SUBSISTENCE FISHING IN THE YUKON RIVER DELTA: A CASE STUDY OF ALAKANUK SUBSISTENCE FISHERY AND THE USE OF LOCAL/TRADITIONAL ECOLOGICAL KNOWLEDGE

by

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Chinook salmon (Oncorhynchus tshawytscha)

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ABSTRACT

The Yukon River delta is home to many subsistence Tribal communities that rely heavily on salmon as a food source. These communities structure resource use and management around Local/Traditional Ecological Knowledge (LTEK). LTEK is a rich source of data built on observations and natural indicators throughout generations. The use of LTEK is growing in interest across the world, as governments, scientists and local people struggle with declining resources, climate change and environmental changes.

Recently, the Yukon River salmon runs have been declining, jeopardizing the well being of subsistence communities. Additionally, climate change may be impacting the communities' food security. This paper will assess the concerns and observations of the Alakanuk Tribal community in relation to food security in order to explore the potential use of participatory methodologies, generated from a combination of LTEK, western science and resource management. Approaching concerns of food security, salmon health, climate change, and impacts of large-scale fisheries through the human dimension and a participatory approach, (built from LTEK, western science and resource management), may bring fisheries science and management to the level of ecosystem-based management further incorporating a holistic approach to fisheries management.

Yukon River Delta

Introduction

The mouth of the Yukon River is home to numerous Native communities that depend on subsistence food sources from the Bering Sea and Yukon River, including three subspecies of salmon: Chinook (*Oncorhynchus tshawytscha*), summer and fall chums (*O. keta*), and coho (*O. kisutch*). The Yukon Delta has been home to the Yup'ik for at least the last two thousand years (Ann Fienup-Riordan 1990:49). These communities have amassed a body of natural history knowledge and resource use practices based on environmental indicators concerning the relationship of living beings to one another and to the physical environment (Berkes 2000, Berkes 1993). This knowledge is referred to by western cultures as local/traditional ecological knowledge or LTEK. LTEK has evolved by adaptive processes and has been handed down through generations orally or through practical experiences (Berkes 2000).

Within LTEK one can see that indigenous people have their own consistent system of logic and thought process, which is no more or less valid than any other (Berkes 2000, Snively & Corsiglia 2000, Ross & Pickering 2002). This source of knowledge is recognized within a growing body of literature as a valuable source of information that offers a unique long-term set of data based on observations and human interactions (Huntington et. al 2004, Ford & Martinez 2000, Ross & Pickering 2002). Today Yup'ik Tribal communities are facing increasing challenges as a result of climate change, declining resources, and social changes, which are threatening the integrity of the ecosystem that they are part of and depend on.

The initial intent of this research project was to investigate the potential affects of climate change on salmon, food security, and the value of LTEK in the face of these current problems. Upon visiting the village of Alakanuk, located in the Yukon River Delta, it became evident that a large problem lies in the concerns of the Tribal community regarding management decisions and lack of their involvement in the face of these challenges. Overall this paper will attempt to address if there is a need for LTEK to be combined with western science and resource management to establish participatory practices (defined below), in response to the concerns raised by the community. To do this I will assess the Alakanuk Tribal community observations and concerns related to food security, provide examples of participatory methodologies applied under similar obstacles, and discuss the importance of LTEK. Subsequently, the largest concerns raised by the Alakanuk community will be discussed:

1) Tribal perception of management decisions and methods
2) Change in salmon behavior, timing, abundance and health
3) Climatic variability/environmental changes
4) Social change
5) Deep-sea fishery bycatch
6) Use of LTEK in resource management

Each one of the six concerns raised by the Alakanuk community could be a full research paper on its own; however, this paper has addressed them together to further highlight the interdisciplinary aspect of the challenges faced. Approaching concerns of food security, salmon health, climate change, and impacts of large-scale fisheries through the human dimension and a

participatory approach, (built from LTEK, western science and resource management), may bring fisheries science and management to the level of ecosystem-based management.

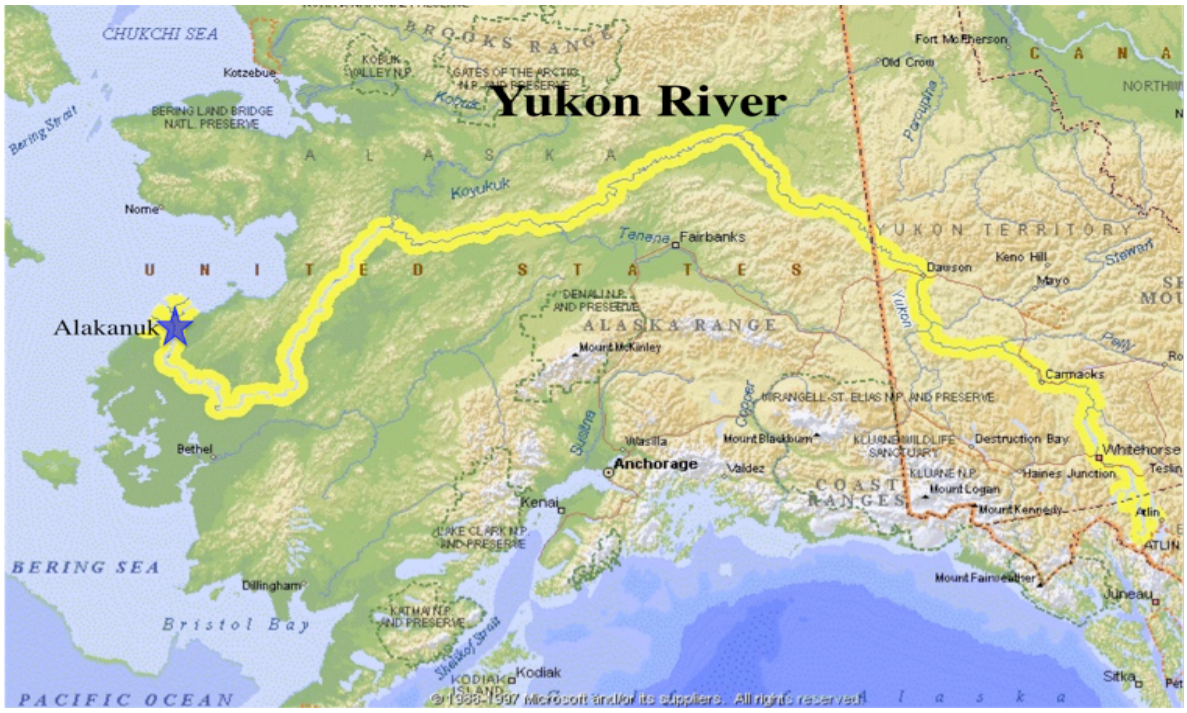


Figure 1. Alakanuk at the mouth of the Yukon River ©1988-1997 Microsoft and/or its suppliers

Participatory methodologies

This paper follows Fisher et al. (2003) use of participatory methodologies in reference to both research and management. The term "participatory research" refers to a process involving LTEK holders and scientists throughout the entire research process, from conceptualizing the issue to investigation to developing a research design, and "from collecting, analyzing, and interpreting the data to disseminating the results" (Fisher et al. 2003). A participatory approach to management involves LTEK holders and managers throughout the entire decision-making process, encompassing the same characteristics of participatory research in which LTEK holders and managers collaborate together to identify problems, solutions and develop affective management tools.

Background

The Yup'ik community has held a close relationship with salmon throughout their history. The importance of salmon as a subsistence food source is evident in the Yup'ik language: the term 'real food' and 'salmon' both share the same Yup'ik word Neq'pik (Anonymous March 31, 2011). In recent years, drastic decreases in salmon numbers have led to the speculation that the decline involves more than just natural fluctuations known to occur within salmon runs and have required regulators to increase regulations on fishing. Between 1997 and 2002, five "state economic fish disasters" were declared in response to declining salmon runs throughout the Yukon River watershed (AYK SSI 2006). The Walleye pollock fishery has been identified as one potential cause for the disaster. The Bering Sea Walleye pollock industry has substantial incidental bycatch of Chinook and chum salmon. This bycatch steadily increased through the late

1990s and into the 2000s (NMFS & NPFMC, EIS 2008). In addition to the impacts of the pollock industry, rapid environmental changes have affected Tribal communities' ability to harvest fish. Both Native communities and western scientists have documented climatic changes, including, changes in the timing of freeze-up and ice break-up, warming water and atmospheric temperatures, increasing salinity in the fresh water, melting permafrost, and more. Changes in climate and the overall ecosystem may also be affecting salmon runs. The changes in salmon runs and environment often give rise to conflicts between resource usage guidelines, state regulations, fishing industries, and Native community management schemes based on LTEK. The following section will offer a brief background of Alakanuk, Yukon River fishery regulations, climate change, and salmon runs.

Figure 2. The Yukon River Delta © eoVision 2008

Alakanuk

Alakanuk is found along the south tributary of the Yukon River, one of three outlets connecting the river to the Bering Sea. This delta is highly dynamic with constantly shifting sediment and vines of water running through the land. The passages of water traditionally freeze solid from late October to late May (Justia 2011). The frozen water is used as a roadway by snow mobile, dog sled and pedestrian alike. During the warmer months, with the ice melted, boats become the major mode of transportation. Small aircrafts bring in mail, outboard engine parts and any other goods that cannot be obtained by water or land. Alakanuk is home to 677 people as of 2010; this is an increase of 23 people since the 2000 census (ACC 2010). The government is the main employer, employing 40% of working age adults, +16 yr (ACDCIS 2011). Wolfe (2010) found 72% of households surveyed in 2008 were active subsistence harvesters. The Bering Sea lies 13 miles to the west of Alakanuk (ACDCIS 2011). The sea is a semi-enclosed high latitude sea that is connected to the Arctic Ocean by the Bering Strait. The ecosystem is controlled by winter sea ice, which forms in the northern regions and extends southward, varying each year with climate conditions (Overland & Stabeno. 2004). The remote location, rough conditions, and lack of natural resources for commercial interest limited the discovery of villages like Alakanuk until the

late 1800s (Fienup-Riordan 1990: 29). The community was not reported until 1899. A cannery opened in the 1940s and by 1946 a post office had moved in (LYSDC 2011). In the 1960s the mode of living in Alakanuk began to change. Their children were sent to boarding schools up the river and housed with foster parents or in boarding schools. Children were told not to speak their native Yup'ik tongue and a disconnect began to arise between older and younger generations (Anonymous April 4, 2011). This disconnect will be addressed further in the paper.

The Alakanuk community holds historical and cultural ties to the fish found in the Yukon Delta. The dependency and close relationship that the Yup'ik hold with fish is evident in their oral history, daily lives and even their language. The Yup'ik word for food is Neqeqaq; and shares the same root with the word Neqaa, meaning 'fish' (Anonymous April 6, 2011). Though subsistence food is largely based on fish, people also hunt and/or trap seal, beluga whales, beaver, moose, geese, ptarmagin, additional waterfowl, fox, hare, land otter, lynx, minx, and muskrat (Wolfe. 2010). Traditionally, subsistence salmon fishing occurs from late May through early October. The salmon runs correspond with the breaking-up of seasonal ice and incoming tides. Set gillnets are used, in the main rivers and coastal marine waters (Fall, James A. et. al. 2009). Drifting gill nets are increasingly being used due to their efficiency in being able to produce more salmon per unit time (Wolfe. 2010). Traditionally fish would be stored within the ground, kept frozen by perma-frost. With the addition of technology, such as freezers, and the melting of permafrost, this practice is in less use. Still in use is the tradition of freezing, drying, or smoking salmon for use throughout the year. The head, gut scraps, and viscera are fed to dogs or used to make fish stock, (Fall et. al. 2009).

Regulation of Yukon River Pacific Salmon and Subsistence

Alaska fishing management is divided into six (plus coastal) districts with Alakanuk falling within the district Y-1 (see fig. 3). Salmon are an anadromous species. Chinook and chum salmon spawn in the Canadian freshwaters traverse the Yukon River to the Bering Sea and return to spawning grounds in Canada to complete their life cycle. The management of fishing this species occurs through both state and federal agencies. The Alaska Department of Fish & Game (ADF&G) is tasked with overseeing state waters, while the US Wildlife & Fish (USFWS) oversees all federal waters (Grabacki. 2008). The National Marine Fisheries Services (NMFS) oversees the ground fisheries in the Bering Sea. As salmon are an anadromous species, NMFS affect subsistence salmon fishers through regulations placed on ground fishery salmon bycatch (Witherell & Clarence. 1997).

The state managed species fishing regulation process begins with a local advisory committee. The advisory committee accepts input from the public and technical assistance from the ADF&G. The advisory committee offers recommendations to the Board of Fisheries (BOF), consisting of seven members appointed by the Alaska Governor. BOF sets the policy and direction of management for fisheries. The BOF receives technical reports, stock status, etc. from ADF&G and also accepts input from the public; this information is used to determine allocation of state managed species. ADF&G implements regulations and manages fisheries according to those regulations (Grabacki 2008).

Figure 3. Alaska fishing districts (four of six districts), Alakanuk lies in district 1. (ADF&G 2011)

The transboundary migratory nature of salmon has lead to the Yukon River Salmon Agreement treaty between Canada and the United States to ensure yearly goals of recruitment and escapements are achieved (YRSA 2002). The ADF&G main objective is to achieve escapement goals for salmon that spawn on either side of the Canadian, U.S. border; therefore, this goal also serves as a conservation strategy. Their second priority is subsistence use and Canadian harvest sharing followed by commercial, sport, etc (Loring & Gerlach 2010). Regulators use forecasts and models of the strength and timing of salmon runs, in-season monitoring and sonar counts to make regulatory decisions (Loring & Gerlach 2010). Protocol dictates that state and federal managers solicit input from NGOs such as the Yukon River Drainage Fisheries Association (YRFDA). YRFDA has acted as a strong voice for Tribal communities of the Yukon.

Recent Decline in Salmon Runs

In 1993, 1998, 2000, 2001 and 2002, the Chinook salmon run came in drastically lower than expected, with a complete closure in 2000. In 2000, the Chinook salmon run was listed as a stock of concern and restrictions were imposed on the summer portion of the subsistence salmon fishery to protect Chinook and summer Chum salmon populations. The intent of the regulations was to meet escapement and Management Strategy Evaluation (MSE) goals. MSE is the process of using models to examine the robustness of candidate management strategies; based on the data generated an acceptable biological catch is determined (A'mar et al. 2008). The MSE and escapement goals were met from 2001 to 2006. The salmon run was very poor in 2007 and in 2008. As a result ADF&G closed commercial fishing, yet MSE was still not achieved. In 2009, MSE and escapement goals were both met, but subsistence salmon take was reduced by 35% (Loring & Gerlach 2010).

Deep-sea Fisheries Bycatch

The Walleye pollock fishery intercepts Chinook and Chum salmon bound for Western and Interior Alaska (Gisclair 2009). This bycatch steadily increased through the late 1990s and into

the 2000s (see appendix A), with chum salmon bycatch reaching a record high in 2005 of 704, 586 salmon before decreasing. Chinook salmon bycatch reached a record high in 2007 of 130,139 salmon (see figure 4), before decreasing (NMFS and NPFMC 2008). NMFS regulates the Bering Sea Walleye pollock industry and have applied rolling hot spots and area closures in attempts to decrease salmon bycatch (Witherell & Clarence 1997). In 2009, amendment 91 to the Bering Sea and Aleutian Islands Fishery Management Plan was passed, requiring 100% observer coverage and implemented a limit on intercepting species (NOAA CFR 2009). The incidental Chinook salmon take is now denominated into the catch; once this limit is reached all fishing for that vessel must stop (NOAA CFR 2009). The Chum salmon bycatch reduction measures are still being evaluated.

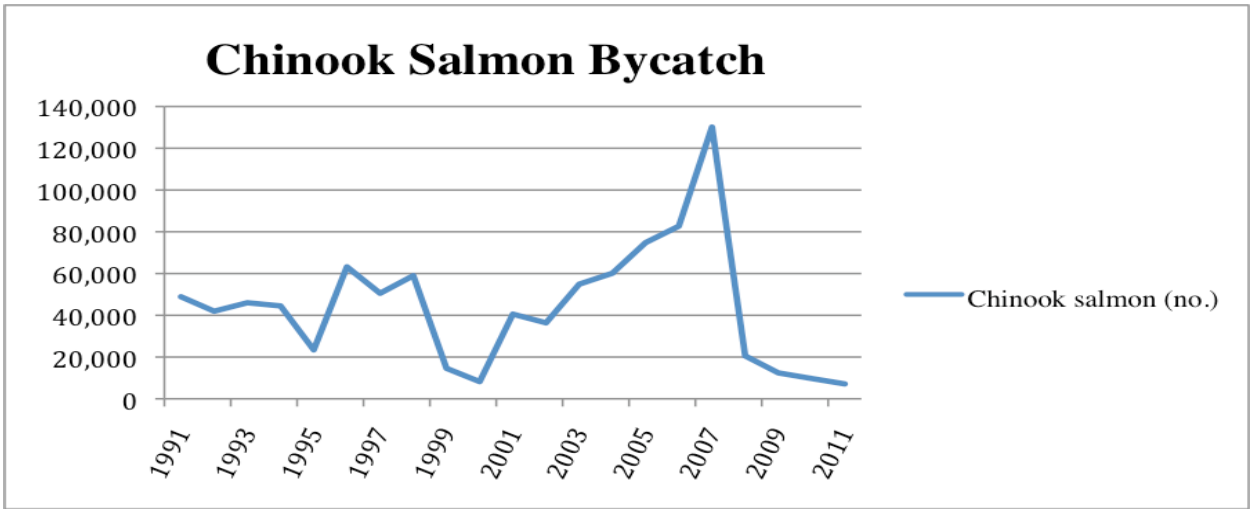


Figure 4. Yearly estimate for the Chinook salmon bycatch from the Bering Sea trawl fishery (NMFS. 2010)

Alaska Climate and Salmon

Tribal knowledge holders and scientists have long recognized salmon sensitivity to water conditions, ranging from riparian water flow and temperature to large-scale shifts in ocean climate conditions (Edmonds et al. 2003).

The Alaska climate is governed by multi-year (2-5 years) and decadal cycles (15-30 years). The El Nino Southern Oscillation, ENSO a multi-year cycle has been characterized by a warm upper ocean temperature and a change in the winds and currents, resulting in a suppression of cold nutrient rich upwelling (Edmonds et al. 2003). The Pacific Decadal Oscillation, PDO, is a decadal cycle. The PDO is thought to be a primary driver of warmer and cooler decade patterns in the North Pacific (Overland & Stabeno 2004). PDO years have been characterized by warmer water and high productivity and extensive sea ice (Overland & Stabeno 2004). It is hypothesized that the cycles are controlled by changes in the sea surface temperature and sea level pressure, both of which affect the ocean and the atmospheric circulation (Overland & Stabeno). The PDO can combine with a warm El Nino affect for a stronger warming, or contrast with it for a lesser impact. Pacific salmon fluctuations timescale have been noted to resemble those of the PDO (Mantua et al. 1997). At the moment these cycles are thought to be causing a cooling cycle (Overland & Stabeno 2004). In spite of the PDO cooling affect, overall climate change and increased temperatures have resulted in a warming trend throughout the entire state of AK.

The state has warmed 2 – 3°C since 1954 (ACIA, 2005). The Bering Sea surface temperature is predicted to increase 1.8°C by 2050 and is predicted to be ice-free year round by 2100 (ACIA 2005). A loss of sea ice will cause an increase in surface temperatures affecting many species including salmon. It is unclear what affect these changes may already be having on salmon populations but they may factor into the decrease in escapement numbers.

Given salmon's sensitivity to climatic variability it is important that aggressive research take place regarding potential impacts. Changes in temperature and ice coverage may also lead to changes in salmon food sources. Phytoplankton is dependent on sea ice through their life cycle in the Bering Sea (Overland. & Stabeno 2004). A decrease in ice and thinning ice is thought to result in less phytoplankton year round (Overland & Phyllis 2004). Zooplankton feed on phytoplankton and salmon feed on zooplankton. A decrease in salmon food sources may result in decreasing survival rates and size. Many additional shifts in the food chain may be occurring due to climate change.

Spawning Chum Salmon Pair (Onchorhynchus keta) ©David Blevins

Methodology

The Alakanuk community was chosen for this study due to the village's proximity and reliance on both the Bering Sea and Yukon River for subsistence. To further this study, additional villages along the Yukon River Delta will need to be included. The community was contacted in March to explain the project and ask for permission to visit the village. The Tribal council previewed the research proposal and provided their approval to the project. Catherine Moncrieff of the Yukon River Drainage Fisheries Association suggested a local guide, Denis Shelden. Denis acted as an interpreter, guide and expert on Yup'ik culture and LTEK throughout the project. Denis was of immense help in conducting this research and continues to offer feedback.

Peer-reviewed literature, technical papers and white papers were reviewed in areas of ecosystem-based management, participatory approach to management and research, natural indicators, local/traditional ecological knowledge, Pacific salmon history, pollock bycatch history, social science survey techniques, fishery laws and management.

A series of one-on-one conversations were conducted in the Village of Alakanuk to document local observations and concerns, with a focus on the impacts of climate change, subsistence fishing and salmon. A semi-directive interview method was used, by which questions were constructed and used to guide interviews as opposed to dominating them, following a conversation form as opposed to a formal interview (Huntington 2000). This survey method was chosen in attempt to eliminate bias created from pre-conceived ideas of the researcher (Corbin, and Strauss 1990). Four questions were devised regarding personal observations of the status of salmon (e.g., run strength, abundance, health, and long-term changes), changes in the environment and use of LTEK. Semi-directive interviews were conducted from late March to early April for six days with 11 Alakanuk Tribal members. Participants were selected by age, subsistence fishing activity, availability, and by recommendation from Tribal members. All, but one, conversation was recorded and transcribed at a later date. The transcribed conversations were then coded for recurring themes.

Conversations were also held by phone with state and federal fishery managers and scientists, to establish overall management practices and to fact-check details regarding their management approach and the specific management actions taking place with the current problems of declining stocks, climate change and relationship with subsistence fishers.

Collected Data Results: Local Assessment of Subsistence Fisheries

Throughout the Alakanuk community Tribal members participated in semi-directive interviews. The questions asked were used to guide the interview. All conversations began with questions concerning the formation and break up of ice, changes within salmon runs and the ability to obtain subsistence. The results generated candid conversations dominated by the communities' concerns. The use of LTEK and participatory practices to address these concerns will be discussed in more detail later in the paper. Six themes continued to arise through the formal recorded conversations and within casual conversations. Table 1 shows the six recurring themes derived through formal interviews; the percentages reflect the frequency of recurrence throughout the survey.

Table 1. Themes Derived From Semi-directive Survey Results (See Appendix D for Participant Comments)

Theme	Example	% Of Participants
Regulations	Distrust in management decisions and methods	100%
Burden of Conservation	Bering Sea pollock Industry salmon bycatch	64%
Observations of environmental changes	Ice formation is occurring later in the year, the ice formed is thinner, ice break-up is occurring earlier in the year and faster	100%
Salmon	Change in salmon runs, timing, behavior and health	100%
Social Change: Loss of Traditional knowledge	Impact of social economic change of the last fifty years has lent to a fraying of social traditions and the passing of knowledge	64%
Use of LTEK in Management decisions	Frustration voiced in having no connection to decisions being made in fishery resources	91%

Concern of Food Security
All participants reported that they were unable to achieve subsistence last year. Survey results showed that 82% of participants did not believe that they would achieve subsistence this year, while the remaining percentage chose not to discuss this topic as it is considered taboo or bragging to claim success in hunting or fishing. The lack of food security was associated with three themes, 1) regulations, 2) deep-sea fishing/burden of conservation, and 3) climate change/environmental change. In addition, all participants expressed concerns regarding observed changes in salmon runs, behavior and health. Furthermore, older participants expressed concern regarding cultural loss and changes in the socio-economic structure of Alakanuk, (this will be addressed in greater detail later in the report).

Tribal Perception of Management Decisions and Methods
Survey results showed 91% of participants hold concern for the impact that management decisions and methods are having on subsistence fisheries and the local ecosystem. Many people expressed distrust in methods used to collect data, regulations placed on when subsistence fishing may take place, referred to as 'subsistence windows', and a disregard for local knowledge and traditions. The following two comments were generated from the semi-directive interviews:

> *It is mainly the regulations…that affect subsistence…because our fishing times were not always when we wanted to or had the time to fish…because there are a lot of things that we do between break-up and time of fishing…and sometimes by the time we are ready the regulated time of subsistence is not good...(Subsistence fisher, Tribal member).*

> *…we are not allowed to fish at the right time [due to regulations]...they tell us to fish when the fish have all passed up river...(Subsistence fisher, Tribal elder).*

Tribal members reported a concern about the lack of understanding of subsistence or traditional ways of self-regulation by regulators.

> *And our way of fishing is…you have to be there when the fish are and we take what we need…we know how much we need…when we reach the amount that we need…then we stop… in the old days, the time of my grandfather, they regulated themselves, the tribe told people when to go fishing how much to catch and when to stop. This was based on how much each family would need to survive the winter…[start fishing] the earlier the better…because then we can spend more time doing other things like collecting logs and fixing fish camps… (Subsistence fisher, Tribal elder).*

> *…it has always been them [regulators, western management]...in the past they harvest like crazy...everything got cut off and then they forced their regulations on us…there the ones that harvest to much ...that they're ones that started it [miss management of salmon fisheries]…I don't know they [should] come out and watch the people, how they do, how they get their subsistence needs and then they'd understand what we are doing…no one ever comes out here…* (*Subsistence fisher, Tribal member*).

Survey results showed concern about regulations that require fish, nets, motors, or boats to be seized when a fisher is found fishing during non-regulated times. The seizing of fish and fishing

equipment was viewed as "…taking away more than half a person's food source and ability to take care of their families" (Anonymous April 5, 2011). Results showed 53% of participants distrust the technology used by scientists and regulators to acquire data on fish runs. Currently sonar technology is used to count fish recruits and fish escapements. A high concern was voiced regarding the limited places that sonars are placed and the sonar equipment ability to count passing fish with accuracy. One of the participants described these concerns:

> *… the sonar… don't work very good...just something like Fish and Game told them [that the sonar don't work well]...you get lots of moss growing around them and debris…but that sonar are not always in the position that it is suppose to be...as a result it is not catching the number of fish that are actually passing ... the current and debris flowing in the water, it can turn the sonar in different directions and positions so that it is not counting accurately.... [Additionally, sonars are placed in one area], if the salmon enter here when the wind comes from the south [the direction of the wind is believed to indicates which tributary the salmon enter], the sonar will miss [the] salmon coming into a different mouth… (Subsistence fisher, Tribal member).*

Survey results showed that all participants changed their harvest strategy in recent years as a result of regulations and increasing gas prices.

> *When the tide is right we set net, when they are not right we try drifting [drift net]. What we want to do is catch enough fish as quickly as possible, so that we can be done…if we fish in according to subsistence regulation then that extends our time that we need to take care of our fish and sometimes we lose them… when we catch fish in the amount that we want we take care of them all at once…we smoke and dry them all together. But, with regulation we have to wait a certain number of days for the season to open and sometimes the fish don't dry the way that we want them to...(Subsistence fisher, Tribal Elder).*

> *The price of gas is very expensive, this limits the time that we can go out and gather the fish, how many times we can actually go out there, it limits how far we can go…(Subsistence fisher, Tribal member).*

> *…in order to get fish they had to go out for about three miles down the coastline. We were not allowed to fish down on the Yukon and I didn't like it because sometimes it's windy down there…(Subsistence fisher, Tribal elder).*

Burden of Conservation/ Deep-sea Fishery Bycatch

Survey results showed deep-sea fishing salmon bycatch was the concern stressed most frequently following regulations. Concerns were voiced regarding the commercial fishing industries being favored over subsistence fishers by regulators. In addition, concern was expressed over the disposal of bycatch (this will be addressed in greater detail later in the report).

> *Mostly I think that it is the high seas fisheries [affecting salmon runs]. I hear reports of how many, how much bycatch [there is]…from what I can see regulations are working against us … the state and federal government our trying to make us be the ones that*

make sure the species survives by over regulating us… I listen to how much the high seas people make, it sounds like quite a bit compared to here… the people of the river, our voices are small almost unheard. But especially the high seas people they've got lots of money they hire lots of lawyers they get what they want and it is harder for us to say are peace… (Subsistence fisher, Tribal elder).

The commercial salmon fishing are getting a better chance to get after the fish then the subsistence fishing… (Subsistence fisher, Tribal member).

Climate Change: Ecosystem Changes

Survey results showed that all participants noted a concern in the increased speed by which the environment is changing. The following concerns were raised numerous times: increasingly unpredictable weather, increase in storm surges, changes in wind patterns, increased erosion, melting of permafrost, decrease in precipitation, change in land animals, (such as an increase of moose, wolves, lynx, bears), change in bird species, change in insects, and a decrease in other species, (such as geese, ducks and beluga whales entering the river at the beginning of the salmon season), warming air and water temperatures.

The mouth of the Yukon River and surrounding coastal area waters traditionally begin to freeze-up in late October and breaks up in late May. Large blocks of ice formed along the coast during colder months protect the village from severe storms (Gregory 2006). Survey results showed that all participants reported a change in the timing of ice formation and break-up. Formation was reported to be occurring later in the season while break-up is occurring earlier; additional concerns were expressed over the thickness of the winter ice, it is much thinner now.

"Ice formation usually [occurs] sometime in October. [This] is when we really have our freeze-up. It gets cold, water gets cold, the temperature goes down and pretty soon ice starts to form. By early Nov. the rivers are frozen the lakes are frozen. But today freeze-up is a lot latter than when I was younger, it occurs more so in early Nov."(Subsistence fisher, Tribal member)

"Today the ice is a lot thinner than it use to be when I was younger…before some of the ice would be five to six feet thick…now it is close to half or a little bit less than half of what it use to be". (Subsistence fisher, Tribal elder).

One participant expressed the impact that some of these changes have on the community:

When we have snow early in the year there are weather changes throughout the whole winter...when it warms up the melting snow packs up and in the spring it gets harder to melt and then we have more water in the spring, [with] that type of snow condition...but right now our snow is coming later and the result is they [the ice] are not as compact or ice packed as they use to be and they melt a lot faster…it causes a lot of changes in the little creeks that we have... because the snow we have melts a lot faster...so the water level will be lower all over...probably including those streams were they[salmon] spawn occurs (Subsistence fisher, Tribal elder).

Survey results showed that the speed of which the environment is changing and the impact of all three forces on subsistence fishing and salmon populations was noted by 73% of the participants.

> *I think that it is changing a lot faster than it used to in the past …there have always been stories of different animals and fish and birds…in the stories we hear…my parents and elders use to say that if the environment is there…no matter of any fluctuations…if the environment is there then they will come back…if the environment where they spawn and if their environment is good out there in the high. But if that is disrupted somehow then it is going to disrupt the fish…(Subsistence fisher, Tribal elder)*

Social Change

Survey results showed a few of the older participants expressed concern for increasing distance between elders and newer generations and a loss of local / traditional knowledge. One participant shared his thoughts about when these changes began to occur following the adoption of western education:

> *… when the schools first came out here they assumed that they would be taught not only about reading and writing but also about our customs and traditions and language, but that never happened. What they found out was, that we were taught how to live in another place not around here. We cannot survive without our knowledge here (Subsistence fisher, Tribal member).*

Survey results showed that this concern expands into the passing of cultural knowledge and the treatment of the environment by both western activities and younger Tribal members. For example, 64% of participants commented on water pollution increasing. Participants identified water pollution sources to include: large water vessels leaking fluids such as oil and community members not tending to nets or gutting fish straight into the river. The dumping of salmon bycatch back into the water (with the salmon dead) was also seen as a pollutant, disrespectful to the animal and wasteful behavior.

> *… salmon are decreasing because conditions on the river and the way that people fish changed...in the early days of his life people fished and took care of their fish and watched how they fished and they watched what they did with what ever the trash or material that they had ... they made sure that the river was as clean as possible...but today that same respect is not there...this kind of taking care of nets and care of what is thrown in the river...people are becoming careless all over around here as well as up river...like around here he notices that some people set there nets under the ice and then leave them and don't check them ... and then ... some fish are being taken just for their roe…and the rest of the fish is thrown. So there is some waste being done all over the river including here and when fish or anything is thrown into the river it changes the sent of the river and maybe the fish don't like that change…(Subsistence fisher, Tribal elder).*

Survey results showed that the custom of having fish camps is connected to the concern of losing the passing of knowledge and misuse of the environment. Fish camps are established along the coastline and river, and often stay in one place throughout generations of ones family (Loring, & Gerlach. 2010). Within these sites Tribal families harvest what they need for the year and elders

teach younger generations of their customs. Today fewer and fewer people are going to fish camp. Of the participants in this project, 36% continue to go to fish camps. Other participants voiced a desire to set-up a fish camp but lacked the means to do so, (time to accommodate regulation windows and gas to go back and forth between the windows).

> *…The price of gas really kills peoples' pockets…we [fish] here [across the river]…(Subsistence fisher, Tribal member).*

Change in Salmon Behavior, Timing, Abundance and Health
One semi-directive question asked if a change in salmon runs had been noticed. Survey results showed that 73% of participants noted a change in local salmon species, and shared reports of salmon coming later in the year, several believe that Chinook salmon may be spawning in different areas, and many have noticed a change in size and abundance of Chinook, summer/fall chum and coho.

> *There [has] been some changes, I think, some things in how the fish travel around here...one of the species of salmon that we catch is coming in at a later time...toward the freeze- up...those are the cohos … I think that they are changing some of their spawning grounds...because in some areas around here we catch them and they're ready to spawn...(Subsistence fisher, Tribal elder).*

Survey results showed all participants voiced concern regarding observed declining health in all salmon species. Participants described a "disease" seen on all salmon species for the past two years. Two participants offered the following description:

> *… some of the salmon that we catch… especially the kings; they've got some infections on them. They look like there skin is peeling off, is rotting, some of their fins begin to deteriorate, some have puss inside [the] meat…(Subsistence fishing, Tribal member).*

> *For the past two years when me and Martha go cutting fish, she showed me what part of the fish was rotten. But the fish was still alive and some had worms and some got lumps almost to the tail...there is a lump and when we open it, it has little worms inside. I have never seen this before… (Subsistence fisher, Tribal elder)*

Use of LTEK in Management Decisions
Survey results showed 91% of participants expressed a desire to be involved in fishery management decisions. Participants also expressed a concern that governing bodies do not understand what "subsistence" is and hold a limited knowledge of the animals and environment in the area. It was stated that science is needed in addition to Tribal knowledge in making decisions. However, it was expressed that the Tribal voice was very small and not recognized.

> *Well if the regulators or anyone else listen to the comments of the people or the knowledge that they know, they don't have to keep the fish in good numbers [the fish populations would remain consistent]...right now they do not know what the people want or think (Subsistence fisher, Tribal elder).*

…our thoughts must be heard. The things that we know must be put into those regulations, how the elders know to look at the people or the animals…the wishes and thoughts of the people are not being heard [by regulators]...our ideas and thoughts must be heard, otherwise we are going to have harder and harder laws [in response to declining salmon populations] (Subsistence fisher, Tribal member).

…some things I want the federal and state to do is first watch the environment, because without the environment no species is going to survive. It [salmon] is not there to support them. It would be good for our people to have the regulators listen to what we would like, what we say, what we think…they are doing [making decisions] without asking about the different intentions of each animal in our area…and how they might make some regulations that might affect how much we need and a good way of handling a species so that the species would survive (Subsistence fisher, Tribal elder).

Pike (*Esox lucius)* drying ©Carolina Behe

DISCUSSION

Participatory Management and Research

LTEK offers both relevant and reliable information in areas such as, climate change, fisheries science, resource management, various natural science fields and more. Just like western science, LTEK is not flawless and requires a means of sifting through to find the best practices (Huntington. 2000). Henry Huntington (2000) has documented Inuit Tribal members in the Arctic; use a process with peers to verify their observations just as scientists use a peer-review process to substantiate scientific papers. The concerns raised by Tribal members in Alakanuk move beyond the scope of current management schemes and question the equity of knowledge and decision-making. However, the intention of this paper is not to analyze the equity of power but to explore the concerns of subsistence fishers and point out where participatory methodologies may improve issues raised. This approach avoids the use of one particular perspective to the exclusion of others (Ison 1997), by imploring LTEK holders, western

scientists and regulators, to collaborate in making decisions together. Through such a process a third source of information may be generated from two different cultures, cosmologies, and ways of knowing (Ison et al. 1996). The following section of this paper will discuss the results of the semi-directive interviews and offer examples of participatory methodology applications under similar themes.

Tribal Perception of Management Decisions and Methods
All participants indicated that they had not succeeded in acquiring enough salmon last year to achieve subsistence and 91% identified regulations to be the cause. The management of harvesting a living migratory, transboundary species, involving numerous stakeholders, is not simple. The fisheries management of the Yukon River salmon is further complicated by the inability to determine stock specific abundance, run timing, overlapping multi-species runs and the shear size of the river (YRP 2011).

This complex system provides the perfect platform for exploring new research projects and ways of improving management schemes through the human dimension and participatory methodologies, utilizing different ways of knowing. A large mechanism for creating an equitable relationship lies with the recognition of LTEK as a legitimate source of information (Berkes & Dudgeon 2003). ADF&G shows progress in building an understanding and relationship with Tribal members and LTEK use. The ADF&G Division of Subsistence conducts subsistence surveys (ADF&G 2011). Research projects are performed to document LTEK, and historical and contemporary importance of salmon (ADF&G 2011). In addition, resource managers participate in weekly teleconferences established by the Alaskan NGO, The Yukon River Drainage Fisheries Association (YRFDA 2011). Through the teleconferences state and federal regulators gain feedback and updates of what is occurring along the river and have stated that the obtained information is weighed in developing weekly management strategies (Anonymous April 22, 2011).

Despite these efforts, Tribal members continue to be at a disadvantage when it comes to the Alaska Board of Fisheries process, a board consisting of members appointed by the Governor. The Board of Fisheries establishes regulations and the ADF&G is tasked with implementing the regulations and in-season management (Loring & Gerlach 2010). Tribal communities' ability to be involved in the current Alaska state regulatory process is questionable. Participation often involves expensive travel from rural areas. Additionally, Tribal members voice concerns of being confronted with negative editorial body language and dismissive tones while offering testimonies or recommendations (Ross & Pickering. 2002). Communication problems may stem from the interaction of two different cultures, with two different cosmologies, that communicate differently even when speaking the same language. The historical relationships between Tribal communities and governments have resulted in a barrier of distrust (Adelzadeh, Mary et al. 2003). Within the participants' testimonies there are many references to a mistrust of management and a feeling of being disconnected from decisions affecting their lives or "ability to feed their family" (Anonymous April 5, 2011).

Survey results showed a frustration and desire to have the Tribal communities' voices heard. All participants wished to be involved in fishery management decisions. Participants also expressed frustration and concern for how management views the environment. One participant stated,

"*…they are doing without asking about the different intentions of each animal in our area*" (Anonymous April 5, 2011). Results further showed a belief that the observations and knowledge held of the environment should be used in a combination with formal science to make informed decisions. For example, combining Tribal knowledge of weather patterns with atmospheric science may lead to identifying new patterns arising.

Throughout these testimonies, comments of knowing how to self-regulate were continuously raised. Before 1961, fishing times were self-regulated by production units, consisting of independent or extended families (Wolfe 1981). Fixed quotas were replaced in 1961 by a system of scheduled weekly fishing periods (Wolfe 2010) and today fishing windows are used in conjunction with technology regulations. Tribal regulations are based on adaptation to changing environments and salmon runs. Practices such as never taking more than what can be handled and always sharing with those that do not have; never wasting or scattering unused wild food to keep from offending animals and attracting predators are examples of Tribal self-regulation based on LTEK and continue to be in use today, (Loring & Gerlach 2010). These philosophies and taboos of wasting life, food or resources are imbedded within Yup'ik culture and aid in conservation.

Survey results showed that subsistence fishing windows do not always correlate with knowledge of salmon runs or culture. Alakanuk subsistence fishers traditionally set test nets as soon as the ice breaks up. When the salmon hit they begin to fish. The fish are reported to come when the river is high and the tide is coming in. Tribal members prefer to obtain enough salmon at one time, for each species. This limits the effort placed on achieving subsistence, decreases the amount of gas needed to travel back and forth to fishing spots, allowing for time to complete additional task, such as collecting wood and fixing smoke houses. Many Tribal members voiced concern that subsistence windows were open during times that the tide is going out or when the salmon have already passed. In fact, subsistence windows are strategically planned to limit the amount of salmon being caught. This regulation practice is used in conjunction with other policies to achieve escapement goals, allowing enough salmon to pass upriver to spawning grounds.

In addition to disagreeing with subsistence windows, survey results showed a belief that the enforcement of regulations is overly aggressive and has added to a perceived lack of understanding of what 'subsistence' is. Tribal members reported feeling compelled, out of necessity, to fish during non-regulated times and concern that gear and catch may be seized for not complying with regulations. One participant recounted a friend's experience of having his net and take seized when fishing during a non-regulated time. The net and fish were seized and put "…in the plane...that's not right, they took them...I don't know where they took them...the plane took off" (Anonymous April 5, 2011). The taking of both net and take was considered unnecessary as it "…affects the fisher from being able to provide for his family for the year".

The integrity of methods used to achieve escapement goals were often raised in conversations with Tribal community members. Salmon escapement numbers are obtained through monitoring stations and the use of sonar (Loring & Gerlach. 2010). Participants questioned the accuracy of salmon counts generated from sonars positioned at the Pilot station, (located at the mouth of the

Yukon River). Concerns were reported regarding the sonars easily being positioned incorrectly with debris brought in with the tide, collect algae, and in regards to the placement of the sonar.

Burden of Conservation and Deep-sea fisheries

The Tribal perception of not having a voice, not being listened to, being dismissed and held responsible for conservation efforts extends into decisions made regarding commercial fisheries in the Bering Sea. Survey results showed that participants voiced frustration in being held accountable for ensuring that the salmon escapement numbers are achieved and responsible for salmon conservation. Participants' testimonies within this theme focused on salmon bycatch and non-native commercial fisheries. Expressing concerns that large-scale fishing industries are being favored through current management schemes. At the time of this research the Walleye pollock bycatch had greatly affected Yukon Chinook and chum salmon runs. The Walleye pollock industry is the largest grossing fishery in the United States and holds a lot of lobbying power. However, amendment 91 to the Bering Sea and Aleutian Islands Fishery Management Plan may prove to drastically decrease the impact that the salmon bycatch has had on Yukon River salmon runs. This will have to be analyzed after this summer (2011) harvest season. As of June 2011, 7,136 Chinook salmon have been taken as bycatch (NMFS. 2011).

Participatory methodologies are being explored in Lapland, Finland to address similar resource conflicts and mistrust of regulation between the Sámi and Finns. A workshop held by Anar/Inari in Finland highlights ways in which a synergetic thought process may generate from a participatory group comprised of LTEK holders, scientists and managers. In the Upper Lapland, Finland, a number of conflicts over future land-use practices and resource utilization between local residents, Sámi and Finns, exist. The two stakeholders have very distinct ways of knowing. Competing uses of natural resources include reindeer herding, fishing, forestry, tourism, and mining, among others. In 1997, Anar/Inari established a workshop to explore participatory methodologies. Amongst many findings, the workshop discovered the differences in thought processes and approaches generated from a participatory group compared to a traditional formal group. While one group addressed resource issues with an objective of improving local livelihood and the environment, the other group approached resource issues with an objective of achieving government mandated goals and improving State economic goals (Müller-Will et al. 1999).

This example highlights findings that may be discovered through the exploration of participatory methodologies in the Yukon River delta. The Yup'ik have a distinct perspective and knowledge of the environment just as the people found in Lapland. On the surface regulators' and subsistence fishers' goals appear to differ drastically. The regulators' objective is to succeed in their responsibility of achieving MSE and escapement goals. The subsistence fishers' goal is to obtain enough fish to last through the winter. Yet both groups wish to not over-exploit the species and hold some level of respect for the animal. A participatory approach would bring together LTEK holders and regulators to identify and address management issues, allowing similarities in objectives to be brought to the surface and offer new insight into management practices through different perspectives.

Change in salmon behavior, timing, appearance and health
Participants' testimonies regarding salmon runs, timing and health raises many questions and presses the need for additional research. Salmon decline is a large concern to everyone. This animal is truly a keystone species, supporting abiotic and biotic elements of the ecosystem. Salmon act as a vector of marine nutrients and energy from marine to riparian environments, are a thriving food source for mammals, birds, insects, microbial populations, and for Tribal communities like Alakanuk.

Though regulations were pointed to be the cause of not achieving subsistence last year by most survey participants, 64% of participants also reported a decline in Chinook and chum salmon. As mentioned before, Alakanuk is located at the mouth of the Yukon along the southern tributary. As salmon arrive members of the Alakanuk community see more salmon than communities further located up the river. It is unclear from this research if the reported decline of salmon is a response to what community members are allowed to catch within regulatory constraints or an awareness of the salmon abundance.


Chinook salmon (*Oncorhynchus tshawytscha*) (YRP 2008)

Multiple hypothesis of what is causing the decline in salmon runs exist. Many managers attribute the decline to the PDO (Loring, & Gerlach. 2010). The Walleye pollock salmon bycatch has also been identified as making an impact on Yukon destined salmon; finally a rapidly changing environment is also a concern. The exact cause of the salmon decline is unclear and all three factors are likely influencing salmon. Observations reported by participants include a decline in Chinook salmon size, change in timing, abundance, spawning locations and a 'disease' on the salmon. Additionally, participants reported a change in chum timing and abundance. All of these points require greater investigation.

The most consistent concern reported through formal and non-formal conversations was a 'disease' on the salmon. Participants reported circular open soars, decaying fins, rotting flesh, worms and puss inside the meat on living fish. The information gained from this report is grossly insufficient to speculate on the cause of the described ailments. However, ichthyophonus is a parasite known to cause similar reactions and has been a problem further upriver in the past (Kocan 2004). When regulators were asked about the reported findings in Alakanuk it was stated that ichthyophonus has been at an all time low for the last two years and is never seen in the lower river, (where Alakanuk is located), further explaining the current general consensus of the parasite being associated with warmer waters (Anonymous April 28, 2011). The two different testimonies offered by Tribal members and regulators show a disconnect that may be resolved through enhanced communication generated through applying participatory methodologies.

LTEK offers valuable insight into how salmon respond to different changes in the river, the wind, currents, etc. Through the creation of participatory research projects these concerns may be investigated with possibly greater insight, through different dimensions, and different perspectives, while offering increased monitoring abilities in a remote environment. For example, the Yup'ik have shared an understanding of the salmon run's relationship with the direction that the wind blows (Catherine Moncrieff et al. 2009). The wind is believed to affect which tributary the salmon will use to enter the river, which may indicate variability within salmon populations. This insight has drawn the attention of anthropologists, fishery scientists, oceanographers, etc.

A participatory approach to research is found within the Alaska Beluga Whale Committee (ABWC). ABWC is comprised of Alaska Native beluga hunters, scientists and resource managers. Scientists and beluga hunters identify and conduct research together, which is used to better inform beluga management. The ABWC research concentrates on five areas important to management: population estimates and trends, harvest levels, migratory behavior, stock identity and LTEK studies (Fernanadez-Gimenez et al. 2006). The ABWC is very successful in generating information through applying a participatory approach. Fernanadez-Gimenez et al. (2006) has documented that the participatory approach within ABWC has resulted in an increase use of hunters' knowledge and hunters' holding a sense of ownership for research projects.

The believed relationship between wind direction and which tributary salmon enter the river by offers a good platform to apply a similar participatory research method used by the ABWC. A participatory research project would be affective in addressing the nature of the relationship between the direction that the wind blows and salmon runs; is there variability within salmon populations; and how do changes in weather patterns, associated with climate change, affect the direction the wind blows?

Climatic Variability: Environmental Changes

LTEK is not limited to the biology of subsistence activities; it also includes detailed observations of species interactions, (Kimmerer 2002). For example, Tribal communities have reported, "salmon mimic the migrating birds at the mouth of the Yukon River and along the coast" (Moncrieff et al. 2009).

House Near Eroding River Bank (DCRACPLR 2001)

Climate change may be affecting the correlation seen in these observations. Tribal community members noted large concerns in the increasing unpredictability of weather and natural indicators, which no longer correlate. Table 2 offers three examples of natural indicators associated with salmon runs, documented by Catherine Moncrieff et al. (2009).

Many participants noted that their elders have always spoken of changes in the land and animals. The surveys show that the concerns voiced regarding environmental changes are related to unease for how these changes affect regulatory decisions being made, adapting in the face of fraying social cues, and increased demand on resources from non-subsistence users, etc. Survey results further show participants' belief that changes occurring among the salmon and increased water pollution are anthropocentrically driven. However, it is unclear if participants view additional changes in the environment, such as increasing temperatures, to be anthropocentrically caused, (i.e. increased levels CO^2 in the atmosphere). Many participants address questions of how they will respond to affects caused by climate change with "we will just go with it". For example, as one participant expressed concern about erosion rates, he also stated, "…you must let the river do what it is going to do and adapt with it when it begins to settle". He saw no reason in establishing barriers to the incoming water while everything was still shifting at an accelerated rate. Increased monitoring and adaptable strategic mitigation schemes are needed within the subarctic. Approaching this need through the concerns of the community will offer greater understanding of changes occurring in the ecosystem and an increased ability to collect consistent data. The perspective of shifting sediment, concern of increased erosion rates and timing of action, offered by the subsistence fisher, is the type of logic that may aid in developing effective climate adaptation schemes.

Kelman et al. (2009) found, that participatory methodology may be very effective in climate change adaptation and research while conducting research in Papua New Guinea. The importance of focus on the community needs as opposed to just climate change was one of the many suggestions made from their findings (Kelman et. al 2009).

Table 2. Examples of Natural Indicators, (Moncrieff et al. 2009)

Many black flies and mosquitoes	Many salmon will arrive
Heavy snow load	More salmon the following season
Wind direction	Affects which mouth of the Yukon salmon will enter

Though both LTEK holders and western science literature have already documented climate and environmental changes, collaboration between the two may provide greater insight. People in the community can provide the knowledge and physical presence needed to monitor changes occurring in rural communities. For example, after a team of scientists and LTEK holders have identified a research need and designed the investigation process, the Alakanuk community can monitor and collect data building upon the information that LTEK has to offer. Monitoring changes such as, the thickness in sea and river ice, water and atmospheric temperatures, changes in aquatic and terrestrial animals and vegetation throughout the year can be conducted through a collaboration of children from the Alakanuk School and Tribal community members.

Table 3. Changes Noted In Alakanuk By Participants And Documented Within Western Science Literature

Noted Changes	Participants	Documented Within Western Science Literature
Increased Air Temperature	X	X
Increased Water Temperature	X	X
Change In Timing Of Ice Formation	X	X
Change In Timing Of Ice Break-Up	X	X
Thinner Ice	X	X
Change In Land Animals	X	X
Change In Birds	X	X
Change In Insects And Abundance	X	X
Increase In Storm Surges	X	X
Increased Salinity In Fresh Water	X	X
Melting Permafrost	X	X
Increase In Erosion Rates	X	X
Decrease In Precipitation	X	X
Increased Unpredictable Weather	X	X

The information generated from such a process can aid in management decisions, decrease uncertainty, and increase science and Tribal understanding of a dynamic environment. Additionally, it may also strengthen LTEK and customary laws, assisting communities in adapting to social changes. The following section will address social changes.

Social Change

The Yupik culture has been maintained and built through an oral history and passing of LTEK from generation to generation (Ann Fienup-Riordan 1990:49). The relationship held between the Alakanuk community and salmon, and the rest of their environment for that matter, provides innate conservation mechanisms, raising a concern for cultural conservation along with the rest of the ecosystem.

Participants' testimonies expressed concern in the weakening and fraying of traditional laws, values, customs and loss of the Yup'ik language. Some of these changes were set in place decades ago with the extension of government authorities, natural resource laws and change in markets, which restricted the natural evolution of the community (Pimbert 2009). The connections people hold with each other, the resources they depend on "for which they have rights and responsibilities" and associated LTEK gives identity to individuals and their culture (Pimbert 2009). As one participant stated, "*…we were taught how to live in another place not around here. We cannot survive without our knowledge here"* (Anonymous April 5, 2011). Though the scope of this paper does not effectively address the social changes occurring throughout rural Tribal communities and the associated distrust lying between western and non-western cultures, the need to recognize these issues is pivotal to establishing participatory mechanisms.

Cultural conservation does not mean returning a culture to what it once was; this is not possible or wanted. It does mean an acknowledgement of the knowledge that many Tribal cultures have to offer. LTEK and customary laws may be strengthened through the gaining of equitable power in fishery management decisions. For example, the Kuna is a rural Tribal community in Panama that has experienced many of the same social fraying and challenges as the Yup'ik in Alakanuk. Once the Kuna began to receive equity in power of their resources, through gaining territorial rights, the use of their LTEK strengthened (Pimbert 2009).

Fish camps are one way in which Tribal knowledge of the environment, salmon, and awareness is taught in Alakanuk; here elders and mixed generations work together in the harvesting and processing of fish. Engaging in fish camp includes long periods of learning the relevant stories and indigenous traditional law associated with fishing (Loring & Gerlach. 2010). Wolfe (2008) reports that the practice of working toward the common goal of achieving subsistence likely "promotes order, solidarity, and social well being of family groups." At one time people spent from May to August at fish camp (Loring & Gerlach 2010)**.** The use of fish camps has declined throughout the Yukon. Only 37% of participants reported continued use of fish camps. As mentioned above, some participants express a desire to continue with the use of fish camps and are unable to due to a combination of gas prices and subsistence windows. A shorter fishing window reduces the benefit of having fish camp (Wolfe 2010). Participants expressed an inability to travel back and forth due to gas prices and time needed to accomplish other task. Survey results showed that older participants expressed a concern of the decreasing use of fish camps and the loss opportunity for the passing on LTEK, needed to survive subsistence life and to understand and respect the ecosystem in which they exist.

The teaching of LTEK aids in the conservation of the ecosystem and self-regulation. LTEK teaches how to identify resources, methods of harvest, efficient and non-wasteful processing of the resources and preparation of the resources (Whiting 2009). Many studies have associated a rapid decline in biodiversity or further environmental degradation with the loss of LTEK. For example, The Himalayas region has witnessed a decline in the use of traditional rice varieties along with the use of LTEK. The depletion is due to the availability of cheaper rice products in the market, and smaller and fragmented land-holdings. The result has been a decline in biodiversity of native food sources, including grains (Swiderska 2006).

The declining use of LTEK in Alakanuk is leading to the loss of understanding and connection to the environment. The results of this loss are seen through increased pollution, changes in fishing practice, etc. It should be pointed out that while this loss is occurring there are still many Tribal members using LTEK and holding onto traditional ways while adapting to contemporary practices, such as the use of out board engines.

Recommendations and Beginning Application Through Cultural Consensus Analysis

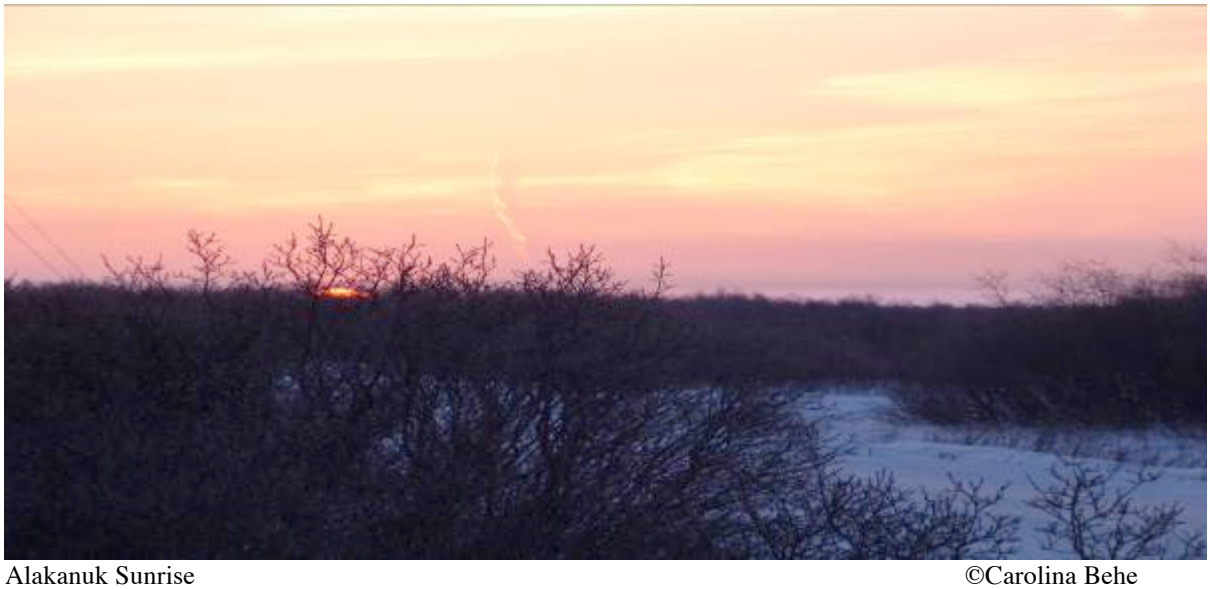
This project has explored areas in which participatory methodologies will be beneficial through the assessment of Alakanuk Tribal communities' comments and concerns. Incorporating interviews with state and federal fishery managers and scientists will further enhance this research. The author is currently conducting a cultural consensus analysis to take the first steps in opening up communication lines with state and federal regulators and scientists. The cultural consensus analysis is a survey derived from the data collected from the semi-directive interviews

conducted throughout this research project. The testimonies generated from the semi-directive interviews have been coded for recurring themes and true/false statements were created from the themes (see appendix F). The survey has been constructed, consists of 34 questions, and has been administered to the Alakanuk Tribal community and federal and state fishery scientists and managers. The survey further solicits commentary from participants and therefore is able to generate both qualitative and quantitative data. The cultural consensus analysis may be able to show were disconnects lay between Tribal perception of current goings-on and those of the state and federal scientist and resource managers. If disconnects do exist, an open dialog can be constructed to find a common ground.

After the cultural consensus analysis is completed, it is the author's recommendation that a steering committee be formed, consisting of LTEK holders, scientists and managers in order to explore ways in which participatory methodologies may be employed.

Conclusion

This paper has discussed the comments and concerns of Alakanuk Tribal participants through the six main themes derived from semi-directive interviews: subsistence fishing regulations, deep-sea salmon bycatch/burden of conservation, climate and environmental changes, changes in salmon runs and health, impacts of social fraying and use of LTEK in management decisions. Furthermore this paper provided examples of participatory methodologies applied under similar themes across the globe. Recognizing the value of LTEK is a step toward advancing our learning of the Yukon River Delta, climate change and salmon. Applying participatory methodologies to both management and research will act as a building block to ecosystem-based management and greater understanding. Through a participatory approach, community-based monitoring stations may be established to research climate and biological changes; aiding in bridging the disconnect in knowledge between Alakanuk generations and building trust between western management, scientists and LTEK holders, while providing much needed information on this rapidly changing ecosystem. Furthermore, combining different methods of understanding the same problem can reduce uncertainty and provide managers with the best information available**.**



Alakanuk Sunrise ©Carolina Behe

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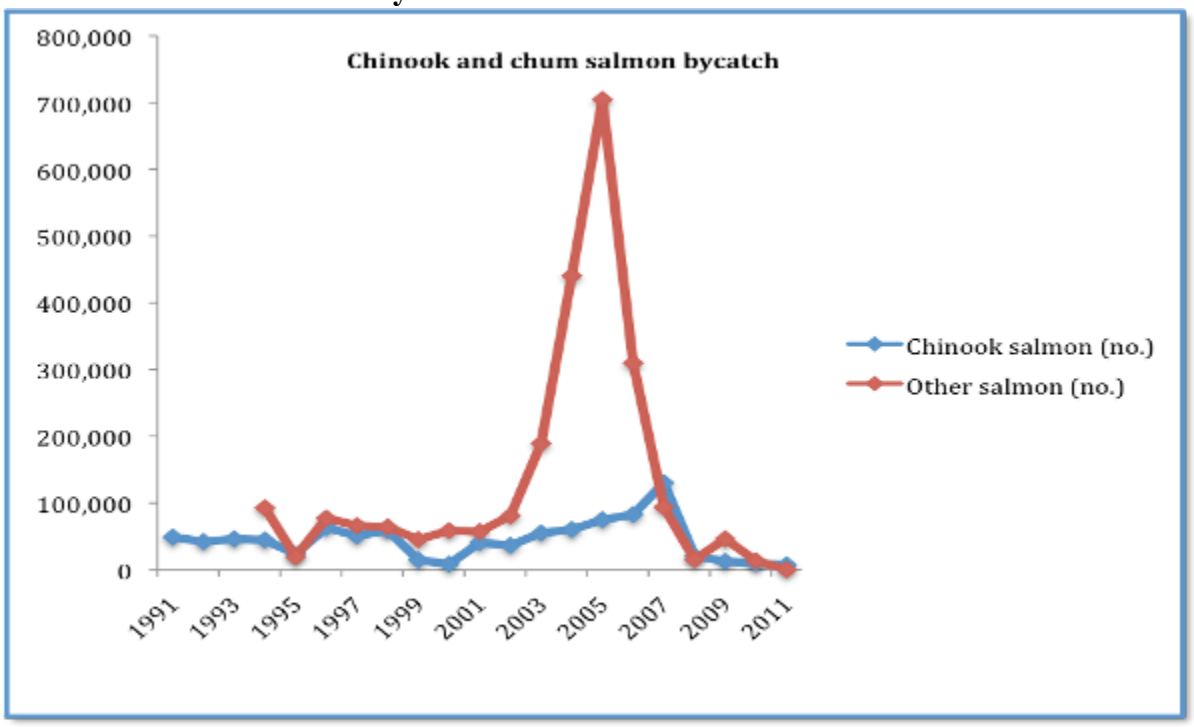
Appendix A

Yearly estimate for the Chinook and chum salmon bycatch from the Bering Sea trawl fishery (NMFS. 2011)

Year	Chinook salmon (no.)	chum salmon (no.)
1991	48,880	
1992	41,955	
1993	46,014	
1994	44,487	92,672
1995	23,436	19,264
1996	63,205	77,236
1997	50,530	65,988
1998	58,971	64,042
1999	14,599	45,172
2000	8,223	58,571
2001	40,548	57,007
2002	36,385	80,782
2003	54,911	189,185
2004	60,146	440,459
2005	74,805	704,586
2006	82,678	309,644
2007	130,139	93,786
2008	20,559	15,157
2009	12,410	46,129
2010	9,737	13,294
2011	7,136	54

Chinook and chum salmon bycatch



Appendix B

Semi-directive interview questions:

1. Intention of question
Ice break-up and Ice formation

1. Question
Can you tell me about ice formation and ice break-up and how this has changed in your life- time.

Possible follow-up questions:

a. Could you tell me about ice break-up and ice formation in the ocean
b. Could you tell me about ice break-up and ice formation in the

2. Intention of question
Changes in salmon run and behavior

2. Question
Could you tell me about changes that you have seen in the salmon runs?
When did this begin to happen?

3. Intention of question
Food security concern

3. Question
Could you tell me about your annual salmon harvest for your family…will you be able to gather enough?

Follow-up question:

a. What would you do if you cannot get enough?

4. Intention of question
Adaptation of practices or traditional / local ecological knowledge, in response to climate change, large-scale fisheries, or other forces (have objectives changed)?

4. Question
Could you tell me about how changes that you have seen affected the way you go about subsistence activity?

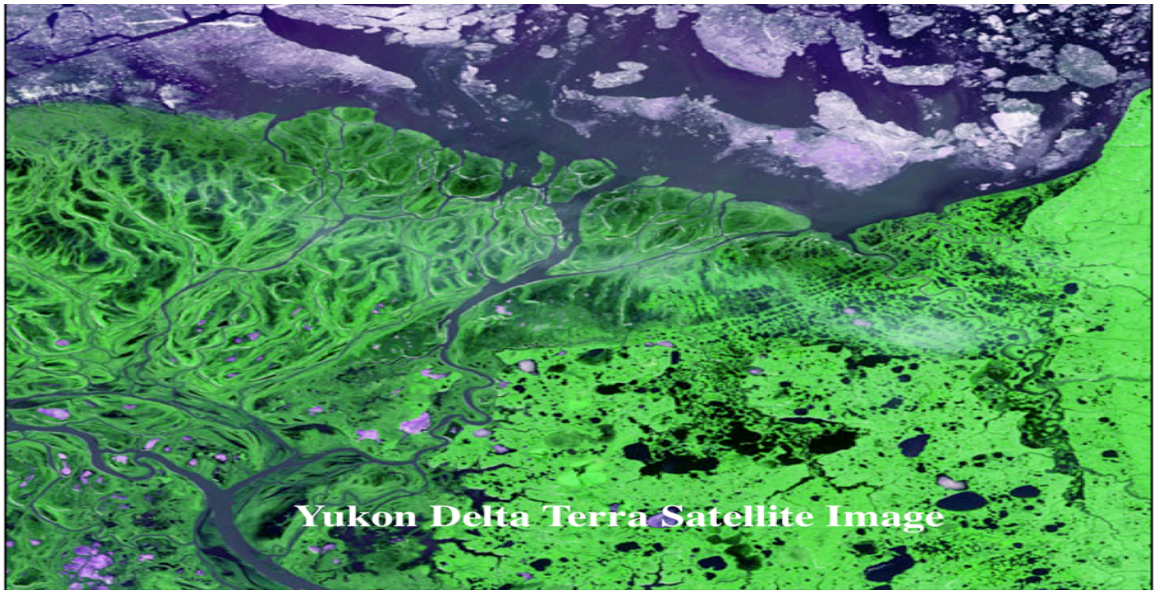
Follow-up questions:

a. How has harvest strategy changed (if it has)?

Appendix C

Selected Characteristics of Key Respondents

Number	11
Gender	
Male	6
Females	5
Age Cohorts	
20s	1
30s	3
40s	
50s	2
60s	2
70s	2
80s	1
90s	
Length (minutes)	
Minimum	23:53
Maximum	93:25
Total	~ 817



Yukon Delta image acquired by the ASTER instrument on NASA's Terra satellite (USGS 2002)

Appendix D

Survey Results: Six Reoccurring Themes Generated From Semi-Directive Interviews

Theme	Example	Comments from Survey	% of Participants
Food insecurity			
Observations of ecological changes	Ice formation is occurring later in the year, the ice formed is thinner, ice break-up is occurring earlier in the year and faster.	"Today the ice is a lot thinner than it use to be [then] when I was younger… before some of the ice would be 5 to 6 feet thick…now it is close to half or a little bit less than half of what it use to be."	100%
Salmon	Change in salmon runs, timing, behavior and health	"…part of the fish was rotten but the fish was still alive and some had worms and some got lumps almost to the tail…" "…they're look like there skin is peeling off, is rotting, some of their fins begin to deteriorate, some have puss in side meet…"	100%
Regulations	Distrust in management decisions and methods	"…it has always been them (Westerners) ...in the past they harvest like crazy...everything got cut off and then they forced their regulations on us..." "…there are something that [they do] to hurt our people..."	91%
Impact of large scale fisheries bycatch		"…bycatch in deep-sea fisheries...that part is not good because over here we need those and up river they need them. I think that they should look into those more. ."	64%
Loss of Traditional knowledge	Impact of social economic change of the last century has slowly leant to a fraying of social traditions and the passing of knowledge	"…the older people say that when the schools first came out here they assumed that they would be taught not only about reading and writing but also about our customs, traditions and language…what they found out was, that we were taught how to live in another place not around here."	64%
Use of TEK in Management decisions	Frustration voiced in having no connection to decisions being made in fishery resources	"…well if the regulators or anyone else listen to the comments of the people or the knowledge that they know they don't have to keep the fish in good numbers...right now they do not know what the people want or think."	91%

Appendix E

Participant Consent Form

Scripps Institution of Oceanography, University Of California, San Diego
Traditional Ecological Knowledge Validation and Climate Change Project
Funded by the Marine Biodiversity and Conservation Center

Contact: Carolina Behe
Telephone: 917.415.7345
E-mail: carolinabehe@gmail.com

As a student at SCRIPPS Institution of Oceanography and in conjunction with Catherine Moncrieff of the Yukon River Drainage Fisheries Association (YRDFA), am interested in exploring aspects of Traditional Ecological Knowledge, adaptation and use of by science communities within a changing environment. As part of this project, an audio digital recording will be made of you during your participation. Please indicate below the uses of these audio recordings to which you are willing to consent. This is completely voluntary and up to you. You may request to stop the recording at any time or to erase any portion of your recording. You may also request to stop the conversation at any time.

1. The audio recording may be studied by the research team for use in this research project. _____ Initials

2. I give permission for my name and/or photo and to record this interview through digital audio to recorder and/or video for the purpose of this research. _____ Initials

3. The audio recording can be reviewed at meetings of scientists interested in the study of Traditional Ecological Knowledge, climate change impact and food security. _____ Initials

4. I give permission for the results of this research to be reproduced, published, or otherwise used. _____ Initials

5. I understand that I will have the opportunity to review the results of this research. _____ Initials

I have read the above description and give my consent for the use of audio recording as indicated above. I acknowledge that I will receive a $20 honorarium for sharing my knowledge in this project.

_____ _____
Signature Date Witness Date

_____ _____
Translator Signature Date Witness Date

Participants Address: _____

_____

_____

Walking on frozen water into Alakanuk. ©Carolina Behe

Appendix F

Cultural Consensus Analysis: True / False Survey Based On Semi-Directive Interviews Conducted Among The Alakanuk Tribal Community. Survey administered through Survey Monkey among federal and state employees. Survey administered to the Alakanuk Tribal community in person; survey results are pending.

1. Ice formation is occurring later in the year.
True False
Comment:

2. The ice is thinner now.
True False
Comment:

3. The ice break-up occurs earlier and faster.
True False
Comment:

4. The water is warmer than before.
True False
Comment:

5. The air is warmer than before.
True False
Comment:

6. There is an increase in storm surges.
True False
Comment:

7. Salt water is coming in further and going into the freshwater.
True False
Comment:

8. Lakes are drying up.
True False
Comment:

9. The environment is changing faster than it has ever in the past.
True False
Comment:

10. If the environment is taken care of the fish will be there.
True False
Comment:

11. The environment and animals have always gone in cycles.
True False
Comment:

12. You are not concerned with how quickly the environment is changing.
True False
Comment:

13. The water is in good condition and is being taken care of.
True False
Comment:

14. King salmon have decreased in number.
True False
Comment:

15. Cause of King salmon decline is partly from a normal cycle, partly from deep-sea fishing, and partially from an environment not being taken care of.
True False
Comment:

16. Salmon runs have changed.
True False
Comment:

17. Salmon are spawning in different locations.
True False
Comment:

18. The salmon have had a 'disease' on them for the last couple of years.
(Flesh soars, rotting flesh, decaying fins, white inside the meat, worms inside the meat)
True False
Comment:

19. Subsistence windows do not always correspond with salmon runs.
True False
Comment:

20. Smaller meshed nets catch more salmon of a smaller size, including Kings.
True False
Comment:

21. I was able to get enough fish for subsistence last year.
True False
Comment:

22. Regulations on subsistence fishing assist subsistence fishers in obtaining all fish needed faster.
True False
Comment:

23. Salmon runs depend on how high the water is and where the wind comes from.
True False
Comment:

24. The Yup'ik people are involved in making decisions about regulations.
True False
Comment:

25. Sonar tools used to detect and count fish are used to create long-term information for science research.
True False
Comment:

26. Sonar tools used to detect and count fish are used to detect salmon escapements to determine the season's regulation.
True False
Comment:

27. Sonar tools used to detect and count fish are well placed and are effective.
True False
Comment:

28. Deep-sea fisheries have a large affect on subsistence fishing.
True False
Comment:

29. The mode of living and subsistence fishing has remained the same.
True False
Comment:

30. Regulators are considering the Yup'ik people's knowledge of the environment and animals before making decisions.
True False
Comment:

31. Regulators harvest strategy and rules are based on fairly splitting up fish stocks to all stakeholders and retaining a healthy stock of salmon for the future.
True False
Comment:

32. Regulators consider subsistence fishing a first priority.
True False
Comment:

33. Yup'ik harvest strategy and community based regulations are used to gather enough subsistence for the year; they do not take more than they can handle.
True False
Comment:

34. Knowledge of the environment and subsistence fishing continues to be passed from elders to younger generations in Tribal communities.
True False
Comment:


Alakanuk School Special Education Building ©CB


Alakanuk School (K-12) ©CB