Local Traditional Knowledge of the Freshwater Life Stages of Yukon River Chinook and Chum Salmon in Anvik, Huslia, Allakaket, and Fort Yukon

by
Alida Trainor
Brooke M. McDavid
Lauren A. Sill
and
Loraine S. Naaktgeboren
Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in Division of Subsistence reports. All others, including deviations from definitions listed below, are noted in the text at first mention, in the titles or footnotes of tables, and in figures or figure captions.

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ABSTRACT

This report summarizes the results of research conducted in 2014 on the local traditional knowledge of Chinook and chum salmon freshwater spawning and migration patterns in four Yukon River drainage communities. Researchers worked with respondents in Anvik, Huslia, Allakaket, and Fort Yukon to map environmental changes that may have affected salmon migration and spawning. Respondents interviewed for this study shared their lifetime experiences traveling, hunting, and fishing on the land and waters around their communities and shared their personal observations of change and changes they had heard of from others in their community or in neighboring communities. The study communities were chosen because of their proximity to an existing or an historical enumeration project. Proximity to enumeration projects gave researchers the opportunity to compare local observations of fluctuating salmon presence with existing data sets. Although this study intended to document possible changes to Chinook salmon spawning and migration, an abundance of environmental and ecological changes were also recorded. Over time, and especially in recent years, respondents have observed a variety of ecological changes. Some of these changes have impeded respondents’ ability to participate in subsistence harvesting activities. Although more research is needed to explore each of these observations and their possible effects on Chinook salmon, it is clear that the environment that respondents are living in is rapidly changing and affecting all aspects of the natural world that they rely upon.

Key words: Allakaket, Anvik, Fort Yukon, Huslia, local traditional knowledge, subsistence fishing, Chinook salmon, chum salmon, habitat, climate change, Porcupine River, Teedrinjik River, Anvik River, Koyukuk River.
1. INTRODUCTION

Alida Trainor

This study examines local knowledge of the freshwater system of the Yukon River Alaska as it pertains to Chinook and chum salmon migration, spawning, and juvenile rearing through in-depth ethnographic interviews, mapping, and participant observation. These observations help to fill gaps in current biological understanding of spawning grounds, spawning behavior, and factors that affect juvenile survival in freshwater systems. Specifically, this research analyzes the observational and experiential knowledge held by active subsistence harvesters relevant to the biological and environmental factors important to the freshwater aspects of Yukon River Chinook and chum salmon life stages including migration, spawning, and larvae/juvenile survival. Further, it tracks any changes that these active harvesters have observed regarding these factors and considers how they explain these changes.

PROJECT BACKGROUND

Since 2000, sharp declines in Chinook salmon abundance have caused severe hardship for fishery-dependent communities along the Yukon River and its tributaries (Brown et al. 2015). In March 2000, the State of Alaska Board of Fisheries designated Yukon River Chinook salmon as a stock of yield concern because it failed to produce expected returns. The federal government declared an economic disaster in the lower portion of the Yukon River in 2009. The Alaska Department of Fish & Game (ADF&G) has not provided commercial or sport opportunity on Yukon River Chinook salmon since 2008, and the subsistence fishery experienced restrictions in 2008–2009 and 2011–2014. The lowest subsistence harvest on record occurred in 2014, when only 3,282 Yukon River Chinook salmon were harvested. Despite conservative management and subsistence restrictions, Canadian border passage obligations outlined in the Pacific Salmon Treaty were not met five of the seven years preceding this study (2007, 2008, 2010, 2012, and 2013). In order to meet escapement goals in 2014, extreme reductions in subsistence harvest opportunity were implemented by ADF&G fisheries managers. For example, portions of the drainage that are typically open seven days per week, such as the Innoko and Koyukuk rivers, were closed or restricted to six-inch or smaller gear (Jallen et al. 2017). In District 5D, the uppermost portion of the Yukon River in Alaska, closures were extended until 95% of the Chinook salmon run had passed.

The difficulty in ensuring sustainable salmon management during this period has resulted in part from a lack of knowledge about the underlying causes of the declines. ADF&G’s Chinook Salmon Stock Assessment and Research Plan identifies freshwater ecosystems as a potential site for changes in productivity (ADF&G Chinook Salmon Research Team 2013:11). The Arctic-Yukon-Kuskokwim Sustainable Salmon Initiative (AYK SSI), a co-management research fund, theorized seven potential drivers of Chinook salmon declines at different parts in the life cycle: ocean mortality, anthropogenic changes to marine ecological processes, marine bycatch, escapement quality, density dependent effects and overcompensation, pathogens, and freshwater mortality. This research, funded by Chinook Salmon Research Initiative funds (ADF&G Chinook Salmon Research Team 2013), explores a currently under-examined body of knowledge represented in local traditional knowledge (LTK) of freshwater systems, specifically with a focus on spawning grounds, juvenile rearing habitats, and other environmental factors that affect salmon migration and reproduction.

The documentation of local and traditional ecological knowledge is important for social, cultural, and biological reasons and can lend important ecological insights to resource management, conservation education, and environmental assessment (Inglis 1993). The incorporation of LTK is often cited as an effective method for involving resource users in fisheries research and cooperative management (Huntington 2000). Several studies of subsistence salmon and nonsalmon fisheries have documented LTK in coastal and interior regions of Alaska (Andersen et al. 2004; Andrews 1986; Brown et al. 2005; Case and Halpin 1990). In general, however, because of the qualitative nature of LTK and the unfamiliarity of most natural science researchers with social science methods, this type of knowledge is often ignored (Huntington 2000). When systematically documented and analyzed, LTK can provide long-term observational data to fisheries
managers and scientists and aid in understanding the environmental variability that influences fluctuations in populations of Pacific salmon.

More recently, the incorporation of LTK in fisheries management and biological studies has become more common with further discussion of the methods for documenting and applying LTK (e.g., Freeman 1992; Huntington 1998; Usher 2000). For example, Brown et al. (2002) compiled LTK regarding the distribution, abundance, ecology, and changes over time of Pacific herring (*Clupea pallasi*) in Prince William Sound. Using interviews and mapping exercises with resource users, they also analyzed and stored data in a geographic information system (GIS) to aid in developing study and management plans for herring. In addition, they were able to document historical changes in the distribution of herring that occurred prior to the collection of quantitative data by ADF&G.

The ethnographic documentation of subsistence fisheries in the Yukon River drainage dates back at least to missionary accounts in the early 1900s (e.g., Jetté 1911). Since then, several researchers have documented the subsistence salmon fishing practices of Yukon River drainage residents (Fienup-Riordan 1986; Loyens 1966; McFayden Clark 1981; Nelson 1983; Osgood 1958). However, fisheries research was not the sole focus of these studies, and only recently have social scientists begun to explore the rich body of local knowledge about various aspects of Yukon River salmon runs. For example, Andrews (1986) documented the methods of harvest, seasonality, and harvest trends of fall chum salmon (*Oncorhynchus keta*) in subsistence communities along the Yukon River. This study found considerable variation in run timing, harvest levels, and uses of fall chum salmon in different parts of the drainage, but was limited by the short time period represented in the historical data. More recently, Moncrieff and Klein (2003) documented local knowledge of Yukon River Chinook salmon that led to a more detailed study of the natural indicators used by fishers to predict salmon run timing and abundance (Moncrieff et al. 2009). Andersen et al. (2013) completed an analysis of local observations of climate change and associated effects on fisheries in the Yukon River drainage. Finally, Brown et al. (2015) used ethnographic data to explore the socio-economic effects of the 2009 Chinook salmon disaster in five communities along the Yukon River.

This study focuses on those aspects of local knowledge that describe the freshwater system by more fully exploring the contributions of LTK to understand what is happening to Chinook salmon populations in the Yukon River.

**Regional Background**

The Yukon River originates in Canada, approximately 1,980 miles from the Bering Sea. The drainage is roughly 330,000 square miles, and the river flows through steep mountainous areas, boreal forests, and sprawling valley floors (Brabets et al. 2000). Most tributaries are clear water, but the headwaters and the Tanana River have a muddy appearance resulting from glacial silt deposits. The muddy appearance is also known as turbidity, and respondents in this study discussed changes to the river’s opacity. Within Alaska, the Yukon River begins by crossing the U.S.–Canada border as a single, deep, quick moving channel. The river flows north until it reaches the community of Fort Yukon, where it changes to a southwest direction. This area, known as the Yukon Flats, is a wide, low lying river basin filled with sandbars and changing channels, which results in a slow moving, braided river. Around the community of Rampart, the Yukon River narrows once again into a single channel as the river flows through a steep canyon known as The Rapids. Not far from The Rapids the Koyukuk River, a major chum salmon spawning tributary, drains into the Yukon River. Further downstream, near the study community of Anvik, numerous other tributaries drain into the mainstem as well, including the Innoko, Bonasila, and Anvik rivers.

Permafrost is present throughout much of the drainage and until recently has been considered fairly stable (Brown et al. 2015). Brown et al. note that “hydrologic changes that may be affecting salmon populations

---

1. Hereinafter herring.
include degrading permafrost and a general decrease in surface water” temperatures. Although annual weather is highly variable throughout the Yukon River drainage, researchers and residents generally agree that climatic patterns are changing. Scientific documentation and observations from local residents along the river agree that winter ice is thinner, forms later, and is less reliable to travel on (Andersen et al. 2013; Weller and Anderson 1999). Additionally, other changes include increased erosion of river banks, drying of lakes and sloughs, and warmer winters.

Although this study was not specifically designed to document climate change, participants invariably shared their observations of change with researchers. Possible changes to the spawning and migration patterns of salmon are associated with environmental change experienced by residents as they use the land and water around them. Consequently, this report documents a variety of ecological changes as well as observed changes to salmon spawning and migration.

**STUDY OBJECTIVES**

In order to investigate and document local knowledge of the freshwater ecology of Chinook salmon in the Yukon River, this research had four objectives:

1. Identify and map the specific areas associated with Chinook salmon spawning grounds or rearing habitats where local residents have personal experience through fishing or other activities;
2. Conduct in-depth ethnographic interviews with local residents from St. Mary’s, Anvik, Huslia, Allakaket, and Fort Yukon to document LTK of these areas with specific reference to:
   a. Spawning density, run timing, and sexual distribution
   b. Migratory access to spawning grounds
   c. Spawning behavior
   d. Predation on spawning grounds
   e. Water quality and temperature
   f. Streambed quality (upwellings, erosion, thawing permafrost, changes in depth)
   g. Riverine debris loads
   h. Fish food sources
   i. Undocumented spawning grounds or areas where spawning populations have been extirpated;
3. Compare ethnographic data to results of area fish enumeration projects near study communities (Anvik sonar, Gisasa weir, and Henshaw weir) for potential correlation; and
4. Consult the *Anadromous Waters Catalog (AWC)* regarding identified areas and compare with results of key respondent interviews/maps.

**RESEARCH METHODS**

**Ethical Principles for the Conduct of Research**

The project was guided by the research principles outlined in the Alaska Federation of Natives *Guidelines for Research* and by the National Science Foundation, Office of Polar Programs in its *Principles for the Conduct of Research*.

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3. Saint Mary’s was originally identified as a study community. However, the local tribal councils did not all agree to participate, so Saint Mary’s was not included in this research.


of Research in the Arctic, the Ethical Principles for the Conduct of Research in the North (Association of Canadian Universities for Northern Studies 2003), as well as the State of Alaska confidentiality statute (AS 16.05.815). These principles stress community approval of research designs, informed consent, anonymity or confidentiality of study participants, community review of draft study findings, and the provision of study findings to each study community upon completion of the research.

During the planning phase of this project, five communities were identified as possible study locations. However, during the community consultation phase of the project, Saint Mary’s declined to participate. Because this project selected communities based on their proximity to fish enumeration projects, there were limited alternatives and ultimately Saint Mary’s was not replaced. As a result, four communities were included in this study: Anvik, Huslia, Allakaket, and Fort Yukon.

**Ethnographic Methods**

This project used a qualitative ethnographic approach. Wheeler and Thornton (2005) argue that the emphasis on “being there” provides the possibility of understanding the nature of subsistence practices and knowledge from a more integrated and holistic perspective. Ethnographic approaches can also allow researchers to extend their inquiries back through time, often exceeding the temporal limits of most biological research to examine how people understand aspects of the natural world, such as the status of a local animal population through time (Andersen et al. 2004).

The ethnographic research for this project included anthropological methods of participant observation, in-depth semi-structured interviews, and mapping. Participant observation fundamentally involves spending time with people in a way that allows the researcher to build rapport and trust and gain the ability to record observations about their lives (Bernard 2011). Participant observation can take at least two forms: simply spending time with people to build relationships (such as visiting, attending community events, traveling around the landscape, and helping community members with chores) and participating in harvesting or processing activities. These events are often opportunistic and so can be difficult to prescribe in advance; however, research field trips lasted from approximately four to seven days and all time spent in the field was generally spent either conducting interviews and mapping or in participant observation. Specific participant observation included visiting different harvest or habitat areas, assisting community members to set or check nets, helping to distribute a harvest to different households, assisting with processing the harvest, or visiting households to learn about kinship relationships or fishing groups in the community, among many other interactions.

Semi-structured interview protocols provide a format for systematically documenting comparable information about the same or an overlapping set of topics in each community while providing flexibility for each key respondent’s level of expertise, experience, and focus. Division of Subsistence staff used a general semi-structured interview guide (Appendix A) framed around the topics listed in Objective 2 and developed in consultation with the tribal councils and other knowledgeable individuals, including research biologists at ADF&G, U.S. Fish and Wildlife Service (USFWS), and Tanana Chiefs Conference (TCC). The guide was modified at times to reflect regional differences along the Yukon River, such as river or tributary morphology or other environmental factors.

Davis and Ruddle (2010:891) stress the importance of a systematic methodology for gathering local knowledge, primarily through peer recommendations. In each community, researchers worked with the tribal council and other community members to identify individuals considered to be knowledgeable about the salmon habitats in their areas.

**Project Planning and Approvals**

This section details community-specific sampling information. Researchers attempted to interview five to ten individuals per community in order to capture the diversity of knowledge and experience present in each community. Field work in all communities occurred between January and February 2014 (Table 1-1).

Researchers were able to complete a total of 26 interviews in the four communities. Interviews lasted an average of 58 minutes 22 seconds (Table 1-2). Project staff are listed in Table 1-3.

**Anvik**

ADF&G Subsistence Resource Specialist (SRS) Alida Trainor traveled to Anvik on February 17, 2014 and gained approval from the Anvik Tribal Council (Table 1-1). Field work was conducted in August 2014. Trainor conducted five interviews in Anvik (Table 1-2).

**Huslia**

SRS Seth Wilson met with the Huslia Tribal Council on February 13, 2014 to discuss this project and seek approval (Table 1-1). The council approved the research, and field work was scheduled for October 2014. Five interviews were conducted during this time (Table 1-2).

**Allakaket**

SRS Wilson received approval from the Traditional Council of Allakaket on February 11, 2014 (Table 1-1). Wilson and ADF&G Fish and Wildlife Technician (FWT) Odin Miller spent nine days in Allakaket during October the same year. During field work, Wilson interviewed eight residents (Table 1-2).

**Fort Yukon**

SRS Alida Trainor met with the Gwichyaa Zee Gwich’in Tribal Council on January 14, 2014, and the Council approved the project (Table 1-1). Trainor and FWT Loraine Naaktgeboren spent five days in November 2014 conducting interviews. Eight Fort Yukon residents were interviewed for this study (Table 1-2).

**DATA ANALYSIS AND REVIEW**

After field work, the interviews were transcribed and uploaded into ATLAS.ti, a qualitative data analysis software. The interviews were coded and analyzed using an established coding structure (Appendix B). The coding guide incorporated topics from the interview protocol and themes that were identified during field work. Some of the topical themes identified during this process included weather and climatic changes, fluctuations in salmon harvests, characteristics of the local water ecosystems, changes to the landscape, salmon ecology, and development. These themes formed the basic structure of the coding system through ATLAS.ti and outlined the foundation of the ethnographic analysis. After the broad themes were identified, researchers established additional tiers of more specific information pertaining to each theme. For example, researchers developed a variety of codes to capture the range of observations relating to changing water conditions such as eddies, flooding events, sandbars, and water levels.

<table>
<thead>
<tr>
<th>Community</th>
<th>Community approval meeting</th>
<th>Field work</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anvik</td>
<td>February 17, 2014</td>
<td>August 18–25, 2014</td>
</tr>
<tr>
<td>Huslia</td>
<td>February 13, 2014</td>
<td>October 7–10, 2014</td>
</tr>
<tr>
<td>Allakaket</td>
<td>February 12, 2014</td>
<td>October 21–30, 2014</td>
</tr>
<tr>
<td>Fort Yukon</td>
<td>January 14, 2014</td>
<td>November 16–21, 2014</td>
</tr>
</tbody>
</table>

*Source* ADF&G Division of Subsistence, 2014.

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7. Product names are given because they are established standards for the State of Alaska or for scientific completeness; they do not constitute product endorsement.
Table 1-2.–Interview summary, study communities, 2014.

<table>
<thead>
<tr>
<th></th>
<th>Number</th>
<th>Average length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anvik</td>
<td>5</td>
<td>1:02:22</td>
</tr>
<tr>
<td>Huslia</td>
<td>5</td>
<td>1:11:26</td>
</tr>
<tr>
<td>Allakaket</td>
<td>8</td>
<td>0:48:02</td>
</tr>
<tr>
<td>Fort Yukon</td>
<td>8</td>
<td>0:51:36</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>16</strong></td>
<td><strong>0:49:49</strong></td>
</tr>
</tbody>
</table>

*Source* ADF&G key respondent interviews, 2014.

Table 1-3.–Project staff.

<table>
<thead>
<tr>
<th>Task</th>
<th>Name</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern Regional Program Manager</td>
<td>Caroline Brown</td>
<td>ADF&amp;G Division of Subsistence</td>
</tr>
<tr>
<td>Principal Investigator</td>
<td>Alida Trainor</td>
<td>ADF&amp;G Division of Subsistence</td>
</tr>
<tr>
<td>Administrative Support</td>
<td>Pam Amundson</td>
<td>ADF&amp;G Division of Subsistence</td>
</tr>
<tr>
<td></td>
<td>Tamsen Coursey-Willis</td>
<td>ADF&amp;G Division of Subsistence</td>
</tr>
<tr>
<td></td>
<td>DeAnne Lincoln</td>
<td>ADF&amp;G Division of Subsistence</td>
</tr>
<tr>
<td>Cartography</td>
<td>Loraine Naaktgeboren</td>
<td>ADF&amp;G Division of Subsistence</td>
</tr>
<tr>
<td>Editorial Review Lead</td>
<td>Rebecca Dunne</td>
<td>ADF&amp;G Division of Subsistence</td>
</tr>
<tr>
<td>Production Lead</td>
<td>Rebecca Dunne</td>
<td>ADF&amp;G Division of Subsistence</td>
</tr>
<tr>
<td>Field Research Staff</td>
<td>Alida Trainor</td>
<td>ADF&amp;G Division of Subsistence</td>
</tr>
<tr>
<td></td>
<td>Seth Wilson</td>
<td>ADF&amp;G Division of Subsistence</td>
</tr>
<tr>
<td></td>
<td>Odin Miller</td>
<td>ADF&amp;G Division of Subsistence</td>
</tr>
<tr>
<td></td>
<td>Loraine Naaktgeboren</td>
<td>ADF&amp;G Division of Subsistence</td>
</tr>
</tbody>
</table>

*Source* ADF&G Division of Subsistence, 2019.
Mapped data were organized in an ArcGIS platform, and known presence and spawning locations of Chinook and chum salmon were obtained through the ADF&G AWC. The maps created for this report highlight those areas identified by the AWC that document known spawning locations of Chinook and chum salmon as well as the areas where those species are known to be present. Maps also included the location of nearby assessment projects. Information related to salmon abundance documented in the interviews was analyzed alongside the Chinook salmon assessment/escapement enumeration project data (e.g., Anvik sonar, Henshaw Creek weir, Gisasa weir) to identify convergences and divergences in local salmon abundance trends. For example, if respondents suggested an increased abundance of salmon on a nearby stream, nearby enumeration data from that stream could confirm or provide more context for those observations.

**Final Report Organization**

This report summarizes the results of the mapped and ethnographic data gathered during field work in four communities in 2014. The findings are organized by study community. Each chapter includes analysis of the ethnographic interviews and custom maps that show the location of nearby assessment projects and the documented presence and spawning locations of Chinook and chum salmon.

ADF&G provided a draft report to the study communities for their review and comment. The report was finalized after receipt of comments.
2. ANVIK

Lauren A. Sill and Alida Trainor

In August 2014, one Alaska Department of Fish and Game researcher traveled to Anvik to conduct ethnographic interviews and mapping activities with five key respondents (tables 1-1 and 1-2). Key respondents were all men over the age of 50. They were longtime residents of Anvik with extensive experience traveling and utilizing the surrounding land and waterways. Interviews averaged 62 minutes in length.

Community Background

The community of Anvik lies on the western bank of the Yukon River near the confluence with the Anvik River. To the east of Anvik are the Innoko lowlands, flat river floodplains of the Yukon River. The community is surrounded by rolling hills that rise to 2,000 ft in elevation. The town is located inside the old mouth of the Anvik River along a hillside called Deloy Ges, which translates from the traditional language of Deg Xinag to “so-called mountain” (Anvik Tribal Council 2016). The traditional name of the community is Git’ringithchagg, meaning “the mouth of the long long river.” White spruce, paper birch, and quaking aspen forests grow in the better drained soils around Anvik. The low-lying areas are full of black spruce and tundra vegetation. Anvik residents depend on the large runs of salmon in the Yukon River as well as healthy local moose populations and the availability of numerous other wild foods.

Anvik is located in Interior Alaska and experiences a continental climate marked by wide annual swings in temperature. However, because the community is only 60 miles from Norton Sound, coastal conditions cause Anvik to experience more clouds, rain, or marginal conditions than other Interior Alaska communities. Anvik averages about 110 inches of snowfall but only 21 inches of precipitation per year. Weather has become more unpredictable in recent years, creating transportation challenges: with warmer conditions, the Yukon and Anvik rivers may not freeze adequately to allow travel by snowmachine (Anvik Tribal Council 2016). The Yukon River is generally ice free from June through October. The lower, or downtown, area of Anvik has high flood potential. Floods are usually caused by ice jams further downstream. During the recorded highest water event in 1992, flood elevation reached 108.3 feet, but a flood in 1925 was higher, according to residents (Anvik Tribal Council 2016).

The Anvik River is a major tributary to the Yukon River, which offers year-round fishing opportunities. It is also a significant spawning area for summer chum salmon. Prior to the community of Anvik being established, Deg Hit’an Athabascans lived and gathered in the area. They are closely related to the Doy Hit’an Athabascans who are originally from Holikachuk, but now live in Grayling. Before contact with Euro-Americans, Deg Hit’an traveled from camp to camp in pursuit of available resources. The Anvik River was a significant trade route between the lower Yukon and Innoko rivers and Norton Sound. Deg Hit’an people engaged in an extensive network of trade partnerships that extended to Siberia. Trade items from the Deg Hit’an included dried smoked fish, wooden tubs, dishes, bowls, and furs. Russian travelers using this route to explore the interior of Alaska often stopped in Anvik (Osgood 1940). After the U.S. purchase of Alaska from Russia in 1867, contact with Euro-Americans increased in frequency. The Yukon, an American river steamboat, began ascending the Yukon River in 1869, inaugurating a new steamboat era which rapidly developed commerce between Alaska Natives and Euro-American traders. The Yukon brought the necessary supplies to establish a trading post in Anvik, which encouraged the presence of Americans, eventually leading to the establishment of a mission.

The Reverend Octavius Parker and Reverend John Chapman of the American Episcopal Church established a mission in 1887 on the opposite side of the river from the old village site (Anvik Tribal Council 2016). Over time, people moved to the mission side, and by 1915 the old village site was used as a fish camp and eventually a dog-staking yard. Children from neighboring towns came to Anvik to attend the mission school.
and after the influenza epidemics of 1918 and 1927, orphaned children from as far away as Fort Yukon became wards of the mission. Although the physical location of the community has not changed since the early 20th century, in 1934 the Anvik River changed its course and began flowing into the Yukon River about 1.5 miles upstream of the community.

The contemporary community is not connected by road to any other community. A gravel air strip is serviced by daily flights from the nearest hub at Aniak. Most supplies arrive in Anvik by barge. In 2014, the Alaska Department of Labor and Workforce Development estimated the population of Anvik to be 80 residents. A kindergarten through grade 12 school is located in the community, but high school students are increasingly completing their education at regional boarding schools. Many homes in Anvik are serviced by wells and a sewage system, but some have individual septic systems and outhouses. A washeteria provides access to washers, dryers, and showers. In addition, the community supports 2 stores, a post office, a clinic, and a community hall.

Salmon Fishing Profile

Several assessments of subsistence harvests and use in Anvik have been conducted over the past 30 years (Ikuta et al. 2014; Wheeler et al. 1992; Wolfe and Scott 2010). These studies have demonstrated increased harvest and use of salmon between study years 1990–1991 and 2011. Household participation in salmon harvesting increased over this time period (from 64% of households in 1990–1991 to 79% in 2011), as did the percentage of salmon in overall harvests. During the 1990–1991 study, researchers found that salmon composed 21% of the overall harvest (as estimated in usable pounds), and in 2011 salmon made up 36%. All households in Anvik used salmon in 2011, and over three-quarters fished for it. Sharing of salmon was also widespread; approximately one-third of households gave salmon to others and received salmon from other households. A greater percentage of households shared Chinook salmon than other species of salmon.

All five types of Pacific salmon found in Alaska are present in the Anvik River. Summer chum and Chinook salmon have been the mainstays of the harvest. Residents also harvest smaller amounts of fall chum and coho salmon (Figure 2-1). Sockeye and pink salmon are present in the Anvik River in small numbers, but they are not typically harvested. Since 1989, ADF&G Division of Commercial Fisheries has collected annual subsistence salmon harvest data through a postseason harvest survey. Although subsistence salmon harvests over the last 30 years have not changed substantially, the composition of harvest has changed. Summer chum and Chinook salmon compose over half of total salmon harvests. As the population of Yukon River Chinook salmon decreased, conservative management actions have limited harvest opportunity of Chinook salmon throughout the drainage (Estensen et al. 2018b). As a result of the conservative management actions, fishers in Anvik have redirected their harvest effort towards summer and fall chum salmon. Chinook salmon harvest had virtually disappeared in the years preceding this study, declining from 1,052 salmon in 2011 to 435 in 2012, 121 in 2013, and 0 in 2014. In contrast, fall chum salmon harvests increased over this same time period, from 202 salmon in 2011 to 1,028 in 2014. Anvik residents mainly harvest coho salmon incidentally to fall chum salmon.

Some key respondents interviewed in 2011 recalled that Anvik residents harvested more chum salmon than Chinook salmon in the past, and generally more fall chum salmon than now (Ikuta et al. 2014). Residents may have harvested more chum salmon in the past because they participated in a summer chum salmon roe commercial fishery between 1978 and 1997. Commercial fishermen would sell the eggs and then could keep the flesh for themselves or their dogs. Another aspect of the commercial fishery operation was the greater prevalence of fish wheels, which were used to harvest the summer chum salmon. Presently, Anvik residents primarily drift with gillnets or use set gillnets, though few suitable setnet sites exist near the community. Residents still occasionally use fish wheels.

Anvik residents use a large area of land around the community for their subsistence harvesting activities, but concentrated their search areas for all resources on the Anvik and Bonasila rivers (Ikuta et al. 2014).

1. Alaska Department of Fish and Game (ADF&G) Division of Subsistence, Juneau. “Community Subsistence Information System: CSIS.” https://www.adfg.alaska.gov/sb/CSIS Hereinafter ADF&G CSIS.
Figure 2-1.–Estimated salmon harvest by species, Anvik, 1989–2014.
Anvik fishers rely on the Yukon River for salmon harvesting. In 2011, residents fished for salmon only in the Yukon River, where driftnet and setnet sites are available. Anvik fishers primarily catch salmon on the Yukon River between Grayling and Holy Cross. Salmon fishing occurs from May through August.

LOCAL SPawning AND MIGRATION

The Anvik River drainage is believed to be the largest producer of summer chum salmon in the Yukon River drainage (Lozori 2017). The Anvik River joins the Yukon River approximately 317 miles upstream from its mouth at the Bering Sea. The river has a substrate of mainly gravel and cobble with areas of exposed bedrock in the upper reaches. Downstream of the Yellow River, a major tributary of the Anvik River, the river changes from a moderate-gradient system to a low-gradient system that meanders through a broad flood plain. Water clarity below the confluence with the Yellow River is decreased due to the turbid water of the Yellow River.

The Division of Commercial Fisheries has been estimating fish passage at the Anvik River sonar site in some manner since 1972, including by counting towers, aerial surveys, and sonar (Lozori 2017). Since 2007, researchers at the site have used dual-frequency identification sonar (DIDSON); they primarily enumerate summer chum salmon but also count pink salmon, because they are in the river concurrently. Between 1972 and 2017, estimated escapements of Anvik River summer chum salmon ranged from a low of 191,566 salmon in 2009 to almost 1,500,000 in 1981 (Clark and Sandone 2001; Lozori 2016; 2017). The Alaska Board of Fisheries classified summer chum, fall chum, and Chinook salmon stocks in the Yukon River as management or yield concerns in the early 2000s due to low returns (Lozori 2017). Runs improved through 2007, but since 2008 Chinook salmon have been returning in lower numbers than expected. Summer chum salmon escapement into the Anvik River was below average from 2014 through 2016 and near or below the low end of the Biological Escapement Goal (350,000–700,000 chum salmon) since 2013. A key respondent highlighted his observations that the size of chum salmon runs over time has fluctuated but overall is smaller now: “The dog salmon [summer chum salmon] has changed, has declined” (08212014ANV4). He attributed this change to the commercial roe fishery that took place in the 1990s. Another respondent felt it was difficult to assess the run because “There’s no way to tell because they won’t let us fish anymore. Can’t tell how much fish going by” (08212014ANV5). Key respondents could distinguish Anvik River chum salmon in the Yukon River from those fish that were heading further upriver. The Anvik-bound fish spawn sooner, so they appear less silver than the summer chum salmon that spawn elsewhere in the Yukon River drainage. Anvik River-bound fish also have an orange-ish stripe on them and are known locally as calico salmon (08212014ANV4).

The Alaska Department of Fish and Game is required by state statute to specify the various rivers, lakes, and streams that are important for spawning, rearing, or migration of anadromous fishes like salmon. The Catalog of Waters Important for Spawning, Rearing, or Migration of Anadromous Fishes (referred to as the Anadromous Waters Catalog or AWC) is the most comprehensive effort to document salmon in Alaska waterways. Anyone may nominate a waterway as containing migrating salmon, spawning salmon, or both. After nominations, ADF&G reviews the submissions and evaluates the evidence provided. Due to the vast size of Alaska generally and the Yukon River drainage specifically, many water bodies have not been assessed for the presence of salmon or spawning salmon. According to the AWC, Chinook and chum salmon are present in the Anvik River and many of its larger tributaries. The AWC notes spawning activity in slightly fewer tributaries (figures 2-2 and 2-3). The AWC also indicates salmon presence and spawning in stretches of the Bonasila River. As long-time users of the lands, local subsistence users provide a wealth of knowledge about the land and its resources that can complement and enhance biological data collected through efforts such as the AWC.

Figure 2-4 shows local traditional knowledge that respondents shared regarding salmon habitat near Anvik. Respondents recalled seeing Chinook salmon carcasses in the Anvik River upstream of the log jam that was present until 2014 (08212014ANV5). Salmon carcasses indicate spawning, because Alaska’s salmon return to their natal streams to spawn, and then they die. Respondents have also observed summer chum salmon spawning in the mainstem of the Anvik River and in many of the tributaries found upstream of the
Anvik River Lodge (08202014ANV2). One respondent noted spawning fish from around the mouth of the Anvik River to “long runs all the way up to the end. Some of the small streams, you know, they spawn just about anywhere, any kind of creek” (08212014ANV1). One respondent recalled watching Chinook salmon spawn “way up past Swift River” (08212014ANV5). The same respondent has seen salmon spawning at Robin Creek, near where he traps. One respondent noted that salmon also spawn at Red Mountain on the Anvik River. At that location, Arctic grayling feed on salmon roe: “waiting for an egg to drift and dart in, dart out” (08202014ANV3).

One respondent observed juvenile salmon, including Chinook salmon fingerlings, near the mouth of the Anvik River (08202014ANV2). This respondent has seen small (one- or two-inch) salmon migrating downstream in the spring, and three- or four-inch salmon in the fall at the mouth of the Anvik River. He recalls only seeing these salmon in the fall a couple of miles up the river, and he does not see them anymore where the water starts to get deeper.

Although the AWC indicates Chinook and chum salmon presence and spawning in the Bonasila River and some of its tributaries (figures 2-2 and 2-3), none of the respondents who spent time on the Bonasila River thought that Chinook salmon went up that river (08202014ANV2; 08212014ANV4; 08202014ANV3). One respondent has seen summer and fall chum going up the Bonasila River, past the Hawk and Stuyahok rivers, but has not witnessed them spawning (08202014ANV2).

**Observations of Change**

Anvik respondents have observed local environmental changes over their lifetimes. Respondents made few direct connections between their observed changes and changes in salmon populations, but demonstrated the multiple ways their use and knowledge of the rivers, lands, and animal populations is changing. Some of the highlighted changes, such as decreasing harvest pressure, may have direct effects on salmon populations; other changes, like warming winter temperatures, may have a less direct connection to salmon populations.

Over their lifetimes, key respondents have observed changes in air temperature, precipitation, and the physical structure of the river. During the 1950s and 1960s, respondents recalled bitterly cold temperatures during winter months, whereas now the weather is much warmer (08202014ANV3, 08202014ANV2, 08212014ANV4, 08212014ANV5). Changes observed in the timing of river freeze-up and the depth of river ice may be linked to these observed changes in air temperature. According to respondents, in the past the river would usually freeze in early fall, providing transportation corridors for early winter activities (08202014ANV2, 08202014ANV3, 08212014ANV5). There has been a gradual shift to a later freeze.

Well, the freeze-up, it’s not as cold as it used to be. For a while I know it was like in the fall time, you get into October it will get like twenty below for like three or four days. It doesn’t do that until like November. That’s when it seems like the river is still open, November. You can’t cross the river unless you have a boat, and breakup, it’s pretty much normal, but this year there was no water too. The ice went out. It’s kind of like there are changes here. When you really think about it there are changes that it’s been so gradual that nobody ever really, if you were somebody that trained to, or if you didn’t pay attention to it all the time you wouldn’t notice it. (08202014ANV3)

The respondents who discussed freeze-up and breakup mostly felt that freeze-up was more variable than breakup. Because of later freeze-up, people have to change their way of traveling. When the river is open, boats are needed; once there is ice, snowmachines can be used. Less predictable river conditions challenge residents’ local knowledge that allows them to access the landscape safely by knowing when the river or lakes are safe to travel. Conversely, the respondent quoted above noted that the change has been very gradual, to the extent that young people have no memory of the colder winters that the older people recall. Younger generations of people have grown up with less predictable weather and river conditions and may consider those to be normal.
Figure 2-2.–Chinook and chum salmon presence in the vicinity of Anvik.
This map depicts the presence of spawning Chinook and chum salmon in the vicinity of Anvik.

Source:
Alaska Department of Fish and Game (ADF&G) Anadromous Waters Catalog (AWC), 2017
Alaska Albers Projection.
Map created by: Loraine Naaktgeboren

Figure 2-3.–Chinook and chum salmon spawning areas in the vicinity of Anvik.
The text boxes provide input from local residents regarding salmon and salmon habitat in the vicinity of Anvik. This map also depicts the presence of spawning Chinook and chum salmon in the area.

Sources:
Alaska Department of Fish and Game (ADF&G): Division of Subsistence interviews, 2014. Anadromous Waters Catalog (AWC), 2017.

Map created by: Loraine Naaktgeboren

Figure 2-4.–Local traditional knowledge contributions to understanding freshwater salmon habitat in the vicinity of Anvik.
When the river does freeze, the river ice is not as thick as respondents remember from their youth: respondents mentioned that the river froze to six, seven, or eight feet in depth in the past. Now they say that four feet is more common (08202014ANV3, 08212014ANV5). Lakes in the area are also freezing later in the year and not as thickly. The timing of snowfall affects ice formation because snow acts as insulation. An early snow provides insulation on the ice and leads to thinner, more dangerous ice, and a later snow results in thicker ice (08202014ANV2). Changes in ice thickness also present travel difficulties and dangers to residents. Respondents noted that the observed changes in freeze-up conditions and ice thickness started occurring about 30 years ago.

Winter is not the only season with changing weather. Several respondents mentioned that they experience cooler temperatures and more rainfall during the summer months now than in the past. More rainfall at this time of year leads to more mosquitoes (08202014ANV2) and difficulties drying fish:

This year is the most rain I have ever seen. It’s twice as much as we had…Like if we had to dry fish we’re going to burn way more wood this year than we did ever…Whenever it rains its cooler. If you are going to dry fish you’ve got to have more heat to maintain so it doesn’t spoil. It got to be where the summers were cooler. I put a electric heater in my smokehouse. Because you know you don’t want to get your fish to get sour after all the work that you did. (08202014ANV3)

People who depend on wild resources develop practices over time to take full advantage of them. Anvik residents have developed fish processing methods that work in rhythm with the season. Hot, dry summers were perfect weather for smoking and drying a fish harvest, but sustained changes in weather, such as increased rainfall, can make these practices less effective. Drying fish is necessary to ensure a sufficient supply of food through the winter. If changes in weather make drying fish impossible, or require extensive economic input, people may adapt their established practices by changing processing methods or targeting different fish populations available during times of more conducive weather.

Increased precipitation also causes high water events. High water provides access to otherwise inaccessible locations, but can also result in stranded salmon eggs. During high water events, sometimes salmon spawn on what will be a sandbar once the water goes down, leaving those eggs exposed to the weather and predators such as ravens (08202014ANV3). High water also leads to bank erosion by tearing up trees and other riverbank vegetation, actions that can cloud an otherwise clear river. Respondents have observed erosion events over significant stretches of the Anvik River (08202014ANV3, 08212014ANV5, 08202014ANV2).

Erosion is not only a consequence of precipitation, however. Melting permafrost due to warmer air temperatures also leads to more erosion. “There’s no more permafrost to keep the land in place…The land is sliding away” (08212014ANV5). The ground where permafrost has melted easily washes away, leading to events such as “half of that hill slid in the river” (08202014ANV2). This respondent observed another dramatic instance of melting permafrost on the Bonasila River. Trees growing in permafrost toppled onto his cabin when the permafrost melted. As air temperatures continue to rise, such events are likely to continue. Hazards of melting permafrost and erosion are not limited to the terrestrial landscape. Erosion can lead to decreased water clarity and potential challenges to salmon, if the silt covers up the gravel where they spawn (08202014ANV2). The warming temperatures and increasing permafrost melting began in the late 1970s (08202014ANV2).

One key respondent connected the disappearance of local lakes to melting permafrost (08202014ANV3). Places that had been full of small lakes where this respondent used to trap beaver now have fewer lakes, and grass has grown in where the old lakes were. The respondent has spoken with others in Holy Cross and Huslia who have noticed the same thing. This phenomenon does not affect salmon populations because they do not live in these lakes, but it speaks to the magnitude of change that Anvik residents have observed on the landscape.

Key respondents noted many changes to the channels and sandbars of the Yukon River. One prominent change occurred in the location of the sandbar in front of the community, which caused the main river channel to move to the west side of the sandbar (08202014ANV3, 08212014ANV4). Another respondent
noted that the main channel used to be very deep, but now “it’s pretty shallow, kind of a sandbar there” (08212014ANV4). Bends and curves have been straightened in the Anvik River (08212014ANV5). One respondent commented that yearly changes in the river channels and locations of sandbars has made navigation more challenging (08202014ANV2).

Some of these changes to the physical structure of the river may only affect how people navigate the river and not directly affect salmon populations or fishing practices. Changes in the river channels, however, are altering the eddies that salmon use as refuges and resting places and that fishers use for harvesting.

We used to have these eddies along the river, but they’re all filling in and there’s no place for the smolts to rest or feed or anything, you know. They just have to shoot right on out. (08202014ANV2)

Juvenile salmon take refuge from strong currents in eddies during their outmigration from the river. Adult salmon rely on eddies to rest during their upstream journey. Where the respondent has observed juvenile salmon using eddies, the water was fairly clear and the juveniles could be seen at the top of the eddy, in the slower water. Big, deep eddies are also good spots to catch mature Chinook salmon (08212014ANV5). Depending on the location in the river, high water can either obscure an eddy or allow one to form (08212014ANV5, 08202014ANV2).

Key respondents also discussed how human activities and preferences have changed the landscape and potentially affected salmon and other fish populations. Changes observed by key respondents include the establishment of the Anvik River Lodge, a change in eating preferences away from northern pike 2, and fewer salmon fishers.

Boat traffic has increased on the Anvik River since the 1980s as a result of the creation of a fishing lodge (08212014ANV4). Respondents felt that this increased traffic was contributing to erosion along the Anvik River.

People don’t believe it, but all you have to do is watch, you know. Wherever there’s mud like the Bonasila you drive along there and the waves hit the wash. The waves hit the bank and there’s a little bit of mud. So that does contribute to the, to the natural erosion. I’ve thought of that many of times. (08202014ANV3)

Additionally, the perceived disturbance of these boats extends to causing river gravel to migrate downstream and create new gravel bars (08202014ANV2). This movement of substrate may be impeding salmon passage through some sections of river.

Finally, key respondents discussed direct and indirect human-caused mortality on salmon populations. Respondents indicated that there were fewer salmon fishers now than in the past. According to one respondent, a major influence on this decreased harvest participation is the lack of dog teams (08212014ANV4). This respondent indicated needing upwards of 300 dried fish per dog to last the winter, when he kept dogs. Since fewer people keep dog teams, fewer fish are needed, so overall harvest effort declined. Another respondent, while echoing others’ observations of fewer salmon fishers, felt that salmon accounted for a greater proportion of people’s diets now than in the past. He attributes this change to people not fishing for or eating pike as much as his elders did. “Because people used to live on pike. You go back here in the spring the whole village takes off and set up camp back in the lakes, fishing pike” (08202014ANV2).

Household survey data collected by the ADF&G Division of Subsistence provides some evidence of this decline. In Anvik in 1990, residents harvested an average of 25 lb of pike per capita. 3 In 2011, the harvest had dropped to less than 9 lb per capita. Pike harvest in Anvik is more of a special occasion harvest now: “the elders a long time ago would eat a lot of pike, and they would always fish pike, and they would always keep the population down, and now we hardly ever do that unless they make fish ice cream and that’s about the extent of it” (08202014ANV3).

2. Hereinafter pike.
3. ADF&G CSIS.
The higher harvest of pike would have kept their populations lower, reducing predation on salmon populations. Several respondents discussed increasing numbers of pike locally (08202014ANV2, 08212014ANV4, 08202014ANV3). Although all respondents that spoke about catching pike have seen salmon smolt, fingerlings, or 3 to 4 lb salmon in their stomachs, only one directly questioned whether pike affect salmon populations (08212014ANV4). Other respondents did not share their thoughts directly on whether increasing pike populations were linked to decreasing salmon populations but given the predator-prey relationship detailed by these respondents, further research is warranted to explore this possible connection.

CONCLUSIONS

All of the respondents in Anvik discussed physical changes to the river and environmental changes. Rivers naturally change course, and these changes affect the daily life of Anvik residents, from where and how they can fish to travel routes on the river. Changes in timing and quality of ice formation have made winter travel more challenging and more dangerous. Cooler and rainier summers challenge fishermen in preserving salmon, to the extent that some fishermen are adding heating elements to their smoke houses. Although respondents did not emphasize significant changes to salmon stocks during interviews conducted for this project, harvest data and stock assessments show changes to salmon runs and harvest amounts over time. Harvest assessments show that Anvik residents are adapting to Chinoook salmon fishing restrictions, perhaps through increased fall chum salmon harvests. Primary harvest targets may have changed over time because of economic forces, such as the end to the commercial summer chum salmon roe fishery; cultural changes, such as declining use of dog teams over time; and biological forces, such as fluctuations in salmon populations. Most of the respondents discussed observed predation on salmon or salmon eggs but did not draw direct connections between predation and salmon populations. However, further research into populations of these fish predators and their potential effect on salmon could be warranted. Taken together, these economic, social, and environmental factors are affecting Anvik residents’ relationship to the land and waters around them. Although this project attempted to document the spawning and migratory patterns of salmon in the Anvik area, the resulting conversations with key respondents demonstrated that the once predictable natural systems are in flux. More research is necessary to determine whether and to what extent these fluctuations are affecting salmon.
In October 2014, one Alaska Department of Fish and Game researcher and one local research assistant conducted ethnographic interviews and mapping activities with five key respondents in Huslia (tables 1-1 and 1-2). Key respondents were all men who were experienced fishers and longtime community residents. Interviews averaged one hour and 11 minutes in length.

**COMMUNITY BACKGROUND**

Huslia, or Ts'aateyhdenaade kk’ohnh Denh (“where it burned out from the hill place where sharp hill extends out;” Jetté 1911), is located in Interior Alaska on the northeast bank of the Koyukuk River approximately 203 miles upriver from its confluence with the Yukon River and within the Koyukuk National Wildlife Refuge (Estensen et al. 2015b). The surrounding low-lying region is dominated by lakes, slow-moving rivers, and open spruce forest (Marcotte 1986). This combination of wetland and forest environment provides excellent habitat for the various fish, land mammals, and waterfowl upon which local people have depended for subsistence throughout history. Huslia is situated in the continental subarctic climate zone: the community experiences cold winters and warm summers as well as low annual precipitation and humidity.

Residents of Huslia are predominantly Koyukon Athabascan; they are descended from the Yukon-Kateel and the Huslia-Dulbi-Hogatza bands whose traditional territory encompassed the middle to lower portion of the Koyukuk River drainage (Marcotte 1986; McFayden Clark 1981). Prior to European contact, Koyukon Athabascans occupied large semi-permanent villages and fish camps during the summer. In the fall and winter, smaller family groups dispersed into the tributary drainages for hunting and trapping. Parts of the territory used by a band were shared communally, while others were considered private. These family-owned or privately held sites included beaver houses and ponds, muskrat swamps, or fishing locations. In the present day, individually-owned Native allotments are located in these traditional use areas, and some families still actively maintain seasonal hunting and fishing camps in these locations.

Historically, the Koyukon Athabascans served as middleman traders in the flow of goods between the coast and the Interior (McFayden Clark 1981). Russian traders began exploring the Yukon River during the 1800s, but the Koyukuk River drainage was not frequented by non-Natives until the later part of the century when gold discoveries brought an influx of Euro-American outsiders. Thereafter, local peoples’ settlement patterns began to shift as Koyukon people began to reside more permanently near trading posts, mining camps, and schools. The Cutoff Trading Post and ensuing community of Cutoff was established in the 1920s about four miles overland to the north of present day Huslia. Due to frequent floods and swampy ground, residents of Cutoff relocated in 1949 and established Huslia in its current location (Huslia Tribal Council 2017).

Contemporary Huslia is a second-class city that was incorporated in 1969 (Huslia Tribal Council 2017). The Huslia Tribal Council was established in 1972, and Huslia Village is a federally recognized tribe. Huslia is not accessible by road, but regional airlines operate daily flights to the community out of Fairbanks. Other Koyukuk River communities may be accessed by boat in summer or by snowmachine or dogsled in winter. Additional community infrastructure includes a school, a health clinic, three stores, a community hall, local government offices, a barge landing site, and a landfill. The community also has a volunteer search and 1. The Alaska Native Allotment Act of 1906 entitled Alaska Natives to apply for up to 160 acres of land as part of an initial aboriginal land claims settlement with the US government. In 1971, the ability to apply for Native allotments was terminated with the passing of the Alaska Native Claims Settlement Act. University of Alaska Fairbanks, n.d. “Alaska Statehood and build up to Alaska Native Land Claims.” Accessed April 15, 2019. http://tribalmgmt.uaf.edu/tm112/Unit-2/Alaska-Statehood-and-build-up-to-Alaska-Native-Land-Claims
rescue team, a volunteer fire department, and a Village Public Safety Officer. In 2014, Huslia’s population was estimated to be 379 people living in 116 households.\(^2\)

**Salmon Fishing Profile**

Salmon have always been an important food source for residents of Huslia. Salmon abundance and migration patterns are generally more reliable than other food species such as large land mammals. Huslia residents spend much of the summer fishing for salmon and processing this staple food. In the middle Koyukuk River drainage, Chinook salmon and summer and fall chum salmon are the primary species available for harvest, although small numbers of coho and sockeye salmon also migrate through the area (Esse and Kretsinger 2009; Dupuis 2010). By the time salmon reach Huslia, they have traveled 711 miles from the mouth of the Yukon River (Estensen et al. 2015b) and are of variable quality depending, in part, on how close they are to their natal streams. High quality salmon are either prepared fresh or preserved for later use by freezing or drying (Marcotte 1986). Low quality salmon are not discarded but are typically used as food for dogs.

Previous subsistence harvest research has documented the prevalence of salmon use within the community.\(^3\) A comprehensive subsistence harvest survey from 1983 estimated that salmon composed 51% (106,674 lb) of the total subsistence harvest by weight (Marcotte 1986).\(^4\) A total of 22,880 salmon were harvested that year, including 297 Chinook salmon, 20,953 summer chum salmon, and 1,631 fall chum salmon. Marcotte (1986) estimated that 75% of the summer chum salmon harvest was utilized as food for dogs.

Since 1989, subsistence salmon harvest data have been systematically collected in Huslia by ADF&G Division of Commercial Fisheries (Figure 3-1). Although salmon run sizes and harvests fluctuate annually, an overall declining trend has been observed since the surveys began. Despite overall declines, salmon harvest composition has remained relatively consistent over time and summer chum salmon have composed the majority of Huslia’s harvest since 1989. Chinook, fall chum, and coho salmon are also consistently harvested, although in smaller quantities. Chinook salmon, locally known as “kings,” are prized for human consumption but have been subject to harvest restrictions in recent years because of low run sizes (Estensen et al. 2015b).

A variety of changes have likely contributed to declines in subsistence salmon harvests at Huslia. Declines in summer chum harvests are related to the decreased use of dog teams and fewer salmon needed to feed dogs. Although 1,349 salmon were harvested for dog food in 2014 (Jallen, Decker, and Hamazaki 2017), this is only a fraction of the estimated 15,000 summer chum salmon used for dogs in 1983 (Marcotte 1986). Declines in Chinook salmon harvests over the long term have not been as pronounced but were extremely low in 2013 and 2014 due to fishing restrictions put in place because of low abundance. In these years, there were reduced salmon fishing opportunities that restricted access to Chinook salmon and concurrently running summer chum salmon.

Ethnographic respondents interviewed as part of this project reported fishing for salmon along the mainstem of the Koyukuk River, in the area between 20 miles downriver of the community to a few miles upriver of the mouth of the Huslia River (10072014HSL5, 10082014HSL2, 10082014HSL4, 10092014HSL1, 10092014HSL3). Families who fish further away from town typically utilize fish camps where they spend a few weeks in the summer harvesting and processing salmon. Those who fish close to the community can conveniently check their set gillnets and bring the fish back to the community to process. One elder respondent mentioned that Chinook salmon typically arrive toward the end of June, but that when he was younger it was more difficult to predict exactly when they would arrive because there was no communication with downriver communities (10092014HSL3).

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3. ADF&G CSIS.
4. ADF&G CSIS.
Figure 3-1.–Estimated salmon harvests by species, Huslia, 1989–2014.
Now days all they do is get on the phone and call Koyukuk…They get there and about three or four days later we know we’re gonna get salmon here. A long time ago it was just matter of you go to camp, go to fish camp and, springtime, and you just set the fish net and just sit and wait. You get a lot of whitefish and pike and stuff for dogs, you know. That’s all they used to have, no snowmachines, just dogs. Just sit and wait, and whatever you catch that’s what you eat. You got no freezer… We get a good run for about three or four days and then it slack off and then you catch a few in between, but then they wait for the second run too. That’s blue backs [salmon] you know…There’s the regulars and the blue backs are the last ones. They’re good ones. (10092014HSL3)

Additionally, this respondent mentioned that catching Chinook salmon was not common in the past because people did not have nets with large enough mesh size. This was echoed by another respondent, “When I was a kid nobody know how to fish for king salmon. All they had was just a little net. They didn’t know such thing as king salmon net” (10072014HSL5).

**Local Spawning and Migration**

Three primary species of salmon migrate up the Koyukuk River drainage via the Yukon River: Chinook salmon, two runs of chum salmon, and coho salmon. Run timing and run sizes vary by species. Chinook salmon are the first species to arrive in the middle Koyukuk River drainage in late June, but are less abundant than the chum salmon that follow. The chum salmon that return to the Koyukuk River are primarily summer chum salmon; most fall chum salmon (known locally as “silvers”) that enter the Yukon River are bound for the upper mainstem drainage. A three-year Yukon River stock composition study estimated that 1–2% of Chinook salmon that enter the Yukon River are bound for the upper Koyukuk River drainage upstream of Huslia (Eiler et al. 2014). Eiler et al. estimated that around 0.1% of the Yukon River Chinook stock returns to the Kateel River and another 0.1% to the Hogatza River, two tributaries of the Koyukuk River within the vicinity of Huslia. Brown et al. (2017) included the Dalki River as a contributor to Chinook salmon production, although on a minor scale, similar to the Hogatza and Kateel rivers.

A two-year study that tracked summer chum salmon migrations found that 22% of the sample of summer chum salmon that were radiotagged in the lower Yukon River returned to the Koyukuk River drainage (Larson et al. 2017). Of these fish, a large proportion returned to the Huslia River and Billy Hawk Creek drainage, as well as the Dalki and Hogatza rivers. Some fall chum salmon do migrate up the Koyukuk River drainage, but they are less abundant and their distribution is not as well documented (Wiswar 1997).

State, federal, and tribal fisheries management programs have conducted various assessment projects throughout the Koyukuk River region to monitor salmon escapement. The assessment project closest to Huslia has been the Clear Cleek counting tower and weir. Clear Creek is a tributary of the Hogatza River, which enters the Koyukuk 69 miles upriver of Huslia (Estensen et al. 2015b). The U.S. Bureau of Land Management operated a counting tower on Clear Creek from 1995 to 1999 and a weir from 2000 to 2005 (Esse and Kretsinger 2009). Chum salmon escapement counts at the weir ranged from a low of 3,674 fish in 2001 to a high of 26,420 fish in 2005. During the same time period, Chinook salmon counts ranged from zero to 30 fish and sockeye salmon ranged from zero to 18 fish. Salmon with later run timings, fall chum and coho salmon, were not counted.

The regularly updated *Anadromous Waters Catalog* (AWC) and its associated atlas include locations where citizens and researchers have documented salmon as migrating, spawning, and/or rearing in the middle Koyukuk River drainage. Figure 3-2 shows the locations where Chinook and chum salmon have been documented as present in the AWC, and Figure 3-3 highlights their spawning locations. These two salmon species are the focus of this study, due to their importance as subsistence foods in the study community. Notations on Figure 3-4 show additional insights provided by study respondents. Slightly further upriver,

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5. Brown et al. (2017) define “minor” as <500 fish when counted in escapement projects, <1% of the run as estimated in telemetry studies, or <165 as estimated by aerial surveys.
This map depicts the presence of Chinook and chum salmon in the vicinity of Huslia.

Source: Alaska Department of Fish and Game (ADF&G) Anadromous Waters Catalog (AWC), 2017.


Alaska Albers Projection.

Map created by: Loraine Naaktgeboren

Figure 3-2.—Chinook and chum salmon presence in the vicinity of Huslia.
This map depicts the presence of spawning Chinook and chum salmon in the vicinity of Huslia.

Source:
Alaska Department of Fish and Game (ADF&G) Anadromous Waters Catalog (AWC), 2017.
Alaska Albers Projection.
Map created by: Loraine Naaktgeboren

Figure 3-3.–Chinook and chum salmon spawning areas in the vicinity of Huslia.
This map provides input from local residents regarding salmon and salmon habitat in the vicinity of Huslia. It also depicts the presence of spawning Chinook and chum salmon in the area.

**Local Traditional Knowledge Contributions to Understanding Salmon Habitats: Huslia**

- **Study community**
- **River**
- **Salmon assessment project**
- **AWC spawning Chinook salmon**
- **AWC spawning chum salmon**

**Sources:**
- Alaska Department of Fish and Game (ADF&G): Division of Subsistence interviews, 2014.
- Anadromous Waters Catalog (AWC), 2017.
- Alaska Albers Projection.

Map created by: Loraine Naaktgeboren

**Figure 3-4.**—Local traditional knowledge contributions to understanding freshwater salmon habitat in the vicinity of Huslia.
Chinook salmon have been found to utilize the lower portions of the Dalki and Hogatza rivers (Figure 3-2). However, spawning has not been documented in any of these locations (Figure 3-3).

Chinook salmon prefer streams with gravel bottoms and cool, fast-moving waters for spawning locations (Delaney 2008rev.). As noted by a respondent, this type of habitat is not common in the vicinity of Huslia. “Water is more dirty down here than up there [near Allakaket]. Down here there’s more sand than gravel. Until you get up around Cutoff [Slough], upper end of Cutoff, above Dakli. That’s where you start hitting gravel” (10092014HSL1). Other respondents echoed that Chinook salmon spawn in the upper Koyukuk River (10082014HSL2, 10082014HSL4).

I don’t know where, how far up, they go quite a ways up though. Up there, John River and up around Allakaket. Yeah, all those drainages. They just go up there ‘til they can’t go no more and then they just spawn right there and die right there. (10082014HSL4)

When asked where Chinook salmon spawn near Huslia, one respondent replied,

I never see any up Huslia River, but I know Dakli River and Clear Creek up the Hog[atza] River and then Caribou Creek is where they spawn. We’d see a lot of dead fish up the Clear Creek in Hog River. After they spawn they just die, some of them. Some of it make it back out. (10072014HSL5)

When asked about Chinook salmon spawning locations, another respondent said, “They probably go quite a ways up the Hog[atza] River, that’s a pretty, pretty big river” (10082014HSL4). The AWC does not show that Chinook salmon are present in the upper portion of the Hogatza River past Clear Creek (Figure 3-2).

When asked where Chinook salmon spawn near Huslia, one respondent replied,

I’ve heard stories where they seen ‘em up the Huslia River, North Fork. One story I heard was someplace up there, North Fork, where just like here where the river got cut off it closed in, and this guy, they landed there, and they looked back that way and that lake, must be shallow water, it is red with king salmon. So they spawn up the Huslia River. (10082014HSL2)

The AWC does not include any Chinook salmon spawning up the North Fork of the Huslia River (Figure 3-2), so this location may warrant further investigation. Another respondent mentioned that “there’s very few [Chinook salmon] up there” in the North Fork of the Huslia River (10092013HSL3). Although the North Fork may not be a major producer of Chinook salmon, it could still be important habitat for smaller numbers of Chinook salmon.

In contrast to Chinook salmon habitats near Huslia, chum salmon usage of nearby areas is much more prolific (Figure 3-2). In addition to the Koyukuk River, the AWC includes chum salmon in the Dulbi, Huslia, Dakli, and Hogatza river drainages and shows spawning locations in portions of each of these drainages. One respondent noted that he typically sees chum salmon carcasses in the mainstem Koyukuk River near Huslia as they float back down the river after spawning.

They don’t spawn around here. Some years, most like a normal year, during the late end of the run, dead salmon start showing up on the beach, dog salmon…They just wash up on the shore. Crows get them, and those bears they go after them too, wolves. All kinds of predators go after them. But this year the water was too high, they just wash down the river. (10082014HSL2)

Other respondents commented on chum salmon in the Huslia River drainage. “The Huslia River gets lots of dog salmons that goes up in there. They spawn up there too” (10092014HSL3). This respondent went on to clarify that chum salmon spawn up both the North Fork and Billy Hawk Creek. Another respondent described the conditions in the Huslia River in more detail, saying that the lower part of the drainage is sandy, but the North Fork features better salmon spawning habitat.
North Fork they go up…that’s where you start running into a little bit of gravel I think…At the North Fork there’s pretty good, pretty good gravel bars. I don’t know how far the kings go, but I know dog salmon go up there quite a ways, quite a ways up. (10082014HSL4)

Although Billy Hawk Creek is noted in the AWC as a spawning location for chum salmon, their presence or spawning in North Fork of the Huslia River has not been documented by biologists (Figure 3-3).

In the region surrounding Huslia, the AWC does not indicate any rearing habitats for Chinook or chum salmon (figures 3-2 and 3-3). When respondents were shown pictures of Chinook salmon fry, several said that they had observed these “little fish” near Huslia. “We used to try and dip it with screen, you know. Us kids would play with ‘em. Right by the boat. And only way I know them is k’itlahona⁶ they call it. It’s Indian name for little fish, k’itlahona” (10072014HSL5). Another respondent recalled,

I know in the mouth [of the Huslia River] I remember I used to see those. Those little buggers, I used to see them on the beach when we were little kids playing. Because we used to fish for whitefish, I remember I used to see them. Yeah, all those little schools just hanging around. (10082014HSL4)

On elder respondent shared his observations of salmon fry: “There’s a lot of little fish in this area. We used to see them all over, but not this summer, we didn’t see nothing this summer [because of high water]. These [little fish], it used to attract those sheefish, the sheefish jumping all the time. And so we found out they’re there” (10082014HSL2). Multiple observations of salmon fry indicate a strong likelihood that salmon rear locally. However, because Huslia residents do not use salmon fry and because the various fry species are visually similar, more research is needed to determine which species of salmon are rearing locally and if they utilize distinct or overlapping portions of the river.

**Observations of Change**

Ethnographic respondents were asked to share their thoughts on any changes they have observed to salmon or the environment during their time living in Huslia. This section will discuss observed changes in Chinook salmon abundance, chum salmon abundance, and the environment.

When asked about salmon populations in general, one respondent replied: “Even that’s going down, pretty much, that salmon population around here. Not like it used to be. We used to catch lots. Net is just full, but it’s not like that anymore. I don’t know what’s going on” (10082014HSL4). Another respondent said that declines are not limited to salmon populations only. “All fish that I know of are kinda declining like” (10092014HSL3).

Some respondents attributed declining Chinook salmon abundance to nonlocal factors.

Not enough of us up here you know, to make any impact on them...We don’t do nothing to limit the population of king salmon. Well, I don’t see anything that would damage their population. We can’t even, we catch some you know, that’s just a few. Yeah, just a very few we catch. They’re hard to catch though. But we use setnet. Other places, they use driftnet. That driftnet is the worst killer for fish there is. Just kill a whole school of fish out at one time, one whole family, you know. That’s the worst killer for fish. I think that’s probably one of the big blames for overharvesting, killing off the kings, catching them all with driftnet. But we don’t do that here, we have setnet. (10082014HSL2)

In addition to driftnet fishing, another nonlocal factor mentioned to have an effect on salmon was pollution in the marine environment. “Nothing around here, just down on the coast I think everything on the coast is affecting them. Yeah, too many oil spills, some of that’s probably not even reported” (10092014HSL1).

⁶ Spelling from Jones (2001).
Some respondents expressed concerns about local pollution sources and the potential effects on salmon health. One such concern centered around mining activities in the Huslia and Hogatza river drainages. “The only thing that would affect the salmon is the mining camps” (10092014HSL3). This respondent was concerned about the chemicals being used to extract gold dust in Clear Creek, a tributary of the Hogatza River, and their potential to contaminate the water. He was also worried about the effects of older abandoned mining camps that were never cleaned up properly, and he specifically mentioned that he was able to smell fuel from abandoned barrels leaking along the North Fork of the Huslia River. Another respondent who spent time on the Hogatza River growing up mentioned changes to the clarity of the water that might be associated with mining. “The Hog River used to be clear. We used to get water from Hog River. Now you go up there, it’s kind of creamy-looking water. So there is something escaping up there” (10072014HSL5). This respondent also said that the water clarity could be affected by increased numbers of beavers that have colonized the drainage. Additionally, respondents expressed concerns about pollution coming from a neglected dump site and leach field in Huslia that commonly floods and may be contaminating the river (10092014HSL1; 10092014HSL3).

Other respondents felt that judging the strength of Chinook salmon runs was difficult when fishing periods or net size was restricted, as in recent years. For example, one fisherman described what seemed to be starting as a strong run of Chinook salmon in 2014:

This year it got really good off the bat. And I just got two or three kings and then they cut us off. I know it was going to be good…Then last year, two years ago, they cut us off with king net…So since that time we never fished for king no more. We catch maybe one or two in small [mesh] net. (10072014HSL5)

When another fisher was asked to comment on the 2014 Chinook salmon run he simply said, “The six-inch net doesn’t catch many kings” (10092014HSL1). Two elder respondents commented on the difficulty in discerning long-term trends in the Chinook salmon population, because when they were younger they did not have larger mesh nets designed to target Chinook salmon (10092014HSL3; 10082014HSL4).

Respondents had mixed views on trends in abundance of chum salmon. For instance, one respondent commented that “we used to put away a couple thousand dog salmons for dogs, last all winter, but no more now, you can’t do that anymore” (10082014HSL4), but another respondent said that people are still able to catch a “lotta chums” (10092014HSL1).

A common theme among respondents in Huslia was that of concern over increasing northern pike populations and the potential for increased predation on juvenile salmon and other fishes. A long-time traditional fishing practice used by Huslia residents involved placing small mesh nets across sloughs and smaller streams in the springtime after breakup and harvesting large numbers of pike. Blocking a waterway with a net, even if only temporarily, is now against fishing regulations, and respondents felt that pike numbers and size have increased since this practice was banned (10082014HSL2, 10092014HSL3, 10072014HSL5).

One thing they used to do long time ago was, before they had regulations, they used to block off the creeks to catch fish you know. They catch a lot of fish that way, catch a lot of pikes when they do that and they keep the population of the pikes down. When they quit that, when the regulations for blocking the creeks came out, they started, those pikes start multiplying. There’s no control you know. (10082014HSL2)

Another respondent joked that the pike are getting so big that people are going to have to start shooting them instead of fishing for them (10092014HSL3).

Respondents mentioned other types of predation on salmon, although they did not characterize these as a threat to salmon populations as they did for pike. One respondent mentioned that he has been seeing more eagles in areas where salmon spawn and die (10082014HSL2). This respondent also said that river otters sometimes pick salmon out of setnets. Another respondent described how Arctic grayling prey on salmon.

eggs. “That grayling, they just follow those king salmon around too. And they spawn up that creek, they just eat the eggs. I heard they’re catching lots of [grayling] up around Hughes” (10072014HSL5).

Several themes arose during respondent interviews regarding changes to weather and the environment. Four lifetime Huslia residents have observed that water levels have decreased. Specifically, rivers and sloughs are shallower, and lakes are “drying up” (10082014HSL2, 10092014HSL3, 10082014HSL4, 10072014HSL5).

Some respondents proposed that these changes are caused by melting permafrost, which allows water to seep into the ground instead of pooling on top of it. Melting permafrost also causes slumping or sinking land and accelerated erosion of riverbanks.

I’ve noticed those lakes down around our camp at Dulbi Slough flats. Lots of those, there used to be lots of high humps. When I was a kid. Now they all sunk. They’re all gone, yeah. And we used to have portages through the willows you know? Now you go from one portage you could see the next lake. The ground is just sinking… Dulbi Slough is getting shallower and shallower. You know we used to be able to go up there with big boats in the fall time, this time of the year. But now you can’t do that ‘cause the water is too low. It’s kind of just sliding in from both sides. The ground is dropping or something. I remember even when I was a kid I used to, we used to go up with outboard motors, way up even with the lowest water you know?...And Huslia [River] is getting like that too, getting low. (10072014HSL5)

Another respondent said, “This summer we really noticed lot of permafrost melting…you can see where the ice melt way back, and once it all melting it all drop in and wash away” (10082014HSL2).

Springtime flooding, which used to be a predictable event that helped to annually refill lakes and sloughs, has become less common. Some respondents think that this may be affecting species composition.

Used to have a flood every spring. Last big flood was probably 10 years ago… When there’s a flood, a lot of those lakes fill up with fish. So that’s usually pretty good. This lake [Fish Lake] used to be famous for whitefish. Fat whitefish…But a few years ago in the springtime, me and [another resident], we drug a canoe back to this lake and we put in a net back there. Watch it there a couple days, but all we caught was pikes. Pike kill off all those whitefish, there’s no more whitefish in there…That’s what the flood used to do, it would bring in fish to this lake (10082014HSL2)

Decreases in water levels and snowfall as well as melting permafrost have affected the way people can access subsistence use areas. One elder commented:

It’s all grass lakes now…We used to get lot of snow, four or five feet of snow, but now we only get about maybe 32 inches, maybe at the most. There’s a lot of difference in that, we used to use snowshoes to break trail. But now you don’t even, we don’t use snowshoes anymore. No snow. Yeah, it used to be, it used to be lotta snow long time ago. The last 20 years it changed so much, even the, like they say, the climate warming or whatever they got. Like I said, used to be portages for miles, from all the way from Huslia down to winter camp. Used to be portages that we used to go over. But once you get over the hill and about maybe ten miles down from here, after you pass Billy Spring Camp Slough, after you pass that then there’s hardly any portage. It just all the willows is dried up and it’s just small stuff that you can go anyplace to where you never used to. The permafrost is melting so much it’s just going down and everything is drying up. (10092014HSL3)

One respondent noted that water levels can have an effect on how salmon migrate. In high water years such as 2014, fishers have to change their gillnet placement because salmon utilize different parts of the river when the water is high (10092014HSL1). Another respondent said that the combination of lower water levels and increased erosion has caused an increase in the number of sandbars; he is worried some fishing eddies are going to be filled by sedimentation (10072014HSL5).
Respondents felt that the melting of permafrost may be accelerated by events such as wildfires or beaver activity, which clear the land of vegetative cover (10072014HSL5). Other environmental changes that respondents mentioned were less rain in the fall time (10082014HSL4), later freeze-ups (10092014HSL3), and warmer water temperatures (10082014HSL2, 10072014HSL5). Respondents directly attributed warmer water temperatures to decreasing salmon quality. One respondent recalled a year during which large numbers of dead fish in the river were getting caught in his net (10072014HSL5). He attributed this to warmer-than-usual water temperatures that year. Warmer water also affects people’s ability to preserve quality fish for later use.

Yeah, even from 10, 15 years ago, water was colder. You can keep the net in overnight and still expect to see good fish in the morning. Last summer it was, you couldn’t keep it overnight, the fish was just mushy in the morning. (10082014HSL2)

**CONCLUSION**

Local traditional knowledge is held by peoples who have had a long history of interaction with their surrounding environment. This knowledge can provide unique and important perspectives to scientists and managers trying to understand complex biophysical systems. Ethnographic respondents from Huslia have seen changes over time in salmon abundance and quality. Some respondents related these changes to driftnet fishing downriver, to fishing activities in marine waters, and to changing climate. Respondents expressed concerns about the potential effects that mining and leaching of chemicals could have on salmon. The most common sentiments shared by Huslia respondents were of decreasing water levels and drying lakes, although the effects that these might have on salmon were not directly discussed.

Respondents also mentioned locations where they have observed or have heard stories from others about salmon migration and spawning. Salmon presence and spawning has been documented in some of the waters near Huslia in the AWC, but local knowledge shared by respondents in this study could help prioritize future cataloging efforts. Respondents specifically mentioned the North Fork of the Huslia River as a location where some Chinook salmon and larger numbers of chum salmon spawn. They also talked about seeing “little salmon” around Huslia. Because no information is recorded in the AWC regarding rearing habitats for Chinook and chum salmon in this area, future research could focus on filling this knowledge gap.
4. ALLAKAKET

Brooke M. McDavid

In October 2014, two Alaska Department of Fish and Game researchers and one local research assistant conducted ethnographic interviews and mapping activities with eight key respondents in Allakaket (tables 1-1 and 1-2). Key respondents represented both men and women across a range of ages who all were experienced fishers and longtime community residents. Interviews averaged 48 minutes in length.

COMMUNITY BACKGROUND

The community of Allakaket, or Aalaa Kkaakk’et (“the mouth of the Alatna River;” Yukon River Drainage Fisheries Association 2008), is located on the eastern bank of the Koyukuk River, approximately 448 river miles upstream of its confluence with the Yukon River at the mouth of the Alatna River and just south of the Brooks Range (Estensen et al. 2015b). The neighboring community of Alatna is situated on the western side of the river opposite of Allakaket. Six other communities share the Koyukuk River valley, which is characterized by a wide range of habitats from alpine tundra to muskeg wetlands that supports a variety of plant, wildlife, fish, and bird species (Holen et al. 2012). Allakaket is situated near a swampy floodplain surrounded by tundra lowlands of birch and spruce. Weather in Allakaket ranges from extremely cold winters to hot summers; the community generally gets no more than 30 inches of rain per year (Henning 1983). The community is prone to flooding, especially during spring breakup.

Residents of Allakaket are predominantly Koyukon Athabascan. Their ancestors were the Todatonten-Kanuti and the South Fork Koyukon Athabaskan bands (McFadyn Clark 1981). Prior to European contact, Koyukon Athabaskans had a long history of interaction with their Inupiaq and Yupik neighbors through interregional trade, feasts, hunting, and marriage. The Alatna and Kobuk rivers were major routes for Siberian and coastal Alaska trade goods such as seal oil, baleen, and seal skins, to come into the Interior. In the opposite direction, furs, hides, birch bark containers, and spruce pitch traveled from Interior Alaska to the coast. Koyukuk Athabaskans were semi-nomadic, moving between seasonal camps and in search of food in small bands made up of several related families. Parts of the territory used by a band were shared communally, while others were considered private. These family-owned or privately held sites included beaver houses and ponds, muskrat swamps, and fishing locations. At present day, individually-owned Native allotments are located in these traditional use areas, and some families still actively maintain seasonal hunting and fishing camps in these locations.

Compared to other regions of Alaska, direct contact with Euroamericans occurred relatively late in the Koyukuk River valley (McFadyn Clark 1981). The fur trade that brought Russians to Interior Alaska was focused mainly on the Yukon River. A Russian trading post at Nulato in 1839 was the first extended presence of non-Natives in Koyukon territory, but residents of the upper Koyukuk River likely did not meet any outsiders until around 1884 (Holen et al. 2012). That year, a trader by the name of Mayo traveled overland from Tanana to the upper Koyukuk River region. The following year, US Army Lt. Henry Allen traversed the same course and then floated the Koyukuk River from present day Bettles to the confluence of Koyukuk and Yukon rivers. During this trip, he made no note of a settlement at present day Allakaket. After these initial voyages, contact with outsiders grew rapidly, in large part because of gold exploration (Marshall 1991). Small deposits of gold were found in the Koyukuk River headwaters, and in 1898 around 1,000 miners set up camps within the Koyukuk River drainage.

This influx of outsiders ultimately had major effects on resident Koyukon Athabascans including changes to settlement patterns, increased competition for resources, introduction of new goods and cash, and the imposition of differing religious, cultural, and governance systems (Holen et al. 2012). Some long-established Native settlements increased in population while others were abandoned. New settlements also developed near mining sites and trade depots. Local residents began to settle more permanently at Allakaket.
after Archdeacon Hudson Stuck of the Episcopal Church established St. John’s-in-the-Wilderness, a mission and day school, in 1906.

Although these changes in settlement precipitated changes in traditional livelihoods, Allakaket residents remain strongly tied to the land and are active participants in hunting, fishing, and gathering. The streams and rivers of the Koyukuk River drainage provide extremely productive breeding grounds for resident and migratory coldwater fish, including Chinook, chum, and coho salmon; whitefishes; sheefish; northern pike; burbot; Arctic grayling; and Alaska blackfish. Nonsalmon fish are particularly important to residents of the Koyukuk River due to their year-round availability and relative abundance compared to salmon.

Contemporary Allakaket is a second-class city; it was incorporated in 1975 and has a federally recognized tribe. After a flood in 1994 that destroyed many of the community’s houses, new homes were built on a nearby hilltop. Residential homes in the community do not have piped water; however, a washteria and the school are connected to a piped water system, and there is a sewage lagoon. Allakaket and Alatna share a school and an airport, both of which are located in Allakaket. The airport is a gravel runway served by daily flights from several regional airlines operating out of Fairbanks. Additional facilities and services in Allakaket include a health clinic, a post office, a landfill, and a store. In 2014, the community population was estimated to be 143 people.

Salmon Fishing Profile

Salmon harvesting and processing plays a prominent role in the seasonal round of subsistence activities in Allakaket, occupying a short but intense period of time in the lives of residents when the fish migrate past the community. Allakaket is located 956 miles from the mouth of the Yukon River, thus salmon swim a great distance before arriving at the community. Chinook and chum salmon are the primary species available in the upper Koyukuk River, although limited numbers of coho salmon may also be present (Esse and Kretsinger 2009; Estensen et al. 2015b). These fish must first avoid harvest in the downriver fisheries to be available for upriver communities like Allakaket to harvest. After the long upriver journey, salmon quality becomes highly variable as the fish approach their spawning grounds (Marcotte and Haynes 1985). High quality Chinook and chum salmon are either prepared fresh or preserved for later use by freezing or drying. Harvested fish that are not fit for human consumption are typically fed to dogs and not wasted.

Previous subsistence harvest research has documented the prevalence of salmon use within the community. In the 1980s, salmon composed roughly 60% of the subsistence harvest of all edible resources by weight in Allakaket and the neighboring community of Alatna. Annual Chinook and chum salmon harvests ranged between 68,000 and 84,600 lb over a 3-year study period. Salmon harvest composition was 92% chum salmon and 8% Chinook salmon. When a similar survey was conducted in 2011, salmon composed only 29% of the total subsistence harvest. The combined Chinook and chum salmon harvests dropped to around 20,000 lb. Although total salmon harvest and salmon’s proportion of the total subsistence harvest significantly declined between the two study periods, the salmon harvest composition by species remained relatively unchanged: Chinook salmon composed 7% of the salmon harvest and chum salmon composed 82%.

1. Allakaket Village.
2. This new portion of the community is known as “uptown” by residents, although the US Census Bureau refers to it as New Allakaket.
   http://factfinder.census.gov/faces/nav/jsf/pages/community_facts.xhtml
4. ADF&G CSIS.
5. Data collected for study years 1982–1984 combined the communities of Allakaket and Alatna.
6. Data collected for study year 2011 represent only Allakaket.
7. In 2011, sockeye, coho, and pink salmon were included on the survey and accounted for a small portion of the total salmon harvest. Only Chinook and chum salmon were included in earlier research.
Figure 4-1.–Estimated salmon harvests by species, Allakaket, 1989–2014.
Since 1989, annual subsistence salmon harvest data has been systematically collected through a post-season harvest survey administered by the Division of Commercial Fisheries (Figure 4-1). Total salmon harvests have declined roughly 50% since the surveys began. However, if the salmon harvests recorded in the early 1980s are included as part of this trend, the decline is even greater: almost 75% fewer salmon. A variety of changes have likely contributed to declines in salmon harvests. A decline in the use of dog teams has resulted in reduced harvests of chum salmon to feed dogs. Declines in Chinook salmon harvests, the primary species used for human consumption, are likely due to decreased abundance and the resulting fishing regulations that have reduced fishing opportunities and restricted access to Chinook salmon.

According to ethnographic respondents interviewed as part of this project and information from Holen et al. (2012), the majority of local residents fish for salmon along the Koyukuk River in the vicinity of Allakaket. Fishing close to the community allows fishers to easily check their set gillnets and bring the fish back to the community to process. Although less common, some families continue to utilize fish camps further from the community or travel to fish with family along the Yukon River. In the past, families commonly stayed in fish camp for most of the summer. However in the present day, residents who travel to fish camp primarily do so during the peak of the Chinook salmon run and generally stay for a few weeks at most. Fishing locations and fish camps are most concentrated downriver of Allakaket between the community and the mouth of the Kanuti River. However, salmon fishing occasionally takes place between the community and Henshaw Creek, in the lower portion of the Alatna River, or as far upriver as the South Fork of the Koyukuk River.

**LOCAL SPawning AND MIGRATION**

Three species of salmon migrate up the Koyukuk River drainage via the Yukon River: Chinook salmon, two runs of chum salmon, and coho salmon. Run timing and run sizes vary by species. Chinook salmon are the first species to arrive in the upper Koyukuk River drainage, in early July, but are less abundant than the chum salmon that follow. The chum salmon that return to the Koyukuk are primarily summer chum salmon; most fall chum salmon (known locally as “silvers”) that enter the Yukon River are bound for the upper mainstem drainage. A three-year Yukon River stock composition study estimated that 1–2% of Chinook salmon that enter the Yukon River are bound for the upper Koyukuk River drainage (Eiler et al. 2014). A similar two-year study that tracked summer chum salmon migrations found that 22% of the sample of summer chum salmon that were radiotagged in the lower Yukon River returned to the Koyukuk River drainage (Larson et al. 2017). Some fall chum salmon do migrate to the South Fork of the Koyukuk River, and the peak of their run occurs in late August (Wiswar 1997).

Over the years, state and federal fisheries management programs have conducted various salmon assessment projects in the Koyukuk drainage to monitor run sizes and estimate escapement for Chinook or chum salmon (Dupuis 2010). The longest running assessment project near Allakaket is at Henshaw Creek, approximately 20 miles upriver from the community. Between 1960 and 1999, aerial surveys were used to estimate escapement into the Henshaw drainage. However, a fish weir was installed in 2000 and has resulted in more reliable escapement estimates. Between 2010 and 2013, the Henshaw weir counted an average of 960 Chinook salmon and 127,589 summer chum salmon annually (Estensen et al. 2018a). Escapement counts such as these provide fishery managers with data inputs for spawner-recruitment models, which help forecast future run sizes. A few shorter term escapement projects have been conducted on the South Fork of the Koyukuk; these gathered escapement and age, sex, and length (ASL) data for Chinook salmon as well as summer and fall chum salmon. The South Fork of the Koyukuk is the only location in the Koyukuk River drainage where fall chum salmon escapement has been assessed. In 1990, a sonar project estimated that 19,000 fall chum returned to the South Fork Koyukuk River (Wiswar 1997).

A number of anadromous fish inventory efforts have documented locations where salmon migrate, spawn and rear in the upper Koyukuk River drainage. The *Anadromous Waters Catalog* (AWC) and its associated atlas provide a regularly updated reference of these locations by species. Figure 4-2 shows the locations where Chinook and chum salmon have been documented as present in the AWC, and Figure 4-3 highlights their spawning locations. Notations on Figure 4-4 show additional insights provided by study respondents based on their personal observations of salmon. Due to the sheer size of the Koyukuk River drainage and
Figure 4-2.—Chinook and chum salmon presence in the vicinity of Allakaket.
Figure 4.3.—Chinook and chum salmon spawning locations in the vicinity of Allakaket.
Figure 4-4.–Local traditional knowledge contributions to understanding freshwater salmon habitat in the vicinity of Allakaket.
its vast number of tributaries, researchers have not been able to collect migration and spawning location data from all water bodies that may be utilized by salmon throughout their lifecycle. However, through participation in a wide variety of subsistence activities, Allakaket residents have spent a substantial amount of time on the land making observations and interacting with resources, including salmon. This local knowledge can provide a useful supplement to information gathered through biological studies. During the ethnographic interviews conducted for this study, respondents described the locations where they have observed salmon during the various stages of their lifecycle. These observations will be discussed below and grouped by geographic area.

When fishing downriver of the community along the Koyukuk River in the vicinity of Discovery Creek and the Kanuti River, one respondent occasionally sees chum salmon carcasses or “zombie fish” floating back downriver (10282014AET5). Two respondents said they have observed that many salmon migrate up the Kanuti River but were not specific about the species (10282014AET2, 10282014AET5). Although he had not observed salmon spawning up the Kanuti River drainage himself because he does not fish in that area, one of these respondents said that he had heard stories from elders about salmon spawning around Kk’eeyh Degheleetno’ (10282014AET2), also known as the Kanuti Kilolitna River (Yukon River Drainage Fisheries Association 2008). The AWC shows that Chinook salmon are present up to the headwaters of the Kanuti Kilolitna River, but does not indicate that anywhere within the Kanuti River drainage is a spawning location (figures 4-2 and 4-3). Chum salmon, however, have been found to spawn in the lower portion of the Kanuti Kilolitna River and in the section of the Kanuti River downstream of this confluence (Figure 4-3). The respondent did not specify the type of salmon he had heard about in that area (10282014AET2); however, the documented presence of Chinook salmon in the AWC suggests there is a possibility that Chinook salmon may spawn in the upper reaches of the Kanuti Kilolitna River.

Salmon migrate into the upper reaches of the Koyukuk River drainage far past Allakaket (Figure 4-2). AWC cataloging efforts are most concentrated in the Middle and South fork regions as a result of surveys related to the installation of the Trans-Alaska Pipeline and the Dalton Highway, both of which parallel a significant portion of the river in this area and occasionally cross it. The farthest north that Chinook salmon have been located in the Koyukuk River drainage is in the Hammond River, a tributary of the Middle Fork of the Koyukuk River that extends north of the community of Wiseman. Chum salmon also migrate up the Middle Fork and into the lower reaches of the Bettles River. Although salmon presence has been noted in the AWC, spawning has not been confirmed in the upper reaches of these migration routes (figures 4-2 and 4-3). Both species of salmon also migrate into the South Fork of the Koyukuk River and the Jim River drainages, each of which are also intersected by the Dalton Highway, and both species spawn throughout the South Fork drainage. Allakaket residents rarely travel into the region beyond the lower South Fork, and therefore did not provide personal observations of salmon in this area.

The South Fork of the Koyukuk River and the Fish Creek drainage were once the sites of historical Koyukon settlements and are still used by some families from Allakaket in the present day. Two respondents described a location on the South Fork that has a traditional place name translating roughly to “salmon spawning” (10282014AET2, 10282014AET1). Data from a separate Koyukon place names mapping project show this location, Neek’eleh Denh, at the confluence of the South Fork of the Koyukuk River and the Jim River (Yukon River Drainage Fisheries Association 2008). Other respondents remarked on the large number of bears along the waterways in these areas, suggesting that their presence may be a natural indicator of a salmon spawning area (10282014AET2, 10282014AET5, 10282014AET1). One respondent recalled fishing for Chinook salmon up Fish Creek when she was younger, but was unsure of the status of Chinook salmon there at present day (10282014AET3).

Other locations in the southern Brooks Range where salmon have been documented include the North Fork of the Koyukuk, the Wild, and the John rivers, as well as the previously mentioned Henshaw Creek drainage (Figure 4-2). When salmon reach Allakaket on their upriver migration, some leave the Koyukuk River to travel up the Alatna River drainage. Both Chinook and chum salmon spawn as far north as the Malamute Fork of the Alatna River, into the lower portion of Mettenpherg Creek, and in the lower portion of the Iniakuk River (Figure 4-3). One respondent reported that he has seen salmon carcasses at Malamute Fork
Respondents reported that Chinook salmon have been caught as far up the Alatna River as Helpmejack Creek (10282014AET5). One respondent had observed salmon migrating up Chebanika Creek when seining in the area, although she did not specify what species of salmon (10282014AET3). Chebanika Creek is not listed as a salmon stream in the AWC. Other respondents reported seeing a lot of salmon spawning just downriver from Chebanika Creek in the areas around Siruk and Sinyalak creeks (10282014AET5, 10282014AET6). The AWC reports that chum salmon spawn in Siruk Creek and are present in Sinyalak Creek. However, they may also spawn in Sinyalak Creek\(^\text{8}\), as one responded noted: “a lot of the creek [Sinyalak] was lots of dead salmons, some were barely swimming” (10282014AET6).

**Observations of Change**

Most respondents who participated in interviews have lived in Allakaket for their entire lives and have observed changes to both salmon and the environment over the course of time. Common sentiments provided by respondents centered around a decline in Chinook salmon quality and abundance. An elder woman who has been fishing throughout her life in the upper Koyukuk River drainage remarked on the decrease in Chinook salmon size: “There used to be a lot of kings, big ones. There’s no more big kings. So many years ago we could make lotta salmon strips out of them…Nowadays there’s just all skinny fish…Not like long ago, they were just wide and thick, but now just thin, smaller” (10282014AET6). Other respondents echoed this observation, saying that king salmon have become shorter and thinner, and their flesh is less firm (10282014AET3, 10282014AET5, 10292014AET7, 10292014AET8). One respondent remarked that this trend in declining Chinook salmon size and quality is not unique to the Koyukuk River drainage. “I don’t think anywhere they get them big king salmon. Because the ones we get was what? They were eight-year-olds. You know, there’s no more eight-year-olds. There’s probably no more seven-year-olds” (10282014AET2). Not only are residents observing smaller Chinook salmon, but they are seeing fewer fish overall; some respondents attributed this to interception by downriver fishers (10282014AET2, 10282014AET4, 10282014AET5, 10282014AET6).

In addition to changes in number, size, and quality of fish, one respondent also observed a change in the sex ratio of harvested Chinook salmon. He said that now when he fishes it seems like he tends to catch more female Chinook salmon than he did in the past, even though he is catching fewer Chinook salmon overall (10282014AET5).

Respondents did not comment on declines in abundance or quality of summer chum salmon, but one respondent has noticed fewer summer chum salmon carcasses floating by town than in the past. “A long time ago we used to see a lot of them carcasses but not as many in the last few years. There’s not as many because you’d notice them. Normally there are birds surrounding them and not as many in the last few years, I would say” (10292014AET8). However, the respondent did remark that occasionally Allakaket will have a really abundant chum salmon year, during which residents can see the fish swimming past town in large numbers with the naked eye. Several respondents raised more specific concerns about fall chum salmon. “I noticed there’s not as big a run as there used to be for silvers, just from local knowledge, talking with people…We used to eat silvers all the time and most of August. My mom used to put a lot of them away” (10292014AET8). One elder fisher said that they used to seine for whitefishes every September up the Alatna River and would see many dead fall chum salmon in the creeks, but that there are “no more dead fish now” (10282014AET3).

A large body of scientific research has documented declines in salmon length, weight, and age of return throughout Alaska and the broader North Pacific region (Bigler et al. 1996; Lewis et al. 2015; McPhee et al. 2016). These declines have been observed as early as the 1920s, and they are not limited to a single species of salmon. In the Yukon River drainage, decreases in mean Chinook salmon length began in the mid-2000s. In part, this decrease in size is attributed to fish returning to spawn at an earlier age; but the reason for the earlier returns is still under debate and is likely a result of many compounding factors. Lewis et. al. (2015)

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8. Sinyalak Creek was added as a chum salmon spawning stream in the AWC in the fall of 2018, after the majority of this project was completed. ADF&G. 2018. “Search nominations: Nomination Number 18-244.” Accessed June 27, 2019. https://www.adfg.alaska.gov/sf/SARR/AWC/index.cfm?ADFG=nomSearch.home
summarize these factors to include: “size-selective fisheries, altered growth patterns from climate and marine environmental changes, nutritional restrictions in a North Pacific ecosystem increasingly saturated by large numbers of salmon, and density-dependent interactions with hatchery-reared salmon.” The effects of these large-scale processes are being seen at the local level, as indicated by the respondents’ observations above.

Allakaket fishers reported a variety of perspectives about the effects of in-river fisheries and environmental changes on salmon size and abundance. Most of these reflections centered around Chinook salmon, which is the species most prized for human consumption and experiencing the worst declines in abundance. In 2014, the lowest ever Chinook salmon harvest occurred along the Yukon River and its tributaries (JTC 2018). This low harvest was due to severe fishing restrictions put in place by fisheries managers as a result of record low returns. Many respondents noted that when fishing is closed downriver, they see greater numbers of fish as well as larger fish locally. “Once they closed down the first and second pulse at the mouth, we noticed that these Koyukuk River fish, they’re bigger. Better quality fish coming in. There’s more of them” (10282014AET2). Another respondent shared similar observations:

> When they close downriver we see more salmon. Chums too, not just kings. Because of first pulse closure more chum coming up, and they’re going farther upriver to spawn. Yeah, we usually respect the closures and really appreciate that way up there that they close it downriver for them to come up. And we notice lots when they do that, we catch a lot of good fish sometimes. (10282014AET5)

However, harvest opportunity was also restricted on the Koyukuk River, and fishers were not able to take advantage of these positive changes (Estensen et al. 2015b). From 2012 to 2014, Allakaket fishers caught fewer than ten Chinook salmon each year (Figure 4–1).

In recent years, the allowable mesh size for subsistence salmon fishing has been limited to six inches in an effort to avoid harvest of Chinook salmon while still allowing for the target of summer chum salmon (Estensen et al. 2015a). One Allakaket fisherman specifically referred to the effects of gillnet mesh-size restrictions on the fish they see up the Koyukuk River. “The mesh size also played a big role in, you know, the larger kings...Fishing for kings I noticed they’re larger, and that’s very rare. That’s one of the main targets is large kings down the Yukon” (10282014AET4). The preferential selection of older, larger fish over the past century is likely a contributor to observed changes in size and age of harvested salmon (Hard et al. 2009).

Even in the past, when fishers in Allakaket harvested more from the Chinook subsistence fishery, their relative take has always been small compared to other communities on the Yukon River, where fish are more abundant and accessible. Therefore, study participants did not feel that local levels of fishing are contributing to declines in Chinook salmon returns.

> I don’t know if there’s any kind of overfishing from around here. I don’t think so. It’s just been the same, fishing the same way every year for a long time and maybe they used to fish more a long time ago. They depended on it more, a lot more. Nowadays not too many people go fishing, especially for salmon. (10292014AET8)

Other factors that respondents considered might be affecting abundance of salmon were mostly related to environmental changes. Although Allakaket experienced high water conditions throughout much of the summer 2014 fishing season, respondents commonly noted that they have seen a trend towards lower water levels over time. Respondents associated lower water levels with decreased precipitation (especially snowfall), the melting of permafrost, and the drying of lakes. Two respondents mentioned seasonal springtime flooding as an important event that helps to “wash out” spawning areas and move young salmon into moving water (10282014AET5, 10292014AET8). They were concerned that as low snow years become more common, these years might have a negative effect on salmon numbers. This period of springtime flooding also helps to wash out sediment deposits and keeps the river from building sandbars (10282014AET5), which can be an impediment to fishing. Environmental factors such as flow levels have been shown to be important for triggering juvenile salmon outmigration (Burril et al. 2009; Sykes et al. 2009). Respondents
did not specify exactly for which life stage they considered flooding to be more important, migration of fry to freshwater rearing habitat or migration of smolt toward the marine environment. The only rearing habitat documented in the AWC for any species of salmon in the upper Koyukuk River is located in the upper South Fork and its tributaries. Therefore, documentation of rearing habitats and further documentation of local observations of this particular life stage might be a priority for future research, given the extensive presence of Chinook and chum salmon in this area of the drainage.

Some respondents thought that occasional major flood events, such as the one that caused significant damage to community infrastructure in 1994, could possibly have detrimental impacts to salmon spawning habitat. Recalling the flood, one respondent said, “The water was moving so fast, that changed a lot of things. And we don’t know if the salmon are still spawning at the same spot, did they move to a different location, or what” (10282014AET2).

Another respondent was concerned about fish passage in creeks and sloughs when water levels are low. They felt that low water and associated low velocity causes sandbars to form and that these sandbars can impede fish passage. In reference to Chinook salmon near the mouth of South Fork of the Koyukuk River, one respondent noted, “Nowadays they don’t hardly get anything now because the river below us is turning all to sandbars...That slough is turning, some places can’t pass if it get too low. And then the fish stay behind because of the shallow waters” (10282014AET3). This respondent was also concerned about low water levels causing rivers to freeze all the way through and decreasing the chances of salmon survival. Another respondent has noticed increases in the number of sandbars but did not note an effect on salmon (10282014AET6). Lower water levels also lead to warmer water temperatures, as one Allakaket resident shared:

[The water] was much colder those days when I was growing up…I’d say the water’s been warming up and I think that has a lot of the effect on the small salmon, fry and stuff like that, you know. Maybe a few degrees of temperature could affect them. You know I saw that somewhere on a program, and I believe that could be one of the big effects of global warming, is that somehow it affects the fish…When it’s real low water, it seems like the water is much warmer than years past. When we don’t have much rain, the water gets really warm. I mean I remember long time ago we used to swim in really cold water even when the water was low. Nowadays it’s just lukewarm. (10292014AET8)

Although respondents did note the drying or shrinking of lakes, they did not mention any direct effects on salmon, perhaps because salmon typically spawn in rivers and streams. However, one respondent has observed beavers moving from dried lakes into creeks and sloughs; he said that their dams have the potential to block fish passage (10282014AET2). The drying of lakes in subarctic Alaska has also been documented by researchers (Riordan et al. 2006; Roach et al. 2011). One respondent shared:

I wonder if this global warming has something to do with that too, because the permafrost melts and the water just gets soaked up by the land instead of staying on top of the permafrost. Seem like there’s more grass lakes than usual. We usually have water in them, especially close to the river. When I went up to Fish Creek one time, all along here there’s lots of lakes that are mostly grass, not much water anymore. (10292014AET8)

At least one respondent was concerned about the development of the proposed Ambler Road, which would pass through salmon spawning habitat north of the community. He believes that the project will negatively affect salmon and consequently the livelihoods of community residents. “Our way of life will be extinct when that road goes through...Around here we are worried about it. Downriver people want the road. They are more business-minded, more for change, and we are not. We like the way we live around here” (10292014AET8).

During ethnographic interviews, respondents were prompted to share any changes they had noticed to predation on salmon over time. Although no one expressed concern over increased predation as a reason for declines in salmon abundance, some respondents did remark on predator species. One elder woman shared
that she has noticed an increase in the size of pike, which prey on salmon (10282014AET3). An older male respondent mentioned that he sees a lot of gulls and eagles where salmon spawn, but that he does not know if there are enough to make a difference on the salmon population (10282014AET5).

Some respondents have adjusted their fishing locations in an attempt to better target Chinook salmon.

> Sometimes we just try out different places to set king salmon net, but we’re just catching dog salmon in the net...Years ago we used to have good quantity of fish creeks way down there, now hardly that many. What we get is really poor at that... Pretty soon we won’t even have to set king net anymore ’cause we don’t catch any. (10282014AET5)

Another respondent mentioned spending more on gas because of the need to travel upriver and downriver to locate a good fishing spot (10292014AET7). Other respondents have changed fishing locations not because of changes in abundance, but because of changes to the river that have damaged their fishing eddies (10282014AET5, 10292014AET8, 10282014AET3). These respondents noted that eddies had filled in with sand or gravel and had become too shallow to set a net.

Although all rivers do change over time, some respondents indicated that erosion seems to be accelerated because of permafrost melting (10282014AET1, 102082014AET2).

> One thing we noticed is a lot of permafrost is going away now and the ground is beginning to sink...Yeah, someplace up Little Portage Slough where all that cut bank is. It caved a lot this summer, I think ’cause it was high water. ’Cause some places you could see maybe 25, 30 feet it wash underneath. So that’ll actually drop some time. (102082014AET2)

Further research would be needed to investigate all the ways which Allakaket residents have adapted to declining salmon runs, but results from a previous comprehensive subsistence study suggest that households may be relying more heavily on nonsalmon fishes and large land mammals (Holen et al. 2012).

**Conclusions**

Local traditional knowledge is held by peoples who have had a long history of interaction with their surrounding environment. This knowledge can provide unique and important perspectives to scientists and managers trying to understand complex biophysical systems. Ethnographic respondents from Allakaket have seen notable changes over time in salmon abundance, as well as in the size and quality of Chinook salmon specifically. They primarily related these changes to heavy harvesting along the mainstem Yukon River and to the changing climate. Respondents also mentioned locations where they have observed salmon migrating and spawning or have heard stories from other local people or elders about salmon spawning. Knowledge of some of these locations has been preserved through traditional place names in the local Koyukon language which translate to “spawning locations.” In several tributaries in the upper Koyukuk River drainage, salmon presence has been documented in the AWC but salmon spawning has not yet been recorded. The local knowledge shared by respondents in this study could help prioritize future cataloging efforts. Specific places that were mentioned by respondents included tributaries of the Alatna River such as Chebanika and Sinyulak creeks where unspecified salmon were noted as present and likely spawning, and the upper Kanuti Kilolitna River where Chinook salmon may spawn. This research also showed that little information is known about the rearing habitats for Chinook and chum salmon throughout the upper Koyukuk River drainage, which could be another data gap that future studies could seek to fill.
5. FORT YUKON

Alida Trainor

In November 2014, two Alaska Department of Fish and Game researchers conducted ethnographic interviews and mapping activities with eight key respondents in Fort Yukon (tables 1-1 and 1-2). Key respondents were all men across a range of ages; all were experienced fishers and longtime community residents. Interviews averaged 49 minutes in length.

COMMUNITY BACKGROUND

The community of Fort Yukon lies along the north bank of the Yukon River at its confluence with the Porcupine River, about 145 miles northwest of Fairbanks. The Yukon Flats region is characterized by flat to gently rolling floodplains that encompass a vast network of lakes, rivers, and wetlands. Breakup of the Yukon and Porcupine rivers often causes local flooding, and the presence of ice jams downriver from the community can worsen this seasonal flooding. The continental climate of this area features bitter cold winter temperatures and warm summer temperatures, averaging close to 70º F in summer months and near -30º F in winter months. Precipitation is minimal, and summer wildfires caused by lightning are common. The geography of the area provides abundant habitat for migrating moose, caribou, and waterfowl, among other terrestrial species. Salmon, whitefishes, and other nonsalmon species are abundant and provide year-round opportunities for harvest.

Fort Yukon is the largest community in the Yukon Flats region, and it serves as a regional hub for the area (Sumida and Andersen 1990). In 2014, the community was home to 514 residents, 93% of whom were Alaska Native. The Yukon Flats and surrounding areas are the traditional territory of the Gwich’in and Koyukon Athabascan people, who remain the principal inhabitants of the region today. Many Fort Yukon residents are descendants of the Gwich’in Athabascan bands from the Teedrinjik River, Birch Creek, Black River and Porcupine River. Three-thousand-year-old artifacts of definitive Athabascan origin have been found on the Old Crow River in the Yukon Territory but it is believed that Athabascans have lived in the region far longer than this (Van Lanen et al. 2012).

Prior to European contact, Gwich’in people’s dependence on the harvest of wild resources for survival led to a highly mobile culture in which people traveled in widely dispersed small bands. According to Osgood (1936), the Gwich’in were divided into nine distinct bands: Yukon Flats (Kutchka); Birch Creek (Tennuth); Chandalar River (Natsit); Koyukuk River headwaters (Dihaii); Black River (Tranjik); Crow River (Vunta); Upper Porcupine River (Tukkuth); Peel River (Tatlik); and Mackenzie Flats (Nakotch). The size and composition of social units among Athabascan bands varied throughout the year, depending on the activities undertaken (U.S. Fish and Wildlife Service 2008). Extended kinship groups would often gather together at summer fish camps to harvest cooperatively. By the mid-1880s some people began living semi-permanently in the settlement of Fort Yukon but still maintained their summer fish camp locations.

Alexander Murray founded Fort Yukon in 1847 as a Canadian outpost in Russian territory; the Hudson Bay Company operated in the community from 1847 to 1869 (Van Lanen et al. 2012). After the United States purchased Alaska, the Alaska Commercial Company took over the trading post. In 1862, a mission school was established in Fort Yukon, and a post office opened in 1898. Euroamericans began arriving in the Yukon Flats region in large numbers in the 1880s to participate in the fur trade. The growing economic activity within the Yukon Flats was largely supported by the presence of the Hudson Bay Company, and

3. USFWS 2018.
later, the Alaska Commercial Company, in Fort Yukon. Many Gwich’in bands began to fragment into smaller units as families started trapping commercially (Van Lanen et al. 2012). Participation by Gwich’in trappers contributed to the Hudson Bay Company’s success. By the 1920s, Fort Yukon was one of the most important fur trading centers in Alaska. Later on, discoveries of gold in nearby Birch Creek fueled another wave of arrivals. Beginning in the 1930s and 1940s, as the town grew to include churches and schools, the settlement of Fort Yukon became a permanent community. A major flood damaged or destroyed many homes in Fort Yukon in 1949. In the 1950s, the Air Force established a station in Fort Yukon along with a White Alice communications site. The city was incorporated in 1959. Fort Yukon is located within the Yukon Flats National Wildlife Refuge, which was established in 1978.

Despite the myriad changes occurring to Gwich’in settlement patterns and livelihoods, dependence on wild resources and a reliance on subsistence activities continued, and a strong subsistence economy and culture remains today (Stephen R. Braund & Associates 2007).

**Salmon Fishing Profile**

The Yukon Flats is known for wide, slow-moving river channels that shift frequently and require adaptive fishing strategies. Fishers often change their fishing locations to accommodate these changing conditions, moving their setnets or fish wheels throughout the season in an attempt to find productive fishing sites. One respondent in this study explained that in order to be successful, a fisher must constantly reevaluate the river.

> [Those who] don’t move their wheel around to find [a good] spot, they just leave it and they say, ‘Oh, this spot was good 20 years ago, it’s gotta be good now,’ you know? But it ain’t…Especially around in here [in the Yukon Flats]. That’s why we got that little area, you know. It’s always changing so we just always move. (11202014FYU4)

Another respondent explained the difficulty of fishing in the Yukon Flats:

> I just fish on the Yukon here, and it’s hard to get fish here too because you go three, four different splits here, you know? Channels split up and if you don’t hit the right place you’re tough luck, can’t get anything. It’s a big job pull around and moving the wheel all the time, moving it and moving it. You can’t just put it in and expect to get fish, you gotta find the right place. (11192014FYU7)

Fish wheels have long been used in the Yukon Flats, but respondents explained that they are becoming the gear of choice even though, as described above, they are burdensome to move in search of a productive fishing site. According to one respondent, nets were more commonly used in the past, but because of unpredictable river conditions and changing eddies, fish wheels are now favored:

> It’s easier setting a net. You can just set net there one day and bang, it’ll be, you know, hopefully you’ll be catching fish. But a lot of time you could, you know, probably last 10, 20 years I been up and down this area, putting in nets here and there, trying to catch fish but you know I can’t catch fish. You know, they’re just not hitting those spots anymore…I just gave up. No more fish nets. Start building a fish wheel. (1182014FYU8)

In addition to adjusting to changing river conditions, fishers adapt their fishing strategy to fluctuations in salmon abundance and the resulting restrictions placed on Chinook salmon fishing. Variations in salmon abundance and environmental conditions can affect Fort Yukon residents’ abilities to harvest the salmon they desire, but fishers will attempt to supplement the harvest of a less abundant species with that of a more abundant one. “Every year’s not the same. It’s different every year. Some year you get lot of fish,
some year you don’t. It slacks down and then you make up with silver salmon [fall chum salmon], with coho” (11192014FYU3). Key respondents observed that the harvest of Chinook salmon has declined greatly in recent years because of regulations that reduce fishing time (11192014FYU2) (11202014FYU4) (11192014FYU7). This has shifted more harvest pressure to fall chum salmon.

The people of the Yukon Flats region have harvested salmon for thousands of years. Since 1989, Fort Yukon residents have participated in the annual postseason salmon harvest surveys conducted by the ADF&G Commercial Fisheries Division. Figure 5-1 shows the community salmon harvests from 1989 to 2014. Additional salmon harvest assessment occurred in the late 1980s as part of a comprehensive subsistence survey (Sumida and Andersen 1990) and again in 2017. In 1987, 97% of Fort Yukon households used salmon and 46% attempted to harvest them (Sumida and Andersen 1990:44). Chinook salmon harvest accounted for the majority of salmon caught by residents (82% by weight), and Chum salmon accounted for 18%. In 2017, fall chum salmon was still the most commonly harvested type of salmon, accounting for 57% of the salmon harvest, but Chinook salmon made up 42%. Fewer Fort Yukon households kept dogs in 2017 than in 1987, which could explain why the proportion of fall chum salmon in the overall salmon harvest decreased. One respondent’s harvest profile fits the trend documented in prior studies. He reported typically harvesting thousands of fall chum salmon each year to feed the family dog team and catching a few hundred Chinook for human consumption (11202014FYU4).

**Local Spawning and Migration**

Located in District 5 of the Yukon River, Fort Yukon is over 1,000 river miles from the Bering Sea. The predominate types of salmon available this far up the Yukon River are Chinook and fall chum salmon. Coho salmon are also present, but Fort Yukon residents primarily rely on Chinook or fall chum salmon. Fort Yukon residents distinguish between two types of fall chum salmon. “Silver” salmon have a south bank orientation and are better quality eating-fish, likely because they have farther to migrate. They have more fat, are brighter in color and arrive in mid-August. “Dog” salmon have a north-bank orientation and are likely bound for spawning relatively nearby in the Porcupine River drainage. As a result, their flesh quality is poorer, and as the name implies, these fish are often caught to feed dogs (Sumida and Andersen 1990:26). This differentiation draws attention to the various use patterns that exist for chum salmon.

Salmon fishing primarily occurs throughout the months of June, July, and August, but can extend as late as early October. One respondent noted that fishing for fall chum or coho salmon can occur so late in the season that ice may already be present in the river, “We used to catch them right here in the Sucker River, they fish hook it, under ice. They don’t get [them] with a wheel or net because ice is moving and [will] just crush it” (11192014FYU2).

Fort Yukon is located on the mainstem of the Yukon River but is also close to major tributaries, including the Porcupine and Teedrinjik (formerly known as Chandalar) rivers. The Porcupine River is a transboundary river. The community of Old Crow is located on the Canadian side of the Porcupine River, and respondents in this study discussed their familial ties to people there and shared observations heard from Old Crow residents. The Teedrinjik River has a confluence with the Yukon River downstream from Fort Yukon and drains much of the southern Brooks Range. The communities of Venetie and Arctic Village are located along the Teedrinjik River, and similarly to Old Crow, residents of these communities have close relationships with Fort Yukon residents. Some ethnography gathered in this study documents observations coming from people in these locations. Respondents also discussed Birch Creek, another tributary near Fort Yukon.

Fort Yukon residents often travel along the Porcupine River during hunting season in the fall and to visit relatives in Old Crow throughout the summer months. Respondents in this study agreed that in the past, Chinook salmon were not known to migrate up the Porcupine River. However, several respondents shared

Figure 5-1.–Salmon harvest estimates, Fort Yukon, 1989–2014.
insights into possible ecological changes that are now pushing more Chinook salmon up the Porcupine and Teedrinjik rivers. Although the *Anadromous Waters Catalog* (AWC) does report the presence of salmon in these streams already, it does not quantify the abundance of these fish. The lack of abundance information makes the ethnography gathered in this study of value and may lead to additional research or new submissions to the AWC. A further discussion of possible changes to salmon migration is presented below in the section Observations of Change.

Respondents discussed the presence of salmon in these major tributaries as well as the presence of salmon in smaller tributaries such as the Coleen, Christian, and Sheenjek rivers. This section discusses the direct observations and speculations shared by respondents and compares these to existing records within the AWC (Figure 5-2).

One respondent has spent his lifetime hunting, trapping, and traveling along the Christian River. As a child and young man, the respondent spent time at Alexander Village. Now abandoned, Alexander Village was a semi-permanent seasonal settlement located approximately 20 miles overland from Fort Yukon. The respondent has seen signs of both spawning and migration of Chinook salmon along the Christian River while fishing for Arctic grayling: “we see the [Chinook] salmon fish, when water is low, we would just see it going up [stream]” (11192014FYU2). The respondent estimates that he has seen Chinook salmon swimming upstream roughly 30 miles from the confluence with the Yukon River (Figure 5-3). A bit further upstream from where the respondent fishes for Arctic grayling, he has seen distinct spawning locations for both Chinook and chum salmon. He notes that “you can’t stay there too very long…there’s a lot of brown bears, yeah.” The presence of numerous brown bears, a well-known predator of salmon, is further indication that this area of the Christian River is a robust spawning location. The respondent remembers being in that area with his grandfather and looking down into the water and seeing “red.” His grandfather explained that “those are eggs.” The same respondent did not think that salmon spawned farther than 30 miles up the Christian River because he had never seen any sign of spawning and thought it unlikely because of how the river becomes shallow and narrow, and fish must pass through boulders and rapids further upstream. Additionally, on the lower reaches of the Christian River, the respondent has seen carcasses of Chinook salmon floating downstream. The AWC does report the presence of Chinook salmon roughly 30 miles up Christian River, confirming the respondent’s observation (Figure 5-3). However, the AWC does not specify a life stage and specifically does not report the presence of spawning Chinook salmon anywhere on the Christian River (figures 5-2 and 5-4) suggesting that the accounts provided by this respondent warrant a submission to the AWC for both Chinook salmon and fall chum salmon.

Several respondents discussed the presence of spawning salmon along the Sheenjek River, a smaller, but still commonly used tributary of the Porcupine River. One respondent reported seeing “a lot of dead fish all the time, just all over the beaches” during the moose hunting season that typically occurs in September (11192014FYU2). The respondent indicated that the salmon he saw were “silver salmon and dog salmon” referring to early and late runs of fall chum salmon. Another respondent also noted seeing fall chum salmon spawning “way up” on the Sheenjek River (11192014FYU3). The AWC documents the spawning presence of fall chum salmon on the Sheenjek River just below the confluence with the Koness River (Figure 5-4). Respondents agreed that Chinook salmon do not spawn on the Sheenjek River. “I can’t tell you that there’s king salmon up there though, ‘cause I’ve never seen them. Seen plenty of chum salmon though, thousands, pretty cool to watch” (11172014FYU6). Although respondents in this study may not have seen Chinook salmon on the Sheenjek River, the AWC does report their presence.

**Observations of Change**

Although this study focused on observed changes to the spawning and migration patterns of Chinook salmon, respondents shared numerous other ecological changes that are underway in the Yukon Flats. For example, according to respondents, the notoriously lake-dense nature of the Yukon Flats region has slowly been changing. Permafrost thawing and a general warming in both air and water temperatures have “dried
This map depicts the presence of Chinook and chum salmon in the vicinity of Fort Yukon.

Source:
Alaska Department of Fish and Game (ADF&G) Anadromous Waters Catalog (AWC), 2017.

Alaska Albers Projection.

Map created by: Loraine Naaktgeboren

Figure 5-2.—Chinook and chum salmon presence in the vicinity of Fort Yukon.
This map provides input from local residents regarding salmon and salmon habitat in the vicinity of Fort Yukon. It also depicts the presence of spawning Chinook and chum salmon in the area.

**Local Traditional Knowledge Contributions to Understanding Salmon Habitats: Fort Yukon**

**Study community**
- Other community
- River
- Salmon assessment project
- AWC spawning Chinook and chum salmon
- AWC spawning Chinook salmon
- AWC spawning chum salmon

**Figure 5-3.**–Local traditional knowledge contributions to understanding freshwater salmon habitat in the vicinity of Fort Yukon.
This map depicts the presence of spawning Chinook and chum salmon in the vicinity of Fort Yukon.

Source:
Alaska Department of Fish and Game (ADF&G) Anadromous Waters Catalog (AWC), 2017.

Map created by: Loraine Naaktgeboren

Figure 5-4.–Chinook and chum salmon spawning areas in the vicinity of Fort Yukon.
out” many lakes in the area (11202014FYU4). Recent wildfires contributed to the permafrost thaw. One respondent explained that the Yukon Flats had

changed quite a bit, because only four feet down we get permafrost up there, but now since they had this big fire that burned all the way down this way, it just thawed out the whole ground and everything...I think that permafrost thawed out by the fire then [the water] drained down. (11192014FYU2)

Some of the lakes with which respondents are familiar are grassy meadows now (11202014FYU4; 11182014FYU8). One respondent recalled that as a child in the 1980s “there used to be a lot of lakes, yeah. But right now it’s just all meadows. Just grass” (11182014FYU8). The respondent went on to explain that the lakes closer to the Yukon River are less prone to drying out because they are more easily flooded by high river water, but the lakes further inland are “all dried out.” He asserts that this began changing about 10 or 15 years ago.

Because respondents all had extensive experience traveling along and utilizing the Yukon River for subsistence activities, many of the observed changes pertained to the nature of the river itself. Nearly all respondents discussed the inconsistency of water levels in the Yukon River. Residents who live on or near a river pay close attention to the fluctuation in water level because of the effects of water level on fishing and boat travel. Although there are seasonal patterns to water levels, some of the respondents interviewed in this study asserted that these seasonal fluctuations are becoming less predictable. For example, the Yukon River has been generally higher in recent years because warm weather has increased runoff from tributaries such as the Porcupine River (11212014FYU1). Tributaries to the Yukon River are fed by melting snow in the Brooks Range, and periods of unseasonably warm weather can increase the volume of water draining into these tributaries and, thus, into the Yukon River. One respondent emphatically stated the biggest change that he has observed in his lifetime: “Geez, just water levels I’d say. Different water levels all the time pretty much” (11182014FYU8).

As discussed above, several key respondents described what they consider to be a recent change to Chinook salmon migration (11202014FYU4; 11172014FYU6; 11192014FYU7; 11182014FYU8). Although the AWC does report the presence of Chinook salmon along the Porcupine and Teedrinjik rivers already, the respondents believe that Chinook salmon are swimming farther up the Porcupine and Teedrinjik rivers than ever before, and in larger quantities than in the past. According to respondents, people living along the Teedrinjik River used to catch an occasional Chinook salmon in a net but now are catching four or five at a time (11202014FYU4). To illustrate the significance of this shift, one respondent explained that the oldest person in Venetie passed away a few years ago—over a hundred years old—and they never seen king salmon up there in her lifetime until the last fifteen years or so. And one guy caught, I forgot what the number was, but for them it was pretty impressive, you know, like, talkin’ 40, 50 salmon. These guys at the border get 60, up in Old Crow, they get 40, 50, 60 salmon. King salmon. (11172014FYU6)

In 1960s and 1970s, this respondent traveled the Yukon River by boat in the fall when it was dark at night and seeing “lights here, lights here…it’s like camp after camp like that.” According to this Fort Yukon respondent, Venetie residents don’t need to travel to the Yukon River to catch salmon anymore because “the king salmon are turning up on the Chandalar [Teedrinjik River]” (11172014FYU6). Another respondent characterized the change in a similar way: “that’s what everybody’s been talking about the past, I don’t know four or five years. That a lot of salmon has been going up, up in the Porcupine and they’ve been catching a lot of good salmon there in that area…especially king salmon” (11182014FYU8). The same respondent went on to say that he had heard that poor quality Chinook salmon have recently been caught as far up the Teedrinjik River as Arctic Village. According to one respondent, the quality of the Chinook salmon migrating up the Teedrinjik River is poorer than those caught in the mainstem Yukon River. “Not good kings, they have the big teeth and [are] dark” but the people who are catching them on the Teedrinjik River “think it’s good” (11202014FYU4). Respondents discussed a possible explanation for this recent change: “Cold water! [Chinook salmon] seek it out, they can’t take warm water, they get their little gyro
all messed up. They don’t know what to do, they actually stress them and it kills them. Warm water is not good for salmon” (11172014FYU6). The respondent went on to describe how he believes warmer, higher water affects Chinook salmon:

I think the weak ones don’t go where they’re supposed to go. Yeah, the current’s too strong for ‘em, yeah, they just can’t make it. For some reason, they’re already stressed, they went through the Yukon, warm water, they’re stressed out, they don’t have the energy no more, to reach where they should be going, traditionally, 40 year ago they’ll go there come hell or high water, but not these days, not after being stressed coming up the Yukon. They’re a bunch of stressed-out fish, you know, not kidding you, yeah, yeah. Them boys—you go to a fish wheel and they just got a bunch of salmon, used to be you couldn’t hang on to a salmon, a live one, you couldn’t pick it up, they’ll throw you in the river. Nowadays, heck, there’s nothing to them…I’m telling you, when they hit that fish box they just lay there. Thunk, thunk and that’s it. Banging around for 40 minutes some of them, 30 years ago. Now they, just a couple of flips and that’s it, not much energy. (11172014FYU6)

According to respondents, turbidity, or the silt content within water, has decreased. They attribute the warming of the Yukon River to decreased turbidity. Without silt in the water, more sunlight can penetrate the water and warm it. Increased water temperature has been documented to have negative effects on salmon, including the rise in *Ichthyophonus* infections (Kahler et al. 2007). “This is my theory, observing the Yukon River: we don’t have the ash content we used to have. In the 1970s that Yukon River out there looked like coffee with a little milk in it, it was almost white—thick with ash, thick, just white. You’d see the contrast” when clearer, glacial fed streams like the Porcupine River flow into the Yukon River and the different waters mix together (11172014FYU6). Another respondent suggested that the Chinook salmon that turn onto the Porcupine River are weaker than those that continue up the mainstem Yukon River (11192014FYU7). He commented that the “Porcupine River is not as strong as the Yukon. Yukon is more swift” and the Chinook salmon that enter the Porcupine “get poor on the way up, they’re not rich like the [ones] around here” (11192014FYU7). Taken together, these respondents offer a local theory regarding salmon migration and behavior: Chinook salmon will seek out environmental conditions favorable for their survival even if that means altering their typical migration routes, possibly leading to new spawning locations over time.

Within the Porcupine River system, respondents noted an increased annual variability in the water level. Key respondents explained that water level and water temperature are related topics, especially on the glacier-fed tributaries. In particularly warm years, more meltwater drains into the headwaters causing higher water levels downstream. A respondent speculated that it might be harder for salmon to “get up[stream] to where they’re supposed to spawn” during low-water years because changing water levels affect the river channels: “low, too, sometimes no water” (11192014FYU7). If the Porcupine River has become a respite for weaker salmon seeking cooler water, low water levels during particularly warm years may create even more challenges for these fish.

**Conclusions**

Fort Yukon respondents discussed a variety of changes that they have observed within the Yukon Flats region including decreased turbidity and warmer water temperatures in the mainstem Yukon River, a gradual “drying” of lakes and sloughs throughout the Yukon Flats possibly caused by thawing permafrost, and unpredictable water levels in major tributaries like the Porcupine River, among many other ecological changes that may have direct or indirect effects on salmon. Although not presented in this chapter, respondents also discussed changes that they have observed to salmon quality and quantity, which have been extensively documented elsewhere (Brown et al. 2015; Moncrieff 2017). All these observations exist within a broad base of traditional ecological knowledge that spans generations of experience and interaction with the environment. The experiential and observational bases of knowledge possessed by respondents in this study present a multitude of possibilities for future research. This study gave particular attention to the numerous comments made by nearly all respondents that Chinook salmon are migrating up the
Porcupine and Teedrinjik rivers. The new migratory routes may have escapement implications because of the transboundary nature of the Porcupine River. The AWC already confirms the presence of Chinook salmon on the Porcupine River, but respondents in this study suggest that the quantity is greater now than in the past. If more Chinook are salmon are migrating up the Porcupine River than in the past, these fish could be crossing the border without getting counted towards the escapement goal agreed upon in the Pacific Salmon Treaty. However, because respondents in this study had not seen Chinook salmon for themselves on these tributaries, but rather had heard of their increased presence from friends and relatives in Venetie and Old Crow, this information must be confirmed with residents in these communities in future research.

By working directly with these communities to document the traditional ecological knowledge surrounding Chinook salmon and by gathering genetic samples of the Chinook salmon migrating the Teedrinjik and Porcupine rivers, stakeholders throughout the Yukon River drainage on both sides of the border as well as Chinook salmon managers can better evaluate the status of this critical stock and begin to understand the in-river ecological effects that might be changing its long standing migration patterns.
6. DISCUSSION

Alida Trainor

This research documented the local traditional knowledge surrounding the freshwater components of the Chinook salmon life cycle, including migration and spawning as well as the larval and juvenile life stages. A total of 26 ethnographic interviews were conducted in four Yukon River drainage communities: two on the mainstem and two on the Koyukuk River. These interviews provided rich context for a rapidly changing ecological system that may be affecting salmon. Andersen et al. (2013) notes that there is a growing appreciation and acknowledgement that local and traditional ecological knowledge (TEK) can facilitate a more holistic understanding of the relationship between people and the land on which they live and rely. Subsistence users have an intimate connection to the landscape and to the food webs they utilize for fishing, hunting, and gathering activities. This connection positions them to keenly observe changes and collaborate with researchers to answer broad questions posed by fisheries scientists and climatologists.

Although Chinook salmon were the focus of this research, many respondents shared their knowledge of summer and fall chum salmon as well. Additionally, respondents mapped locations associated with salmon spawning and migration, and they recorded any other areas associated with salmon habitat. The maps published in this report were created from existing salmon presence and spawning location data found in the ADF&G Anadromous Waters Catalog (AWC).

This chapter summarizes and compares the themes from the ethnographic interviews in all communities and documents the salmon spawning and migration locations that respondents described. Some of these areas are not currently included in the AWC. These locations will be submitted to the AWC through the public nominations process.

Aquatic Change

During ethnographic interviews, respondents in all communities shared broad observations of change, particularly in the rivers, lakes, and other waterways that surround them. Many respondents noted that these changes, including thinner ice, loss of eddies, less predictable water levels, and decreased turbidity have occurred approximately within the last 20 years and are locally considered rapid change. In order to understand shifts in the spawning and migration patterns of salmon, respondents often began by explaining their understanding of the water around them.

Despite living in geographically distinct communities, all 26 respondents interviewed for this study agreed that significant changes to the water that they live near are underway. Although a variety of topics were discussed, three areas stood out as significant and possibly connected to broader ecological factors that may affect salmon: changes to freeze-up and breakup timing, thawing of permafrost, and drying of lakes. This section will discuss examples from each community pertaining to these topics.

Along the Koyukuk River, respondents noted that the timing of freeze-up is occurring approximately two weeks later than it typically did in the past. Respondents in Allakaket agreed that freeze-up regularly occurred during the first or second week of October, but within the last decade, freeze-up has started occurring in the second half of October, sometimes as late as Halloween, and that ice is forming more slowly (10282014AET4, 10282014AET2, 10292014AET8). In Huslia, respondents shared that the Koyukuk River is breaking up earlier and river ice is thinner and more dangerous than in the past (10092014HSL3, 10092014HSL1).

On the mainstem river, respondents in Anvik and Fort Yukon have also experienced later freeze-up, earlier breakup, and poorer ice conditions. In Anvik for example, one elderly respondent recalled being able to travel across the frozen Yukon River on the first of November to set his trap line in the 1970s. Now, the river is often still open, and little to no ice is flowing at that time (08212014ANV5). Another Anvik respondent cited rapid change to ice conditions in the last 20 years that has shifted freeze-up later into the winter. Instead of being able to travel by dog sled or snowmachine to hunt and fish, “now we’re taking
boat rides into October and November” (08202014ANV2). These respondents in Anvik credit slightly warmer weather with fewer stretches of deep cold temperatures for the change in freeze-up conditions. In Fort Yukon, respondents described warmer spring temperatures that have resulted in less predictable river breakups (11172014FYU6; 11192014FYU2; 11212014FYU1).

Scientists have discovered strong correlations between juvenile salmon survival and the timing of breakup or “ice out” at Dawson, Yukon Territory (NOAA Fisheries 2015). Early breakups and warmer water temperatures can cause juvenile salmon to migrate to the Bering Sea at a time when there is low abundance of prey necessary for salmon survival. If prey abundance matches the outmigration of juvenile salmon, the fish will be healthier and larger later in their life cycle. Understanding the effects of earlier ice-out events and rising water temperature on juvenile salmon is critical to understanding the long-term survivability of Yukon River Chinook salmon. Fort Yukon residents presented a local theory that the warmer water in the mainstem Yukon River is straining Chinook salmon and resulting in more salmon in cooler tributaries such as the Porcupine River. This presents an opportunity for biologists to explore changing spawning locations related to changes in water temperatures.

Warming temperatures have also resulted in the thawing of permafrost. Much of the permafrost found in the Arctic and Interior regions of Alaska is tens of thousands of years old.1 This frozen ground is a central feature of the ecosystems surrounding the four study communities. The National Park Service is closely monitoring the effects of thawing permafrost on rivers in the arctic and subarctic regions of Alaska and the possible effects on fish habitat (O’Donnell et al. 2017). Experts in geophysics, hydrology, chemistry, and biology are developing multidisciplinary approaches to understanding the complex effects of melting permafrost. Although this approach is still being developed, many of the observations made by respondents in this study have been confirmed by researchers in these disciplines. O’Donnell et al. (2017) conclude that thawing permafrost

may alter stream and river discharge and the location and magnitude of stream inflows. Permafrost thaw in ice-rich terrain can cause the formation of thermokarst features, or depressions associated with melting of ground ice and subsidence of the ground surface. In many cases, thermokarst can lead to erosion of soils from terrestrial uplands followed by deposition into rivers and lakes. These effects of permafrost thaw can alter the physical structure of streams and rivers, which can improve or deteriorate habitat for fish and other aquatic organisms.

Respondents in this study shared numerous examples of thawing permafrost in their areas that is increasing erosion and, consequently, changing the dynamics of local tributaries, many of which are documented salmon spawning streams. An Allakaket respondent has noticed that “a lot of permafrost is going away now and the ground is beginning to sink” (10282014AET2). Thawing and sinking ground caused “big mature trees” to fall and crush a trapping cabin 17 miles downriver from Anvik (08202014ANV2). The same respondent expressed concern that thawing permafrost is resulting in increased sedimentation in the Bonasila River. As permafrost thaws, bank erosion increases and the silty ground washes into the river. The respondent first began noticing this in the late 1950s but saw a rapid acceleration of thawing and erosion patterns in the late 1970s.

Fort Yukon respondents who have contact with relatives in Arctic Village noted that caribou hunters there no longer need to look over hills to scout for caribou because the frozen ground below has melted so much that the hills have receded four or five feet in some places (11192014FYU3). Similarly, a Huslia respondent remembered when there used to be “lots of high humps” around his family’s camp at Dulbi Slough but “now they are all sunk. They’re all gone” (10072014HSL5). These humps are formally known as pingos and are formed when water from a lake drains into the ground below, freezes, and then pushes the land above it upward.2 “The ground is just sinking” (10072014HSL5).

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2. APLI n.d.
In recent years, the Yukon Flats region has experienced a series of intense forest fires that have exacerbated the thawing of permafrost and resulted in the “draining” of some lakes (11192014FYU2). One respondent speculated,

I wonder if this global warming has something to do with that too because the permafrost melts and the water just gets soaked up by the land instead of staying on top of the permafrost...seems like there’s more lakes, more grassy [lakes] than usual. We usually have water in them, especially close to the river...not much water anymore. (10292014AET8)

Thawing permafrost results in a variety of changes to land topography and river morphology. Taken together, the observations described above likely cause both direct and indirect effects on salmon. An effort to understand the relationship between permafrost and fish habitat is already underway. As O’Donnell et al. (2017) note:

Changing hydrology and stream chemistry associated with permafrost thaw will likely impact fish in Arctic rivers. While climate change may directly affect fish by increasing stream temperature, permafrost thaw will likely affect fish indirectly by altering different components of the stream food web. For instance, the slow release of nutrients from thawing permafrost can increase algal growth on sediments, influence stream invertebrate (e.g., insect larvae) composition and productivity, and fish size (Slavik et al. 2004). Thermokarst (irregular topography resulting from ground ice melting) can also increase the amount of solids transported in stream flow, which can negatively impact stream invertebrates (Chin et al. 2016), an important food source for many fish.

Yukon River salmon migrate across vast portions of Interior Alaska waterways to spawn. Consequently, they are undoubtedly in contact with the diverse aquatic changes underway throughout this region. Although more monitoring and research is needed to understand the specific effects on Yukon River salmon, the ethnography described confirms that changes to breakup and freeze-up timing, thawing of permafrost, and the drying of lakes are widespread across the region.

All respondents shared a sense of uncertainty during their ethnographic interviews. The seasonal round that they used to understand is no longer predictable. The timing of seasonal events and the reliability of factors such as frozen ground or thick river ice is no longer certain. One respondent concluded: “No, you can’t predict the weather no more, them days are gone” (11172014FYU6). Local people throughout the Yukon River drainage are struggling to understand the rapid environmental changes that are occurring and the resulting unpredictability that accompanies them.

**PROPOSED SUBMISSIONS TO THE ANADROMOUS WATERS CATALOG**

In addition to the ethnographic interviews, respondents were asked to mark on a map places where they have seen or heard of salmon presence, spawning, or both. Researchers took care to distinguish, both on maps and on the audio recordings, between places where respondents had actually witnessed salmon migrating or spawning and those where the respondents were sharing second-hand information.

One objective of this study was to compare known spawning and migration locations identified by respondents with the existing entries in the AWC and submit new entries if any were sufficiently documented. This section will summarize all the recommended areas for submission to the AWC.

**Anvik**

No new spawning or presence locations were identified by respondents near Anvik. However, respondents disagreed with indication by the AWC that Chinook salmon are present and spawning in the Bonasila River. Numerous respondents have never seen Chinook salmon on that tributary or any of the smaller streams that flow into the Bonasila River (08202014ANV2; 08212014ANV4; 08202014ANV3). These respondents all discussed the chum salmon that are present in large numbers on the Bonasila River, but all were confident that Chinook salmon did not migrate up that river or use it as a rearing habitat.
Huslia

Two respondents identified the North Fork of the Huslia River as a potential site for Chinook salmon spawning (10092014HSL3; 100082014HSL2). When shown pictures of Chinook salmon fry, several other respondents said they had seen these “little fish” near Huslia on the Huslia River. “Us kids would play with ‘em” (10072014HSL5). Another respondent remembers playing with Chinook salmon fry at the mouth of the Huslia River when fishing for whitefishes (10082014HSL4). The AWC does not currently recognize this stream as a spawning or rearing location for Chinook salmon; but, as the Huslia chapter notes, “although the North Fork may not be a major producer of Chinook salmon, it could still be important habitat for smaller numbers of Chinook salmon.” Similarly, the lower reaches of the Huslia River, especially near the mouth, may be an important rearing habitat, and this area should be recognized on the AWC salmon presence map.

Allakaket

Within the Koyukuk River drainage, the AWC reports the presence of Chinook salmon along the Kanuti River, all the way to the confluence with the Kanuti Kilolitna River. Allakaket respondents discussed seeing salmon carcasses floating down the Kanuti River (10282014AET5). Although respondents were not specific about the species that they observed, the documentation of Chinook salmon presence so far up the Kanuti River is a likely indication that Chinook salmon are spawning in the upper reaches of the Kanuti Kilolitna River drainage.

Chebanika Creek, a tributary of the Alatna River, is not currently listed as a salmon stream in the AWC. However, one respondent has observed salmon migrating up this waterway when she was seining in the area (10282014AET3). Because the respondent did not identify the species, this observation cannot be submitted to the AWC for consideration; however the ethnography documented in the Allakaket chapter strongly suggests that salmon migrate and spawn in numerous tributaries to the Alatna River. Two other respondents reported seeing a lot of salmon downstream from Chebanika Creek, in Sinyalak Creek and Siruk Creek (10282014AET5, 10282014AET6). The AWC reports that chum salmon spawn in Siruk Creek and are present in Sinyalak Creek. However, according to one respondent, there were “lots of dead salmons, some barely swimming” in Sinyalak Creek (20282014AET6). Lethargic and dead salmon indicate spawning, because salmon return to their natal streams to spawn, and they die after doing so.3 Updating the AWC to include chum salmon spawning in Sinyalak Creek will more accurately reflect their activity in this area.

Fort Yukon

The AWC does not identify the Christian River as a location for salmon spawning or migration, however one respondent had detailed accounts of witnessing Chinook and fall chum salmon spawning on this stream, roughly 30 miles from the confluence with the Yukon River (11192014FYU2). In addition to watching salmon deposit and fertilize eggs in this area, the respondent also described a variety of other indicators, such as increased presence of bears during spawning season and floating Chinook and chum salmon carcasses on the lower portion of the Christian River, all of which indicate the existence of a strong spawning area.

Much of the discussion during the Fort Yukon ethnographies dealt with increasing presence of Chinook salmon on the Porcupine River, possibly because of warmer water temperatures in the mainstem Yukon River that is forcing fish into the cooler tributary. Although the Porcupine River is a known tributary and habitat for both Chinook and chum salmon, participants in this research were adamant that a change to Chinook salmon migration is occurring, and they believe that more of these fish are swimming up the Porcupine River than ever before. Several respondents shared second-hand knowledge from relatives and friends in Old Crow, Canada, that indicate increased harvests of these fish. The AWC does not account for abundance, but these ethnographic observations do warrant further investigation.

CONCLUSIONS

This research met its primary objective: to document salmon spawning and migration locations not currently in the AWC. The research also adds to the growing understanding of Alaska’s changing climate. The ethnography shared by respondents who participated in this study indicates that extensive ecological change is rapidly occurring. Respondents conveyed to researchers that in order to understand changes to salmon spawning and migration patterns, a discussion of changing ecology and climate is also necessary. Although the knowledge respondents shared during the interview and mapping process was local in scale, the common experiences shared by respondents across all four study communities indicate that environmental change across much, if not all, of Interior Alaska is underway and is affecting how people travel, hunt, fish, and plan their yearly subsistence activities.

Many of the environmental observations shared with researchers may have a significant effect on Pacific salmon species. However, they are outside the scope of this research to confirm. Consequently, research conducted in the sub-Arctic region should take an interdisciplinary approach whenever possible in order to fully capitalize on the opportunity to understand the full scope and effect of the ecological and climatic changes on the people and salmon that are living in this region.
REFERENCES


2017. *Solar estimation of summer chum and pink salmon in the Anvik River, 2016*. Alaska Department of Fish and Game, Division of Sport Fish, Research and Technical Services, Fishery Data Series No. 17-26: Anchorage.


The protocol below is intended to summarize the kinds of information we aim to gather during our LTK interviews. While the content listed in the present protocol is important, the way to gather the information will differ with each interview. Please, adapt your strategy according to the interviewee you are talking to (age, specific interest/knowledge, quantity/quality of information provided with each answer, etc.).

**INTRODUCTION**

1. Indicate the following basic information that needs to be on record:
   - Interviewer(s) name
   - Date and place of interview
   - Respondent’s name and place/year of birth (+ their parents’ name/place of birth)
   - Name of project this interview is conducted for

2. Remind respondent about the goals of the LTK project:
   - WHO we are,
   - WHY is this project conducted,
   - WHAT kind of information we are hoping to gather,
   - WHICH AREAS we are interested in learning about,
   - HOW the interview will be conducted/the kinds of questions we will be asking to try and get the information we are looking for.

**MAPPING EXERCISE**

I would like to start this interview with looking at a few maps with you. I will ask you about places where you have been conducting different subsistence activities to better understand which areas you have been utilizing throughout your lifetime. This will help me identify specific areas of the watershed where you may have observed important changes related to salmon habitat.

1. Where do you go and what do you do out on the land/along the river/in the watershed?

2. Map present use areas by season/activities *(in relation to the watershed of interest)*:
   a. Spring (Non-salmon fishing / Bird hunting)
   b. Summer (Salmon fishing / Berry picking)
   c. Fall (Moose hunting / Berry picking / Non-salmon fishing / Bird hunting)
   d. Winter (Caribou hunting / Trapping / Wood gathering)

3. Map use areas through time, also by season/activities:
   ⇒ Last 5-10 years / 10-30 years ago / Pre 1980 / Pre 1950
PROMPTS FOR QUESTIONS

Discuss the following points with regards to both:

- MIGRATION WATERS and SPAWNING GROUNDS
- PRESENT OBSERVATIONS versus HISTORICAL OBSERVATIONS

WEATHER/CLIMATE CHANGE

In this first section, I am interested in learning a bit more about any changes in the climate you may have witnessed since you have been living in [COMMUNITY X]. I would like to hear your observations regarding the kinds of affect these changes may have had on the river condition, fishing and also any impact you may have observed on fish behavior.

○ Break-up/freeze-up
  - Change in timing of break-up? Freeze-up?
  - How does this impact the river?
  - How does it affect salmon fishing/fish behavior?

○ Precipitations [should we combine snowfall & rainfall?]
  ✓ Snowfall (winter)
    - Any changes in the amount of snow loads over time?
    - Low snowfall years (winter 2013/14?): When? Any effects observed on the river condition? Impact on fishing? Impact on fish behavior?
    - High snowfall years: When? Any effects observed on the river condition? Impact on fishing? Impact on fish behavior?

  ✓ Rainfall (spring/summer)
    - Any changes in the amount of rainfall over time?
    - Low rainfall years (spring/summer 2013/14?): When? Any effects observed on the river condition? Impact on fishing? Impact on fish behavior?
    - High rainfall years: When? Any effects observed on the river condition? Impact on fishing? Impact on fish behavior?

○ Temperatures
  - Any years with exceptional warm/cold temperatures? Effects on the river? Effects on fishing/fish behavior?
  - (Changes in water temperature: does the water “feel warmer” in some areas than it did in the past? Any impact on fishing/fish behavior?)
With this second set of questions, I would like to discuss with you about changes you may have observed in the nature of the river itself, and how these may have affected salmon distribution and behavior as well as the way you interact with the river (watershed?).

- **Nature of the water bodies**
  - **Structure of the river**
    - Any changes in the location and amount of sandbars formed along the river?
    - Any major erosion of the river banks observed in the slough and tributaries? Any erosion close to spawning areas?
  - **Water level** [See section above: “Precipitations”]
    - Impact of low/high water levels on the river?
    - Impact of low/high water on fishing? Salmon migration?
    - Any observation of new/alternative spawning ground in case of low/high water?
    - Any slough or lakes that have dried up in the area? Were there salmon in those before?
    - Any flooding events in the area? Has that changed over the years? Any effect on the river/fishing/fish?
    - Aware of areas where overflows/open water are usual during winter time?
  - **Water clarity**
    - Any observations of areas where water clarity has been changing?
    - Any area with noticeable sedimentation issues?
    - How does clear water vs. turbid water affect your fishing?
    - How does clear water vs. turbid water affect fishing behavior?
  - **Potential barriers to fish passage**
    - Aware of any structural barrier that could impede salmon to access to their fishing spawning (beaver dams, log jams, drying lakes, etc.)?
    - How do they affect the river system?
    - Why do you think these may impact fish passage? Observations?
    - Have these barriers more numerous today than they used to be?
    - Any other kind of barrier preventing salmon from getting upriver?
  - **Insects/Invertebrates**
    - Difference in the quantity/diversity of insects present in the river/lakes compared to the past? Observed impact of these changes on salmon?
Use of the River

Fishing
- What/where/when do you fish [Mapping Section]? Gear type used?
- Most significant environmental factors affecting when/where you fish?
- Does the fishing location/gear used changes with the time of day/year or with the weather conditions?
- Is the presence of debris (drift wood, log jam, “sweeper”, “sleeper”) in the river an issue in the area? How is it nowadays compared to the past?
- Changes in the location and numbers of eddies? Impact on your fishing? Any changes observed in fish behavior?

Travel/access
✓ Boat use => [Mapping Section]
- Where on the river and its tributaries do you boat for other subsistence activities (berry picking, hunting, etc)?
✓ Other activities => [Mapping Section]
- Do you travel on the river during hunting season? Where/when?
- Do you travel on the river for berry picking? Where/when?
- Do you use ATVs around the river or its tributaries? When/where?
- Where on the river, its tributaries, and its banks do you snow machine in the winter?

LAND CHANGES (in the vicinity of water bodies of interest)

I also would like to hear about your observations regarding any changes you may have observed in the landscape since what happens on the riverbanks will often impact the river ecology as well.

Riparian changes
- Any major erosion/permafrost melt along the river banks affecting river morphology?
- Any changes in the vegetation composition and density along the river banks (shrubs, tree species, berry crops, lichen condition)?
- Any changes in the moisture levels in the soil (berry crops, lichen condition)?

Wildfire
- Any major wildfires within the watershed? Where? When?
- Any impact on the surrounding ecosystem (animals, plants composition, water quality, etc.)?
- Any effect on where king salmon would go? Did you see king salmon in the area affected by the wildfire during spawning season (before vs. after the fire)?
Let’s focus now on the potential impacts of human activities on the ecosystem surrounding your community:

**Population size**
- Has the population of “community X” changed over time (grown/shrunk)?
- Effects of population change on the river and surrounding environment?

**Fishing pressure**
- Have the fishing pressure changed over time in your community?
- Do people from other villages fish in the same areas you do? When did they start fishing there?

**Boat traffic**
- Have the boat traffic been increasing or decreasing on the river? Any changes in fish behavior that may be related to boat traffic?
- Is there any barge traffic around the area? How does this affect the river? Your fishing?

**Local pollution**
- Any places you know of along the river or its tributaries where pollution (gas, oil, sewage, etc.) may be affecting salmon runs? What kind of pollution? How has it affected the river or surrounding land?

**Development projects**
- Any development project (mining, construction work, etc.) along the river or its tributaries that you worry affects salmon runs? What kind of development? How has it affected the river or surrounding land (noise, pollution, sedimentation, wake of boats, etc.)?

**Other factors**
- Are you aware of any other factors potentially altering the water quality of the river/streams/lakes around your community?
- What about any other factors potentially altering the land?
Now that we have a better understanding of the environmental and human-induced changes that have affected the area, I am really interested in hearing specifically about your life-time experience fishing for and interacting with king salmon.

- **Natural indicators**
  - How do people know when salmon are in the area?
  - Are there signs indicating a good or bad salmon year?

- **Changes in populations**
  - **Run timing**
    - When do Chinook salmon arrive in your area?
    - Has the timing of salmon arrival changed?
    - How long are salmon in your area for?
    - Different local names according to the different kinds of kings present in this area?
  - **Run abundance**
    - Any change in salmon abundance overtime?
    - Has there ever been a time in the past when there were relatively very few king salmon? When/how long did it last? What happened?
    - Have you noticed a change in the number of salmon in nearby tributaries?
  - **Run composition**
    - Thinking about a normal king salmon fishing year (=for most of the year that you have fished for king salmon), if you fished all season, would there be any changes in the fish you are catching from the beginning to the end of the season (size change, color, number of eggs, etc.)? Has that changed in recent years?
    - Any differences between the king salmon you catch in the mainstem and the ones you catch in smaller tributaries?
    - Do you know of any area that formerly had king salmon that don’t anymore?

- **Changes in fish health**
  - Any changes in salmon size over time? May it be linked to gear type?
  - Any changes in the general shape of the fish (ex: “torpedo fish” on the Yukon)?
  - What do you call a “jack”? Describe.
  - Any changes in the fat/oil content?
  - Any changes in flesh quality/lesions on the fish (parasites, wounds/bites, worms, color, net wounds, other observations) [Provide pictures]? Does that change how you process or eat fish?
  - Any changes in how fish act when you catch them or when you see them swimming?
Changes in reproduction

Sex-ratio
- Any changes in the sex ratio male vs. female overtime?
- Does sex-ratio in harvests usually vary throughout the fishing season? Do you think this may be related to the gear-type you use?

Spawning ground [Define spawning vs. migration]
- Do you know of any current spawning ground? Are there any areas where you normally see king salmon carcasses? [Mapping]
- What about old spawning grounds that are not used anymore? [Mapping]
- What are characteristics of a good or bad spawning ground for king salmon? What about rearing habitat?
- Do you know of any present/past spawning ground for other salmon species?
- Has there been any changes in the number of carcasses observed on spawning grounds?

Females health
- Any changes in the size of roe sacs or the quality of the eggs (size, color, opacity, shape, taste)? What have you observed?
- Have you noticed any females releasing their eggs early (in harvest prior to spawning ground)?

Changes in fishing levels
- Are there places where people tend to lose their nets (summer or under the ice net) or traps (blackfish, lush)? When/where?
- Historical harvests levels (prior to harvest monitoring): do you remember about how many king salmon your family got each year in the past (especially before 1980)?

Predation
- Any changes in the population of adult salmon predators (bears, seals, eagles, etc.)?
- Any changes in the species who may feed on salmon juveniles (sheefish, pikes, dolly varden, trout, grayling, sculpins, minks, otters, kingfishers, mergansers, etc.)?
- Has there been a change in the level of harvest of these species?
- Any areas that used to not have pike that do now?
APPENDIX B–CODING STRUCTURE
<table>
<thead>
<tr>
<th>Category</th>
<th>Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate</td>
<td>Breakup/ freeze-up conditions, Overflow, Temperature, Precipitation increase or decrease</td>
</tr>
<tr>
<td>Development</td>
<td>Roads or other construction events, Other</td>
</tr>
<tr>
<td>Fishing</td>
<td>Changes to fishing practices, Fishing history, Harvest amounts, Other</td>
</tr>
<tr>
<td>General codes</td>
<td>Good quote, Mapped, Observed impact to salmon, Possible impact to salmon</td>
</tr>
<tr>
<td>Land conditions</td>
<td>Fires, Other, Permafrost, Vegetation</td>
</tr>
<tr>
<td>Pollutants</td>
<td>Boat traffic, Impacts to fish, Mining, Other, Present currently in community, Spill near river</td>
</tr>
<tr>
<td>Salmon</td>
<td>Abundance, Chinook, Coho, Migration, Natural indicators, Observed changes over time, Other, Predation, Quality, Run timing, Sex ratios, Spawning, Summer chum, Fall chum</td>
</tr>
<tr>
<td>Travel</td>
<td>Competition with other users, Locations used for subsistence activities, Regulations, Other</td>
</tr>
<tr>
<td>Water conditions</td>
<td>Changes to lakes or sloughs, Changes to the river, Eddies, Flooding, Other, Sandbars, Water levels</td>
</tr>
</tbody>
</table>

Source ADF&G Division of Subsistence, 2019.