Annual Report, May 2009

Project Number: FIS 08-206

Title: Development of a Strategic Plan for Research of Whitefish Species in the Yukon and Kuskokwim River Drainages

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Summary: As outlined in the timeline (pg. 8) of the Investigation Plan for 08-206, it was envisioned that the materials produced for discussion at the two planned meetings would serve as the annual report. These materials follow this summary report in reverse chronological order beginning with the agenda and discussion topics for the April 23-24 meeting (pages 4-23), the January 2009 update (pages 24-28), the agenda for the November 18-19 meeting (pages 29-30), the background reading for the first meeting (pages 31-52), the annotated bibliography of the traditional ecological knowledge literature (pages 53-85), and the biological sciences reference list (pages 86-103).

To date, the principal investigators have conducted preliminary background research and syntheses of biological and ethnographic studies, documentation of traditional knowledge, harvest data, and management reports. These syntheses were distributed to a group of delegates with experience in fish biology, anthropology, and fish management, as well as representatives from fishery user groups in the Yukon and Kuskokwim rivers region. A series of meetings was convened with these delegates to discuss and debate the information presented in the syntheses, and prioritize critical research needs and approaches.

The first phase of this project began in April 2008 and included several tasks that were completed prior to the first meeting including: A) scoping meetings were conducted in communities or sub-regional areas where TEK research has not already occurred in order to capture local concerns and pertinent local information about whitefish fisheries; B) pertinent biological and social science literature was reviewed and synthesized in an interim report; and C) principal investigators solicited the participation of a small group of scientists and representatives of regional user groups to take part in discussions on whitefish species and fisheries that will ultimately be the basis of the strategic plan. The final list of participants at the second meeting is presented in Table 1.

Table 1. List of Whitefish Strategic Planning Group Delegates to the second meeting.

Name	Occupation or Position	Affiliation
Bob Aloysius	RAC Delegate	Yukon Kuskokwim Delta RAC
David Andersen	Anthropologist	Research North
Brandy Berkbigler	Partners Biologist	Tanana Chiefs Conference
Caroline Brown	Subsist. Res. Specialist	AK Dept. of Fish and Game
Randy Brown	Fishery Biologist	U.S. Fish and Wildlife Service
John Burr	Fishery Biologist	AK Dept. of Fish and Game
Richard Cannon	FRMP Delegate	U.S. Fish and Wildlife Service
Richard Carroll, Jr.	RAC Delegate	Eastern Interior RAC
John Chythlook	Fishery Biologist	AK Dept. of Fish and Game
Larry Dubois	Fishery Biologist	AK Dept. of Fish and Game
Dan Gillikin	Fishery Biologist	U.S. Fish and Wildlife Service
Jason Hale	Moderator	Yukon River Drainage Fish. Assoc.
Steve Hayes	State Fishery Manager	AK Dept. of Fish and Game
Ken Harper	Fishery Biologist	U.S. Fish and Wildlife Service
Russ Holder	Federal Fishery Manager	U.S. Fish and Wildlife Service
Jennifer Hooper	Dir. of Fish. & Forest. Res.	Assoc. of Village Council Presidents
Gary Lawrence	Natural Resources	Council of Athabascan Tribal Gov.
Paul Manunik, Sr.	RAC Delegate	Yukon Kuskokwim Delta RAC
Doug Molyneaux	State Fishery Manager	AK Dept. of Fish and Game
Laurie Montour	Natural Resources	Council of Athabascan Tribal Gov.
Bill Morris	Habitat Biologist	AK Dept. of Fish and Game
Stanley Ned	Delegate	Koyukuk River Communities
Jenny Pelkola	RAC Delegate	Western Interior RAC
Gene Peltola	Federal Refuge Manager	U.S. Fish and Wildlife Service
Lily Ray	Subsist. Res. Specialist	AK Dept. of Fish and Game
Mike Thalhauser	Fisheries Biologist	Kuskokwim Native Association
Liz Williams	FRMP Delegate	U.S. Fish and Wildlife Service

The second phase of this project took place during the winter of 2008-2009, consisting of two group meetings. The first meeting took place in Anchorage on November 18 and 19, 2008, and the minutes of the meeting were professionally transcribed. The objective was to discuss the interim synthesis report, identify biological and social science gaps in existing information, and explore appropriate methods for assessment, research, and management. Additionally, the group developed criteria that can be used to assign relative priority levels among issues such as fisheries, species, user-groups, research objectives, and management options. There was tremendous discussion at the first meeting as delegates shared their perspectives on fisheries, management, biology, fishing practices, environmental changes, other wildlife, and many other issues. Each delegate shared their two or three greatest concerns for whitefish and whitefish fisheries, which were then discussed by the group. Local representatives expressed their concerns over the impacts of commercial fisheries, beaver activity, and changes in water levels. They also provided regionally specific information on whitefish in their areas. Management biologists discussed harvest and abundance information they would require to effectively manage whitefish populations. Anthropologists explained the importance of understanding how subsistence fisheries take place and not just how many fish are taken. Biologists suggested that locating spawning locations was a necessary first step to defining populations. It was generally agreed that there was great potential to use genetics approaches to identify stocks of origin in mixed stock fisheries. All delegates agreed on the importance of species identification in harvest and stock assessment programs.

The second meeting took place on April 23rd and 24th, 2009 in Fairbanks. The meeting began with the presentation of a framework of hierarchical risk levels associated with fisheries, development activities, and management decisions based on threats to species, populations, fish distribution, and fisheries. A number of research scientists presented various types of projects to the group to provide some perspective of the types of information that is obtained, the challenges of funding projects, the time-frame from concept to completion of reports, management issues, and more. Each of the delegates introduced issues, species, fisheries, and other ideas related to whitefish research that they considered important. These ideas were eventually prioritized in a discussion-based forum using previously developed rating criteria. Transcripts of the meeting are being professionally prepared. The meeting concluded on a very positive note. The ideas introduced and prioritized at the meeting will be the basis of the strategic plan for research of whitefish species in the Yukon and Kuskokwim River drainages.

Whitefish Strategic Plan Meeting 2— April 23-24, 2009
Westmark Hotel, Fairbanks, Alaska

Agenda
Thursday, April 23: 8:30 am – 5 pm

1) Introductions
2) Recap of Meeting 1
    a. Concerns? Additions?

Discussion Items (See companion discussion and action items guide for details)

3) Risk assessment and order of priority (pg. 5)
    a. Loss of a species, loss of a population, decline of a fishery, a reduction in population distribution, a decline in abundance
4) Possible management decisions (pg. 8)
    a. Habitat protection, harvest regulation and allocation
5) Information needs for population assessment and management (pg. 10)
    a. Understanding fisheries, understanding fish

Lunch

6) Presentations describing whitefish research projects (pg. 10)
    a. David Andersen: Conducting a TEK/harvest monitoring project in rural Alaska
    b. Randy Brown: Demographic assessment of a whitefish population
    c. Ken Harper: Locating spawning origins of whitefish species with radio telemetry
    d. Lisa Stuby: Spawning Distribution and Migratory Timing of Kuskokwim River Sheefish Using Radio Telemetry
    e. Ray Hander: Estimating a sheefish spawning population with a mark and recapture project
    f. Dave Esse: Obtaining a census of a sheefish spawning population using a DIDSON sonar system
    g. Jeff Olsen: Developing genetic baseline data for mixed-stock fisheries analyses
    h. Audra Brase: Management of the Chatanika River spear fishery
    i. Doug Molyneaux: Information needs for fishery management

Friday, April 24: 8:30 am – 5 pm

7) Prerequisite studies and the ordering of research (pg. 11)
    a. Background information
8) Additional considerations for establishing priorities (pg.13)
    a. Categories of threats and risks, issues specific to species, populations, fisheries, geographic regions

Lunch

Action Items

9) Identification of critical whitefish issues (pg. 22)
10) Research recommendations (pg.22)

Whitefish Strategic Plan Meeting 2 — April 23-24, 2009
Westmark Hotel, Fairbanks, Alaska

DISCUSSION AND ACTION ITEMS FOR SECOND MEETING

Introduction

The following is a list of topics and issues for discussion at our April 23-24 meeting in Fairbanks. It is not an exhaustive list; rather it should serve as a guide for thinking about, discussing, and prioritizing issues of concern related to whitefish species in the Yukon and Kuskokwim River drainages. We ask that you come to the second meeting having read this list of issues, be prepared to suggest additional concerns you may have, and be ready to discuss priority species, populations, fisheries, and research. At the end of the meeting we would like to have identified the most critical issues related whitefish and whitefish fisheries in the Yukon and Kuskokwim River drainages, and provided some recommendations for future research to address these issues.

3) **Risk assessment and order of priority**—As we consider various situations related to development, fisheries, monitoring populations, managing harvests, etc., we should keep in mind the risks inherent in our actions and decisions. The consequences of our actions, or lack of actions, may be large or small depending on the situation. The list below, which is not exhaustive, highlights a few situations in which risk levels vary from being very large to relatively small.
    a. **Situations in which we risk losing a species**—Bering cisco is the only species we are considering where there appears to be a very limited worldwide distribution. There are three known populations worldwide; all in Alaska, two within the region we are considering.
    b. **Situations in which we risk losing a population**—Spawning populations are interbreeding groups of individuals that all originate from the same spawning location. If the number of individuals in a spawning population drops to very low levels, the probability that they will find each other to successfully spawn, and that their young will survive to maturity and return, becomes very low and the population could be eliminated. Some possible situations with this type of risk include…
        i. Small sheefish populations in the Chatanika River and Highpower Creek that were last sampled and studied in the early 1970s
        ii. Broad whitefish in the Kuskokwim River may constitute a single spawning population and are reportedly less common in subsistence catches than in previous times
        iii. River bottom gravel mining or placer mining that blocks passage to spawning habitat or takes place in spawning habitat may eliminate a population
        iv. Chatanika River spear fishery for humpback whitefish and least cisco on their spawning grounds

v. The fall beach seine fishery on the Alatna River takes place on the spawning grounds of several whitefish species

vi. A mixed stock fishery composed of individuals from strong and weak stocks may appear to be adequately productive, based on harvest rates, while the weak stock may decline or be eliminated without being noticed

c. **Situations in which we risk losing a fishery**—By losing a fishery we mean that harvest levels drop so low that it is not worth the effort for people to fish anymore. If contributing populations remained viable, however, the fishery would probably improve again over time. Some possible situations with this type of risk include…

i. Whitefish Lake in the lower Kuskokwim River drainage, primarily a feeding habitat, is fished extensively by residents of several communities along the Kuskokwim River with gear type regulation only. Some residents are concerned for the fishery, which was the incentive to initiate the recent research on the lake fishery.

ii. The Johnson River whitefish fishery, primarily harvesting broad whitefish and humpback whitefish that are feeding in the lakes, is fished extensively by residents of the tundra villages as well as others from as far away as Bethel or even farther. Many in the tundra villages are concerned with the level of fishing and have attempted to establish their own regulations limiting the number of nets in certain areas and requiring that they be checked with a certain frequency to minimize waste.

iii. Tetlin Lake, a large feeding habitat for humpback whitefish in the upper Tanana River drainage, is fished extensively by residents of the community of Tetlin, which is located on the outlet river. Fish enter the lake to feed and exit the lake to spawn elsewhere, making them very vulnerable to capture during migration. Residents of Tetlin have a long tradition of fishing these migrations and report that their capture rates are less than during previous times and that the fish are smaller now than before. This fishery is similar in some ways to the Whitefish Lake fishery, except that there is only one whitefish species in Tetlin Lake, and only one community fishes the lake, although other communities harvest these fish once they leave the lake.

iv. Under-ice gillnets are extensively fished in the Yukon and Kuskokwim rivers during much of the winter without harvest regulation. This is overwintering habitat for many whitefish species. The fisheries harvest species other than whitefish also and probably capture mature fish more than immature fish because of gear type choices (gillnet mesh size), although the fisheries have rarely been evaluated.

d. **Situations in which we risk a reduction in the distribution of a population**—Reduction in distribution of a population is most likely to be

the result of isolation from feeding habitats. If members of a population, for example, could not reach their spawning habitats or their larvae could not access their rearing habitats, the population would probably be eliminated. Feeding habitats for some species though, are widely dispersed and many are vulnerable to isolation. The isolation of some feeding habitats used by a population would not eliminate the population but could reduce its distribution. Some possible situations with this type of risk include…

i. Venetie Lake, a feeding habitat in the northern part of the Yukon Flats, once supported a local fishery for whitefish species (probably broad whitefish, humpback whitefish, and least cisco) that it no longer supports. The connecting stream between the lake and the lower Chandalar River has grown in with sediment and aquatic vegetation to the point where it prevents fish passage and the lake does not appear to support overwintering. Whitefish are no longer present in Venetie Lake.

ii. Many off-channel feeding lakes are accessible through small streams that can easily be blocked with gillnets during harvest activities, or with culverts or fill when creating a vehicle crossing. In many river systems in the lower 48 states, off-channel lakes and ponds were isolated from the river system to facilitate roads, agriculture, and shipping. Any activities that prevent access to off-channel feeding habitats will reduce the distribution of feeding whitefish. Species that utilize off-channel habitats are broad whitefish, humpback whitefish, and least cisco. Sheefish and Bering cisco rarely enter off-channel lakes so their populations would not be directly affected.

e. **Situations in which we risk a noticeable reduction in population abundance**—There are many ways in which populations of fish could vary in abundance: natural variation due to environmental conditions or interactions with other prey, predator, or competitor species; development projects that alter the environment in some way; or harvest in various fisheries. Some possible situations with this type of risk include…

i. Riverbed gravel mining took place at the community of Tanana on the Yukon River during the summers of 2006 and 2007. A dragline dredge was used to extract approximately 500,000 cubic yards of gravel from the river bottom in front of town to upgrade the community airport. A 50 meter gravel causeway was built out from shore to extend the reach of the dredge into the river. The hole that was created during gravel removal quickly filled with silt. To our knowledge, spawning activity did not occur at that location, although spawning migrations of at least five whitefish species and three Pacific salmon species pass that site going upstream. Local Tanana residents that traditionally fish for broad whitefish and humpback whitefish in front of town reported very poor fishing while the dredge was operating, suggesting that the dredging

operation may have affected their migration patterns along that shore. If the activity occurred in a spawning reach, however, changing the interstitial flow patterns and replacing gravel substrate with silt or other soft material, it would probably ruin the spawning site. Riverbed gravel mining is common throughout the drainages we are considering here.

ii. Gillnet salmon fisheries in the main-stem Yukon and Kuskokwim rivers incidentally harvest sheefish and broad whitefish and certainly cause an overall reduction in drainage-wide abundance of these species. This situation has persisted for many decades and these species are still present, suggesting that the contributing populations are able to sustain this level of exploitation. A similar situation, however, has impacted sheefish populations in the Great Slave Lake in Canada. Sheefish have been eliminated from several spawning rivers there because of a combination of fisheries activities: directed fisheries on the upstream spawning migrations each summer; and the incidental catch of sheefish in commercial gillnet fisheries for lake trout and lake whitefish within the lake. If fishing effort changes dramatically in the Yukon and Kuskokwim River systems, the apparently sustainable combination of fisheries on these species could become unsustainable.

iii. There is recent evidence that many lake systems across interior Alaska are shrinking in size and river connectivity. If this trend continues, available feeding habitat could be progressively reduced for the three species that depend on accessing connected lake systems for feeding each summer; broad whitefish, humpback whitefish, and least cisco. It is possible that these species would change their distributions within the drainages and concentrate in places where connected lake systems were still available. Alternatively, if density dependent factors limit the number of fish occupying feeding lakes, the loss of feeding habitat may cause an overall reduction in fish abundance.

4) **Possible management decisions**—This section introduces some of the different types of management decisions that could be taken to preserve fish species, populations, and fisheries that may be threatened throughout the Yukon and Kuskokwim River region.

a. **Critical habitat protection**—These following general habitat types must be available to whitefish populations to ensure population survival. Some of the qualities of these habitats, their importance to whitefish populations, and a basic assessment of our ability to identify and specifically protect them are presented in subtext.

i. Spawning areas

1. Very small geographic regions
2. Essential to population

3. Relatively easy to define geographically
4. Must know where they are
5. Relatively easy to specifically protect

ii. Off-channel feeding lakes
1. Widely distributed across the landscape
2. Collectively essential to population
3. Individually important but not essential to population
4. Relatively easy to define geographically
5. Must recognize them
6. Case-by-case protection effort required
7. Collectively difficult to specifically protect

iii. Migration corridors
1. The drainage system
2. Essential to population
3. Relatively easy to define geographically
4. Must know the range of the population
5. Impacts to drainage systems (dams, settling pond breaches, agricultural runoff, chemical spills, etc.) can be large political events
6. Very difficult to specifically protect

iv. Rearing and overwintering habitats
1. Very large geographic region
2. Essential to population
3. Relatively difficult to define geographically
4. Must understand life history
5. Very difficult to specifically protect

b. Harvest regulation and allocation—The following is a selection of harvest management options that could be applied to whitefish fisheries to limit or reduce the harvest if there were a conservation issue requiring the action. Some of these options are currently being applied to whitefish fisheries in the Yukon and Kuskokwim River drainages.

i. Fishery open or closed

ii. Fishery open with restrictions
1. Open and closed periods or seasons
2. Gear type restrictions
3. Quantity limitations
4. Fish size limitations

iii. Allocation of harvest among user groups
1. Must consider the nature, level, and importance of use

5) **Information needs for population assessment and management**—This section introduces some of the information that fisheries or land use managers might need to monitor whitefish populations, assess impacts of fisheries or land development on these populations, and to make effective management decisions that protect fish populations. Recommendations for future research will focus on obtaining these information needs for priority fisheries and populations.

   a. **To understand the nature of a fishery we may need to know…**
      i. The social value, occurrence, timing, and location of the fishery
      ii. The nature of the fishery (e.g., sport, subsistence, or commercial)
      iii. The gear used (fishwheel, spear, gillnet, mesh size, etc.)
      iv. The demographic group harvested (e.g., mature, immature, spawning)
      v. The species harvested
      vi. The populations harvested (i.e., single or mixed stock)
      vii. The number of each species harvested

   b. **To assess fish populations we may need to know…**
      i. Their spawning origins (which can lead to habitat protection)
      ii. Their baseline genetic qualities (which may allow mixed stock genetic analyses)
      iii. The geographic range of the population (which allows us to know which fisheries they are harvested in)
      iv. Life stage and habitat associations (which can lead to habitat protection)
      v. The age at maturity (i.e., generation time)
      vi. The longevity of individuals within the population (which may provide an understanding of annual survival)
      vii. Spawning frequency (permitting an estimate of the mature component of the population)
      viii. The number of fish in the spawning population (or relative abundance; which may allow calculation of sustainable harvest)

6) **Presentations describing research projects focused on whitefish fisheries and populations**—The following presentations will provide us with a concept of what it takes in time and money to conduct various types of fisheries projects and activities in rural Alaska. We should also gain an understanding of the type of information obtained from these different types of projects and activities.

   a. David Andersen: Conducting a TEK project in rural Alaska
   b. Randy Brown: Demographic assessment of a whitefish population
   c. Ken Harper: Locating spawning origins of whitefish species with radio telemetry
   d. Lisa Stuby: Spawning Distribution and Migratory Timing of Kuskokwim River Sheefish Using Radio Telemetry

e. Ray Hander: Estimating a sheefish spawning population with a mark and recapture project
f. Dave Esse: Obtaining a census of a sheefish spawning population using a DIDSON sonar system
g. Jeff Olsen: Developing genetic baseline data for mixed-stock fisheries analyses
h. Audra Brase: Management of the Chatanika River spear fishery
i. Doug Molyneaux: Information needs for fishery management

7) **Prerequisite studies and the ordering of research**—This section is presented to show that in many cases with whitefish species, there will be preliminary studies required before the information we would like can be obtained.
   a. **If we want to obtain a spawning population estimate** (a quantitative measure of the spawning population abundance; i.e., 15,000 to 20,000 fish this year vs. 40,000-50,000 fish another year) we must first…
      i. Know the spawning origins of the population (geographic location)
      ii. Which may be discovered from traditional knowledge accounts
      iii. But in many cases a radio telemetry study is required to locate spawning origins
      iv. To use radio telemetry we must first recognize that a spawning migration is occurring
      v. Which often requires a biological assessment to identify pre-spawning demographics
      vi. To deploy transmitters in a representative manner we may also need to know the timing of the spawning migration
      vii. Which can sometimes be determined using catch rate data combined with a biological assessment
   b. **To obtain an index of spawning population abundance** (a relative measure of the spawning population abundance; i.e., many fish this year vs. few fish another year) we must first…
      i. Obtain standardized catch rate data from a spawning migration
      ii. Which requires that we recognize that a spawning migrations is occurring
      iii. Which often requires a biological assessment to identify pre-spawning demographics
      iv. Preliminary catch rate data from an existing fishery combined with a biological assessment may be required to establish the timing of a spawning migration
      v. To use catch rate data as an index of spawning population abundance we must assume or establish a positive correlation between catch rate and spawning population level

c. **To obtain an index of recruitment** (a qualitative measure of spawning success or production; i.e., good production this year vs. poor production another year)
    i. For larvae (age-0 fish), we must…
        2. Know the spawning origins of a population (see 5.a.i)
        3. and know the timing of larval emigration
        4. Literature sources will help to define the time frame
        5. But, a pilot study may be necessary to establish and confirm emigration timing, which will guide the sampling schedule
        6. To use an index of recruitment to monitor a population we must assume or establish a positive correlation between the index of recruitment and spawning population levels
    ii. For recruits to the spawning population (first time spawners), we must…
        1. Obtain standardized catch rate data from the spawning population each fall
        2. Which requires that we know the spawning origins of the population (see 5.a.i)
        3. We should know the age range of first time spawning fish in order to identify them within the sample (see 5.d)
        4. To use an index of recruitment to monitor a population we must assume or establish a positive correlation between the index of recruitment and spawning population levels
d. **To obtain an estimate of the age at maturity for a population** we must…
    i. Age a relatively large, random sample of mature fish from the population
    ii. Which may require a biological assessment in late summer or fall necessary to identify fish as mature, or
    iii. To sample from a known spawning aggregation in the late fall
    iv. Either of these options require that we know the spawning origins of the population (see 5.a.i)
e. **To conduct a mixed stock genetics assessment of a fish harvest**, we must…
    i. Have established baseline genetic markers for all major spawning populations of a species of interest
    ii. Which requires that stock specific genetic material from all major populations has been collected
    iii. Which requires that we know the spawning origins of all major populations of a species of interest (Multiple factor case of 5.a.i)

8) **Additional considerations for establishing priorities**

a. **General categories of threats and risks**—this section introduces three categories of human caused and natural events that could impact whitefish species, populations, and fisheries.

i. New and ongoing development activities, possible examples include…

1. Railroad extension between Fairbanks and Delta
2. Riverbed gravel mining
3. Donlin Creek hard-rock gold mine
4. Innoko River (Ophir) placer gold mine
5. Beaver Creek land trade and potential oil development

ii. Fisheries, possible examples include…

1. Bering cisco coastal fishery
2. Chatanika River spear fishery
3. Main stem salmon fishery
4. Alatna River fall beach seine fishery
5. Johnson River gillnet fishery
6. Yukon and Kuskokwim rivers under-ice fishery

iii. Environmental changes, possible examples include…

1. Drying lakes reducing habitat access or increasing risk of becoming trapped
2. Changing precipitation patterns altering river flow patterns
3. Warmer lakes increasing incidence of summer fish kills
4. Increased beaver activity may reduce habitat access or increase risk of becoming trapped, alternatively, may increase water storage and provide rearing habitat

b. Species specific issues and considerations—this section introduces certain issues and events that pertain to mixed stock groups of a whitefish species within the two drainages.

i. Species harvested in a fishery, possible examples include…

1. Sheefish incidentally captured in Yukon River salmon fisheries
2. Broad whitefish in fall Whitefish Lake fishery
3. Humpback whitefish in Tetlin Lake fishery
4. Bering cisco in coastal fisheries

ii. Species with limited worldwide distribution, for example…

1. Bering cisco

iii. Species of great importance for many people and communities, possible examples include…

1. Sheefish
2. Broad whitefish
3. Humpback whitefish

        4. Bering cisco
    iv. Species most vulnerable to expected environmental change (i.e., drying lakes reducing access)…
        1. Broad whitefish
        2. Humpback whitefish
        3. Least cisco

c. Population specific issues and considerations—this section introduces certain issues and events that may affect individual populations of whitefish.

    i. Populations that may be in decline, possible examples include…
        1. Kuskokwim River broad whitefish
        2. Highpower Creek sheefish
        3. Chatanika River sheefish
    ii. Fishery on a specific population, possible examples include…
        1. Chatanika River humpback whitefish and least cisco fishery
        2. Alatna River fall beach seine fishery
        3. Bering cisco coastal fishery (subsistence and commercial)
    iii. Development activities that could impact a population, possible examples include…
        1. Riverbed gravel mining in spawning area
        2. Metals mining upstream from spawning area
        3. Dam construction between spawning and rearing areas
        4. Channelization of river, isolating feeding lakes
        5. Road crossing at a spawning area

d. **Fisheries specific issues and conditions**—this section introduces several categories of fisheries, most being multiple species, mixed stock fisheries, that take place in the Yukon and Kuskokwim rivers and in the coastal region that is occupied by whitefish originating in the two drainages. Basic qualities of each fishery are listed in subheadings.

    i. Salmon fisheries along both Yukon and Kuskokwim rivers
        1. Mid-summer to fall fisheries
        2. Salmon gillnets primarily capture sheefish and a few broad whitefish
        3. Fishwheels capture all whitefish species
        4. Mixed stock groups of each species
    ii. Directed fisheries for non-salmon species along main-stem rivers
        1. Primarily early spring and late summer or fall fisheries
        2. Small-mesh gillnets used for broad whitefish and humpback whitefish
        3. Large-mesh gillnets used for sheefish

4. Hook and line used in lower reaches of clear-water tributaries for sheefish
5. Mixed stock groups of each species

iii. Directed fisheries for non-salmon species in off-channel lakes
1. Primarily spring and summer fisheries
2. Small-mesh gillnets capture broad whitefish, humpback whitefish, and least cisco
3. Mixed stock feeding groups of each species

iv. Coastal fishery
1. Primarily, but not exclusively, a summer and fall fishery
2. Small-mesh gillnets used for Bering cisco
3. Subsistence and commercial fisheries
4. Probably a mix of up to two stocks

v. Under-ice fisheries in both drainages
1. Winter fishery
2. Large-mesh gillnets used for sheefish
3. Small-mesh gillnets used for broad whitefish and humpback whitefish
4. Fish traps used in some areas
5. Mixed stock overwintering groups of each species

vi. Upper drainage fall fisheries
1. Gillnets and fishwheels used to capture pre-spawning sheefish, broad whitefish, and humpback whitefish
2. Beach seines used for all species on or near spawning areas
3. Spears used in certain locations
4. Almost exclusively mature demographic group
5. Single stock groups of each species in some cases

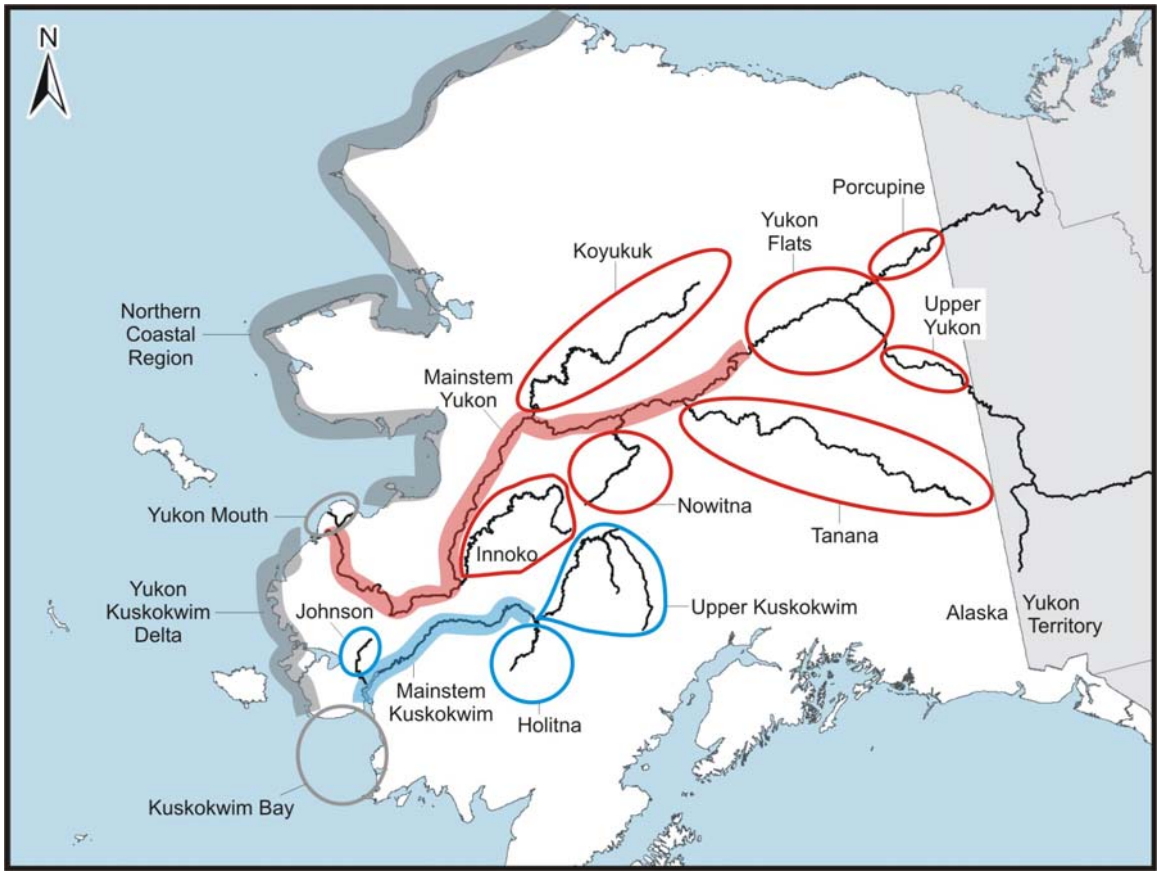

Figure 1. Geographic sub-regions in the Yukon and Kuskokwim rivers and the coastal region that is occupied by whitefish originating in the two drainages.

e. **Geographic sub-region specific issues and conditions**—this extensive section describes the fisheries qualities of numerous sub-regions of the Yukon and Kuskokwim rivers and of the coastal region that is occupied by whitefish originating in the two drainages (Figure 1). The sub-regions were geographically identified based on broad-scale similarities in fisheries practices, species compositions, demographic groupings, and habitat use qualities. These general qualities are listed in the subheadings.

   i. Yukon River

      1. Main stem from mouth to the Yukon Flats

         a. Incidental harvests of whitefish species in salmon fisheries, which use gillnets and fishwheels
         b. Fisheries for non-salmon fish use gillnets and hook and line
         c. Summer and winter fisheries common
         d. Mixed stock fisheries for sheefish, broad whitefish, humpback whitefish, and least cisco
         e. Single stock fishery for Bering cisco
         f. All demographic groups present in lower reaches

g. Mature demographic groups dominate in upper reaches
h. Lower reaches used for feeding, overwintering, and rearing
i. Upper reaches used primarily for migration and overwintering

2. Innoko River
    a. Fisheries for non-salmon fish target larger whitefish species
    b. Gillnets and hook and line methods used
    c. Summer fisheries are most common
    d. Mixed stock fisheries
    e. All demographic groups are present
    f. Serves primarily as feeding habitat
    g. Known humpback whitefish and least cisco spawning areas in upper reaches
3. Koyukuk River
    a. Salmon fisheries take sheefish and broad whitefish
    b. Fisheries for non-salmon fish take all whitefish species present
    c. Bering cisco are not present in drainage
    d. Summer and winter fisheries common
    e. Probably single stock fisheries on sheefish and broad whitefish
    f. Mixed stock fisheries on humpback whitefish and least cisco
    g. Almost entirely mature demographic groups
    h. Anadromous life history forms dominate
    i. Spawning areas for all four species are known in upper reaches
    j. Sheefish leave the drainage for overwintering
    k. Mature broad whitefish, humpback whitefish, and least cisco use the drainage for overwintering and feeding
4. Nowitna River
    a. Directed fishery on sheefish
    b. Broad whitefish, humpback whitefish, and least cisco also present, but not actively fished
    c. Primarily hook and line methods
    d. Summer fishery only
    e. Predominantly single stock fishery
    f. Mature demographic group

    g. Sheefish use drainage for feeding and spawning
    h. Sheefish leave the drainage for overwintering
5. Tanana River
    a. Incidental harvests of whitefish species in main stem salmon fisheries
    b. Fisheries for non-salmon species harvest all whitefish species present
    c. Bering cisco not present in drainage
    d. Gillnets and fishwheels used in salmon fisheries
    e. Gillnets, hook and line, traps, and spears used in directed fisheries
    f. Mixed stock fisheries in lower main-stem reach
    g. Single stock fisheries in some upper reach fisheries
    h. Mature demographic group dominates in main stem
    i. All demographic groups present in many off-channel lake habitats
    j. Both freshwater resident and anadromous forms present
    k. Riverine and lake resident forms present
    l. Drainage used for rearing, feeding, overwintering, and spawning, but varies considerably by region and by species
6. Yukon Flats region
    a. Incidental harvests of whitefish species in main stem salmon fisheries
    b. Fisheries for non-salmon species harvest all whitefish species present
    c. Gillnets and fishwheels used in salmon fisheries
    d. Gillnets, hook and line, and traps used in directed fisheries
    e. Single stock fishery likely for most species in most of the region
    f. Mature demographic group dominates in main stem
    g. Immature demographic groups present in some tributary and off-channel lake systems
    h. Anadromous life history forms dominate
    i. Region used primarily for spawning, overwintering, and feeding
7. Porcupine River (Yukon Flats to Canadian border)
    a. Incidental harvests of whitefish species in main stem salmon fisheries
    b. Fisheries for non-salmon species harvest all whitefish species present

c. Gillnets and hook and line methods used
d. Single stock fishery likely for sheefish and broad whitefish
e. Mixed stock fishery probable for humpback whitefish and least cisco
f. Mature demographic group dominates in main stem
g. Freshwater resident life history forms dominate
h. Reach used primarily as a migratory pathway between downstream rearing and feeding areas and upstream spawning areas

8. Upper Yukon main stem (Yukon Flats to Canadian border)
    a. Incidental harvests of whitefish species in main stem salmon fisheries
    b. Fisheries for non-salmon species harvest all whitefish species present
    c. Gillnets and fishwheels used in salmon fisheries
    d. Small hook and line fishery for sheefish
    e. Single stock fishery possible for sheefish and broad whitefish
    f. Low relative abundance of all species
    g. Mature demographic dominates
    h. Freshwater resident life history forms dominate
    i. Rearing and feeding habitats are very limited
    j. Reach used primarily as a migratory pathway

ii. Kuskokwim River

1. Johnson River drainage
    a. Fisheries for non-salmon species only
    b. Gillnets are primary gear
    c. Summer and winter fisheries
    d. Primary species are broad whitefish, humpback whitefish, and least cisco; sheefish and Bering cisco are very rare or absent
    e. Mixed stock fishery
    f. Drainage used for rearing, feeding, and possibly overwintering
2. Main-stem Kuskokwim from mouth to confluence with Holitna River
    a. Incidental harvests of whitefish species in main stem salmon fisheries
    b. Gillnets and fishwheels used in salmon fisheries
    c. Fisheries for non-salmon species use gillnets and hook and line

d. Summer and winter fisheries common
e. Mixed stock fisheries for sheefish, broad whitefish, humpback whitefish, and least cisco
f. Single stock fishery for Bering cisco
g. All demographic groups present in lower reaches
h. Mature demographic groups dominate in upper reaches
i. Lower reaches used for feeding, overwintering, and rearing
j. Upper reaches used primarily for migration and overwintering

3. Holitna River drainage
    a. Fisheries for non-salmon species target larger whitefish species
    b. Summer and winter fisheries occur
    c. Gillnets and hook and line methods are used
    d. Mixed stock fisheries are thought to occur for all species
    e. Mature demographic groups probably dominate
    f. There may be lake resident forms in Whitefish Lake in the headwaters of the Hoholitna
    g. Spawning areas for humpback whitefish and least cisco may be present in upper reaches
    h. Sheefish use the drainage for feeding
    i. Broad whitefish, humpback whitefish, and least cisco may use the drainage for overwintering and feeding
4. Upper Kuskokwim drainage, upstream from confluence with Holitna River
    a. Incidental harvests of whitefish species in main stem salmon fisheries
    b. Fisheries for non-salmon species target the larger species
    c. Bering cisco known to migrate through main stem and into South Fork but not into other tributaries
    d. Gillnets and fishwheels used in salmon fisheries
    e. Gillnets, hook and line, and spears used in non-salmon fisheries
    f. Mixed stock fisheries through most of the main-stem reaches
    g. Single stock fisheries in some upper reach fisheries
    h. Mature demographic group dominates
    i. Possible lake resident forms in upper drainage

j. Upper drainage used primarily as a migratory pathway to spawning habitats in the upper part of the region; some feeding and overwintering may take place

iii. Coastal region

1. Kuskokwim Bay
    a. Fisheries target marine and whitefish species
    b. Bering cisco is the most common whitefish species
    c. Other species more common close to river mouth
    d. Gillnets are the most commonly used gear
    e. Immature demographic groups dominate
    f. The bay is used for rearing and feeding; possibly for overwintering also
2. Yukon Kuskokwim delta (Kinak Bay to Black River)
    a. Fisheries target Pacific salmon, marine, and whitefish species
    b. Bering cisco is the most commonly harvested whitefish species
    c. Other species present but rare
    d. Gillnets are the most commonly used gear
    e. Summer and winter fisheries take place
    f. Immature demographic groups dominate
    g. The coastal region is used for rearing and feeding
    h. Overwintering fish probably retreat to brackish bays
3. Yukon mouth (Black River to Pastol Bay)
    a. Fisheries target Pacific salmon, marine, and whitefish species
    b. Large and small-mesh gillnets are used depending on target species
    c. Summer and winter fisheries take place
    d. Fall commercial fishery focuses on Bering cisco
    e. Immature demographic groups dominate
    f. The region is used for rearing, feeding, and overwintering
4. Northern coastal region (north of Pastol Bay)
    a. Yukon and Kuskokwim River Bering cisco are the most wide-ranging whitefish species north of Pastol Bay
    b. Incidental catches of sheefish, broad whitefish, and humpback whitefish probably occur in coastal waters of the eastern Norton Sound; more in the south than in the north

c. Bering cisco rear in coastal waters from Kuskokwim Bay north into the Chukchi Sea but spawning populations in the region are known only from the Yukon and Kuskokwim rivers
d. Bering cisco harvests throughout coastal Norton Sound, Seward Peninsula, Kotzebue Sound, and farther north are, therefore, considered to be Yukon and Kuskokwim populations
e. Almost all are immature, rearing fish

9) Identification of critical whitefish issues

a. Do we know of…
    i. Situations in which we risk the survival of a species?
    ii. Situations in which we risk the survival of a population?
    iii. Situations in which we risk losing a fishery?
    iv. Situations in which we risk a reduction in the distribution of a population?
    v. Situations in which we risk a dramatic reduction in population abundance?
b. Data gaps that should be filled, possibilities include…
    i. Catalog of spawning areas?
    ii. Stock specific genetics samples for baseline development?
    iii. Species specific harvest data?
    iv. Abundance indices?
c. Priority species for research…
    i. Sheefish?
    ii. Broad whitefish?
    iii. Bering cisco?
    iv. Humpback whitefish?
    v. Least cisco?

10) Research recommendations, possibilities include…

a. Map known whitefish spawning areas and provide this information to the agencies permitting development activities in the region
b. Broad whitefish
    i. Verify suspected broad whitefish spawning location in Kuskokwim River
    ii. Determine whether there is one population or more than one population in the Kuskokwim drainage
    iii. Attempt to determine and monitor population status of broad whitefish in the Kuskokwim drainage (e.g., spawning population level, population trend, harvest level, index of abundance)

c. Bering cisco
    i. Develop genetic baselines for the three known populations
    ii. Determine the proportional contribution of the three populations in the commercial harvest at the Yukon River mouth
    iii. Test coastal samples to determine if their genetic characteristics are consistent with the three population hypothesis
    iv. Determine the relative population sizes of contributing populations
    v. Map the distribution of the known populations in nearshore waters throughout their coastal range
    vi. Determine whether Bering cisco spawn only once and die like Pacific salmon species, or spawn multiple times like other whitefish species
    vii. Develop a population monitoring program sufficiently rigorous to detect the effects of increasing harvest levels
d. Sheefish
    i. Investigate the status of Chatanika River and Highpower Creek spawning populations
    ii. Locate spawning destination of pre-spawning Tanana River sheefish migrating upstream past Nenana
    iii. Search for suspected sheefish spawning population in the Black River drainage in the upper Yukon Flats
    iv. Develop genetic baselines for all known populations throughout the region

January 2009 Update:
Development of a Strategic Plan for Research of Whitefish Species in the Yukon and Kuskokwim River Drainages

Whitefish species common to the Yukon and Kuskokwim River drainages. (Scale is in cm.)

In 2007, the U.S. Fish and Wildlife Service, Fishery Resource Monitoring Program (FRMP) allocated funding for subsistence specialist Caroline Brown (ADF&G) and fish biologist Randy Brown (USFWS) to develop a strategic plan for research of whitefish species in the Yukon and Kuskokwim River drainages. The FRMP recognized that whitefish species were being intensively harvested in numerous fisheries around the State, including the Yukon and Kuskokwim River drainages, yet there was such a poor understanding of population biology, harvest levels, and migration patterns of these fish that effective management was not possible in most cases. The FRMP has received numerous requests for funding to conduct whitefish research over the years and several of the requests have been funded. While individual projects have provided important migration, habitat, or life history details about a particular species in a particular location, it was never clear how this information contributed towards an overall understanding of these species or how this understanding might lead to effective management. The FRMP

wanted a larger perspective than any one project might provide. The overall goal of this project was to provide this larger perspective to guide whitefish research in the Yukon and Kuskokwim River drainages.

You have all had an opportunity to review and comment on the details of this project in the original investigation plan that was submitted to the FRMP in 2007, so we will just briefly remind you of the major objectives of the project here.

Goal: Develop a strategic plan for research of whitefish species for the Yukon and Kuskokwim River drainages. This plan will include six major objectives:

1. a review of whitefish fisheries within the two drainages;
2. a review of the biological, life history, and ethnographic studies that have occurred in the region;
3. an assessment of data gaps;
4. a review of methods and approaches that have been used around the world to monitor and manage whitefish species with an assessment of their appropriateness for use in Alaska;
5. a discussion with stakeholders and other interested parties of issues, fisheries, and species of regional concern; and
6. writing and critical review of a strategic plan for whitefish research in the Yukon and Kuskokwim River region.

The timeline for these different components of the project are detailed on the calendar below. We are currently on schedule with our plan. We completed our initial review of whitefish fisheries within the region, conducted scoping meetings in areas where fishery information was lacking, conducted reviews of biological and ethnographic studies that have occurred in the region, and held our first meeting with a panel of invited delegates (Table 1). We prepared a summary of our initial reviews and provided it to the delegates prior to the first meeting so we all began with the same background information. The meeting took place in Anchorage on November 18 and 19, 2008, and the minutes of the meeting were professionally transcribed.

There was tremendous discussion at the first meeting as delegates shared their perspectives on fisheries, management, biology, fishing practices, environmental changes, other wildlife, and many other issues. Each delegate shared their two or three greatest concerns for whitefish and whitefish fisheries, which were then discussed by the group. Local representatives expressed their concerns over the impacts of commercial fisheries, beaver activity, and changes in water levels. They also provided regionally specific information on whitefish in their areas. Management biologists discussed harvest and abundance information they would require to effectively manage whitefish populations. Anthropologists explained the importance of understanding how subsistence fisheries take place and not just how many fish are taken. Biologists suggested that locating spawning locations was a necessary first step to defining populations. It was generally agreed that there was great potential to use genetics approaches to identify stocks of origin in mixed stock fisheries. All delegates agreed on the importance of species identification in harvest and stock assessment programs. These priorities and others will be considered as we plan for the second meeting scheduled in April 2009. During the second meeting we will begin the process of prioritizing species, fisheries, research methods, management practices, and geographic regions on which to focus our research efforts. At this time we are in the process of synthesizing the information discussed during the first meeting and preparing for the second meeting. We will provide you with additional updates as appropriate.

Please contact either Caroline or Randy if you are interested in obtaining a copy of the original investigation plan, our summary document to the first meeting, the bibliographies of anthropology or biology literature, or other information related to this project. Thank you for your support.

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Schedule:

2008

January	February	March	April
		Start Project	Begin phase 1: background research, scoping meetings, synthesis reports, planning for meetings.
May	June	July	August
	End AK FY08		
September	October	November	December
End Fed FY08	First interim report prepared and sent to group participants. This report will be FRMP progress report.	First group meeting will take place in November 2008	Begin phase 2: Synthesize ideas generated in first meeting, prepare for second meeting.

2009

January	February	March	April
		Second interim report prepared; will guide 2nd meeting discussion, and will serve as FRMP annual report.	Second group meeting will take place in April 2009
May	June	July	August
Begin phase 3: Writing the strategic plan, including the review process.	End AK FY09		
September	October	November	December
End Fed FY09			No annual progress report will be submitted to FRMP at this time, unless draft of final report is requested.

2010

January	February	March	April
		Strategic Plan for whitefish research in the Yukon--Kuskokwim region completed. This will be the final report.	End Project

TABLE 1.—List of delegates and guests invited to the November 18-19, 2008 meeting. Those who were unable to attend are indicated in italics.

Name	Position	Affiliation
Robert Aloysius	RAC Delegate	Yukon Kuskokwim Delta RAC
David Andersen	Subsistence Researcher	Research North
Brandy Berkbigler	Fish Biologist	Tanana Chiefs Conference
Caroline Brown	Subsistence Specialist	Alaska Dept. of Fish and Game
Randy Brown	Fish Biologist	U.S. Fish and Wildlife Service
John Burr	*Fish Biologist*	*Alaska Dept. of Fish and Game*
Richard Carroll, Jr.	*RAC Delegate*	*Eastern Interior RAC*
John Chythlook	Fish Biologist	Alaska Dept. of Fish and Game
Kevin Clark	State Fishery Manager	Alaska Dept. of Fish and Game
Dani Evenson	State Research Manager	Alaska Dept. of Fish and Game
Ken Harper	Fish Biologist	U.S. Fish and Wildlife Service
Russ Holder	Federal Fishery Manager	U.S. Fish and Wildlife Service
Jennifer Hooper	Dir. of Fish. & Forest. Res.	Assoc. of Village Council Presidents
Paul Manumik, Sr.	RAC Delegate	Yukon Kuskokwim Delta RAC
Doug Molyneaux	State Research Manager	Alaska Dept. of Fish and Game
Bill Morris	*Habitat Biologist*	*Alaska Dept. of Fish and Game*
Stanley Ned	Stakeholder	Koyukuk River Representative
Jenny Pelkola	RAC Delegate	Western Interior RAC
Gene Peltola	Federal Refuge Manager	U.S. Fish and Wildlife Service
Amy Russell	Subsistence Specialist	Alaska Dept. of Fish and Game
Mike Thalhauser	Fish Biologist	Kuskokwim Native Association
Bruce Thomas	*Natural Resources Director*	*Council of Athabascan Tribal Gov.*
Jason Hale	Moderator	Yukon River Drainage Fish. Assoc.
Tina Hile	Recorder	Computer Matrix
Liz Williams	Guest	U.S. Fish and Wildlife Service
Richard Cannon	Guest	U.S. Fish and Wildlife Service
Daniel Gillikin	Guest	U.S. Fish and Wildlife Service

First Meeting for the Development of a Strategic Plan for Research of the Whitefish Species in the Yukon and Kuskokwim River Drainages

November 18-19, 2008

Sheraton Hotel, Anchorage, Alaska

AGENDA

DAY 1 – November 18, 2008

8:30 am	Introductions
9:00 am	Review agenda and discuss meeting moderation
9:30 am	Presentations (including discussions/question)
	I. Traditional Knowledge and Harvest Monitoring Research
	II. Biology of whitefish species in the Kuskokwim River
	III. Biology of whitefish species in the Yukon River
10:30 am	BREAK
10:45 am	Presentations, continued…
12:00 pm	Lunch (on your own)
1:30 pm	Presentations and discussion, continued…
2:30 pm	BREAK
2:45 pm	Round-table discussion of major concerns of each delegate
5:00 pm	Adjourn for the day

DAY 2 – November 19, 2008

8:30 am	Classification of concerns a) social b) biological c) management
10:00 am	BREAK
10:30 am	Discussion of major research categories (see next page)
12:00 pm	Lunch (on your own)
1:30 pm	How do we address identified concerns within research categories
4:00 pm	Adjourn

Preliminary List of Research Categories

Social Science Projects

Harvest monitoring/assessment
- Number of fish of each species harvested by community or location
- Time series of harvest estimates versus a single year estimate
- Methods/Gear type
- Seasonality of harvest
- Community patterns of harvest use and sharing

Traditional knowledge
- Historical and contemporary use patterns
- Harvest locations
- Processing methods
- Other local observations (relative population assessment, life history observations, environmental change, fish health, fish kills, etc.)

Impact assessments on community harvest patterns
- Effects of regulation changes
- Effects of environmental changes

Biological Projects

Life history investigations
- Migration routes (feeding areas to spawning areas, overwintering habitats to feeding habitats, larvae dispersal to rearing habitats, etc.)
- Age and size at maturity
- Age and length distribution
- Identification of critical habitats (spawning, rearing, feeding, overwintering)

Demographic assessments
- Mature versus immature
- Spawning versus resting
- Male versus female

Population monitoring
- Spawning population estimates
- Recruitment monitoring

Impact assessments
- Beaver activity
- Lake drying
- Gravel mining
- Harvest regulation

Background Reading for the First Meeting
To be held November 18 and 19, 2008
In Anchorage, Alaska

Development of a Strategic Plan for Research of Whitefish Species in the Yukon and Kuskokwim River Drainages

Whitefish species common to the Yukon and Kuskokwim River drainages. (Scale is in cm.)

Introduction to the First Group Meeting

We, the organizers and invited delegates to this meeting (Table 1), come from a wide range of backgrounds. We each bring different experiences and knowledge to share on whitefish fisheries, taxonomy, harvest, biology, natural history, management, regional concerns, organizational concerns, and more. Please read through this document prior to the meeting so we all start with a similar basic understanding of the species involved and the fisheries that focus on them. We would like to see a broad discussion of the issues introduced here as well as issues we may have missed. It is our hope that during this meeting a smaller number of the most important issues related to whitefish in the Yukon and Kuskokwim River drainages will become clear. This will allow us to focus the second meeting on a more refined set of discussion topics. Ultimately, it is our goal to develop a document that summarizes everything we know about whitefish throughout both drainages and identifies the research needs for all the major fisheries and species that we, as a group, judge to be of greatest importance or concern at this time.

In the sections that follow we have chosen to leave out in-text citations and references to our statements, which is a necessary part of scientific writing. We reasoned, however, that this document was simply an introduction to the process and that it would be easier to read for all of us in its current form than in a formal style. An annotated bibliography of the important literature we have accessed up to this point will be available to everyone at the meeting. All final documents associated with this strategic plan will be in a formal scientific style.

As we get closer to the actual meeting dates we will send out an agenda that will guide the discussions during the first meeting. We will contact you soon regarding travel and lodging arrangements and other details about the meeting. Tina Hile will record the proceedings and provide us with a transcript. Jason Hale has agreed moderate the meeting, which will provide some structure to the discussions. Please don't hesitate to contact us if you have any questions, suggestions, or concerns. We look forward to seeing everybody on **November 18 and 19, 2008, in Anchorage**.

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TABLE 1.—List of delegates and guests to the November 18-19, 2008 meeting related to the development of a strategic plan for whitefish research in the Yukon and Kuskokwim rivers.

Name	Position	Affiliation
Robert Aloysius	RAC Delegate	Yukon Kuskokwim Delta RAC
David Andersen	Subsistence Researcher	Research North
Brandy Berkbigler	Fish Biologist	Tanana Chiefs Conference
Caroline Brown	Subsistence Specialist	Alaska Dept. of Fish and Game
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John Chythlook	Fish Biologist	Alaska Dept. of Fish and Game
Dani Evenson	State Research Manager	Alaska Dept. of Fish and Game
Ken Harper	Fish Biologist	U.S. Fish and Wildlife Service
Steve Hayes	State Fishery Manager	Alaska Dept. of Fish and Game
Russ Holder	Federal Fishery Manager	U.S. Fish and Wildlife Service
Jennifer Hooper	Dir. of Fish. & Forest. Res.	Assoc. of Village Council Presidents
Paul Manumik, Sr.	RAC Delegate	Yukon Kuskokwim Delta RAC
Doug Molyneaux	State Research Manager	Alaska Dept. of Fish and Game
Bill Morris	Habitat Biologist	Alaska Dept. of Fish and Game
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Bruce Thomas	Natural Resources Director	Council of Athabascan Tribal Gov.
Jason Hale	Moderator	Yukon River Drainage Fish. Assoc.
Tina Hile	Recorder	Computer Matrix
Polly Wheeler	Guest	U.S. Fish and Wildlife Service
Richard Cannon	Guest	U.S. Fish and Wildlife Service
Daniel Gillikin	Guest	U.S. Fish and Wildlife Service

The study region in Alaska encompassing the Yukon and Kuskokwim River drainages. A selection of major tributaries are identified and most villages in the region are indicated. This study region represents an area of approximately 300,000 square miles, which is just less than the combined areas of the states of California, Oregon, and Washington (~330,000 square miles).

Whitefish Species in the Yukon and Kuskokwim River Drainages

Taxonomy

Whitefish species are members of the subfamily Coregoninae of the family Salmonidae. In addition to whitefish species, the family Salmonidae includes salmon and trout *Oncorhynchus* spp., char *Salvelinus* spp., and grayling *Thymallus* spp. In the Yukon and Kuskokwim River drainages in Alaska and Canada, seven whitefish species are generally recognized; sheefish (known elsewhere as inconnu) *Stenodus leucichthys*, broad whitefish *Coregonus nasus*, humpback whitefish *C. pidschian*, least cisco *C. sardinella*, Bering cisco *C. laurettae*, round whitefish *Prosopium cylindracium*, and pygmy whitefish *P. coulterii*. Whitefish species share many life history and reproductive qualities but differ from each other in certain ways as well.

Life history qualities common to all riverine whitefish

All whitefish living within river systems follow a similar life history pattern. Spawning takes place in upstream regions in the late fall or early winter in flowing water over gravel. They are broadcast spawners and do not build redds like Pacific salmon species. Whitefish species have very high fecundities compared to Pacific salmon, with the smaller species producing 30,000 to 50,000 eggs and the larger species producing up to 500,000 eggs for each spawning event. Their eggs are cast into the water column where they drift downstream and sink to the bottom, becoming lodged in the gravel. The eggs develop through the winter, hatch in the spring, and emerge into the water during breakup. The tiny juveniles, which may be only an inch or less in length, are carried downstream in the river to a wide array of chance destinations that include backwaters along the river, off-channel lakes, and estuary regions at river mouths. After several years of growth young whitefish become mature and prepare to spawn. Beginning in midsummer, they migrate toward upstream spawning sites during which time they are not actively feeding. Following spawning, they retreat downstream to overwintering locations in large river channels or in brackish water at river mouths. Whitefish are capable of spawning multiple times although not necessarily every year. During the fall spawning period there are three main components of whitefish populations: immature fish far downstream of the spawning areas; mature non-spawners also downstream of the spawning areas but not necessarily as far downstream as immature fish; and mature spawners at or near upstream spawning areas.

Species profiles

Sheefish

Sheefish are generally found in large river systems and their estuaries. They are rarely found in clear-water tributaries or lake systems, although, they will congregate and feed where clear-water tributaries join larger river systems. They feed almost exclusively on fish. They mature at 8 to 12 years of age and may live for 30 years or more. Mature fish are generally 25 to 40 inches in length and weigh 5 to 30 lb. They make spawning migrations as far as 1,200 miles in the Yukon River, for example, from rearing areas at the mouth of the river to spawning areas in the upper Yukon Flats, the Alatna River in the upper Koyukuk drainage, and into the Tanana River. In the Kuskokwim River they

migrate as far as 600 miles to a spawning area in the Big River and 750 miles to a spawning area in Highpower Creek. Spawning period varies somewhat by location with the earliest spawning populations beginning in the last few days of September and the later spawning populations near mid-October.

Broad whitefish

Broad whitefish are commonly found in large rivers, estuaries, and in lake systems with stream connections to large rivers. They are rarely found in swift, clear-water streams. They are not known to maintain populations in isolated lake systems in the Yukon or Kuskokwim River systems, although there are anecdotal accounts of them being captured in some floodplain lakes. They feed primarily on bottom dwelling aquatic invertebrates such as insect larvae, amphipods, and mollusks. As far as we know, all broad whitefish populations spawn in river systems. They migrate into lake systems to feed during summer and exit the lakes in the fall or early winter to spawn and overwinter in the river system or its estuary. Broad whitefish generally mature at 5 to 8 years of age and may live for 30 years or more. Mature fish are generally 18 to 25 inches in length and weigh 2 to 5 lb. Like sheefish, they make spawning migrations as far as 1,200 miles up the Yukon River and its major tributaries from estuarine rearing areas. They appear to spawn in the mainstem Kuskokwim River as much as 550 miles from the sea. Spawning period for broad whitefish in the Yukon River is thought to be in early November, almost a month later than other riverine spawning whitefish species.

Humpback whitefish

Humpback whitefish are commonly found in large rivers, estuaries, and in lake systems. They are rarely found in swift, clear water streams, although a few spawning areas have been located in these habitats. Like broad whitefish, they feed primarily on bottom dwelling aquatic invertebrates such as insect larvae, amphipods, and mollusks. Humpback whitefish maintain populations that are riverine and populations that are lake based. Riverine populations spawn in gravel-bottom, upstream reaches of rivers, rear downstream as far as the estuaries, and migrate seasonally into connected lake systems to feed. Humpback whitefish generally mature at 4 to 7 years of age and may live for 30 years or more. Mature fish are generally 16 to 22 inches in length and weigh 1.5 to 3 lb. Like sheefish, riverine populations make spawning migrations as far as 1,200 miles up the Yukon River and its major tributaries from estuarine rearing areas. They spawn from late September to mid-October depending on the population. Several humpback whitefish populations are known to maintain themselves in isolated lake systems in the Yukon River drainage. Spawning period for lake populations are reported to be from November to January, later than for riverine populations, and extend over several months.

Least cisco

Similar to humpback whitefish, least cisco are commonly found in large rivers, estuaries, and lake systems. They are rarely found in swift, clear water streams, although a few spawning areas have been located in these habitats. They feed almost exclusively on pelagic invertebrates but they also eat small larval fish when they are available. Least cisco maintain populations that are riverine and populations that are lake based. Riverine populations spawn in gravel-bottom, upstream reaches of rivers, rear downstream as far

as the estuaries, and migrate seasonally into connected lake systems to feed. Least cisco generally mature at 3 to 4 years of age and may live for 10 years or more. Mature fish are commonly 12 to 16 inches in length and weigh 0.5 to 2 lb. Riverine populations make spawning migrations as far as 1,100 miles up the Yukon River and its major tributaries from estuarine rearing areas. They spawn from late September to mid-October depending on the population. Several least cisco populations are known to maintain themselves in isolated lake systems in the Yukon River drainage. Least cisco living in isolated lakes are often reported to develop into one or more unusual forms such as dwarf populations, attaining only 4 to 6 inches in length, or jumbo spotted forms that attain 20 inches or more in length. Similar to humpback whitefish, spawning period for lake populations are also reported to be later and extend over a longer period of time than riverine populations

Bering cisco

Bering cisco is the only whitefish species common to the Yukon and Kuskokwim rivers that is entirely anadromous. Immature fish are found in coastal waters, estuaries, and brackish lagoons of the Bering and Chukchi seas where they feed on pelagic invertebrates and small fish. Bering cisco encountered upstream from the deltas of the Yukon and Kuskokwim rivers are mature fish migrating upstream to spawn. They do not feed during this migration. They mature at 5 to 8 years of age and very few exceed 9 years of age. Length and age distribution data indicates that most Bering cisco die following spawning, which is in contrast to all other whitefish species. Mature fish are generally 12 to 16 inches in length and weigh 0.5 to 2 lb. They make spawning migrations as far as 1,300 miles in the Yukon River from coastal rearing areas up to the braided, gravel regions of the upper Yukon Flats and beyond, and 600 miles in the Kuskokwim River into a similarly braided region of the South Fork Kuskokwim River. Spawning migrations have not been identified in any tributaries of the Yukon River or in other branches of the Kuskokwim River, suggesting a single population in each river. The only other Bering cisco population that has been identified spawns in the Susitna River, which drains into Cook Inlet. Bering cisco spawn during the first half of October. Their spawning migrations in the Yukon and Kuskokwim rivers begin early in the summer and decline dramatically by September.

Round whitefish

Round whitefish are the only whitefish species that is most commonly found in clear, swiftly-flowing, gravel-bottom, tributary streams. They are also found in lakes, including many isolated lakes. In general, they prefer similar habitats to Arctic grayling *Thymallus arcticus*. They feed primarily on bottom dwelling aquatic invertebrates such as insect larvae, amphipods, and mollusks. They mature at 4 to 7 years of age and may live for 30 years or more. Mature fish are generally 12 to 20 inches in length and weigh 0.5 to 2 lb. Fall spawning migrations have been documented in the Tanana River, but, not in other large river sampling sites in the Yukon River drainage. Most spawning is thought to take place in early October in smaller tributary rivers. In contrast to the other whitefish species in the Yukon and Kuskokwim River drainages, round whitefish are rarely found in estuary habitats and are therefore considered to be freshwater residents in Alaska.

Pygmy whitefish

Pygmy whitefish are found in a small number of relatively large, deep lakes in Alaska. They have been identified in some headwater lakes in the upper Yukon River drainage in Canada, but not in the Alaska portion of the drainage or in the Kuskokwim River drainage. It is possible that pygmy whitefish could be identified in this region with more comprehensive sampling of relatively large lakes. Given their apparent absence in our region of interest, we will not consider pygmy whitefish any further in this document.

Subsistence Fisheries

Subsistence whitefish fisheries along the Yukon and Kuskokwim River drainages have long been documented in the ethnographic literature, agency technical papers, and the local or indigenous knowledge of residents. This information is available in essentially two forms: documentation of traditional ecological knowledge (TEK) and harvest estimates.

Traditional ecological knowledge is increasingly recognized as important to natural resources management as a means of integrating important and long-term local observations with western scientific observations. TEK can be usefully classified into categories of: 1) empirical or generalized observations of specific events or phenomena, e.g. observations of seasonal migration or spawning; 2) factual knowledge about past or present uses, e.g. land use patterns or harvest levels; 3) cultural value statements about appropriate behavior, e.g. treatment of animals; and 4) cosmological knowledge or how observational information is organized to provide explanations or guidance, e.g. local classificatory systems of whitefish. Harvest surveys are also valuable management tools in a fisheries management and regulatory system. Harvest estimates and patterns of use and distribution within a community provide critical empirical information about subsistence sharing practices. This information is essential for drafting customary and traditional use determinations that are protected by both federal and state subsistence statutes. Additionally, by documenting past and current levels of harvest and subsistence fishers' local observations about resource abundance, health, and condition, managers may identify questions or concerns about a species' population trends. The following summaries of subsistence whitefish fisheries, organized by regions within drainages, provide brief descriptions of each area, highlighting information about harvest levels, seasonality, gear selections, use patterns, and concerns.

Yukon River drainage

Upper Tanana River (Northway, Tetlin, Tanacross, Dot Lake, Tok, Healy Lake)

Lacking salmon in appreciable numbers, upper Tanana River communities target whitefish species as their primary fish resource. Until quite recently, upper Tanana fishermen used dip nets at weir sites, gillnets, and less often, fishwheels, to harvest the majority of their catch. Many dip net spots conform to traditionally-used whitefish fishing spots. Indeed, some of the contemporary communities were established in their current locations because of the presence of whitefish weirs. The Mansfield Lake area, Tetlin River, and the Nabesna-Chisana area and others are all historical fishing sites still used today. Most fish are now caught in set gill nets.

Residents target whitefish during the start of their migration in June or July, but, also catch them at other times of the year, especially fall and early winter, in various streams and lakes. Participation in the upper Tanana whitefish fishery is high. A 1984 study documented that 80% of Tanacross households, 85% of Tetlin households, and 87% of Northway households participated in harvesting whitefish. In 1988, upper Tanana residents reported that non-salmon fish, particularly whitefish species, accounted for an average of 34% of their total annual subsistence harvest. In some villages, whitefish accounted for half of their total annual harvest. In total, residents of the entire area reported harvesting approximately 65,218 pounds of whitefish species, though species specific information is not available. Comparatively, upper Tanana residents reported harvesting approximately 38,557 pounds of whitefish species in 2005. Harvests were comprised primarily of humpback whitefish and round whitefish, but other species were documented in smaller numbers (Table 2). Whitefish are used for food, as well as to barter with Copper River Athabascans for salmon.

Table 2. Estimated harvest (pounds) of whitefish species by upper Tanana residents, 2005.

Resource	Dot Lake	Northway	Tanacross	Tetlin	Tok
Sheefish	0	0	0	0	31
Broad whitefish	95	0	568	0	1,158
Humpback whitefish	748	16,156	2,500	8,570	7,935
Bering cisco	0	0	0	0	0
Least cisco	0	0	0	0	0
Round whitefish	0	200	145	0	0
Unidentified whitefish	200	0	0	0	251
Total	1,043	16,356	3,213	8,570	9,375

Source: Alaska Department of Fish and Game, Division of Subsistence, household surveys, 2005

Residents of the upper Tanana River villages have expressed concern over a number of issues and observations related to their fisheries. A traditional fishing lake near the village of Northway is now receiving a larger flow of silty river water than it has in the past. The silt is being deposited on the lake bottom and they believe it is impacting their fishery. Residents of Tetlin believe the humpback whitefish they harvest are smaller now than they were 15 years ago. Finally, Upper Tanana residents report higher levels of parasitism in whitefish over the last several years.

Yukon Flats (Arctic Village, Venetie, Beaver, Birch Creek, Fort Yukon, Stevens Village, Chalkyitsik, Circle, and Central)

Whitefish have long been an important subsistence resource for Yukon Flats communities. Gwich'in speakers have names for all six species of whitefish, including round whitefish and sheefish. They also make more informal classifications based on size or habitat preference (lake and river whitefish). Historically, fishing areas played an important role in the settlement of Yukon Flats communities. Whitefish were harvested with fish-traps, nets made of willow bark or other materials, hang-jigs, and willow-root lassos. Commercial nets have largely replaced these gear types. Fishing for whitefish was practiced year-round, though intense fishing occurred in the late spring and early fall when whitefish were moving in the highest numbers. By comparison, today's whitefish harvest is intensely focused in the late fall preceded by heavy salmon fishing throughout the summer. Though spring and fall witnesses the most concentrated movement of whitefish, according to respondents, whitefish move consistently throughout the summer. A preference was stated for "later season" fish or fall fish due to their recovery after the long winter, though some are occasionally caught through the ice in winter.

In the Yukon Flats, one of the most notable changes surrounding the harvest and use of whitefish today is the considerable reduction in overall use. Community members reported that they now harvest less or no whitefish compared with a generation ago and instead focus on salmon species. Circle and Central residents reported little to no harvest in 2005. In Fort Yukon, however, the harvest of whitefish species continued to be more intense than in other nearby communities. In Birch Creek, whitefish continue to play a central role in their diets.

Recent reported harvest estimates are lower for Yukon Flats communities than for other interior regions. In 1987, residents of Fort Yukon reported harvesting more than 52,000 pounds of whitefish and sheefish, which decreased to 11,800 pounds in 2006 (Table 3). In 2006, humpback and broad whitefish species constituted 77% of the total coregonid harvest and cisco species were the least harvested. Area residents noted that whitefish provide a sort of "insurance" for declines in the quality and quantity of salmon (particularly Chinook/king), and are therefore often perceived as a "back-up" food. When caught, whitefish may be used for consumption by either humans or dogs.

Table 3. Estimated harvest (pounds) of whitefish species by Yukon Flats residents, 2006.

Resource	Beaver	Birch Creek	Central	Circle	Fort Yukon
Sheefish	432	72	187	31	2,147
Broad whitefish	354	880	0	0	7,131
Humpback whitefish	306	150	0	118	2,201
Bering cisco	0	0	0	55	0
Least cisco	0	0	0	26	261
Unidentified whitefish	0	0	11	0	60
Total	1,092	1,102	198	230	11,800

SOURCE: Alaska Department of Fish and Game, Division of Subsistence, harvest surveys, 2006

Residents of the Yukon Flats communities expressed concerns about the drying of otherwise seasonally flooded lakes, which provide important feeding habitat for whitefish

species. Overall whitefish quality and quantities are believed to be suffering, though not to the same degree as the quality and quantity of salmon. Additionally, Birch Creek residents believe there was a severe decline in whitefish quality and quantity due to mining activities in Central in the 1980s. They report that the fish are recovering but note that they have not reached pre-1980s conditions as they observed them. Very little whitefish harvest and use information exists for other Yukon Flats communities including Venetie, Chalkytsik, Arctic Village, and Stevens Village.

Middle Yukon (Tanana, Ruby, Galena, Nulato, Koyukuk)

Historical records dating back to the late 1800s document the harvest and use of whitefish species in the middle Yukon settlements. Historically, families used nets, traps, dipnets, and sometimes spears in spring and fall to exploit whitefish during their seasonal migrations, and used fish traps and nets under the ice for a year-round supply of fresh fish. Fishermen in the contemporary communities of Tanana, Ruby, Galena, Nulato, and Kaltag primarily use fish wheels, set nets (open water and under the ice), hook and line, and more rarely fyke nets, to harvest whitefish species. In 2006, whitefish species constituted 90% (141,922 lbs) of the total non-salmon fish harvest across the middle Yukon, with 60% of the total whitefish harvest comprised of the larger species of broad whitefish (49,346 lbs) and humpback whitefish (35,482 lbs) (Table 4). The 2006 harvest estimates for Tanana are approximately one-third of the estimated harvests of all whitefish species in 1987, while the 2006 harvests reported by Galena fishermen far exceed 1986 estimates.

Table 4. Estimated harvest (pounds) of whitefish species by middle Yukon residents, 2006.

Resource	Tanana	Ruby	Galena	Nulato	Kaltag
Sheefish	5,006	1,193	11,892	3,356	1,238
Broad whitefish	10,822	55	35,326	3,143	0
Humpback whitefish	6,210	896	27,701	675	0
Bering cisco	4,223	0	5,572	0	0
Least cisco	474	0	1,990	23	0
Unidentified whitefish	36	105	19,140	713	1,734
Total	26,771	2,249	101,621	7,910	2,972

SOURCE: Alaska Department of Fish and Game, Division of Subsistence, harvest surveys, 2006.

A large percentage of the whitefish harvest in the middle Yukon region is used for dog food. Harvests in Tanana and Galena are predominantly for dog food, with a relatively small percentage of households (dog mushers) harvesting the greatest quantities of whitefish, while a larger percentage of whitefish harvested in Ruby, Nulato and Kaltag are used for human food. The seasonality of harvest among communities appears to differ as well. Communities with a greater focus on human food fisheries tend to harvest whitefish more broadly through the year while communities that focus more on dog food tend to harvest whitefish primarily during the late summer and fall. Finally, the harvest areas primarily used by each community vary depending on social and other factors such as whether the community has moved over time, changes in waterways that affect productive sites, and if families continue to travel to seasonal camps and fishing areas.

Fishermen from the middle Yukon region have expressed concerns about a number of issues related to their whitefish fisheries. Some are worried about the impacts of beaver activity on whitefish populations. Some believe the quantity and size of sheefish and large whitefish species is declining. Others are concerned that drying lakes and sloughs may reduce overall feeding habitat or access into these habitats.

Koyukuk River (Bettles/Evansville, Allakaket, Alatna, Hughes, Huslia, Koyukuk)

Koyukuk River people rely heavily on whitefish species because salmon runs in the Koyukuk River are relatively poor compared to other regions of the Yukon drainage. Historically, fishery resources have been one of the most stable and consistent in the Koyukuk River area. Large funnel traps were formerly used to harvest whitefish in the fall at specific sites as the fish left lake habitats. Today, most fishermen use hook and line, set nets, and seine nets to harvest whitefish species and sheefish.

Sheefish appear to have a defined geographical distribution in the Koyukuk River; they are primarily captured in the Koyukuk main stem during their migration to spawning locations in the upper Alatna River. They are not captured farther upstream in the Koyukuk and are found only in the lower reaches of its other tributaries. Sheefish enter the Koyukuk River as early as March with a large pulse heading upriver in June. Similarly, the larger whitefish species, mostly broad whitefish, move up the Koyukuk River during break-up and into June, shortly before the Chinook salmon run. Hence, fishing for whitefish and sheefish generally begins in early May after the river ice breaks up, preceding the arrival of salmon, and nets are set in the mouths of sloughs and creeks. Fishing continues through the summer months and into October when fishermen travel to seining spots for sheefish, whitefish, and other fish species. Least cisco were readily identified by Koyukuk River residents, round whitefish were also recognized as inhabiting primarily the upper reaches and headwater areas, while Bering cisco were not readily recognized by many, raising questions about the extent to which Bering cisco are distributed in the Koyukuk River.

In 1982, upwards of 80% of upper Koyukuk River households (Allakaket, Alatna, and Hughes) participated in harvesting whitefish species. In 2003, approximately 45% of households participated in harvesting those same whitefish species. In 1983, approximately 50% of Huslia households participating in harvesting 2,135 whitefish. In 2003, 30%-50% of households participated in harvesting sheefish and whitefish (Table 5).

Several fishermen in the region expressed concerns in 2003 about the overall health and condition of whitefish species in the drainage. It was their perception that fish were not as fat as they used to be. They suggested that habitat changes in feeding areas or changes in the climate may have reduced habitat quality.

Table 5. Estimated harvest (pounds) of whitefish species, Koyukuk River communities, 2003.

Resource	Koyukuk	Huslia	Hughes	Alatna	Allakaket
Sheefish	2,304	5,410	1,078	78	8,778
Broad whitefish	3,996	9,715	7,922	600	7,140
Humpback whitefish	144	10,836	10,123	57	3,885
Least cisco	0	135	5,726	68	1,829
Bering cisco	0	722	32	0	280
Unidentified whitefish	0	0	0	0	0
Total	6,444	26,818	24,881	803	21,912

SOURCE: Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 282.

GASH (Grayling, Anvik, Shageluk, and Holy Cross)

The earliest accounts of whitefish use by the Deg Hit'an and Holikachuk Athabascan residents of the lower-middle Yukon River date back to the late 1800s. Deg Xinag speakers distinguish five species of whitefish, though these species distinctions did not map precisely onto Linnean classifications. Instead, classifications were also made by size (small whitefish - *dilmig*), age (juvenile whitefish – *Xilch'edh*), and habitat (lake whitefish - *taghiy*). Historically, whitefish species were harvested with a combination of juvenile and adult whitefish traps, homemade nets, and hooks. Shageluk and Holy Cross residents participated in spring and fall fishing events in which the river was "shut down" by placing a weir of willow boughs across the Innoko and then using dipnets to dip whitefish out behind or in front of the weir (depending on seasonal direction) through troughs cut in the ice. Today, most whitefish species are harvested with nets, hooks, and fishwheels.

Although the lower-middle Yukon region (GASH) is known for the quality and size of its pike, whitefish species are second only to salmon in terms of harvest and use for the GASH area. Broad and humpback whitefish species are available most of the year, with significant seasonal movements in the fall and spring. The larger whitefish species begin an up-river migration under the ice in the springtime, heading out of the main river and into sloughs and lakes, coincident with break-up. Shageluk residents observed that the springtime run of whitefish begins with larger fish and that the size of fish generally decreases as the run progresses, an indicator to fishermen to pull their nets. In addition to their seasonal presence, broad whitefish were also reported as year-round residents of certain lakes in the Holikachuk area.

During fall, larger whitefish migrate out of sloughs and lakes and back into the main stem Yukon, where most residents believe they overwinter. Sheefish follow a similar migration to broad and humpback whitefish, however, they apparently leave the Innoko River during the winter months and move into the Yukon River. Most of the whitefish harvest in the region (Table 6) occurs during the spring and fall migrations. Consistent with this, a 2003 survey documented that 94% of the Broad whitefish harvest occurred between May and September. Smaller species, *dilmig*, which likely include Bering cisco, least cisco, and round whitefish, are most often harvested in fishwheels during the late summer while fishing for chum salmon.

Table 6. Estimated harvest (pounds) of whitefish species by GASH communities, 2003.

Resource	Anvik	Grayling	Holy Cross	Shageluk
Sheefish	2,267	4,698	44	5,033
Broad whitefish	3,586	9,612	2,555	10,750
Humpback whitefish	1,535	6,336	0	0
Bering cisco	7	0	0	0
Least cisco	21	0	0	0
Unidentified whitefish	0	43	0	0
Total	7,416	20,686	2,599	15,783

SOURCE: Alaska Department of Fish and Game, Division of Subsistence, household survey, 2003.

In 1990-1991, whitefish species, including sheefish, constituted 16% of the total annual fish harvest for subsistence purposes. In general, whitefish harvests were relatively consistent between 1990 and 2002, while sheefish estimates show more variability between years and communities. For example, sheefish harvests decreased in 2002 in Grayling while nearly doubling in Shageluk.

Lower Yukon (Hooper Bay, Emmonak, Alakanuk, Kotlik, Nunam Iqua, St. Mary's, Russian Mission)

There is limited published research on the subsistence whitefish fisheries of the lower Yukon River. Nonetheless, scoping meetings conducted in May 2008 in Emmonak suggest that people residing in lower river communities actively harvest significant numbers of whitefish of several species over the course of a year.

A harvest study from 1978 provided additional information about whitefish fisheries from Holy Cross to the mouth of the Yukon. Much of the report focused on the winter sheefish fishery in the region. In general, under the ice fishing began in mid October when the ice was thick enough to safely walk on, peaked in November (83% of total harvest in Oct-Nov), and slacked off until May when it started up again. The timing of the winter harvest was affected by location on the river with later harvests in the more upriver communities. Local knowledge suggested several interesting conditions that may affect fishing success such as time of day, tide, wind direction, and how high the water is when the river freezes. The report concluded that while still an active fishery, the sheefish fishery has declined in effort and quantity due to the shift away from keeping dog teams and the transition towards a mixed-cash economy where regular employment keeps people from participating in subsistence activities all year long.

The reported sheefish catch for the study area from October 1977 to June 1978 totaled 3,394 sheefish and the expanded figure could be as high as 5,438. Communities at the mouth comprised 85% of the total harvest for the study area. Lower Yukon fishermen also reported harvesting 3,562 whitefish, including broad whitefish, humpback whitefish, and Bering cisco. Harvest estimates by season suggested that other whitefish species arrived earlier than sheefish in these lower river communities.

A 1984 baseline survey conducted in Russian Mission documented that fishing for whitefish species occurs in every month of the year. Sheefish show up first after break-up in May, referred to as *kuigpagtat*, or "ocean run", distinguishing it from sheefish caught at other times of the year. The larger whitefish species are targeted in fall

around freeze-up and late winter through early spring. *Arulailkat*, or "ones that have stopped moving around", primarily broad whitefish resident in land-locked lakes in the Russian Mission area, are targeted in early spring because of their high fat content. Some Russian Mission fishermen also harvested Bering cisco in small whitefish nets (3 5/8 to 4 inch mesh), coinciding with the whitefish harvest. Round whitefish were caught in low numbers, however, no whitefish harvest estimates are available for Russian Mission.

Kuskokwim River Drainage

Kuskokwim Bay and Coastal Y-K Delta

Studies on the subsistence use of whitefish in communities from the coasts of the Y-K Delta have been conducted in Hooper Bay, Kwigillingok, Quinhagak and Goodnews Bay, representing the western coast and Kuskokwim Bay area. In Hooper Bay, whitefish are primarily targeted in the fall, although they are commonly caught while salmon or herring fishing in the summer. Residents generally fish for whitefish all around the bay and in streams close by their camps. In winter, Hooper Bay residents join families from Scammon Bay and Chevak for whitefish fishing in the *Ingalluk* area near the Askinuk Mountains. In 1983, fishermen harvested whitefish in 60-foot nets with between 2½ and 4-inch mesh. Bering cisco were harvested around Nuok Spit, up the Ninglikfak, Keoklevik, and Kashunuk rivers and along an outlet of Nashak Lake. Harvesting mostly Bering and least cisco, fishermen also catch sheefish and humpback whitefish.

In Kwigillingok, local fishermen target a spring run of primarily Bering cisco (*Imarpinraq*) at the mouth of the Kwigillingok River and several tidally influenced sloughs that drain Bow Lake. The Ishkowik River is another place commonly fished for Bering cisco. In the 1980s, Kwigillingok fishermen typically used 60-foot long set or drift nets with 3-inch mesh. The spring run of Bering cisco usually ends with the arrival of herring at Kwigillingok, by which time Bering cisco have traveled to inland lakes. Some fishermen harvest Bering cisco in summer at the outlet to Bow Lake, however, most summer fishing is focused on salmon and herring. Kwigillingok fishermen typically resume whitefish fishing in the fall. Between August and September, subsistence fishermen intercept Bering cisco as they migrate out of the lakes back down to the Kuskokwim Bay.

On the south side of Kuskokwim Bay, some fish stocks arrive a couple of weeks later then they do on the north side and at the mouth of the Kuskokwim River. A traditional ecological knowledge study conducted in Quinhagak and Goodnews Bay revealed that Bering cisco (called *Imarpinraq* or *Naptaq)* are also the most heavily utilized whitefish species in this part of the Kuskokwim Bay. Round whitefish are occasionally harvested but in smaller numbers than in the past. Elders in Quinhagak and Goodnews Bay were not familiar with least cisco. One person indicated that these were only found out in Kuskokwim Bay. The main seasons for harvesting Bering cisco were spring and fall during their migrations. Historically, spring Bering cisco were the only food source available during April in Goodnews Bay. Whitefish populations were said to be abundant in the Kanektok River near Quinhagak, but in decline on the Goodnews River, near Goodnews Bay. A survey conducted in Quinhagak in 1982 estimated that subsistence fishers harvested 2,564 Bering cisco that year.

The coastal environment of the Y-K Delta provides a variety of marine, estuarine

and riverine habitats for fish resources and the foods that they depend on. Whitefish stocks and run timing along these coasts may also differ significantly from those in the Kuskokwim River. Whereas subsistence fishers on the coasts and near the mouth of the Kuskokwim River actively harvest Bering cisco, there is very little reported harvest of this species upstream on the Kuskokwim.

Lower Kuskokwim

In the lower Kuskokwim River, tidal influence has a major effect on whitefish fishing. The subsistence whitefish harvests of many lower Kuskokwim River communities have not yet been studied. An in-progress traditional knowledge project in Eek, Tuntutuliak, and Nunapitchuk preliminarily suggests that lower Kuskokwim communities historically relied heavily on broad whitefish, but apparent declines in this species have shifted harvest towards humpback whitefish. Generally, fishermen use 4-5 inch mesh, 25-fathom nets for larger whitefish and 3—3½ inch mesh for least and Bering cisco. They set their nets in the spring when the whitefish are migrating to area lakes, and catch them again in fall, when the whitefish return to the Kuskokwim River. The fall run of whitefish is the preferred fishing season. Cisco are harvested exclusively from October to November. Sheefish are also caught with nets or by rod and reel in the spring and early summer. Round whitefish are also occasionally harvested in this region. In 1983, Nunapitchuk households caught 2,927 whitefish (8,781 pounds) and 3 sheefish (22 pounds). Community harvests from 2005-2006 were substantially higher (Table 7).

Table 7. Estimated harvest (number and pounds) of whitefish species by lower Kuskokwim communities, 2005-2006.

Resource	Eek		Tuntutuliak		Nunapitchuk	
	Fish	Lbs	Fish	Lbs	Fish	Lbs
Sheefish	236	1,415	372	2,333	53	319
Broad whitefish	532	2,129	1,976	7,903	2,321	9,285
Humpback whitefish	1,726	5,179	4,335	13,004	3,373	10,120
Bering cisco	1,598	2,237	467	654	29	41
Least cisco	20	20	265	265	0	0
Round whitefish	0	0	114	57	236	118
Total	4,112	10,980	7,529	24,216	6,012	19,883

SOURCE: Alaska Department of Fish and Game, Division of Subsistence, Household Survey, 2006

Whitefish harvest locations near Eek include the Eek Channel, Apokak Slough, the Eenayarak and Eek Rivers and Ciituci Lake. Harvest locations for Tuntutuliak include the Kuskokwim River, Apokak Slough, the Tagayarak River and the lake country up the Kinak River. Whitefish harvests near Nunapitchuk take place within a wide lake and stream region through which the Johnson and Kialik rivers flow.

Nunapitchuk residents have been taught by their elders that Nanvarpak Lake is the origin of local whitefish. That region is renowned for the health and quality of its fish, especially whitefish, which is thought to depend on the flushing out of area lakes and streams. Commercial sale or barter of whitefish from this region to people on the Bering Sea Coast has taken place for many years. Some in the region felt that the fishery was being overexploited in the late 1980s and early 1990s so tribal elders from Kasigluk,

Nunapitchuk, and Atmautluak adopted a resolution in 1992, prohibiting nets in the lake, especially at the outlet. People not in compliance with the resolution have been issued citations or had their nets confiscated, which has led to controversy about the resolution and its enforcement.

Lower Kuskokwim communities have expressed concern that a growing population of beavers has ruined whitefish habitat in some locations and caused whitefish numbers to decline. Lower Kuskokwim fishermen were also concerned that recent climate changes including warmer weather, less snowfall, and lower water levels in local lakes and streams may have had an effect on whitefish habitat and abundance.

Harvest data on non-salmon species was collected in Bethel, the Y-K Delta regional hub, between 2001 and 2004. Studies have, however, focused on the nearby communities of Kwethluk, Akiackak, and Tuluksak. Although geographically close, these communities display very different whitefish fishing patterns. Bethel residents actively catch whitefish in drift and set nets in the summer, and with set nets under the ice and by jigging in winter. In 1984, local residents set 83 nets under the ice along a six mile stretch of the Kuskokwim River close to Bethel to catch whitefish, pike and burbot. In addition, Bethel residents typically catch sheefish in their salmon nets or by rod and reel in the summer. Kwethluk residents, who also subsistence fish for whitefish in the main stem of the Kuskokwim River, reported harvesting whitefish primarily in fall between August and November. Broad whitefish, humpback whitefish, round whitefish, least cisco and sheefish were said to be the species available in the region and many of these species were available throughout the year. Harvest data from 1985-1986 for Kwethluk are shown in Table 8.

Table 8. Estimated harvest (number and pounds) of whitefish in Kwethluk in 1985 and Akiachack in 1998.

Resource	Kwethluk		Akiachak	
	Fish	Lbs	Fish	Lbs
Sheefish	2,119	13,775	205	1,335
Broad whitefish	0	0	4,167	16,671
Humpback whitefish	0	0	7,233	14,466
Unknown cisco	0	0	353	264
Round whitefish	0	0	422	634
Unidentified whitefish	9,946	29,839	0	0
Total	12,065	43,614	12,380	33,370

SOURCE: Alaska Department of Fish and Game, Division of Subsistence, Household Surveys, 1985 and 1998

In Akiackak, whitefish are available year-round in the Kuskokwim River, but most fishing for broad and humpback whitefish in 1998 took place in July and August, using 6” mesh nets. Some residents also harvested humpback whitefish with rod and reel gear. Cisco (not identified to species) were harvested throughout the year in the main stem of the Kuskokwim River between Bethel and Aniak. Of these fish, 10% of broad whitefish, 1% of humpback whitefish, and 100% of sheefish had been caught while commercial fishing. The subsistence harvest of sheefish in Akiachak was not recorded

during the survey, but, would undoubtedly provide a substantial addition to the harvest total (Table 8).

Between 1980 and 1983, Tuluksak fisherman harvested whitefish between May and October and sheefish from September to November. Harvest locations near Tuluksak include the Tuluksak River, Otter Creek, Fog River, Little Bogus Creek, Mishevik Slough, and a tributary of Birch Creek. Residents of Tuluksak expressed concern that mining operations up the Tuluksak River and beaver dams were impacting fish habitats in the region. Whitefish populations were generally thought to be in decline in this part of the lower Kuskokwim River drainage.

Central Kuskokwim

The central Kuskokwim region covers a span of the Kuskokwim River from Lower Kalskag to Lime Village up the Stony River. Within that region, three distinct cultures—Yup'ik, Deg Hit'an Athabaskan and Dena'ina Athabaskan—are present. Most non-salmon fisheries research in the central Kuskokwim has concentrated on the communities of Aniak, Chuathbaluk, Sleetmute, Stony Village and Lime Village. Aniak and Chuathbaluk rely heavily on salmon and whitefish while communities upstream from Chuathbaluk harvest smaller proportions of salmon and rely on fall whitefish primarily as a winter food source.

Species available in the area include broad whitefish, humpback whitefish, round whitefish, least cisco and sheefish. Whitefish species migrate from the Kuskokwim River into tributary rivers and lakes in the spring, and back into the Kuskokwim River in fall. Whitefish are harvested from May until November. Sheefish are harvested between May and September, depending on location, while least cisco are targeted in August and September. The preferred time to catch whitefish in Lime Village is in late fall, when whitefish are easy to put away for winter because they can be frozen and stored outside. Harvest data for Aniak and Chuathbaluk are shown in Table 9.

Table 9. Estmated harvest (number and pounds) of whitefish in Aniak and Chuathbaluk, 2002-2003. These totals do not include cisco harvests.

Resource	Aniak		Chuathbaluk	
	Fish	Lbs	Fish	Lbs
Sheefish	366	2,379	207	1,346
Unidentified whitefish	1,649	4,947	1,295	3,885
Total	2,015	7,326	1,502	5,231

SOURCE: Alaska Department of Fish and Game, Division of Subsistence, household surveys, 2002-2003

There are many important harvest locations throughout the region, including the main stem Kuskokwim River, Aniak River, Whitefish Lake, Holitna, Hoholitna River Swift River, and Stony River. Lime Village and Stony River residents use certain seasonal camps specifically for catching whitefish. Most of the camps used by Lime Village residents are in the lake country to the south and in Tishimna Lake. Communities in the central Kuskokwim employ a range of whitefish harvest methods including fyke nets, driftnets, set nets, and hook and line gear. In Sleetmute, a traditional method of spearing whitefish continues to be used. In Stony River and Lime Village, set nets, fish

wheels, fish fences combined with traps and dipnets, hook and line gear, spears, and burbot traps are all used for catching whitefish. In Aniak, concern that whitefish have decreased in size and number has been expressed for several decades. Lime Village fishermen stated that, in their experience, destroying beaver dams has improved whitefish abundance.

Upper Kuskokwim

The upper Kuskokwim River region consists of the villages of Telida (whose name means"Lake Whitefish Place"), Nikolai, McGrath and Takotna. Research conducted in all four communities indicated that they each fish for whitefish in separate areas, some near the mouth of the North Fork of the Kuskokwim River, where it meets the main stem, and others in lakes and tributaries close to their communities. Nikolai fishermen make day trips to fishing spots as far as 40 miles away in the winter. McGrath fishermen set their nets at the mouth of the Takotna River in the spring. There are no spring runs of whitefish that reache the village of Takotna, so Takotna residents generally travel to other communities or to the main stem of the Kuskokwim River to catch whitefish. When the communities of Medfra and Vinasale were still active, people used to live or work in these communities and fish in that vicinity. Now, only a handful of households fish in that area.

Whitefish are harvested in spring, summer, and fall (including under-the-ice fishing in November). When spring break-up occurs, broad and humpback whitefish head from the Kuskokwim River to outlying lakes and fishermen set nets at strategic locations to intercept them. Fishermen from the four communities use a variety of gear including nets, fishwheels (primarily in Nikolai), fyke nets, and historically, fish fences, traps, and spears. In November, when rivers and lakes have frozen, nets are placed under the ice in deeper areas. Late fall whitefish are easily frozen and stacked outside.

Sheefish are harvested in summer and fall using fishwheels, nets, and spears. The Big River drainage between Nikolai and McGrath once hosted a large fishery for sheefish. In the early 1900s, when roadhouses operated in the area and people traveled by dog teams, dogs were often boarded with local residents through the winter and whitefish and sheefish were commercially harvested for winter dog food. Since the replacement of dog teams with snowmachines, sheefish are harvested to a lesser extent with rod and reel in summer and are caught incidentally in fish wheels and nets through the fall. In 1984, residents of Telida were believed to utilize sheefish more than other Upper Kuskokwim communities harvesting them in nets from Highpower Creek.

In 1984, McGrath fishermen harvested an estimated 2,500 whitefish and 300 sheefish. In 1984, Nikolai harvested an estimated 167 whitefish and 4 sheefish; a second survey in 2002 documented an estimated harvest of 386 whitefish (676 edible pounds) and 181 sheefish (997 edible pounds). Harvest numbers for Telida and Takotna are not available.

Local reports from 1980 and 1984 suggested that whitefish populations in the upper Kuskokwim River were in severe decline. In 2001, residents of Nikolai and Telida again stated that whitefish numbers were in decline. They believed it was due to uncontrolled beaver populations, gradual warming trends in the climate, and lower water levels in the area. Residents of Nikolai also suggested that declining numbers of

whitefish could be attributed to changes since the 1964 earthquake and more recent melting of permafrost in some areas.

Discussion and Conclusions

Several notable issues arise from these regional summaries. It seems clear that there is a paucity of information readily available for several regional areas, including the lower Yukon, the northern portion of the Yukon Flats, and the coastal, lower and central Kuskokwim regions. Research projects documenting local or indigenous knowledge and harvest estimates in these areas would provide a more complete picture of subsistence whitefish fisheries throughout the two drainages. This would provide a basis for more interdisciplinary work that integrates biological investigations, which might seek to identify critical habitats using radio telemetry technology, with locally important questions or social science questions about subsistence use patterns and practices. It is important to keep in mind that the estimates of subsistence harvests presented here are point estimates, or "snap-shots" of harvest in a single year, rather than a time series or an average harvest among years. Additionally, previously documented harvest estimates frequently lumped whitefish species into size or other categories instead of by species, which limits their utility. Species identification can be difficult and not all fishermen can or do make the same distinctions between species as fisheries biologists. Given the differences in the life histories of whitefish species, and the regional or even community-level differences in how they are harvested and used, species-specific information will be critical to achieve effective, sustainable management of these important species.

Commercial Fisheries

Whitefish species are the targets of major commercial fisheries in many different places in the world. Lake whitefish *C. clupeaformis*, a close relative to our humpback whitefish, are harvested for market in the Laurentian Great Lakes of North America as well as in many smaller lakes across Canada. They are the major commercial species in Great Slave Lake within the Mackenzie River drainage, where lake trout *Salvelinus namaycush* and sheefish are also taken in smaller numbers. Several whitefish species are taken in commercial fisheries in European and Scandinavian countries, where both natural and stocked populations are targeted.

Commercial whitefish fisheries have taken place in Alaska as well. Arctic cisco *C. autumnalis*, a close relative to our Bering cisco, along with least cisco have been taken in a winter commercial fishery at the mouth of the Colville River in northern Alaska beginning in the 1960s. As many as 30,000 to 40,000 Arctic cisco and 20,000 to 30,000 least cisco have been taken each year in that fishery. A local commercial fishery for sheefish in the Kotzebue region has taken place most years since the late 1960s with annual harvests ranging from less than 100 to more than 2,000 fish. Commercial fishing permits are available by application to the ADF&G for both the Yukon and Kuskokwim River drainages where intermittent commercial fisheries have taken place. For example, during the 1980s in the lower Yukon area 300 to 400 sheefish and up to 2,000 other whitefish species were taken each year for sale. During the early 1970s there were commercial fisheries for various whitefish species in two Tanana River drainage lakes; Healy Lake, where up to 2,600 fish were harvested annually, and Lake Minchumina,

where up to 3,200 fish were harvested annually. Commercial whitefish fisheries in the Kuskokwim River exclude sheefish and fishing locations in the Johnson River drainage and in Whitefish Lake. Records of commercial harvests of whitefish species in the Kuskokwim River go back to the late 1970s, with harvest numbers ranging from zero to more than 4,000 fish taken annually for sale. Virtually all of these whitefish commercial fisheries described above have catered to local markets and have not expanded to markets outside of Alaska.

Since 2005, however, there has been a commercial whitefish fishery in the Yukon River delta region and the catch is being marketed in New York City. The permits have allowed a combined total harvest of up to 10,000 pounds of miscellaneous whitefish. The 10,000 pound harvest cap for whitefish was based on the historical commercial harvest information from 1980-1990 of sheefish and other whitefish species in the lower Yukon area. The exact dates of this fishery have varied somewhat each year, but, it has always taken place in the fall (Table 10). Gear restrictions implemented during the 2007 whitefish commercial fishery reduced the maximum stretch-mesh size from 6 inches (allowed in 2005 and 2006) to 4 inches. The gear restriction was implemented to target cisco species and to reduce fishing pressure on the larger older fish. ADF&G collects baseline age, sex, and length (ASL) data on this harvest. The market for this fishery has the potential to expand if it is allowed to do so.

Table 10. Commercial whitefish harvest (number and pounds) in the lower Yukon River, 2005-2008.

Year	Dates	Fish	Pounds	No. Fishers
2005	Oct 15-28	3,246	6,506	13
2006	Sept 8-21	6,901	11,263	19
2007	Sept 26-Oct 1	4,615	9,002	23
2008	Sept 22-Oct 2	9,337	10,072	16

Management

Management of whitefish species in the Laurentian Great Lakes of North America, Great Slave Lake, and other smaller lake systems in North America and Europe have usually been based on an understanding of population biology, harvest data, and annual assessments of relative abundance and recruitment. Large or isolated lake systems encompass entire populations of fish (juvenile and mature, young and old) so it is possible to develop representative sampling projects to monitor populations. With this type of information harvest levels can be adjusted based on the results of the monitoring programs. Commercial harvests of lake whitefish in the Laurentian Great Lakes have been monitored since the late 1800s, providing a tremendous historical perspective of those fisheries. Harvests in Lake Michigan, which is the sixth largest freshwater lake in the world based on surface area (22,300 sq. miles, about 2/3 the area of the Yukon Delta National Wildlife Refuge), have seen tremendous fluctuations over the years, ranging from less than 500,000 lbs to over 7,000,000 lbs. Fishery management plans for the lake have been developed over the years to guide fishing effort based on historical relationships between relative abundance, recruitment, and harvests.

Management of whitefish fisheries in the Yukon and Kuskokwim River drainages consists of general sport fishing regulations for sheefish, some timing and gear

restrictions associated with subsistence fisheries, and permits with some harvest guidelines and location restrictions for commercial fisheries. Data required for more informed management strategies are not yet available. Many important aspects of whitefish biology, as they apply to populations in large rivers, are poorly understood. Species specific harvest data are very rare. And finally, we have not developed methods of sampling to determine relative abundance or recruitment of whitefish populations.

An exception to these generalizations has been the spear fishery for humpback whitefish and least cisco in their spawning grounds on the Chatanika River at the Eliot Highway crossing. This fishery began in the 1970s as a small-scale food fishery for Fairbanks residents following its discovery shortly after the Eliot Highway was completed in 1959. Easy access for the Fairbanks population allowed the spear fishery harvest to grow from an estimated 1,500 fish in 1977 to over 25,000 fish in 1987. A series of spawning population estimates with age and length assessments in the 1980s and early 1990s revealed that the humpback whitefish and least cisco populations were declining. Undoubtedly the fishery played a role in the decline, but, there was also age and size structure evidence of recruitment failures. The fishery was initially reduced and then closed entirely in 1994 for a number of years to allow the stocks to rebuild. A fishery management plan was developed for the Chatanika River fishery that established prerequisite spawning population levels of 10,000 humpback whitefish and 40,000 least cisco before the fishery could be reopened. In 2007 a limited spear fishery was allowed again on the Chatanika River by permit only, with a maximum of 100 permits issued for the harvest of 10 fish for each permit.

Several qualities of the Chatanika River spear fishery are unique among whitefish fisheries in the Yukon and Kuskokwim River drainages making it both risky for the humpback whitefish and least cisco populations that are targeted and manageable by the Alaska Department of Fish and Game. The fishery itself takes place on the spawning grounds where a large fraction of the mature component of these populations concentrates each fall. The accessibility of the fishery to a relatively large urban population exposes it to potentially unsustainable harvest levels, a situation that requires active monitoring and management. The stock-specific nature of this fishery and its accessibility to the city of Fairbanks are the same qualities that allow the fish populations to be monitored and regulated as well. At this time, no other whitefish fisheries within the Yukon or Kuskokwim River drainages are similarly managed.

Annotated Bibliography

Yukon River

Yukon Flats

Adams, F.J., T.L. Tanner, and M. A. Nelson. 2005. Harvest and biological characteristics of the subsistence fishery in Arctic Village, Alaska, 2001-2003. U.S. Fish and Wildlife Service, Alaska Fisheries Data Series No. 2005-18, Fairbanks.

Describes and quantifies the subsistence fishery of Arctic Village between 2001-2003, based on post-season user surveys and some biological sampling. Residents of Arctic Village have expressed concerns about declines in harvests of whitefish which is significant given that whitefish comprise a significant component of the subsistence fish diet, lacking an appreciable harvest of salmon. The study was designed to describe gear types and harvest areas, estimate annual harvest levels, and document sharing patterns, comparative harvest levels with the past and current perceptions of fishing quality. According to the survey, humpback whitefish comprised the largest number and weight of all species harvested at an estimated 10,944 fish (11,230 kg). While harvests of most included species remained similar to 1973 harvest levels, whitefish harvests increased 32-85% during 2001-2003, depending on the species. Gillnets were the most productive gear types and the Chandalar River and Old John Lake were the most productive sites for broad whitefish and humpback whitefish, respectively. There are methodological questions not answered in the text regarding the sampling which allowed community estimates; additionally, there was difficulty in distinguishing between whitefish species and life stages by local residents. Authors suggest that further study on the life histories and behaviors of harvested species, as well as periodic estimates of harvest (including the development of accurate conversion factors) and documentation of use patterns will foster a better understanding of the fishery by users and resource managers.

Andersen, D. B., and C. L. Fleener. 2001. Whitefish and beaver ecology of the Yukon Flats, Alaska. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 265.

The researcher interviewed 15 residents of Fort Yukon and Beaver, documenting information on whitefish life histories, seasonal movements, diet, spawning areas, population trends, and local whitefish taxonomies in the Yukon Flats region. Gwich'in Athabaskans in this region had distinct terms for Broad whitefish (chihshoo), humpback whitefish (neeghan), round whitefish (khaltai'), least ciscos (ch'ootsik), Bering ciscos (treeluk) and sheefish (shyrah), which was not considered a species of whitefish. This study also mapped local fishery locations and recorded methods of harvesting and preserving whitefish. Whitefish were said to be used primarily for human food followed by dog food and occasionally as trapping bait.

Residents of the Yukon flats indicated that a combination of factors was responsible for decreased numbers of whitefish in recent years. The main factors were entrapment in beaver dams, which were no longer destroyed as they had been pre-1940s, a historically high beaver population in the area, a lack of flooding to push whitefish out of lakes and streams, warming trends causing lakes to dry up, and reduced rainfall in recent years. The author recommended further research into environmental changes in areas that serve as bottlenecks for whitefish populations, and into possible strategies for facilitating whitefish movement through these bottlenecks.

Caulfield, R. A. 1983. Subsistence land use in the upper Yukon Porcupine communities. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 16, Fairbanks.

This paper documents wild resource use in the Yukon Flats villages of Arctic Village, Birch Creek, Chalkyitsik, Fort Yukon, and Venetie. The lowland hydrography of the Yukon Flats is said to provide particularly good habitat for muskrat, beaver, whitefish and waterfowl. All five villages utilize whitefish. Some may be more reliant than others, based on location and availability of salmon runs. A 1960 study recorded an estimated annual harvest of 4,000 whitefish and sheefish in Chalkyitsik. Whitefish can be harvested year-round in some locations. The main gear used were gillnets (sometimes set under the ice) and fish wheels, with some traditional use of small fish traps. Interviews documented some changes to whitefish populations and environment in the early 1980s. Some declines in whitefish were linked to traumatic events in tribal oral history, such as a dual between two shamans in the Venetie area. Other declines were linked to the drying of lakes and changes in vegetation. This study also mentions traditional beaver dam control efforts near Chalkyitsik, that are not as commonly practiced today.

Caulfield, R. A., W. J. Peter, and C. Alexander. 1983. Gwich'in Athabaskan Place Names of the Upper Yukon-Porcupine Region, Alaska: A Preliminary Report. Alaska Department of Fish and Game, Division of Subsistence, Juneau, Technical Paper No. 83.

This short report documents placenames in the Upper Yukon-Porcupine region, including place names related to fisheries. Place name data are valuable sources of information about the relationships between people, land, and animals; they also provide information about the history and cultural life of residents.

Nelson, R. K. 1973. Hunters of the Northern Forest: Designs for Survival Among the Alaskan Kutchin. Chicago: The University of Chicago Press.

The author conducted field work in Chalkyitsik, Hughes and Huslia in 1969-1970 and part of 1971, recording observations on resource use by both Gwich'in and Koyukon Athabaskans. This book focuses mostly on resource use by Gwich'in Athabaskans of Chalkyitsik in the Yukon Flats. Chalkyitsik is advantageously positioned to exploit the fall run of whitefish as it descends Chalkyitsik Creek to enter the Black River, near the

village. This run is generally abundant with whitefish as are certain lakes near the village, such as one called Cha'atritt. Whitefish and sheefish were noted to be most important to the local economy at Chalkyitsik after chum and silver salmon. The author discusses fishing methods and gear and documents the recent transition from an elaborate system of fish traps and fences to cotton or nylon nets.

One unique sluice trapping method, used to catch whitefish exiting the lakes above Chalkyitsik Creek, was still employed. This run typically arrives in September and usually consists of the smaller whitefish, about a foot long. He also documents the use of beaver dams as a trapping method. The author covers some uses and methods of cooking whitefish. He also emphasizes that fluctuations in resource abundance are common in this area and in 1969, there were almost no fish of any species in the area, in rivers or in lakes. The Chalkyitsik Creek run of whitefish "failed completely" that year. Some fishermen had commented that whitefish used to be larger in this region.

Osgood, C. 1936. Contributions to the Ethnography of the Kutchin. Yale University Publications in Anthropology Number 14. London: Yale University Press.

The author conducted field research in 1932, traveling down the Yukon River from Dawson to Fort Yukon, recording his observations of the Peel River, Crow (Porcupine) River, and Fort Yukon Athabaskans. The author observed that whitefish were of primary importance to the Peel River people in the way that salmon are valued by Crow River people. His observations of fishing in the Yukon Flats conveyed that "lake whitefish" and "river whitefish with a crooked back" were harvested seasonally through the use of dipnets, weirs, and wicker traps. The traps were made by men and women and usually required about 6 men to install them in swift but shallow water (around 2 to 4 feet deep). Dipnet fishing generally took place in the evening. The ethnography includes further discussion of fishing techniques and comparisons between the Peel and Crow River fisheries.

Slobodin, R. 1981. Kutchin. In Subarctic. June Helm, ed. pp. 514-532. Handbook of North American Indians, Vol. 6. Washington, D.C.: Smithsonian Institution.

This chapter of the Handbook series describes the history and culture of Gwich'in people. It describes the harvest of whitefish species with post and with weir/basket traps, bone hooks, gill nets, leisters.

Sumida, V. A. 1988. Land and resource use patterns in Stevens Village, Alaska. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 129, Fairbanks.

Drawing on household surveys, resource use area mapping, key respondent interviews, and a literature review, this report describes contemporary patterns of the harvest and use of fish and wildlife resources by the residents of Stevens Village, based on research conducted in 1984-85. Whitefish species are harvested between late May and into December while sheefish are mostly targeted between August and early November,

with less harvest pressure in the early summer months of June and July. The contemporary harvest of whitefish and sheefish echo historic patterns developed in response to seasonal migrations and localized movement. A major component of the annual harvest is taken in the summer with fishwheels while lesser amounts are taken with nets in sloughs in the fall or under the ice in winter. 73% of Stevens Village households harvested whitefish (4,771 lbs.) while 47% harvested sheefish (1,434 lbs). High percentages of whitefish and sheefish harvests were fed to dogs (72% and 78% respectively). Whitefish of various species, but lumped together, accounted fro 52% of the freshwater fish harvest, while sheefish accounted for 16%.

Sumida, V. A. 1989. Patterns of fish and wildlife harvest and use in Beaver, Alaska. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 140, Fairbanks.

This study documents the harvest and use of subsistence resources by Beaver residents in 1984-5. Whitefish are generally harvested from late March through November with concentrated effort beginning in late May. Sheefish are harvested beginning in late May and going through early November, with concentrated effort from June through early September. 42% and 19% of Beaver households participated in harvesting whitefish and sheefish respectively. Beaver residents reported harvesting 3,058 lbs of whitefish (about half of which was fed to dogs) and 218 lbs of sheefish (approximately 10% was fed to dogs). Most freshwater fishing occurred in sloughs off the Yukon River and in the lakes and tributary systems in the area including the Elbow, Mud, and Twin lakes and Marten, Howard, Elbow, and Joe Guay sloughs. The Hodzana and Hadweenzic rivers and Beaver and Fish creeks were among the tributaries used for harvesting freshwater fish. Nets and traps remain the most common way to harvest whitefish and sheefish.

Sumida, V. A. and D. B. Andersen. 1990. Patterns of fish and wildlife use for subsistence in Fort Yukon, Alaska. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 179. Fairbanks.

This research combined household surveys, updated land use mapping, and socio-economic data to produce a quantitative complement to earlier ADF&G research in 1983 (Caulfield 1983). Several types of non-salmon fish were utilized by Fort Yukon residents including several whitefish species, cisco (locally known as “herring”), sheefish which were traditionally harvested using fish weirs and basket traps, gill nets, dip nets of spruce root or babiche, hook and line, and spears (Slobodin 1981516; Osgood 1970:35). Contemporary gear includes traps, hook and line, set net and fishwheels. Larger whitefish species, including sheefish, are harvested with nets during the spring and fall months and also incidentally in fishwheels, while a run of cisco is targeted with small mesh net just prior to the king run and again following the coho run in the fall. Whitefish and sheefish were harvested with under the ice nets and jigging through the ice during the winter months. Whitefish counted as one of the top five resources used by Fort Yukon residents, with 79% of households reporting that they used whitefish during the survey year (while 45% reported using sheefish). Fort Yukon residents reported harvesting

18,732 whitefish equaling 35,030 lbs; though Fort Yukon residents did distinguish between larger whitefish species and cisco in their harvest practices, these were not surveyed separately. 2,966 (17,793 lbs) sheefish were also reported harvested. Significant levels of sharing exist between Fort Yukon households: only 38% and 28% of households reported harvesting whitefish and sheefish respectively while 79% and 45% of households reported using them. Whitefish and sheefish together accounted for approximately 9-10% of the total subsistence harvest. Approximately 10% of the whitefish harvest was used for dog food.

Upper Tanana

Case, M. F. 1986. Wild resource use in Northway, Alaska. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 132, Fairbanks.

This paper documents baseline subsistence use of fish and wild resources in the interior community of Northway. Unlike most predominantly-Athabaskan communities, Northway has no access to salmon-bearing streams nearby, and as a result, primarily targets whitefish. Moose and whitefish are said to be Northway's subsistence staples. Residents fish for whitefish with dipnets at weir sites located within 10 miles of the village, or catch whitefish in gillnets. One fish wheel was also used for catching whitefish in the late 1970s. At least four different Athabaskan groups use the lands near Northway. Dipnet sites conform to traditionally-used whitefish fishing spots; families tend to fish in areas formerly used by their predecessors or band members for whitefish. Family allotments have discouraged some users from returning to traditional whitefish fishing spots. Whitefish are used for food, as well as to barter with Copper River Athabaskans for salmon. Between the Fall of 1984 and Spring of 1985, active fishing households in Northway harvested 371 pounds of whitefish. This paper is mostly intended to describe land use patterns by residents of Northway, but discusses the importance of whitefish within the Chisana and Nabesna rivers in the Upper Tanana River drainage.

Guedon, M. 1974. People of Tetlin, why are you singing? National Museums of Canada, Ethnology Division, Mercury Series, Paper No. 9.

An ethnography of Athabaskan tribes of the Upper Tanana area, this paper focuses primarily on kinship systems but also describes subsistence use of wild resources. Whitefish are said to provide most of the fish reserves of people living in this area. Residents utilize fish weirs in certain locations in conjunction with fish traps and dip nets. The use of small gillnets was also said to be increasing. The paper describes a method of driving fish with willow branches toward gravel dams in shallow creeks. Residents target whitefish during the start of their run in July, but also catch them throughout the year in various streams and lakes. Particular whitefish harvest locations are identified by name and on maps. The paper includes useful information about whitefish use in the Upper Tanana/Tetlin area.

Halpin, L. 1987. Living off the land: contemporary subsistence in Tetlin, Alaska.

Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 149, Fairbanks.

The report discusses whitefish without species specific distinctions and does not mention sheefish. The author describes the importance of whitefish for subsistence for the people of Tetlin and the old village of Last Tetlin. The report describes gear types used to harvest whitefish, methods of preserving and eating fish, use for dog food, and harvest levels for the 1983-84 seasonal round. The report indicates that the villages were established in their current locations because of the presence of whitefish weirs. In addition to the weirs, the report outlines other traditional fishing locations and their names in the local Athabaskan dialect. The report includes a map of gear types used in fishing locations between 1974 and 1984. The maps do not specify the species harvested.

Haynes, T. L., M. Case, J. A. Fall, L. Halpin, and M. Robert. 1984. The use of Copper River salmon and other wild resources by Upper Tanana communities, 1983-1984. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 115, Fairbanks.

This report provides background information designed to assist the Board of Fisheries in identifying customary and traditional uses of the Copper River salmon fishery and also describes the participation of Upper Tanana communities in a seasonal round of other resources, including whitefish species. According to this study, 80% of Tanacross households, 85% of Tetlin households, and 87% of Northway households participated in harvesting whitefish. Authors also include information about harvest areas by community, which were mostly targeted in June and July and to a lesser extent throughout the fall and early winter months.

Marcotte, J. R. 1991. Wild fish and game harvest and use by residents of five upper Tanana communities, Alaska, 1987-88. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 168, Fairbanks.

This study summarizes the results of a household survey of subsistence resources conducted in Dot Lake, Tanacross, Tok, Tetlin, and Northway. In general, residents of these communities averaged approximately 183 pounds per capita of wild resources, with the largest contributions coming from moose and whitefish. In addition to the larger whitefish species, round whitefish and least cisco are also available in the Upper Tanana. Fishermen rely on local knowledge to know when best to target their harvests; the concentrated movement of whitefish along area streams and rivers, especially during June and July from lakes to the main stem of rivers, returning in August. In terms of quantifiable harvest, whitefish estimates are not divided by species. Together, the five communities harvested an estimated 31,056 whitefish (individuals) which represented approximately 39 pounds per person. They also harvested an estimated 293 sheefish, representing .6 pounds per person.

Martin, G. 1983. Use of natural resources by residents of Dot Lake, Alaska.

Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 19, Fairbanks.

This study describes the harvest and use of wild resources by Dot Lake residents during 1982. Four species of whitefish are found in the Dot Lake vicinity: Broad whitefish, humpback whitefish, round whitefish, and pygmy whitefish; individual lakes and tributaries are locally indexed based on the kind and quality of whitefish found there. Historically, Dot Lake residents used weirs in conjunction with fish traps or dip nets to harvest large quantities of whitefish in July as they moved from lakes into the Tanana River. A family could harvest 300 to 400 whitefish using this method. This study provides an excellent description of these historical weirs, traps, and dipnetting techniques. In 1982, four family fish camps were in operation, situated near good net sites which include places where the water is approximately 6 to 8 feet deep and moves slowly. Whitefish are cut, smoked, and dried and then stored for winter. Often their stomachs are rendered down into oil used for dipping. This study did not estimate harvest for Dot Lake residents.

Robinson, M. A. 2005. Linking local knowledge and fisheries science: the case with Humpback whitefish (*coregonus pidschian*) in Interior Alaska. Masters Thesis. University of Alaska Fairbanks.

This thesis investigates connections between local knowledge of humpback whitefish in the Upper Tanana (Northway) and western biological science. Robinson worked with research biologists and local residents alike to investigate local concerns and gaps in the scientific knowledge, including insights into long-distance migrations, small-scale use of creeks and channels by humpback whitefish, annual site fidelity, and repeated long-term use of seasonal habitats through investigations that focused on gendered knowledge, local observations and harvest patterns, leading to questions about the behavioral response of whitefish to increased sedimentation and water temperature.

Shinkwin, A., and M. Case. 1984. Modern foragers: wild resource use in Nenana Village, Alaska. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 91, Fairbanks.

This report documents the harvest and use of wild resources by residents of Nenana. As part of the annual cycle, Nenana residents harvest whitefish species during the summer generally as a by-catch in summer fish wheels targeting salmon. In the fall before ice up and in the spring after break up, fishermen set nets for whitefish and also set lines or use hook and line through the ice in the winter. Whitefish are highly valued as a spring food and were often an important food source when other species were less available.

<u>Middle Yukon</u>

Case, M. F., and L. Halpin. 1990. Contemporary wild resource use patterns in Tanana, Alaska, 1987. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 178, Fairbanks.

This study provides a baseline description of the harvest and use of subsistence resources, including whitefish, by residents of Tanana in 1987. Researchers found that many Tanana families would still "spring out" to spring camps to trap and fish, setting nets under the ice for whitefish. Researchers documented a seasonal round for subsistence resources, including whitefish and sheefish, which were harvested from April through December. Approximately 30% of Tanana households harvested whitefish and sheefish with 24,918 (87,212 lbs – more than king salmon by weight that year) whitefish and 5,250 sheefish (34,127 lbs) harvested. The report notes the primary subsistence use of whitefish and sheefish was for dog food: 92 percent of whitefish, and 87 percent of sheefish harvested were fed to dogs. Interestingly, Tanana residents reported harvesting only humpbacks and cisco, referred to locally as "shiners"; however, whitefish harvest estimates are lumped into one category.

Loyens, W. J. 1966. The Changing Culture of the Nulato Koyukon Indians. P.h.D. Thesis, Department of Anthropology, University of Wisconsin, Ann Arbor.

The author conducted ethnographic fieldwork through the Catholic mission at Nulato between 1962 and 1966. Most of his description of the Nulato fishery concerns salmon harvest, but some of this information also pertains to whitefish. The author observed that Lower Koyukon Athabaskans, including Nulato residents, prohibited the use of any kind of metal in the harvest or processing of fish. An ulu knife, called a *tlamas*, could not be used to cut a fish until a day after it was caught. Fishing by rabbit sinew nets, dipnets, fences, weirs, spears and traps was described. Large traps were placed on the Yukon River in summer and winter. Nulato residents fished for whitefish using several smaller traps placed simultaneously by fences that crossed smaller tributaries. Multiple families would fish for whitefish collaboratively. Dipnets used for whitefish were 6 feet long, shorter than salmon dipnets. The report draws heavily on work by a former Catholic missionary named Jette, but itself contains little information on the whitefish fishery.

Marcotte, J. R. 1990. Subsistence harvest of fish and wildlife by residents of Galena, Alaska, 1985-86. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 155, Fairbanks.

Documents the harvest and use of subsistence resources by Galena residents in 1985-6, including an account of the historic seasonal round throughout the late 1800s and early 1900s, in which whitefish species were harvested all year long, but primarily in the summer, fall and winter months. Today, whitefish species are targeted between late May through January, except for a brief period during freeze-up. In 1985-6, Galena residents reported harvesting an estimated 10,402 whitefish and 519 sheefish. Most of the whitefish harvested by Galena residents were either humpback whitefish or broad whitefish, though they also harvested smaller amounts of small whitefish, including Bering cisco, least cisco, and round whitefish; as a result, they are lumped together in this report. These species were largely harvested as incidental catch in fishwheels or targeted

in spring and fall set nets in open water, or under the ice nets in the winter. Whitefish provided the largest volume of subsistence fish after salmon. Use patterns indicate significant sharing practices. While only 19% of households reported harvesting whitefish, 45% of households reported using whitefish species. Overall, whitefish harvests represented 6% of the total subsistence harvest by Galena residents and 78% of the total whitefish harvest was fed to dogs.

Koyukuk River

Andersen, D. B. 2007. Local and Traditional Knowledge of Whitefish in the Upper Koyukuk River Drainage, Alaska. U.S. Fish and Wildlife Service, Office of Subsistence Management. FIS Report 04-269.

In 2006, the researcher returned to the Upper Koyukuk where he had surveyed residents on non-salmon subsistence fishing in 2003. In 2006, he interviewed residents of Allakaket and Hughes about whitefish in the Upper Koyukuk and Kanuti Rivers. This Upper Koyukon Athabaskan area is culturally distinct from the Alatna region to the west, where many local residents have Inupiaq heritage. Therefore, the study investigates Koyukon Athabaskan taxonomies of whitefish, but does not cover all of the local taxonomies of the Upper Koyukuk area.

Because of the scarcity of other resources in the Upper Koyukuk, whitefish, waterfowl and small game figure prominently in the local subsistence diet. Alatna, Allakaket and Hughes collectively harvested approximately 37,600 pounds of whitefish in 2002, which equates to about 400 pounds of whitefish per household. The interviews revealed that residents of Hughes and Allakaket did not know Bering cisco to occur in the Upper Koyukuk, thus harvest data for Bering cisco from 2002 probably actually refers to least cisco. Round whitefish were infrequently seen and a cultural belief held that these were only to be eaten by elders. Most of the local harvest is made up of Broad and humpback whitefish.

The report covers whitefish seasonal movements, fishing methods and gear, uses of whitefish and perceptions of the health and abundance of whitefish in this area. Maps included in the report show whitefish harvest locations, distinguished by gear type. They do not differentiate between the whitefish species harvested.

Andersen, D. B., C. L. Brown, R. J. Walker, and K. Elkin. 2004. Traditional Ecological Knowledge and Contemporary Subsistence Harvest of Non-Salmon Fish in the Koyukuk River Drainage, Alaska. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 282.

In 2002, the authors conducted a subsistence harvest survey of non-salmon fish in the Koyukuk River drainage villages of Alatna, Allakaket, Bettles/Evansville, Hughes, Huslia and Koyukuk. Between 2001 and 2003, they conducted TEK interviews in the same Koyukuk River villages as well as the community of Wiseman.

Through the surveys, the researchers learned that local residents harvest more whitefish than any other non-salmon species (in edible pounds). Drainage-wide, this

accounted for 63,209 lbs (or 24,187 fish) in 2002, an estimated 86% of the total harvest of non-salmon species. Allakaket harvested an estimated 13,134 pounds, Alatna harvested an estimated 725 pounds, Bettles/Evansville harvested 0, Hughes harvested an estimated 23,802 pounds, Huslia harvested an estimated 21,408 pounds, and Koyukuk harvested an estimated 4,140 pounds of whitefish. These estimates were further broken down into how many Broad whitefish, humpback whitefish, and Bering and least cisco were harvested.

Sheefish were treated separately in the survey and accounted for an additional 19% (17,713 lbs or 2,953 fish) of the drainage's non-salmon harvest. Allakaket harvested an estimated 8,778 pounds, Alatna an estimated 78 pounds, Bettles/Evansville 65 pounds, Hughes 1,078 pounds, Huslia 5,410 pounds, and Koyukuk harvested an estimated 2,304 pounds of sheefish in 2002.

Through interviews, the researchers recorded local knowledge about whitefish and sheefish movements, life histories, diets, run timing, spawning movements, health and population changes, and traditional and modern practices of harvesting, preserving and using sheefish and whitefish. The authors provided baseline information on several aspects of non-salmon subsistence harvest in each village. The study discusses how people of this drainage rely heavily on whitefish for human and dog food, and have preserved many traditional practices in their harvest and use of whitefish.

Marcotte, J. R. 1986. Contemporary resource use patterns in Huslia, Alaska, 1983. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 133, Fairbanks.

The study looks at subsistence use of wild resources in Huslia on the Koyukuk River, where the author conducted a harvest survey with 56 participating households. In 1983, the community harvested 4,650 whitefish and 873 sheefish. Whitefish information was not species specific. Whitefish were second to summer chum in highest numbers of fish harvested. In edible pounds, sheefish were the second highest number harvested and whitefish the fourth (based on an estimate of 7 lbs per sheefish and .9 lbs per whitefish). Whitefish harvest locations were within an average of eight miles of the village, and sheefish locations were within eleven miles. Twelve fish camps were in active use in 1983. The report includes a map of non-salmon fishing locations; but not whitefish locations exclusively. Some whitefish locations may be mentioned in the narrative.

Marcotte, J. R., and T. L. Haynes. 1985. Contemporary resource use patterns in the upper Koyukuk Region, Alaska. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 93, Fairbanks.

Marcotte and Haynes provide a focused examination of contemporary resource use patterns in the Upper Koyukuk region during the two-year period of 1982-3 by residents of Allakaket, Alatna, Bettles, Evansville, and Hughes. Whitefish species are harvested between early May and late November in these communities; approximately 70-80% of Allakaket, Alatna, and Hughes households reported harvesting whitefish species. Together, fishermen in all five communities harvested approximately 7,203 whitefish in 1982-3.

Nelson, R. K. 1983. Make Prayers to the Raven: A Koyukon View of the Northern Forest. University of Chicago Press. Chicago.

The author recorded observations of Koyukon Athabaskans in Huslia and Hughes from his visits there in 1968, 1970—72 and his field work there in 1976—77. The author notes that five species of whitefish are present in this area: Broad whitefish or *taasiza*, least cisco or *tsaabaaya*, Alaska whitefish (*c. nelsonii*) or *holahga*, round whitefish or *hultin*, and sheefish, or *nidlaagha*. Another whitefish, about six inches long and with bluish scales, possibly a juvenile Broad whitefish, is called *biltibidza*. The author describes the seasonal migrations of whitefish into lakes and streams in the summer and back out each fall. A resident lake population has also been observed, which elders say spend the winters hanging vertically in the water, with mouths pointed downward, and barely moving.

Whitefish were harvested with the use of nets and hooks, the most abundant time to harvest being at dusk a couple of days before freezeup. Historically Koyukon people would celebrate the first whitefish caught each spring, as it symbolized the end of winter hunger. In cooking and eating the fish, care was taken to keep ribs, bones and backbone intact, as a disassembled skeleton was considered a bad omen. The author also covers some natural history information about whitefish and states that cyclical floods are considered necessary to maintaining healthy fish populations.

Strong, B. J., and E. W. McIntosh. 1985. Progress report: resource harvest by local residents of the upper Koyukuk Region in 1984. U.S. Fish and Wildlife Service, Kanuti National Wildlife Refuge, Fairbanks.

This research was done in conjunction with the Marcotte & Haynes subsistence report in 1985. Over 80% of households in Bettles/Evansville, Alatna and Allakaket were surveyed by Kanuti National Wildlife Refuge staff about their subsistence harvests from 1984. Seining for whitefish by Alatna and Allakaket residents took place on the Alatna River, upriver from the Siruk Creek confluence and on the Koyukuk River. Bettles/Evansville residents set nets in the Koyukuk River downriver of Bettles and at the confluence with the Koyukuk River's South Fork. Residents of Bettles/Evansville also fish for all non-salmon species with rod and reel. Sheefish were caught with setnets and "hooking" (including rod and reel). In Allakaket and Alatna 66.7% of households harvested sheefish in 1984. In Allakaket, 52.1% of households harvested whitefish. In Bettles/Evansville, most households fished for grayling and pike. The estimated total community sheefish harvests were 1,786 sheefish in Allakaket/Alatna and 14 sheefish in Bettles/Evansville. The estimated whitefish harvests were 3,282 whitefish in Allakaket/Alatna and 0 whitefish in Bettles/Evansville. Because one household could not estimate the number of whitefish harvested, the Allakaket/Alatna estimate is believed to be low. The 1984 whitefish harvest in Alatna/Allakaket was lower than the 1983 and 1982 harvest estimates, which were 11,610 and 4,858 whitefish, respectively. Bettles did not harvest whitefish in 1983 but harvested 210 whitefish in 1982. Fishing effort in Alatna/Allakaket was reported to be higher in 1984 than in 1983.

GASH

Brown, C., J. Burr, K. Elkin, and R. J. Walker. 2005. Contemporary subsistence uses and population distribution of non-salmon fish in Grayling, Anvik, Shageluk, and Holy Cross. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 289, Fairbanks.

This report combines traditional ecological knowledge (TEK) on non-salmon species in the lower-middle Yukon and Innoko Rivers with a harvest survey and pike sampling project on the lower-middle Yukon. The research involved the communities of Grayling, Anvik, Shageluk and Holy Cross (known as the GASH area), where researchers interviewed local fishermen and elders on their knowledge of the life histories, diets, seasonal movements, population status, cultural significance and subsistence harvests of whitefish and sheefish. The researchers asked about five species of whitefish (Broad whitefish, humpback whitefish, round whitefish, least cisco and Bering cisco), and found that Broad whitefish were most commonly and heavily harvested in all four communities, and round whitefish were not harvested by any. Whitefish proved to be harvested more heavily than other non-salmon species in the region. A taxonomy of Deg Xinag and Holikachuk Athabaskan words for whitefish and sheefish was also compiled, showing that people in the GASH area have distinct terms for lake whitefish and whitefish fry. Lake whitefish are considered a separate species by many local fishermen familiar with whitefish. The report also described traditional and current gear types and methods of harvesting whitefish. The report outlines subsistence harvest and use of whitefish by community. Overall harvest estimates for Grayling were 4,529 whitefish and 783 sheefish in 2002. Anvik's estimate was 1,434 whitefish and 378 sheefish. Holy Cross harvested an estimated 639 whitefish and 7 sheefish, and Shageluk caught an estimated 2,688 whitefish and 839 sheefish. Whitefish harvest totals were further broken down by species harvested. Maps included in the report show the harvest locations for whitefish and sheefish by each community. Exact species of whitefish are not distinguished on the harvest maps, implying that different whitefish species are caught in the same general areas.

Osgood, C. 1940. [1970 edition.] Ingalik Material Culture. Yale University Publications in Anthropology. No. 22. Reprinted by Human Relations Area Files Press. New Haven.

The author conducted field research in Anvik and Shageluk in 1934 and 1937. In this first published volume of his ethnographic observations, he describes the material objects used by the "Ingalik" Athabaskans of this region. Contains a detailed description of a whitefish trap for summer use, composed of three sections, the last section of which could be removed from the trap like a basket to empty out whitefish without having to pull out the entire trap. The name of this trap translated to "can take it out." Also describes the fence used to block a slough near Shageluk, used in conjunction with several large fishtraps from August until freezeup for catching whitefish. A winter trap primarily used for harvesting loche but also useful for catching whitefish in the spring after breakup was described. A fish rake was used to empty fish from this trap, in observance of a taboo against touching the fish. The author believed this to be the only

trap where such a rule existed. The report contains illustrations of the traps and photos of winter fishing in the Anvik-Shageluk area.

Osgood, C. 1958. Ingalik Social Culture. Yale University Publications in Anthropology. No. 53. Department of Anthropology, Yale Universtiy. New Haven.

In his second volume of ethnographic observations, the author focused on social customs of the Anvik and Shageluk people. Describes use of the summer whitefish trap, placed near a fence in swift water, either in the Yukon River or one of its larger tributaries. The trap was held in place with a triangular frame visible above water. Describes the collaborative effort to install the fence, the ownership of fishing spots, the men's custom of whitefish spearing, and the individualized practice of dipnetting by canoe for two species of whitefish in the spring after breakup.

Osgood, C. 1959. Ingalik Mental Culture. Yale University Publications in Anthropology.No. 56. Department of Anthropology, Yale University. New Haven.

In the third ethnographic volume on "Ingalik" culture in Anvik and Shageluk, the author focused on his observations of cultural language, knowledge and beliefs. The author lists the "Ingalik" Athabaskan names and meanings of five varieties of whitefish, emphasizing that these are not easily paired with scientifically-distinguished species of whitefish. The Ingalik classifications of whitefish reflect types that behave and are harvested differently. One type (*ses*) is found in the Innoko but not in the Anvik River because it doesn't like fast water. The oil from this type exhibited excellent burning qualities. Another type (*kodok nei*), with a name reflecting that they don't eat their own young in times of hunger, was reportedly very thin with poor meat in the spring. One type of whitefish (*tayi*) was named for its habit of keeping its head down, and the tails of this kind were usually seen above the water in a lake near Shageluk. Another type (*conle'ga*) which only grows about a foot long and was a popular eating fish, was named for its resemblance to human excrement. A fifth type (*keg or kega*), with a different name if it was large and old than if it was small or recently matured, was only found on the sides of streams and harvested by men during hunting trips.

<u>Lower River</u>

Crawford, D. 1979. Lower Yukon River sheefish study, October 1977-June 1978. Alaska Department of Fish and Game, Division of Commercial Fisheries, Sheefish Investigation No. 9

This study documents the fall/early winter and spring subsistence fishery for sheefish in the lower river villages down river from and including Holy Cross. Researchers combined a harvest survey through catch calendars with interviews with knowledgeable fishermen. In general, under the ice fishing began in mid October when the ice was thick enough to safely walk on, peaked in November (83% of total harvest in

Oct-Nov), and slacked off until May, when it started up again, but not comparable to fall levels. However, catch timing appears to be affected by location on the river; the more upriver communities in the study area did not report substantial harvests until January and later. The reported sheefish catch for the study area from Oct 1977 to June 1978 totaled 3,394 sheefish and the expanded figure could be as high as 5,438; communities at the mouth comprised 85% of the total harvest for the study area. Lower Yukon fishermen also reported harvesting 3,562 whitefish, though species distinctions were not made but included Broad whitefish, humpback whitefish, and Bering cisco; total monthly harvest reports suggest that whitefish arrive slightly earlier than sheefish. Local knowledge suggested several interesting conditions that may affect fishing success such as time of day, tide, wind direction, and how high the water is when the river freezes. Mean sheefish size in the sampling component were 670mm and 7.2 lbs with a roughly equal sex ratio, though most of the females were slightly older. The report concludes that while still an active fishery, the sheefish fishery has declined in effort and quantity due to the shifts away from keeping dog teams and the transition towards a mixed-cash economy where regular employment keeps people from participating in subsistence activities all year long. Suggested future study includes a winter tagging program to understand seasonal movements and answer questions about the locations of spawning and feeding habitats and whether or not these fish represent one stock or mixed stocks?

Pete, M. C. 1986. Contemporary patterns of wild resource use by residents of Russian Mission, Alaska. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 127.

This report describes the patterns of hunting, fishing, trapping, and gathering wild resources by residents of Russian Mission in 1984. According to this study, Russian Mission residents harvest whitefish species in every month of the year, though they are targeted in the spring and the fall, when they are considered best for eating. Sheefish show up first after break-up in May, referred to as *kuigpagtat*, or "ocean run," distinguishing it from sheefish caught at other times of the year. The larger whitefish species are targeted in fall around freeze-up and late winter through early spring. *Arulailkat*, or "ones that have stopped moving around," primarily Broad whitefish resident in land-locked lakes in the Russian Mission area, are targeted in early spring because of their high fat content. Some Russian Mission fishermen also harvested Bering cisco in small whitefish nets (3 5/8 to 4 inch mesh), coinciding with the whitefish harvest. Round whitefish were caught in low numbers, however no whitefish harvest estimates are available for Russian Mission.

Thorsteinson, L. K., P. R. Becker, and D. A. Hale. 1989. The Yukon delta: a synthesis of information. National Oceanic and Atmospheric Administration, Outer Continental Shelf Environmental Assessment Program, Report No. MMS 89-0081.

This paper summarizes information available by 1989 on the ecology of the Y-K Delta region, with emphasis on species and habitats that could potentially be impacted by offshore oil and gas leases. In its chapter on delta fisheries, the paper highlights the commercial fisheries report by Geiger et al in 1983, Bob Wolfe's area subsistence fishery

summary from 1981, and Martin et al's description of whitefish activities in 1986 and 1987. All whitefish subsistence information in this paper comes from Bob Wolfe's 1981 report. In brief, the report states that the fish species harvested in greatest numbers for subsistence in the Y-K Delta is salmon, but cisco, whitefish, sheefish and blackfish follow as the next most numerously-harvested subsistence fish, in that order. The paper also describes a sampling project in 1984 which found that the most abundant subsistence species present under the ice in winter in lower Y-K Delta rivers are sheefish, whitefish and smelt and discusses a 1985 summer sampling effort where sheefish, whitefish and ciscoes totaled 65% of the fish caught in the Lower Yukon drainage. Juvenile fish appear to have been included in the summer sampling study. Harvest areas were spread over coastal, riverine, and lake environments and harvesters captured a total of 44,000 fish, of which 35% were whitefish (not including sheefish and cisco). The paper confirms that whitefish were caught in a variety of environments and that their migrations are complex. It concludes that the mud flats of the Y-K Delta provide important habitat for several varieties of fish food, such as epibenthic crustaceans and other invertebrates that are important food sources for whitefish and sheefish.

Wolfe, R. 1981. Norton Sound/Yukon Delta Sociocultural Systems Baseline Analysis. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 59.

Between 1980 and 1981, the author took part in a subsistence baseline analysis in the study communities of Alakanuk, Emmonak, Kotlik, Mountain Village, Sheldon Point, Stebbins, Hamilton and Bill Moore Slough. These communities were located in an area of potential impact by a proposed offshore petroleum development project in the Norton Sound Basin. The author indicates that Bering cisco, Broad whitefish, humpback whitefish, round whitefish and sheefish are species common to this region; Bering cisco, Broad whitefish and sheefish were the most important non-salmon species in the local subsistence economy in 1980. Like many other fish, these species were harvested for personal use and for commercial sale and trade both locally and in the Siberian trade markets in the past. Between 1980 and 1981 whitefish and cod were substantial components of food production in this region.

Although summer fishing in this region is generally devoted to salmon harvests, spring, fall and winter fishing and camps are designed to maximize the harvest of several resources simultaneously. Thus, hunting for seals or other furbearers often involved setting a net for whitefish in the non-summer months. Although these species are available in the area through most of the year, sheefish were the only whitefish species targeted in the summer, and distinct runs of Broad whitefish and Bering cisco in the fall translated into concentrated efforts to harvest those species during that season. Nets with 4-inch mesh were used for Broad whitefish and 3-inch mesh for Bering ciscos and round whitefish. Round whitefish were occasionally caught by most communities but were targeted by Stebbins residents using basket traps. Sheefish were generally caught using 6-inch gillnets in the river either in the summer or under the ice in winter, with a strong and distinct run during January and February.

Harvest areas for smaller whitefish included smaller rivers, particularly at the mouths, and estuarine sloughs. For larger fish such as Broad whitefish, nets were set in freshwater lakes and streams. Some Broad whitefish migrated out of lakes starting in

September, whereas others that remained in the upriver country could be caught through the winter, although less frequently in January and February. In some communities the author noted a trend where younger fishermen concentrated their efforts on the commercial salmon harvest, and older fishermen were responsible for more of the community's non-salmon harvests. No conservation concerns were noted.

The report contains ample information on the different fisheries of each of the study communities. Maps showing the fishing location and gear used throughout the area were also provided. The report also discusses efforts to create a market for whitefish prior to 1980 and lists local terms and Yup'ik names for the whitefish.

Drainage wide/miscellaneous

Andersen, D. B. 1992. The use of dog teams and the use of subsistence-caught fish for feeding sled dogs in the Yukon River drainage, Alaska. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 210, Fairbanks.

Describes the use of subsistence-caught fish for dog food by Yukon River drainage mushers in Fort Yukon, Huslia, Kaltag, Manley Hot Springs, Russian Mission, St. Mary's and Tanana. Whereas salmon are more heavily used for dog food on the upper Yukon, non-salmon are more heavily used along the lower Yukon. The main non-salmon species harvested on the lower Yukon were lamprey eels, northern pike, and Alaska blackfish. Whitefish and sheefish were used in smaller proportions. For roughly five months between breakup and freezeup, the entire river concentrates on salmon harvest. During this time, a lot of incidental, freshly-caught fish is used to feed dogs, usually non-salmon or salmon scraps. For the remaining seven months dogs are generally fed preserved fish. On the upper Yukon this preserved fish is generally chum and coho salmon. On the lower river, lamprey eels, pike and blackfish make up the bulk of preserved fish, including smaller amounts of whitefish and sheefish. Whitefish can be captured year-round in the lower Yukon and provides a fresh fish source and a break from preserved fish during winter. Methods for preserving whitefish for dog food are briefly discussed in this report and said to be less elaborate than methods for preserving salmon.

Perhaps as much as 62% of the small salmon (summer chum, fall chum and coho) harvested along the Yukon in the late 1980s was used for dog food (approx. 281,000 fish). This study did not collect data on how many whitefish and sheefish were harvested for dog food.

Bryan, J. E. 1973. The influence of pipeline development on freshwater fishery resources of northern Yukon Territory, aspects of research conducted in 1971 and 1972. Pacific Region Department of the Environment, Northern Operations Branch Fisheries Service, Task Force on Northern Oil Development Report No. 73-6 (Information Canada Catalog No. R72-9773).

This study identified the relationship of major fish spawning areas to two potential pipeline projects near the Beaufort Sea and the Porcupine River in the

Northwest Canada. Spawning areas upstream of pipeline corridors were considered more resistant to the adverse effects of effluent discharged into the water during pipeline development than downstream spawning grounds. Spawning areas for burbot, Broad whitefish, Fourhorn sculpin, sheefish, lake whitefish and least cisco occur downstream of the proposed pipeline in the Porcupine drainage. The study found that burbot and four species of whitefish (Broad whitefish, sheefish, lake whitefish and Least Cisco) are important species in the subsistence fishery of the Porcupine River area. The author concluded that there would be more adverse effects to spawning areas in the Porcupine drainage than in the Beaufort Sea region, thereby indicating a Beaufort Sea region pipeline route would likely have less impact on subsistence fisheries. The report includes a brief description of whitefish behaviors on the Porcupine River, a large tributary of the Upper Yukon.

Duffy, L. K., E. Scofield, T. Rodgers, M. Patton, and R. T. Bowyer. 1999. Comparative baseline levels of mercury, Hsp 70 and Hsp 60 in subsistence fish from the Yukon-Kuskokwim delta region of Alaska. Comparative Biochemistry and Physiology. Part C, Pharmacology, Toxicology & Endocrinology 124: 181-186.

In this study, the relationship between mercury (Hg) levels and heat stressor proteins (Hsps) in fish in the Yukon-Kuskokwim Delta was examined to see if the fish exhibited high mercury levels. Subsistence users were concerned that metals left in the water from past mining activities could be causing fish contamination. Subsistence users selected fish sampling sites, and 9 of the 66 fish sampled were whitefish. 4 were sheefish. The study cites an estimate from previous research that 9% of the fish in Western Alaska have mercury levels above 0.5 ppm. Of the Y-K Delta whitefish sampled in this study, none had mercury levels that high. In this study, pike (11 sampled) had the highest mean levels of mercury. Whitefish and sheefish were the next highest with mean mercury levels of 0.163 ppm +/- 0.076 and 0.159 +/- 0.022 respectively. Whitefish showed variable levels of heat stressor protein 70. Sample size was very small and there was no information about the sample season or locations. The reasons subsistence fishers had for selecting those locations was not provided.

Georgette, S. and A. Shiedt. 2005. Whitefish: traditional ecological knowledge and subsistence fishing in the Kotzebue Sound Region, Alaska. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 290, Fairbanks.

The researchers interviewed 57 residents of communities in the Kotzebue Sound region between 2002 and 2004, and recorded a regional taxonomy of Inupiaq terms for whitefish and related fishery information. Researchers examined the importance of whitefish to subsistence and recorded traditional ecological knowledge about subsistence use of five species (Broad whitefish, humpback whitefish, round whitefish, least cisco and Bering cisco). One of the authors had conducted separate studies on sheefish in this region in the 1980s and did not discuss them in this report (Georgette and Loon 1990).

Least cisco are abundant on the lower Kobuk River and prized for their eggs throughout the Kotzebue Sound region. Small-mesh nets (½ inch) are used to catch least

cisco in Ambler, but larger-mesh nets (3-4 inch) are used in nearby villages. The smaller mesh ensures that more cisco are harvested; however, least cisco remain more abundant near Ambler than near other villages. Residents of Kotzebue Sound eat least cisco less frequently today than in the past, when large quantities had been harvested for dog food. Some subsistence users may harvest least cisco just for their eggs. Some people noted that least cisco have small worms (ringworm larvae) in them.

Humpback whitefish are harvested at the same time as least cisco in the fall. Bering cisco were considered an ocean fish, and caught by people whose summer fishing camps were along Kotzebue Sound. Broad whitefish are widely harvested throughout the region in spring and fall. Many prefer to harvest Broads in the spring, when weather is drier and better for processing and hanging, as Broad whitefish tend to be oily and hard to dry. Broad whitefish are typically the last to spawn. Round whitefish are usually found far upstream and were occasionally harvested by residents of the upper Kobuk River and Noatak. These were said to taste metallic, like something left too long in a tin can. When round whitefish are caught, no other fish are said to be around.

The spawning season of whitefish is very important to subsistence users because of the value of their eggs. Spawning seasons of round whitefish and Bering cisco were unknown, but the report described the spawning times for Broad whitefish, humpback whitefish and least cisco. Spawning locations were unknown. Biologists believe that Bering cisco found in the Kotzebue Sound region spawn in the Yukon River. The report described findings from biological studies about the seasonal movements of whitefish within Kotzebue Sound. Movements in the Upper Kobuk mirrored those of the Upper Koyukuk River.

Several subsistence fishers noticed that adult whitefish get rough spots (tubercles) on their scales before freezeup. This was likened to putting on their winter parkas, and informs people that freeze-up is imminent. The report documents local observations on the introduction of beaver to the region and its effects on whitefish. Innovative techniques for catching whitefish (such as gravel ditches), special uses and processing methods and the sale value of whitefish in one Kotzebue Sound community are addressed in this report. The report includes whitefish harvest information for these communities from 1997-2003.

Jones, A. 2006. Iqaluich niginaqtuat = fish that we eat. Anchorage, Alaska: U.S. Fish and Wildlife Service, Office of Subsistence Management, Fisheries Resource Monitoring Program.

The sheefish and humpback whitefish from the Kotzebue Sound area grow slower and larger than whitefish in the more southern drainages of the state. The report documents life histories, seasonal movements, names in the local Inupiaq dialects, usage, harvest methods, methods of processing and recipes for sheefish, humpback whitefish, Broad whitefish, least and Bering cisco, and round whitefish. Very useful source of information on subsistence use of whitefish in Kotzebue Sound, lacking only harvest data and maps. Report contains photographs of all aspects of subsistence whitefish harvest and use in Kotzebue Sound. A project similar to this would be very useful to have for the Y-K Delta.

Nelson, E. and T. Bean. 1887. Field notes on Alaskan fishes with additional notes by Tartleton Bean. Published in *Report on Natural History Collections Made in Alaska between the Years 1977 and 1881. No. III.* H. Henshaw (ed.) Washington: Government Printing Office.

Between 1877 and 1881, Natural historian and ethnographer Edward Nelson collected fish samples from the Bering Sea, the Yukon River, the Kuskokwim River and the Northwest coast of Alaska. In 1887, he turned his specimens over to Dr. Tarleton Bean to sketch, catalog and describe them. Using Nelson's field notes, the author described several new species of whitefish, one of which he named after Nelson (*coregonus nelsoni*). All of Nelson's whitefish specimens appear to have come from Andreavsky, Nulato and St. Michaels in either March, June or in winter.

From Bean's description, Nelson's whitefish (known to Russians as *Nelma*) was common to both the Yukon and Kuskokwim Rivers and was harvested at the mouth of the Yukon with the use of spears and wicker traps. The largest run took place during November, at the start of winter, about two to three weeks after the lamprey run. In spring, the whitefish would leave the large rivers for smaller streams.

A separate whitefish called c*oregonus quadrilateralis* or "Slender whitefish," (known to Russians as *Sigi*) was described as confined to lakes and streams, moving into the deeper part of streams after freezeup. This species was harvested in fyke traps by people of the Yukon and Kuskokwim Rivers, as well as Kotzebue Sound. Bean's specimen was harvested by a Unalakleet man on January 30, 1878, who claimed this type of whitefish to be abundant during that part of the year.

Zhang, X. 2001. Assessment of total mercury and methyl mercury in selected subsistence fish in Western Alaska. . Thesis/Dissertation. University of Alaska Fairbanks.

This study examined levels of mercury in species of fish commonly consumed as wild subsistence foods in the Yukon-Kuskokwim Delta. In addition to assessing total levels of mercury (THg), the study looked for traces of methyl mercury (MeHg) which is generally found in larger proportions in marine environments than other ecosystems. MeHg has been known to be absorbed by fish species and capable of contaminating the food web (a process called "biomagnification") with toxins that can cause harmful effects, such as mercury poisoning, neurological disorders and developmental damages to children. Concern for mercury levels in the Y-K Delta was prompted by Duffy's 1999 study, which found the mean level of mercury in freshwater fish in the Delta to be 368 ng/g, which is higher than average levels in many other parts of the state. This was considered particularly significant as the Y-K Delta is an area heavily reliant on subsistence fish.

In 1999 and 2000, the researcher captured fish in the Kuskokwim, Yukon, Nushagak and Kvichak River drainages. The researcher sampled muscle and liver from salmon and several species of freshwater fish to compare mercury levels. Six whitefish (*coregonus nelsoni*, or Humpback whitefish) from the Aniak River were sampled. In the results of mercury tests, there were noticeably higher levels of THg and MeHg in pike and grayling from the Yukon than pike and grayling from the Kuskokwim.

Unfortunately, there were no whitefish sampled on the Yukon to compare to those from the Aniak River. Mercury levels in Aniak River whitefish were found to be much lower than those for Pike from the same region. The six whitefish sampled had a mean MeHg level in muscle samples of 26 ng/g, compared to 578 ng/g for Pike. In liver, the MeHg levels were a mean of 31 ng/g. Total mercury levels were 32 ng/g in muscle and 57 ng/g in liver. The mercury levels found by this researcher were lower than those found by Duffy in 1999, although it is not clear if they sampled whitefish from the same locations. The whitefish sample size was small, only from one sampling location, and only looked at one species of whitefish.

This study's focus was not to analyze whether existing mercury levels were harmful to human health or were abnormal for the regions where they were found but to build data on mercury levels that fishery managers could compare to the mean mercury levels of other fish and public health professionals could compare to national indices for dietary mercury thresholds. A separate study (Egeland et al., 1998) estimated an average mercury concentration in most fish to be about 200 ng/g. The FDA and EPA released separate information useful for determining consumption limits of pike, grayling, Chinook, and chum salmon for children and adults. The mercury levels found in whitefish in this study did not appear to indicate hazards for human consumption, and no whitefish consumption limits are mentioned in this study. The author suggests that erosion from old cinnabar mining sites may be one source of mercury in the Y-K Delta watersheds.

Kuskokwim River

Coastal

Stickney, A. 1983. Coastal ecology and wild resource use in the Central Bering Sea Area—Hooper Bay and Kwigillingok. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 85.

Between 1981 and 1983, the author conducted field work in two Yukon-Kuskokwim villages along the Bering Sea coast—Hooper Bay and Kwigillingok—and compared their subsistence economies and seasonal harvests. The report indicates that Bering cisco are the most abundant whitefish available to Bering Sea coastal villages. Kwigillingok fishes predominantly for Bering cisco. Other whitefish species are present near Kwigillingok, although which species these are is not specified. Least cisco, Humpback whitefish and sheefish are also present at Hooper Bay. Round whitefish and Broad whitefish were not mentioned at all in the report.

Some of the differences between the Hooper Bay and Kwigillingok fisheries were that whitefish that are available during winter in Hooper Bay, such as least cisco, sheefish, and humpback whitefish are not available during the winter in Kwigillingok. Kwigillingok is said to rely more on the strong salmon runs of the nearby Kuskokwim River as a result. The spring migration of Bering cisco in Kwigillingok is also more pronounced, leading to more harvesting effort during the spring run. Harvests of sheefish in Kwigillingok were not mentioned.

Both villages are home to an elaborate coastal fishery of herring, smelt, whitefish, tomcod, sculpin, flounder and several other non-salmon species. Most households were accustomed to fishing in tidal zones and in deep seas. Most whitefish and cisco harvest was done with drift nets and set net gear. Whitefish nets were generally 60 feet in length using 3-inch mesh. Fishing for whitefish was linked to fishing for other non-salmon species. Methods and gear adapted for whitefish and cisco harvests were also used for catching herring. Trappers were said to set whitefish nets and blackfish traps at the same time.

Most of the report is devoted to the timing and location of harvests and is organized by season. The behavior of tides was said to have an impact on the timing of whitefish harvests. The report includes maps showing whitefish locations and contains extensive information about the whitefish fisheries in both villages. The report does not give harvest estimates of whitefish. Methods of preparing whitefish were described including the use of whitefish stomachs for tomcod bait. Seal oil is prevalent among coastal communities and involved in some preparations of whitefish. In the local Yup'ik dialect, Bering cisco are *Naptaq* or *Imarrpinraq*, least cisco are *Qassayagaq* or *Neq'yagaq*, humpback whitefish are *Qaurtuq* and sheefish are *Ciiq*.

Lower Kuskokwim

Andrews, E. F. 1989. The Akulmiut: territorial dimensions of a Yup'ik Eskimo society. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 177.

This paper provides baseline information on subsistence use of resources by the Akulmiut of Nunapitchuk in the Yukon-Kuskokwim Delta. The Akulmiut are also locally called "tundra people" and inhabit a heavily saturated landscape known as the "Big Lake Country" along the Johnson River to the west of the Kuskokwim River. The villages of Kasigluk and Atmautluak also reside in this area. In 1983, a harvest survey was conducted in Nunapitchuk. Harvesting households caught 2,927 whitefish, an estimated 8,781 pounds, and 3 sheefish, or 22.3 pounds.

Pike, salmon, blackfish and whitefish were the most important fish species, in the order of pounds harvested. Whitefish were caught from spring through late fall. Location of permanent settlements in the area were governed by access to whitefish and seasonal settlements were located where blackfish could be trapped. Whitefish are harvested with set nets in the Johnson River, Nanvarnarrlak Lake (on USGS maps as Nunavakanukakslak Lake), Nanvarnaq Lake, and Arviryaraq Lake, within 8 miles of Nunapitchuk. A map showing harvest locations is included. Nets are typically between 3-½ to 5-3/8 inch mesh, typically 150 feet long, and of varying depths of 26 to 35 meshes deep. A fish fence is also typically constructed on the Johnson River before freezeup in October.

Young men with 8 to 9-foot long dipnets would catch whitefish in front of the fence, and women and children would later jig through holes in the ice near the fence. Shorter 20 to 30 foot nets were also used under the ice to catch whitefish. Several family members from other Kuskokwim River villages (particularly Bethel) also come to the

Johnson River to fish for pike and whitefish. The specific whitefish species harvested were not listed, although Broad whitefish (Yupik: *akakiik*), humpback whitefish (*cingikeggliq*) and least ciscos (*neqyaalleraq*) were said to be in the area. Sheefish (*ciiq*) are also caught incidentally in this area in May and November. Dried whitefish were traditionally traded between Kuskokwim River people and their neighbors on the Lower Yukon and the Bering Sea coast. Since the 1970s, local people have reported reduced numbers of whitefish and pike.

Andrews, E. F. 1994. Territoriality and Land Use among the Akulmiut of Western Alaska. Published in *Key Issues in Hunter-Gatherer Research.* Burch, E. and L. Ellanna (eds.). Berg Publishers: Dulles, VA.

This paper expands on conclusions from Andrews' 1989 paper on the resource use of Akulmiut from Nunapitchuk, focusing on indigenous systems of territoriality. The researcher supports the theory that territorial boundaries evolve as means of ensuring access to critical food resources. Based on her findings that Akulmiut have no access to the coast and its marine mammals and no territory on the Kuskokwim River and its large salmon runs, yet maintain territorial boundaries, the researcher concludes that the abundance of whitefish, pike and blackfish have been sufficient to support Akulmiut traditionally and motivated them to assert territorial rights to key fishing grounds.

The paper cites the whitefish, blackfish and pike numbers in the 1983 Nunapitchuk harvest survey and states that these "critical foods" accounted for 71% of the edible pounds consumed per capita in Nunapitchuk that year. Historical travelers such as Edward Nelson and missionary John Kilbuck also highlighted the abundance of whitefish and blackfish in their descriptions of traditional settlements in Akulmiut territory. Waterfowl, muskrat, caribou and salmon have been other important food sources but the researcher emphasizes that whitefish, blackfish and pike have been reliable, dense and predictable enough to define the land use of the Y-K Delta's Akulmiut. Access to whitefish has been the primary factor in determining the location of permanent villages in this area.

Andrews, A., and R. Peterson. 1983. Wild resource use of the Tuluksak River drainage by residents of Tuluksak, 1980-1983. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 87.

This study documented subsistence use of wild resources by the village of Tuluksak in the Lower Yukon between 1980 and 1983. Data was collected by a bilingual field researcher from 11 household heads selected by the Tuluksak Tribal Council (21.2% of Tuluksak households). Research showed that residents used the Tuluksak River and its tributaries for most of their harvest activities. Among the most important activities was whitefish fishing. The report briefly describes use of whitefish and sheefish.

Whitefish were said to be targeted in late fall from September-October and sheefish were incidentally harvested from September-November. Whitefish nets, however, were set in May, June, August, September and even under the ice in November. Net locations were within the Tuluksak River, as far upstream as 30 miles from Tuluksak, in lower Otter Creek, lower Fog River, lower Little Bogus Creek, Mishevik Slough, and a

tributary of Birch Slough. A map showing the approximate whitefish net locations is included in this study. No information on net size, or other whitefish harvest gear was included. Whitefish information is not species specific and no harvest numbers were collected during interviews. Tuluksak residents expressed concerns about mining activity in the upper Tuluksak River and an increase in beavers as possible causes of a recent decrease in non-salmon fish stocks in the area. A decline in fish was also linked to a decline in black bear, mink and otter, other important subsistence resources for Tuluksak people.

Residents of Akiak, Akiachak, Kalskag, Kwethluk, Bethel, Napaskiak, Napakiak and Tuntutuliak were also said to use the Tuluksak River for subsistence activities (primarily as a moose hunting area), during which time they may also fish for whitefish.

Brown, C., T. Krauthoefer, C. Wassallie and J. Hooper. *Unpublished draft*. Local Knowledge and Harvest Monitoring of Non-Salmon Fish in the Lower Kuskokwim River Region, Alaska, 2005-2007. Alaska Department of Fish and Game, Division of Subsistence.

Researchers conducted non-salmon local knowledge interviews in three Lower Kuskokwim River Region communities. Between 2005 and 2007, household surveys and key respondent interviews were conducted in Eek, Tuntutuliak, and Nunapitchuk. Follow-up interviews are planned for the Fall/Winter of 2008. Information on harvest numbers and locations, life histories of non-salmon species, gear-types used, and changes to historical harvest and use patterns was covered in the interviews.

Interviews that have been conducted so far reveal that a concern for decreasing populations of Broad whitefish exists in all three communities. Whitefish fisheries are different for each community, although all harvest Broad and humpback whitefish. Eek and Tuntutuliak have Bering cisco in nearby fishing locations, whereas Nunapitchuk residents have Least cisco nearby. Concerns over user conflicts at Nanvarpak Lake near Nunapitchuk were expressed. Whitefish from the Nunapitchuk area were said to taste different than whitefish from other areas, resulting in an area-wide distinction and demand for their whitefish. Flooding cycles and drainage of area lakes by several rivers were cited as reasons for the unique character of Nunapitchuk area whitefish. Behavior of tides and winds exert heavy influence on fishing conditions in Tuntutuliak and Eek. The final report will contain a map of the fisheries, and local names for whitefish. Results from recent interviews conducted in 2008 will be included in the final report.

Coffing, M. W. 1991. Kwethluk subsistence: contemporary land use patterns, wild resource harvest and use and the subsistence economy of a Lower Kuskokwim River Area community. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 157.

This report looks at the subsistence economy of Kwethluk, a Lower Kuskokwim River community located 20 river miles above Bethel. Surveys and interviews conducted by the researcher between 1985 and 1986 revealed that fish play the largest role in the subsistence diets of Kwethluk residents, while trapping and big game hunting are also important harvest activities. Residents primarily target salmon during summer fish camp

activities, and often incidentally catch sheefish during that time. Whitefish are usually targeted toward the end of the open water season between August and November. The species said to be available in this area are Broad whitefish, humpback whitefish, "Alaska" (or unidentified) whitefish, round whitefish, and Least Cisco. Whitefish harvests were not broken down by species, other than distinguishing whitefish from sheefish.

Between 1985 and 1986, subsistence fishers in Kwethluk harvested an estimated total of 9,946 whitefish (29,839 lbs), and 2,119 sheefish (or 13,775 lbs). Whitefish amounted to 7% of the estimated total subsistence harvest of the community, and sheefish accounted for another 3%. Commercial fishermen in Kwethluk have typically caught whitefish as by-catch while commercial fishing, and some commercially-caught whitefish were sold in the past. The influence of commercial fishing on the Kwethluk economy and subsistence practices and gear types is also discussed.

The paper describes changing gear types, fishing methods, and methods of processing whitefish. Included in the report is a table showing that whitefish and sheefish could be harvested throughout the year in this area. Nets used to catch whitefish were generally small and portable, which allowed Kwethluk families to harvest whitefish during travel between camps and while moose hunting. Maps show areas used to catch all species of freshwater fish, not whitefish or sheefish exclusively. The report includes names for whitefish species in the local Yup'ik dialect.

Coffing, M., L. A. Brown, G. Jennings, and C. J. Utermohle. 2001. Subsistence harvest and use of wild resources in Akiachak, Alaska, 1998. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 258.

In 1998, a baseline harvest survey was conducted in Akiachak on the Lower Kuskokwim River. The survey data showed that Akiachak fishermen harvested 4,167 Broad whitefish (16,671 pounds); 7,233 humpback whitefish (14,466 pounds); 205 sheefish (1,335 pounds); 422 round whitefish (634 pounds) and 353 ciscos (264 pounds). The subsistence harvest totals included 411 Broad whitefish (1,643 pounds), 205 sheefish (1,334 pounds), and 213 humpback whitefish (425 pounds) caught and retained by commercial fishermen from Akiachak. The sheefish harvest total reflects only commercial catches because sheefish were omitted from the subsistence survey. This total is therefore low and not meant to represent Akiachak's estimated subsistence sheefish harvest.

Of the 118 households in Akiachak. 76% used Broad whitefish, and 75% used humpback whitefish in 1998. About 85 households (or 72%) harvested both Broads and humpbacks in 1998. Blackfish provided most of the total non-salmon harvest at 27%, but whitefish species combined provided the second highest proportion, at 25%, with sheefish underrepresented. Whitefish and sheefish were not listed among fish species used for dog food, except where organs and scraps were fed to dogs.

Most subsistence-caught whitefish were harvested with gillnets, although 4% of the households who caught humpback whitefish used only rod and reel gear, and 21% harvested humpbacks in nets set under the ice. Gillnets were said to be the same nets used for salmon, either up to 6" mesh and 45 meshes deep; or over 6" and up to 35

meshes deep, and all up to 300 feet long. Under-the-ice nets were probably smaller.

Although Broad whitefish, humpback whitefish, and ciscos could be caught any month of the year, most Broads and humpbacks were caught in July and August. Ciscos were taken evenly throughout the year and caught in the Kuskokwim River between Akiak and Bethel. Other whitefish harvest locations were not specified. Non-salmon harvest locations were shown on a map, but not separated by species. No information about whitefish life history or the abundance of whitefish populations in this area was addressed.

Hooper, J. 2003. Four Sub-Regional Planning Session Meetings in the AVCP Region. U.S. Fish and Wildlife Service, Office of Subsistence Management, Fisheries Resource Monitoring Program. Final Report, Study 01-019.

In 2002, the Association of Village Council Presidents (AVCP) coordinated meetings in sub-regions of the Yukon-Kuskokwim Delta to solicit community input about local fisheries within the 56 villages that AVCP represents. The meetings were held in Toksook Bay (Coastal area), Bethel (Lower Kuskokwim area), and Emmonak (Lower Yukon area), and village representatives were flown in to participate in the meetings. Another meeting, conducted by the Kuskokwim Native Association (KNA), was held in Aniak (Central/Upper Kuskokwim area), under a related contract. In the Coastal area it was mentioned that people used to herd whitefish up the rivers and that beaver dams had caused whitefish to disappear from the area. Sores on whitefish skin and discolored skin under whitefish scales were also mentioned. In the Lower Kuskokwim area it was mentioned that some individuals left their whitefish nets out too long and the fish rotted. The tribal council of Atmautluak passed a natural resource ordinance that limits the number of setnets in known fishing spots and they check these every weekend to see if the owners have been checking them. Whitefish populations in the area were said to have declined in recent years. In the Lower Yukon area it was mentioned that sheefish numbers and sizes had decreased. Some Broad whitefish have been caught with worm-like bugs in their gills. Some had been deformed with no tail vertebrae or their stomach stuck to the inside walls. Their numbers were also in decline, as were those of the cisco population which were also said to be less fat and oily than before. No meeting summary for the Central/Upper Kuskokwim area was published in this report, since another entity conducted the meeting in that region.

Wolfe, R. J., J. A. Fall, V. Fay, S. Georgette, J. Magdanz, S. Pederson, M. Pete, and J. Schinchnes. 1986. The role of fish and wildlife in the economies of Barrow, Bethel, Dillingham, Kotzebue, and Nome. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 154.

The paper provides information on the subsistence economies of five Alaskan cities defined as rural in ANILCA legislation. Since no systematic subsistence studies had been conducted in Bethel by the study year, the paper's description of Bethel's subsistence economy focused on socioeconomic and resource use information. By 1986, no harvest data for whitefish had been collected in the region. The report mentions that Bethel residents actively subsistence fish for whitefish in drift and set nets in the summer, and use set nets under the ice and hooks in winter. In 1984, local residents set 83 nets

under the ice along a six mile stretch of the Kuskokwim close to Bethel to catch whitefish, pike and burbot. The report stated that Bethel residents rely on several species of whitefish, as well as on sheefish. The species of whitefish used in this area were not specified. In a table showing the annual round of subsistence activities, Bethel residents were shown to fish for whitefish and sheefish (as well as pike and burbot) year-round.

Central Kuskokwim

Brelsford, T. R., R. Peterson, and T. Haynes. 1987. An overview of resource use patterns in the Central Kuskokwim: Aniak, Crooked Creek, and Red Devil. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 141.

This study focused on identifying general subsistence harvest zones for the Kuskokwim River villages of Aniak, Crooked Creek and Red Devil. The paper mentions that Aniak residents fish for whitefish in the Kuskokwim River, not far from Aniak. Crooked Creek residents harvest whitefish near a portion of the main stem Kuskokwim River called "the Big Bend." Red Devil harvests non-salmon species in general along the Kuskokwim River, the mouth of the George River, the mouth of Eightmile Creek, and several miles up the Holitna River to the former village of Kashegelok. Aniak and Crooked Creek used set nets to harvest whitefish. The report doesn't list gear types used to harvest whitefish in Red Devil, or what size of net is used in Aniak and Crooked Creek. The maps are not included in the report, but apparently show fishing locations for all non-salmon as one resource category.

The subsistence hunting, fishing, trapping and gathering activities recorded in 1986 were said to represent continuity with past practices. The researchers documented the harvest seasons for whitefish, least ciscos, and sheefish in each village. Aniak harvested whitefish in May, August, September and October; Least ciscos in September and October; and sheefish in May and June. Crooked Creek harvested whitefish in May, August, September, and October, sheefish in May, June and July. Red Devil harvested whitefish from May through October and sheefish from May through September. In Crooked Creek and Red Devil, there were no recorded harvests of least ciscos.

Charnley, S. 1982. Resource use areas in the Aniak and Oskawalik river drainages. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 50.

The researchers interviewed a total of 60 people from the villages of Aniak, Chuathbaluk, Crooked Creek and Sleetmute in 1982. Residents from Aniak and Chuathbaluk were asked about use of the Aniak River, and residents from Chuathbaluk, Crooked Creek and Sleetmute were asked about use of the Oskawalik River. The researchers then mapped resource use along these two drainages. In this area, no one food source is said to be in abundance. For this reason, these communities rely almost equally on a large variety of resources for subsistence needs. Salmon and moose are used in the heaviest amounts, followed by non-salmon fish species, other big game, birds and small furbearers and other small game. This report maps non-salmon fishing areas,

where whitefish and sheefish are not distinguished from other non-salmon species.

Charnley, S. 1984. Human ecology of two Central Kuskokwim communities: Chuathbaluk and Sleetmute. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 81.

In this study the author spent a year between 1982 and 1983 observing subsistence activities and socio-economic patterns in the Kuskokwim River villages of Chuathbaluk and Sleetmute. The study describes several differences in resource utilization between these two communities, historically and in 1982, and describes the distinct cultural backgrounds and land use "territories" of each. In Chuathbaluk, more influenced by Lower Kuskokwim Yup'ik communities, there was historically greater emphasis on seasonal runs of salmon and non-salmon species, and the location of the settlement reflects an interest in accessing both salmon and whitefish in the same area. In Sleetmute, traditional use areas indicate more of an emphasis on moose and caribou hunting grounds and access to winter trapping sites. Whitefish were also utilized by people from Sleetmute, but usually as a supplementary resource harvest, as opposed to a targeted effort to harvest and put away large numbers of whitefish for the winter. Sleetmute's method of spear fishing for whitefish is discussed. Whitefish migrations typically occur in late spring and fall on this part of the Kuskokwim. Chuathbaluk residents fish more out of the Aniak and Oskawalik drainage areas and Sleetmute residents fish more out of the Holitna and Hoholitna Rivers.

The report covers harvest seasons, harvest methods and methods of processing Broad, humpback and pound whitefish, least ciscos and sheefish. Bering ciscos were not mentioned, implying that these are not found in the region. The report does not include harvest estimates. Only salmon, moose and caribou harvests were counted. In both villages, the 1982 whitefish harvests took place between May and November, while sheefish were only caught between May and September. Maps show traditional whitefish harvesting locations and locations used in 1982. Some traditional whitefish harvest methods may have been prohibited by regulations introduced in 1977. The paper provides valuable information on historical whitefish gear types used in these two villages.

Jonrowe, D. 1980. Middle Kuskokwim food survey December 1979. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 51. Fairbanks, Alaska.

This technical paper describes the survey and interviews conducted in seven villages (Stony River, Sleetmute, Red Devil, Georgetown, Chuathbaluk, Kalskag, and Lower Kalskag) of the Central Kuskokwim River in 1979. The survey attempted to identify the most important sources of subsistence food for this group of villages. Moose meat was said to be the most important food resource for Stony River, Sleetmute, Red Devil and Georgetown, and next in importance were salmon and whitefish. The report contains no whitefish harvest estimates or information on particular species harvested. The report stated that Stony River relied heavily on whitefish during the survey year, however. "Fish" were the major protein source for Chuathbaluk, Kalskag and Lower

Kalskag. The report does not identify what these fish species were, other than salmon.

Kari, P. R. 1983. Land use and economy of Lime Village. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 80.

This report describes the subsistence resource use of Lime Village, located up the Stony River near the upper end of the Kuskokwim River. The researcher visited the community between May 1982 and April 1983. The residents of this community are Athabaskans similar to those at Sleetmute, Illiamna and Pedro Bay, but distinct from the Upper Kuskokwim Athabaskans to the north.

The researcher noted that whitefish are very important to the people of Lime Village, and generally preferred in taste and nutrition to salmon. Lime Village residents have camps specifically for the spring and fall harvests of whitefish. Generally the fishery takes place in the "lake country" down the Stony River and south of the community. Camps were generally set up on the sides of small streams with access to larger lakes nearby. One such location was near Tishimna Lake about 30 miles downstream of Lime Village.

Most Lime Village residents preferred to harvest whitefish in the fall because the fall run provided the whole winter's supply of whitefish, and it is easier to store fall whitefish by freezing them in the colder temperatures. Whitefish harvested during spring are generally dried and smoked and eaten through the fall. Gear used to harvest whitefish included fish wheels, set nets, fish fences combined with traps and dipnets, and hook and line. Sheefish were harvested occasionally, in addition to other non-salmon fish. No harvest estimates were included in the report.

Within the Dena'ina dialect of the Lime Village Athabaskans, Broad whitefish are *telay*, humpback whitefish are *hulehga*, least cisco are *ghelghuli*, round whitefish are called *hasten* and sheefish are *shish*. The residents of Lime Village noted that populations of whitefish could be variable but were generally larger in the past when residents consistently destroyed nearby beaver dams.

Kari, P. R. 1985. Wild resource use and economy of Stony River Village. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 108.

This report describes the subsistence resource use of Stony River, located at the mouth of the Stony River in the upper portion of the Central Kuskokwim River. Residents of Stony River rely on fish stocks year round, generally harvesting salmon in the summer, whitefish in the spring and fall and burbot (loche) in the winter. Located on the territorial border of three different cultures—Yup'ik , Ingalik Athabaskan, and Dena'ina Athabaskan—the people of Stony Village are familiar with many words and traditions regarding whitefish. Whitefish are called *quartuq* in Yup'ik, and *tilay* in Kuskokwim Ingalik, while sheefish are *ciiq* in Yup'ik and *ses* in Kuskokwim Ingalik. The larger sized whitefish (Broad and humpback whitefish and sheefish) are prized for human and dog food and preferred by many to the taste of salmon. While residents also rely on moose and caribou meat, their dogs were traditionally fed only fish. Most residents harvest whitefish in spring and fall.

The whitefish species present in the area are Broad whitefish, humpback whitefish, sheefish, round whitefish and least cisco. The report describes gear types, harvest seasons and methods of preparing and preserving whitefish. Spears were commonly used to harvest whitefish at the time of research. Whitefish were often harvested from whitefish camps within 75 miles of Stony Village and often in conjunction with muskrat and waterfowl hunting. The report includes a map showing whitefish harvest locations. The report does not provide harvest estimates. When the run is at its peak, one pair of brothers was able to harvest 100 whitefish within 24 hours. Whitefish are commonly shared for the making of "native ice cream."

Krauthoefer, T., J. Simon, M. Coffing, M. Merlin, and W. Morgen. 2007. The harvest of non-salmon fish by residents of Aniak and Chuathbaluk, Alaska, 2001-2003. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 299.

Between 2001 and 2003, researchers conducted two annual surveys on the subsistence harvest and use of non-salmon fish species in the Central Kuskokwim River by residents of Chuathbaluk and Aniak. In 2002, researchers also interviewed five individuals from Aniak about local and historical knowledge of non-salmon fishing.

Surveys revealed that whitefish were the predominant non-salmon resource harvested in Aniak, where an estimated 2,477 fish (or 7,434 pounds) were harvested during the 2001-2002 year, accounting for 34% of the overall non-salmon harvest. The sheefish harvest was an additional 808 fish (or 5,244 pounds), accounting for an additional 23% of non-salmon harvest. In 2002-2003, an estimated 1,649 whitefish (or 4,947 pounds) and 366 sheefish (or 2,379 pounds) were harvested in Aniak.

Surveys from Chuathbaluk showed less reliance on whitefish among the available non-salmon species during the first survey year, but more reliance the second year. In 2001-2002, Chuathbaluk harvested an estimated 205 whitefish (or 615 pounds) and 187 sheefish (or 1,215 pounds), whereas in 2002-2003, they harvested 1,295 whitefish (or 3,885 pounds) and 207 sheefish (or 1,346 pounds). Both surveys showed harvests of whitefish to be highly variable from year to year in both villages. Surveys described the locations where residents harvested whitefish, revealing that both villages harvest most of their whitefish off the main stem of the Kuskokwim River.

Whitefish harvests were not species specific but appear to have included all species of whitefish except for cisco. Cisco were apparently lumped into a miscellaneous non-salmon category. One respondent mentioned that cisco travel as far up the Aniak River as Buckstock Creek. These are presumably least cisco, since least cisco are present both upstream and downstream from Aniak, and no harvests of Bering cisco have been documented in this area. The paper does not indicate which other whitefish species are present in this area, although a conservation concern for Broad whitefish populations was mentioned.

From interviews and survey comments, the researchers learned that residents of these two villages considered whitefish to be less abundant and much smaller than they had been in the past, when some of them had reached lengths of around 3 feet long. The report gives very little background about historical whitefish fishing in Aniak. Information about historical whitefish fishing in Chuathbaluk was addressed by a 1984

report by Susan Charnley. This report provides the first baseline information about whitefish harvests in Aniak and Chuathbaluk, although harvest totals do not include ciscos.

The research for this project appears to have been focused on the use of hook and line gear to harvest non-salmon in response to regulations prohibiting subsistence use of this gear type in the Aniak River. The report briefly mentions that nets and fyke nets have been used by Aniak residents to harvest whitefish in the past and that gillnets were the most common gear used to harvest whitefish and sheefish from 2001-2003. The report also states that hook and line gear, including jigging through the ice, was used to harvest all species of non-salmon except for suckers. The author recommends that additional research be done on individual whitefish species in this region, and in other regions, which may be utilizing the same stocks of whitefish. The variability of harvest between the two survey years also poses questions about what level of harvest is representative of each village. Further research may also want to investigate differences in health, size and abundance of current and historical whitefish populations.

Stickney, A. 1980. Subsistence resource utilization: Nikolai and Telida-interim report. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 20, Fairbanks.

This report looks at subsistence resource use in the Upper Kuskokwim communities of Telida and Nikolai. Moose is said to be the main staple of the subsistence diet for both communities. Caribou, salmon and whitefish are the next major resources available to residents. In 1980, big game hunting from non-local hunters in this area caused local residents to have to compete for available resources and required more use of other subsistence resources, notably salmon and whitefish. Whitefish runs were noted to be in decline in this area, and becoming "inadequate for village needs." Residents of Telida and Nikolai both generally fish for whitefish in the fall. Residents from Telida harvest whitefish in Lower Telida Lake. Maps show nearby fishing locations, without listing particular fish species harvested. Sheefish were not mentioned in the report. Both communities are predominantly Athabaskan.

Stickney, A. 1980. Middle Kuskokwim food resources survey: status report. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 52.

In 1979, researchers surveyed 48% of the households in Stony River, Sleetmute, Red Devil, Georgetown, Chuathbaluk, Kalskag and Lower Kalskag about subsistence resource use. This paper introduces a supplementary project to better define the harvest levels, harvest regions and resource issues of the Central Kuskokwim villages. (see the following report)

Stickney, A. 1981. Middle Kuskokwim food survey-II. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 53.

In 1980, researchers surveyed the Central Kuskokwim River villages of Stony River,

Sleetmute, Red Devil, Crooked Creek, Chuathbaluk, Aniak, Kalskag, and Lower Kalskag. The survey described the percentages of households in each community who harvested non-salmon and stated that whitefish and grayling were caught in each village in the fall, through the use of hook and line gear, rods and reels, and occasionally spears. The report does not mention nets. Sheefish and ciscos do not appear to have been included on the survey. The report does not provide whitefish harvest estimates and does not state which species of whitefish are present in the area.

Upper Kuskokwim

Holen, D., W. E. Simeone, and L. Williams. 2006. Wild resource harvests and uses by residents of Lake Minchumina and Nikolai, Alaska, 2001-2002. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 296.

This report concluded a project to assess the subsistence use of resources in the Upper Kuskokwim community of Nikolai, begun in 2002. The report provides whitefish harvest numbers of 181 sheefish (997 edible pounds) and 386 whitefish (676 edible pounds) harvested in 2002. As the harvest survey asked only about whitefish harvests generically, without using a species-specific approach, the whitefish harvest total may or may not include ciscos. The whitefish edible pound conversion also does not likely reflect distinctions in weight between different species. Over 55% of the community of Nikolai was reported to have used whitefish in 2002. Harvests were reportedly higher than those listed in a 1984 survey (data in the Division of Subsistence CSIS database); however, several residents noted a decline in whitefish and sheefish populations. Interference by beavers, lack of beaver harvest, warmer water, lower water levels, the presence of weeds, changes since the 1964 earthquake, and melting permafrost were cited as possible reasons for the decline. Sheefish and whitefish were harvested in a wide range of locations in the vicinity of Nikolai. Some locations were described by name. Maps showed fishing locations of all non-salmon as one category.

Stokes, J. 1984. Natural resource utilization of four Upper Kuskokwim communities. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 86.

Research conducted between 1980 and 1984 is summarized in this report. The author interviewed subsistence users in the four Upper Kuskokwim villages of Takotna, McGrath, Nikolai and Telida. The report covers each community's history and traditional resource use in addition to the harvest patterns, locations and techniques used in the early 1980s. The villages were similar in reliance on big game species and salmon runs, with the exception of Telida, which was predominantly reliant on whitefish. Located farthest upstream on the Swift Fork of the Kuskokwim River, Telida was said to be settled in this location because of the abundance of whitefish in nearby Lower Telida Lake. The name Telida is derived from the Athabaskan *tilaya'da*, meaning "lake whitefish place." The traditional residents of all four communities are Upper Kuskokwim Athabaskans, sometimes formerly called Kolchan Athabaskans.

The report gives extensive information about the whitefish fisheries of all four villages, which generally fish in distinct locations ranging from the main stem of the Kuskokwim to eddies in related tributaries, to lakes and lake outlets. Species included "cisco" (*dilmije*); humpback whitefish (*tsendude*) and Broad or "lake" whitefish (*tilaya*). "Candlefish" or round whitefish (*Hwstin*) were reportedly captured in this region but not popular as a human food source. An additional unidentified species (*taghye*), was said to be similar to "lake" whitefish. Whitefish are fished for both human and dog food, and the same is true for sheefish (*zidlaghe*) in this area.

Various types of gear used to harvest whitefish and sheefish are discussed, including fish fences, fish traps, spears, fishwheels and nets with 4½ inch mesh. The traditional use of fences in the Little Tonzona River appears to have ceased after the mid-1960s when locals were informed that any gear blocking the width of streams was illegal. The report includes maps of fishing locations, characterization of whitefish harvesting in spring, summer and fall, and photos of setting whitefish nets under the ice. No harvest data was presented in the report. Concerns about declining salmon and whitefish runs were reported.

Williams, L., C. Venechuk, D. L. Holen, and W. E. Simeone. 2004. Lake Minchumina, Telida, Nikolai, and Cantwell subsistence community use profiles and traditional fisheries use. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 295.

This report described changes to the subsistence fisheries in selected villages bordering the Denali National Park and Preserve. By 2001, when the research for this report began, Telida had only three remaining residents (compared to thirty-three in 1980), with most residents having relocated to Nikolai. The report describes the combined whitefish fisheries of Nikolai and Telida, where Broad whitefish, humpback whitefish, round whitefish, Bering cisco, least cisco and sheefish were said to be available. Local Athabaskan names for whitefish vary slightly from those reported by Stokes in 1984. The Athabaskan word for the month of September (*tiayano'o'*) is said to mean "Whitefish month." Whitefish were harvested year-round by these residents.

The main feature of this report is its traditional ecological knowledge component, wherein many local observations about whitefish were recorded. Whitefish populations were reported to have decreased, due to either an increase in beavers or lower water levels. The report does not include harvest numbers, but states that salmon and whitefish are the primary fish resources utilized by Nikolai and Telida.

<u>Drainage-wide/miscellaneous</u>

Lavine, R., M. J. Lisac, and P. Coiley-Kenner. 2007. Traditional Ecological Knowledge of 20th Century Ecosystems and Fish Populations in the Kuskokwim Bay Region. U.S. Fish and Wildlife Service, Office of Subsistence Management, Fisheries Resource Monitoring Program, FIS Report 04-351.

This report summarizes traditional ecological knowledge (TEK) from four elders from

Quinhagak and two from Goodnews Bay about fish populations in Kuskokwim Bay. The report also examined Community Profile Data Base (CPDB) information about salmon harvests in this area and combined elders' knowledge with scientific life history information about each locally harvested fish. The report listed Bering cisco, called either *Imarpinraq* or *Naptaq*, as the most heavily utilized whitefish in the Kuskokwim Bay. These ciscos were traditionally harvested in late fall, winter and early spring up the Apokak Slough, Kanektok River, and Goodnews Rivers. One Quinhagak elder remembered spearing for Bering ciscos at Quinhagak prior to the 1930s. Currently they are fished with small nets, nets under the ice, jigging, and digging snow pits on top of the ice. One elder from Goodnews Bay recalled that Bering ciscos were historically targeted during winter when other foods were scarce. On the Goodnews River, Bering cisco and Dolly Varden were the primary food sources during the early spring melt. An elder from Quinhagak indicated that April is the best time to catch Bering ciscos on the Kanektok River. Elders in Quinhagak said that Bering cisco are abundant on the Kanektok River, and elders in Goodnews Bay stated they were in decline on the Goodnews River.

Round whitefish *(Cauirrutnaq or Uraruq*) were also used by local residents on occasion. Round whitefish were said to be less abundant today than in previous years. Elders from both communities were less familiar with least ciscos (*Kassiaq, Qassayaaq, Neqyaaq or Cingikegliq)*, which were said to be present only out in the Bay. The report contains no whitefish harvest information and does not document any knowledge of Broad whitefish or humpback whitefish. The report states that sheefish are incidental visitors to this region. Mapping was done during the interviews, but no harvest maps were included in this report. Researchers interviewed elders in Goodnews Bay and Quinhagak. Information from elders in Kipnuk, Kwigillingok, Kongiganak, and Platinum would be necessary to a discussion of whitefish importance to the whole Kuskokwim Bay.

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Among the many things in this report, Alt identifies the sheefish spawning migration into the Alatna River.

Alt, K.T. 1970. Sport fish investigations of Alaska: Sheefish and pike investigations of the upper Yukon and Kuskokwim drainages with emphasis on Minto Flats drainages. Alaska Department of Fish and Game, Division of Sport Fish, Annual Performance Report, 1969-1970, Project F-9-2, Vol. 11, Juneau (pages 321-330).

Information is reported on tagging results of sheefish in the Yukon drainage showing that fish move between the Yukon delta and the Alatna River.

Alt, K.T. 1971. Occurrence of hybrids between inconnu, *Stenodus leucichthys nelma* (Pallas), and humpback whitefish, *Coregonus pidschian* (Linnaeus) in Chatanika River, Alaska. Transactions of the American Fisheries Society 100: 362-365.

Alt, K.T. 1972. Sport fish investigations of Alaska: A life history study of sheefish and whitefish in Alaska. Alaska Department of Fish and Game, Division of Sport Fish, Annual Performance Report, 1971-1972, Project F-9-4, Vol. 13, R-11, Juneau (pages 1-34).

Information is presented regarding sheefish spawning in Highpower Creek in the upper Kuskokwim River. Also, sheefish were sampled at the mouths of many middle-Yukon streams.

Alt, K.T. 1973a. Age and growth of inconnu (*Stenodus leucichthys*) in Alaska. Journal of the Fisheries Research Board of Canada 30: 457-459.

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Information is presented in this report on the life history of least cisco.

Alt, K.T. 1980b. Inventory and cataloging of sport fish and sport fish waters of western Alaska. Alaska Department of Fish and Game, Division of Sport Fish, Annual Performance Report, 1980-1981, Project F-9-12, Vol. 21, G-I-P, Juneau (pages 32-59).

Fish were sampled and characterized in five rivers in the region between the villages of Holy Cross and Koyukuk on the Yukon River. The rivers were the Innoko, Bonasila, Anvik, Khotol, and Nulato.

Alt, K.T. 1981a. A life history study of sheefish and whitefish in Alaska. Alaska Department of Fish and Game, Division of Sport Fish, Annual Performance Report 1980-1981, Project F-9-13, Vol. 22, R-II-A&B, Juneau (pages 1-28).

Data are presented showing that sheefish spawn in the Big River in the Kuskokwim River drainage, the second spawning location identified in the Kuskokwim. Evidence is also presented in this report that sheefish probably do not spawn in the Holitna River drainage.

Alt, K.T. 1981b. Inventory and cataloging of sport fish and sport fish waters of Western Alaska. Alaska Department of Fish and Game, Division of Sport Fish Division, Annual Performance Report 1980-1981, Project F-9-13, Vol. 22, G-I-P, Juneau (pages 34-55).

The results of fish surveys in the Melozitna and Andreafsky rivers are presented in this report.

Alt, K.T. 1982. Inventory and cataloging of sport fish and sport fish waters of western Alaska. Alaska Department of Fish and Game, Division of Sport Fish, Annual Performance Report, 1981-1982, Project F-9-14, Vol. 23, G-I-P-B, Juneau (pages 66-78).

Results of the first of two fisheries surveys in the Innoko River drainage are presented here. Whitefish species figure prominently in the report. Alt suggested, based on a tag recapture and on a failure to find prespawning sheefish in the Innoko drainage, that sheefish used the river for feeding but not for spawning.

Alt, K.T. 1983. Inventory and cataloging of sport fish and sport fish waters of western Alaska. Alaska Department of Fish and Game, Division of Sport Fish, Annual Performance Report, 1982-1983, Project F-9-15, Vol. 24, G-I-P-B, Juneau (pages 34-78).

Results of the two year fisheries survey of the Innoko River drainage are presented. Humpback whitefish and least cisco spawning areas were located. More evidence was presented that sheefish left the system to spawn.

Alt, K.T. 1984. Inventory and cataloging of sport fish and sport fish waters of western Alaska: Fisheries resource investigations and sheefish adaptability studies. Alaska Department of Fish and Game, Division of Sport Fish, Annual Performance Report, 1983-1984, Project F-9-16, Vol. 25, G-I-P-B, Juneau (pages 70-90).

The results of fish surveys on the Melozitna and Tozitna River drainages are presented. Some information on the Holitna River and other miscellaneous information is also presented.

Alt, K.T. 1985. Inventory and cataloging of sport fish and sport fish waters of western Alaska: Nowitna and Fish-Niukluk River study, Western Alaska creel census, sheefish enhancement assessment. Alaska Department of Fish and Game, Division of Sport Fish, Annual Performance Report, 1984-1985, Project F-9-17, Vol. 26, G -I-P-B, Juneau (pages 134-171).

The results of a fish survey on the Nowitna River drainage are presented. Humpback whitefish, broad whitefish, least cisco, and sheefish are present. A sheefish spawning area is reported to be in the Sulukna River, an upper drainage tributary of the Nowitna.

Alt, K.T. 1988. Biology and management of inconnu (*Stenodus leucichthys*) in Alaska. Finnish Fisheries Research 9: 127-132.

Babaluk, J. A., R. J. Wastle, and M.A. Treble. 2001. Results of tagging and biological studies in the lower Mackenzie River, Northwest Territories, conducted during 1992 and 1993 Department of Fisheries and Oceans, Canadian Technical Report of Fisheries and Aquatic Sciences, No. 2387, Winnipeg.

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Bickham, J.W., J.C. Patton, S. Minzenmayer, L.L. Moulton, and B.J. Gallaway. 1997. Identification of Arctic and Bering ciscoes in the Colville River delta, Beaufort Sea coast, Alaska. Pages 224–228 *in* J. Reynolds, editor. Fish ecology in Arctic North America. American Fisheries Society Symposium 19, Bethesda, Maryland.

Morphological and genetic differences between these two species are confirmed. Also, the authors discuss the prevailing belief that Bering cisco encountered in the Colville River delta originate in the Yukon River.

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Bogdanov, V.D., S.M. Mel'nichenko, and I.P. Mel'nichenko. 1992. Descent of larval whitefish from the spawning region in the Man'ya River (lower Ob basin). Journal of Ichthyology 32(2):1-9.

This paper documents the timing, density, magnitude, and other qualities of the downstream distribution of larval whitefish in a tributary of the Ob River in northern Asia.

Bond, W.A. 1982. A study of the fishery resources of Tuktoyaktuk Harbour, sourthern Beaufort Sea coast, with special reference to life histories of anadromous coregonids. Canadian Technical Report of Fisheries and Aquatic Sciences No. 1119, Winnipeg.

This report presents a wealth of information on many species that frequent the Tuktoyaktuk Harbour, near the Mackenzie River delta, during both summer and winter. Habitat qualities of the aquatic environment, as well as demographic, maturity, and migration data for fish species encountered are detailed.

Bond, W.A., and R.N. Erickson. 1985. Life history studies of anadromous coregonid fishes in two freshwater lake systems on the Tuktoyaktuk Peninsula, Northwest Territories. Canadian Technical Report of Fisheries and Aquatic Sciences 1336.

This report documents life history variables of several whitefish species in the Mackenzie River delta and nearby estuary and freshwater systems. A great deal of information is presented on gonadosomatic index values over time as well as ageing methods and other biological data.

Bond, W.A., and R.N. Erickson. 1992. Anadromous coregonids of a Canadian Arctic estuary. Polskie Archiwum Hydrobiologii 39:431-441.

Bond, W.A., and R.N. Erickson. 1993. Fisheries investigations in coastal waters of Liverpool Bay, Northwest Territories. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2204, Winnipeg.

This manuscript presents the results of a fish sampling project in Liverpool Bay, a large brackish water body east of the Mackenzie River delta. The primary objectives were to evaluate migratory, demographic, and maturity qualities of Arctic cisco. Habitat qualities of the aquatic environment, as well as information regarding other fish species were also detailed.

Bradford, M.J., J. Duncan, and J.W. Jang. 2008. Downstream migrations of juvenile salmon and other fishes in the upper Yukon River. Arctic 61:255-264.

This article presents the results of sampling in the mainstem Yukon River near Dawson in the Yukon Territory. Juvenile whitefish of several species were a major component of their catch.

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Brown, R.J. 2004. A biological assessment of whitefish species harvested during the spring and fall in the Selawik River delta Selawik National Wildlife Refuge, Alaska. U.S. Fish and Wildlife Service, Alaska Fisheries Technical Report No. 77, Fairbanks.

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This report provides demographic, migratory, spawning, and other life history information for humpback whitefish populations in the upper Tanana River drainage.

Brown, R.J. 2007. Freshwater mollusks survive fish gut passage. Arctic 60:124-128.

This article documented that freshwater clams and snails were capable of surviving gut passage in humpback whitefish and broad whitefish in Alaska.

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This report presents data on the distribution of fish of several species and demographic groups among riverine habitats and oxbow lakes that were seasonally blocked with beaver dams.

Brown, R.J., N. Bickford, and K. Severin. 2007. Otolith trace element chemistry as an indicator of anadromy in Yukon River drainage Coregonine fishes. Transactions of the American Fisheries Society 136: 678-690.

This article presents otolith chemistry evidence that five whitefish species in the Yukon River drainage migrate from estuarine or marine rearing habitats to spawning areas over 1000 miles upstream.

Bryan, J.E. 1973. The influence of pipeline development on freshwater fishery resources of northern Yukon Territory, aspects of research conducted in 1971 and 1972. Pacific Region Department of the Environment, Northern Operations Branch Fisheries Service, Task Force on Northern Oil Development Report No. 73-6 (Information Canada Catalog No. R72-9773).

This report includes an early survey of the fish community in the Porcupine River in Canada. It documents the presence of sheefish, lake (humpback) whitefish, broad whitefish, least cisco, and round whitefish.

Bryan, J.E., and D.A. Kato. 1975. Spawning of lake whitefish, *Coregonus clupeaformis*, and round whitefish, *Prosopium cylindraceum*, in Aishihik Lake and East Aishihik River, Yukon Territory. Journal of the Fisheries Research Board of Canada 32: 283-288.

Chang-Kue, K.T.J., and E.F. Jessop. 1992. Coregonid migration studies at Kukjuktuk Creek, a coastal drainage on the Tuktoyaktuk Peninsula, Northwest Territories. Canadian Technical Report of Fisheries and Aquatic Sciences No. 1811, Winnipeg.

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Chudobiak, D.H., R.F. Tallman, and M.V. Abrahams. 2002. Variation in the morphology of two populations of Arctic broad whitefish, *Coregonus nasus* (Pallas), in the Mackenzie River, Northwest Territories, Canada. Advances in Limnology 57:291-305.

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Corkum, L.D., and P.J. McCart. 1981. A review of the fisheries of the Mackenzie delta and nearshore Beaufort Sea. Canadian Manuscript Report of Fisheries and Aquatic Sciences No. 1613, Winnipeg.

This manuscript details the commercial and domestic fisheries in the Mackenzie River delta region. A detailed annotated bibliography of studies in the region is included. Several whitefish species are prominent in these harvests. Concerns related to over-harvest and deficiencies in harvest and biological data required for effective management are discussed.

COSEWIC. 2004. COSEWIC assessment and update status report on the Bering cisco *Coregonus laurettae* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa.

Craig, P.C., and J. Wells. 1975. Fisheries investigations in the Chandalar River region, northeast Alaska. Pages 1-114 (Chapter 1) *In* P.C. Craig (ed.), Fisheries Investigations in a Coastal Region of the Beaufort Sea, Aquatic Environments Limited, Arctic Gas Biological Report Series, Volume 34.

Fishery survey data is presented for waters in the headwaters of the Chandalar, Sheenjek, and Colleen rivers, which document the presence and biological qualities of several whitefish species.

Crawford, D. 1979. Lower Yukon River sheefish study, October 1977-June 1978. Alaska Department of Fish and Game, Division of Commercial Fisheries, Sheefish Investigation No. 9 (52 pages).

By documenting the winter harvest at the Yukon River mouth region, this report establishes the presence of many whitefish species in the Yukon delta during winter.

Cumbaa, S.L., D.E. McAllister, and R.E. Morlan. 1981. Late Pleistocene fish fossils of *Coregonus*, *Stenodus*, *Thymallus*, *Catostomus*, *Lota*, and *Cottus* from the Old Crow basin, northern Yukon, Canada. Canadian Journal of Earth Sciences 18: 1740-1754.

Daum, D.W. 1994. Fisheries investigations on the Kandik, Charley, Nation, and Tatonduk rivers, Yukon-Charley Rivers National Preserve, 1987 and 1988. U.S. Fish and Wildlife Service, Alaska Fisheries Technical Report No. 23, Fairbanks, Alaska.

This report documents the presence and relative abundance of round whitefish in upstream reaches of four rivers in the upper Yukon River drainage in Alaska.

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This article documents an effective method of monitoring the relative abundance of migrating fish in the Yukon River drainage.

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Bering cisco are documented at Dawson in the Yukon Territory portion of the Yukon River drainage.

Doyon, J.-F., L. Bernatchez, M. Gendron, R. Verdon, and R. Fortin. 1998. Comparison of normal and dwarf populations of lake whitefish (*Coregonus clupeaformis*) with reference to hydroelectric reservoirs in northern Quebec. Advances in Limnology 50:97-108.

Durst, J.D. 2001. Fish habitats and use in the Tanana River floodplain near Big Delta, Alaska, 1999-2000. Alaska Department of Fish and Game, Habitat and Restoration Division, Technical Report No. 01-05.

The presence and habitat associations for two whitefish species are documented in turbid and clear waters of the Tanana River drainage.

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Fechhelm, R. G., B. Streever, and B. J. Gallaway. 2007. The Arctic cisco (Coregonus autumnalis) subsistence and commercial fisheries, Colville River, Alaska: a conceptual model. Arctic 60:421-429.

This article provides a synthesis of many years of study of the Arctic cisco life history as it pertains to the fishery in the Colville River delta.

Fleischer, G.W. 1992. Status of coregonine fishes in the Laurentian Great Lakes. Polskie Archiwum Hydrobiologii 39: 247-259.

This article traces the commercial harvests and relative abundances of several whitefish species in the Laurentian Great Lakes since the mid-1800s. The effects of overharvest, habitat degradation, and invasive species are discussed.

Fleming, D.F. 1994. Stock assessment and relative age validation of humpback whitefish and least cisco in the Chatanika River during 1993. Alaska Department of Fish and Game, Division of Sport Fish, Fishery Data Series No. 94-41.

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Franzin, W.G., and J.W. Clayton. 1977. A biochemical genetic study of zoogeography of lake whitefish (*Coregonus clupeaformis*) in western Canada. Journal of the Fisheries Research Board of Canada 34: 617-625.

Fuller, W.A. 1955. The inconnu (*Stenodus leucichthys mackenziei*) in Great Slave Lake and adjoining waters. Journal of the Fisheries Research Board of Canada 12:768-780.

Geiger, M.F., R. Regnart, R. Baxter, and C. Yanagawa. 1968. Arctic-Yukon-Kuskokwim area anadromous fish investigations: lower Yukon sheefish tagging study, 1967-68. Alaska Department of Fish and Game, Annual Technical Report No. AFC-7-2: 77-81.

This report documents the earliest tagging efforts to document migrations of sheefish in the Yukon River drainage.

Glesne, R.S. 1986. Lake fishery habitat survey and classification on interior Alaska National Wildlife Refuges, 1984 and 1985. U.S. Fish and Wildlife Service, Fairbanks Fishery Resources Project Report No. FY-86/7, Fairbanks, Alaska.

This informal report documents the presence of whitefish species in numerous lakes in interior Alaska during the summer season and discusses the importance of open stream connections to seasonal fish use.

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This report documents the presence and distribution of five whitefish species in the Hodzana River drainage in the Yukon Flats.

Hallberg, J.E. 1985. Evaluation of Interior Alaska waters and sport fish with emphasis on managed waters-Fairbanks district. Alaska Department of Fish and Game, Division of Sport Fish, Annual Performance Report, 1984-1985, Project F-9-17, Vol. 26, G-III-H, Juneau (pages 1-26).

This wide-ranging report documents the presence of a number of whitefish species in a variety of locations.

Hallberg, J.E. 1988. Abundance and size composition of Chatanika River least cisco and humpback whitefish with estimates of exploitation by recreational fishermen. Alaska Department of Fish and Game, Division of Sport Fish, Fishery Data Series No. 61.

Hallberg, J.E. 1989. Abundance and size composition of Chatanika River least cisco and humpback whitefish with estimates of exploitation by recreational fishermen. Alaska Department of Fish and Game, Division of Sport Fish, Fishery Data Series No. 108.

Hallberg, J.E., K.T. Alt, and M.R. Doxey. 1986. Interior whitefish program: whitefish/sheefish studies. Alaska Department of Fish and Game, Division of Sport Fish, Annual Performance Report, 1985-1986, Project F-10-1, Vol. 27, W-8-1, Juneau (pages 25-44).

This report deals primarily with assessment of the Chatanika River whitefish populations.

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In this article evidence is presented that fecundity increases with increased exploitation of lake populations of lake whitefish.

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Howland, K.L. 1997. Migration patterns of freshwater and anadromous inconnu, *Stenodus leucichthys*, within the Mackenzie River system. Master's Thesis, University of Alberta, Edmonton.

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This article empirically establishes lethal temperature and dissolved oxygen conditions for ciscoes in Minnesota. This phenomenon may be what has caused a number of observed fish kills in interior Alaska lakes in recent years.

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This article presents an analysis of harvest levels and population effects on several fish species including lake whitefish, sheefish, and lake cisco species.

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Kennedy, W.A. 1954. Tagging returns, age studies and fluctuations in abundance of Lake Winnipeg whitefish, 1931-1951. Journal of the Fisheries Research Board of Canada 11:284-309.

Kennedy, W.A. 1963. Growth and mortality of whitefish in three unexploited lakes in northern Canada. Journal of the Fisheries Research Board of Canada 20:265-272.

Kepler, P. 1973. Sport fish investigations of Alaska: Population studies of northern pike and whitefish in the Minto Flats complex with emphasis on the Chatanika River. Alaska Department of Fish and Game, Division of Sport Fish, Annual Performance Report, 1972-1973, Project F-9-5, Vol. 14, G-II-J, Juneau (Pages 59-81).

This report documents the some aspects of the spawning populations of humpback whitefish, least cisco, and sheefish in the Chatanika River. An argument was presented that broad whitefish leave the Chatanika River in the late fall to spawn elsewhere.

Kostohrys, J., B. Lubinski, and N. Collin. 1994. Aquatic resources of the Salmon Fork Black River, Alaska: A preliminary survey, 1991. U.S. Bureau of Land Management, Open File Report 51, Anchorage.

This report documents the presence of round whitefish and sheefish in the Salmon Fork of the Black River in eastern interior Alaska.

Kramer, M.J. 1976a. Sport fish investigations of Alaska: Inventory and cataloging of interior Alaska waters, Tanana River drainage between the Little Delta River and mouth of Tanana River. Alaska Department of Fish and Game, Division of Sport Fish, Annual Performance Report, 1975-1976, Project F-9-8, Vol. 17, G-I-K, Juneau (Pages 1-21).

Kramer, M.J. 1976b. Sport fish investigations of Alaska: Inventory and cataloging of interior Alaska waters, Chandalar River drainage. Alaska Department of Fish and Game, Division of Sport Fish, Annual Performance Report, 1975-1976, Project F-9-8, Vol. 17, G-I-N, Juneau (Pages 117-128).

This report documents the fish fauna, including several whitefish species, in several lakes in the upper Chandalar River drainage.

Kretsinger, C. 1986. Stream inventory on Bonanza Creek, Alaska. U.S. Bureau of Land Management, Unpublished Report, Fairbanks (15 pages).

This report documents the presence of round whitefish in upstream reaches of two tributary streams in the upper Koyukuk River drainage.

Lindsey, C.C. 1962. Distinctions between the broad whitefish, *Coregonus nasus*, and other North American whitefishes. Journal of the Fisheries Research Board of Canada 19: 687-714.

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This article argued that the Alaska whitefish should be considered a species within the humpback whitefish complex.

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This article documented the presence of two forms of humpback whitefish in the same lake in the upper Yukon River drainage.

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Lindsey, C.C., and J.D. McPhail. 1986. Zoogeography of fishes in the Yukon and Mackenzie basins. Pages 639-674 *In* C.H. Hocutt, and E.O. Wiley (editors). The Zoogeography of North American Freshwater Fishes. John Wiley and Sons, New York.

This book chapter presents geological explanations for the current distributions of fish species in northwest Canada and Alaska.

Martin, D.J., D.R. Glass, C.J. Whitmus, C.A. Simenstad, D.A. Milward, E.C. Volk, M.L. Stevenson, P. Nunes, M. Savioe, and R.A. Grotefendt. 1986. Distribution, seasonal abundance, and feeding dependencies of juvenile salmon and non-salmonid fishes in the Yukon River delta. Envirosphere Company, Final Report for the Outer Continental Shelf Environmental Assessment Program, Research Unit 660.

Martin, D.J., C.J. Whitmus, L.E. Hachmeister, E.C. Volk, and S.L. Schroder. 1987. Distribution and seasonal abundance of juvenile salmon and other fishes in the Yukon River delta. Envirosphere Company, Final Report for the National Oceanic and Atmosphereic Administration and the Minerals Management Service, Contract No. 50-ABNC-6-00016.

This report documents a sampling and habitat assessment program in the Yukon River delta and the associated near-shore region of the Bering Sea. Juvenile whitefish were a major component of the sampling catch.

McCart, P.J., W. Griffiths, C. Gossen. 1974. Catalogue of lakes and streams in Canada along routes of the proposed Arctic gas pipeline from the Alaskan/Canadian border to the 60th parallel. Aquatic Environments Limited, Arctic Gas Biological Report Series, Vol. 16.

This report documents fish presence in many lakes and streams on the Beaufort Sea coast and in the Porcupine River drainage upstream from the Alaska Yukon Territory border.

McDermid, J.L., J.D. Reist, and R.A. Bodaly. 2005. Phylogeography and postglacial dispersal of whitefish (*Coregonus clupeaformis* complex) in Northwestern North America. Advances in Limnology 60:91-109.

This article seeks to clarify the taxonomic confusion surrounding the humpback whitefish complex in North America. The authors recommended that the three humpback whitefish forms, currently recognized as different species, be reclassified as different subspecies of lake whitefish Coregonus clupeaformis.

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This report discusses the occurrence and seasonal migrations of whitefish species in the Chandalar and Christian River drainages in interior Alaska.

McPhail, J.D. 1966. The *Coregonus autumnalis* complex in Alaska and northwestern Canada. Journal of the Fisheries Research Board of Canada 23: 141-148.

This article presents evidence in support of Bering cisco and Arctic cisco being considered distinct species.

McPhail, J.D., and C.C. Lindsey. 1970. Freshwater fishes of northwestern Canada and Alaska. Fisheries Research Board of Canada, Bulletin 173, Ottawa.

This is perhaps the most comprehensive and informative freshwater fish book currently available for northwest Canada and Alaska. Some of the taxonomy, life history, and distribution data is out of date.

Mecklenburg, C.W., T.A. Mecklenburg, and L.K. Thorsteinson. 2002. Fishes of Alaska. American Fisheries Society, Bethesda, MD.

This is a relatively new book of freshwater and marine fishes of Alaska. It contains very little life history information and does not add substantially to distribution or taxonomy data on freshwater fishes presented in previous fish books.

Mills, K.H., and R.J. Beamish. 1980. Comparison of fin-ray and scale age determinations for lake whitefish (*Coregonus clupeaformis*) and their implications for estimates of growth and annual survival. Canadian Journal of Fisheries and Aquatic Sciences 37:534-544.

Mills, K.H., S.M. Chalanchuk, D.J. Allan, and L.C. Mohr. 1995. Responses of lake whitefish (*Coregonus clupeaformis*) to exploitation at the experimental Lakes Area, northwestern Ontario. Advances in Limnology 46:361-368.

This article presents experimental evidence that brief periods of intensive exploitation of mature lake whitefish in small lakes stimulates growth without risking stock collapse.

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Mills, K.H., E.C. Gyselman, S.M. Chalanchuk, and D.J. Allan. 2004. Growth, annual survival, age and length frequencies for unexploited lake whitefish populations. Annales Zoologici Fennici 41:263-270.

This article documented the differences in growth and survival estimates that result from under-aging lake whitefish. The authors argue that under-aging whitefish populations result in over estimates of growth and under estimates of survival, which together can lead to over exploitation.

Mills, K.H., E.C. Gyselman, R.F. Tallman, and L. Johnson. 2005. Comparison of two harvest scenarios for lake whitefish (Coregonus clupeaformis) of the Chitty Lakes, Northwest Territories, Canada. Advances in Limnology 60:485-501.

This article presents the results of a series of experiments designed to determine appropriate exploitation rates for lake whitefish populations.

Mohr, L.C., and M.P. Ebener. 2005. Evaluation of two harvest policies for managing lake whitefish (*Coregonus clupeaformis*) populations in a Laurentian Great Lake, Lake Huron. Advances in Limnology 60:471-483.

This article compares two different methods of setting harvest limits for commercial fisheries using catch-at-age data and other measurable population parameters.

Morrow, J.E., E.W. Schallock, and G.E. Bergtold. 1977. Feeding by Alaska whitefish, *Coregonus nelsoni*, during the spawning run. Fisheries Bulletin 75(1): 234-235.

Most accounts of spawning behavior in whitefish species indicate that they do not feed during the spawning migration. This article provided evidence that this is not universally true.

Morrow, J.E. 1980. The freshwater fishes of Alaska. Alaska Northwest Publishing Company, Anchorage.

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Netsch, N.F. 1975. Fishery resources of waters along the route of the Trans-Alaska Pipeline between Yukon River and Atigun Pass, in north central Alaska. U.S. Fish and Wildlife Service, Resource Publication 124, Washington DC.

Normandeau, D.A. 1969. Life history and ecology of the round whitefish *Prosopium cylindraceum* (Pallas), of Newfound Lake, Bristol, New Hampshire. Transactions of the American Fisheries Society 98:7-13.

Osborne, B.M., and J.L. Melegari. 2006. Use of split-beam sonar to enumerate fall chum salmon in the Chandalar river, Yukon Flats National Wildlife Refuge, Alaska, 2001. U.S. Fish and Wildlife Service, Alaska Fisheries Data Series No. 2006-6.

While focused on chum salmon, this report discusses a newly discovered spawning migration of least cisco into the river.

Ott, A.G., and P.W. Scannell. 1996. Baseline fish and aquatic habitat data for Fort Knox Mine 1992 to 1995. Alaska Department of Fish and Game, Habitat and Restoration Division, Technical Report No. 96-5.

This report documents the presence of round whitefish in upper reaches of some small streams in the vicinity of the Fort Knox Mine site.

Ott, A.G., J.F. Winter, and A.H. Townsend. 1998. Juvenile fish use of selected habitats in the Tanana River near Fairbanks (preliminary report). Alaska Department of Fish and Game, Habitat and Restoration Division, Technical Report No. 97-1.

This sampling project documented small numbers of juvenile least cisco and round whitefish in the central Tanana River and some associated clearwater flows and backwater areas.

Pearse, G.A. 1976. Sport fish investigations of Alaska: inventory and cataloging of the sport fish and sport fish waters of interior Alaska, Tanana River drainage between Tok and Little Delta rivers. Alaska Department of Fish and Game, Division of Sport Fish, Annual Performance Report, 1975-1976, Project F-9-8, Vol. 17, G-I-L, Juneau (pages 23-68).

Pearse, G.A. 1978. Sport fish investigations of Alaska: inventory and cataloging of interior waters with emphasis on the upper Yukon and the Haul Road areas. Alaska Department of Fish and Game, Division of Sport Fish, Annual Performance Report, 1977-1978, Project F-9-10, Vol. 19, G-I-N, Juneau (pages 1-35).

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Peckham, R.D. 1976. Sport fish investigations of Alaska: inventory and cataloging of the sport fish and sport fish waters of interior Alaska, Delta River Drainage. Alaska Department of Fish and Game, Division of Sport Fish, Annual Performance Report, 1975-1976, Project F-9-8, Vol. 17, G-I-M, Juneau (pages 69-116).

Power, G. 1978. Fish population structure in Arctic lakes. Journal of the Fisheries Research Board of Canada 35:53-59.

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Regier, H.A., and D.S. Robson. Selectivity of gill nets, especially to lake whitefish. Journal of the Fisheries Research Board of Canada 23:423-454.

Reist, J.D., and W.A. Bond. 1988. Life history characteristics of migratory coregonids of the lower Mackenzie River, Northwest Territories, Canada. Finnish Fisheries Research 9: 133-144.

This article summarizes life history data gathered over many years from five anadromous whitefish species common to the Mackenzie River in northern Canada. The general life history principles introduce in this article appear to apply to the same or similar species that are present in the Yukon and Kuskokwim River drainages.

Reist, J.D., J. Vuorinen, and R.A. Bodaly. 1992. Genetic and morphological identification of coregonid hybrid fishes from Arctic Canada. Polskie Archiwum Hydrobiologii 39:551-561.

Rempel, L.L., and D.G. Smith. 1998. Postglacial fish dispersal from the Mississippi refuge to the Mackenzie River basin. Canadian Journal of Fisheries and Aquatic Sciences 55: 893-899.

Reynolds, J.B. 1997. Ecology of overwintering fishes in Alaskan freshwaters. Pages 281–302 *in* A.M. Milner, and M.W. Oswood, editors, Freshwaters of Alaska: ecological syntheses. Springer-Verlag New York, Inc., New York.

This book chapter describes many of the environmental conditions faced by northern freshwater fishes in the winter and discusses the adaptations fish have developed to survive.

Riffe, R.R. 1992. Abundance, length, and age composition of Chatanika River round whitefish, 1991. Alaska Department of Fish and Game, Fishery Data Series No. 92-19.

Roach, S.M. 1996. Influence of electrofishing on the survival of Arctic grayling, chinook salmon, least cisco, and humpback whitefish eggs. Alaska Department of Fish and Game, Fishery Manuscript No. 96-1.

Robson, D.S., and D.G. Chapman. 1961. Catch curves and mortality rates. Transactions of the American Fisheries Society 90:181-189.

Roguski, E.A., and C.E. Spetz. 1968. Sport fish investigations of Alaska: inventory and cataloging of the sport fish and sport fish waters in the interior of Alaska. Alaska Department of Fish and Game, Annual Performance Report, 1967-1968, Project F-5-R-9, Vol. 9, Juneau (pages 265-285).

This report presents fish sampling data from numerous lakes and streams south of the Brooks Range in interior Alaska.

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