at approximately 20 mph. January is considered the windiest month on the AIR, with severe winter storms bringing high velocity winds clocking over 100 mph[5].



Graph 1-0: Climate Variables of Annette Islands. Representing Average water temperatures, average air temperatures, average precipitation, and average snowfall from 1995-2016.

1.2.2 Geography

The Metlakatla Peninsula is fairly flat, lying just above sea level and 100 feet over Mean Sea Level (MSL). Approximately two miles outside of town, Yellow Hill is measured to be the highest point on the peninsula at 540 feet MSL (Figure 1-3 below). There, slopes range from 25 to 42 percent and merge downhill into the surrounding muskeg areas. The Metlakatla Peninsula has slopes ranging between zero to one percent from the interior of the island to the coast. There are various lakes, marshes, and bogs found throughout the peninsula as well.

[3] Weatherspark: Average Weather in Metlakatla. (2016, December).
[4] Windfinder. (2014).
[5] Weather Underground: Historical Weather. (2017).

Figure 1-3: Yellow Hill is found two miles outside of town and is measured to be the highest point on the peninsula (Left). A view of the Metlakatla Peninsula from the adjacent Crow Island, 4,764.5 feet out from the community's shoreline (Right). The town is low lying surrounded by mountain and muskeg terrain. (Photographer: Julia Scott).

1.2.3 Geology[6]

The geology of Southeast Alaska can be categorized into bedrock and surficial deposits. Due to past erosion, once covered bedrock found deep within the Earth's crust and deposited onto the seafloor was uplifted and exposed; leaving the Metlakatla Peninsula occupied by many muskegs and surficial deposits. The most aged rocks found on the mainland are *Silurian* (430 million years ago), mainly found on the north and south-central regions of the island. These rocks were formed through metamorphosed volcanic, sedimentary rocks arranged in between various mineral strata.

The Cretaceous Period (65-135 million years ago) was described by its warm and lush climate, with active advancement of land masses. During the onset of the Pleistocene Epoch (1 million-11, 000 years ago) there was a rapid shift in climatic conditions. The Pleistocene is considered the most recent glacial period due to its extensive continental glacial forces (Figure 1-3 below). At this time the climate was cool and moist as glaciers were expanding, the AIR was covered by an ice sheet (with the possible exception of Tamgas Mountain peak). As the glaciers retreated, valleys were scoured leaving behind glacial till deposits. Ice, water, and gravity acting upon geological processes over many centuries resulted in the evident landscape of the AIR today.

[6] Richeson, J., & Steinbrenner, E. (1980). *Soil Survey of the Annette Islands Reserve*.

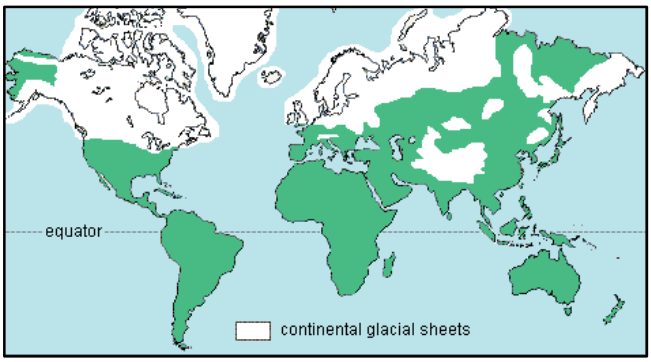


Figure 1-4: The major continental glacial extent at the height of the last glacial period, approximately 20, 000 years ago. It is estimated that 27 percent of the Earth's surface was covered by ice, displayed in white.
(Source: The University of Southampton, England).

The AIR's landscape now consists of fairly deep, well drained, fertile soils resulting from prior glacial activity. Approximately 40 percent of the AIR's land is considered non-productive due to its abundant muskeg and rock outcrops. As the variable landscape was depicted from coastal to mountainous landforms, four main associations of soil emerged. (Table 1-4, Below).

Table 1-1: Soil Association Summary[7]

Soil Association	Soil Type	Description	Landform	Acres	Percent	Parent Material	Texture
Bingo	Organic	Three types Gentle slope Sea level to 500 ft. 110-140 in. rainfall	Scoured Glacial Area	15, 701	18 %	Granite Rocks	Sedge Muck
Tolstoi	Mineral	Two types Interior Most extensive 500 to 2, 500 ft. 120-150 in. rainfall	Mountain Slope	27, 012	31%	Granite Rocks	Gravelly Loam
Annette	Mineral	Two types Moderate slope 400-1, 500 ft. 110-150 in. rainfall	Mountain Slope	3, 863	4 %	Glacial Till	Gravelly Loam

[7] Richeson, J., & Steinbrenner, E. (1980). *Soil Survey of the Annette Islands Reserve*.

Nadzaheen	Mineral	One type Lower elevations Well-drained 100-1, 200 ft. 110-150 in. rainfall	Mountain Slope	4, 848	6 %	Glacial Till	Gravelly Sandy Loam

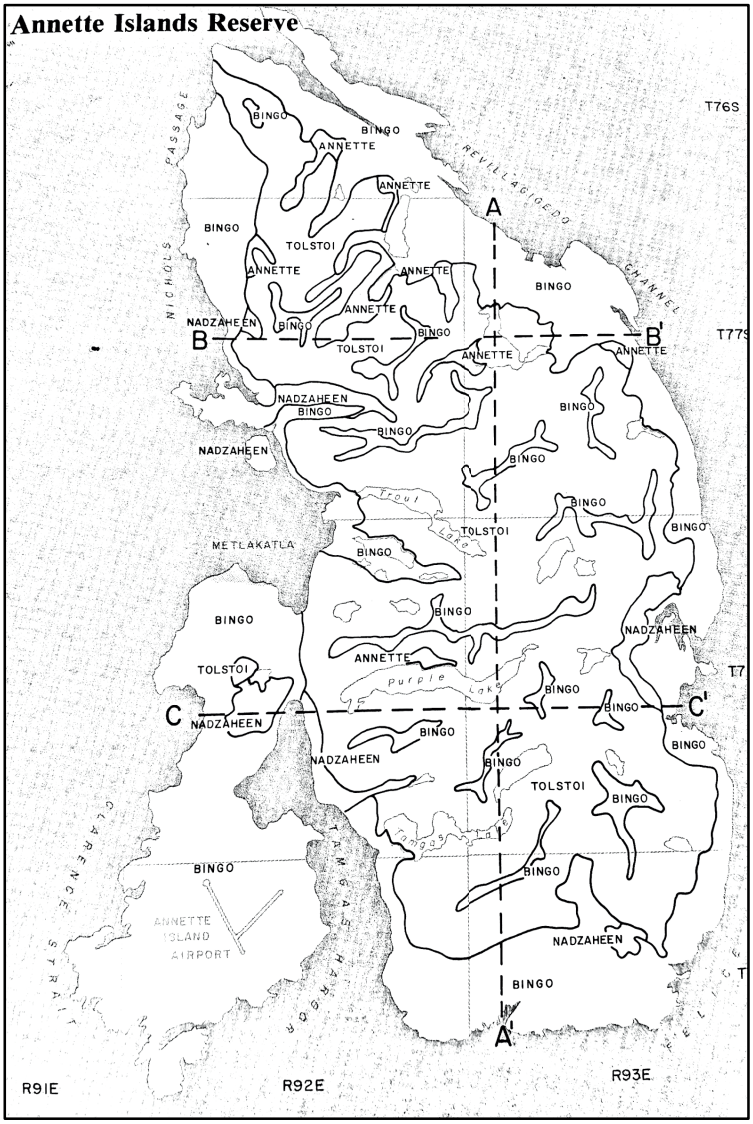


Figure 1-5: Soil Association Map of the AIR. (Source: J. Richeson & E Steinbrenner)

1.2.4 Vegetation

The vegetation on the AIR is classified into four wetland communities: coastal, coastal forest, meadows, and muskeg[8]. Alaskan vegetation is primarily influenced by the ocean's tide; coastal meadows allow for high salinity concentrations in the surrounding air. Soils found within Muskeg areas are composed of peat, giving them the name peat bogs. Peat is formed through plant material which is not fully decayed, with large accumulations of organic material hosting a variety of vegetation. Meadows are characterized by their flat terrain dominated by grasses such as Lindbye's sedge, tufted hair-grass, and silverweed. Coastal forests outline the perimeter of the island, but are also found within the interior.

Alaskan Yellow Cedar, Sitka Spruce, Western Red Cedar, and Western Hemlock are the assorted tree species that dominate the Metlakatla Peninsula. Understory vegetation species include Devil's Club; Huckleberry; Salmonberry; Salal; Thimbleberry; Wild Cranberry; and Wild Rose, which are generally used for subsistence purposes. There are numerous other species, from ferns and mosses to lichens. Familiar shrubs on the AIR consist of Bog Rosemary, Crabapple, Salal, and Labrador Tea (also known as Hudson Bay Tea). Low lying vegetation such as Skunk Cabbage, Sedges, and many other forbs thrive in this environment as well.

1.2.5 Water

There are two lakes of significant importance to the Tribe, Chester and Purple Lake. The Tribe's potable water source is collected from Chester Lake. This lake is measured at approximately 42 acres and is located two miles out of town[9]. Lying at a higher elevation than most of the Metlakatla Peninsula, Chester Lake allows the town to collect quality water through gravity. It is estimated that the Tribe consumes approximately 1, 000, 000 gallons of water each day for both municipal use and hydropower generation. The Tribe uses Purple Lake exclusively for hydropower. Purple Lake has a measured area of approximately 840 acres with a drainage area of 6.2 square miles.

1.2.6 Wildlife

Wildlife inhabitants of the AIR include beaver, Sitka black-tailed deer, wolves and other small mammals[10] such as American Minks and land otters. Recent evidence suggests the presence of resident black bear, which will be further evaluated by wildlife management staff. There are many avian species including American Bald Eagle, Blue Heron, Grouse, Hawks, Osprey, Owls, Ptarmigan, and numerous species of Waterfowl.

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8 *Comprehensive Development Plan* (Publication). (1972). Metlakatla Indian Community.

9 *Comprehensive Development Plan* (Publication). (1972). Metlakatla Indian Community.

10 *Comprehensive Development Plan* (Publication). (1972). Metlakatla Indian Community.

Figure 1-6: Metlakatla Wildlife. (Top Left) Bald Eagle, (Top Middle) American Mink, (Top Right) Grouse, and (Bottom) Sitka black-tailed deer.
(Photographer: April Atkinson).

When speaking of the surrounding waters of AIR, it is appropriate to discuss the commercial and subsistence fisheries management of resources. There are five commercial fisheries currently being conducted on the AIR which are listed below.

Five Commercial Fisheries of the AIR

- Salmon
  - King (*Oncorhynchus tshawytscha*)
  - Sockeye (*Oncorhynchus nerka*)
  - Coho (*Oncorhynchus kisutch*)
  - Chum (*Oncorhynchus keta*)
  - Pink (*Oncorhynchus gorbuscha*)
- Groundfish
  - Halibut (*Hippoglossus stenolepis*)
  - Rockfish (*Sebastes sp.*)
  - Pacific Cod (*Gadus macrocephalus*)
  - Lingcod (*Ophiodon elongatus*)
- Herring (*Clupea pallasii*)
- Sea Cucumber (*Parastichopus californicus*)
  - Dive fishery
- Geoduck (*Panope abrupta*)
  - Dive fishery

Of the following commercial fisheries harvested each year, the salmon fishery is the most valuable to the Tribe. It is the heart of the Tsimshian culture tracing back through the Reserve's history, both in terms of its ex-vessel value and its economic importance.

1.3 Metlakatla Indian Community Profile

The Metlakatla Indian Community is a Federally recognized Tribe residing on the Annette Islands Reserve (AIR) in Southeast Alaska, located between the Clarence Strait and the Revillagigedo Channel. This location is in what is known as the "Inside Passage" and is found at the southern tip of the Alexander Archipelago. The AIR has a total of 132, 332 acres of land. In 1891, an Act of Congress created the Annette Islands Reserve, setting aside land for the Tsimshian Indians. If permitted to become a tribal member, other Alaskan Natives may use the land as well. The AIR's perimeter was increased in 1916 by the Presidential Proclamation. This expanded the Reserve's water boundary to a total distance of 3, 000 feet at MLW, with the intent of supplying subsistence resources to the Tribe. All of the land located on the AIR is held in trust status for tribal members. The Metlakatla Indian Community operates under a Constitution approved by the Secretary of Interior. Every governance decision is decided by a Tribal Council of twelve elected individuals and three executives. As of 2016, the Tribe had 641 adult voting members and 2, 425 enrolled members, half of whom currently reside on the island.

1.3.1 Culture

The Tsimshian Tribe of the Metlakatla Indian Community is located on the Annette Islands Reserve (AIR). The Tribe chose not to participate in the Alaska Native Claims Settlement Act of 1971, maintaining their sovereignty. Therefore, all 132, 332 acres of the Indian Reserve, plus the surrounding water boundary are locally managed by the Tribe. This territory is not subject to state jurisdiction and the Tribe's commercial fishing industry operates within the boundary. The traditions of the Tsimshian People rely heavily upon a subsistence lifestyle.

Figure 1-7: Painting of the First Nations traveling through rough seas in a Yellow Cedar carved canoe from British Columbia, Canada to their new home in Southeast Alaska, Metlakatla.

1.3.2 Demographics

According to the 2010 U.S. Census, the AIR had an estimated population of 1, 661 residents in 2015[11] and approximately a total of 528 households. The median age for both male and female is 34 years old. Since the year of 2000, the population has grown slightly less than 1 percent per year.

1.3.3 Economy

The economy of Metlakatla is predominantly dependent on its fishing industry; residents rely on fish for income and subsistence. The Tribe has employees operating a local hatchery, tribal court, and other services. Under the U.S. Department of Agriculture (USDA), the Metlakatla Indian Community has been named an enterprise community due to its status of Federal Indian Reserve. The Tribe has no local taxes.

[11] 2015 Population ACS 5-Year Population Estimate. (2010, October).

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Section 2

Section 2: Culture

2.1 History of the Tribe

Before "New Metlakatla" was established, the Tsimshian people who relocated to Annette Islands were previously living in British Columbia, Canada. William Duncan was commissioned from the Church of England as an Anglican Missionary, who served in northern British Columbia, due to the growing tensions among the Fort Simpson tribes. The Hudson Bay Company established Fort Simpson and wanted a missionary to Christianize the "savage Indians". When Mr. Duncan arrived, he recognized the unhealthy influences in the region and moved his converts to an ancient Tsimshian winter village near Prince Rupert, Canada. Later on, this would come to be known as the first Metlakatla. As land claims began to develop between Metlakatla, British Columbia and the Church of England, the Church decided to lay claim to the Tsimshian territories. William Duncan sought out the assistance of United States President Grover Cleveland, seeking new residence for those who followed him. Annette Island, located in Southeast Alaska then became home to Tsimshian individuals who made the journey across the Dixon Entrance, designating "New Metlakatla".

Figure 2-1: Historical aerial photograph of Metlakatla, Alaska. (Photographer unknown).

In 1887, 826 Tsimshian People departed from British Columbia, Canada in wooden canoes bound for Annette Island of Southeast Alaska. Upon arrival, a grid-style layout was pursued for the "New" Metlakatla settlement. August 7th, 1887 marked the official birth of "New" Metlakatla. Longhouses were no longer acceptable living quarters, and instead, nuclear family styled homes were built. The Tsimshian People were self-sufficient in their new home. A saw mill, church, cannery, carpentry shop, and boardwalks were immediately constructed. In 1891, the United States Congress established the Annette Islands Reserve for the exclusive use

of Tsimshian tribal members. In 1944, the Metlakatla Indian Community was officially designated as a Federally Recognized Tribe, under the Indian Reorganization Act. The Annette Islands Reserve is the only Federal Reserve in Alaska due to the decision of opting out of the Alaska Native Claims Settlement Act to maintain tribal sovereignty.

Figure 2-2: Historical photograph from 1887 displaying the Tsimshian Tribe's first winter on the Annette Islands (Photographer unknown).

2.2 Cultural Resilience

Cultural resilience refers to the capacity of individuals within a community maintaining and practicing their own culture and traditions. Resilience is the capacity to recover after hard times, while culture can be defined as a group of individuals that share the same values, customs, and traditions. In the past, individuals were familiar with gardening and specializing in edible plants. Trade between individuals diversified food options, thus contributing to the overall holistic approach of community wellness. Understanding traditional culture strengthens community resilience, allowing for adaptation of current challenges such as a changing climate to occur. During a time of great uncertainty, it is imperative to conform to abrupt environmental changes. The Tsimshian people are intrinsically connected to the land and sea. They sustain their traditional lifestyle by monitoring natural cues of the local environment. The Tsimshian are aware of the natural changes occurring in this community; such insight aides the Tribe to truly understand their environment. Table 2-1 (Below) represents anecdotal information supporting environmental Tsimshian Traditional Indicators, specifically referring to the impacts from potlatches and feasts, food security, and the communication of TEK. The descriptive comments within the table explain observations that local community members have witnessed throughout their lifetime.

Table 2-1: Tsimshian Traditional Indicators	
Potlatches and Feast Impacts	
Feasts	● Residents are witnessing less harvestable seaweed in surrounding waters ● Shellfish cannot be shared/traded due to high level of PST ● Offset timing of berry harvest has weakened jam giving ● The use of nontraditional foods is occurring due to lacking cultural foods
Natural Connections	● Bringing the families together ● Natural world is a living thing ● Giving thanks for food
Security of Food	
Food Availability	● Less edible shellfish due to PST ● Less locations on the island to harvest
Food Timing	● Spring is arriving earlier ● Vegetation is blooming earlier (salmonberries, fireweed, etc.) ● Harvesting times are not aligning with "traditional" harvesting ○ For example, the seaweed harvest window is becoming earlier and shorter than previous years
Traditional Knowledge Communication	
Youth	● Metlakatla youth are uninformed/unaware of the traditions ● Youth must be taught because they are the future ● They will receive and respect cultural knowledge
Elders	● Elders preserve cultural knowledge ● Elders are the teachers of tradition ● They are the knowledge keepers who are well respected

2.3 Indigenous Plants

Gathering food and medicine is a vital aspect of this Tribe's traditions because it is the foundation of the Tsimshian Peoples identity. Through harvesting protocols and trade relations, kinship ties are reinforced. Great care must be put into the consideration of maintaining sensitive systems through protecting natural resources and ensuring that there will be plenty for future generations. The Tsimshian foods and medicines reflect their epistemology, the way one relates to another and the land that is lived on, resulting in a living connection to the Earth. It also serves as a reminder that no individual should be separated from nature. Table 2-2 (Below) includes examples of how key components of Tsimshian culture reflect the land, foods, and medicines.

Figure 2-3: The 2013 Tsimshian Harvesting Class offered in Spring. Mr. Gavin Hudson singing songs while harvesting berries (Left)and Tia Atkinson harvesting Licorice Fern Root (Right). (Photographer: Naomi Leask).

Table 2-2: Traditional Tsimshian Plants[12]			
Sm'algyax Name	**English/Common Name**	**Scientific Name**	**Uses**
Smmaay	Blueberry	*Vaccinium uliginosum*	Food, fresh, dried, & preserve
mihaał	Dwarf/Mountain Blueberry	*Vaccinium caespitosum*	Same as above
wüłeexs	Huckleberry	*Vaccinium parvifolium*	Same as above
ts'e'ex	Cloudberry	*Rubus chamaemorus*	Same as above
maayag̲a̲lipliip	Thunderberry (Twisted Stalk, watermelon berry)	*Streptopus amplexifolius*	Berries eaten fresh, New shoots eaten fresh
waakyil	Grey Currant, Grey Gooseberry, Red Flowering Currant	*Ribes sanguineum*	Food fresh, dried, & preserved
k̲'oo	Thimbleberries	*Rubus parviflorus*	Same as above
ma̲g̲ooxs	Salmonberry	*Rubus spectabilis*	Same as above
Ooył	Salmonberry sprout/shoot	-	Peeled & eaten fresh, Keeps body cool

[12] Leask, N. (2016, November). Cultural Climate Interview [Personal interview].

k̲'a̲pk̲'oop	Bunchberry, Pigeon Berry, Dwarf dogwood	*Cornus canadensis*	Berry cake thickening agent to make pliable
dza̲was (plant or berry) sga̲n dza̲'was (foliage)	Laughing berry, salal berry	*Gaultheria shallon*	Berries eaten fresh, Branches used as a whisk
k̲'a̲laamst	Rose Hips	*Rosa gymnocrapa*	Eaten fresh or preserved, Do not eat insides
Maaym k̲'awk̲'aw	Crowberry	*Empetrum nigrum*	Used to quench thirst
moolks	Crabapple	*Malus fusca*	Moolks are really ripe in the late fall and before Christmas, At this time they are brown with liquid inside, People take moolks after supper to keep away colds Mixed w/K'awtsii to make guweex
da̲hdee	Lowbush Cranberry, Bog Cranberry	*Oxycoccus oxycoccos*	Food, fresh, dried, & preserved
łaaya	Highbush Cranberry	*Viburnum edule*	Same as above
Haas	Fireweed	*Epilobium angustifolium*	*Pith:* Can be eaten fresh or used as a natural sweetene,. *Cotton:* Mixed w/ weaving materials for padding, *Outer layer:* Nets, twine, whisk for soapberries (yel'as), *Shoots:* Eaten fresh, *Leaves:* Eaten like any other greens or made into tonic
Miiya ma̲m	Sword Fern	*Polystichum munitum*	Roots are roasted then eaten
Maadzüga̲'aam	Licorice Fern Root	*Polypodium glycyrrhiza*	Root pieces can be chewed to soothe sore throat
Aa	Fern roots; edible root; medicine root	*Dryopteris expansa* or *Dryopteris felix-mas*	Roots come in a globe, Each segment looks like a little banana, You boil the globe, pull apart the segments, & mix them with grease & sugar before eating,

			This can also be used as an antidote for food poisoning
Maw̲an	Horsetail	*Equisetum arvense, E. hyemale, or E. telmateia*	Can be used for water collection
Steti	Stinging Nettle	*Urtica dioica*	Sprouts are eaten as a tonic, Fiber is used for making twine & fishing nets
Nag̲ag̲anaw	Lungwort; Lichen; "Frog's Dress"	*Lobaria pulmonaria*	Boil lungwort and use it (tonic) as medicine for sore throats
Bil̲ax	Moss	*Bryophytes* (various)	The type of moss where lowbush cranberries, crowberries, & cloudberries are found, Used in earth ovens
Wooms	Devils Club	*Oplopanax horridus*	Medicine
L̲axsa'n̲ax'nox	Juniper	*Juniperus communis*	Medicine
N̲a maasa sa'mn Or Ksiu	Spruce bark	*Picea sitchensis* (tree)	Spruce bark is used for medicine & berry cakes
Sginiist	Pitch from inner spruce	-	Pitch from center can be eaten after boiled, pink gum chewed w/o boiling first (like chewing gum). Used as medicine
Sganmgan	Jackpine sap	-	Medicine/ointment
Naga laxsa sginiis	Pine needles	-	Medicine to heal internal problems
N̲a maas̲a luwi	Alder bark	-	Medicine, Dye for cedar bark
N̲amaas̲agyiik	Hemlock bark (inner)	-	Eaten in berry cakes (fresh or preserved)
N̲a maasa amg̲an	Red Cedar bark	*Thuja plicata*	Weaving
Amgan	Red Cedar		
G̲alaaẅ	Young Red Cedar (larger than a sapling)		Weaving, Rope
Wał	Yellow Cedar	*Chamaecyparis nootkatensis*	"Needles" are pinched off, pounded & mixed w/

			Jackpine sap and used as ointment for wounds
Gyiims	Teased/shredded cedar bark, cedar cotton	-	Diaper material, Fire starter
Sahakwdak	Yew wood/tree	*Taxus brevifolia*	Medicine
K'wila̲'ma̲xs Halaxsanaxnox (Plant or entire bush)	Hudson Bay Tea	*Ledum groenlandicum*	Medicine
‘Wnagm w'na̲x	Skunk Cabbage Leaves	*Lysichiton americanum*	Solely for cooking or preserving, Not to be consumed
P'iins	Cow Parsnip/ Indian Celery *(Male)*	*Heracleum lanatum*	Young plants eaten
Layoon	Cow Parsnip/Indian Celery *(Female)*		Mature plants eaten
Legi	Eel Grass	*Zostera marina*	A very 'hairy' seaweed used to collect xs'waanx (herring eggs)
P’aatsah	Rockweed, Popweed, focus algae	*Fucus gairdneri*	Eaten fresh in spring time, used for wounds, Used in earth ovens
Gyoos	Kelp	*Macrocystis integrifolia*	A flat-leaf kelp used to collect xs'waanx (herring eggs), Also refers to roe-on-kelp for some speakers
Mook̲	Bull Kelp	*Nereocystis luetkeana*	Eaten fresh, Used for earth ovens & food storage (K’awtsii), Musical instrument
ła'ask	Black Seaweed	*Porphyra abbottiae* or *Enteromorpha intestinalis*	Eaten fresh or dried for storage
Huułens	Poison root, false hellbore	*Veratrum viride*	Medicine **Solely for external use**
Miyuubmgyet	Wild Rice	*Frittilaria camchatcensis*	Boiled or steamed, Used as rice
Lo'ots	Elderberries	*Sambucus racemorsa*	Medicine

A changing climate is affecting local growth cycles of traditional foods and medicines by increasing/decreasing the harvestable abundance and availability, resulting in negative

consequences on the Tribe. For example, each year for the past five years, the harvest window of seaweed has been arriving earlier and is shorter. Multiple members rely heavily on the Gregorian calendar system (and do not use environmental markers), for some Tribal members this has resulted in the missing of seaweed harvest. An interview respondent specifically noted that they have had to adjust their time tables based on the transition in harvest times[13]. Another interviewee stated that "the timing for harvesting is difficult to get correct"[14]. On the AIR, the harvestable Black Seaweed (*Porphyra abbottiae*) generally has two growing seasons, one modest growth around late January and another more abundant growth period that occurs in late May to early June. The changing climate has resulted in the seaweed harvest window becoming shorter and scarce on the AIR. The impact of the scarcity of subsistence has caused two specific barriers to occur. First, it has forced members to harvest from locations that are further away, which increases necessary time travel. Secondly, it has made traveling a hazardous risk, as it requires travel into Clarence Strait as well as the open ocean at the southern region of Prince of Wales Island, in Southeast Alaska. Small-scale fluctuations in local air and water temperatures have posed a significant influence on subsistence harvesting on the AIR. Marine and terrestrial habitats are extensively transforming due to climate change placing subsistence customs at high risk, stressing subsistence lifestyles and posing significant cultural challenges.

Table 2-3: Traditional Tsimshian Calendar Harvest Months[15]

Sm'algyax Word	*English Equivalent*	*Literal Translation*
Ha'lil̲ax six'ẅa̲h	March	Time for harvesting eulachans/oolichans
Ha'lil̲ax sixs'waanx	April	Time for gathering herring eggs
Ha'li'l̲ax siła'a̲sk	May	Time for gathering seaweed
Names of Tribes & Villages		
Sm'algyax Word	*English Equivalent*	*Literal Translation*
Gispaxlo'ots	-	The "people of the place where elderberries are consumed"
Gitwilgyots	-	The "people of the kelp"
Lax Kw'alaams	Formally known as Port Simpson	Where the wild rose bushes grow, On the rose bushes

2.4 Tsimshian Cultural Interviews

The consequences of a changing climate are directly impacting cultural traditions of the Tsimshian Tribe. Such alterations will continue to affect cultural events and practices, thus, defining what changes occur and how they relate to adaptation must be distinguished. This is key in achieving cultural resilience and aiding the preservation of the Tsimshian lifestyle. To better understand how climatic impacts are challenging the Tsimshian culture, the Tribe has conducted interviews with the local residents of Metlakatla. These interviews were key to gathering insight

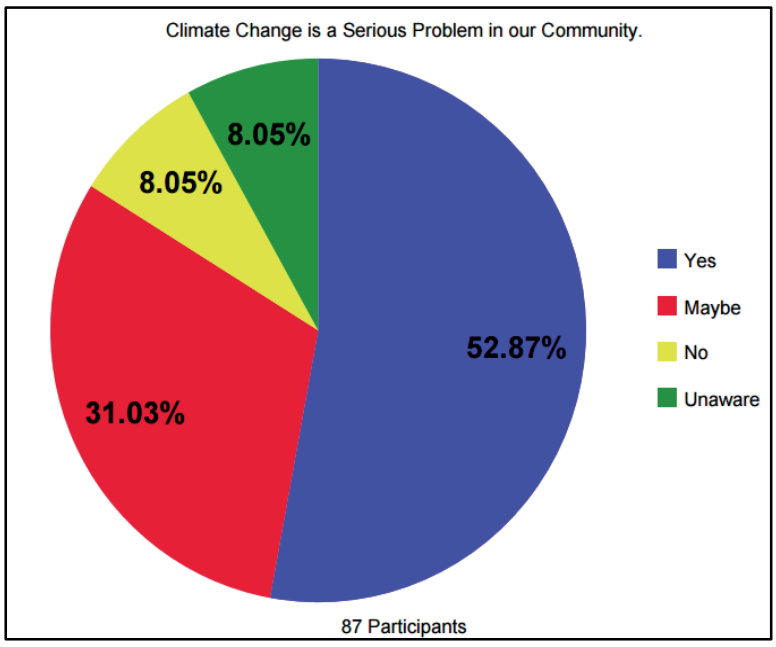
[13] Janes, R. (2016, November). Cultural Climate Interview [Personal interview].
[14] Leask, J. (2017, February). Cultural Climate Interview [Personal interview].
[15] Leask, N. (2016, November). Cultural Climate Interview [Personal interview].

from community members, while ensuring they have input and contribute to the formation of this Climate Change Adaptation Plan. At the beginning of each interview, individuals were asked about their personal views on a changing climate and whether or not they have witnessed specific environmental changes in recent years. The following subsections contain a summary of all the responses received during local interviews. There were six categories of questions: Climate, Coastal, Vegetation and Wildlife, Traditional, and a set of broad questions related to the Tsimshian lifestyle. The last subsection concludes the "Cultural Interview" chapter by offering advice to future generations received from local residents.

Note, all responses below are brief summaries on local observations which are based on TEK, rather than scientific facts.

2.4.1 Climate

Environmental markers are fundamental in a subsistence lifestyle. This is imperative in determining local harvest times. Among all the interviewed participants, in recent years, a changing climate has been observed on the AIR. There were multiple observations of less precipitation and warming temperatures. Spring was noted as arriving a few weeks earlier each year, typically arriving towards the conclusion of March to early April. According to nine survey respondents, who are community harvesters, Spring arrived during early March in 2016. Community members trust natural cues to subsist, for example, the highly variable Spring weather is the environmental marker of the potential arrival of herring. Tribal members stated that the first frost is occurring later than usual, recently it has been observed as arriving as late as November (2016). The overall climate of the AIR has warmed, this has resulted in less snowpack, with consequences such as the reduction of resilience in local water bodies and vegetation.



Graph 2-1: The question, is climate change a serious problem in our community was asked to 87 participants, the responses are presented in a pie chart. The color blue symbolizes "yes", red symbolizes "maybe", yellow symbolizes "no", and green symbolizes "unaware".

2.4.2 Vegetation & Wildlife

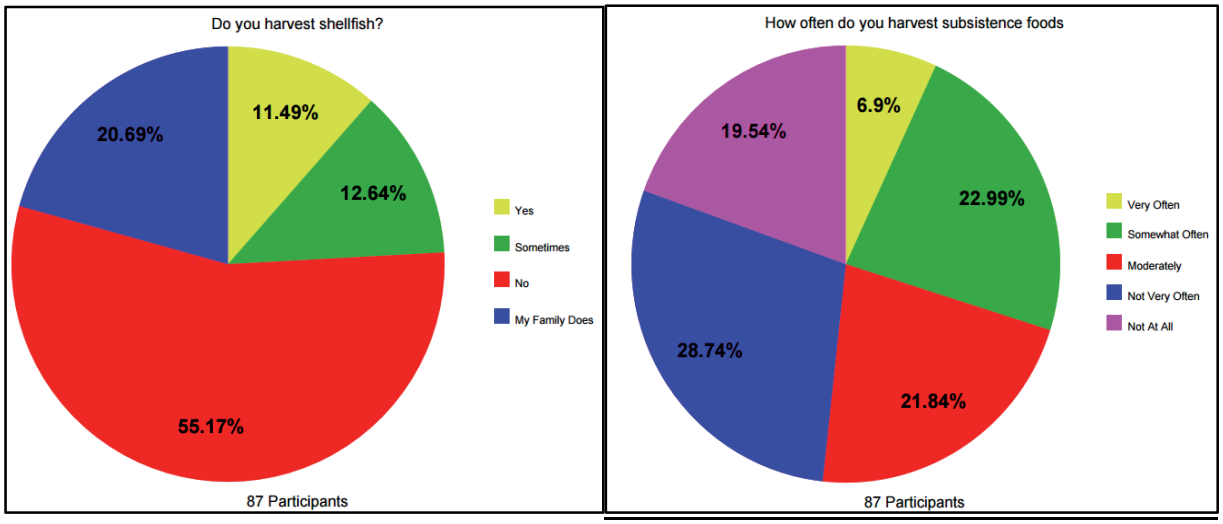
As previously noted, the seasons appear to be occurring earlier; vegetation, including berries, are blooming much earlier. Native plants gradually adapt to warmer temperatures, while invasive species thrive in warmer conditions and have a high likelihood of outcompeting local vegetation. Currently, there is less Yellow Cedar to harvest. A sharp decline in the past has left the Alaskan Yellow Cedar nearly unharvestable on the AIR.

The result of a warming climate has affected migratory species such as birds and whales. Local observations of such species indicate unusual behaviors, such as humpback whales, persisting to reside around the AIR for extended durations and possibly becoming annual residents. There have been less occurrences of residents encountering native wildlife, such as deer and grouse. Local fisherman have been catching new species of fish, such as Sunfish, which originate from the tropics. Rising sea temperatures have been observed by subsistence harvesters, and quantified by fisheries management and local divers.

Figure 2-4: A Sunfish caught off the AIR during the 2015 salmon season by a local salmon purse seiner. Sunfish are an unusual species recently discovered in Alaskan waters. This massive fish is normally considered a tropical fish.
(Photographer: Kelsie Hayward).

2.4.3 Coastal

There have been a limited amount of clinical cases in which a few Tribal members have been harmed by Paralytic Shellfish Toxins (PST) found in shellfish harvested on the AIR, and its surrounding waters. In past years, it has become dangerous to harvest untested shellfish, such as cockles and clams. Seaweed has become less abundant and the strands are smaller. One interviewed local, stated that she has to "pick seaweed before it reaches full length"[16].



Graph 2-2: The question, do you harvest shellfish is compared to the question, how frequent do you harvest subsistence foods from 87 participants.

2.4.4 Advice

A significant pattern has been recognized among the advice received from local community members. Their suggestions to increase the current knowledge of the Tsimshian culture will aid in the preparation of adaptation to a changing climate. This includes preserving the connection between the Tsimshian and their natural environment. Simultaneously, community action and participation directly related to cultural practices and traditional activities must be encouraged. Metlakatla's youth will be able to assist in the combating of climatic impacts through obtaining the knowledge about their ancestors' culture. They will learn how to harvest and hunt in a sustainable manner which maintains the traditional equilibrium. One interviewer responded, "we should go back to the old way of fish camps"[17]; another suggested, "each household should have their own gardens and start raising animals, like chickens"[18]. Such local inputs will assist in countering local impacts. There were many concerned voices of the Tribe who believe it is time the community began recycling and keeping local land and waters clean for future generations. The Tribe seeks to ensure that their voices have been heard.

2.5 Conclusion

[16] Leask, A. (2017, February). Cultural Climate Interview [Personal interview].
[17] Anonymous. (2016, November). Cultural Climate Interview [Personal interview].
[18] Byrd, B. (2017, February). Cultural Climate Interview [Personal interview].

The Tsimshian People assign names to each month of the year representing traditional harvest times, displayed in Table 2-4 (Below). In recent years, members have not been able to rely on the traditional harvest windows; interview responses have mentioned that the harvesting window on the AIR has been arriving earlier each year. Local harvesters have had to become more observant to environmental markers, using them to adapt to a changing climate and the complexity it brings the Tribe.

Table 2-4: Traditional Tsimshian Harvest Calendar

January	Trap Hunting
February	North Winds
March	Ooligans
April	Herring Eggs
May	Seaweed Harvest
June	Salmonberry Harvest
July	Sockeye Run
August	Pink Salmon Run
September	Berry Harvest
October	Cockle Harvest
November	Clam Harvest
December	Feast

A few residents of the Tribe stated that they do not believe in climate change, but did state they have witnessed environmental changes occurring in recent years. Community members have been adapting to a changing climate without realizing it. For example, local fishermen have been washing their fishing nets due to "muddy buildup" (most likely a diatom bloom) for several seasons now. This was not a common practice but has become an important adaptation tool by commercial fishermen as warmer water temperatures have continued. The inability to participate in traditional food practices due to loss of land, language, and culture poses a serious challenge for the stewardship of the Tribe. Table 2-5 (Below) represents community suggestions for climate adaptation strategies that local residents stated within their interviews.

Metlakatla Indian Community Adaptation Suggestion Responses

- Residents should consider driving less and walking more.
- The community should be looking for clean energy to use.
- To combat the decrease in rainfall, there should be larger storage to hold water.
- Members used to have personal gardens where they grew raw foods, this practice needs to return.
- A new "harvesting" calendar should be created for the local Tsimshian along with finding alternative and sustainable ways of harvesting shellfish, seaweed, etc.

Impacts of a changing climate could potentially result in the reduction of access to culturally important locations and species, however the use of local values, TEK, and the creation of future adaptation strategies could mitigate these effects. The Tribe has a holistic view of the natural environment, which is a major source of existing adaptations. Through the integration of future practices and adaptation, the efficiency of climate change strategies will improve. If the community loses its ability to traditionally harvest, a considerable portion of the Tsimshian culture and identity would be lost.

Key Terms	
Traditional Ecological Knowledge (TEK)	Includes the cultural traditions, values, beliefs, and views of local peoples distinguished from Western scientific knowledge. Traditions being passed on from their forefathers to the present generation for the purpose of survival while still living in harmony with the ecosystems. Such local knowledge is the product of indigenous peoples' direct experience of the workings of nature and its relationship with the social world.
Paralytic Shellfish Poison (PST)	A neurologic multi-symptomatic presentation secondary to saxitoxin ingestion, including oral, facial, and other paresthesias; gastrointestinal upset, including drowsiness, nausea, and diarrhea; weakness and paralysis; death is uncommon but could possibly be life-threatening.
Epistemology	A branch of philosophy that investigates the origin, nature, methods,and limits of human knowledge.

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Section 3

Section 3: Climate Vulnerabilities

3.1 Components of a Changing Climate

Alaska is undergoing both gradual and rapid environmental changes. It is necessary to analyze the impact of threat responses to an ecosystem and the community that lives within it. The section below reviews seven high priority local vulnerabilities being addressed: Coastal Erosion, Invasive Species, Salmon, Shifting Precipitation Patterns, Overall Subsistence Practices: specifically including Alaskan Yellow Cedar, Berries, and Shellfish, and Human Health.

Goals of this plan include:

- Understanding how a changing climate will impact the Tribe's ability to achieve resource management and recovery
- Exploring potential climate change integration options altering the decision making process
- Identifying adaptation strategies and steps following advancement for the future

The intent of the Metlakatla Indian Community is to ensure that local resources and traditions are preserved by clearly identifying potential vulnerabilities to a changing climate. TEK and scientific data support that a changing climate is already impacting the Tribe. Increasing the awareness of a changing climate and understanding of its impacts, allows for a nexus between tradition and science to be developed.

3.2 Vulnerabilities of a Changing Climate

3.2.1 Vulnerability 1: Coastal Erosion

Most of Southeast Alaska is considered a coastal region and will continue to experience significant climatic impacts in the future. The Annette Islands coastal wetlands, tidal flats, and beaches are likely to substantially be transformed in both extent and quality due to storm acceleration rates. With increasing frequency and intensity of Pacific storms, there is a higher likelihood of destruction from storm surges (Figure 3-1, Below). Coastal regions are, and will continue suffering from storm damage, causing infrastructure and habitat loss.

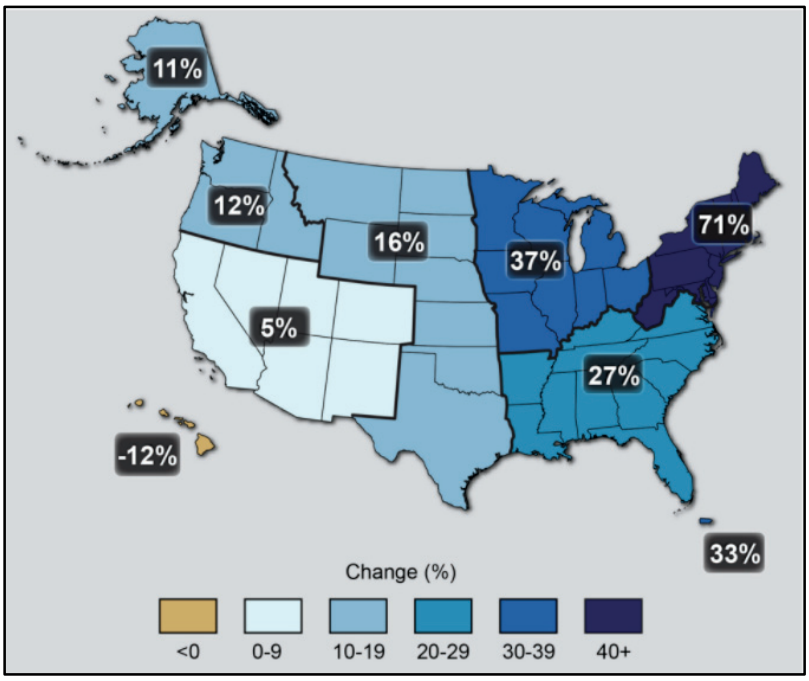

Figure 3-1: Observed change in very heavy precipitation. Intense storms have increased. Alaska experienced an 11 percent increase in the amount of precipitation falling in very heavy events from 1958 to 2012. (Source: NOAA U.S. Climate Resilience Toolkit 2015)

The northern regions of Alaska are potentially sinking due to a rising sea level; while Southeast Alaska's land mass is rising, causing the retreat of the ocean[19]. Southeast Alaska is undergoing "isostatic rebound"[20]; where low lying lands rise and create new land due to rapid glacial melting.

Approximately 20 to 30 buildings (15 percent) on the AIR are located near and/or on the immediate shoreline. These structures are constantly encountering storm threats. It is evident that storm surges have eroded the AIR for several years. Abrasive wind gusts, continuous precipitation, much higher tides and ruthless waves have slowly deteriorated coastal landforms putting many homes, businesses, streets, and even burial grounds at risk. Regional tide books provide evidence of tides as high 19 feet, which was unheard of twenty years ago. Observational evidence of shoreline erosion is present on the AIR (Figure 3-2, Below), however, due to the lack of scientific records there is little quantifiable data.

[19] Dean, C. (2009, May 17). As Alaska Glaciers Melt, It's Land That's Rising.

[20] Motyka, R.J., Larsen, C.F., Freymueller, J.T., and Echelmeyer, K.A., 2007, Post little ice age rebound in the Glacier Bay Region, in Piatt, J.F., and Gende, S.M., eds., Proceedings of the Fourth Glacier Bay Science Symposium, October 26– 28, 2004: U.S. Geological Survey Scientific Investigations Report 2007-5047, p. 57-59.

Figure 3-2: Shoreline erosion exposing tree roots and stumps found on the AIR. (Photographer: Julia Scott & Genelle Winter).

Loss of key coastal habitats is likely to have a significant impact on associated species, such as shorebirds and forage fish. Effective management of the local shorelines will assist in the future preparation of maintaining the natural dynamics of the AIR. The community must recognize coastal erosion and the risks it poses to residents. Monitoring (through GPS and tidal gauges) as well as continuing shoreline research will aid in the approach of future climatic effects. The Tribe's response is critical.

3.2.2 Vulnerability 2: Invasive Species

Invasive species can be defined as an introduced species of animals, insects, vegetation, fungi, pathogens, and other organisms that if not controlled will quickly spread to negatively impact local resources. Agriculture, gardens/landscaped areas, and natural resources including fish, game, and other vegetation are often what land managers seek to protect from invasive species impacts. If management fails to occur, significant alterations to the affected ecosystems will cost landowners, managers, and land users considerable funds to manage and/or supplement lost resources. For more information on invasive species, visit the Alaska Division of Agriculture and Alaska Department of Fish and Game web pages. A list of non-native plants and profiles as well as an interactive map of the locations non-native plants are documented can be found at the Alaska Exotic Plant Information Clearinghouse.

Shifting weather patterns have increased the vulnerability of native species, while also increasing the likelihood of successful introduction and spread of invasive species. As native species struggle with adaptation due to the diversity of growing conditions, the ability to outcompete native plants will become a challenge, especially in situations when the native species are stressed under environmental pressures. The Tribe has successfully implemented an Invasive Species Management Plan since 2005, and recognizes that a changing climate is a vector in the spread and invasion of non-native species.

The general definition of a species being 'noxious' is if it is harmful or injurious to human health or physical well-being. While the legal definition of a noxious weed is a weed which is considered to be harmful to the environment or animals, especially one which may be the subject of regulations governing attempts to control it. The State of Alaska has an established list of noxious weeds that are governed by specific legislation to prevent the movement, spread and propagation of these harmful species. AIR follows the established lists used by the State of Alaska, as well as referring to current research available from the nearby province of British Columbia, Canada and the State of Washington.

The increase in noxious weeds has caused many negative impacts on local lands and resources, causing health and safety concerns for land managers and the public. New invasions of noxious weeds and the spread of established infestations are threatening the productivity and sustainability of subsistence activities on local residents and Tribal lands. As of 2016, MIC has listed eleven (11) noxious and/or invasive weeds have been located on approximately 261.10 acres of the AIR lands. Management of noxious weeds is critical for maintaining healthy ecosystems.

The Tribe employs funding from the Bureau of Indian Affairs and other sources to conduct invasive species oversight. Executive Order 13112 of February 3, 1999 (Invasive Species), called upon executive departments and agencies to take the necessary steps to prevent the introduction and spread of invasive species, and to support efforts to eradicate and control invasive species that have established. Executive Order 13112 created a coordinating body -- the Invasive Species Council, also referred to as the National Invasive Species Council -- to oversee the implementation of order, encourage proactive planning and action, develop recommendations for international cooperations, and take further steps in improving the Federal response to invasive species.

In response to this Executive Order the Tribe has worked to implement strategies employed by land managers nationwide, and stayed abreast on current science and technologies, along with employing TEK in invasive species management on the AIR. The MIC has

Resolution 16-62 which states that the Tribe's commitment to invasive species management including the prevention, early detection, and rapid response mechanism. This process is commonly referred to as EDRR within invasive species management. To assist in the implementation of the Resolution 16-62, the Law & Order Code, Title 6 Chapter 2 Section 2 lays out the specific ordinance regarding invasive species management on the AIR.

Each of the following measures, the Environmental Assessment (2017), the Invasive Species Management Plan (2016), the Executive Order 13112, and the Law & Order Section are aspects of a reactive and successful invasive species management program. As it relates to a changing climate, it is recognized that shifting environmental conditions improve the habitat for invasive species to thrive in, whether they are terrestrial, marine, aquatic, mammal or avian. The application of the edict of Early Detection, Rapid Response (EDRR) is particularly useful in addressing the potential threats of invasive species impacting threatened ecosystems and lending itself to swiftly apply prevention strategies. As a result, the Tribe identifies the preparation of facing the threat of invasive species with the most efficient tools available, while recognizing the need to maintain a high level of urgency of awareness to identify new infestations or invasions.

3.2.3 Vulnerability 3: Salmon

Salmon are a key species in Native Alaskan traditions, it is the foundation of the commercial, social and cultural survival of the Tribe. Pacific salmon are being directly impacted on a local, regional and global scale. Due to a changing climate, there have been significant alterations in the behavior of many species, including fish. There are five species of Pacific salmon found in Southeast Alaska: Coho also known as Silver (*Oncorhynchus kisutch*), Chum or Dog (*Oncorhynchus keta*), Chinook or King (*Oncorhynchus tshawytscha*), Pink or Humpy (*Oncorhynchus gorbuscha*), and Sockeye or Red (*Oncorhynchus nerka*)[21].

Salmon are vulnerable to changing water temperature, acidity and other microscopic ocean conditions and as such, can be considered a marker species for a changing climate. Pacific salmon are an anadromous fish; species that hatch and live the beginning of their lives within freshwater, later migrating to the sea where they occupy most of their adulthood. The timing of migration runs is a seasonal trait, which has been observed to be shifting from previous years. They are particularly vulnerable when entering ocean waters and before spawning.

Salmon are a unique species, beginning and ending their lives in freshwater and feeding in saltwater. Due to a complex life cycle, salmon are highly vulnerable to environmental changes. The interactive relationship between a shifting climate, aquatic environment, and Pacific salmon catch rate is strong. Southeast Alaska is known as one of the most lucrative and productive salmon regions in the world. Rich fishing waters result in Alaska's prime location for a lucrative Pacific salmon industry, providing ideal food sources for the majority of the

[21] Science - North Pacific Anadromous Fish Commission. (2016).

population as well as the country. Accordingly, the State of Alaska is the number one producer of wild salmon in the world and the salmon industry is certified as "sustainable" by the Marine Stewardship Council[22]. The Tribe has their own MSC Certification, independant of the State of Alaska, this is appropriate due to the Tribe managing the entire commercial fishing on the AIR and uses sustainability as a guiding principle in this field of work.

Statewide, "subsistence fishing accounts for approximately 40 million pounds and recreational fishing for around seven million pounds"[23]. The salmon thrive when there is an abundance of the food sources for them found in Pacific waters. Availability and abundance of feed is related to ocean temperatures.

Salmon appear to be migrating in wider ranges, at times traveling out of the the AIR fisheries boundary, this impairs local fishermen participating in cultural and commercial harvesting from harvesting salmon outside of the Reserve's boundary. As water temperatures change, the salmon are following the thermocline that leads them outside the AIR boundary. Salmon are a surface oriented marine species; their productivity is climate sensitive. The higher the water surface temperature, the deeper the salmon will migrate and vice versa. The Tribe's Fish and Wildlife Department is monitoring local efforts and has witnessed fish catch rates dramatically fluctuating.

While at this time there is not sufficient data to support whether or not climate change is directly impacting local Salmon due to many other variables, such as sea surface temperatures, sea level changes, shifting precipitation, sediment and turbidity changes, loss of snowpack, ocean acidification, increasing storm frequency and intensity, and fishing pressures, local observation shows a direct link between Salmon and a changing climate. The Tribe is currently and will continue to assess salmon production and catch rates in the future. The most critical factor in a salmon's life cycle is water temperature, to survive they need cold, clean and oxygenated waters as necessary[24]. Changing ocean conditions are the most urgent threat to Pacific salmon management for Southeast Alaska.

Through the the Tribe's Fish and Wildlife Department research, there appears to be a positive correlation between warmer oceanic conditions and salmon, specifically Sockeye and Chum. Salmonids internal temperatures and metabolism are determined by the ambient temperatures of surrounding waters influencing them during their lifecycle[25]. Such fluctuations in temperature affect the development and growth rates of salmon, while also causing stress and possibly fatality. The optimum water temperature range for most salmon is between 55 - 64°F[26], currently the average water temperature for the AIR for the 2016 year averaged at 49°F. Currently, the changing climate has significantly impacted freshwater systems with higher than average water temperatures and alterations within the hydrologic cycle.

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22 Economy, Alaska Kids' Corner, State of Alaska. (2017).

23 Sepez, J. A., B. D. Tilt, C. L. Package, H. M. Lazrus, and I. Vaccaro. 2005. Community profiles for North Pacific fisheries – Alaska. U. S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-160, 552pp.

24 How Water Temperature Affects Development of Young Salmon. (2017).

25 Gilbert, N. (2012, July 11). Pink Salmon Evolve to Migrate Earlier in Warmer Waters.

26 "Salmon and Global Warming. (2017).

With dramatic environmental changes occurring, numerous fish and wildlife species depend on these vulnerable natural systems. It appears that global temperatures are connected to fish catchment. Correlation does not mean causation[27].

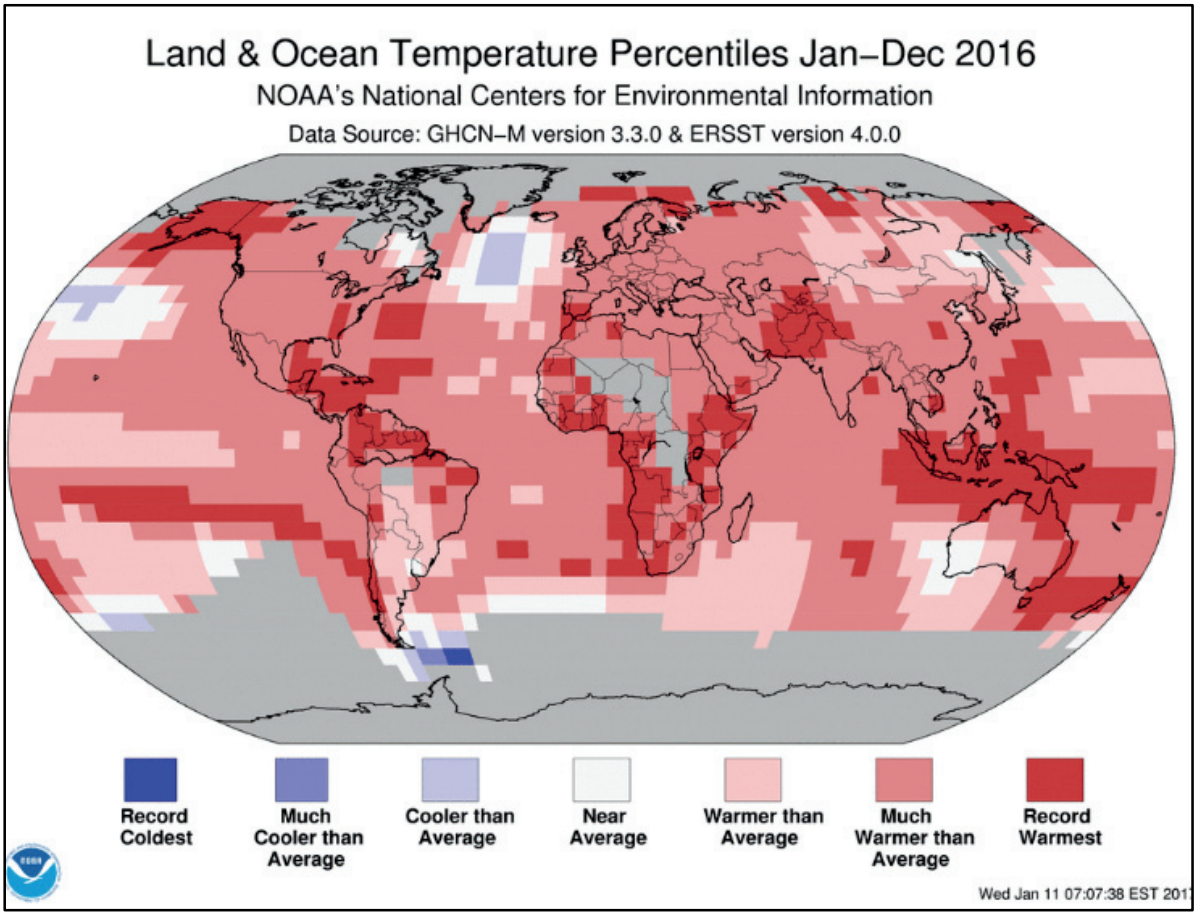


Figure 3-3: Land and Ocean Temperature Percentiles: Jan - Dec 2016. The image above presents 500 mb pressure anomalies related to Earth's surface temperatures. The majority of the world's land surfaces experienced above average temperatures, indicated by the bottom legend. No land areas were cooler than average for the year.
(Source: State of the Climate: Global Climate Report, Feb 2016).

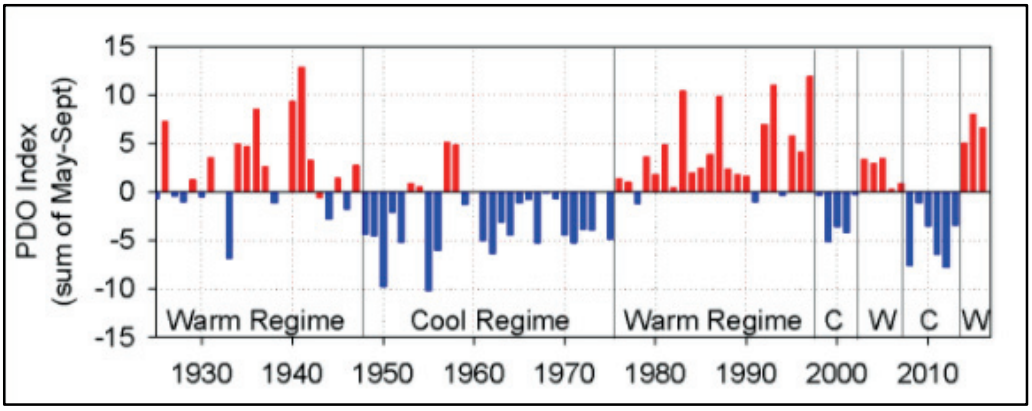
Pacific Decadal Oscillation

According to The National Center for Atmospheric Research (NCAR), Pacific Decadal Oscillation (PDO) is defined as a recurring pattern of ocean-atmosphere variability[28]. Sea surface temperature (SST) anomalies are occurring in North Pacific waters (typically polewards of 20°N). PDO components such as amplitude, occurrence, and predictability are still unknown but

[27] Winter, D. (2017) Decreased Sockeye Catches on Annette Islands Reserve. [PowerPoint slides].

[28] Mantua, N., Hare, S., Zhang, Y., Wallace, J., & Francis, R. (1997). A Pacific Interdecadal Climate Oscillation with Impacts on Salmon Production. *Bulletin of the American Meteorological Society,78*(6), 1069-1079.

evidence suggests that such irregular events affecting coastal regions, temperatures, and water flow last between 20 to 30 years[29] (Graph 3-0, Below) and are mainly focused in northern latitudes[30]. In the United States, PDO specifically affects two major salmon production regions, the Pacific Northwest and Alaska.



Graph 3-0: Time Series of shifts in Pacific Decadal Oscillation (PDO), from 1925 to present. Values are presented over a span of May through September. Red bars indicating positive (Warmer) years and blue bars indicating negative (Cooler) years. The years 2008 and 2012 were recorded as the lowest values since 1956. (Source: Northwest Fisheries Science Center).

PDO has two variable phases, a negative (cool) phase and a positive (warm) phase (Figure 3-3 below)[31]. The climate index is based upon oceanic patterns which are constantly shifting and fairly unpredictable. A positive PDO results in warmer than usual sea surface temperatures (SST), therefore enhancing ocean stratification and upwelling providing nutrient rich waters for marine life to thrive in. It is likely, but unproven, that Harmful Algal Blooms (HAB's) are influenced by such environmental conditions, however this is merely a correlation and not determination. While a negative PDO results in the exact opposite oceanic conditions, with cooler than usual SST's.

[29] Global Patterns - Pacific Decadal Oscillation (PDO). (2017).

[30] Latif, M., & Barnett, T. (1994). Science. *Causes of Decadal Climate Variability over the North Pacific and North America, 266*(5185), 634-637. doi:10.1126/science.266.5185.634

[31] Northwest Fisheries Science Center - Pacific Decadal Oscillation (PDO). (2017).

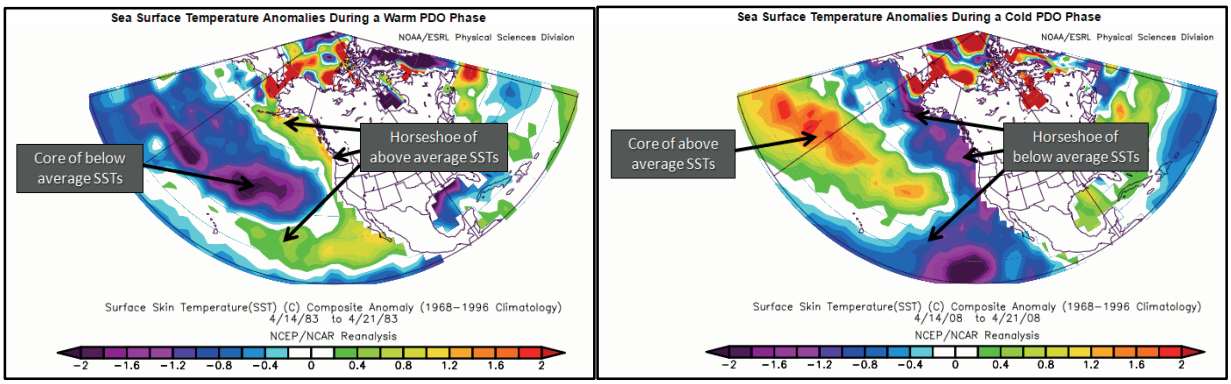


Figure 3-4: PDO Phases. Warm/Positive PDO (Left) represents above average water temperatures, below average winter temperatures, and above average winter precipitation off the coast of Alaska. The Cold/Negative PDO (Right) below average water temperatures, above average winter temperatures, and below average winter precipitation off the coast of Alaska. (Source: NC State University).

The PDO Index represents positive and negative events impacting Alaska and its Pacific salmon productivity presented in Table 3-1 (Below). The overarching general question is how PDO is impacting climate, specifically whether or not PDO is a driving force among salmon production in the state of Alaska. For now, scientists have observational correlations to base this knowledge on.

Table 3-1: PDO Index

	AK Impacts	*PNW Impacts*
Negative PDO	Less Salmon	More Salmon
Positive PDO	More Salmon	Less Salmon

Some salmon runs have decreased in size over the past few years and observations of unusual fishing patterns have also been observed by residents of the AIR. Correlations between total salmon catch (gillnet and purse seine) and a changing climate have been noted below in Table 3-2, three environmental variables are being compared to the two main fishing methods of the AIR. “Yes” represents a present relationship between salmon and climate, while “No” does not.

Table 3-2: Correlations Between Salmon and Climate		
Climatic Variable	*The AIR Fisheries*	
	Gillnet Catch	*Seine Catch*
PDO Index	Yes	No
Global Temperature	Yes	No

Based on the table above, gillnetting gear exclusively targets a specific oceanic depth (thermalcline), while seine vessels are able to reach greater depth, and thus deeper, cooler waters, gillnet fishermen are at a greater risk of negative commercial revenue from climate impacts.

Ocean Chemistry

Increasing temperatures are shifting the ocean's chemistry leading to ocean acidification (OA). The abundance and distribution of marine species has direct interactions with commercial, recreational, and subsistence harvesting. Evidence suggests that acidifying ocean conditions could possibly be affecting certain species already. A combination of factors renders the Pacific Coast especially vulnerable to ocean acidification, as naturally more acidic deep ocean waters brought to the surface through upwelling combine with waters whose pH has been reduced by anthropogenic carbon dioxide[32]. Pacific salmon are expected to migrate further northward with warming waters. Within the future, non-native species are projected to invade Alaskan waters. Colder water temperatures established at the continental shelf base could possibly limit species migrations.

The health of aquatic species is likely to be impaired, as multiple observations of abnormalities internally and externally on local fish have been witnessed. Shelled pteropods are directly impacted by acidifying waters resulting in the weakening of their protective calcium carbonate shells. There is alteration of marine food webs and species food availability such as herring and [Pink] salmon which rely on pteropods to sustain themselves. For example, a ten percent decrease in pteropods could result in 20 percent decrease in salmon weights[33].

3.2.4 Vulnerability 4: Shifting Precipitation Patterns

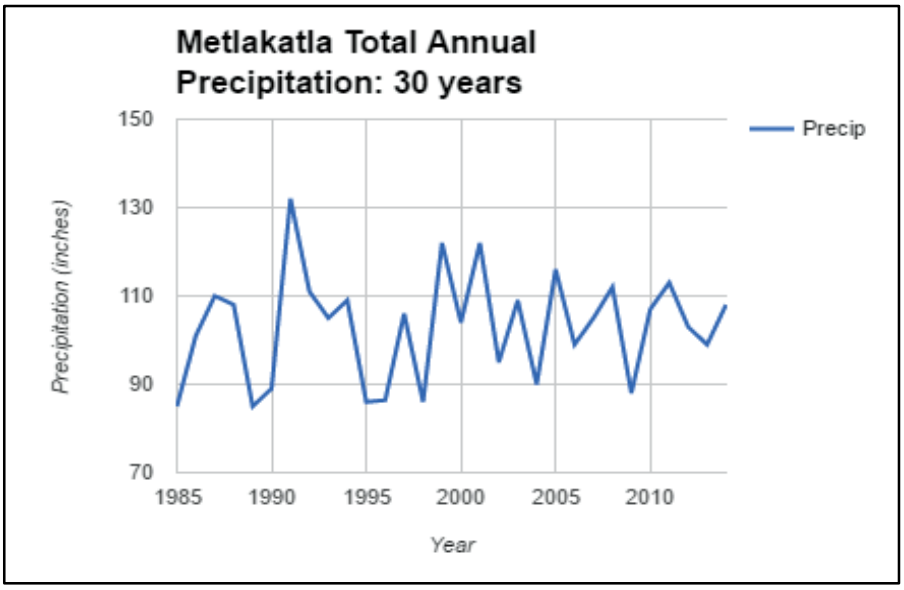
Energy & Water

In recent years, the AIR has witnessed a dramatic shift in precipitation patterns. The frequency and intensity of climatic events, such as hurricanes, will continue to be negatively altered. Changes in precipitation is likely to result in water shortages and/or flooding. In the last

[32] Feely, R., Klinger, T., Newton, J., & Chadsey, M. (2012). Scientific Summary of Ocean Acidification in Washington State Marine Waters. *NOAA OAR Special Report*.
[33] Stephens, C., & Mathis, J. (2011, August). New Findings Show Increased Ocean Acidification in Alaska Waters.

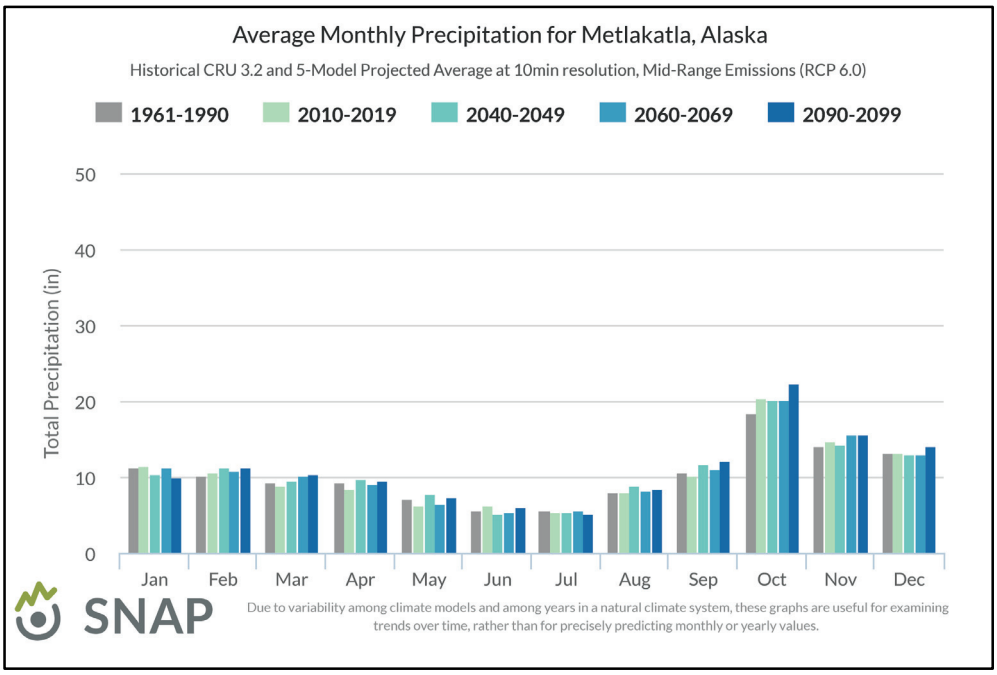
ten years, the AIR has averaged approximately 105 inches of rainfall per year. The years 2014 and 2015 recorded above average rainfall with 108 inches annually, compared to 2016, which was measured below average at 94 inches[34].

Chester Lake supplies both municipal water and hydropower to the Tribe, while Purple Lake is the hydropower resource of the community. These lakes are fully reliant on precipitation recharge and runoff, rather than streams or drainage reserves. This section will discuss the two main lakes located on the AIR, and how within the past decade fluctuating precipitation rates (Figure 3-1 and 3-2, Below) have directly impacted the Tribe's energy security and municipal water supply.



Graph 3-1: Total Metlakatla Annual Precipitation: 30 year span from 1985-2014. (Source: The Metlakatla Indian Community).

[34] Northon, K. (2017, January 18). NASA, NOAA Data Show 2016 Warmest Year on Record Globally.



Graph 3-2: Projected monthly precipitation for Metlakatla to the end of the century assuming a mid-range emission scenario. (Source: Scenarios Network for Alaska & Arctic Planning 2017).

Chester Lake

Chester Lake is the smaller of both lakes and is measured at approximately 42 acres with an additional drainage area of 1.6 square miles. Following heavy rainfall, lake recharge is possible within a few weeks. As Chester Lake's water supply becomes low due to high consumption and low precipitation rates, decisions are made by the Tribe to shut down the 1.2 MW Pelton turbine operating from this lake. The water is solely utilized for municipal water purposes until the water supply has recovered to a sustainable capacity to justify reactivation of the hydro-generator.

Figure 3-5: Chester Lake 2003 (Left) compared to Chester Lake 2016 (Right). The left image represents average lake levels, while the right image presents a significant amount of reduction in water resulting in the exposure of shoreline. (Source: The Metlakatla Indian Community).

Purple Lake

Purple Lake, the larger of both lakes is approximately 840 acres with an additional six square miles in drainage area. Recently, this lake has experienced lower than average water recharge rates. In 2016, low rainfall occurred with merely 94.09 inches total[35]. In the last three years, water level data on Purple Lake has begun to be recorded, anecdotal evidence suggests that lake levels were historically much higher, as much as 30 feet from current levels. Lake level data will continue to be collected in order to understand recharge capability at this lake, this is essential to sustainably manage this important hydropower resource. There are currently three hydro turbines present in Purple Lake, two 1.0 Francis turbines, installed in 1956, and a third turbine which was installed in the 1962.

Energy Security

The Tribe has historically relied upon hydropower for energy generation. The first hydropower plant was established at the base of Waterfall Creek, at the head of Chester Bay (Figure 3-6). This hydropower plant supplied power to the entire Tribe and the Annette Island Packing Company since 1926. In 1956, two 1.0 MegaWatt (MW) Francis Turbines were installed into Purple Lake via an underground tunnel penstock. In 1962, a third Francis Turbine was introduced at Purple Lake for a total capacity of 3.0 MW from Purple Lake.

[35] XmACIS2. (2017).

Figure 3-6: Comparison of Waterfall Creek located on Chester Bay taken in Spring of unknown year (Left) and present taken in Spring of 2017 (Right). There are subtle differences in water flow but the snow on the mountains suggests Spring time.
[Photographer: Unknown (Left) & Julia Scott (Right)].

The Purple Lake outflow discharges towards the eastern side of the AIR while the penstock flows in the opposite direction towards Tamgas Bay. A small dam was constructed across the outflow upon the eastern portion of Purple Lake to increase the water storage capacity. Due to Purple Lakes size of 842 acres and its drainage area of 6.4 square miles, there are multiple perspectives on recharge capability. Little information was provided to management staff that included evaluation of lake levels, thus, without adequate lake level data, at times the lake was being consumed faster than recharging. Once management became aware of this disconnect in 2015, lake levels began to be regularly recorded to benefit the operation of the hydropower at Purple Lake.

Figure 3-7: Purple Lake 2003 (Left) compared to Purple Lake 2016 (Right). The left image represents average lake levels, while the right image presents a significant amount of reduction in water resulting in the exposure of shoreline. (Source: The Metlakatla Indian Community).

The Tribe's energy demand grew beyond the hydropower's total capacity of 4.0 Megawatts (MW) beginning in 2010. This hydropower was solely available when the lakes were adequately recharged. With highly variable lake levels, the Tribe began relying on backup diesel generation. Using diesel as backup energy has been reliable and commonplace throughout the years. However, the Tribe desires to diversify their energy sources, and several evaluations of additional energy are currently being studied. As a result, the Tribe has collaborated with the state of Alaska and Federal Government to evaluate the potential for additional hydropower installation.

Another significant impact to the Tribe's energy supply on the AIR is warmer winter temperatures. This has resulted in precipitation occurring as rain, rather than snow at higher elevations, therefore, drastically reducing the potential storage capacity of the lakes. The consequence of having a snow shortage is creating a challenge for less potential water storage. With a growing community and an increasing demand for energy, additional stress has been placed on the AIR lakes. In 2013, Chester Lake reached a record low level and the penstock intake was nearly exposed. Repeatedly in 2015, lake levels on Chester Lake reached critically low, jeopardizing the ability to meet both hydropower and municipal water demands. In Fall 2015, the Tribe decided to install a penstock extension which allowed access to an additional 20 feet of water. The penstock extension was installed in Spring 2016 and provided additional energy and municipal water security.

Municipal Water Supply

The Tribe has historically used Chester Lake as a municipal water supply, drawing water from the outflow of Waterfall Creek (Figure 3-8, Below). The mechanisms of water delivery have evolved, beginning with wooden stave pipes, wooden stave storage tanks, six to eight inch pipe into storage tanks, and recently to a large 24 inch penstock originating at Chester Lake Dam. Chester Lake has proven to be a reliable source of municipal water for the Tribe. However, with the 1.2 MW Hydro drawing from Chester, additional pressure is placed on the lake and when precipitation is low, this can result in very low lake levels. When the levels become too low, the Tribe makes the decision to prioritize municipal water over hydropower from Chester Lake. Working with Village Safe Water (State of Alaska Rural Community Service), the Tribe has made incremental improvements to the water delivery system over the years. With assistance from the state and other resources the Tribe will continue to develop the efficiency of the municipal water system.

Figure 3-8: Waterfall Creek outflow, May 2017 (Photographer: Genelle Winter).

With the combined pressures of hydro consumption, community water utilization, and low rainfall events, the Tribe has reached deficit status upon Chester Lake, on several occasions

since 2013. The Tribe acknowledged the need for water and energy management, therefore developing an Emergency Preparedness Task Force in 2016. By working together, this team of individuals work together to ensure a secure municipal water supply, balanced with available water for hydropower. The Public Works Department has a very efficient system for operating the Tribe's municipal water. Their equipment is able to determine water consumption by the Tribe. When the fish packing plant is in full production during summer months, the Tribe consumes an average of 300 gallons per minute. During this time, the peak water use is between 500 - 800 gallons per minute (per MIC Public Works Department 2016) from the storage tanks located at the water treatment facility.

Conclusion

The combination of the utilization of two hydro lakes on the AIR is currently inadequate to meet the Tribe's energy demands. Energy diversification is necessary to reduce overuse of the existing hydropower capacity. If the Chester Lake Hydropower is offline, Purple Lake Hydro cannot meet the energy demand on its own. Low lake levels in recent years have resulted in the Tribe relying on Purple Lake and diesel generation. This is because of the shift in precipitation coupled with warmer winter temperatures that results in little to no snow pack coupled with increased energy demands. Snowpack is essentially water energy in the "bank", providing additional water reserves in the form of runoff over the season. When the water level is too low, the pounds per square inch (PSI) of the available water declines. As a result, there is an insufficient amount of pressure accumulating, which does not provide the maximum efficiency in operating the hydro generators at Purple Lake. A limited amount of data currently exists on lake level recharge.

The shift in precipitation has put financial stress upon residents of the Tribe, in the form of a diesel surcharge as Metlakatla Power & Light operates the diesel generator to backup the difference in energy demand that is unavailable from hydropower. When the Chester Lake hydropower is offline, reliance on the Purple Lake hydros and 2.0 MW diesel generators has becomes essential. The utility absorbs $0.62 of the cost for diesel and passes the balance onto the consumer. This rate is frequently too costly for members to pay, creating a financial imbalance. A resolution can be reached if the Tribe can diversify their energy production and reduce reliance on diesel as backup energy.

The construction of multiple new buildings (homes, facilities, and businesses) is causing the annual energy demand of the Tribe to increase. In 2010, the Metlakatla Housing Authority (MHA) converted the majority of homes from diesel oil hydronic boiler heating to electric boilers. Simultaneously, the conversion from diesel/wood heat to electric heat was nearly community wide. For the past 18 months (as of April 2017), the Tribe's primary energy source has been obtained from the diesel generator, as opposed to primarily hydropower generation. The Emergency Preparedness Task Force and the Planning Committee have been collaborating and working on solutions to relieve this economic strain on the community.

3.2.5 Vulnerability 5: All Subsistence Practices

Traditional Ecological Knowledge (TEK) facilitates the adaptation framework of a changing climate. Cultural traditions are built on subsistence practices, they include the harvesting of many fish, wildlife, and vegetation species. An abundant variety of food sources and medicinal vegetation has been collected and consumed for centuries on the AIR, it is essential to preserve such vital assets. Local resources are currently experiencing high levels of variability due to a changing climate.

A sense of accomplishment and personal dignity are established through traditional harvesting, which allows for individuals to experience family time and build self-worth while forming relationships to the land. Appreciation for locally harvested food, supports sharing resources with the community which sustains the Tribe's well-being. Harvesting activities teach many natural skills, for example, harvesting educates how to identify wildlife and vegetation as well as the various subsistence methods. Recently, harvest times and conditions for preserving traditional foods have been undergoing transition.

Direct impacts on subsistence activities include:

- Decreasing anadromous fish stocks
    - Directly affecting economic and dietary well-being of harvesters
- Alterations in the distribution and density of wildlife resources
    - Including plants, berries, and other vegetative subsistence sources of foods/medicines
- Disturbance of existing habitat and wildlife
- Increasing frequency and amplitude of severe storms
    - Resulting in more coastal damage with storm surges and erosion

An increase in temperatures will likely result in the alteration of the growing season, directly impacting the food security and health of the Tribe. Subsistence resources provide the community not only with ethical and spiritual values, but also with basic nutrition needs. Understanding how subsistence resources have been impacted by recent climatic changes is necessary to plan and prepare for the future, along with increasing management of food security.

Alaskan Yellow Cedar

Forests in Southeast Alaska are primarily formed by a Western Hemlock and Sitka Spruce structure. The AIR has a temperate rainforest which occupies a portion of the 2, 000 mile along the coastal strip from northern California to Southcentral Alaska. There are six types of conifers species found on the AIR: Alaskan Yellow Cedar (*Cupressus nootkatensis*), Western Red Cedar (*Thuja plicata*), Western Hemlock (*Tsuga heterophylla*), Lodgepole Pine (*Pinus contorta* subsp. *contorta*), Sitka Spruce (*Picea sitchensis*) and Western Hemlock-Sitka Spruce.

The forest composition is 96 percent of Western Hemlock and Western Hemlock-Sitka Spruce and the remaining four percent is Western Red Cedar and Alaska Yellow Cedar[36].

Yellow Cedar (*Cupressus nootkatensis*) is also known as Alaskan Yellow Cedar, Alaskan Cedar, and/or Alaskan Cypress. It is found in the Pacific Northwest region; from British Columbia, Canada to the Cascade Range of Oregon and Washington, and as far north as Alaska. Yellow Cedar forest decline covers about 600 miles from north to south. Aerial surveys over Southeast Alaska have mapped a decline across 580, 000 acres[37]. This iconic Pacific Northwest tree thrives in a maritime, subalpine climate, found mainly at low elevations in damp coastal regions. Yellow Cedar is entirely reliant on snow cover to survive the cold winter temperatures. Vegetation grows in particular locations because the ecosystems provide optimal conditions for that species. With abrupt changes occurring in the environment, these conditions which species have grown dependent on will be altered.

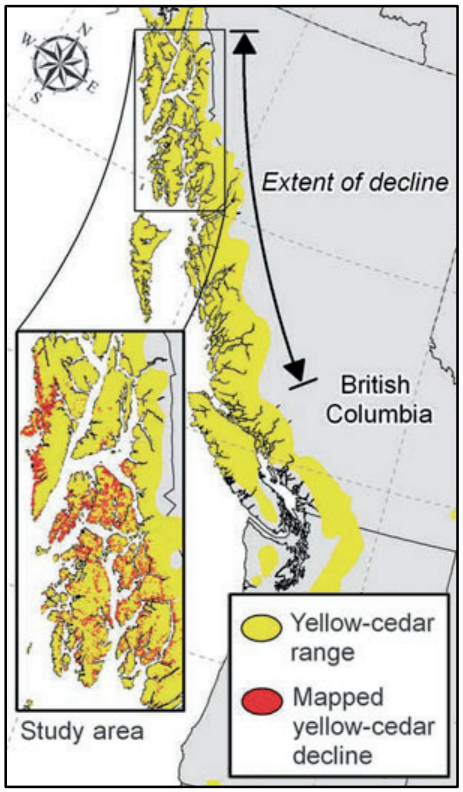


Figure 3-9: Yellow Cedar Range. The Yellow Cedar range extending from California to south-central Alaska. Forest decline covers approximately 600 miles, north to south. Aerial surveys over southeast Alaska have mapped a decline across 580, 000 acres, depicted in black[38].

[36] Tanana Chiefs Conference. (2017). *Forest Resource Management Plan for the Annette Islands Reserve* (pp. 1-113).

[37] Hennon, P., D'Amore, D., Schaberg, P., Wittwer, D., & Shanley, C. (2012). *Shifting climate, altered niche, and a dynamic conservation strategy for yellow-cedar in the North Pacific coastal rainforest,62*(2), 1-12.

[38] Hennon, Paul E.; D'Amore, David V.; Schaberg, Paul G.; Wittwer, Dustin T.; Shanley, Colin S. 2012. Shifting climate, altered niche, and a dynamic conservation strategy for yellow-cedar in the North Pacific coastal rainforest. BioScience. 62: 147-158.

With less snowpack covering the ground, rising temperatures, and shifting precipitation patterns, Yellow Cedar is vulnerable to a changing climate. Variable climatic conditions impact the number of freeze dates, leaving less snow insulation causing slow deterioration of the trees. Coastal Alaska has also seen an increase in gale winds. This increases the risk of forest blowdown and canopy breakage. Yellow Cedar grows slowly, life cycles reaching between 700 and 1, 200 years old[39]. This species is vulnerable to freeze in a warming climate due to recent fluctuations in precipitation. A snow blanket normally protects shallow root systems from frigid winter temperatures. With less snowpack, the result has been in the decline of Alaskan Yellow Cedar. Currently, there is widespread mortality, estimated around 60 to 70 percent of all Yellow Cedar has died. Paul Hennon, a multidisciplinary researcher and plant pathologist, stated within his Bioscience journal, "Affected stands are typically composed of long-dead, recently dead, dying, and some surviving trees, which suggests that mortality is long term and continuing. Elevated Yellow Cedar mortality began around 1880 to 1900 and continued through the 1900's, with peak values in the 1970's and 1980's"[40]. According to the Alaska Coastal Rainforest Center, Yellow Cedar decline is a Climate induced mortality event[41].

For the Tribe, cedar is a powerful symbol of strength. Having ecological, cultural, and commercial worth, it is not only a key resource in production of materials but also plays a meaningful role in spiritual and cultural beliefs. It is a highly valued species due to its traditional uses of carving material for native art, building material for homes and vessels, and weaving. There is great desire culturally and commercially for such a high quality tree with natural beauty and strength. Cedar is known for its strong, lightweight, and straight grained wood, therefore making it ideal to craft with. The AIR is dependent on the Yellow Cedar timber for subsistence practices. The Tribe is currently managing its forestry program through the Bureau of Indian Affairs (BIA). The Forestry Department is responsible for all management activities crucial to improve, establish, maintain, and promote a strong forest habitat.

Figure 3-10: Depiction of multiple cedar snags found on the southern portion of the AIR. (Photographer: Julia Scott).

[39] Lepisto, C. (2017, May 01). Yellow Cedar Die-off in Alaska Linked to Global Warming.

[40] Hennon PE, Shaw CG III, Hansen EM. 1990b. Symptoms and fungal associations of declining *Chamaecyparis nootkatensis* in southeast Alaska. *Plant Disease* 74: 267–273.

[41] University of Alaska Southeast: Yellow-cedar Decline. (2013).

Abundant snags, which have remained dead for decades, are observed standing, as depicted in Figure 3-8 (Above). Alaskan Yellow Cedar timber remains a viable resource after tree death. Enhancement of local forest resources and providing necessary management services to protected and threatened species is essential. According to the Juneau Empire News, Alaskan Yellow Cedar is under consideration for endangered species protection in the future[42]. Scientists are attempting to gain an understanding of environmental responses resulting from a changing climate, especially those of vegetation species. Continuing research is necessary to determine if this species will be placed on the endangered species list. Paul Hennon, working with U.S. Forest Service (USFS) out of Juneau, Alaska, conducted a 15-year study on Yellow Cedar decline. This study has been labeled the most extensive research on Cedar species to date. Paul states, "It was never one of our goals to research climate change effects on forests. We simply followed the most likely evidence and it turns out that climate change is a central part of cedar death. After many inclusive results, it was evident that there is a response present between vegetation and climate change."[43]

Another natural event impacting forests due to climatic changes is a result of the spruce aphid. This small non-native species has caused severe damage to the composition of Alaskan forests. The Forest Service has dated the spruce aphid outbreaks back to 1967, when the aphid was first observed in Sitka, Alaska. The pest continues to defoliate spruce trees, leading to a dramatic decline in tree growth. As of March 2017, approximately 34, 000 acres[44] have been mapped throughout the state of Alaska containing spruce aphid damage (Figure 3-11, Below). Approximately 16, 000 of those damaged acres were found in Southeast Alaska's coast and urban lands.

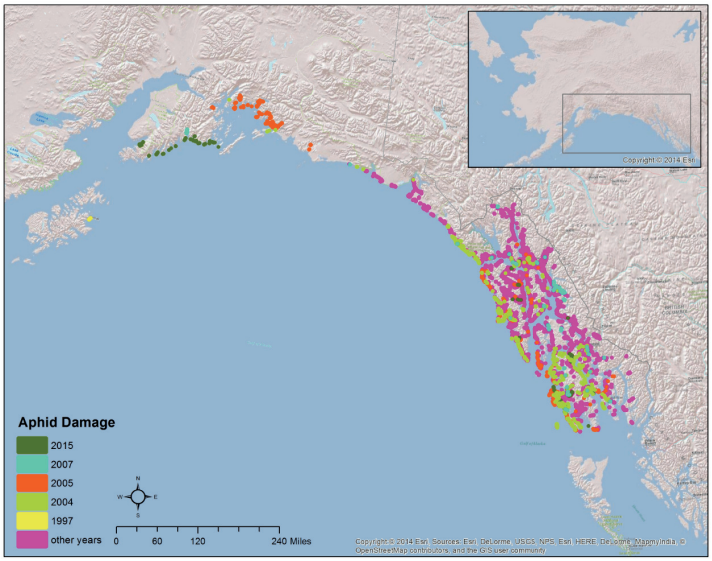


Figure 3-11: Spruce aphid damage mapped from 1981-2015. Damage is designated by year.

[42] Joling, D. (2015, April 10). Yellow Cedar under Consideration for Endangered Species Protection.

[43] Forests in Decline: Yellow-Cedar Research Yields Prototype for Climate Change Adaptation Planning. (2013).

[44] Schultz, ME. CJ Fettig, RR Borys, and RE Burnside. 2009. Evaluation of Systemic Insecticides for Control of *Elatobium abietinum* (Homoptera: Aphididae) on *Picea sitchensis* in Southeast Alaska. J. Entomol. Sci.. 44:78-84.

Berries

Alaska has a diverse and challenging environment. Climate change exerts definitive impacts on terrestrial plants, including wild indigenous berries. The main berry species harvested on the AIR are blueberries, cranberries, huckleberries, thimbleberries, salal, and salmonberries. Salmonberries typically bloom first, towards the end of May and into June; Blueberries and Huckleberries bloom at the beginning of June; Thimbleberries in late June to early July; and Salal normally blooms in late July but has recently been blooming during the same time frame as the Thimbleberry[45]. Highbush cranberries are ready to harvest in late summer and fall; Lowbush cranberries are available in late fall. Additional species of berries are represented in Table 2-2: Traditional Tsimshian Plants found in Section 2: Culture (Page 22). Wild berries are valued as a traditional food. This edible resource flourishes on the AIR. Berries contain high antioxidants, providing diversity for rural Alaskan diet.

Figure 3-12: Freshly harvested Salmonberries, early June 2016. (Photographer: Alexis Wagner)

Katie Spellman has conducted a variety of research[46] on the impacts of bloom times being altered by climatic changes. She has studied the impact on the salmonberries long-term survival rates and its adaptability. It is noted that salmonberries have been fruiting two to three times annually. Local Master Gardener, Genelle Winter, has noted that salmonberries are able to support successive fruitings when the weather warms early in the spring. These observations are consistent with the research being conducted by Katie Spellman. An increase in non-native plant species have had noticeable effects on the reproductive characteristics of local berry vegetation. The non-native plants have changed the pattern of pollination, frequently decreasing the quality of it. These are what Ms. Spellman calls "competitive effects". At the same time, warmer temperatures also affect the pollination times, therefore affecting the fruiting periods.

Though berries are not high on the Tribe's Vulnerability Assessment, a changing climate will affect cultural harvesting by local residents. Increasing temperatures will affect the ecology where berries thrive. This is likely to continue causing the berries to bloom earlier. Anecdotal

[45] Leask, N. (2016, November). Cultural Climate Interview [Personal interview].

[46] Spellman, Katie V., Laura C. Schneller, Christa P. H. Mulder, and Matthew L. Carlson. "Effects of non-native Melilotus albus on pollination and reproduction in two boreal shrubs." *Oecologia* 179.2 (2015): 495-507. *ResearchGate*. Web.

evidence suggests that the timing of berry blooming and the berry harvest window has shifted to earlier than typical. Harvesters have perceived that over the past decade, berry harvests have declined and/or becoming more variable. Changes in berry productivity have been witnessed within the last decade resulting in a great deal of uncertainty for the Tribe regarding harvest security. Currently, there is a limited amount of published data concerning Alaskan berries. The Tribe intends to collect such data for future decision making, in Section 2: Culture (Page 22) are Tribal observations of the AIR and its changing climate. Changes in precipitation and temperature are likely the greatest factors that will affect berry production as well as pollination rates[47].

Shellfish

For the purpose of this section, coastal regions will be defined as being any resources within beaches, marine ecosystems, shorelines, tidal lands, wetlands, and all marine species found there. NOAA reported that the summers of 2014, 2015, and 2016 reported record breaking Paralytic Shellfish Toxins (PST) levels which were more frequent and widespread due to warmer sea temperatures. Occurring in salt and freshwater bodies, algae can grow at fast rates and form natural, dense clusters known as "blooms". With dramatic shifts in ocean chemistry, there is a possibility that Alaska will have a rapid increase in Harmful Algal Bloom (HAB) occurrences as the ocean continues to warm. HAB's will have a negative impact on the community level; culturally, commercially, recreationally and most significantly impacting the health of local consumers.

Contaminated shellfish cause challenges

- Commercial expenses through the necessity of shellfish testing
- Local shellfish harvesting may be unsafe due to potential PST
- Restriction of cultural lands and modification to harvest times
- High amounts of water quality challenges

Algae is one of the most important organisms on Earth; it is the foundation of all aquatic life. Many algae species are completely harmless, while others may produce threatening toxins causing sickness. When bivalves such as clams, oysters, and mussels consume algae, their main source of energy, it is possible that they also collect toxins, which are then released into the digestive system and remain in the soft tissue of the shellfish. Although most filter feeders are relatively sensitive, some accumulate high concentrations of toxins, consequently becoming a hazard to those who consume these shellfish.

3.2.6 Vulnerability 6: Human Health

The Tribe is vulnerable to health and wellness impacts related to a changing climate. From clean air, safe drinking water, and secure food resources; human health will be impacted in

[47] Brown AO, McNeil JN. Pollination ecology the high latitude dioecious cloudberry (*Rubus chamaemorus*; Rosacea) Am J Bot. 2009;96: 1096–107.

the future. It is plausible that with rising temperatures, health threats will intensify, while as yet unknown threats are possible. Rainfall has already and is projected to continue be variable (Figure 3-11 below), potentially compromising available freshwater for localized drinking and energy.

Various diseases, such as those transmitted through insects or wildlife, are likely to spread. Timing and location of such illnesses could expand simultaneously. The exposure of human well-being to a shifting climate due to impacts such as extreme weather events, increased illnesses, decreased water quality and availability is possible. More frequent, lengthy, and intense heat events can be a main driver of negative health effects.

Note: Not all individuals will be impacted in a similar way from a changing climate, health threats fluctuate depending on numerous factors: age, location, income, available resources, etc.

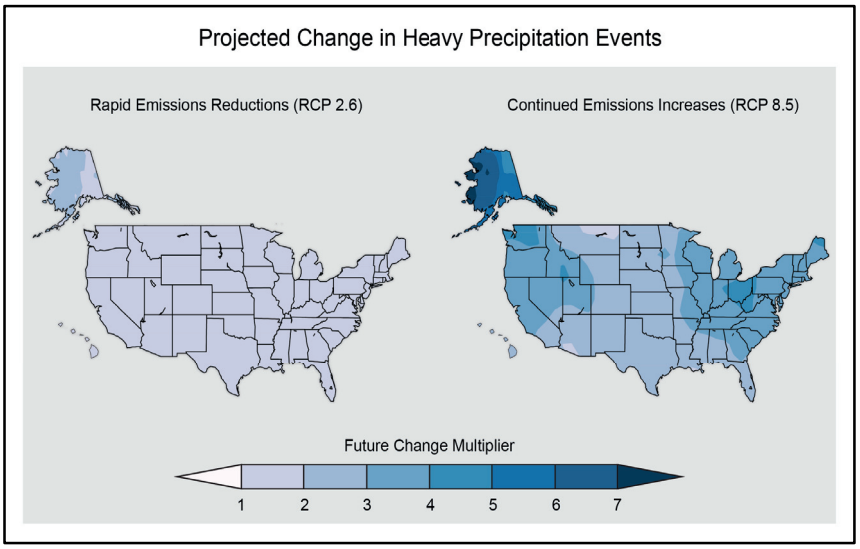


Figure 3-13: The maps above display the increase in frequency of daily precipitation events in the later part of this century (2081 - 2100) compared to the latter part of the last century (1981 - 2000). Extreme events are projected to become more frequent. Under a rapid emissions reduction scenario (RCP 2.6), such events would occur twice as frequent, while the scenario assuming continued increases in emissions (RCP 8.5), these events would occur up to five times as frequent. (Source: NOAA NCDC/CICS-NC).[48]

[48] National Climate Assessment: Human Health. (2014).

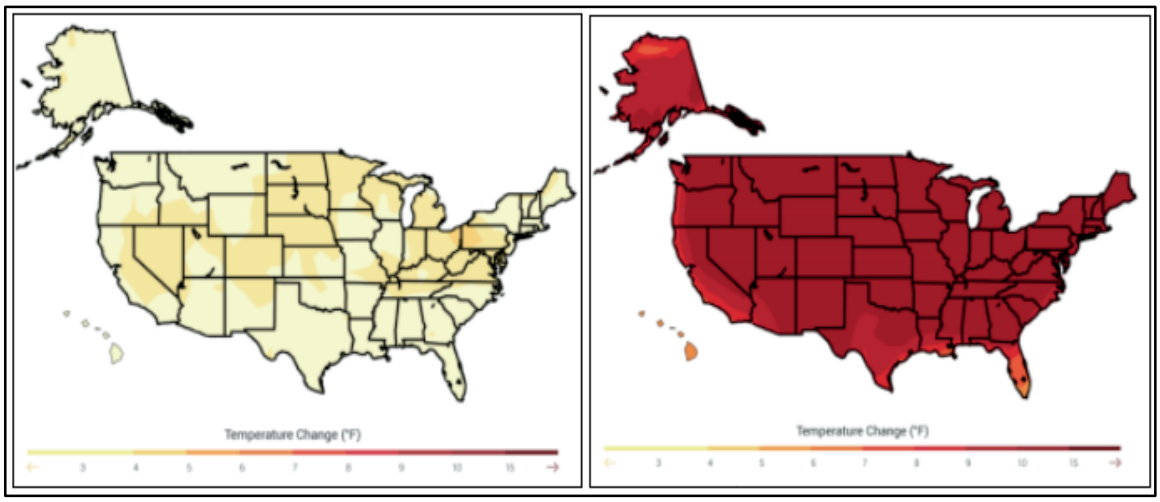


Figure 3-14: Rapid Emissions Reductions (RCP 2.6, Left) in comparison to Continued Emissions Increases (RCP 8.5, Right). Representing projected increases in the average temperature on the hottest days by the end of this century (2081 - 2100) compared to past years (1986 - 2005) under a scenario assuming a rapid reduction in greenhouse gases (RCP 2.6, Left) and a scenario assuming the continued increase of greenhouse gases (RCP 8.5, Right). (Source: NOAA NCDC/CICS-NC).

Allergies are likely to increase with a warming climate. Frost free days and higher air temperatures are occurring more frequently, thus contributing to a shift in vegetation. Average bloom times and pollen initiation from certain plant species has been occurring earlier than usual within recent years. Higher pollen concentrations and extended blooming seasons have resulted in increased allergies[49]. Variability of a warming climate has also accelerated infectious disease transmission. Many vector-borne diseases pose serious threats in North America, including Lyme Disease, Dengue Fever, West Nile Virus, and the Zika Virus. Following natural disasters, mental health challenges have been noted to increase. Exposure to stressful situations are of substantial concern due to increased stressors that contribute to mental illness such as warmer temperatures. Suicide rates have been reported to vary with rising temperatures[50].

It is expected that a changing climate will threaten food production. Quality, availability, prices, and distribution of food will be directly impacted with rising temperatures. Projections show that livestock and fish production are likely to decline. In response, prices are expected to rise[51]. Dietary patterns of rural Alaskan communities, such as the Tribe, are dependant upon subsistence, therefore securing subsistence resources is essential to avoid potential food shortages. Access and abundance of traditional subsistence resources will decline or change. The Tribe is dependant on such harvesting and gathering for food, medicine, and health and to maintain important cultural practices directly connected to those resources.

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[49] Brown AO, McNeil JN. Pollination ecology the high latitude dioecious cloudberry (*Rubus chamaemorus*; Rosacea) Am J Bot. 2009;96: 1096–107.

[50] Deisenhammer, E. (2003). Acta Psychiatrica Scandinavica. *Weather and suicide: the present state of knowledge on the association of meteorological factors with suicidal behavior,108*(6), 402-409. doi:10.1046/j.0001-690X.2003.00209.x.

[51] Centers for Disease Control and Prevention: Food Security. (2014, December 11).

Section 4

Section 4: Adaptation Strategies for a Changing Climate

4.1 Adaptation Introduction

This section reviews the current climate concerns on the AIR, including potential impacts on the Tribe. Adaptation is a collaborative process allowing the Tribe to cope with an uncertain future, by taking precise measures in the reduction of negative climatic impacts, by working and planning together. Adaptation planning will likely increase community resilience, while possibly reducing local resource vulnerability. There are many new and upcoming options for adaptation due to the advancement of technology. There is serious urgency in addressing local vulnerabilities due to the speed of change occurring. After identifying all climate change impacts, subsistence traditions, and adaptation goals, another critical task was to identify objective strategies for the Tribe. Potential threats of climatic vulnerabilities on the community are listed as high risk, found on Table 4-2: Vulnerability Assessment (Page 68). Each of the five climate vulnerabilities has been locally prioritized from least likely to become a threat to most. Appropriate actions and efficient planning methods are required for successful climate change adaptation. Efficient adaptation tools include: risk timeframe for projected short and long term impacts, potential funding costs, and decision making limitations.

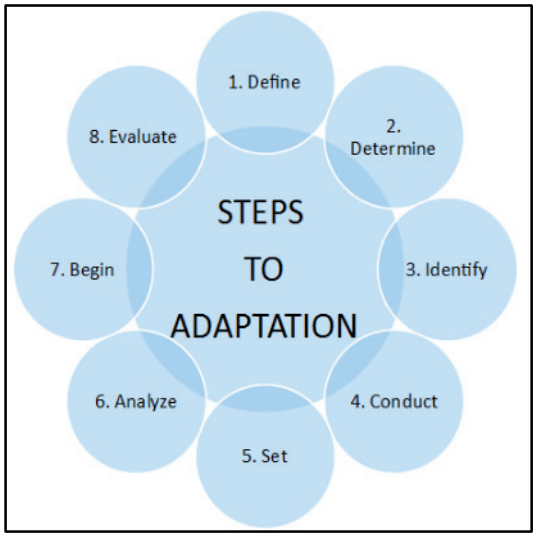

Figure 4-1: Eight Steps to Adaptation: (1) Defining community planning area, (2) Determining motives for adaptation, (3) Identifying vulnerability components, (4) Conducting climate change assessments, (5) Setting preparedness goals, (6) Analysing how to meet those goals, (7) Beginning implementation, and (8) Evaluating progress through monitoring changes.

This section describes the six climate change vulnerabilities, specifically the explanation of potential adaptation options. Recommended strategies and upcoming steps (near- and long-term) are proposed for each vulnerability category that have the highest impacts on the Tribe. At the beginning of each vulnerability topic, a brief description of the following subsection is provided. Considerations to take into account while planning for climatic adaptations are community participation, future funding, TEK, and scientific data. Developing climate change

evaluation approaches with efficient cost and benefit improvements are essential towards progress. The Tribe will continue to collaborate with its departments and partners to identify future opportunities for climate adaptation strategies and improving community resilience.

The Tribe must prepare to adapt. A changing climate will continue to affect natural resources at an unknown rate. The cultural resources on the AIR are nonrenewable and unique to this location and its people. Climate change adaptation will include a range of probable responses towards a desired future. The following section provides recommended adaptation strategies for addressing local climate change impacts on the AIR. Recommended practices, current practices referenced to in previously written documents, considerations such as TEK and scientific needs, and upcoming steps are included in near- and long-term goals which are based on a variety of factors such as: types of impacts, magnitude of impacts, future funding opportunities, scale of planning effort, governing authorities, and projected timeframes. Potential considerations of project costs, timeframe, TEK, and scientific evidence should also be taken into account. It is important to be aware of adaptation difficulties including the potential of low staff capacity, a lack of funding opportunities, poor data collection, limited local awareness, lack of management communication and collaboration. Overcoming such barriers aide in the progress of climate change adaptation strategies.

4.2 Potential Adaptation Strategies

4.2.1 Vulnerability 1: Coastal Erosion

The goal for coastal adaptation is to prevent further shoreline erosion from occurring and to increase coastline protection on the AIR. There are various structural options to reduce the energy caused by tidal waves and high winds causing coastal erosion. The intention is coastal stabilization, although a gradual process.

Recommended Strategies

- Collaboration with the Annette Island School District students while using methods for monitoring coastal erosion is likely to be incorporated within the science curriculum.
    - Utilizing the Emery Rod Method (Step-by-Step Instructions found in Appendix) and/or constructing a time-lapse camera within high priority coastal locations will be used for observations of developing hazards on the AIR.
- Nourishment of the coast through new stabilization using natural materials, vegetation planting, bio-engineering techniques, forming hard barriers such as seawalls or breakwaters are strategies recommended for restoration opportunities should future funding be available.
    - Beach Wildrye (Elymus mollis or Elymus arenarius)[52] has been known to decrease the impact of severe shoreline erosion on the coastline of Alaska[53].

[52] Huny, P., & Wright, S. (2017). 'Reeve' Beach Wildrye. *Revegetation and Erosion Control by Seed in Coastal Alaska,* 1-2.
[53] Wright, S., & Czapla, P. (2013). Alaska Coastal Revegetation & Erosion Control Guide.

Beach Wildrye sprigs are able to withstand the high tides and storm surges once they are planted. They can be harvested from wild Beach Wildrye and transplanted in the area affected by coastal erosion.

Figure 4-2: Beach Wildrye revegetation for coastal erosion prevention in Alaska. (Source: State of Alaska Department of Natural Resources).

- Introduction of zoning to prevent construction in vulnerable coastal areas, (Forest Management Plan)[54].
- Investigation of ecological buffers is part of the latest Forest Management Plan (2016).
- Enhancement of coastal protection can be addressed in the Forest Management Plan and in the proposed Integrated Resource Management Plan.

Next Steps

Near Term

- Collaboration with Annette Island School District to create a new science curriculum including climate change and its impacts on coastal erosion
- Stabilization of locations affected by severe coastal erosion

Long Term

- Monitor coastal erosion activities
- Improve and enhance coastal protection

[54] Tanana Chiefs Conference. (2017). *Forest Resource Management Plan for the Annette Islands Reserve* (pp. 1-113).

4.2.2 Vulnerability 2: Invasive Species

Invasive species are commonly introduced by way of human activity via movement and trade of goods such as crops, livestock, ships, and various other products; frequently through unintentional transport. Invasive species alter sensitive ecosystems through changing the environmental composition of habitats, frequently creating competition between native species. The primary goal for invasive species adaptation is Early Detection Rapid Response (EDRR). Preventing new species from establishing themselves on the AIR, through practices such as rinsing work equipment, gear, and vehicles for the removal of any potential invasive species through mud, sediment, and debris transfer. Invasive Species thrive in impacted environments and are biologically suited for highly volatile environments. Our changing climate increases the ability of these species to out compete native species, particularly those that are important for subsistence species such as berries.

Another possible threat likely to arise due to invasive species is direct impacts to local fish populations as well as the streams they inhabit. There are multiple species of invasive plants which have dense root systems that degrade the spawning strata in creek and stream beds, the resulting strata is left inhospitable to fish spawning. There is a possibility that if such an event were to occur, no streams could host salmon. Thus far, the Tribe has employed the prevention tactic of EDRR and has restricted the movement of invasive species entering such a sensitive environment.

The presence of the European Green Crab (*Carcinus maenas*) in British Columbia, Canada and the state of Washington threatens the local Alaskan Dungeness Crab **(***Metacarcinus magister***)** population, as well as other smaller crustacean species. The most successful strategy for combating invasive species is prevention, which requires strict monitoring of waters south of the AIR. Should any invasive species be discovered at this location, a comprehensive trap and removal project would be necessary for implementation.

Figure 4.3: On the left is the invasive European Green Crab. On the right is the local Dungeness Crab. (Source: Alaska Department of Fish and Game)

A changing climate increases the competitiveness of invasive species, while reducing the native species ability to resist the pressure from non-native species. In such cases, where this has no discernable impact on subsistence species, the Tribe may opt to take no action, however in all instances in which subsistence or commercially valuable species could be impacted, every effort will be employed to protect those species.

Recommended Strategies

- Examination of materials shipment such as rock, gravel, and soils to determine their point of origin, therefore, determining the potential source of invasive species.
- Usage of a vehicle/vessel decontamination system to prevent the spreading of potential contamination.
- Treatment or removal of invasive species immediately when detected for the reduction and likelihood of establishment.
- Implementation of the 2016 Noxious Weed and Invasive Species Management Plan; to be updated in 2017.
- A consistent community education program to ensure new infestations are noted and managed.

Next Steps

Near Term

- Evaluation of high concern locations
- Inspection (decontamination if needed) of current and past work sites.
    - For example, barges; float planes; ferries; vehicles; construction/landscaping equipment; etc.

Long Term

- Annual evaluations should be conducted
- Monitoring of known at risk sites, such as streams, channels that support fish spawning and could host European Green Crab
- Update the Invasive Species Management Plan annually to stay current with potential invasive species.

4.2.3 Vulnerability 3: Salmon[55]

A changing climate poses multiple consequences for the Fisheries Department, with profound impacts on salmon populations and other aquatic life surrounding the AIR. Evaluation of the Tribe's intrinsic value of salmon from local residents and determination for the most efficient strategy to manage the threat without harming the local fishing industry is necessary. This will allow for the creation of a long-lasting and sustainable Fisheries Department for the future of the AIR. It is imperative that the Tribe advocates extensive inter-departmental cooperation, consultation, and collaboration.

[55] "Alaska Department of Fish and Game Climate Change Strategy." *Adaptation Clearinghouse*. Georgetown Climate Center, 2011. Web.

Recommended Strategies

- The Tribe's Fisheries Department are currently and will continue to set limitations on the amount of species harvested and timing of the harvesting, to protect threatened species.
- Improvement and expansion of fisheries management through stream monitoring water quality and aquatic populations.
- Stream alteration data should be collected and compared with productivity/loss of aquatic populations to correlate with a changing climate.
- Attempting to minimize stressors to fish species by voluntarily setting limitations on local disturbances by restoring water systems, removing unnecessary and potentially harmful barriers is necessary.
- Tracking trends and forming assessments on local impacts to annual recreation, tourism, commercial, and subsistence fishing will allow the Tribe to establish priorities.

Note, all the above are referenced within the Fisheries Management Plan

Next Steps

Near/Current Term

- Setting limitations on the quantity and timing of aquatic species harvest, resulting in the protection of locally threatened species which are addressed in the conditions of the Marine Stewardship Certification requirement
- Enhancement and preservation of cultural, commercial, and subsistence fish habitats on the AIR
    - No harvesting and/or road construction within a determined buffer limit
- Fisheries will be monitoring the water quality in our creeks with a new sampling device that will measure temperature, salinity, pH, as well as other anomalies

Long Term

- Correlation between stream changes and productivity/loss in a changing climate is an ongoing project that will include an in stream potential and productivity report

4.2.4 Vulnerability 4: Precipitation Patterns

Adaptations to shifting precipitation patterns include striving to conserve and protect the AIR's natural resources, primarily water. A changing climate will alter rainfall in multiple locations, strengthening existing precipitation patterns resulting in wet areas becoming wetter and dry areas becoming drier[56]. The lack of water resources currently afflicts the Metlakatla Peninsula. The following recommended strategies will provide the Tribe with potential options for adapting to shifting precipitation patterns and protecting local natural resources. Though options are limited, the strategies listed below are highly feasible.

[56] Ogburn, S. (2013, November). Climate Change Is Altering Rainfall Patterns Worldwide.

Recommended Strategies

- Adaptation strategies are limited to actions that can be carried out by managing the existing resources wisely.
    - For instance, individual homeowners need to adopt conservation practices. Tribal leadership should set the example through employing basic conservation practices using water saving nozzles; repairing and fixing all leaks in water delivery systems; and using water catchment systems where practical to use rainwater for plants and gardens.
- When water levels in the municipal supply drop below threshold levels, community conservation practices will be enforced. These should include, no hoses or other water left running; no draining and refilling of pools; and reducing water use community wide wherever practical.
- Home water catchment systems in particular should be promoted to encourage conservation in yard work and gardening. This will support efforts to encourage food security by members to grow their own food without negatively impacting the water resources of the Tribe.
- The Tribal leadership can also promote and make accessible water saving nozzles, showerheads and other tools to reduce water consumption.
- Larger efforts could include increasing the capacity of available water reservoir, through increasing the size of the existing dam or by increasing the number of storage tanks currently being utilized to treat and circulate municipal water supply.
- Tribal entities directing everyday water conservation practices
    - Such as not leaving unnecessary water running, encourage water saving nozzles and efficient water delivery systems.
- Using basic conservation steps, the Tribe will be able to conserve local resources, preserving for future use. Basic adaptation needs becoming standard practices to benefit the Tribe and its resources.
- Proper management of the Tribe's limited lake resources.

Next Steps

Near Term

- Maintenance of water quality that meets the National/State standards
    - Annual monitoring of water quality trends
- Acquire future funding opportunities

Long Term

- Monitoring all climate-related resources
- Obtaining annual feedback from local harvesters

4.2.5 Vulnerability 5: Subsistence Practices

A warming Alaskan climate has amplified regional temperatures, resulting in broad-scale ecological diversity. It is critical to understand how subsistence resources on the AIR have been impacted by a changing climate. There is a high likelihood of further environmental alterations occurring, therefore it is necessary to plan for food security in now. A changing climate threatens subsistence which contributes to the livelihood of the Tribe's members. It is important to sustain hunting, gathering, and fishing, which have a significant role in cultural, economic, and social customs on the AIR. Protection of the resource biodiversity of local ecosystems occurs through habitat conservation, manipulation, and relocation management of species. Local individuals must be willing to transition into becoming more flexible, and informed through the expansion of TEK. For example, holding local discussions, encouraging Elders and harvesters to share their experiences with others, would strengthen community resiliency.

Alaskan Yellow Cedar

With the rapid decline of the Alaskan Yellow Cedar throughout the Pacific Northwest, it is necessary to identify solutions to preserve this tree species on the AIR. Alaskan Yellow Cedar is utilized for countless traditional and commercial activities, such as native art and woodworking. The main drivers of regional Yellow Cedar decline are temperature increases and snowpack reduction. Potential strategies to preserve this species include efficient conservation and management-practices.

Recommended Strategies

- Potential project
    - Rooted Cutting Project
- Assess and analyze forestry objectives, refer to the FMP for specifics
    - Listing suggestions obtained from the environmental assessment.
- The Forestry and Natural Resources Department should include risk assessments in future management plans.
- Residents should be encouraged to salvage dead timber.
- Cataloguing of Alaskan Yellow Cedar harvest should be enforced.
- Seed-lots can be established throughout the community.
- Increase forestry staff on the AIR
- The Forestry and Natural Resources Department could assist with species migration using standard practices.
- Update existing GIS data to be as accurate as possible. Improving database layers as necessary and maintaining conditions overtime to aide in forestry management.
- The Tribe could expand and operate the current greenhouse, raising containerized seedlings (produce # capacity/year)
- Conduct continuous forest inventories on the AIR to manage existing and new tree stands

Next Steps

Near Term

- Enhancement and maintenance of forest health
    - Combine research and climate data to identify forest trends
    - New tree planting
    - Identification and monitoring at risk areas
    - Monitoring of invasive species populations

Long Term

- Update forest information and data annually
    - Adhere to Forest Management Plan to ensure sustainable harvesting
- Allow for natural regeneration and/or succession to occur
- Protection of Alaskan Yellow Cedar species

Berries

Alaskan wild berries are a highly valued traditional staple for the Tribe. A changing climate will affect not only the range of berries, but also the quality and quantity. This will directly impact the Tribe's ability to harvest. Therefore, the Tribe is seeking to ensure the survival of indigenous berries on the AIR through conservation and protection. The primary goal for protecting the berry species is to increase its regional abundance. This can be accomplished through the collection of seeds and/or the teachings of sustainable harvesting practices.

Recommended Strategies

- The Tribe's Landscaping or Forestry Department can collect seeds of each species and gift them to reliable community members.
    - Seed bombs can be handed out to children on Earth Day and Arbor Day.
- Berry pickers should be informed on subsistence updates through social media and community postings in public buildings.
- The MIC could conduct a berry picking survey
    - Asking members specific questions referring to berry harvesting to quantify the magnitude of berry abundance
        - Which berry species are most valued, picked?
        - Has the berry abundance changed in recent years, how?
        - What is the volume of berries harvested, distance traveled to pick them?
- Allowing for natural migration to take place
    - Allowing for the potential to increase the species populations.
    - This can be done, by admitting local berry patches to grow in select locations, protected from being cut back for development or other construction priorities.

Next Steps

Near Term

- Identification of additional plant species to potentially harvest
- Restoration and expansion of the local greenhouse to grow vegetation species in

Long Term

- Environmental managers must monitor vegetation blooms and abundance
    - Evaluation of harvest trends and site specific measurements of species composition and abundance

Shellfish

Shellfish is a staple in the Tribe's diet. Testing and monitoring of PST levels a method in maintaining safe and healthy subsistence customs. A potential option would be for the Tribe to invest in their own shellfish testing facilities, local residents would then be able to receive results on their subsisted resources in a reasonable time frame and at a lower cost. While doing this, harvesting regulations should be considered.

Recommended Strategies

- The Tribe can arrange for training for fisheries employees to be samplers of HAB's.
    - Opening doors for further PST testing in the future.
- Test shellfish samples on both individual and community level to prevent PSP and PST poisoning.
- Placing regulations on harvest collections should be considered.
- The Tribe/AISU should provide community outreach on the dangers of HAB's.

Next Steps

Near Term

- Workshop training fisheries employees to sample HAB's. This will open the door for PSP testing in the future for the Tribe
- Encouragement and enhancement of local scientific testing and monitoring of HAB's

Long Term

- Support local, state, and federal research of PSP and PST

4.2.6 Vulnerability 6: Human Health

Investing in environmental conservation will assist in the reduction of climate change impacts upon the Tribe. Monitoring resources, setting up warning systems, improving infrastructure, etc. will assist avoidance of severe impacts on the community. Having the ability

to respond effectively and quickly provides opportunity; being prepared, allows for improvement in health of vulnerable residents. Understanding is a large component as well, comprehending the risks involved in a shifting climate can assist the community work together to lower the threats. With effective networking and collaboration, it is possible to limit climatic vulnerabilities and to build community resilience.

Recommended Strategies

- If more recreation trails were to be developed, it could create a community wide effort to change lifestyles and gain healthy habits.
- A better sidewalk system is necessary to protect pedestrians and a safe walking zone. It will also encourage residents to walk more.
- Enforcement of building codes
    - Hazards such as living capacity, and whether or not the house is suitable to live in (enforce condemnation) need to be addressed.
- Collaboration between the Emergency Preparedness Task Force for implementation community wide referring to emergency plans and warning systems.

Next Steps

Near Term

- Collaboration between the Tribe and the AISU
- Improvement on Lepquinum Wellness Center

Long Term

- Continuation of annual Health Fairs
- Community outreach and awareness
- Encouragement to residents on utilizing local support groups and services

Key Terms	
Adaptation	Planning for inevitable impacts of climate change and reducing vulnerability to those impacts.
Anadromous	Migrating up rivers from the sea to breed in freshwater, used for fish.
Anomalies	Something different, abnormal, peculiar, or not easily classified.
Anthropogenic	Changes in nature made by people. Anything created and/or caused by human activity. For example, pollution is anthropogenic.
Boreal Forest	Of, relating to, or comprising the northern biotic area characterized especially by dominance of coniferous forests.

Emery Rod Method	A simple profiling method used to measure the transverse beach profile using only tape and leveling rods. A hand level will be necessary if the horizon is not visible. In order to accurately measure shoreline profile changes, consistent and precise measurements of the profile are mandatory for the most accurate results.
Erosion	The physical process by which materials (soil, rock, or sand) from the Earth's surface are removed, primarily due to natural agencies such as water or wind.
Harmful Algal Bloom (HAB)	An algal bloom where the algae produce powerful toxins that can kill fish, birds, and mammals, and ultimately cause illness in humans. The harmful bloom can also cause oxygen depletion in the water due to the death and decomposition of non-toxic algae species.
Isostatic Rebound	(Also known as "post-glacial rebound") The rise of land masses which were previously depressed from the capacity of the ice sheets during the last glacial period.
Megawatt (MW)	A unit of power, equal to one million watts.
NOAA	National Oceanic and Atmospheric Administration where scientists study the correlations between the sky and the ocean.
Noxious Weed	A weed considered to be harmful to the environment surrounding it, with attempts to control it. Most noxious weeds have been introduced into an ecosystem through ignorance, mismanagement, or accident but some are native.
Ocean Acidification	The increase in acidity of seawater due to increasing concentrations of carbon dioxide.
Pacific Decadal Oscillation (PDO)	The leading pattern of sea surface temperature anomalies in the North Pacific basin (typically, polewards of 20°N).
Pounds per Square Inch (PSI)	A measurement of pressure in the Imperial system of measurement, commonly used to measure the pressure of gasses or liquids.
Sea Surface Temperatures (SST)	Water near the ocean's surface, 1 millimetre (0.04 in) to 20 meters (70 ft) below the sea surface.
Seedbomb	A little ball made up of a combination of compost, clay and seeds. After a

	few weeks the first seedlings work their way through the seedbomb and root into the ground. The seedlings then grow into mature plants, as they grow, more seeds germinate while the seedbomb dissolves.
Shelled Pteropods	Any small marine gastropod mollusc of the group or order *Pteropoda,* in which the foot is expanded into two winglike lobes for swimming and the shell is absent or thin-walled.
Snag (Ecology)	A standing, dead or dying tree, frequently missing a top or most of the smaller branches.
Sprig	The smallest division taken from a live Beach Wildrye plant that can be used to grow a new plant.
Traditional Knowledge (TK)	Cultural traditions, values, beliefs, and views of local peoples distinguished from Western scientific knowledge. Traditions being passed on from their forefathers to the present generation for the purpose of survival while still living in harmony with the ecosystems. Such local knowledge is the product of indigenous peoples' direct experience of the workings of nature and its relationship with the social world.
Recharge (Water)	Water that is added to an aquifer through rainfall seeping into the ground.

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Section 5: Vulnerability Assessment

5.1 Vulnerability Introduction

Every community is vulnerable to change. Impacts of a changing climate are likely to be highly variable. A vulnerability assessment is defined as the process of identifying, quantifying, and prioritizing the vulnerabilities within a specific environmental system. Investigating the risks surrounding a particular impact; a changing climate is of substantial concern while assessing the AIR. Vulnerability assessments designate the Tribe's resource priorities to improve and target future adaptation strategies. The purpose of this section is to identify ample threats on the AIR resources. Assessing environmental conditions and subsequently regulating adaptation strategies requires quality data. This will be accomplished through information gathering on local climatic and non-climatic data, with available resources, tools, and assessments. Evaluation of vulnerabilities allows for the Tribe to establish a baseline for futuristic actions in environmental management. It is imperative that the Tribe recognizes that the alteration of climatic conditions is complex, therefore the threats to the community are difficult to quantify. For instance, there is a significant ecological driving force directly affecting the AIR, the shift in precipitation patterns. This vulnerability is likely to intensify in the future. This will lead to consequential challenges and cause a cascade of impacts, resulting in a massive force directly affecting the Tribe's water abundance and availability.

Figure 5-1: Assessment to Adaptation. Starting with the assessment of vulnerabilities is imperative in defining risks posed by a changing climate and providing information to identify actions for adaptation. This enables decision makers to determine the most vulnerable locations of the community. The continuation of vulnerabilities monitoring whether or not changes occur must be reported. Adaptation is a collaborative process necessary in strategic planning, monitoring and reporting assure long term adaptation and management of local resources.

The Tribe will be affected through the following vulnerable environmental components: Coastal Erosion; Invasive Species; Salmon; Shifting Precipitation Patterns; Overall Subsistence Practices: Alaskan Yellow Cedar, Berries, and Shellfish; and Human Health. Sensitive systems are less likely able to adapt well to abrupt changes and have a higher possibility of becoming vulnerable to a changing climate. Reducing vulnerability is critical to the adaptation of changes related to the changing climate; adaptations improve resiliency. The section below highlights a vulnerability analysis on the local AIR environmental assets and determines the top threats to the Tribe.

5.2 Vulnerability

While natural systems may decrease in vulnerability, exposure and sensitivity; they also increase adaptive capacity. Exposure is defined as an asset located in an area experiencing direct impacts of a changing climate (temperature and precipitation) or indirect impacts (sea level rise). Sensitivity captures how an asset manages when exposed to an impact such as a changing climate. There are various types of sensitivities: cultural, economic, environmental, physical, and social. Sensitivity estimations of vulnerability levels are related to climatic community responses. Adaptive capacity allows for the community risk to be balanced; the ability for a system to adjust to a changing climate. Flexibility of the community is predicted by responding to, coping with, and recovering from climatic impacts. Lifestyle patterns may shift, therefore other opportunities will likely be presented. Risk is known as the combination of two elements: the likelihood of an event occurring and the consequence of such an event. An intricate climate system has risks which frequently influences detrimental impacts. Consequences, plus probability, results in environmental risk (Figure 5-2, Below).

Figure 5-2: The risk formula consists of consequences plus probability results in environmental risk, such methodology is used to evaluate environmental risks associated with complex climatic shifts. Such risks are characterized by two components: magnitude of consequences and probability of consequence occurrence.

Vulnerability is explained as the degree to which a system is exposed and impotent to cope with unfavorable effects of a changing climate, from climatic variability to extremes. Vulnerability is dependent on specific variables in specific locations. For example, this community traditionally and economically values Alaskan Yellow Cedar, which is highly dependent on snowfall. Due to recent shifts in precipitation patterns from a warming climate this has posed a serious challenge to this tree species. Through integrating vulnerability components of adaptive capacity, exposure, risk, and sensitivity, there is a foundation for future decision making. It must be recognized that high sensitivity + low adaptive capacity = high vulnerability and vice versa, low sensitivity + high adaptive capacity = low vulnerability. Adequate knowledge and understanding of a subject improves the decision-making made by community members or Tribal Leaders. Understanding convoluted processes can be daunting but approaches to climatic impacts can be simple and realistic.

The intention of vulnerability assessments are to inform the community of the upcoming stages in adaptation planning. Vulnerability of natural systems relating to a changing climate and its ability to adapt, is a rather new field of research, thus uncertainty is possible. Natural systems are expected to adjust intrinsically by making environmental alterations, directly affecting the

quality of the community's environmental variables: local air, land, and water. Any threats which exist are exposed to the impacts are called hazards. Hazards can be discrete and/or continuous. The vulnerability status of local resources will depend on the hazardous nature of the community. Being challenged with acute ranges of conditions, exposure and sensitivity impacts are possible to be direct or indirect upon the Tribe.

Table 4-1: Introductory Vulnerability Assessment		
High Vulnerability	**Medium Vulnerability**	**Low Vulnerability**
Subsistence	Invasive Species	Shellfish
Shifting Precipitation Patterns	Yellow Cedar	-
Salmon	Shoreline Erosion	-

The intent of the information presented in Table 4-1 (Above), is to inform the community and assist in future planning decisions. The table identifies potential high, medium, or low vulnerabilities for the Tribe. *Note, this is not an inclusive list.* Each perceived vulnerability is based on basic reviews, not thorough research. A more accurate vulnerability matrix will be presented in the Appendix representing detailed descriptions of climate change impacts. Since natural systems will be increasingly affected by a changing climate, understanding all potential impacts is an important first step to local sustainability[57]. Ranking the vulnerabilities will allow the Tribe to decide how to allocate resources and funding based on the needs of the community.

5.3 Assessment

In Southeast Alaska, documentation has demonstrated that climatic variability has increased from coastal wetlands to high mountainous elevations. The vulnerability assessment presented below includes four local vulnerability categories: adaptive capacity, exposure, risk, and sensitivity. The following prioritizes components that were catalogued as high risk resources on the AIR were assigned a quantitative value. Vulnerability threats and stressors were also identified. The vulnerabilities were then placed on a scoring matrix to provide a numerical vulnerability score for each vulnerability impacting the Tribe. For the purpose of this plan, the vulnerability assessment score totals that range between four and five were ranked as highly vulnerable resources, three was considered as moderately vulnerable, and between one and two were scored as low vulnerability. The results were then calculated using the mathematical formula (sensitivity × risk - adaptive capacity = total vulnerability priority). This equation produced quantitative vulnerability totals for the Tribe, aiding prioritization of impacts that pose the greatest threats.

[57] Füssel , H., & Klein, R. (2006). Climate Change. *Climate change vulnerability assessments: an evolution of conceptual thinking, 75*(3), 301-329.

Note, all of the information provided below (Table 4-2 & 4-3) are preliminary assessments and not comprehensive rankings. The comprehensive vulnerability assessment is found in the Appendix.

Table 4-2: Vulnerability Assessment

Exposure	Sensitivity	Risk	Adaptive Capacity	Total Priority
Human Health	5	5	2	**23**
Shifting Precipitation Patterns	5	5	3	**22**
Salmon	5	5	3	**22**
Subsistence Practices	4	5	2	**18**
Invasive Species	4	5	5	**15**
Shoreline Erosion	5	3	4	**11**
Yellow Cedar	3	3	1	**8**
Shellfish	3	3	3	**6**
Berries	2	3	3	**3**

Table 4-3 (Below) represents the likelihood of climatic impacts occurring upon the Tribe's ecosystem assessed and described on a quantitative scale. Each of the following components presented in Table 4-2 (Above) resulted in one of three priority categories: high, moderate, or low vulnerability priority. After examining the results, it was determined that three immediate concerns with major risks and high likelihood are (shaded red): Human Health, Hydrological Resources and Salmon Migrations. Continuing; Coastal Erosion, Invasive Species and Forest Decline (shaded orange) were deemed moderate vulnerability priority with moderate risk and medium likelihood of occurring. Lastly, all other subsistence practices including Alaskan Yellow Cedar, Shellfish and Berry harvesting (shaded yellow) were ranked as low vulnerability priority with minor risks and a low likelihood of impacting the AIR from a changing climate. Table 4-3 (Below), the Vulnerability Priority Ranking Scale presents a key to decipher the Total Priorities column in the Vulnerability Assessment Table 4-2 (Above). The Total Priorities were calculated using the mathematical formula of (sensitivity × risk - adaptive capacity = total vulnerability priority).

Table 4-3: Vulnerability Priority Ranking Key	
0-10	Minor impact on community, short duration and minimal effect on environment and species
10-20	Moderate impact on community, impairment of environment and species
20-30	Major impact on community, extended duration with significant impairment of environment and loss of species

5.4 Conclusion

Analyzing vulnerability assists in the priority establishment of each threatened location, seeking proper planning techniques in forest, coastal, wildlife, and cultural sectors of the Tribe. Impacts are dependent on various factors, such as location and species, all of which are subject to be altered with continuous climatic transitions. Preparation and prioritization of the Tribe's goals is significant in addressing climatic impacts. These impacts are based on multiple components, from funding opportunities, governing authorities, planning scales, and time frames, to TEK considerations. Limitations must be acknowledged when interpreting information, specifically relating to potential hazards. Southeast Alaska has to consider the diversity of vulnerabilities when referring directly and indirectly to a changing climate. During decision making it is imperative that all resources are allocated and factors involved are understood for the reduction of vulnerability threats.

Key Terms	
Adaptation	Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities
Adaptive Capacity	Allows for the community's risk to be balanced, is the ability for a system to adjust to climate change.
Continuous (Data)	Data that assumes value within a range, based on measurements that has an infinite number of possible values.
Discrete (Data)	Data containing distinct values, based on counts represented by a finite value.
Exposure	An asset that is located in an area experiencing direct impacts of climate change, such as temperature and precipitation changes, or indirect impacts, such as sea level rise.
Hazard	A field of certain threats or impacts, which exist regardless of the availability of object or element exposed to the impact.
Risk	A combination of two elements: the likelihood of an event occurring and the

	consequence of such an event.
Sensitivity	How the asset fares when exposed to an impact.
Vulnerability	The degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes.

Section 6

Section 6: Implementation

6.1 Implementation Strategies

Climate change is complex and intransigent. It continuously challenges community aspects by compromising the progress and well-being of local species. It is essential to understand what, when, where, why, and how while planning for implementation[58]. There is a higher likelihood of adaptation strategies to be implemented by improving the understanding of the dynamics of climatic systems relating to natural variability. A connection between climate change adaptation assessments, planning and implementation should be established on a community based scale. There is a strong relationship between implementation, evaluation, and monitoring, interpreted in the section below. This chapter is intended to provide guidance for the Tribe on adaptation strategies for a changing climate.

Implementation strategies include:

- Leadership supporting TEK and scientific data collection
- Community outreach, focusing primarily on environmental opportunities
    - Gardening and composting
    - Hosting community events and celebrating conservation
    - Advertising community harvesting lessons offered by knowledgeable individuals
    - Informing the community of individual impacts on the local environment
    - Stressing the importance of understanding the unprecedented climatic situation
- Forming necessary partnerships
    - Collaborating with agencies to accomplish monitoring and evaluation efforts
- Ensuring appropriate funding
- Providing sufficient tools and resources needed to conduct climate change research

There are limitations on implementation strategies because every action cannot be enforced at once. This is the importance of prioritizing each of the six climate topics evaluated in the vulnerability assessment presented in Table 4 - 2 (Page 68).

[58] Snover, A.K., Whitely Binder, L.C., Lopez, J., Willmott, E., Kay, J.E., Howell, D., Simmonds, J. 2007. Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments. University of Washington's Climate Impacts Group and King County, Washington, in association with and published by ICLEI – Local Governments for Sustainability, Oakland, CA.

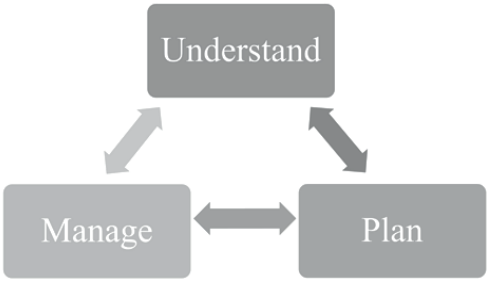

Figure 6-1: Understanding, planning, and managing for climatic risks is critical for the future. Regulating the effects is a community mission both in short- and long-term. Monitoring the performance of climate stressors will be necessary to evaluate variability. Climate change impacts are being felt today and will be for decades to come. Shifting weather events are beyond human expertise and experience, the past may no longer be a reliable predictor for the future. Identifying dependable goals to be developed from climate change strategies, policies, and plans will promote success.

6.2 Monitoring & Evaluation

Monitoring approaches must be logical and provide accurate data in response to the plan's goals and objectives. Reliable data will determine the current status of vulnerabilities and model projections for the future. The following section will highlight new monitoring efforts and evaluation strategies for at risk resources on the AIR. Community awareness is vital. Monitoring and Evaluation (M&E) must assure long term adaptation and management of local resources[59]. This Climate Change Adaptation Plan is to be modified routinely as new data and information becomes available.

Some challenges posed by a changing climate will be new to the community, other challenges have existing or ongoing efforts. There are three main categories of adaptation monitoring: monitoring preparation of the plan, monitoring of actions, and monitoring results of implementation. While monitoring, it is important to bear in mind the need to accept a certain amount of uncertainty, extended timeframes, baseline changes, inconsistent data, and information diversity. Understanding that one must have an open mind while monitoring climatic impacts and accepting that there is no exact way to adapt will guide future decisions.

Evaluation is defined as the process of reviewing and analyzing specific outcomes to determine its effectiveness. Options include formal evaluations through funding agencies or non-formal evaluations through the community itself.

The Evaluation Process is as follows:

- Review adaptation goals
- Recognize community adaptation actions
- Compare the goals with implementation actions

[59] "Monitoring and Evaluation in Climate Change Adaptation. (2016, July 01).

- Assess vulnerability changes and identify whether or not adaptation actions were affected while achieving such goals
- Record all results in a written report

With the collection of qualitative and quantitative data, adequate analysis facilitates moving towards a desired goal. Evaluation assists the determination of accountability involved in plan preparation as well as the support for future funding opportunities.

6.3 Conclusion

As stated in the Executive Summary (Page 9), the change in climate is occurring and Alaska is being directly and indirectly impacted. Planning for adaptation now is a vital step in community preparation for climatic vulnerabilities. Developing such efficient adaptation allows for effective, less expensive strategies. All future impacts are dictated by the actions made now. Sustainability is critical in maintaining Earth's ecological and biological systems. As such natural systems diminish, anthropological well-being and health will become threatened. Earth has limitations as every system does, technology will only allow for humans to advance so far. Realizing humans play an immense role in adaptation is critical to the success of the future. Human influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history. Recent climatic alterations have had widespread impacts on human and natural systems[60].

A changing climate increases the potential for climatic risks to arise, therefore management is necessary, which in turn reduces local impacts on the Tribe. Climate change adaptations require consistent actions, through adaptation the community can limit risks. For implementation to be successful, reliable resources and tools that will allow for appropriate capacity to be improved are necessary. Such responses can then be integrated into planning due to their relevance to energy planning and climate change implementation. Accommodating climate change adaptation into planning and decision making plays a key role in promoting implementation.

Key Terms	
M&E	Monitoring and Evaluation
Monitoring	A continuous/periodic process where specific data indicators are systematically collected to provide information about performance.
Evaluation	A systematic and objective feedback of a completed or ongoing action, aimed at providing information about design, implementation and performance.

[60] IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

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Section 7

Section 7: Conclusions

The section below will be utilized as a guidance tool for the Tribe on how the AIR should respond to future climatic impacts. Focusing on which of the following steps must be taken to establish a successful and resilient future, will ensure that climate change adaptation actions enable opportunities to promote a sustainable community. Funding and partnerships are necessary in accomplishing the recommended strategies provided in this document. At the end of this section, the Metlakatla Indian Community Climate Team will provide acknowledgements to those who have contributed to the preparation of this Climate Change Adaptation Plan.

7.1 Looking Forward

Climatic threats are widespread and uncertain thus, multiple sectors of the community are being impacted. To ensure the success of advancement, monitoring the progression of ongoing assessments through formal and informal evaluations will be necessary. The Plan will be adjusted and updated should circumstances significantly change. Using engineering and natural solutions, and a willingness to alter personal practices, the Tribe can be prepared for inevitable change. The Tribe can decrease potential vulnerabilities associated with a changing climate by efficient mitigation and planning efforts[61].

Future studies may be needed regarding greenhouse gas emissions inventory, community ecological footprint, and/or shifting towards renewable energy. Should funding and opportunity arise, the Tribe will be open to improving scientific data collection to better understand ecological thresholds. The use of TEK will be included within all community plans.

Monitoring the progress of implemented adaptation efforts on the community is encouraged. As a working document, this plan can be revised continuously as new information becomes available. Routinely updating the plan along with proactive community outreach will ensure the plan remains relevant. The practice of combining TEK with generally accepted western science will provide data that is useful to the Tribe and will produce a plan the Tribe will support.

The Tribe is currently working to update the Pre-Disaster Mitigation Plan and Emergency Preparedness Plan by using the recommendations in this plan to balance the best mitigation measures in the face of a changing climate and potential impacts on human health and safety. This includes supporting community outreach education, advocating individual and community clean lifestyles, and informing the Tribe on local health updates. Climate change risk awareness must be raised, by local outreach, discussion groups, community events, or local news. As awareness begins to increase, so will the level of communication, respect, and understanding of the Tribe in order to develop the strength necessary to overcome future challenges. Enabling climate adaptation strategies through enhanced understanding is a vital role in community awareness. This can be established through training sessions for local members and workers to

[61] UN Environment: Climate Change Mitigation. (2017).

attend, therefore promoting climate planning and management of resources. This will give individuals the ability to expand their knowledge within the scientific, technological, and TEK sectors of the community relating to climate vulnerabilities. The intended goal of this plan is to achieve community resilience and self-sufficiency, as reflected in the Tribe's Mission Statement. This will be achieved when key adaptation strategies are put into action.

7.2 Funding

Funding to support implementation of actions will vary. Portions of funding could possibly be acquired from the Department of the Interior (DOI) and Bureau of Indian Affairs (BIA). These funding opportunities will support existing efforts to modify subsistence practices that will benefit the resource and the Tribe. Subsistence adaptations will not require funding, instead behavioral modification of timing is required. Alternative funding options will be necessary to support implementation of renewable energy, such as from the Department of Energy-Indian Energy (DOE) and the Division of Energy and Minerals Development (DEMD). Qualifying for such federal and state funding resources will require flexibility and willingness.

7.3 Partnerships

- Metlakatla Indian Community Tribal Council
    - Planning and Natural Resource Committee
- Metlakatla Indian Community Department of Fish and Wildlife
- Metlakatla Indian Community Department of Forestry and Land Resources
- Annette Islands School District
- Annette Islands Service Unit
- Bureau of Indian Affairs Northwest Region
- Central Council of Tlingit and Haida
- Department of Interior - Division of Energy and Minerals Development
- University of Alaska Fairbanks
- U.S. Forest Service
- U.S. Fish and Wildlife Service
- Sitka Tribe

Key Terms	
TEK	Cultural traditions, values, beliefs, and views of local peoples distinguished from Western scientific knowledge. Traditions being passed on from their forefathers to the present generation for the purpose of survival while still living in harmony with the ecosystems. Such local knowledge is the product of indigenous peoples' direct experience of the workings of nature and its relationship with the social world.
Mitigation	Reducing climate change, such as emissions of and stabilizing the levels of heat-trapping greenhouse gases in the atmosphere.

Acknowledgments

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Special recognition to all the contributors

- Metlakatla Tribal Council
- Climate and Energy Grant Department
- Fish and Wildlife Department
- Tamgas Creek Fish Hatchery
- Forestry and Natural Resources Department
- Duncan Cottage Museum
- Annette Islands School District
- Metlakatla Community Members
- Sealaska Corporation

Metlakatla Indian Community Climate Team

- Julia Scott, Climate Change Analyst
- Alexis Wagner, Climate and Grant Intern
- Genelle Winter, Climate and Energy Grant Coordinator

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- David Nelson, Graphic designer of cover page

This plan will become an important asset for the MIC and its resource management.

Refer to Master Copy